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A Simulation Model for the Problem in Integrated Berth Allocation and Quay Crane Assignment

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ABSTRACT

Sea transportation has been progressively increasing over the past few decades. Maritime transport has been mentioned as the largest cargo for goods in transit and currently it is pertinent for supporting international trade. Currently, nearly 95% of freight in the world is transported by cargo vessels. With this increasing volume of marine cargo, the efficient transporting and handling of vessels and containers has been a more critical issue. Mandatory Procedures for Vessel Operations from entrance to departure at a container terminal have been simulated. The cyclic variation in tide levels is considered in the simulation model as an important cause for Vessel waiting times. Applying these new constraints makes the simulation model more realistic in Port Operations. Greedy heuristic for berth allocation is applied in this paper by which strategies are evaluated in proposed simulation model. As a real-world case, simulation model has been applied on Rajaee Port. The simulation results demonstrate that port expansion options have different impacts on performance measurements. The berth and quay operation planning is the most critical element in container terminal management. In this paper, discrete event simulation (DES) as a form of computer-based modeling is proposed to evaluate the Berth Allocation Planning and also the problem in this domain. The berth operation with ship transportation and operation for quay crane are integrated in the simulation framework. An important success factor for marine transport over the past two decades is the standardized container which is an effective means of freight transportation. Port managers are trying to decrease port operation costs by utilizing resources efficiently, such as berths, quay and yard cranes, various yard equipment and speeding up the port services.

KEYWORDS: simulation model, container terminal, greedy berth allocation, quay crane assignment

1. INTRODUCTION

The assignment of vessels to berths and quay crane assignment are probably the most important parts of container terminal operations. A container terminal usually consists of a set of berths, a temporarily storage zone and a landside where trucks and AGVs are serviced to transfer the goods. Container terminals are important part of the transportation where containers are loaded and unloaded continuously. In this way, allocation of ships to berth locations at container terminals is a critical part of port operation management. The competitiveness of a container terminal is based on service time and fast turnover of containers. These factors relate to a reduction of the berthing time and, therefore, of the total cost of the port operations. A container terminal should be managed in such a way that port operations be handled efficiently. Operations of container terminals are divided into four main categories, berth operation, crane operation, yard operation and gate operation. Berth operations are the most costly operation among other categories because it deals with arriving vessels. Consequently, any improvement in this part of the saving time or reducing costs in this system is encouraged. In this section, the problem on which investigation is done is being described in details. The problem is the allocation of berths to vessels and assigning a number of cranes to each vessel. The berth allocation procedure is difficult as a result of variation of ship arrival times, arriving ships with various sizes, drafts and TEUs, different lengths and dynamic draft of berths, entrance channel constraints and limited transporters. [1][2]

Two major types of vessels operate in the port. First, liner vessels working on regulated paths with specified schedules and second, tramp or feeder vessels getting hired for doing jobs in transportation system which these would

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be exclusively planned and scheduled for that job. Arrived ships should wait until all the necessary conditions are met. These different conditions are available berths, berth length; current draft level of the available berths; no outbound (leaving) ship on the entrance channel and the availability of tugs. After a ship reaches to a berth, the quay crane operation starts by available resources. The number of cranes which are already assigned to a vessel can increase. In the middle of loading and unloading operations, some new adjacent cranes may be released and they could be assigned to the crane operations of the ships. In this situation, the remained load and unloading time may decrease. [3]

Two safety issues are considered for the entrance channel accessibility. First, the variations in entrance channel's draft should be continuously considered and the simulation model can use it to check whether a departure or leaving is allowed or not. Second, the entrance channel is designed in a manner that allows ships pass through the same direction at same time. So the crossing and conflict of two opposite vessels is not allowed on entrance channel. A maximum number of quay cranes could load and unload cargo from a container ship simultaneously. Actually, maximum number of cranes can operate on a single ship at a particular time. This maximum number of crane is called QC-norm through the entire paper. QC-norm is an attribute of each arriving vessels depending on vessel's characteristics. [4][5] This paper addresses the problems in berth allocation and quay crane assignment using simulation approach. Simulation model is used to evaluate the effectiveness and robustness of berth allocation strategies. The remainder of the paper is organized as follows. A review of related literature is presented in the next section. The problem statement is presented in Section3. Section 4 explains the developed simulation model. In section 5, computational results of scenarios are presented and finally the conclusions and further research are summarized in Section 7. [3]

