

Performance Improvement for Port Loading and Unloading Process with Process Mining

Amanda Dewi Paramita¹ and Iwan Vanany¹

Abstract—Port is one of the important things in trade and logistics. The major influence factor of port productivity is the cycle time for loading and unloading. The container activity in port logistics consists of several activities, such as discharging, loading, receiving, delivery, gate-in, and gate-out, among others. These activities using various equipment including container cranes, Rubber Tyred Gantry (RTG), trucks, and other related machinery. The availability of equipment is one of the factors the influence delays in container activities, which can negatively affect productivity. The productivity of the port will affect to Key Performance Indicator (KPI) of the port. The purpose of this study is to analyze the flow of containers that used process mining. Moreover, it provides a recommendation to increase the productivity at Terminal Nilam Multipurpose Port of Tanjung Perak. Process mining method includes many of other analysis, that is discovery, prediction and real-time, bottlenecks and deviation analysis. Disco program used to analyze container activity, besides this, the disco program also use to determine bottleneck mapping that effect to port productivity. The result show delivery and receiving are the cause of the bottleneck. Delivery cancel is known as an activity that inappropriate with the ideal process and indicates as an error in the flow of container activities. The improvement scenario carried out from the results of the analysis obtained is to minimize the occurrence of cancel loading delivery, to obtain a time reduction of ± 11.6 hours. This will affect the productivity of container activities.

Keywords—Cycle Time, Process Mining, Bottleneck, Loading, Receiving, and Delivery Cancel.

I. INTRODUCTION

The performance of a port is influenced by the cycle of loading and unloading activities, as is the case at the Terminal Nilam Multipurpose Port of Tanjung Perak, increasing from year to year in the cycle of loading and unloading activities, especially container loading and unloading. Container activities include discharging, loading, delivery, receiving, gate-in and gate-out. Whereas in carrying out container activities it is supported by tools and facilities including container cranes, Rubber Tyred Gantry (RTG), trucks, Reach Steaker (RS) and others. Based on observations in the field, several conditions that result in an increase in the loading and unloading cycle, from, among others, the existence of queues when the

trailer will load the container from the ship or vice versa. cause delays from a predetermined schedule and cause unwanted activity and impact on productivity achievement. Currently, the Terminal Nilam uses a spinner application to record each container loading and unloading activity. The results of the recording can be used as data to measure the productivity of a port which is one of the indicators in achieving KPI. So it is necessary to analyze loading and unloading performance using process mining, that is by using secondary data from the event log. By choosing this method, it can be known transparently the difference between ideal business processes and real processes that occur in the field.

II. METHOD

A. Flow Chart

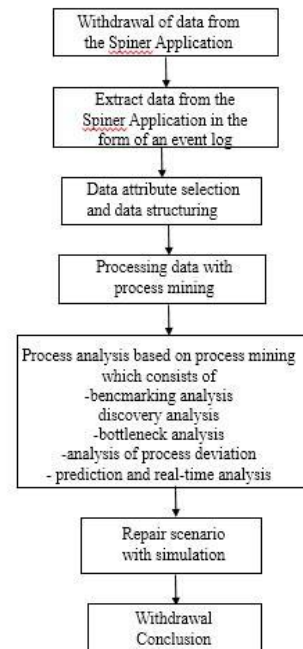


Figure 1. Flow chart of methodology

B. Extracting

Selecting and structuring data Extracting data is obtained from the export of the spinner application data. Event log data consists of various types of attributes, including date and time of loading and unloading activities, ship code, container size (20 ft, 40 ft), container type (general purpose container, temperature, reefer container), goods activities

¹Amanda Dewi Paramita is with Department of Management Technology, Institut Teknologi Sepuluh Nopember, Indonesia. Email: amandadewiparamita@gmail.com.

²Iwan Vanany is with Department of Industrial Engineering, Institut Teknologi Sepuluh Nopember, Indonesia. Email: vanany@ie.its.ac.id.

(stabilizing, delivery, stacking), type of loading and unloading (loading, discharge), equipment used (container crane, RTG and truck), ship code, number of production and production units.

