Simulation optimization of truck queue loading process discrete simulation approach with Promodel Software at PT. XYZ

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ABSTRACT

This research focuses on optimizing truck queues in the Loading processes at PT. XYZ in Karawang. This research aims to optimize truck queues in the loading process at PT. XYZ uses a discrete simulation approach with ProModel software. The problem of long truck queues and high delivery order (DO) waiting times disrupted the operational efficiency of distribution facilities. In this study, 3 simulation scenarios were tested to evaluate the impact of adding loading docks on throughput, waiting time, and resource usage by removing the Delivery Order (DO) waiting time. The data collected includes loading process time, namely truck arrival data, warehouse information data, transport truck information data, and product information data implemented using ProModel software and then validated through replication tests and validity tests using the t-test method. The simulation results show that using scenario 1, the addition of one loading dock increases throughput by 45% and reduces the average wait time from 18 minutes to 9.3 minutes per truck. In addition, the use of resources becomes more optimal, increasing overall productivity. With these results, the study concludes that the addition of loading dock is an effective solution to overcome bottlenecks in the loading process at PT. XYZ, which can be implemented to improve operational efficiency.

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1. Introduction

A warehouse is a place used to store goods in large quantities in anticipation of fluctuating consumer demand. In addition, warehouses also function as temporary storage for finished goods, semi-finished goods, raw materials, spare parts, equipment, and a place to add value to an item, or any goods that support the activities of a company (Zhang et al., 2016). Good warehouse management can reduce losses and costs, as well as improve service speed and operational efficiency. Each warehouse is designed to meet the specific needs of a company's supply chain activities, so its operations can differ from one business to another.

PT. XYZ is a company that produces culinary products with typical Indonesian flavors and has a warehouse to store these items. However, there are problems that hinder supply chain activities, especially in the process of loading goods in the warehouse loading dock. PT. XYZ uses four types of trucks for distribution, namely CDD, Axle, Container, and Tronton load trucks, with three active loading docks. The average time of truck service tends to be long, leading to the next truck queue, which can result in cost losses and decreased customer satisfaction due to customer loss. Queuing system analysis can be done by conducting research at the place where the queue occurs. In this research, it must go through a condition where the service system is functioning optimally (Hanrizaldi Bagus Satrio Langgeng, Hilyatun Nuha, 2022).

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This research aims to minimize truck queues in the loading process at the PT. XYZ by decreasing the average time in system by increasing the number of loading docks. ProModel provides effective tools for simulating complex systems, enabling detailed analysis of process efficiency and bottleneck identification. The research data used is data on the fleet loading time cycle to provide an overview of the performance of the loading process of each fleet. This data presents about the average load time for each fleet or vehicle type, which can help identify the most efficient fleet and which need improvement. This data also shows variations in loading process times between fleets or vehicle types, which can reveal differences in loading process efficiency. This analysis makes it possible to evaluate the loading performance of the fleet based on the type of goods being transported and identify areas where efficiency improvements can be made, including the delay time that occurs in the DO process during loading activities.

2. Methods

The Fig. 1 following is a picture of the flow chart in this research divided into introduction up to the results:

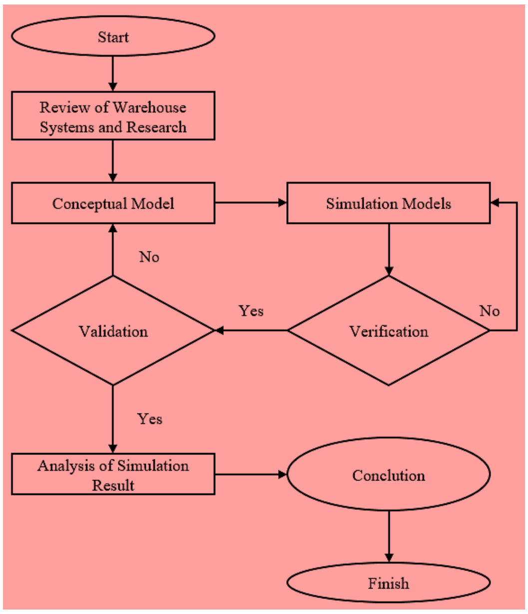

Fig. 1 Flow Chart

The simulation research on truck queue optimization in the loading and loading process using a discrete simulation method with ProModel software aims to improve efficiency in truck queue management during the loading process. The initial step involves an in-depth understanding of the workflow and the factors that affect performance, such as loading capacity and runtime. Through modelling with ProModel, elements such as trucks, loading areas, and process times are integrated into the simulation model. This type of research can be categorized as quantitative research, which involves collecting numerical data that can be statistically analyzed to answer research questions and test hypotheses. In this study, the data collected includes truck arrival data, warehouse information data, transport truck information data, and product information data.

Warehousing not only includes goods storage activities, but also the handling of goods starting from receipt and recording, storage, selection, labelling, to delivery of goods (Warman, 2010:75). Through good warehousing management, transportation distances in distributing goods can be shortened and the frequency of item picking and delivery to customers can be increased. Warehouses are needed in the process of coordinating the distribution of goods due to the imbalance between the supply and demand processes, which encourages the emergence of inventory or inventory that requires temporary storage space. Supply chain management is a series of activities that include planning, managing, and activating products, with an efficient-based cost strategy to increase profits (Jebarus, 2001). The use of information technology, such as software, is indispensable to manage this process.

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Queue theory discusses the mathematical study of queues, which occurs when the arrival of customers exceeds the capacity of the service. Simulation is the modeling of real systems based on events that take place over time (R.C. Harrell, 2004). Discrete refers to data or variables that can only take a finite specific value, as opposed to a continuous one. Discrete simulations model a system that evolves according to changes in certain variables under certain conditions, and is suitable for problems with specific time stages. The advantage of discrete simulation is its ability to model wait times that are not clearly known in a system. Simulation-optimization seeks and makes decisions from the results of experiments by verifying, validating, and analyzing data to find optimal conditions (Suprianto et al., 2018).

