Optimization of Tanker Queue at Jetty 3 and 5 in PT X Dumai

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AT JETTY 3 AND 5 IN PT X DUMAI

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ABSTRACT

PT X Dumai is a company engaged in the processing of crude oil in the earth. The oil is processed into several types such as premium, pertalite, solar and others. The distribution of the oil is done by using sea transportation or tanker. PT X Dumai has 6 jetties, where each jetty has a predetermined path. There are two jetties which always queues many ships waiting, the jetty 3 and the jetty 5. Jetty 3 and jetty 5 is a service of loading/discharge for premium oil, diesel and pertalite that commonly used by the public. Queues that occurred on jetty 3 and jetty 5 reached the jetty utilization of 90%. This is above the limit set by the utility company under 70%.

Therefore, improvements using Software Arena that provides several scenarios for optimal results. Software Arena is one of the software used to simulate the queue by using multiple scenarios for troubleshooting. For the scenario 1 the result of simulation utilization is 96%. In scenarios 2 and 3 with the addition of 1 jetty on each jetty, the utilization is still at 75%. In scenario 4, additional 2 jetties the result of simulation utilization is 55%.

After repairs with arena, the results obtained by adding 2 jetties again with utilization of 55%. And the service can be done by 98%.

Keywords: Queue, Simulation, Software Arena

1. Preliminary

PT X is one of the countries engaged in the processing of crude oil contained in the earth. The crude oil is processed into various types of oils such as premium, pertalite, aviation fuel, kerosene, diesel, and non-oil products such as LPG (liquefied petroleum gas), green coke, lubricants, and products intermedia (intermediate) as an element of naphtha. As for how to distribute the fuel and non-fuel using sea transport or ship. Each loading or discharge has its own standard time, but still waiting time or delay occurred which led the company into a loss both cost and time. Queues boat jetty common in 3 and 5 with jetty occupancy is equal to 97% and 72% for jetty 5, which limits the optimal use of the jetty is below 70%. For that reason, the simulation queue by using Software Arena to help the company make decisions on the matter.

2. Theoretical basis

Based on research conducted by Suparti and Hermantoro (2014), service to the community as a place of payment of motor vehicle tax. The problem that

often occurs is the long queue when it will make the payment. Based on case studies conducted in the office vehicle tax in Temanggung district, it is known that in October-December long queue of 20-30 people. This means that the number of servers serving the taxpayers should be added. To find the most optimal number of servers, simulation problem using the software arena. From the simulation results is known that the utilization of the server reaches 1.00. Can be explained that the server is very busy carrying out their duties without any time for pause. After the simulation of the real conditions then made scenarios to determine the optimal number of servers. Scenario simulations carried out with the addition of 1 server up to 4 servers. Based on the analysis of simulation output data, showed that the best scenario is the addition of two servers to serve taxpayers.

2.1. Queue

Queue is a condition in which the service system is greater than the arrival time of the service time. A simple example of a queue is a motor vehicle tax payment process that customers arrival time greater than the time officers serving the payment service, which will cause the queue (Suparti and Hermantoro, 2014). There are three components in the queuing system, that is arrival, queuing and service facilities.

2.2. Simulations

Simulation is the process of designing a model of a real system and implementation of experiments with this model for the purpose of understanding the behavior of the system or to develop strategies (within a limit determined by one or several criteria) with respect to the operating system (Suparti and Hermantoro, 2014).

2.3. Software Arena

ARENA is a simulation software which is published by Rockwell Software Inc. According to Kelton (2009) in Suparti and Hermantoro (2014), this provides an alternative simulation charts and analysis that can be combined to create simulation models that quite wide and varied. This software has the capability of two-dimensional animation.

3. Research methodology

The research was conducted at PT X Dumai with loading/discharging tankers data in December 2016 for jetty 3 and 5 which 23 ships at the jetty 3 and 16 ships on the jetty 5. Here is a flow diagram of the research that can be seen at Figure 3.1.
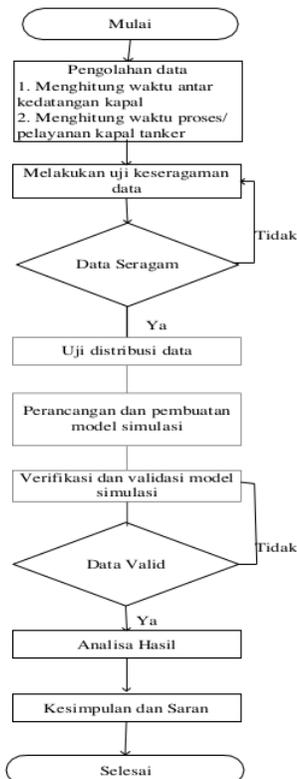
Figure 3.1. Flow Chart of Queue Simulation Tankers
Source: Data Processing, 2017