The next step is to select the data on the extraction results to determine the required attributes. This is because the extraction data obtained is very broad and not all of these attributes are following the data requirements needed to analyze the process. The data needed is data that has an identity, activity and time of operational activities. Next is doing the rearrangement of event log data by equating the format and compiling data according to the mapping of each activity related to the flow of the container activity process.

C. *Processing data with Process mining*

Process analysis to be carried out in the form of analysis of discovery, bottleneck, process deviations, and prediction and real-time, with the explanation as follows:

- Benchmarking analysis to identify each data in the event log, as needed.
- Discovery analysis to identify business process models and on which processes occur deviations and obtain the calculation of the average time of each activity process.
- Analysis of bottlenecks which can later be used as a reference for improving performance by knowing the influential factors.
- Analysis of process deviations that obtained differences between the flow of container processes that occur in the field with the ideal process.
- Prediction and real-time analysis with the results obtained can be predicted against the possibility of errors in the process that will occur and can be monitored in real time the flow of the container process so that it can be dealt with quickly and precisely if there is an error in a process.

D. *Scenario improvement with simulation*

The model of the simulation will be used to determine the best improvement scenario. And an indicator that will be used to determine the best repair scenario is that there is no bottleneck so that the time of container activities is faster with higher loading and unloading productivity results.

After obtaining several model simulations and variations, an analysis of several variants was obtained. By identifying several of these variants, several analyzes were obtained relating to the flow of business processes including bottleneck analysis, discovery and process deviations.

E. *Withdrawal conclusion*

Drawing conclusions is done after doing all the analyses carried out and obtained the most optimal results. After obtaining the results of the analysis, recommendations can be given to PT Pelindo III for further improvements.

III. RESULTS AND DISCUSSION

A. *Withdrawal of data from the Spinner Application*

The data used is in the form of event logs that are obtained from the export of data from spinner.

B. *The results of the process of selecting data attributes and structuring data*

After the event log is formed, then the data is selected and structured, this is because the extraction data obtained is very broad and not all of the attributes are following the data requirements for conducting process analysis. The data needed is data that has an identity, activity and time of operational activities. Next is to reorganize event log data by equating the format and compiling data according to the mapping of each activity related to the flow of the container activity process.

C. *Event log Information*

Initial conditions where 21,382 logs are input into this model

TABLE 1.
EVENT LOG ANALYSIS

Event log analysis	
Number of case	341
Number of activity	16
Number of events	21.382
Start	02.11.2018 2:45:00
End	31.03.2019 16:33:00
Median case duration	17,7 hours
Mean case duration	65,4 hours
Number of variants	279

D. *Statistical Information*

The following are statistical information including:

- a. Case Duration: Shows information about the duration of the case contained in the model.
- b. Activity: Shows the frequency of each loading and unloading activity consisting of loading, discharge, receiving and delivery
- c. Resource: Indicates the statistics of the resource frequency used in each case. In this case, the intended resource is the loading and unloading equipment used, namely Container Crane.

E. *Process Analysis based on mining processes*

1) *Analysis of the benchmarking process*

in analyzing the benchmarking process classification is carried out on several parameters relating to the container loading and unloading activities, including resources, container size, container shipping destinations, shipping, and activity agent names.