ProModel is a software used to simulate and analyze production systems of various types and sizes. The software allows the creation of realistic simulation models of the loading and unloading process of trucks, including all variables such as waiting time, loading time, loading capacity, and truck arrival patterns. ProModel provides the flexibility to easily add dock doors to the simulation model, allowing researchers to evaluate the impact of adding the number of loading docks on throughput and operational efficiency. ProModel also supports optimization and sensitivity analysis to examine how parameter changes affect simulation results. Validation and verification of simulation models is important to ensure the accuracy of the model by comparing the simulation results with empirical data or field observations.

3. Results and Discussion

The optimization of the loading process is a crucial aspect in logistics management, especially for large companies such as PT. XYZ which faces the challenges of truck queuing and dock loading efficiency. This research focuses on data collection and analysis to understand existing obstacles and find optimal solutions through discrete simulations using ProModel software. Here's the Summary Loading Time from Company Data that use:

Table 1 Summary loading time of transporter fleet with 3 loading docks

	Work Element	Declare (Second)			
		CDD	Axle	Tronton	Container
Summary	Total Time (In Seconds)	4581	7955	9568	5164
	Total Time (In Minutes)	76	133	159	86
	Total Time (In Hours)	1.3	2.2	2.7	1.4
	FG Withdrawal Time from Production (In Hours)	2	2	2	2
	FG Withdrawal Time from FS (In Hours)	0.7	0.7	0.7	0.7
	Loading Dock	3	3	3	3
	Available Time (In Hours)	11.3	11.3	11.3	11.3
	Maximum Number per Fleet Type	27	15	13	24
	Loading Portion	48%	18%	18%	16%
	Maximum Amount per Fleet Type according to Portion	13	3	2	4
	Hood. Per day	7		Car/day	
	Caps per 3 LD	22		Car/day	

Data Collection and Problems

In the context of loading and loading, data collection is a solid foundation for understanding the challenges and opportunities associated with this process, as well as helping to develop effective strategies to optimize load performance and efficiency. During the research process at PT. XYZ, data collected from the company and observations in the field. Based on the loading process using one server (checker), the loading process of PT. XYZ is categorized as an M/M/1 type queue, according to the company's data regarding the loading process that has occurred. The researcher collected important data during the loading process to be applied into the ProModel software to align the research objectives, which is to optimize the truck queue during loading by adding one loading dock. The following data was collected:

a. Truck Arrival Data
Fig. 2. describes the fluctuation in the number of truck arrivals during the operating hours of the PT. XYZ:

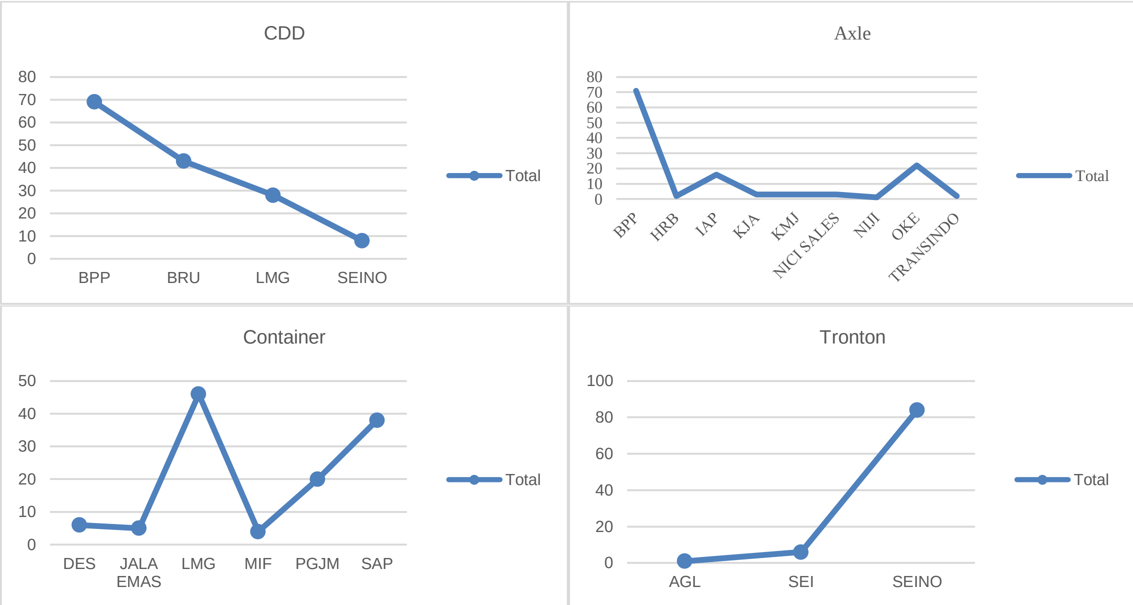

Fig. 2 Data arrivals for each type of truck.

b. Warehouse Information Data
Table 2 Contains warehouse information of PT. XYZ, which consists of operating hours and warehouse dimensions. Also in Fig. 3 is a depiction of the existing layout of the current warehouse.

Table 2 Warehouse information data

Depot	Operating Hours	Dimensions Warehouse	Loading Dock Size	Pallet Size 100cm x 120cm			
				CDD	Axle	Container	Tronton
Warehouse	SHIFT 1 (07:00 – 15:00) SHIFT 2 (15:00 – 23:00)	30cm x 48cm x 8m	12m x 6m	16 Pallet	45 Pallets	28 Pallets	52 Pallets

c. Transport Truck Information Data
The haul truck information is detailed in Table 3, loading size, capacity, loading time, vehicle speed, loading cost, and fix cost of each truck.

