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ANALYSIS OF SHIP SERVICES PERFORMANCE AT THE KOJA CONTAINER TERMINAL QUAY

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Abstract: The purpose of this research is to analyze the ship's service time which will affect the ship's queue and ship operational performance using FVFS queue analysis and calculation guidelines set by the Regulation of The Director General Of Sea Transportation: HK 103/2/2/DJPL-17 Concerning Guidelines For Calculating Port Operational Service Performance. Then, the achievements of ship and goods services performance at the koja container terminal compared to the standards set by the director general of sea transportation on operational service performance standards The results of operational performance achievements at the Koja Container Terminal compared to the Port Operational Service Performance Standards are almost all indicators are considered good. ET:BT is considered quite good and the achievements for B/C/H, B/S/H, and BOR are considered good.

Keywords: *Queue, Port Operational Service Performance, Container Terminal, Waiting Time, Ship Service Time*

1. INTRODUCTION

Indonesia is an archipelagic country that has thousands of islands from Sabang to Meruke. In 2021, there were 17,000 islands in Indonesia. "Previously in 2020, the Gazeter of the Republic of Indonesia was recorded as many as 16,771 islands. With this number, there will be an addition of 229 islands from the study in 2021." (Indonesiabaik.id, 2021, Para.2). With thousands of islands in Indonesia, a mode is needed that can reach mobility from one island to another.

Sea transportation is a vital means for the Indonesian economy in the trade sector, both national and international trade. Coinciding with this, sea transportation is a mode that needed to provides the mobility that support fast, safe, comfortable and capacity-based movements.

Ports play an important role in driving the economy of regions that depend on sea transportation. Several indicators related to sea port activity can give an idea of the development of the marine transportation industry. The port is a link in the sea transportation chain in Indonesia. The port is also an interface, which is a place to move cargo from sea transportation modes to other transportation. Ports have a very crucial role in the transfer of cargo. The transfer of the load must be carried out as quickly and efficiently as possible, without neglecting the aspect of address.

One of the Container Terminals located at Tanjung Priok Port that has a busy flow of ship

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visits is the Koja Container Terminal. Koja Container Terminal is the result of Operation Cooperation (KSO) between State-Owned Enterprise PT Pelindo II Tanjung Priok and PT. Hutchison Port Holding. The Koja Container Terminal, operating since 1998, has contributed to Indonesia's economic growth moving through the provision of services that include loading and unloading services and container stacking. Ship loading and unloading activities will affect the queue of ships entering and leaving the port.

The loading and unloading process is often delayed due to various factors such as the ship docking process is not carried out on time, lack of coordination of the loading and unloading process and ship cranes as an inefficient loading and unloading tool. In fact, one of the important activities of the Koja container terminal dock is ship service, which is part of the bething process that affects the number of ships entering or leaving the port.

Based on ship visit data at the Koja Container Terminal Pier from January to December of the 2022 period, it can be seen that August is the busiest month with ship visits reaching 57 ships. In such a situation, the ship can wait a long time to get service. Seeing the existing conditions and understanding the importance of more optimal service, it is necessary to improve operating services at the Koja container terminal dock which will affect ship queues and ship operational performance at the Koja Container Terminal Pier.

2. RESEARCH METHOD

Port performance can be used to determine the level of port service (ship and cargo), depending on how long a ship has been in port. The high performance of the port shows that the port provides good service. By knowing these standards, plans can be made to improve or add port facilities. (Pahala et al., 2018)

Queuing theory is queuing theory is a mathematical way to measure queue lines (Hutapea, 2011). According to (Kuznetsov et al., 2020), Ships arriving at the port will dock to any mooring, but when all moorings are occupied, the ship will enter the queue outside the dock and wait until there is an empty mooring. Service quality is usually estimated by queue length, and the operating efficiency of the system is judged by the average service time of vessels in the system – in this case ship turnaround time, and its relative lead time. Each server is characterized by job handling time. A ship can enter a queue when: 1) when guidelines are occupied, 2) when no moorings are empty, 3) Busy docks.