TABLE 1.
EVENT LOG

KD_CABANG	KD_TERMINAL	NO_APPROVAL	UKURAN PETIKEMAS	KODE ALAT	SATUAN PRODUKSI	JUMLAH PRODUKSI	NAMA_POL	NAMA_POD	AGENT_NAME	KEGIATAN_BRG	START_WORK	END_WORK
2	4	SR020418000001	20	NCC04	BOX	10	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	40	NCC04	BOX	10	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	20	NCC04	BOX	10	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	40	NCC04	BOX	8	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	40	NCC04	BOX	8	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	20	NCC04	BOX	122	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	20	NCC04	BOX	122	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	40	NCC04	BOX	4	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	40	NCC04	BOX	10	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000001	40	NCC04	BOX	4	MAKASSAR	MAKASSAR	PELAYARAN CARAKA TIRTA PERKAS	DELIVERY LOSSING-DCL	11/2/2018 2:45	11/2/2018 16:55
2	4	SR020418000107	20	NCC03	BOX	1	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000107	40	NCC03	BOX	1	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000107	20	NCC03	BOX	9	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000107	20	NCC03	BOX	1	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000107	20	NCC03	BOX	9	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000107	40	NCC03	BOX	1	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000107	20	NCC03	BOX	38	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000107	20	NCC03	BOX	38	TANJUNG PERAK	BALIKPAPAN	TANTO KARYA UTAMA, PT	DELIVERY LOSSING-DCL	11/3/2018 2:45	11/3/2018 12:11
2	4	SR020418000002	20	NCC05	BOX	10	SAMARINDA	SAMARINDA	SALAM PACIFIC INDONESIA LINES, PT	DISCHARGE-DCH	11/3/2018 12:10	11/4/2018 6:13
2	4	SR020418000002	40	NCC05	BOX	9	SAMARINDA	SAMARINDA	SALAM PACIFIC INDONESIA LINES, PT	DELIVERY-DLV	11/3/2018 12:10	11/4/2018 6:13
2	4	SR020418000002	40	NCC05	BOX	5	SAMARINDA	SAMARINDA	SALAM PACIFIC INDONESIA LINES, PT	DELIVERY LOSSING-DCL	11/3/2018 12:10	11/4/2018 6:13
2	4	SR020418000002	40	NCC05	BOX	9	SAMARINDA	SAMARINDA	SALAM PACIFIC INDONESIA LINES, PT	DISCHARGE-DCH	11/3/2018 12:10	11/4/2018 6:13

TABLE 2.

THE RESULTS OF THE BENCHMARK PROCESS ANALYSIS FOR "RESOURCES"

Resources Name	Procentage
CC04	4485 (20,98%)
CC05	4335 (20,27%)
CC03	3903 (18,25%)
CC01	3237 (15,14%)
RTG 01	1154 (5,4%)
RTG 04	1049 (4,91%)
RTG 05	917 (4,29%)
RTG 03	754 (3,53%)
RTG 02	740 (3,46%)
RTG 06	638 (2,98%)
RS 01	166 (0,78%)
SHIP 01	4 (0,02%)

TABLE 3.

MEAN DURATION FOR RESOURCES

Resources Name	Mean duration
CC 04"	21 hour 36 minutes
CC 05	22 hours 2 minutes
CC 03	19 hours 46 minutes
CC 01	22 hours 23 minutes
RTG 01	20 hours 23 minutes
RTG 04	21 hours 36 minutes
RTG 05	21 hours 40 minutes
RTG 03	22 hours 13 minutes
RTG 02	19 hours 50 minutes
RTG 06	21 hours 14 minutes
RTG 06	17 hours 17 minutes
RTG 06	21 hours 38 minutes

From the results of the analysis of the benchmark process for these resources, it can be seen that the highest level of tool used is the use of CC 04 with a percentage value of 20.98%, with an average duration of use for one loading and unloading cycle of 21 hour 36 minutes.

TABLE 4.
THE RESULTS OF THE BENCHMARK PROCESS ANALYSIS FOR "CONTAINER SIZE"

Type of containers	2 type
Frequency "size 20 ft"	13.175 (61,62%)
Frequency "size 40 ft"	8.207 (38,38%)

From the analysis of the benchmark process for the size of the container, it can be seen that the highest level of container usage is the use of containers measuring 20 ft with a percentage of 61.62%.

TABLE 5.
THE RESULTS OF THE BENCHMARK PROCESS ANALYSIS FOR "DELIVERY DESTINATION"

Delivery destination	Frequency
to Samarinda	6442 (30,13%)
to Makassar	3254 (15,22%)
to Kupang	2264 (10,59%)
to Tarakan	1987 (9,29%)
to Balikpapan	1502 (7,02%)
to Ambon	1490 (6,97%)
to Pantoloan	996 (4,66%)
to Palaran	827 (3,87%)
to Nunukan	714 (3,34%)
to Timika	541 (2,53%)
to Banjarmasin	521 (2,44%)
to Merauke	364 (1,7%)
to Dobo	151 (0,71%)
to Bau Bau	97 (0,45%)
to Jakarta	87 (0,41%)
to Kendari	57 (0,27%)
to Tual	50 (0,23%)
to Maumere	20 (0,09%)
to Ampenan	18 (0,08%)

From the results of the analysis of the benchmark process for delivery, it can be seen that the most shipping destination is shipping to Samarinda with a percentage value of 30.13%.

