ANALYSIS OF SHIP QUEUES AND OPTIMIZATION STRATEGIES OF BERTHING OCCUPANCY RATE

Melliana[1], Sirlyana[2], Azmi[3], Sanco Simanullang[4], Juni Saputra[5,] Anugrah Tri Pambudi[6]

Industrial Engineering Study Program, Sekolah Tinggi Teknologi Dumai, Dumai, Indonesia

Correspondence: Juni S. E-mail: junisaputr4@gmail.com

Abstract

PT For PT XYZ, operating a jetty effectively and efficiently is not easy because there are many phenomena that often occur during ship operational activities. One of them is the high queue of ships and the Berthing Occupancy Rate. The aim of this research is to analyze the characteristics of queues and berthing occupancy rates in the form of simulation results of ship queues at PT XYZ and design improvement scenarios with the help of Arena software. The results of the simulation test can be concluded that the existing utilization of jetty 1 reached 97%, above the limit set by the company, namely <70%. Improvements made according to the results of the arena simulation analysis are the addition of 1 server/jetty to accommodate the arrival of Large Range ships, so that the addition of 1 server/jetty will reduce the waiting time from the real average waiting time of 30.18 hours by adding 1 server. /jetty waiting time is an average of 7.54 hours. So, these improvements can help companies to minimize the queue time for cargo entry so that the processing process can be optimal.

Keywords: Queue, Berthing Occupancy Rate, Simulation, Software Arena.

1. Introduction

PT For PT XYZ operating a jetty effectively and efficiently is not easy. Many phenomena often occur during ship operational activities. One of them is the high Integrated Port Time (IPT), namely the ship's time from before the ship docks until the ship leaves the jetty. This raise concerns that port performance is not optimal, of course this results in ship waiting times or ship queues and the capacity of ship loading and unloading services at the dock or berthing occupancy rates increasing.

Table 1. Integrated Port Time and Berthing Occupancy Rate at Jetty 1 and Jetty 2 PT XYZ in 2024

No.	Period	*Jetty* 1		*Jetty* 2	
		Berthing Occupancy Rate (%)	Average IPT (O'clock)	*Berthing Occupancy Rate* (%)	Average IPT (O'clock)
1	January	52,99	474,10	56,06	554,70
2	February	52,62	453,10	66,04	523,83
3	March	57,73	771,90	64,17	380,23
4	April	65,60	706,00	73,69	803,83
5	Mai	71,35	853,57	56,06	554,70
6	June	43,38	549,53	61,19	803,83
7	July	89,05	1.401,55	73,09	523,83
8	August	69,27	741,60	58,48	554,70
9	September	75,29	1.387,20	61,64	523,83
10	October	74,77	1.045,75	82,95	554,70
11	November	82,89	1.401,50	59,80	803,83
12	December	65,72	1.006,77	73,09	523,83
	Amount	800,67	10.792,57	786,27	7.105,87
	Average	66,72	899,38	65,52	592,16

Source: PT XYZ, 2025

Table 1 shows that the IPT and BOR at PT XYZ have increased every month, resulting in an increase in the non-operational schedule. In the process of loading and unloading each ship, it should take 2 days but can take up to 2 days and can also take more than 3 days, because there are too many ships that have to be served by the dock, so the operational performance of the existing officers is lacking. good at managing performance.

Queuing is a problem that occurs when the number of customers is greater than the number of resources available for the service, causing customers to wait before being served. This problem can cause losses if no corrective solution is found. One thing that can influence this is reduced customer loyalty due to waiting times that are too long before service. If customers have to wait before being served, then customers will form a queue and stay in line until it is their turn to be served. Customers will be served with a constant or varying service rate and then eventually leave the system. The queuing system includes both queues and existing service facilities. Thus, the resulting queues can influence customer activity and the company strives to maintain customer loyalty by providing fast service.

Based on the descriptin on of the background above, the problem formulation is how to analyze ship queues and optimization strategies for the Berthing Occupancy Rate at the PT XYZ Dumai jetty.

2. Literature Review

Queuing is a situation where a group of people who need services have to wait in a certain line before finally getting service [1]. Queuing theory is a branch of Operation Research because the results of queuing theory use optimization methods to get optimum results. Hospitals are an example of applying queuing theory to life [2]. Container stacking allocation planning has a big influence on minimizing ship berthing time and terminal operational costs. The stacking yard allocation model aims to reduce the distance traveled by trucks in loading activities and balance the number in each block [3]. Efforts to resolve this problem use evaluation and optimization methods in planning the allocation of container stacking yards [4].

