Available online at: http://publikasi.mercubuana.ac.id/index.php/ijiem

IJIEM (Indonesian Journal of Industrial Engineering & Management)

ISSN (Print) : 2614-7327 ISSN (Online) : 2745-9063

Optimization Unloading Time Container Use Multiple-Channel Queuing Model at Car Industry

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ARTICLE INFORMATION

Article history:

Received: 17 November 2023
Revised: 11 January 2024
Accepted: 22 February 2024

Category: Research paper

Keywords:
Queue
Multiple-channel queuing model
Waiting time
Container parking
Cross-dock

DOI: 10.22441/ijiem.v5i3.24198

A B S T R A C T

The development of the car assembly industry in Indonesia is increasing from year to year and competition is getting tighter. To be able to compete in the competition, a system with low costs is needed. Logistics is an activity that does not add value and logistics is also included in the price formation elements. Logistics costs in Indonesia are high, reaching 30% of the total product. Waiting time for containers to be unloaded is a hidden cost and can reduce service levels. The aim of this research is to reduce waste when waiting to unload containers which is related to the capacity of the area waiting to unload containers. The method used is the Multiple-Channel Queuing Model queuing method where analysis is carried out to reduce waiting time so that there are no containers waiting outside the cross-dock warehouse. The results of the research found that by increasing the number of containers unloading docks, the unloading time could be reduced from 2.25 hours to 1 hour and increase the service level where the container waiting area which initially required 5 parking lots became 2 container parking lots. Not only can it reduce the number of queues outside the warehouse and reduce waiting times. In this study, it was found that by adding docking from 2 to 3, it can make a cost reduction of 1 million per month because there is no need to pay overtime costs to unload containers.

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1. INTRODUCTION

The development of the car assembly industry in Indonesia is increasing from year to year and competition is getting tighter (Irawan et al., 2018). An increase in sales always shows a good sales trend (Sultana & Amilin Ibrahim, 2014). If there is a decline, it will increase again in connection with economic developments. The current development of the car assembly industry also influences the distribution of industrial area areas (Serrano et al., 2021). One of them is the industrial area in Cikarang, wherein the industrial area there are four car assembly industries in one industrial area (Purba et al., 2023). The high level of activity in these industrial areas means that companies providing warehousing services will also be required to be able to compete and participate in