From the results of the analysis of the process, it can be seen that the most loading and unloading activities are loading activities with a frequency of 7731 times with an average duration of 20 hours 52 minutes.

From the results of the analysis of the process, it can be seen that shipping agents that often carry out container loading and unloading activities are PT Meratus Line with Frequency of 9105 times with a percentage of 42.58%.

TABLE 6.
THE RESULTS OF THE BENCHMARK PROCESS ANALYSISFOR "ACTIVITY"

Activity	Procentage
Delivery	7731 (36,16%)
Delivery cancel loading	83 (2,98%)
Delivery lossing	2582 (12,08%)
Delivery lossing transhipment direct between terminal	2 (0,01%)
Delivery lossing transhipment transit CY	130 (0,61%)
Discharge	4320 (20,2%)
Loading	7731 (36,16%)
Loading transhipment between terminal	300 (1,4%)
Receiving	4882 (22,83%)
Receiving lossing	16(0,07%)
Receiving tambah	14(0,07%)
Reefer"	1(0%)
Relocation haulage	120(0,56%)
Shifting with landing	9(0,04%)
Shifting with landing CY	3(0,01%)
Shifting without landing	6(0,03%)

TABLE 7.
MEAN DURATION FOR ACTIVITY

Activity	Mean duration
Delivery	23 hours 51 seconds
Delivery cancel loading	1 hour 3 hours
Delivery lossing	21 hours 51 minutes
Delivery lossing transhipment direct between terminal"	22 hours 39 minutes
Delivery lossing transhipment transit CY	1 hour 3 hours
Discharge	21 hour 50 minutes
Loading	20 hours 52 minutes
Loading transhipment antar terminal	1 hour 2 hours
Receiving	20 hours 29 minutes
Receiving lossing	1 hour 13 minutes
Receiving tambah	1 hour 11 hour
Reefer	1 hour 1 hour
Relocation haulage	22 hours 51 minutes
Shifting with landing	1 hour 3 hours
Shifting with landing CY	1 day 1 hour
Shifting without landing"	23 hours 32 minutes

TABLE 8.
THE RESULTS OF THE BENCHMARK PROCESS ANALYSISFOR "SHIPPING AGENT"

Name of shipping agent	Procentage
PT Meratus Line	9105 (42,58%)
PT SPIL	7524 (35,19%)
PT Tanto Karya Utama	2338 (10,93%)
PT Perusahaan Pelayaran Nusantara Panurjawan	1448 (6,77%)
PT Pelayaran Caraka Tirta Perkasa"	967 (4,52 %)

2) Analysis of process discovery

In analyzing the discovery process, 3 (three) variants can be found with the highest ranking with the following details:

TABLE 9.
TOP 3 VARIANT

Top 3 variant	case	Event
Variant 1	15	30
Variant 2	12	12
Variant 3	8	8
Total	35	

From Table 9. it can be seen that there are 3 paths most often carried out in the process of loading and unloading activities. The 3 lines cover 10.26% of the 341 trajectories that occur in loading and unloading activities.