Table 3 Transport truck information data

No	Kind	Dimensions (cm)	Capacity (Tons)	Loading Time (seconds/ Ton)	Vehicle Speed (m/h)	Whole Fit Portion Armada
1	CDD	5300 x 2000 x 2100	5	3981	500 - 700	48%
2	Axle	2000 x 1500 x 700	12	7395	450 - 650	18%
3	Container	1219.2 x 243.8 x 259,1	10	8968	400 - 600	18%
4	Tronton	1200 x 300 x 300	20	4684	400 - 550	16%

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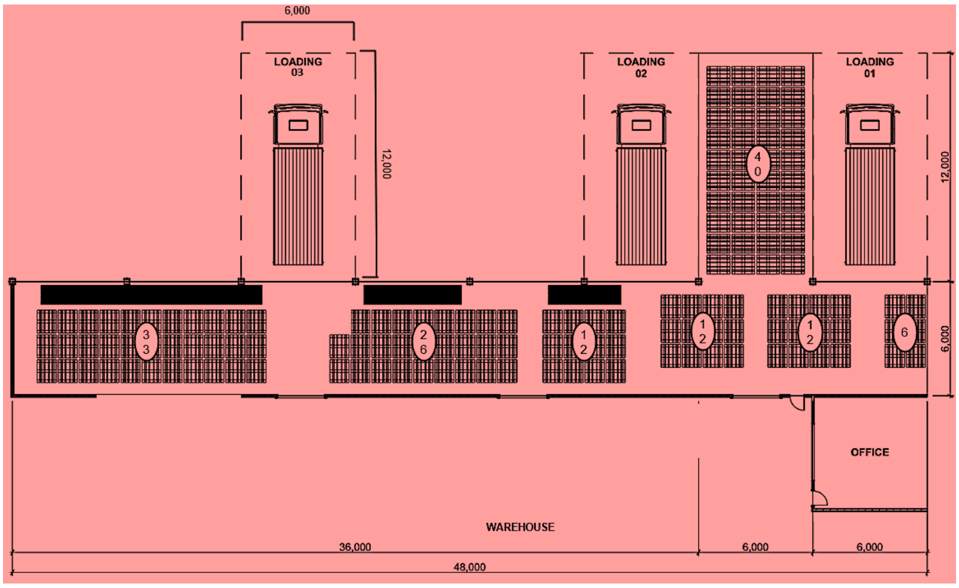


Fig. 3 Existing loading dock layout.

d. Seasoning Information Data
   Table 4 explains that each product of PT. XYZ.

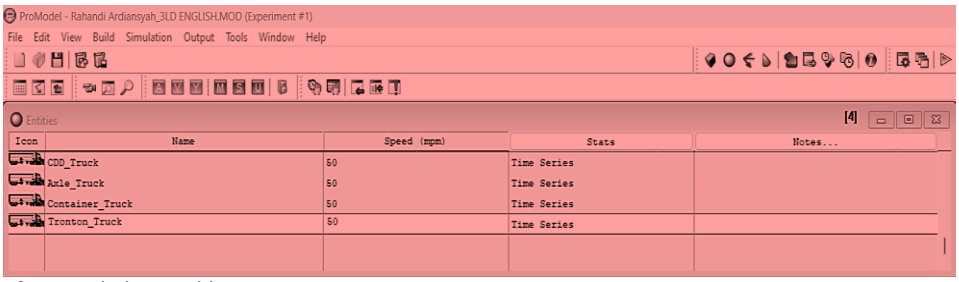
Table 4 Seasoning information data

Product Name	Size / Timing per Box	Number of Boxes/ pallet	Pallet mass
	Pet = 135 ml x 48 pcs	70	453.6 kg
Chili Sauce and Tomato Sauce	Tanggung= 275 ml x 24 pcs	70	462 kg
	Botol = 335 ML 12	40	160.8 kg
	Bag = 8 gr x 504 pcs	75	302.4 kg
Homemade Chili Sauce	Bag = 200 gr x 12 pcs	88	211.2 kg
	Pet = 135 ml x 48 pet	70	453.6 kg
	Bear = 275 ml x 24 bear	70	462 kg
Sweet Soy Sauce	Sachet = 225 ml x 12 Sachet	60	162 kg
	Gallon = 5, 7 x 4 pcs	20	456 kg
	Pack = 520 ml x 12 pack	60	374.4 kg
Special Ready-to-Eat Seasoning	Pack = 45 gr x 24 pcs 6 box	36	233.3 kg
Ready to Eat Seasoning – Potatoes	Pcs = 25 gr x 20 pcs	96	48 kg
Ready-to-eat Seasoning	Packs = 33 gr x 200 packs	40	264 kg
	Pcs = 250gr x 24 pcs	77	462 kg
Seasoning	Pcs = 10 gr x 288 pcs	96	276.48 kg
	Cube = 20 gr x 100	120	240 kg
Seasoning Flour	Sachet = 75 gr 120 packs	35	315 kg
	Wrap = 210 gr x 24 pcs	54	272.16 kg

Development of Existing System Simulation Models

The following are the inputs in creating an existing system simulation model carried out with ProModel software:

a. Entities
   In the ProModel software, the entities are populated as shown by the following Fig. 4.



Icon	Name	Speed (mpm)	Stats	Notes...
	CDD_Truck	50	Time Series	
	Axle_Truck	50	Time Series	
	Container_Truck	50	Time Series	
	Tronton_Truck	50	Time Series	

Fig. 4 Existing entities.

b. Location

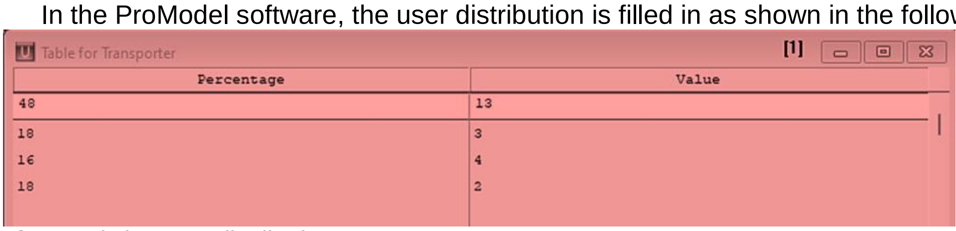
In the ProModel software, the location is filled in as shown in the following Fig. 5.