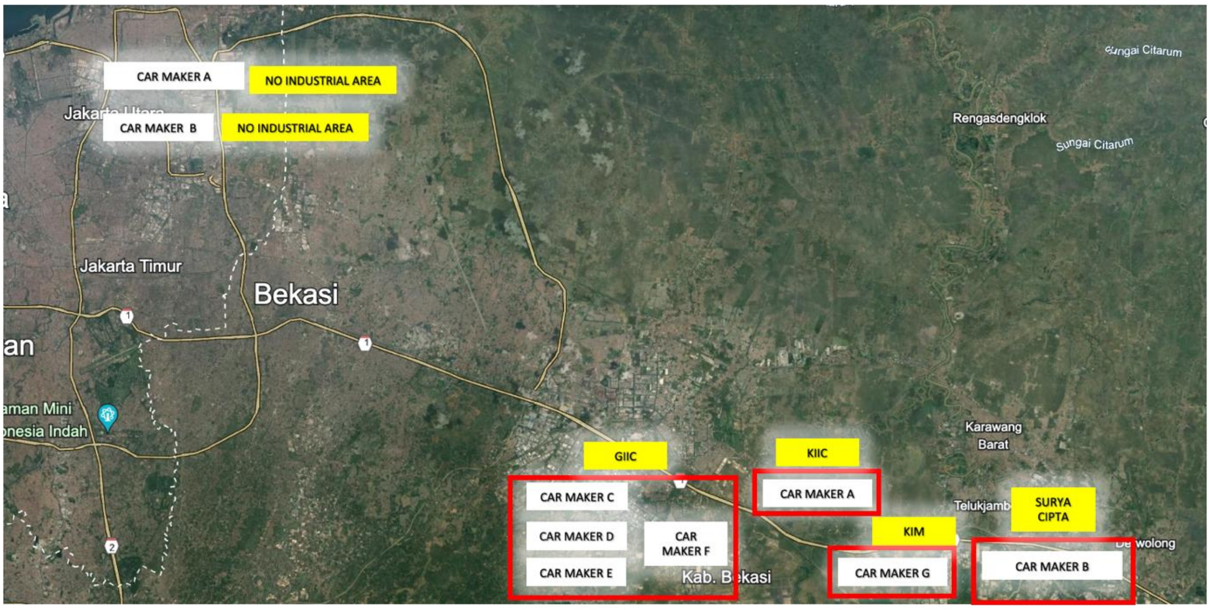

Figure 1. Car assembly industrial area

providing cheap services with a good level of service. This is also because logistics costs in Indonesia is high, reaching 30% of the total product (Barata, 2020) and the time waiting for the container to be unloaded is a hidden cost and can reduce the service level of warehousing for the car assembly industry (Guan & Liu, 2009). The aim of this research is to reduce waste when waiting to unload containers which is related to the capacity of the area waiting to unload containers (Shahpanah et al., 2014). This is also based on the regulation that containers cannot be parked outside the building area. If this happens, the industrial area manager can issue a warning and charge a price. Apart from that, if there are containers parked outside the warehouse area, it can disrupt traffic which can lead to security problems (Moatasim, 2023). This research aims to obtain ideal conditions for a cross-dock warehouse operating to serve the car assembly industry in the Cikarang area. The method used is the Multiple-Channel Queuing Model queuing method (Hasani Goodarzi et al., 2022), where analysis of running conditions and improvements is carried out to get the shortest waiting time and there are no containers parked outside the warehouse area.

2. LITERATURE REVIEW

This research will use the multi-channel-Single Phase (M/M/S) method to optimize service delivery (Dragan & Jereb, 2013). This method can be used to make improvements by looking at the overall container operation(Abbaspour et al., 2022). By making improvements using the (M/M/S) method, it is found that the service level can be increased because it reduces the total time spent on the container (Delfi Wiranda, 2022). The (M/M/S) method can be used in multi-door cross docking environment queuing systems, and this is like in car assembly companies (Hasani Goodarzi et al., 2022). A thorough analysis is needed to improve waiting times, including checking processes both physically and administratively (Burdzik et al., 2014). In the loading-unloading process in the warehouse, it is very important to calculate the efficiency of the material handling process starting from the movement of the forklift and the operator and the forklift (Amjath et al., 2023). In improving the queuing method, it is necessary to plan the arrival of the container, but if there are no congestion, administration and accident factors, this planning cannot be used (Wang et al., 2022). Planning in the use of cargo handling is very important, this is because using the wrong equipment can result in loading and unloading times for the container (Martinov, 2022). Planning in M/M/C can also be combined with vehicle routing problems where this planning can reduce the total time required for the total processing time (Suprata et al., 2020). The planning process for heading to the warehouse can also be done using the vehicle routing problem method (Burdzik et al., 2014). This research complements previous research where the improvement method uses the multi-channel queuing method (Hai & Masniyom, 2016) .The queue improvement process will be related to the capacity of the container waiting area which will also be related to the regulations of industrial areas in Indonesia (Pekih & Sutawijaya, 2023).

3. RESEARCH METHOD

This research method uses a multiple-channel queuing model which will carry out an initial analysis of the initial system running in a cross-dock warehouse that is operational to serve car assembly plants. Containers that arrive in the form of a Poisson number, which is a combination of several car assembly manufacturers whose data will be taken in units of container arrivals per hour which will be marked with (λ), Service capacity data from cross docking warehouses in units of hours marked with (μ), Data What is taken again is the docking capacity data used, denoted by (s). Truck parking data available in the cross-dock warehouse is marked with Container Waiting Area (Wc) (Table 1).

Table 1. Input and output multichannel-single phase (M/M/S)

Input	Output
Container waiting area (Wc)	Level intensity for serving (P)
Container Service per hours (μ)	Probabilities Container in system (Pn)
Container arrival per hours (λ)	Probabilities Container no in system (Po)
Total docking services (s)	Average time container in system (L)
	Average container waiting in system (Lq)
	Total time Container waiting in system (Wq)
	Target requirement (Wc >Lq)

From the data above, calculations will be carried out using the Multi-Channel-Singel Phase (M/M/S) queuing method formulation as follows:

level Intensity for Serving Warehouse

$$P = \frac{\lambda}{\mu . s} \quad (1)$$

Probabilities Container in Warehouse

$$Pn = \frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} \quad (2)$$

Average Container waiting in Warehouse.