Queues are an important part of operations management in both the service and industrial sectors. In everyday life, very long queue systems are often found [5]. Determining the number of service servers is the right thing to overcome customer queue problems [6]. The method used in this research is simulation, where this simulation is supported by Promodel software to determine the level of facility usability by adding one simulated service server [7]. The timeliness of the distribution process is influenced by the smoothness of a good distribution service process with the support of a good service system. The number of vehicle arrivals still exceeds the capacity of the loading process service [8].

A queue is a collection of processes and mechanisms in a system that are related to the order (priority) carried out by the system [9]. The main actors in a queuing situation are customers and servers. The queuing process can be implemented using several systems, including Multi Queue Multi Channel [10]. The queuing system is the result of the development of queuing theory, which regulates services according to arrival to achieve effective and efficient performance, as a solution to the queuing problem [11]. Elements of the queuing system [11]:

a. Entities and Attributes
b. Activity and Delay
c. Resources and Control

Berthing Occupancy Rate

Berthing Occupancy Ratio is the ratio or percentage of dock usage at a port during a certain time period [12]. This ratio measures the extent to which the dock is used or occupied by anchored ships. BOR is usually calculated by comparing the total time the ship is berthed with the total time available at the dock [13].

Optimization

Definition of Optimization According to the Big Indonesian Dictionary (2012) Optimization is derived from the basic word optimal which means best, highest, most profitable, making the best, making the highest, optimizing the process, method, act of optimizing (making the best, highest, and so on) so that optimization is an action, process, or methodology to make something (as a design, system, or decision) more/fully perfect, functional, or more effective [14].

Berthing Time

Berthing Time is the time used while mooring at the pier to carry out loading and unloading activities which is calculated from the time the first rope is tied to the last mooring rope from the pier [15].

The indicators that influence Berthing Time consist of [16]:

a. Approach Time or piloting service time is the amount of time used for the ship to move from the anchor location until the rope is tied at the mooring.
b. Effective Time is the effective amount of time used to carry out loading and unloading activities while the ship is moored.
c. Idle Time is time that is ineffective or unproductive or wasted while a ship is moored due to the influence of weather and damaged loading and unloading equipment.
d. Not Operation Time is the pause time, the planned stopping time while the ship is in port.
e. Berth Time is the mooring time from the first line to the last line.
f. Berth Occupancy Rate or level of pier usage is a comparison between the time the pier is used and the time available (the pier is ready for operation) in a certain time period expressed as a percentage.
g. Turnaround time is the arrival time of the ship at anchor at the pier and the ship's departure time after carrying out loading and unloading activities (TA to TD).
h. Postpone Time is the waiting time caused by administration at the port (document processing). Berth Working Time is the time for loading and unloading activities while the ship is at the berth/pier.

2.5 Simulation

Simulation is the application or practice of building models that represent real systems or predict the future or experiment on models, which are used to study system behavior, improve system performance, or design new systems with specified dimensions [17].

2.6 Arena Software

Arena is a tool that is often used by management in studying or analyzing the work behavior of a system or process. Arena Software is software that contains interchangeable templates and alternative graphical and analytical simulation models that can be combined to create simulation models of quite wide and varied sizes. Queuing Theory and Arena Software are used to analyze existing Queues [18]. From this, an optimal Queue model can be developed based on the results of the analysis of Queue theory and Arena Software [19].

3. Research Methods

This research was conducted at PT XYZ which is located on Jalan Raya Kilang Putri Tujuh, Tanjung Palas, Dumai. The time of the research was carried out from October 2024 to February 2025. The population and sample in this study was the number of ships that were unloaded in October 2023 at PT XYZ Dumai. The types and sources of data used in this research consist of secondary data which includes actual data on ships entering in October 2024 which contains data on ship entry and exit times, unloading, as well as secondary data including literature, the internet, journals and other related sources. closely related to this research.