TABLE 10.
VARIANT 1

No Case	Activity	Resource	Duration
Case 1	Delivery	RTG 01	17 hours 17 minutes
	Delivery	RTG 01	19 hours 17 minutes
Case 2	Delivery	RTG 01	17 hours 17 minutes
	Delivery	RTG 01	17 hours 17 minutes
Case 3	Delivery	RTG 01	17 hours 17 minutes
	Delivery	RTG 01	17 hours 17 minutes
Case 4	Delivery	RTG 04	19 hours 17 minutes
	Delivery	RTG 04	19 hours 17 minutes
Case 5	Delivery	RTG 01	19 hours 17 minutes
	Delivery	RTG 01	19 hours 17 minutes
Case 6	Delivery	RTG 01	17 hours
	Delivery	RTG 01	17 hours
Case 7	Delivery	RTG 04	1 hour 34 minutes
	Delivery	RTG 04	1 hour 34 minutes
Case 8	Delivery	RTG 04	17 hours 19 minutes
	Delivery	RTG 04	17 hours 19 minutes
Case 9	Delivery	RTG 01	17 hours 42 minutes
	Delivery	RTG 01	17 hours 42 minutes
Case 10	Delivery	RTG 05	19 hours 58 minutes
	Delivery	RTG 05	19 hours 58 minutes
Case 11	Delivery	RTG 05	1 hour 7 hours
	Delivery	RTG 05	1 hour 7 hours
Case 12	Delivery	RTG 05	17 hours 25 minutes
	Delivery	RTG 01	17 hours 25 minutes
Case 13	Delivery	RTG 01	22 hours 5 minutes
	Delivery	RTG 01	19 hours 26 minutes
Case 14	Delivery	RTG 02	9 hours 50 minutes
	Delivery	RTG 02	1 hour 4 hours
Case 15	Delivery	RTG 01	17 hours
	Delivery	RTG 01	17 hours
Mean duration			19 hours 32 minutes

TABLE 11.
VARIANT 2

No Case	Activity	Resource	Duration
Case 1	Delivery	RTG 04	17 hours 17 minutes
Case 2	Delivery	RTG 01	20 hours 13 minutes
Case 3	Delivery	RTG 01	1 hour 11 hour
Case 4	Delivery	RTG 01	17 hours 19 minutes
Case 5	Delivery	RTG 01	11 hour 44 minutes
Case 6	Delivery	RTG 01	20 hours 3 minutes
Case 7	Delivery	RTG 05	1 hour 7 hours
Case 8	Delivery	RTG 05	13 hours 7 minutes
Case 9	Delivery	RTG 05	17 hours 25 minutes
Case 10	Delivery	RTG 01	8 hours 30 minutes
Case 11	Delivery	RTG 01	1 hour 5 hours
Case 12	Delivery	RTG 01	1 hour 21 hour
Mean duration			22 hours 5 minutes

TABLE 12.
VARIANT 3

No Case	Activity	Resource	Duration
Case 1	Delivery cancel loading	RTG 01	2 hours 7 minutes
Case 2	Delivery cancel loading	RTG 06	1 hour 7 minutes
Case 3	Delivery cancel loading	RTG 04	7 hours 50 minutes
Case 4	Delivery cancel loading	RTG 01	17 hours 45 minutes
Case 5	Delivery cancel loading	RTG 06	17 hours 2 minutes
Case 6	Delivery cancel loading	RTG 05	1 hour 29 minutes
Case 7	Delivery cancel loading	RTG 05	2 hours 12 minutes
Case 8	Delivery cancel loading	RTG 01	18 hours 33 minutes
Mean duration			1 day 3 hours 30 minutes

From the discovery process analysis, by taking the top 3 variants, there were 2 emerging activities, namely delivery and delivery canceling activities, with an average duration of variants 1 for 19 hours 32 minutes, variant 2 for 22 hours 5 minutes, variant 3 for 3 hours 30 minutes. Thus it can be concluded that the highest duration of time is in variant 3 with activities in it, namely, cancel loading delivery. This indicates that the emergence of cancel loading delivery activities is one of the factors that cause the duration of the container loading and unloading cycle. From the table it can be seen that there are 3 paths most often carried out in the process of loading and unloading activities. The 3 lines cover 10.26% of the 341 trajectories that occur in loading and unloading activities.

3) Analysis of process bottleneck

Several factors that become bottleneck boosters can be identified by searching for process loops on the process

map. The loop process is expected to show the normal function of the process and can also show errors or process problems.