This study aims to analyze the ship queuing system at the KOJA container terminal for one year of work. To find out the performance of ship services at the Koja Container Terminal. After knowing how the performance of these services will be obtained the value of performance measures in each service that occurs. The steps taken in this study are as follows: 1) Conduct a literature study or literature study on the description of problems faced by the Koja Container Terminal, 2) Conduct a literature study or literature study on the research topic, namely operational service performance, 3) Determine the limits of research, namely on ships and docks, 4)Collecting data from research subjects needed in analyzing ship performance at container terminals, 5) Processing and analyzing research data using so as to obtain a technical

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picture of the various indicators needed to evaluate the performance of ship services at the Koja Container Terminal, 6) Take conclusions and suggestions from the results obtained in the process of evaluating ship service performance at the Koja Container Terminal.

2.1 Ship's Waiting Time (Queuing Theory)

To calculate the waiting time for ships in the service system at the Koja Container Terminal Pier using queuing discipline in accordance with the characteristics of service at the Koja Container Terminal, namely assuming First Vacant First Served (FVFS). This assumption means that there is only one queue (single lane) where ships in the front queue will be served by a vacant first place of service. According to (Ofyar Z Tamin, 2008) queuing system with FVFS has the formula:

1) Chance of conditions where there are no ships in the queuing system (P0)

$$P_0 = \frac{1}{[\sum_{n=0}^{K-1} \frac{1}{n!}(\frac{\lambda}{\mu})^n] + \frac{1}{K!}{}_M \frac{K\mu}{K\mu-\lambda}} \; for\; M\mu > \lambda$$

2) Average number of ships in the system ($\bar{n}$)

$$\bar{n} = \frac{\lambda\mu(\frac{\lambda}{\mu})^K}{(K-1)!\,(K\mu-\lambda)^2} P_0 + \frac{\lambda}{\mu}$$

3) Average number of ships in queue ($\bar{q}$)

$$\bar{q} = \frac{\lambda\mu(\frac{\lambda}{\mu})^K}{(K-1)!\,(K\mu-\lambda)^2} P_0 = \bar{n} - \frac{\lambda}{\mu}$$

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4) Average time spent by ships in the system ($\bar{d}$)

$$\bar{d} = \frac{\mu(\frac{\lambda}{\mu})^K}{(K-1)!\,(K\mu-\lambda)^2}\,P_0 + \frac{1}{\mu}$$

5) Average time ship's waiting time in queue ($\bar{w}$)

$$\bar{w} = \frac{\mu(\frac{\lambda}{\mu})^K}{(K-1)!\,(K\mu-\lambda)^2}\,P_0 = \bar{d} - \frac{1}{\mu}$$

Note :

K : Number of services (moorings)
$\boldsymbol{\lambda}$: Ship arrival rate per unit
μ : Ship service rate per unit
P_0 : Probability of no (0) ship in the system
$\bar{n}$: Average number of ships in the system
$\bar{q}$: Average number of ships in queue
$\bar{d}$: Average time spent by ships in the system
$\bar{w}$: Average time ship's waiting time in queue

2.2 Ship Services Performance

To calculate ship services performance using calculation guidelines set by the Regulation of The Director General Of Sea Transportation (Regulation of The Director General Of Sea Transportation: HK 103/2/2/DJPL-17 Concerning Guidelines For Calculating Port Operational Service Performance,2017)

1) Ship Service Performance (Service Time At The Mooring)

a. Berthing Time

BT = Berth Working Time – Not Operation Time

$$\text{BT} = \frac{\text{Annual Average of Ship Mooring Time}}{\text{Annual Ship Visit}}$$

b. Berth Working Time

$$\text{BWT} = \frac{\text{Annual Loading and Unloading Working Time}}{\text{Annual Ship Visit}}$$

c. Not Operation Time

NOT = Berthing Time – Berth Working Time

d. Effective Time

$$\text{ET} = \frac{\text{Annual Effective Work Time}}{\text{Annual Ship Visit}}$$

ET = Berth Working Time – Idle Time

e. Idle Time

IT = Berth Working Time (BWT) – Effective Time (ET)

f. Effective Time : Berthing Time

$$\text{ET/BT} = \frac{\text{Effective Time (ET)}}{\text{Berthing Time (BT)}} \text{ X } 100\%$$

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g. Turn Round Time

TRT = Waiting Time (WT) + Berthing Time (BT)