To reduce waiting time in ship queues, the research chose to use the queuing method with Arena software, namely:

1. Counting incoming ships.
2. Calculate the time between ship arrivals, processing or service time.
3. Carry out a uniformity test
4. Carry out data distribution tests and create Arena simulation designs and models.
5. Verify and validate the simulation model.
6. Carry out improvement analysis.

4. Results and Discussion

4.1 Time Between Ship Arrivals

The observation data examined by the author is the actual data on the arrival time of tankers in October 2024, especially at jetty 1 and jetty 2 which can be seen in Table 2 and Table 3.

Table 2. Observation Data and Calculation of Time Between Arrivals of Jetty 1 Ships

No.	Boat	Cargo	Ship Arrival		Time (Hours)
			Date	(Hours)	
1	MT SHIP TRINITY	Solar	28/09/2024	16:00	0,00
2	MT SUCCESS PEGASUS XXXV	Solar	28/09/2024	21:00	5,00
3	MT DOUBLE SEVEN	Buco	03/10/2024	19:30	118,50
4	MT NEW BRIGHT	LBO	04/10/2024	04:28	8,97
5	MT EMMANUEL	Buco	05/10/2024	19:30	39,03
6	MT DEEP BLUE	Buco	06/10/2024	05:30	10,00
7	MT SHIP TRINITY	Solar	06/10/2024	13:00	7,50
8	MT GAMALAMA	Buco	07/10/2024	17:36	28,60
9	MT DOUBLE SEVEN	Buco	11/10/2024	12:54	91,30
10	MT OVERSEAS	Solar	13/10/2024	03:00	38,10
11	MT GLOBAL TOP	Solar	13/10/2024	21:18	18,30
12	MT NECTAR	Solar	15/10/2024	14:30	41,20
13	MT SHAN CHI	Buco	18/10/2024	10:30	68,00
14	MT BRITISH SAILOR	LSFO	18/10/2024	17:30	7,00
15	MT ALPHA POINT	Buco	19/10/2024	14:42	21,20
16	OVERSEAS PETROMAR	Solar	24/10/2024	10:18	115,60
17	MT DOUBLE SEVEN	Buco	24/10/2024	12:06	1,80
18	MT SHIP TRINITY	Solar	26/10/2024	03:00	38,90
19	MT SUCCESS PEGASUS XXXV	Solar	26/10/2024	09:06	6,10
20	MT GLOBAL TOP	Solar	29/10/2024	18:24	81,30

Source: Data Processing, 2025

Table 3. Observation Data and Calculation of Time Between Arrivals of Jetty 2 Ships

No.	Boat	Cargo	Ship Arrival		Time (Hours)
			Date	(Hours)	
1	OB PATRA 2301	Solar	29/09/2024	16:00	0,00
2	OB PATRA 2302	Solar	01/10/2024	05:30	37,50

3	SPOB SULTAN SAMUDERA	Solar	01/10/2024	16:30	11,00
4	OB PATRA 2303	Pertalite	04/10/2024	14:42	70,20
5	OB PATRA 2303	Pertalite	06/10/2024	13:42	47,00
6	OB PATRA 2301	Solar	07/10/2024	21:48	32,10
7	OB PATRA 2302	Solar	08/10/2024	20:30	22,70
8	OB PATRA 2303	Pertalite	11/10/2024	21:12	72,70
9	SPOB SULTAN SAMUDERA	Pertalite	12/10/2024	00:36	3,40
10	OB PATRA 2301	Solar	15/10/2024	02:48	74,20
11	OB PATRA 2302	Pertalite	16/10/2024	04:18	25,50
12	SPOB SULTAN SAMUDERA	Pertalite	20/10/2024	12:48	104,50
13	OB PATRA 2301	Solar	22/10/2024	05:00	40,20
14	OB PATRA 2302	Solar	23/10/2024	12:18	31,30
15	OB PATRA 2303	Pertalite	24/10/2024	10:36	22,30
16	SPOB SULTAN SAMUDERA	Pertalite	25/10/2024	20:48	34,20
17	OB PATRA 2301	Solar	28/10/2024	15:00	66,20

Source: Data Processing, 2025

4.2 Ship Service Processing Time

The calculation results of the ship service process time in October 2024 at PT XYZ Dumai at jetty 1 can be seen in Table 4 and Table 5.