Icon	Name	Cap.	Units	DTs...	Stats	Rules...	Notes...
	Trucks_Enter	22	1	None	Time Series	Oldest	
	Entry_Queue	INFINITE	1	None	Time Series	Oldest, FIFO	
	Check_In_Security_Guard	1	1	None	Time Series	Oldest	
	Queue_to_Enter_Warehouse_Area	INFINITE	1	None	Time Series	Oldest, FIFO	
	Report_Warehouse_and_PO	1	1	None	Time Series	Oldest	
	Queue_to_Enter_Loading_and_Parking_Area	INFINITE	1	None	Time Series	Oldest, FIFO	
	Make_DO_TO	1	1	None	Time Series	Oldest	
	Cars_Enter_Loading_Area	INFINITE	1	None	Time Series	Oldest, FIFO	
	Loading_Dock_1	1	1	None	Time Series	Oldest	
	Loading_Dock_2	1	1	None	Time Series	Oldest	
	Loading_Dock_3	1	1	None	Time Series	Oldest	
	Queue_for_Travel_Documents	INFINITE	1	None	Time Series	Oldest, FIFO	
	Make_and_Hand_Over_Travel_Documents	1	1	None	Time Series	Oldest	
	Leave_The_Warehouse_Area	INFINITE	1	None	Time Series	Oldest, FIFO	
	Check_Out_Security_Guard	22	1	None	Time Series	Oldest	

Fig. 5 Existing location.

c. User Distribution

In the ProModel software, the user distribution is filled in as shown in the following Fig. 6.

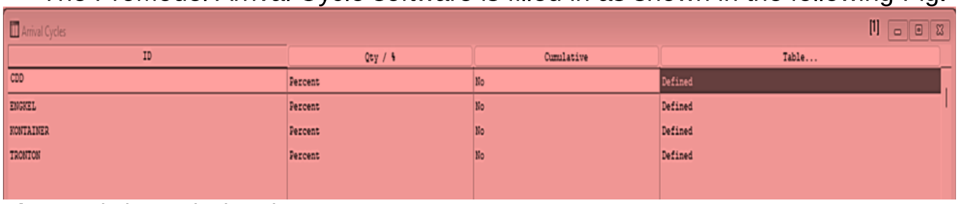


Percentage	Value
48	13
18	3
16	4
18	2

Fig. 6 Existing user distribution.

d. Arrival Cycle

The ProModel Arrival Cycle software is filled in as shown in the following Fig. 7.

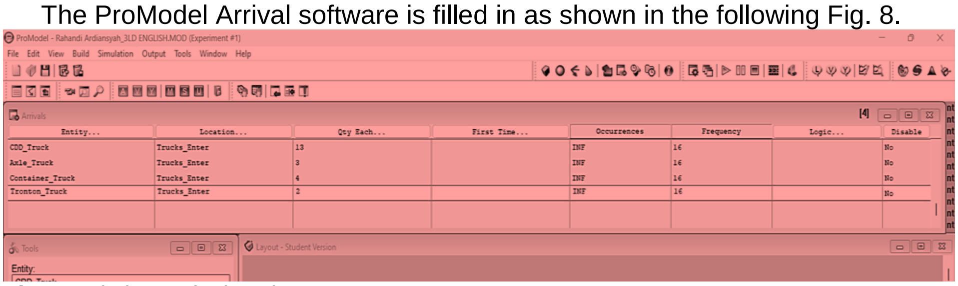


ID	Qty / %	Cumulative	Table...
CDD	Percent	No	Defined
ENGKEL	Percent	No	Defined
KONTAINER	Percent	No	Defined
TRONTON	Percent	No	Defined

Fig. 7 Existing arrival cycle.

e. Arrival

The ProModel Arrival software is filled in as shown in the following Fig. 8.



Entity...	Location...	Qty Each...	First Time...	Occurrences	Frequency	Logic...	Disable
CDD_Truck	Trucks_Enter	13		INF	16		No
Axle_Truck	Trucks_Enter	3		INF	16		No
Container_Truck	Trucks_Enter	4		INF	16		No
Tronton_Truck	Trucks_Enter	2		INF	16		No

Fig. 8 Existing arrival cycle.

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f. Processing
The Processing software is filled in as shown in the following Fig. 9.

Entity...	Location...	Operation...
Axle_Truck	Check_Out_Security_Guard	WAIT 8 min
Container_Truck	Trucks_Enter	Wait 1 min
Container_Truck	Entry_Queue	
Container_Truck	Check_In_Security_Guard	Wait 1 min
Container_Truck	Queue_to_Enter_Warehouse	
Container_Truck	Report_Warehouse_and_PO	WAIT 28 min
Container_Truck	Queue_to_Enter_Loading_a	
Container_Truck	Make_DO_TO	WAIT 12 min
Container_Truck	Cars_Enter_Loading_Area	WAIT 3 min
Container_Truck	Cars_Enter_Loading_Area	WAIT 3 min
Container_Truck	Cars_Enter_Loading_Area	WAIT 3 min
Container_Truck	Loading_Dock_1	WAIT 39 min
Container_Truck	Loading_Dock_2	WAIT 39 min
Container_Truck	Loading_Dock_3	WAIT 39 min
Container_Truck	Queue_for_Travel_Documen	
Container_Truck	Make_and_Hand_Over_Trave	WAIT 5 min
Container_Truck	Leave_The_Warehouse_Area	WAIT 2 min
Container_Truck	Check_Out_Security_Guard	WAIT 8 min
Tronton_Truck	Trucks_Enter	Wait 1 min
Tronton_Truck	Entry_Queue	
Tronton_Truck	Check_In_Security_Guard	Wait 1 min
Tronton_Truck	Queue_to_Enter_Warehouse	
Tronton_Truck	Report_Warehouse_and_PO	WAIT 24 min
Tronton_Truck	Queue_to_Enter_Loading_a	
Tronton_Truck	Make_DO_TO	WAIT 22 min
Tronton_Truck	Cars_Enter_Loading_Area	WAIT 13 min
Tronton_Truck	Cars_Enter_Loading_Area	WAIT 13 min
Tronton_Truck	Cars_Enter_Loading_Area	WAIT 13 min
Tronton_Truck	Loading_Dock_1	WAIT 95 min
Tronton_Truck	Loading_Dock_2	WAIT 95 min
Tronton_Truck	Loading_Dock_3	WAIT 95 min
Tronton_Truck	Queue_for_Travel_Documen	
Tronton_Truck	Make_and_Hand_Over_Trave	WAIT 5 min
Tronton_Truck	Leave_The_Warehouse_Area	WAIT 2 min
Tronton_Truck	Check_Out_Security_Guard	WAIT 8 min

ProModel - Rahandi Ardiansyah_3LD ENGLISH.MOD (Experiment #1)
File Edit View Build Simulation Output Tools Window Help