2) Loading And Unloading Service Performance

a. Box/Ship/Working Hour

$$= \frac{\text{Annual Average of loading and unloading per ship}}{\text{Annual Average of Loading and Unloading Working Time}}$$

b. Box/Ship/Hour at Berth

$$= = \frac{\text{Annual Average of loading and unloading per ship}}{\text{Berthing Time}}$$

c. Box/Crane/Hour

$$= \frac{\text{Annual Average of Total Loading and Unloading per ship / Crane Intensity}}{\text{Annual Average of Loading and Unloading Working Time } x\ Crane\ intensity}$$

3) Facility Utilization Performance

a. Berth Occupancy Ratio

$$\text{BOR} = \frac{(\text{LOA}+5) \times \text{number of ships} \times \text{BT}}{\text{L} \times \text{Tt}} \text{ x } 100\%$$

Note :

LOA : Length over all (meter)

5 : Safe distance between ships (meter)

Number of ships : Number of annual ships visit

BT : Berthing Time

Tt : Operational Service Time of docks in one range time. For review in 1 Year is 24 x 365

b. Berth Through-put

$$= \frac{\text{Total Throughput per year}}{\text{Total Length of Quay}}$$

3. RESULTS AND DISCUSSION

3.1 Ship Wating Time

Tabel 3.1 Ship Service Time in 2022

Month	**Ship Visit**	**Ship Service Time**
January	45	910,44
February	39	963,47
March	48	832,53
April	47	1746,02
May	38	784,86
June	50	921,15
July	52	1056,98
August	57	1042,36
September	50	820,7

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October	40	951,63
November	46	1082,9
December	46	888,12
TOTAL	558	12001,16

Services at Koja Container Terminal are using First Vacant First Served (FVFS) discipline with the Queue Model and kendal notation is M/M/3 which means the dock has 3 moorings and there is only one queue (single phase) where ships in the front queue will be served by a vacant first place of service. The number of container ship arrivals in 2022 is 558 ships with a total of 351 working days and the average service time of container ships (WP) is 21.51 hours.

The results of the calculation of the average number of container ship arrivals is $\boldsymbol{\lambda} = \frac{558}{351}$ = 1,59 ships per day and service level $\mu = \frac{21,51}{24}$ = 0,896 day. So the calculation for ship's waiting time are :

$\overline{w} = \frac{0,896\,(\frac{1,59}{0,896})^3}{(3-1)!\,(3 \times 0,896-1,59)^2} \times 0,173$ = 0.288 days or equivalent to 6.9 hours

So, the waiting time that one ship spends in a queue is 0.288 days or 6.9 hours.

3.2 Ship Services Performance (Service Time At The Mooring)

Service time at the

Tabel 3.2 Service Time at The Mooring in 2022

Month	Ship's Visit	Ship Mooring Time	Loading and Unloading Working Time (hour)	Effective Work Time
January	45	910,44	816,21	816,21
February	39	963,47	675,42	675,42
March	48	832,53	717,72	717,72
April	47	1746,02	905,94	905,94
May	38	784,86	675,77	675,77
June	50	921,15	808,42	808,42
July	52	1056,98	934,49	934,49
August	57	1042,36	905,82	905,82
September	50	820,7	688,81	688,81
October	40	951,63	839,57	839,57
November	46	1082,9	925,95	925,95
December	46	888,12	765,16	765,16

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a. Berthing time

$$BT = \frac{\text{Annual Average of Ship Mooring Time}}{\text{Annual Ship Visit}}$$

$$BT = \frac{12001{,}16 \text{ hour}}{558 \text{ ship}} = 21{,}51 \text{ hour/ship}$$

b. Berth working time

$$BWT = \frac{\text{Annual Loading and Unloading Working Time}}{\text{Annual Ship Visit}}$$

$$BWT = \frac{9659{,}28 \text{ hour}}{558 \; ship} = 17{,}31 \text{ hour/ship}$$

c. Not operation time

NOT = Berthing Time – Berth Working Time

NOT = 21,51 hour – 17,31 hour = 4,2 hour

d. Effective time

$$ET = \frac{\text{Annual Effective Work Time}}{\text{Annual Ship Visit}}$$

$$ET = \frac{9659{,}28 \text{ hour}}{558 \text{ ship}} = 17{,}31 \text{ hour/ship}$$

e. Idle time

IT = Berth Working Time (BWT) – Effective Time (ET)

