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Object Oriented Simulation For Improving Unloading And Loading Process

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Abstract

The Unloading – loading process at Tanjung Priok port is a complex process. It still causes high dwelling time due to inaccurate quay gantry crane allocation, number of Trucks during the unloading – loading process and probabilistic elements such as Truck's speed changed, Quay Gantry Crane's speed changed and number of containers to be processed. To tackle the problem, in this paper an Object Oriented Simulation (OOS) is proposed. This method show characteristics and behavior from every class that influence the systems. Several scenarios are used. This paper illustrated the best scenario for unloading – loading container process.
Keywords: Object Oriented Simulation, Unloading-Loading, Dwelling Time, Quay Gantry Crane

1. Introduction

Shipping containers by sea transport plays an important role in the development of the world economy nowadays. The market environment in which container ports and shipping lines are operating is substantially changing. One of the main driving forces to change emerges from the globalisation process and the large-scale adoption of the container since the late 1960s according to Notteboom (2004). Sea transportation provides many benefits to companies that ship large quantities of goods and distant destinations as the costs incurred for marine transportation are less than air and land transportation although it takes longer time.

Many countries are competing to become a transit routes, temporary terminals, or countries destined for ships carrying containers because it will improve the country's economy. This will make developing countries to improve the efficiency of their existing. Tanjug Priok Port is one of the ports in Indonesia that have high intensity in serving sea transportation, many lines of import starting from the port of Tanjung Priok or export ending at the port of Tanjung Priok or just passing the port in a short time. As it have dense export activities, imports and movement of goods the port of Tanjung Priok authority must regulate the loading and unloading activities very precisely in order to obtain optimal efficiency.

Loading and unloading activities are the activities of removing containers from ships to the yard at the port and vice versa. The complexity of the loading and unloading activities and the number of linkages between the components such as the number of Quay Gantry Cranes , the number of Trucks used the total load time, and the probabilistic elements such as the speed of Quay Gantry Cranes used for loading and unloading processes are not always in similarly, the number of containers carried by each ship is not always the same amount, the speed of the truck carrying the container in the loading or unloading process is not always the same and the queue of Trucks or Quay Gantry Cranes may occur during loading or unloading process.

The complexity of loading and unloading process and the number of probabilistic elements cause the calculation of the average loading and unloading time difficult do analytically. So that the simulation is proposed in this study to determine the number of Quay Gantry Cranes and the number of Trucks in serving the loading and unloading process as according to Law (2007), the simulation model is an appropriate alternative in describing a complex system, especially when the analytic mathematical model is difficult to do.

The simulation model used is a simulation with Object Oriented Simulation (OOS) approach. An Object-Oriented Simulation models the bahivior of interacting objects over time. Object collections, called classes, encapsulate the charaterustics and functionality of common objects according to Banks (1998). OOS constructs a process method and other elements into an object that can interact with other objects. OOS has the advantage of representing

systems whose components are class and behavior in methods that are adaptable to their environment. The purpose of this simulation is to make tools that can be used to get the best scenario for unloading and loading process.

2. Object Oriented Simulation

The Object-Oriented Simulation provides a rich and lucid paradigm for building computerized models of real world phenomena. Its strength lies in its ability to represent objects and their behaviors and interaction in a cogent from that can be designed, evolved and comprehended by domain expert as well as system analysts. It allows encapsulating objects (to hide irrelevant details of their implementation) and viewing the behavior of a model at a meaningful level. It represents special relations among objects (class-subclass hierarchies) and provides "Inheritance" of attributes and behaviors along with limited taxonomic inference over these relations. It represents interactions among objects by "messages" sent between them, which provides a natural way of modeling many interactions. Despite these achievements, however, there remain several largely unexplored areas of need, requiring advances in the power and flexibility of modeling, in the representation of knowledge, in the comprehensibility, scalability and reusability of models (Rothenberg, 1989).

3. Model Development

Simulation was conducted using Visual Studio 2015, with the replication as many as 30 trials.

3.1. Assumptions

The assumptions used in this study are as follows; Simulation is only designed for the container loading / unloading process, oobservation data obtained from interviews and estimation, the size of the container is ignored, not considering the amount of Rubber Tired Gantry in the field area, as the loading process the number of containers in the field is always available, for each process of unloading and loading the number of containers processed is in the range of 100 to 150, and the distribution used is the uniform distribution.

3.2. System Identification

Unloading – loading system investigated, identification sequence as per Fig.1.