4. Discussion result

4.1. Inter-arrival time and process Tanker Services

Table 4.1. Inter-arrival Time Tanker

No.	Jetty	Inter-arrival Time (hours)
1	Jetty III	0,00
2	Jetty III	0.33
3	Jetty III	1.00
4	Jetty III	3.24
5	Jetty III	4.12
6	Jetty III	0.54
7	Jetty III	0.52
8	Jetty III	1.18
9	Jetty III	2.15
10	Jetty III	1.42

Source: Data Processing, 2017

Table 4.1. Inter-arrival Time Tanker (Continued)

No.	Jetty	Inter-arrival Time (hours)
11	Jetty III	0.24
12	Jetty III	0.24
13	Jetty III	1.00
14	Jetty III	0,00
15	Jetty III	0.30
16	Jetty III	1.10
17	Jetty III	1.18
18	Jetty III	0.48
19	Jetty III	5.30
20	Jetty III	1.24
21	Jetty III	0.59
22	Jetty III	0.54
23	Jetty III	0.48
24	Jetty V	0,00
25	Jetty V	1.30
26	Jetty V	4.12
27	Jetty V	1.30
28	Jetty V	1.06
29	Jetty V	1.18
30	Jetty V	0.38
31	Jetty V	1.36
32	Jetty V	1.42
33	Jetty V	1.30
34	Jetty V	2.00
35	Jetty V	0.30
36	Jetty V	1.24
37	Jetty V	4.06
38	Jetty V	1.54
39	Jetty V	1.12

Source: Data Processing, 2017

After that, the calculation for the service of tanker at the jetty 3 and 5 can be seen at Table 4.2.

Table 4.2. Service Processing Time Tanker

No.	Jetty	Process Time (h)
1	Jetty III	52.3
2	Jetty III	13.15
3	Jetty III	37.06
4	Jetty III	26.42
5	Jetty III	18.24
6	Jetty III	19.36
7	Jetty III	51.02

Source: Data Processing, 2017

Table 4.2. Service Processing Time Tanker (Continued)

No.	Jetty	Process Time (hours)
8	Jetty III	12,15
9	Jetty III	34.48
10	Jetty III	51
11	Jetty III	29.06
12	Jetty III	30.42
13	Jetty III	49.42
14	Jetty III	35
15	Jetty III	42.3
16	Jetty III	53.2
17	Jetty III	33.3
18	Jetty III	29.54
19	Jetty III	31.36
20	Jetty III	24.25
21	Jetty III	29.12
22	Jetty III	22.36
23	Jetty III	24.06
24	Jetty V	46
25	Jetty V	17.54
26	Jetty V	24.18
27	Jetty V	43.54
28	Jetty V	20.06
29	Jetty V	34.04
30	Jetty V	16.36
31	Jetty V	43.18
32	Jetty V	31.3
33	Jetty V	36.24
34	Jetty V	47.36
35	Jetty V	35.12
36	Jetty V	20.54
37	Jetty V	29.24
38	Jetty V	47.18
39	Jetty V	39.06

Source: Data Processing, 2017

4.2. Uniformity Testing Data

Uniformity testing data using Minitab software. The results of the uniformity of data can be seen in Table 4.3.

Table 4.3. Uniformity Test Result Data

Jetty	Information	Upper limit	Average	Lower limit
3	Inter-arrival Time	2,151	0.727	-0.698
	Service Processing Time	70.4	32.55	-5.32
5	Inter-arrival Time	4.735	1.48	-1.775
	Service Processing Time	73.24	33.18	-6.88

Source: Data Processing, 2017

The result from Table 4.3 can be concluded that the data obtained was uniform, so it can be done for further processing.

4.3. Test Data Distribution

Test for data distribution is using input analyzer on the software arena. The results of the test data for the distribution of inter-arrival time can be seen in Table 4.1. For the results of the data distribution service process tanker can be seen in Table 4.2.
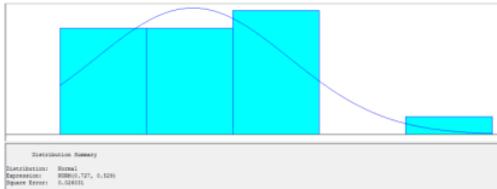

Figure 4.1. Probability of Distributions Arrival Time Tanker for Jetty 3
Source: Data Processing, 2017

Figure 4.1 show the results of *input Analyzer* in the software arena for the probability distribution of time between arrival jetty 3 that using a normal distribution with expression norm (0.727, 0.529).
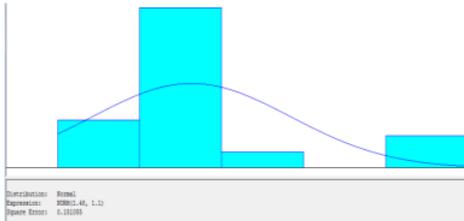

Figure 4.2. Probability of Distributions Arrival Time Tanker for Jetty 5
Source: Data Processing, 2017