LITERATURE REVIEW

Because of the importance of container transport, a growing number of studies dealing with the Operation Research models related to container terminal especially berth allocation problem, is reported. The Berth Allocation Problem (BAP) or berth scheduling problem (BSP) refers to efficient allocation of vessels to appropriate berths in a port. The efficient allocation of berths to vessels is a major problem and the results directly affect the operational performance of the terminal container. The main objective of BAP is to minimize the total service time of all ships. The continuous classification schemes are two primary approaches that can be used to model berth allocation problems. In this approach, BAP can be modeled as a problem considering the quay as a finite set of independent berths with fixed length under which each berth can accept only one ship at a certain time. In contrast, continuous models assume that ships can berth anywhere alongside the quay and therefore the quay capacity fluctuates dynamically. It is clear that continuous berth allocation would lead to a better berth utilization in comparison with the discrete allocation. In case of discrete berth allocation, we found different interesting models and solution approaches (see e.g. Nishimura et al. 2001, Imai et al. 2003 and simulated annealing proposed by Kim and Moon 2003). Discrete static version of BAP was formulated to minimize the sum of service times of vessels by Imai et al (1997). A dynamic version of BAP was studied by Imai et al. (2001). Imai et al (2005) have developed a continuous berth allocation model to minimize the total handling times. Greedy heuristic for berth allocation is proposed by Cordeau et al (2005) to resolve two different discrete BAPs. In this relation, several interesting assumptions of real-world problems and the issue of time and also adequate berthing zones were considered. Lee et al (2010) proposed Greedy Randomized Adaptive Search Procedure (GRASP) for continuous and dynamic Berth Allocation Problem to minimize the total weighted flow time. Both discrete and dynamic versions of BAP are NP-Hard problems. Lim (1998) proved that the continuous BAP belongs to the NP-complete problems. [6][7]

The quay crane scheduling problem (QCSP) also refers to allocation of quay cranes to multiple vessels for container load and unloading operations. A primary objective is to minimize the vessel's overall completion time. The types of quay cranes are categorized as Rail-mounted gantry cranes (RMG cranes) and rubber tyred gantry cranes (RTG crane). In the first type, loading/unloading procedure on different ships can be performed through moving the crane. In order to carry out the operations for loading/unloading cargo, there is a certain area used as a buffer to keep the containers there. [4]

Integer programming based methods are extensively being used to model and solve different classes of BAP (see e.g. Imai et al. 1997, 2001; Park and Kim 2002; Guan and Cheung 2004; Cordeau et al. 2005). The main challenges in MIP approaches are putting uncertainties and dynamics into models which are inherently exist in real world situation. In the contrast with exact approaches, simulation models are flexible approaches to evaluate complex problems. In the container port, simulation models have been used for port operations including berth allocation problem, quay crane assignment and scheduling problems. Simulation models can be used to determine the required resources in order to complete the port operations subject to a set of constraints. Recently, wide ranges of the BAP are integrated planning of berth allocation and quay cranes (see e.g. Park and Kim 2003, Imai et al.

2008, Liang et al. 2009, Meisel and Bierwirth 2009). An integration of berth allocation, tug assignment, quay operations and vessel transportation planning has not been well addressed in the literature. In this paper, a discrete berth allocation model is proposed considering fixed length and dynamic draft for every berth. The berth allocation problem is integrated with quay crane operations and vessel carrying plan considering limited number of tug boats.

Simulation model

Berth planning is a complex and critical task in container terminals. In this situation, the application of discrete event-driven simulation would come useful, and this is due to the point that whole organization can be viewed as a complex queuing system. For reducing the total service time in this complex, and dynamic and stochastic problem, a simulation approach may have advantages. In this research, a discrete approach to berth modeling is utilized. A valid simulation model considering the impact of environmental conditions helps us to estimate performance measurements and analyze different berth allocation scenarios. To model the problem, we should identify the most important events and activities. For every incoming vessel, repetitive operations will be executed by involving different resources. Hence, in this scenario figure 1 shows the descriptions.