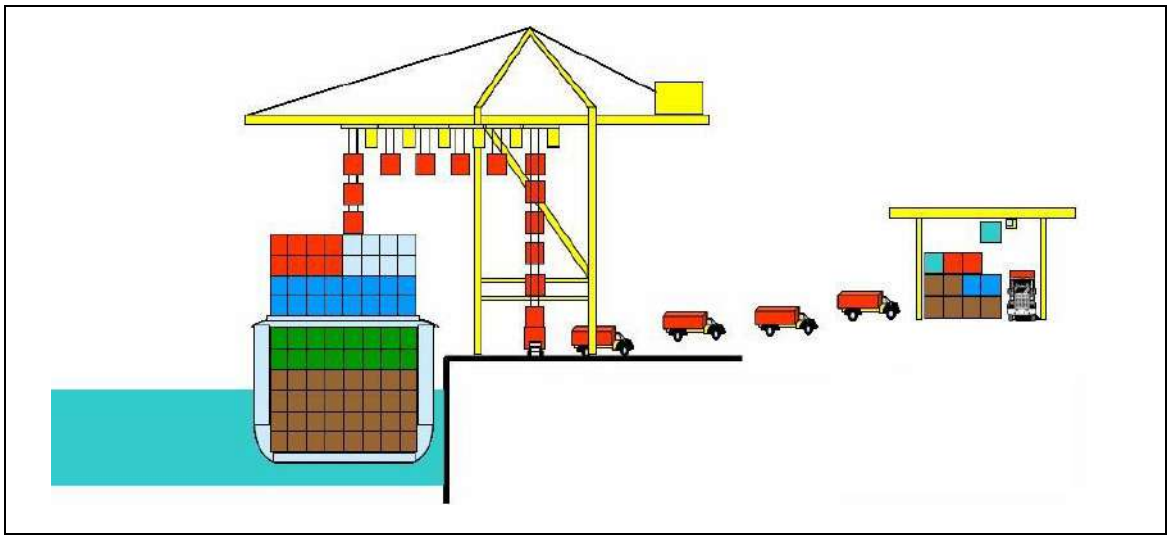

Fig. 1: Loading and Unloading Process (Suhirnoo)

As per Figure1, the unloading sequence process is the movement of a container from ship to truck by using quay gantry crane, then Trucks carry the container to the yard to and use a rubber tyred gantry to unload the container. Then, the truck goes back to Harborside. A loading process is started when Trucks carry the container from the yard using a rubber tyred gantry crane then load the container onto the ship using a quay gantry crane

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3.3. Determination of Output Model and Variabels Model

Output modes are output generated by a model that is affected by parameter and variables. Output model in the unloading – loading process can be seen in Table 1.

Table 1: Output Model

No.	Output Model
1	Average time of unloading process
2	Average time of loading process
3	Trucks utility used during loading and unloading process
4	Quay Gantry Cranes utility used during loading and unloading process

The input variable model is affected variable that can change output model. These variables are conditions which decision maker should be taken on a system. The variables model in this unloading – loading research can be seen in Tabel 2.

Table 2: Variabels Model

No.	Variabels
1	Number of Trucks used during unloading process
2	Number of Trucks used during the loading process
3	Number of Quay Gantry Cranes used during unloading process
4	Number of Quay Gantry Cranes used during unloading process

3.4. Identification of Classes in The System

Class is an object that can take a decision and interact among agent. Interaction that happened among class will affect the overall system. The classes which are involved in the unloading – loading process such as the Ship, Quay Gantry Cranes and Trucks. The interaction is given by Figure.2.

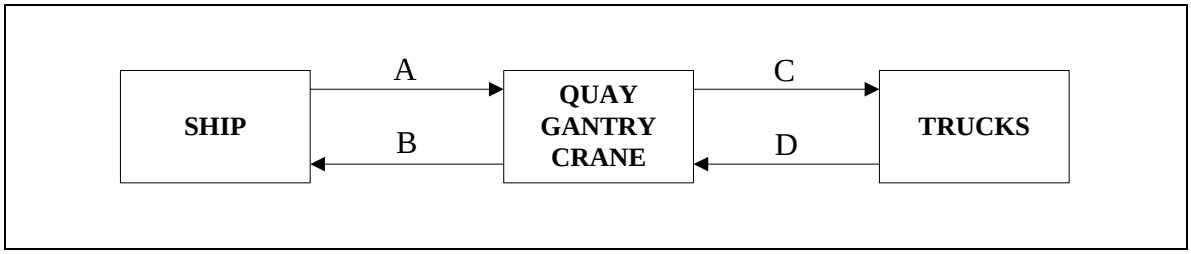

Fig. 2: Interaction Between Classes

In Figure 2, we can see that the Ship will affect Quay Gantry Cranes and Quay Gantry Cranes will affect ship (A-B), Quay Gantry Cranes will affect Trucks and vice versa (C-D).

3.5. Identification of Attributes

Attribute is characteristic that owned by the object. Attribute example owned by ship class as per Table 3.