$$Lq = \frac{Po\left(\frac{\lambda}{\mu}\right)^s P}{s!\,(1 - P)^2} \quad (3)$$

Time Container at the Waiting area

$$Wq = \frac{Lq}{\lambda} \quad (4)$$

Total Time Container Waiting in Warehouse

$$L = Lq + \frac{\lambda}{\mu} \quad (5)$$

From the calculation results, data will be obtained on the waiting time for containers, namely (Wq) and the total containers waiting in the queue (Lq). An additional parameter is that no trucks are allowed to be outside the cross-dock warehouse. The conditions that apply are that the total queue must not be more than the total capacity of waiting trucks, so it is written with the formula:

$$Wc \geq Lq \quad (7)$$

From the data obtained, improvements will be made to get shorter waiting times and fulfill the system that there are no containers waiting outside the cross-dock warehouse. The methodology description for this research is described as follows (Figure 2).

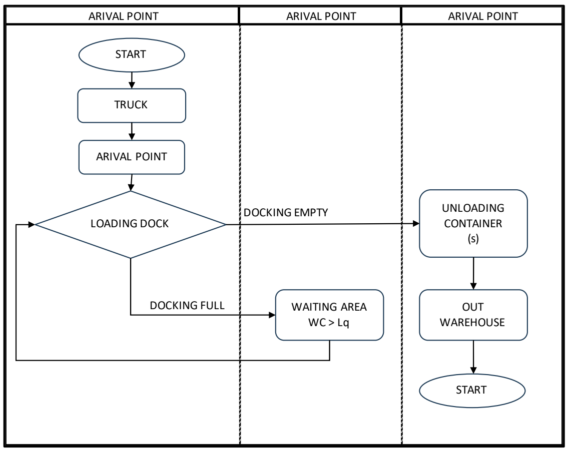

Figure 2. Research method

The picture above Fig.3 provides an overview of the system that runs where when the container enters the warehouse, the cross-dock container will be at the security post or called the arrival port. The container will go to area unloading container. If the unloading area is full, the container will wait in the waiting truck area. The container will wait and queue until the unloading area is empty. After the unloading process is complete, the container will immediately exit the cross-dock warehouse.

4. RESULT AND DISCUSSION

The data collection process is carried out by adding up all container arrivals in one day. The data obtained will be used in calculating cross-dock warehouse conditions. For arrivals from containers in Poisson numbers. The arrival of the container was in unplanned conditions. The data collection process for container unloading capacity is carried out by asking the cross-dock warehouse company. Data for parking and docking capacity was obtained by observing the conditions of the warehouse company. The data obtained from observations and discussions with the cross-dock warehouse company are as follows Table 2.

Table 2. The current condition

Wc	2 Parking Container
μ	2 Container / Hours
λ	10 Container / Hours
s	2 Docking

From the data above, a description of the running system is created as follows (Figure 3):

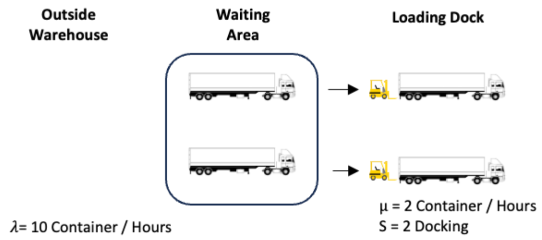

Figure 3. Unloading Container Before Condition

Based on the data obtained, multiplication was carried out using the formula M/M/2 and the following results were obtained (Table 3):

Table 3. Thr result first condition

Output	Value
P	2.5
Po	0.052
Lq	4.5 Container
Wq	2.25 hours
W	2.75 Hours

From the data above, it is found that the waiting time for containers is very high, namely reaching 2.25 hours per container with a total time of 2.75 hours per container waiting in the cross-dock warehouse unloading system. With these results, the number of container queues will be 5 to 4 containers. As is known, there are only 2 parking containers waiting capacity and this will result in 2 containers being parked outside the warehouse cross dock. In terms of targets, this is not included because it is known that the queue target is formulated as Wc ≥ Lq. From observation data, it is known that Wc = 2 containers and Lq = 4 containers. The following is an overview of the container unloading condition system at the cross-dock warehouse.