IT = 17,31 hour – 17,31 hour = 0 .

f. Effetive time : berthing time (ET:BT%)

$$ET : BT = \frac{\text{Effective Time (ET)}}{\text{Berthing Time (BT)}} \text{X } 100\%$$

$$ET : BT = \frac{17{,}31 \text{ ship/hour}}{21{,}51 \text{ ship/hour}} \text{X } 100\%$$

$$ET : BT = 80{,}47\%$$

g. Turn Round Time

TRT = Waiting Time + Berthing Time

TRT = 6,9 hour + 21,51 hour = 28,41 hour

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3.3 Loading and Unloading Service Performance

Tabel 3.3 Loading and Unloading in 2022

Month	Ship Visit	Boxes	Loading and Unloading per Ship	Crane Intensity	Total Loading and Unloading per ship / Crane Intensity
January	45	50.484	1122	2,5	449
February	39	44.114	1131	2,5	452
March	48	50.114	1044	2,5	418
April	47	53.934	1148	2,5	459
May	38	47.884	1260	2,5	504
June	50	53.271	1065	2,5	426
July	52	52.990	1019	2,5	408
August	57	52.404	919	2,5	368
September	50	43.053	861	2,5	344
October	40	47.154	1179	2,5	472
November	46	50.115	1089	2,5	436
December	46	45.904	998	2,5	399

a. Box/Ship/Working hour

Box/Ship/Working Hour

$$= \frac{\text{Annual Average of loading and unloading per ship}}{\text{Annual Average of Loading and Unloading Working Time}}$$

$$= \frac{1.070\ \text{Box/Ship}}{17{,}31\ \text{Hour}} = 62\ \text{box/ship/working hour}$$

b. Box/Ship/Hour at berth

$$\text{B/S/H} = \frac{\text{Annual Average of loading and unloading per ship}}{\text{Berthing Time}}$$

$$\text{B/S/H} = \frac{1.070\ \text{Box/Ship}}{21{,}51\ \text{hour}} = 49\ \textit{Box / Ship / Hour}$$

c. Box/Crane/Hour

$$\text{B/C/H} = \frac{\text{Annual Average of Total Loading and Unloading per ship / Crane Intensity}}{\text{Annual Average of Loading and Unloading Working Time}\ \ x\ Crane\ intensity}$$

$$\text{B/C/H} = \frac{1070}{17{,}31\ \text{hour x}\ 2{,}5} = 25\ \text{Box/Crane/Hour}$$

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3.4 Facility utilization performance

Tabel 3.4 Ship Visit Data in 2022

Month	**Ship Visit**	**LOA**	**Berthing Time**	**Ship Production (TEUS)**
January	45	176	910,44	76.904
February	39	175	963,47	67.723
March	48	166	832,53	75.947
April	47	177	1746,02	80.522
May	38	179	784,86	72.815
June	50	167	921,15	80.309
July	52	170	1056,98	79.766
August	57	159	1042,36	79.565
September	50	154	820,7	66.538
October	40	183	951,63	72.542
November	46	168	1082,9	77.045
December	46	166	888,12	70.244

a. Berth Occupancy Ratio

$$BOR = \frac{((170+5)\times 558 \times 21{,}51}{630 \times 24 \times 365} \times 100$$

$$BOR = \frac{2.100.451{,}5}{5.518.800} \times 100\% = 38{,}06\ \%$$

b. Berth Throughput

$$BTP = \frac{\text{Total Throughput per year}}{\text{Total Length of Quay}}$$

$$BTP = \frac{899920}{630} = 1428 \text{ teus /m/year}$$

3.5 Comparison of The Achievements Of Ship And Goods Services At The Koja Container Terminal With The Standards Set By The Director General Of Sea Transportation On Operational Service Performance Standards

Tabel 3.5 Achievement Comparison

Variable	Achievement	Standards Set By The Director General Of Sea Transportation	Level of Achievement (%)	Valuation
ET : BT%	80%	85%	94,12%	Quite Good
	25 Box/Crane/Hour	25 Box/Crane/Hour	100%	Good

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Box Crane Hour (BCH)				
Box Ship Hour (BSH)	49 Box/Crane/Hour	50 Box/Ship/Hour	98%	Good
Berth Occupancy Ratio (BOR)	38,06%	70%	54,37%	Less Than Optimal

The Koja Container Terminal achievemnt then compare to the standards set by the director of general Of Sea transportation (Regulation of The Director General Of Sea Transportation: Number *: HK.103/2/18/DJPL-16,* 2016) for ET : BT (%), Box/Crane/Hour, Box/Ship/Hour, and Berth Occupancy Ratio.