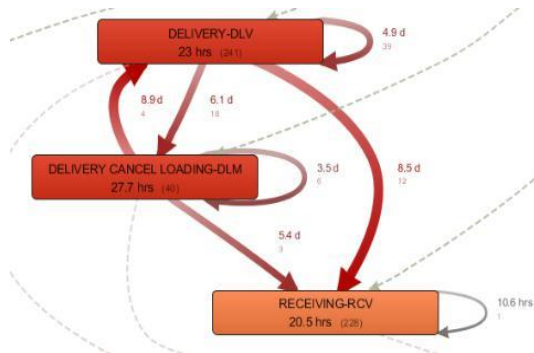


Figure 4. Loop Process

In Figure 4. it can be seen that activities in the red box are delivery, delivery cancel loading and receiving activities and it can be concluded that the three activities are bottlenecks in container activities.

TABLE 13. RESULTS OF ANALYSIS OF THE BOTTLENECK PROCESS

Activity	Mean duration	Min duration	Max duration
Delivery	23 jam	4,9 jam	7 hari
Delivery → delivery	4,9 hari	95 menit	28,4 hari
Delivery → Delivery cancel loading	6,1 hari	30,4 jam	14,6 hari
Delivery cancel loading	27,7 jam	6,4 jam	4,9 hari
Delivery cancel loading → delivery	8,9 hari	3,1 jam	21,6 hari
Delivery cancel loading → Delivery cancel loading	3,5 hari	20,7 jam	7,2 hari
Delivery → receiving	8,5 hari	30,4 jam	16,2 hari
Delivery cancel loading → receiving	5,4 hari	25,5 jam	7,2 hari
Receiving	20,5 jam	4,8 jam	7 hari
Receiving → receiving	10,6 jam	10,6 jam	10,6 jam

From the analysis of the bottleneck process, there were 3 activities which were the causes of a bottleneck, namely the activities of delivery, delivery cancel loading and receiving. From each of these activities which have the highest average duration is cancel loading delivery activities with an average duration of 27.7 hours.

4) Analysis of process deviations

In analyzing the deviations process, several processes can be found that do not match the actual process flow.

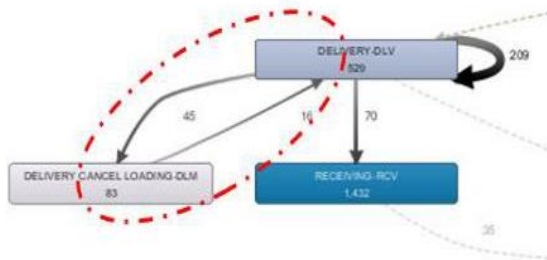


Figure 5. Analysis of Process Deviations

From Figure 5. it can be seen that there is a process that is not in accordance with the actual process, that is, after the delivery process occurs a cancel loading delivery process, which means that the delivery process is canceled due to some technical errors including job orders that do not meet the requirements it is not permitted to carry out the delivery process or it can be said that one of the processes on the job order request for the delivery process has passed.

5) Analysis of process prediction and real time

After analysis, it can be predicted that one of the errors in the container process flow is the emergence of cancel delivery activities because according to the actual container flow the process is greatly avoided because it will hinder other operational activities. If this activity occurs, there will be a buildup density in the stacking field, so that it will disrupt the smooth delivery of the next delivery activity.

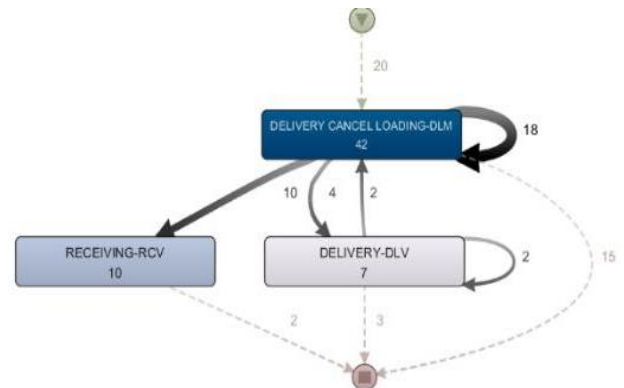


Figure 6. Prediction and Real Time Process

TABLE 14.