Table 4. Calculation of Ship Service Processing Time at Jetty 1

No.	Boat	Cargo	Rest		Free		Processing Time Service (Hours)
			Date	Hours	Date	Hours	
1	MT SHIP TRINITY	Solar	29/09/2024	19:24	01/10/2024	03:00	31,60
2	MT SUCCESS PEGASUS XXXV	Solar	01/10/2024	21:00	03/10/2024	10:12	37,20
3	MT DOUBLE SEVEN	Buco	03/10/2024	23:00	04/10/2024	20:00	21,00
4	MT NEW BRIGHT	LBO	04/10/2024	21:18	05/10/2024	19:06	21,80
5	MT EMMANUEL	Buco	05/10/2024	20:06	07/10/2024	15:30	43,40
6	MT DEEP BLUE	Buco	07/10/2024	16:36	09/10/2024	19:12	50,60
7	MT SHIP TRINITY	Solar	09/10/2024	20:18	11/10/2024	03:12	30,90
8	MT GAMALAMA	Buco	11/10/2024	04:24	12/10/2024	11:36	31,20
9	MT DOUBLE SEVEN	Buco	12/10/2024	12:36	13/10/2024	17:30	28,90
10	MT OVERSEAS PETROMAR	Solar	13/10/2024	22:42	15/10/2024	00:42	26,00
11	MT GLOBAL TOP	Solar	15/10/2024	14:12	17/10/2024	04:24	38,20
12	MT NECTAR	Solar	17/10/2024	12:06	18/10/2024	15:18	27,20
13	MT SHAN CHI	Buco	18/10/2024	23:12	20/10/2024	01:30	26,30
14	MT BRITISH SAILOR	LSFO	20/10/2024	02:30	22/10/2024	00:18	45,80
15	MT ALPHA POINT	Buco	22/10/2024	01:12	23/10/2024	01:30	24,30
16	OVERSEAS PETROMAR	Solar	23/10/2024	02:36	24/10/2024	15:18	36,70
17	MT DOUBLE SEVEN	Buco	25/10/2024	15:12	27/10/2024	21:12	54,00
18	MT SHIP TRINITY	Solar	27/10/2024	06:12	28/10/2024	14:12	32,00
19	MT SUCCESS PEGASUS XXXV	Solar	28/10/2024	15:18	30/10/2024	05:18	38,00
20	MT GLOBAL TOP	Solar	30/10/2024	06:24	31/10/2024	12:42	30,30

Source: Data Processing, 2025

Table 4. Calculation of Ship Service Processing Time at Jetty 2

No.	Boat	Cargo	Rest		Free		Processing Time Service (Hours)
			Date	Hours	Date	Hours	
1	OB PATRA 2301	Solar	01/10/2024	06:24	02/10/2024	05:42	23,30
2	OB PATRA 2302	Solar	02/10/2024	06:18	03/10/2024	05:24	23,10
3	SPOB SULTAN SAMUDERA	Solar	03/10/2024	21:36	04/10/2024	19:18	21,70
4	OB PATRA 2303	Pertalite	04/10/2024	19:42	06/10/2024	16:42	45,00
5	OB PATRA 2303	Pertalite	06/10/2024	19:42	07/10/2024	19:42	24,00
6	OB PATRA 2301	Solar	08/10/2024	11:36	09/10/2024	09:06	21,50
7	OB PATRA 2302	Solar	10/10/2024	05:36	11/10/2024	02:54	21,30
8	OB PATRA 2303	Pertalite	12/10/2024	03:42	13/10/2024	21:06	41,40
9	SPOB SULTAN SAMUDERA	Pertalite	14/10/2024	05:00	15/10/2024	03:06	22,10
10	OB PATRA 2301	Solar	15/10/2024	04:30	16/10/2024	04:12	23,70
11	OB PATRA 2302	Pertalite	17/10/2024	06:36	19/10/2024	05:54	47,30
12	SPOB SULTAN SAMUDERA	Pertalite	21/10/2024	20:00	22/10/2024	20:06	24,10
13	OB PATRA 2301	Solar	22/10/2024	20:32	23/10/2024	13:24	16,87
14	OB PATRA 2302	Solar	23/10/2024	13:36	24/10/2024	10:42	21,10
15	OB PATRA 2303	Pertalite	25/10/2024	12:42	26/10/2024	13:36	24,90
16	SPOB SULTAN SAMUDERA	Pertalite	26/10/2024	16:18	27/10/2024	15:00	22,70
17	OB PATRA 2301	Solar	28/10/2024	16:24	29/10/2024	17:00	24,60