The realization of the ET:BT ratio from January 2022 to December 2022 at the Koja Container Terminal was 80%. This figure shows that the achievement level has reached 94.1% of the results set from the Standard Of The Director General No: Hk.103/2/18/Djpl-16, which is 85%. If the achievement value is 90% to 100% of the standard value of operational service performance set, it is considered quite good. This is due to the working time of the ship that has not been aligned with the ship's mooring time, another influencing factor is the ability of different loading and unloading tools so that the productivity of working time is reduced.

The realization of the productivity of container crane loading and unloading equipment (Box Crane Hour) at the Koja Container Terminal from January 2022 to December 2022 is 25 B/C/H. This figure shows that the Koja Container Terminal has reached the standard set by the Regulation of the Director General of Sea Transportation, which is 25 B/C/H, therefore the results of the productivity assessment of container crane loading and unloading equipment at the Koja Container Terminal have been achieve standards and can be categorized and declared GOOD. This is due to the influence of tool utilization, loading and unloading work time and crane intensity owned by the Koja Container Terminal which is well prepared.

The realization of the ship's loading and unloading movement (Box Ship Hour) at the Koja Container Terminal for the 2022 period is 49 B/S/H, when compared to the performance standard set by the Director General of Sea Transportation for the Koja Container Terminal is 50 B/C/H, therefore the results of the assessment of the ship's loading and unloading speed at the Koja Container Terminal almost reach the standard and can be categorized and declared GOOD.

The realization of Berth Occupancy Ratio (BOR) at the Koja Container Terminal in the 2022 Period is 38.51%, when compared to the performance standard set by the Director General for the Koja Container Terminal is 70%. Therefore, the BOR value of the Koja Container Terminal is below the value of service performance standards so that the assessment referring to the standards set is Less than Optimal. This is because the BOR value is below 70%, which means that the dock still has the ability to serve if there are

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additional ships that want to mooring. There must be consideration to increase the length of the pier so that it will reduce the waiting time.

4. Conclusion

1. The average time spent by a container ship waiting for service in a queue (Waiting Time) is 0.288 days or 6.9 hours
2. Ship Service Performance at the Koja Container Terminal, namely BT is 21.51 hours per ship, BWT is 17.31 hours per ship, NOT is 4.2 hours, ET is 17.31 hours per ship, Idle Time is 0 hours. The ratio of Effective time : Berthing time is 80.47%, and Turn Round Time is 28.41 hours.
3. Loading and Unloading Service Performance at the Koja Container Terminal for B/S/Workng Hour is 62 boxes/ship/working hour, B/S/H is 49 boxes/ship/ and B/C/H is 25 Box/Crane/Hour
4. Facility Utilization Performance of Koja Container Terminal for Berth Occupancy Ratio/ BOR utilization rate is 38.06% and loading and unloading productivity for Berth Through-put / BTP is 1428 TEUs / M / year
5. The results of operational performance achievements at the Koja Container Terminal are compared to the Port Operational Service Performance Standards of the Director General NO: HK.103/2/18/DJPL-16 with the realization of ET: BT achievements are 80% considered quite good, B/C/H of 25 Box/Crane/Hour is considered good and B/S/H of 49 boxes/crane/hour and the Berth Occupancy Ratio (BOR) is less than optimal with the realization of achievements of 38.06%.

5. Research limitations

1. The service performance review scale is only specialized in:
   a. Waiting time for ship service using a queuing system
   b. The current performance of the vessel reviewed is the service time at mooring
   c. Loading and unloading current performance
   d. The performance of port facilities and supporting facilities reviewed is the utilization rate of dock facilities (Berth Occupancy Ratio / BOR)
   e. Comparison of operational performance achievements only on
2. One year of service (2022)
3. Review of the utility structure of the tool is not discussed

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