RESULTS OF ANALYSIS OF THE PREDICTION AND REAL TIME PROCESS

Activity performance of delivery cancel loading	
Total Duration	45,1 hour
Mean duration	25,8 hours
Max Duration	60,7 hours
Min Duration	7,8 hours

F. Scenario improvements with simulation

1) Scenario improvement results from the analysis of the bottleneck process.

It Will be repaired for the delivery and receiving process flow. The improvement plan for the delivery process is to combine the print job order and gate in delivery as shown in Figure. 6. Meanwhile, for the receiving activity, repairs will be carried out by merging the print job order and gate in receiving as shown in Figure. 7. This is done to save the container cycle time so that it becomes more effective and efficient.

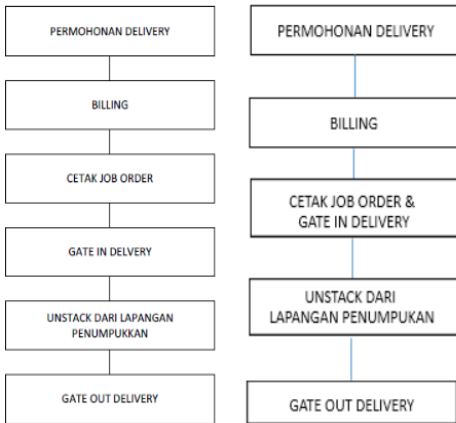


Figure 7. Delivery Activity – Existing (Left), the Result (Right)

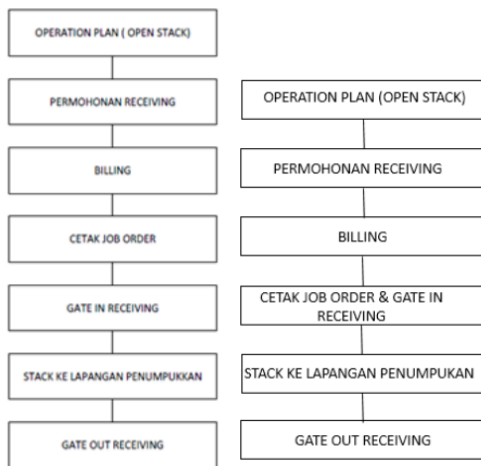


Figure 8. Receiving activity – Existing (left), the result (right)

2) Scenario improvement results from the discovery process and prediction and real-time process one improvement technique is to add a menu in the display of the Order

Delivery Job, which displays the requirements for completing documents so that if one of the requirements cannot be met, the delivery request is automatically not approved.

If the cancel delivery process is omitted in the data, different simulations are obtained, with different variant and case results.

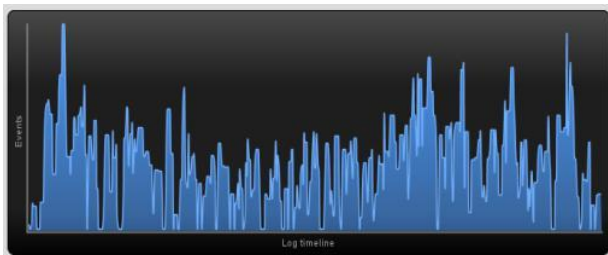


Figure 9. The Graph of the Analysis of Delivery Cancel Conditions is Omitted.

TABLE 15.
EVENT LOG ANALYSIS

Number of case	327
Number of activity	15
Number of events	21.299
Start	02.11.2018 02:45:00
End	31.03.2019 16:33:00
Median case duration	17,4 hours
Mean case duration	53,8 hours
Number of variants	255

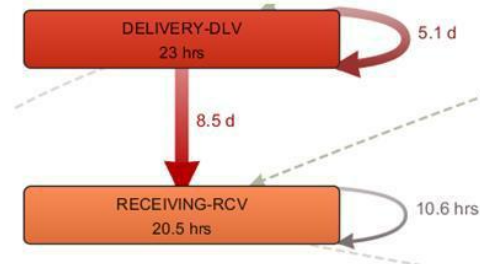


Figure 10. Loop process of delivery cancel conditions are omitted

When an improvement simulation is carried out by eliminating the cancel loading delivery, the results of the analysis of the activation process are as follows.