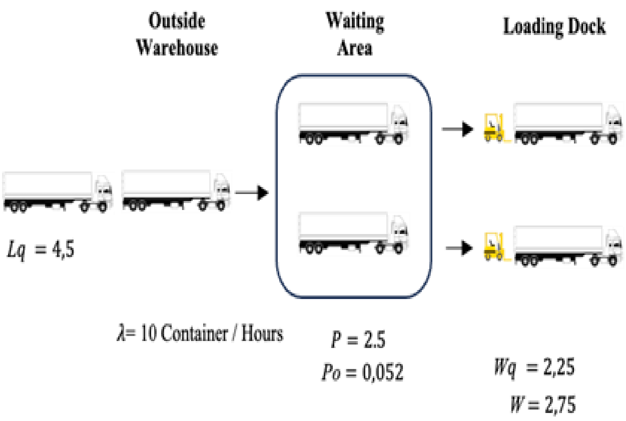

Figure 4. Result unloading container on first condition

So, it is necessary to improve the current condition. One way to make improvements is to speed up the unloading time thereby increasing the container unloading capacity from 2 containers per hour. After observing field conditions, it was found that it was difficult to accelerate container unloading. This is due to:

1. Narrow container unloading area

2. Safety elements for the forklift handling

process. Based on the problems above, the type of repair was shifted to adding unloading services, namely adding docking containers from 2 docking to 3 docking. The choice of 3 docking is to carry out calculations and improvements with the smallest option. It is hoped that using the smallest option from 2 to 3 will be able to meet the requirements of no containers being parked outside the warehouse and reducing the waiting time for containers at the cross-dock warehouse company. The following is a table of changes in calculation parameters where previously the parameter s = 2 became s = 3.

Table 4. Improvement condition

Wc	2 Parking Container
μ	2 Container / Hours
λ	10 Container / Hours
s	3 Docking

By changing the docking parameter(s) or unloading service, the system is redefined as follows (Figure 5).

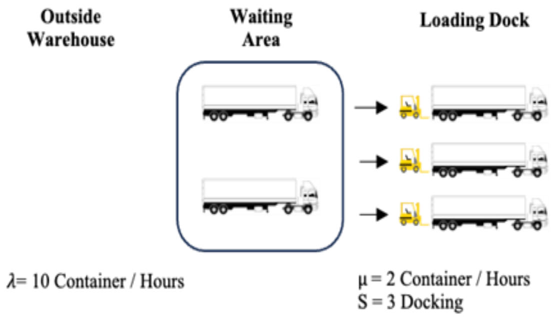

Figure 5. Unloading container second condition

Based on the parameter change data, a recalculation was carried out using the M/M/3 queuing system and the following results were obtained (Table 5).

Table 5. The results after condition

P	1.6
Po	0.02
Lq	2 Container
Wq	1 hours
W	1.5 Hours

Based on the results of multiplication using M/M/3, the results obtained meet the system where the number of Lq = 2 Containers. With results that meet the system, there are no containers outside the cross-dock warehouse. description of the M/M/3 system can be described as follows (Figure 6).

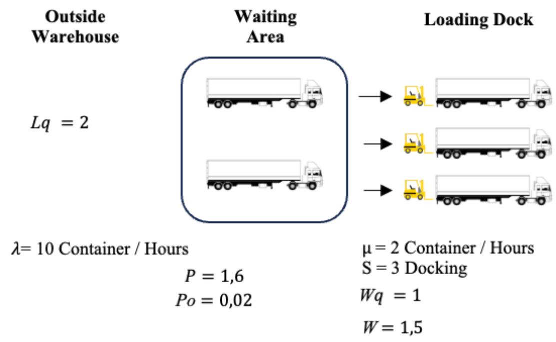

Figure 6. Unloading container finish improvement

The waiting time for these containers also fell from 2.25 hours per container to 1 hour per container. By reducing the waiting time for containers, it is hoped that the service level of the cross-dock warehouse will increase for customers, namely car assembly companies in Cikarang. The following is a comparison table before and after improvements to the waiting time for containers at the cross-dock warehouse.