Source: Data Processing, 2025

4.3 Data Uniformity Test

4.3.1. Test the uniformity of time data between ship arrivals at jetty 1

The average time between ship arrivals at jetty 1 is calculated using formula as follows:

$$\bar{X} = \frac{\sum \times}{N}$$

$$\bar{X} = \frac{(5{,}00 + 118{,}50 + 8{,}97 + \ldots + 81{,}30)}{20}$$

$$\bar{X} = 37{,}32$$

Next, the standard deviation is calculated using formula as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(xi - \bar{x})^2}{n - 1}}$$

$$SD = \sqrt{\frac{(5{,}00 - 37{,}32)^2 + (118{,}50 - 37{,}32)^2 + (9{,}97 - 37{,}32)^2 + \ldots + (81{,}30 - 37{,}32)^2}{20 - 1}}$$

$$SD = 36{,}90$$

The Upper Control Limit value can be calculated using formula and the Lower Control Limit value can be calculated using formula as follows:

$BKA = \bar{X} + (K.SD)$
$BKA = 37{,}32 + (3 \times 36{,}90)$
$BKA = 148{,}02$
$BKB = \bar{X} - (K.SD)$
$BKB = 37{,}32 - (3 \times 36{,}90)$
$BKB = -73{,}38$

To find out whether the data is uniform, a control chart graph is created which can be seen in Figure 1

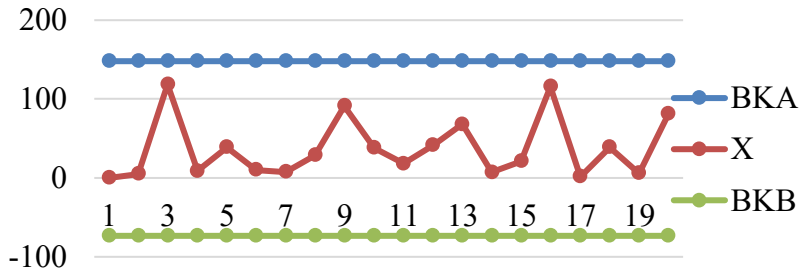

Figure 1. Time Control Map between Ship Arrivals at Jetty 1 (Source: Data Processing, 2025)

4.3.2. Test the uniformity of time data between ship arrivals at jetty 2

The average time between ship arrivals at jetty 2 is calculated using formula as follows:

$$\bar{x} = \frac{\sum x}{N}$$

$$\bar{x} = \frac{(37{,}50 + 11{,}00 + 70{,}20 + \ldots + 66{,}20)}{17}$$

$$\bar{x} = 40{,}88$$

Next, the standard deviation is calculated using formula as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(xi - \bar{x})^2}{n - 1}}$$

$$SD = \sqrt{\frac{(37{,}50 - 40{,}88)^2 + (11{,}00 - 40{,}88)^2 + (70{,}20 - 40{,}88)^2 + \ldots + (66{,}20 - 40{,}88)^2}{17 - 1}}$$

$$SD = 26{,}39$$

To find out whether the data is uniform, a control chart graph is created which can be seen in Figure 2.

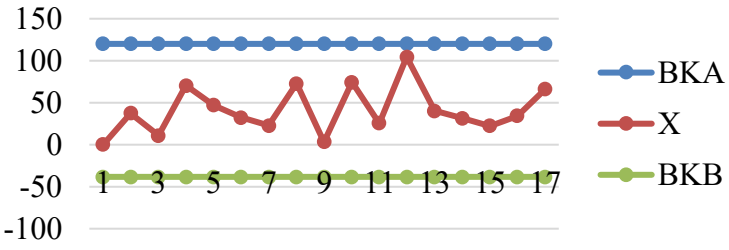

Figure 2. Time Control Map between Ship Arrivals at Jetty 2 (Source: Data Processing, 2025)

4.3.3 Data Distribution Test

Summary of Distribution Tests can be seen in Table 5.