Figure 4.2 shows the distribution used in the inter-arrival time *jetty* 5 is using a normal distribution with expression norm (1.48, 1.1).
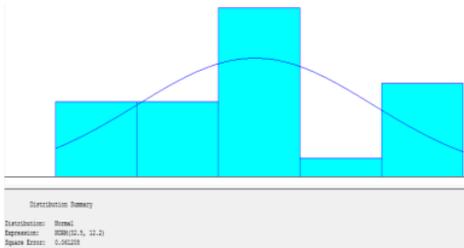

Figure 4.3. Probability of Distribution Process Time Tanker for Jetty 3
Source: Data Processing, 2017

Figure 4.3 is the result of *input Analyzer* a probability distribution service process jetty 3 is using a normal distribution with expression norm (32.5, 12.2) and the square error is 0.0612.
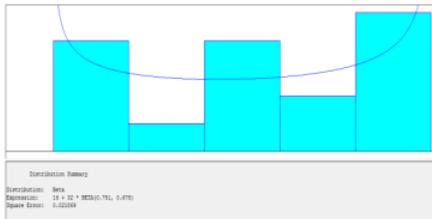
Figure 4.4. Probability of Distribution Process Time Tanker for Jetty 4
Source: Data Processing, 2017

Figure 4.4 shows the probability of distribution that is used for a service process *jetty* 5 is use beta distribution with the expression 16 + 32 * beta (0.751, 0.678) and the square error is 0.022.

4.4. Design and Modeling Simulation

After getting the results for a probability of distribution, then design model can be performed. The simulation model can be viewed in Figure 4.5.
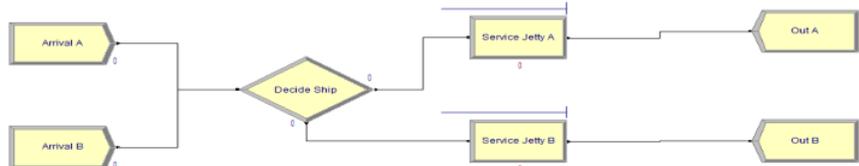

Figure 4.5. Queue Simulation Model Tankers At PT X Dumai
Source: Data Processing, 2017

Figure 4.5 show a model simulation to tankers queue on *jetty* 3 and 5 by using a basic template process. Once the model is complete, then running the model. Output recapitulation of running can be seen in Table 4.4.

Table 4.4.Result of Output Simulation Model for Early

Scenario	Number In		Number Out		Utilization		Queue Waiting Time	
	Ship A	Ship B	Ship A	Ship B	Jetty A	Jetty B	Jetty A	Jetty B
Early	73	16	54	12	0.89	0.88	3.66	2.56

Source: Data Processing, 2017

Table 4.7 show the persistence of the queue happens to service tankers with look at the incoming ships to ship out unbalanced. Utilization of 90%, which indicates the jetty too busy and does not comply with the limit *occupancy* of the company that is below 70%.

4.5. Verification and Validation of Simulation Model

Before the improvements, the model first verified and validated to conform to the real system. The results of verification of the model can be seen in Figure 4.6.

Figure 4.6. Model Verification Results
Source: Data Processing, 2017

Figure 4.6 show there are no mistakes or errors of the model, so the model can be run and used for further data processing. After that, the model validation by comparing the real system with simulation models created. As for the formula is: H_0: $\mu_1 - \mu_2 = 0$ (data received), H_1: $\mu_1 - \mu_2 \neq 0$ (data is rejected), and $\alpha = 0.05$.

Table 4.5. Results of Output Real Model Simulation System

Jetty	Real System	Existing models	Difference
Jetty A	23	54	-31
Jetty B	16	12	4
		Mean	-13.50
		Standard Deviation	24.75

Source: Data Processing, 2017

Table 4.5 show that the value of zero is between the range $\mu_1 - \mu_2$, that mean H_0 is accepted, which means early models were designed by arena is valid or in accordance with the real system.

4.6. Analysis Results

From the result of running simulations previously, it is necessary to make some improvements or scenarios. Result improved by the addition of scenario can be seen in Table 4.6.

Table 4.6. Scenario System Improvement

Scenario	Total Jetty		Number In		Number Out		Utilization	
	A	B	A	B	A	B	A	B
1	1	1	135	29	115	25	0.96	0.96
2	1	2	134	29	124	26	0.96	0.55
3	2	1	135	28	124	26	0.54	0.97
4	2	2	135	28	133	28	0.55	0.55

Source: Data Processing, 2017

Table 4.6 show that in the initial scenario, utilization of jetty reach 0.96 or nearly 1 which means the jetty is busy. If added one more jetty, utilization reached 0.75. With the addition of two jetties can be seen that the utilization is at 0.55 or below 70%.

5. Conclusions and Recommendations

5.1. Conclusion

Optimization of the tanker queue at jetty 3 and 5 in PT X Dumai by adding 2 jetties again and the occupancy is below 70% according to the occupancy of the company. So it can reduce the queues that often occurs on the jetty 3 And 5 in PT X Dumai.

5.2. Recommendation

To obtain optimal results, it is necessary to do a cost analysis of the queues and the addition of the jetty. So, it can pick and choose additional servers or jetty which is in accordance with the optimal alternative.

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