Table 3: Ship's Attributes

No	Agent	Attribute	Remarks
1	Ship	Id	Ship identity
		Status	Ship activity (come/go)
		Maximum number of containers	Maximum number of containers that will be processed at unloading / loading
		Minimum number of containers	Minimum number of containers that will be processed at unloading / loading
		Number of containers	Number of containers that will be processed in unloading / loading
		Time of arrival	Time of arrival ship at dock
		Time of departure	Time of ship departure from the dock

3.6. Identification of Classes Behaviors

Every classes has their behaviors, behaviors are activities or habits that are routinely performed by the classes in the system and these behaviors can interact with other behaviors. Identification of classes behaviors can be seen in Table 4.

Table 4: Identification of Classes Behaviors

No.	Class	Behavior
1	Ship	The ship arrives at the port to perform the unloading process
		The ship left the port after the unloading process
		The ship arrives at the port to perform the loading process
		The ship left the port after the loading process
2	Quay Gantry Crane	Quay Gantry Crane's setup before the unloading process
		Quay Gantry Crane's setup before the loading process
		Move containers from the ship to the Trucks
		Move containers from the Trucks to the ship
3	Truck	Truck's setup before the unloading process
		Setting up Trucks before the loading process
		Trucks take container while unloading process
		Trucks take container while loading process
		Trucks back to the parking area after the unloading process is complete
		Trucks back to the parking area after the loading process is complete
		Truck waiting for Rubber Tyred Gantry operation completed during unloading process
		Truck waiting for Rubber Tyred Gantry operation completed during loading process

State diagram is a diagram showing the behavior of each class and behavioral changes that occur. State diagram of the unloading process can be seen in Fig. 3.