Table 5. Recapitulation of Data Distribution Test

Process	*Expression*	*Resources*
Arrival of Jetty 1	-0.001 + GAMM(61.1, 0.611)	20 arrival
Arrival of Jetty 2	TRIA(-0.001, 17.6, 105)	17 arrival
Jetty Services 1	TRIA(21, 24.3, 54)	1 Facilities
Jetty Services 2	16 + LOGN(10.6, 9.82)	1 Facilities

Source: Data Processing, 2025

4.3.4 Planning and Making Simulation Models

After getting the results of the probability distribution used, the model design can be carried out. The design and creation of the simulation model was carried out in Arena Software. The modules used are create, decision, process and dispose. The results of the model design for the simulation can be seen in Figure 3.

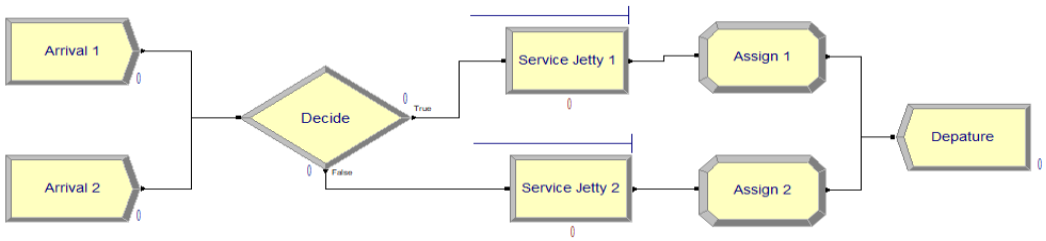

Figure 3. Ship Queuing Simulation Model at PT XYZ Dumai. (Source: Data Processing, 2025)

The results of the initial simulation output data replications can be seen in Table 6.

Table 6. Initial Simulation

Scenario	*Number In*		*Number Out*		*Waiting Time*		*Inst Utility*	
	Jetty 1	*Jetty* 2	*Jetty* 1	*Jetty* 2	*Jetty* 1	*Jetty* 2	*Jetty* 1	*Jetty* 2
Beginning	20	17	20	17	47,46	16,00	97%	67%

Source: Data Processing, 2025

Table 6 shows that there are still queues for ship services by looking at waiting time and utility or Berth Occupancy Ratio (BOR) values. The inst utility value at jetty 1 is 97% and the inst utility value at jetty 2 is 67%. According to [20], the benchmark for normal pier usage is 70%. Based on the Decree of the Director General of Sea Transportation, the proposal from the Harbormaster and Port Authority Office (KSOP) which has a criteria for a pier usage level of 70% indicates that the sea port is not in good condition and further development of the pier is needed.

Simulation Model Verification and Validation

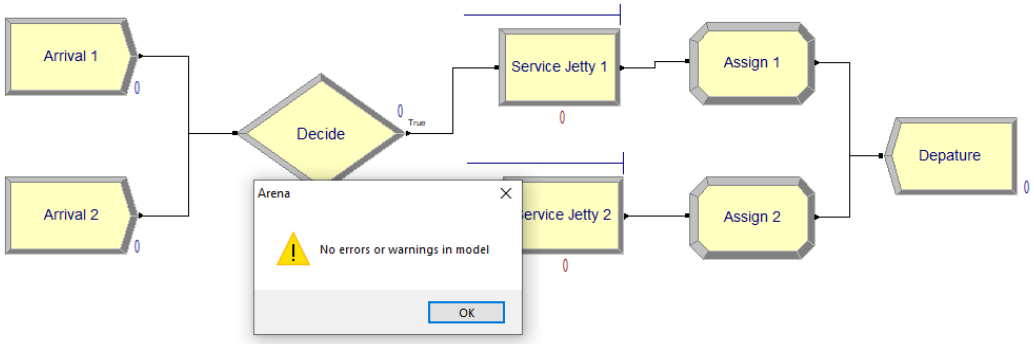

Figure 6. Ship Queue Simulation Model (Source: Data Processing, 2025)

There are no errors or mistakes in the model created so that the model can be run and used for further data processing.

4.3.5 Analysis of Results

The results obtained from running the arena software simulation require improvements to be made to improve the existing system so that it can reduce the queues that have occurred at

PT XYZ Dumai so far. This improvement can also help companies to minimize loading and unloading queue times so that the service process for incoming ships is stable.