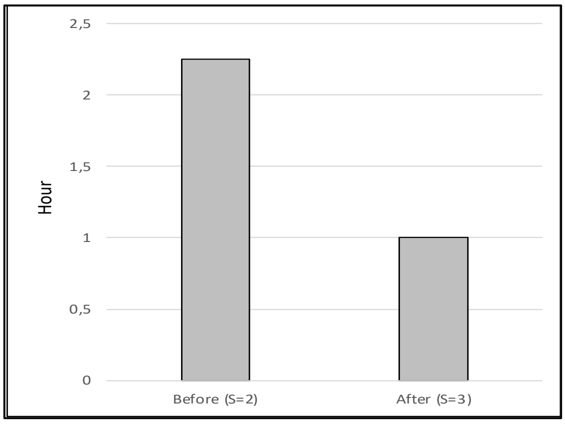

Figure 7. Container waiting time before and after conditions

By adding a docking station, it can reduce the number of queues for containers and the waiting time. Need to see the cost impact, calculations are made by comparing the cost of adding docking and the costs caused by overtime. This overtime fee is obtained by having 2 containers that are at the end of working time. This can be seen in picture 11. The cost that needs to be incurred to do loading unloading overtime is IDR 250,000 per container. The calculation of the increase in docking costs will be calculated by 2 elements, namely manpower and the addition of forklifts. Calculations are made to see the increase in costs caused by the addition of docking.

Table 6. Additional cost 3 docking

Item	Cost /Unit	2 Docking	3 Docking
Man power	6M	12 M	18 M
Forklift	8 M	16 M	24 M
Total Cost		28 M	42 M
Balance			14 M

(M: Million)

From the data above, it can be seen that the cost of adding docking from 2 to 3 docking add 14 million per month. The next calculation is the calculation of the cost per month due to overtime to unload containers as many as 2 units every working day.

Table 7. Cost saving 3 docking

Overtime Cost/Container	0,25 M
Container Over Time/Per Days:	2 Container
30 days	15 M

(M: Million)

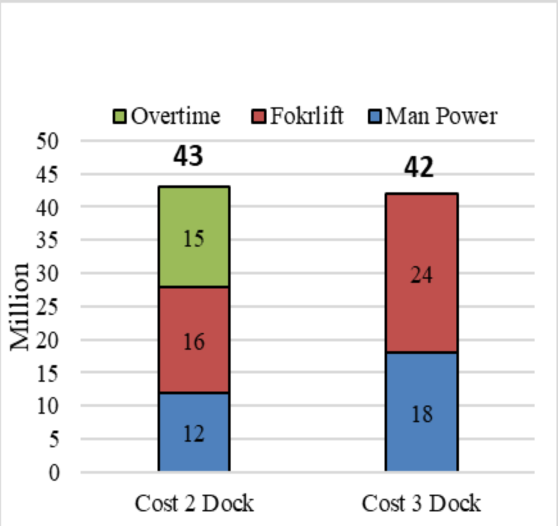

Figure 8. Total cost comparison

Based on calculations using 2 dockings, it is still required to pay cost overtime due to the presence of 2 containers at the end of each shift. The next stage is to calculate the total cost where the sum of the costs of manpower, forklift, and overtime. From the comparison of total costs, it is found that the cost to operate 2 docks is 43 million per month and for 3 docks is 42 million per month. 3 docks are 1 million cheaper per month than 2 docks.

5. CONCLUSION

Based on the experimental results, it was concluded that by reducing the waiting time from 2.25 containers per house to 1 house per hour, the number of container queues was reduced from 4.5 containers to 2 containers. Adding docking from 2 to 3 eliminates overtime work from 2 containers per day to none. The calculation is done by comparing docking cost operation and the cost of paying overtime. Obtained by adding cheaper docking as much as 1 million per month. This shows that adding docking can reduce operational costs if there are still abnormal costs to be paid. One of the fees paid here is the cost of overtime. Improvements to reduce waiting time can be done by speeding up unloading times by making technical improvements so that unloading times are faster. However, it is necessary to check whether the area of the unloading process is supported, and it must be ensured that there will be no safety problems. This research is a development of several previous studies where the focus was on container unloading at post Indonesia which is now being applied in cross dock warehouses. This research is expected to provide an overview of the container unloading process using the M/M/S method in the car assembly industry, where it is hoped that using the same method can also be applied to car assembly industry areas other than the Cikarang area.

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