Entity...	Location...	Operation...
CDD_Truck	Trucks_Enter	WAIT 1 min
CDD_Truck	Entry_Queue	
CDD_Truck	Check_In_Security_Guard	WAIT 1 min
CDD_Truck	Queue_to_Enter_Warehouse	
CDD_Truck	Report_Warehouse_and_PO	WAIT 21 min
CDD_Truck	Queue_to_Enter_Loading_a	
CDD_Truck	Make_DO_TO	WAIT 15 min
CDD_Truck	Cars_Enter_Loading_Area	WAIT 9 min
CDD_Truck	Cars_Enter_Loading_Area	WAIT 9 min
CDD_Truck	Cars_Enter_Loading_Area	WAIT 9 min
CDD_Truck	Loading_Dock_1	WAIT 26 min
CDD_Truck	Loading_Dock_2	WAIT 26 min
CDD_Truck	Loading_Dock_3	WAIT 26 min
CDD_Truck	Queue_for_Travel_Documen	
CDD_Truck	Make_and_Hand_Over_Trave	WAIT 5 min
CDD_Truck	Leave_The_Warehouse_Area	WAIT 2 min
CDD_Truck	Check_Out_Security_Guard	WAIT 8 min
Axle_Truck	Trucks_Enter	Wait 1 min
Axle_Truck	Entry_Queue	
Axle_Truck	Check_In_Security_Guard	Wait 1 min
Axle_Truck	Queue_to_Enter_Warehouse	
Axle_Truck	Report_Warehouse_and_PO	WAIT 32 min
Axle_Truck	Queue_to_Enter_Loading_a	
Axle_Truck	Make_DO_TO	WAIT 23 min
Axle_Truck	Cars_Enter_Loading_Area	WAIT 10 min
Axle_Truck	Cars_Enter_Loading_Area	WAIT 10 min
Axle_Truck	Cars_Enter_Loading_Area	WAIT 10 min
Axle_Truck	Loading_Dock_1	WAIT 62 min
Axle_Truck	Loading_Dock_2	WAIT 62 min
Axle_Truck	Loading_Dock_3	WAIT 62 min
Axle_Truck	Queue_for_Travel_Documen	
Axle_Truck	Make_and_Hand_Over_Trave	WAIT 6 min
Axle_Truck	Leave_The_Warehouse_Area	WAIT 2 min

Fig.9 Existing processing.

g. Variable
The Processing software is filled as shown by the following Fig. 10.

ProModel - Rahandi Ardiansyah_3LD ENGLISH.MOD (Experiment #1)
File Edit View Build Simulation Output Tools Window Help
Variables (global)

Icon	ID	Type	Initial value	Stats	Notes...
Yes	Truck	Real	0	Time Series, Time	

Fig. 10 Existing variables.

h. Macros
The Macros software is filled in as shown by the following Fig. 11.

Fig. 11 Existing Macros.

i. Layout Model
The Layout Model software is filled in as shown in the following Fig. 12.

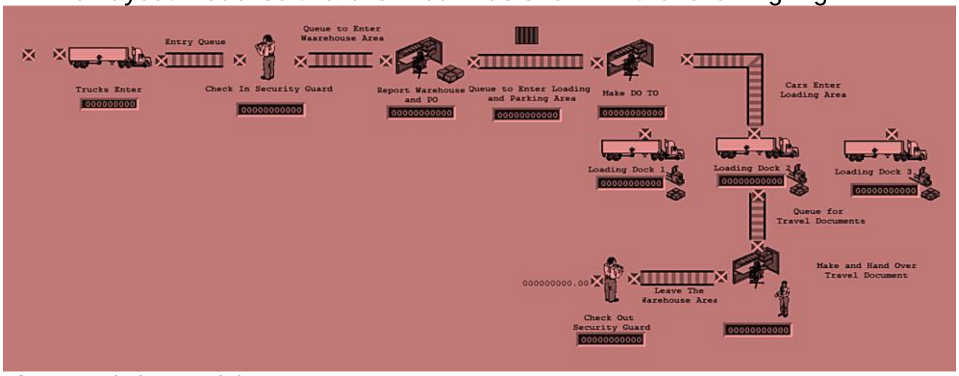

Fig. 12 Existing Model Layout

j. Validation Test
This simulation model is valid and able to represent the actual loading and loading system well. This successful validation gives confidence that the model can be used to conduct further simulation experiments to optimize workflows and improve operational efficiency at the facility.

k. Summary of Existing Modelling Results

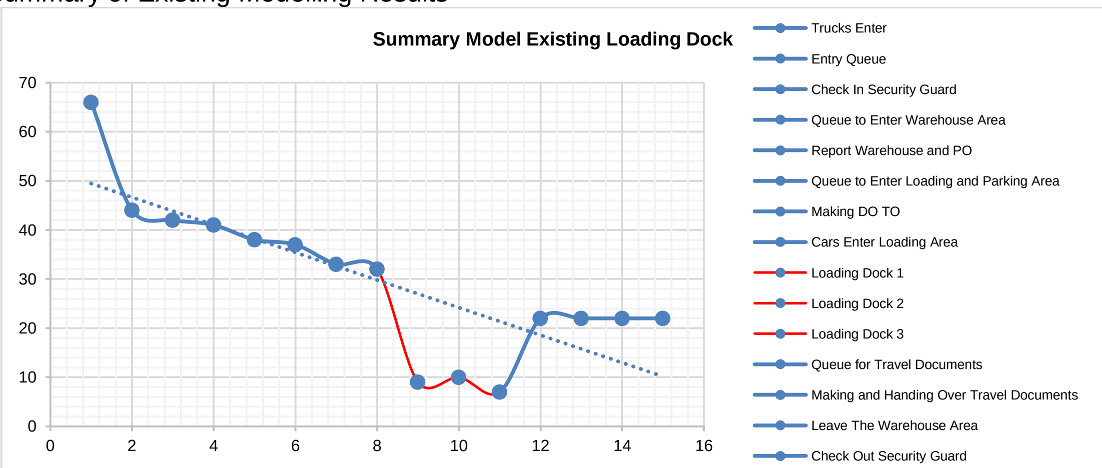

Fig. 13 Summary of Existing Model

From an operational perspective, this study indicates that in order to achieve maximum efficiency improvement, in addition to adding loading docks, it is necessary to make improvements in the administrative process related to the elimination of DO waiting time.