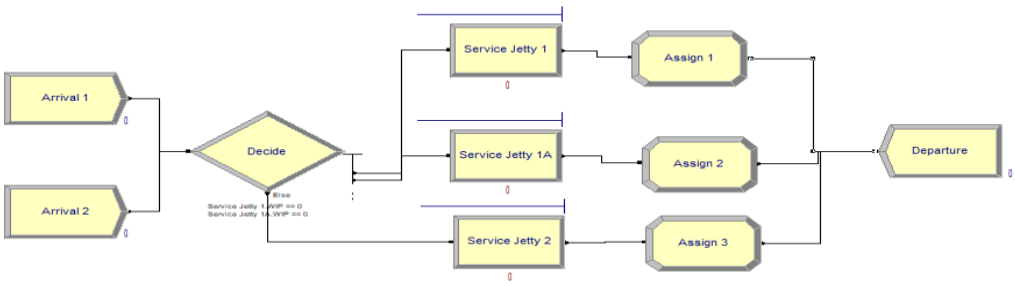

Figure 4. Proposed Ship Queue Simulation Model (Source: Data Processing, 2025)

The results of the initial simulation output data replications can be seen in Table 7.

Table 7. Proposed Simulation

Scenario	*Number In*		*Number Out*		*Waiting Time*		*Inst Utility*		
	Jetty 1	*Jetty* 2	*Jetty* 1	*Jetty* 2	*Jetty* 1	*Jetty* 2	*Jetty* 1	*Jetty* 1A	*Jetty* 2
Suggestion	20	17	20	17	0	24,07	64%	44%	50%

Source: Data Processing, 2025

5 Conclusion

Based on the results of ship queue simulation tests using Arena software, it can be concluded that the existing berthing occupancy rate for jetty 1 reached 97%, above the limit set by the company, namely <70%. The proposed improvements made according to the results of the Arena software simulation analysis are the addition of 1 server/jetty to accommodate the arrival of Large Range ships, so that the addition of 1 server/jetty will reduce the BOR of jetty 1 to 64% and reduce the queue from the real jetty 1 queue condition. existing average of 30.18 hours by adding 1 server/jetty so that the queue becomes an average of 7.54 hours. So that these improvements can help the company to minimize the queue time for cargo entry, so that the processing process at PT XYZ becomes optimal and can optimize the use/charter of ships.

References

Aspinall, E. (2015). Democracy in Indonesia: From stagnation to regression? In W. Case (Ed.), Democracy in Retreat: Is Southeast Asia in Danger? (pp. 1–20). ISEAS-Yusof Ishak Institute.

CNN Indonesia. (2023, 17 Juli). Jurang si kaya dan si miskin makin lebar, Maret 2023. Retrieved from https://www.cnnindonesia.com/ekonomi/20230717145351-532-974471/jurang-si-kaya-dan-miskin-di-ri-makin-lebar-maret-2023

Cooper, R. (1981). Introduction to queueing theory (2nd ed.). Elsevier North Holland, Inc.

Davidson, J. S. (2019). Indonesia: Twenty Years of Democracy. Cambridge University Press.

Dutková, S., Hostakova, D., Misok, T., & Rybicka, I. (2017). Determination of probability distribution of customer input at post office. In: Transport and communications (Sci. journal). 5(2), 6–10.

Emmerson, D. K. (2001). Indonesia beyond Suharto. Gramedia.

Feith, H. (1962). The decline of constitutional democracy in Indonesia. Cornell University Press.

Fitra, S. L., Melliana, Mesra, T., & Siregar. (2019). Optimization of tanker queue at Jetty 3 and 5 in PT X Dumai. Mater. Sci. Eng., 505, 1–9.

Fukuoka, Y., & Djani, L. (2016). Revisiting the rise of Jokowi. South East Asia Research, 24(2), 204–221.

Guo, S., Wang, H., & Wang, S. (2023). Network disruptions and ripple effects: Queueing model, simulation, and data analysis of port congestion. J. Mar. Sci. Eng., 11.

Harvey, D. (2005). A brief history of neoliberalism. Oxford University Press.

Hasugian, S. I. A., & Fernando. (2020). Simulation of queuing system for customer service improvement: A case study. IOP Conf. Ser. Mater. Sci. Eng., 851.

Hermanto, & Pratiwi, I. (2019). Analisis sistem antrian dengan metode simulasi. J. Desiminasi Teknol.