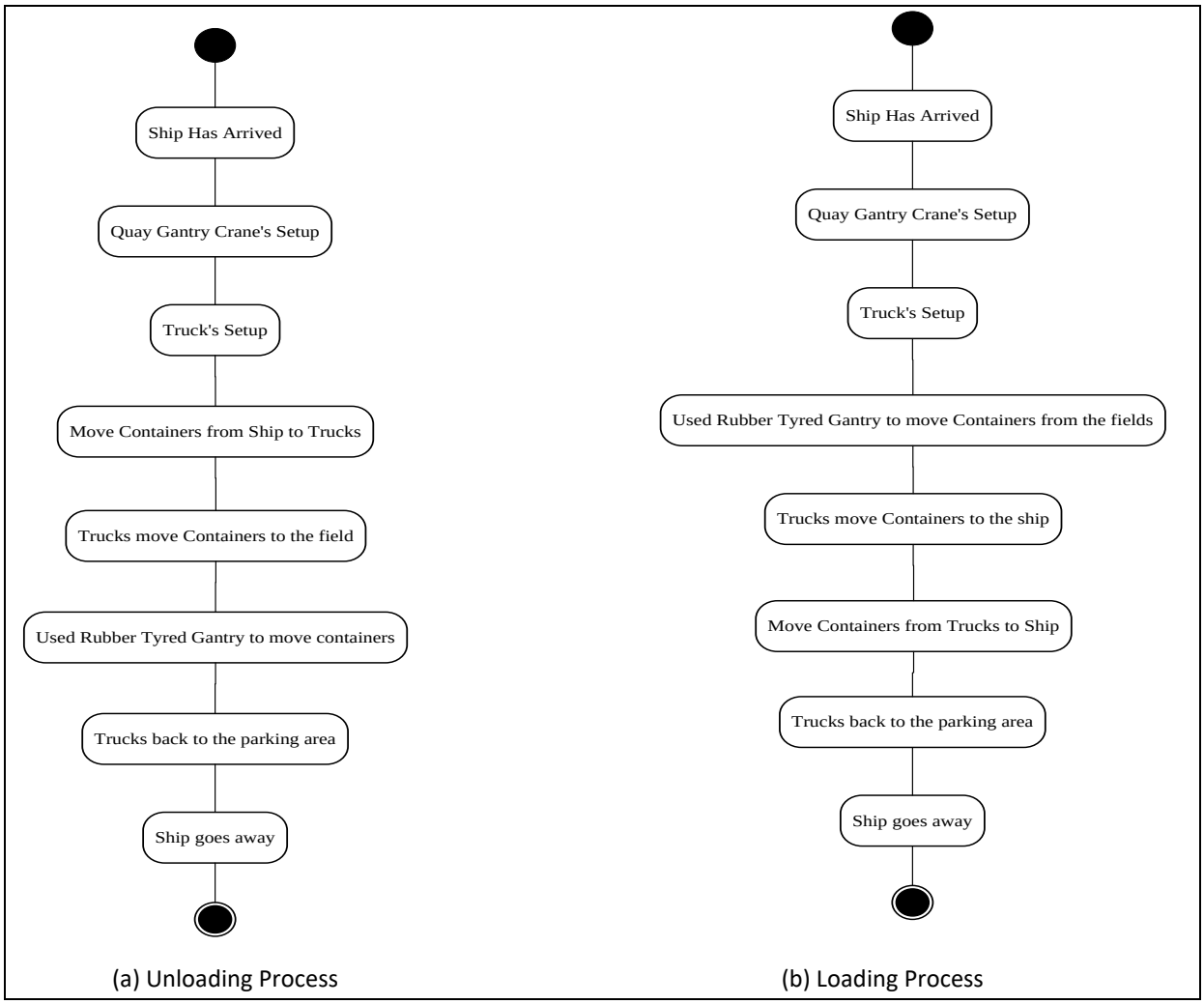

Fig. 3: State Diagram

4. Result and Discussion

Simulation is conducted by using Visual Studio 2015, with the replication as many as 30 trials. Test scenarios are done to obtain the best scenario for loading and unloading process. The result of test scenario for unloading and loading process can be seen in Table 5. and Table 6.

Table 5: Scenarios for Unloading Process

Scenario	Number of Quay Gantry Crane	Number of Trucks	Number of Ships(Units)	Average Time For Unloading Containers (minutes)	Utilization of Quay Gantry Crane (%)	Utilization of Trucks (%)
Scenario 1	1	2	2005	838	52	92
Scenario 2	2	4	3334	412	52	92
Scenario 3	2	8	4370	271	74	92
Scenario 4	3	8	4870	220	64	92
Scenario 5	3	12	5317	180	74	92

Table 6: Scenarios for Loading Process

Scenario	Number of Quay Gantry Crane	Number of Trucks	Number of Ships(Units)	Average Time For Unloading Containers (minutes)	Utilization of Quay Gantry Crane (%)	Utilization of Trucks (%)
Scenario 1	2	4	1627	1078	26	95
Scenario 2	2	8	2761	549	46	93
Scenario 3	2	12	3579	387	58	91
Scenario 4	3	9	3032	480	38	95
Scenario 5	3	12	3637	370	48	94

Table 5 shows that increasing the number of Quay Gantry Cranes used and the number of Trucks will make the average time for the loading process will be faster. The best scenario for unloading process is the scenario 5 which using 3 units Quay Gantry Cranes and 12 units Trucks with an average time of the loading process is 370 minutes from serving 3637 ships in a year. The utilization of Quay Gantry Cranes is 48% and 94% of the Trucks. The addition the number of truck should be accompanied by the addition of the number of cranes to produce faster time and higher utility.

For the unloading process the result of scenario test does not vary much with the process of loading. The best scenario for unloading process is by using 3 Quay Gantry Cranes and 12 units Trucks with average time of unloading process is 180 minutes from serving 5317 ships in a year. The utilization of Quay Gantry Crane is 74% and utilization of truck is 92%. Increasing number of Quay Gantry Cranes and the number of Trucks will make the average time for the loading process faster. Increasing the number of Quay Gantry Cranes and the number of Trucks used will not necessarily make total time became faster. If we find the case using similar number of Trucks used but different number of Quay Gantry Crane used, then we select the scenario with less Quay Gantry Cranes as more Quay Gantry Cranes will require higher cost but the average loading time generated does not very much.

Quay Gantry Cranes utility is lower when compared to the Trucks utility because the Quay Gantry Cranes and Trucks are ready to be used relatively at the same time but when the unloading process the Quay Gantry Cranes operates early after it the Quay Gantry Cranes will wait for the Trucks to operate. The Trucks operates longer than the Quay Gantry Cranes which causes the utility of the Quay Gantry Cranes to be smaller than the Trucks utility.

The Quay Gantry Cranes utility during the loading process is also smaller than the Trucks utility because the Quay Gantry Cranes and Trucks are ready in relatively the same time but the Trucks start to operate first and after that the Quay Gantry Cranes start operates that process causing incrased the waiting time for the Quay Gantry Crane and that make happen reduce the utility of the Quay Gantry Cranes.

5. Conclusion

Object Oriented Simulation is used to solve the problem of loading and unloading process and it produce: The best scenario for loading unloading process is by using 3 Quay Gantry Cranes and 12 units Trucks, the research produced a simulated model for loading unloading process by using Object Oriented Simulation, the simulated model has been designed to show the behavior of each object involved in the loading unloading process and changes in the number Quay Gantry Cranes and Trucks used in the process will affect the average time of loading and unloading process.

For future research the followings could be considered: Using truck movement animation during the loading and unloading process and consider the number of Rubber Tyred Gantry Cranes in loading and unloading proces

6. References

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