Proposed Scenario Simulation Model

The proposed scenario developed is made into 3 Scenarios by looking for 1 Scenario that best suits the purpose of minimizing the number of queues by increasing the number of loading docks available at the PT. XYZ. The range of the number of loading docks that can be added is around 1 loading dock so that the proposed number becomes 4 loading docks with the addition of a prepare table in the warehouse to meet the amount of good finish materials.

The warehouse currently has three loading docks, so there are often queues that result in delays in the delivery order (DO) and loading process. To overcome the problem, eliminating the DO process time can be done so that it has met the target time that has been set by PT. XYZ. So that the summary is obtained as in Table 5.

Table 5 Summary Loading Time Loading Fleet Transporter with 4 Loading Docks

	Work Element	Declare (Second)			
		CDD	Axle	Tronton	Container
Summary	Total Time of One Cycle (in seconds)	3981	7395	8953	4684
	Total Time of One Cycle (in minutes)	66	123	149	78
	Total Time One Cycle (In Hours)	1,1	2,1	2,5	1,3
	FG Withdrawal Time from Production (In Hours)	2,0	2,0	2,0	2,0
	FG Withdrawal Time from FS (In Hours)	0,7	0,7	0,7	0,7
	Loading Dock	4	4	4	4
	Available Time (In Hours)	11,3	11,3	11,3	11,3
	Maximum Number per Fleet Type	41	22	18	34
	Loading Portion	48%	18%	18%	16%
	Maximum Amount per Fleet Type according to Portion	20	4	3	5
	Hood. Per day	8		Car/day	
	Capacity/4 LD	32		Car/day	

a. Relayout 4 loading dock

Based on the layout, it can be known how the location and flow of the loading and loading process with the addition of loading docks to 4 loading docks:

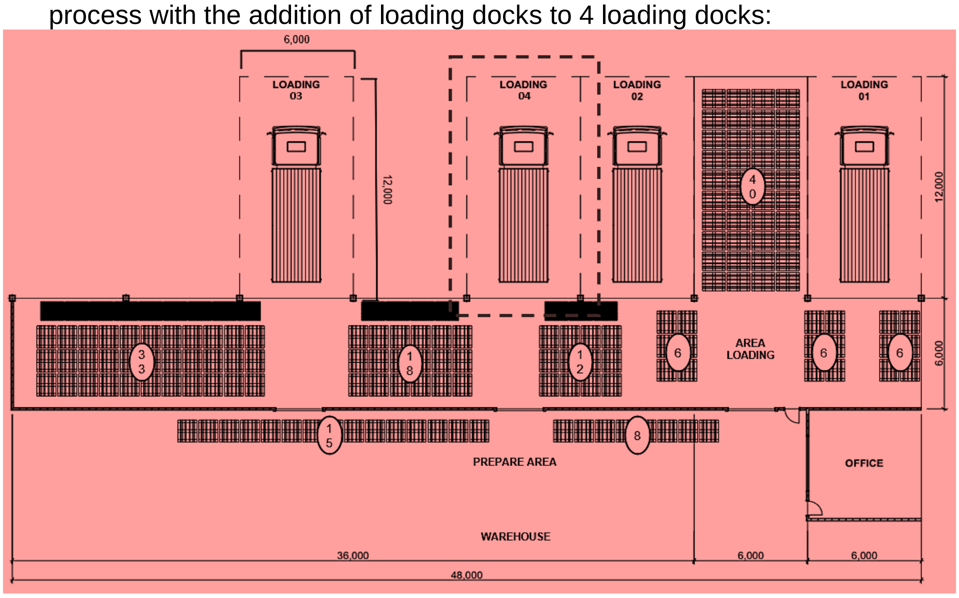

Fig. 14 Relayout 4 loading dock.

The Fig. 15 is a model of the loading queue process scenario with a total of four loading docks using ProModel software.

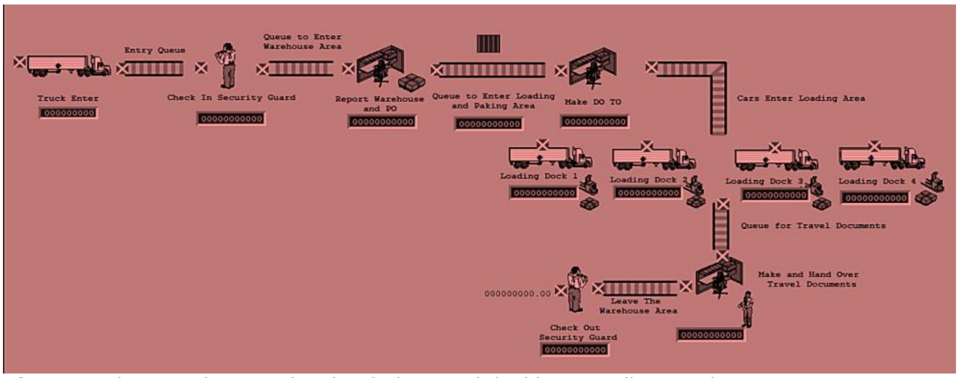

Fig. 15 Relayout of Scenario Simulation Model with 4 Loading Docks

b. The Danger of Scenario 1

The following is the result of the Entity States-Baseline Output from the proposal with 4 Loading Docks using ProModel software

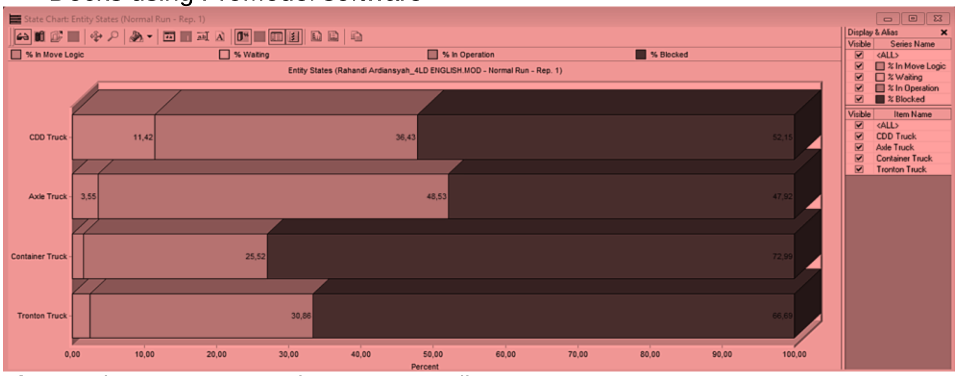

Fig. 16 Diagram Output Entity States-Baseline

The Table 6 show the results of the Scoreboard Output of the proposed 4 Loading Dock using ProModel software.