Hu, X., Barnes, S., & Golden, B. (2018). Applying queueing theory to the study of emergency department operations: A survey and discussion of comparable simulation studies. Int. Trans. Oper. Res., 25, 4–59.

Jackson, K. D., & Pye, L. W. (Eds.). (1978). Political power and communications in Indonesia. University of California Press.

Kiat, H. (2021). Analysis of ship waiting time to get shipyard service at PT. Dokp and Shipping Waiame in Ambon City. J. Econ. Bus.

Kim, J., & Kim, W. (2018). Queueing analysis of port systems with offshore container unloading: Queueing analysis of mobile harbour system. J. Ind. Eng. Manag. Syst. ISSN 1598-7248.

Krpan, L., Maršanić, R., & Milković, M. (2017). A model of the dimensioning of the number of service places at parking lot entrances by using the queuing theory. Tech. Gazette, 24, 231–238.

Lev, D. S. (2009). The transition to guided democracy: Indonesian politics, 1957-1959. Equinox Singapore.

Manurung, E. H., Melliana, & Mesra, T. (2018). Penerapan metode antrian pada kapal bongkar muat di PT Pelabuhan Indonesia I (Persero) Dumai. J. ARTI, 16(1).

Mietzner, M. (2018). Indonesia's democratic stagnation: Anti-reformist elites and resilient civil society. Democratization, 25(3), 392–409.

Nair, A. M., S., S. K., & Ushakumari, P. V. (2021). Application of Queuing Theory to a Railway ticket window. 2021 Int. Conf. Innov. Pract. Technol. Manag. (ICIPTM), 154–158. https://doi.org/10.1109/ICIPTM52218.2021.9388368

Nur, M. F., & Qitri. (2017). Analisa sistem antrian loket pada PT. Tiki Jalan Teuku Umar Pekanbaru dengan menggunakan software Arena. J. Tek. Ind., 02(02).

Oxfam lndonesia dan INFID. (2023). Laporan Oxfam lndonesia dan INFID. (Asumsi: Ini adalah judul laporan).

P., L., & R. M., M. (2019). Queueing analysis for operations modeling in port logistics. J. Marit. Bus. Rev., 5(1).

Park, S. W., Lee, M. K., & Park, Y. S. (2020). Analysis and improvement of communications in port areas using the Queuing Theory. J. Navig., 73, 912–931.

Pruyn, J. F. J., Kana, A. A., & Groeneveld, W. M. (2020). Analysis of port waiting time due to congestion by applying Markov chain analysis. J. Marit. Supply Chain., 4, 69–94.

Ratnasari, E. L. S., & Rahadian, N. (2020). Pemodelan dan simulasi sistem antrian pelayanan konsumen gerai MCD Solo Grand Mall dengan ArenaNo Title. Pros. Semin. dan Konf. Nas. IDEC, 7–8.

Robison, R. (2004). Presiden baru yang mana, pentingkah itu? Kompas (Opini), 28 Juli 2004.

Robison, R., & Hadiz, V. R. (2004). Reorganising power in Indonesia: The politics of oligarchy in an age of markets. Routledge.

Roy, D., Ommeren, J. K., & Koster, R. (2022). Modeling landside container terminal queues: Exact analysis and approximations. J. Transp. Reserach, 162(01), 73–102.

Sahrasad, H. (2007, Maret). Berpulangnya Prof Sarbini Sumawinata, The Grand Oldman Ekonomi Kerakayatan. Jawa Pos (Opini).

Sahrasad, H. (2023a). Mahasiswa, Kuasa dan Negara. Paramadina Graduate School of Islamic Studies-PGSI dan Freedom Foundation.

Sahrasad, H. (2023b). Membangun negara hukum dan demokrasi yang kuat. Kompas (Opini), 20 November 2023.

Sasongko, G., & Asih, E. (2019). Pemodelan dan simulasi sistem antrian pelayanan perbaikan sepeda motor di Honda Mitra Utama Cirebon. J. Rekavasi.

Stiglitz, J. E. (2024). The road to freedom: Economics and the good society. Allen Lane.

Svolik, M. (2012). The politics of authoritarian rule. Cambridge.

Syahidah, Melliana, & Mesra, T. (2023). Optimalisasi antrian truk di PT Kuala Lumpur Kepong Dumai. J. ARTI, 18(2), 1–10.