TABLE 16.
RESULTS OF PROCESS ANALYSIS FOR ACTIVITY

Activity	Procentage
Loading	7731 (36,3%)
Receiving	4882 (20,28%)
Discharge	4320 (10,93%)
Delivery	1183 (6,77%)

TABLE 17.
MEAN DURATION FOR ACTIVITY

Activity	Mean duration
Loading	20 hours 52 minutes
Receiving	20 hours 29 minutes
Discharge	21 hour 50 minutes
Delivery	23 hours 51 seconds

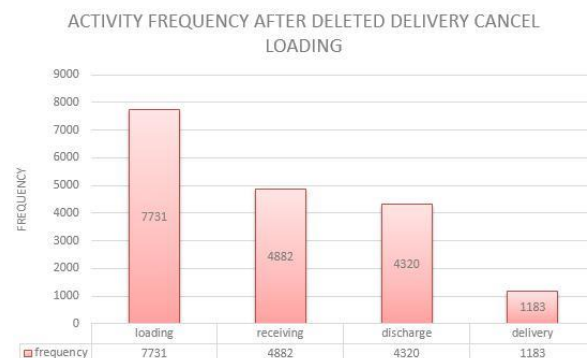


Figure.11. Activity Frequency After Deleted Delivery Cancel Loading.

TABLE 18.
RESULTS OF PROCESS ANALYSIS FOR "RESOURCES"

Resources	Procentage
CC 04	4485(21,06%)
CC 05	4335 (20,35%)
CC03	3903(18,32%)
CC01	3237 (15,2%)

TABLE 19.
MEAN DURATION FOR RESOURCES

Resources	Mean duration
CC04	21 hour 36 minutes
CC05	22 hours 32 minutes
CC03	19 hours 46 minutes
CC01	22 hours 5minutes

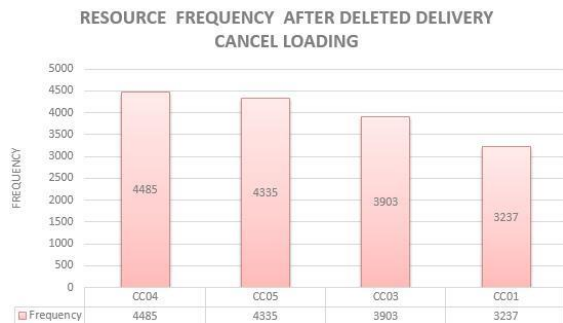


Figure 12. Resources frequency after deleted delivery cancel loading

From the tables and graphs, it can be seen that the tool that is often used is CC04 with an average duration of 21 hour 36 minutes with a frequency of use of 4485 times.

By reducing the frequency of occurrence of cancel loading delivery events and even by eliminating, because then the time needed for the loading and unloading cycle

will be reduced, making it more effective and efficient. Next, a comparison before and after the cancel loading delivery activity will be displayed, so that the amount of time savings can be determined directly.

TABLE 20.
COMPARISON BEFORE AND AFTER ELIMINATION OF THE CANCEL LOADING DELIVERY PROCESS

Comparison	Before	After	Difference
Median case duration	17,7 hours	17,4 hours	0,3 hours
Mean case duration	65,4 hours	53,8 hours	11, 6 hours
Number of Variants	279	255	24

From the table above, it can be seen that after the elimination process in cancel delivery activities is carried out, the average duration of time is shorter, so it is more efficient and can improve the performance of the flow of container activity processes. The difference in average time is 11.6 hours. This value is very influential on the flow of container loading and unloading processes, by saving time it can reduce the number of ship queues and facilitate container loading and unloading operations.

IV. CONCLUSION

In conclusion, after eliminating the cancel delivery activities, the reduction in the duration of the average time from 65.4 hours to 53.8 hours is reduced. So, the time decreases by ± 11.6 hours, which means it reduces the cycle time and increases more productivity of the loading-unloading container.

REFERENCES.

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