Tabel 6 Output Scoreboare 4 loading dock

Name	Total Exits	Average Time In System (Min)	Average Time In Operation (Min)
CDD	20	367.62	133.92
Axle	3	423.08	205.33
Container	6	671.61	171.42
Tronton	3	777.41	239.93

The results of the Single Capacity Location State–Baseline Output and the Multiple Capacity Location State–Baseline of the proposed 4 Loading Dock using ProModel software.

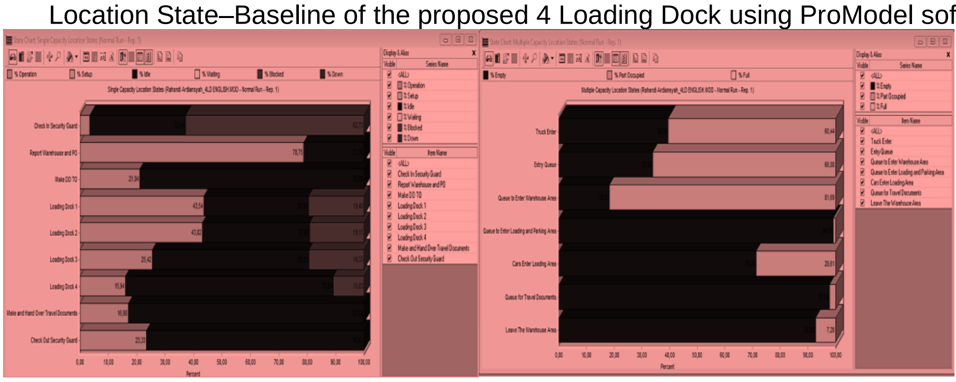

Fig. 17 Diagram output capacity.

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After the analysis using the ProModel, here are the summary results from Scenario 1:

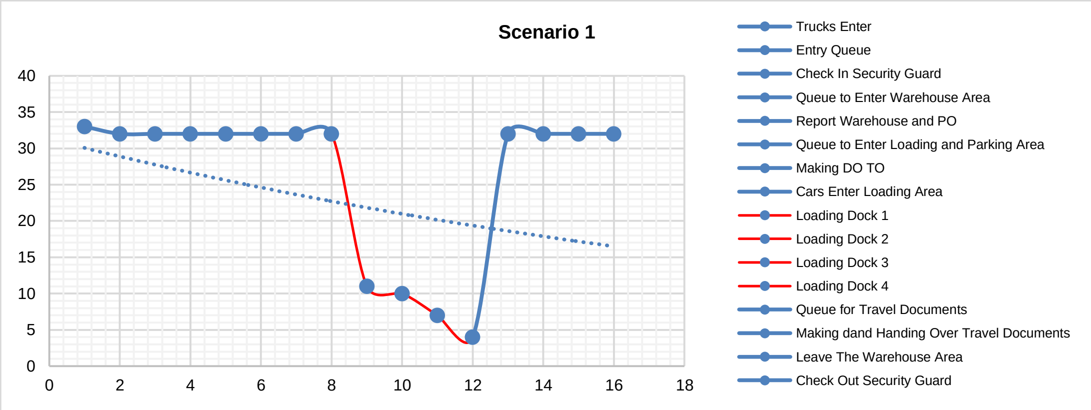

Fig. 18 Summary scenario 1.

The scenario has significant results according to the Improve Truck Arrival data on 4 Loading Docks that have been created with a total of 32 trucks/day with a significant reduction in queues on each Loading Dock showing the Exponential distribution flow.

c. The Perils of Scenario 2

After the analysis using ProModel, here is a summary of the results of the implementation:

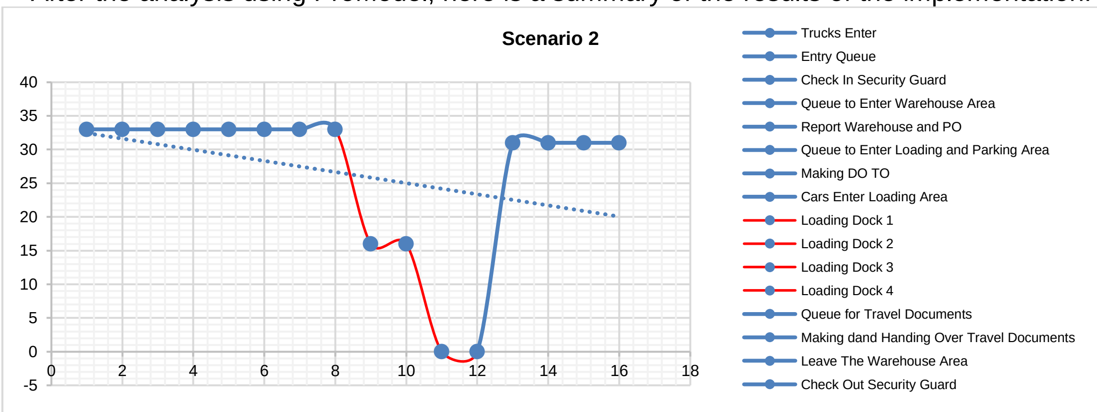

Fig. 19 Summary scenario 2.

Scenario 2 is not significant and does not match the Improve Arrival data of 4 Loading Dock Trucks with a total of only 31 trucks/day in Scenario 2.

d. The Devil's Nest 3

After the analysis using the ProModel, here are the summary results from Scenario 3:

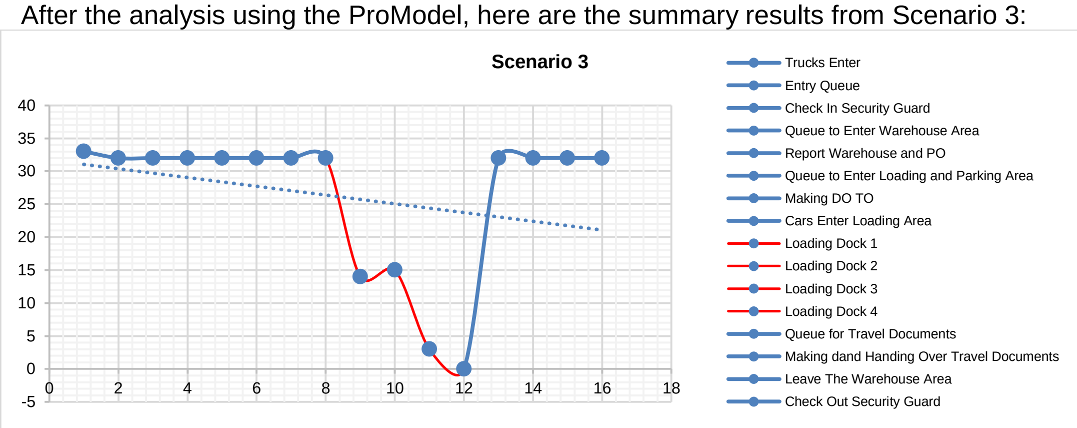

Fig. 20 Summary scenario 3.

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The scenario has significant results according to the Improve Truck Arrival data on 4 Loading Docks that have been made with a total of 32 trucks/day. However, there is too little loading activity that occurs in Loading Dock 4 so that it is not efficient to propose in depth.

e. Validation Test

Based on the results of the three scenarios that have been carried out, Scenario 1 can be used as the most effective proposal and a validity test is carried out.

Based on replication tests, there are the results of the related data replication calculations:

Table 7 Calculation of Many Replication of Loading and Loading Process

Replication	Real System Time (minutes/loading)	(Xi-Xavg)^2
1	78.95	197.09
2	78.50	209.93
3	121.52	813.83
4	92.99	0.00
Average	92.99	
	S. Deviation	352
	Lots of Replication	156

Based on the validity test, the following t-stat results of the Loading and Loading Process:

Table 8 T-Stat Validity Test of Loading Process 4 Loading Dock

	Real Time	ProModel
Mean	220.8214286	220.3730471
Variance	162976.6399	163075.7216
Observations	7	7
Pearson Correlation	0.999999127	
Hypothesized Mean Difference	0	
df	6	
t Stat	2.166666667	
P(T<=t) one-tail	0.036699328	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.073398656	
t Critical two-tail	2.446911851	

The table above shows that the t-stat value is smaller than the two-tail critical t-value, which means that H0 is accepted, so the runtime data on the real system in the Loading and Loading process can be said to be valid.

Based on the verification test, it is revealed that the simulation model can accurately describe the variation in truck flow and dock utilization, with stable and reliable simulation results through repeated replication. With this verification, the simulation model is considered valid and can be used as an effective tool to conduct simulation experiments to identify opportunities to improve operational efficiency and optimize the management of loading docks at the facility.

Discussion

Through Scenario 1, a simulation was held to understand the effect of adding loading docks on throughput, wait time, and resource usage. The simulation results show that by adding one loading dock, the number of vehicles that can be serviced per day increases significantly, from an average of 22 vehicles to 32 vehicles, which represents a 45% increase in throughput. Vehicle wait times have also been reduced from about 18 minutes to 9.3 minutes, leading to an increase in overall efficiency.

In addition, the validity analysis conducted shows that the simulation model accurately replicates the loading and loading operations that occur in real distribution facilities. Validity tests and statistical tests performed, including t-tests, confirm that the simulated data and the actual data have a good fit, with acceptable differences. The increase in resource usage and the reduction of total cycle time from an average of 114 minutes to 104 minutes shows that the addition of a loading dock not only improves efficiency but also optimizes labor utilization. Research by Nur Layli Rachmawati et al (2022), Scenario 4 can significantly speed up the average truck time, 163.3 minues for small single trucks and 12.1 minutes for trailer trucks so that it is more effective to implement with a total reduction of 176.4 minutes or 8% lower than the existing condition.

Overall, the results of the study confirm that the addition of a loading dock is an effective solution to overcome bottlenecks in the loading and loading process. Investing in adding loading docks has proven to provide great benefits in terms of operational performance, reduced wait times, and increased productivity. By using ProModel as a simulation tool, this study proves that the addition of these facilities can have a significant positive impact on the operational efficiency of distribution facilities.

4. Conclusion

This research aims to optimize truck queues in the loading and loading process at PT. XYZ uses discrete simulations with ProModel. By adding one loading dock to four, the simulation results showed a 45% increase in facility throughput, from 22 trucks/day to 32 trucks/day. Model validation is performed by comparing the simulation output with historical data, showing accurate and reliable results. The simulation also identifies bottlenecks in truck flow and provides an optimal solution to reduce truck wait times from an average of 18 minutes to 9.3 minutes, as well as reduce the total cycle time for loading and unloading from 114 minutes to 104 minutes.

The results reveal that optimization can be achieved through the addition of loading docks and more efficient truck flow management. The implementation of the ProModel simulation model provides valuable insights for PT. XYZ to improve dock loading management, speed up the loading process, and reduce truck waiting time. These findings show that the use of discrete simulation is an effective tool in identifying and overcoming operational problems, so that it can be implemented to improve the efficiency and productivity of loading and unloading facilities at PT. XYZ significantly.

In conclusion, this study successfully shows that the use of discrete simulation with ProModel is an effective tool to identify and overcome problems in the loading and loading process and truck queue process at PT. XYZ. With model validation that shows accurate and reliable results, the recommendations from this simulation can be implemented to improve operational efficiency and optimize the performance of loading facilities. The implementation of suggestions such as the addition of loading docks, bottleneck analysis, and regular workforce training will help PT. XYZ in improving efficiency and productivity, and ensuring continuous operational improvements in the future.

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