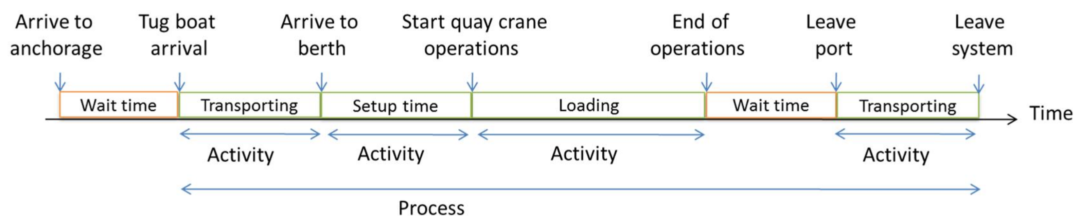

Figure 1 Cyclic events occurs for incoming vessels

The simulation model of a container terminal has been developed in ARENA discrete-event simulation software. ARENA as flowchart form is the most popular discrete event in which powerful commercial simulation tool is used to model and analyze complex systems. With ARENA, we would be capable of doing things such as modeling complex processes, visualizing dynamic operations with animation and analyzing the system performance. In this paper, ARENA simulation package has been chosen as a simulation platform because of capability of modeling, powerful simulation engine and ability to implement complex logic and rules. To build models, we may use flowchart or data modules and combinations. [6][8]

Berth allocation model

Every ship arriving to anchorage should check whether there is any available berth or not. The next condition is the current status of entrance channel. The draft and occupancy of entrance channel should be suitable for the waiting vessel. The vessel will remain at anchorage until all conditions turn to its favor. The vessel which can reserve at least a free berth, request for desirable number of tug boats for transporting from anchorage to the berth. Vessel characteristics and attributes will be generated in several steps as illustrated in

Figure 2. [9][4]

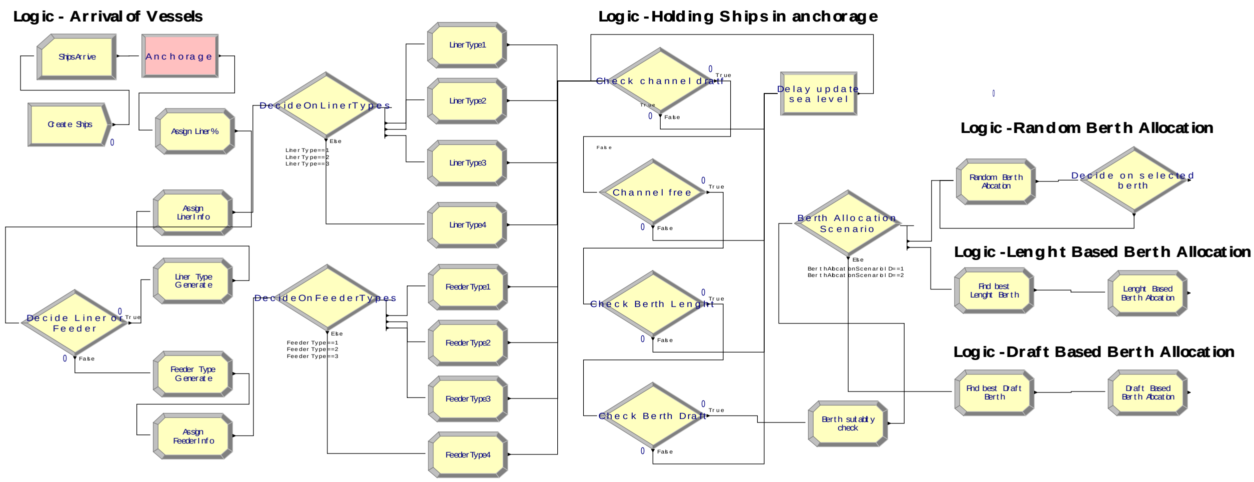

Figure 2 Berth Operation modeling in ARENA

After arrival of vessels, as stated previously they will stay in anchorage until the conditions for entrance meet. In simulation model, structure in

Figure 2 is used for simulating the entrance of different classes of vessels according to data collection from Rajaee port. The transit from anchorage to the berth s one during performance of high tides by tug boats. This procedure is performed by one or two tugboats a nds upon the length of the vessel. For large size vessel, two tug boats are needed and only one vessel is needed for others. Ships leaving the berth have higher priority to request tugboats and occupy entrance channel over the entering ships. In order to model this part of system, first a create module is used to produce tugboats. It should be mentioned that the creation process is done once in an hour and each time it produces two tugboats. The underlying reason for using this method rather than implementing transportation modules is that the maximum number of transporters can be assigned to an entity is one, while in this model some entities needs more than one tugboat in order to move through the system. Therefore, tugboats are created as entities forming a queue in their station. In the next stage, a ship takes necessary number of tugboats from the queue and start moving to make all conditions favorable. The ship and tugboat move to berth and are separated once they arrive in berth by a drop-off module. After separation, the ship continues its way to loading (unloading) process while the tugboat returns immediately to its station. The scheme of ship transition procedure is illustrated in

Figure 3. [10][11]

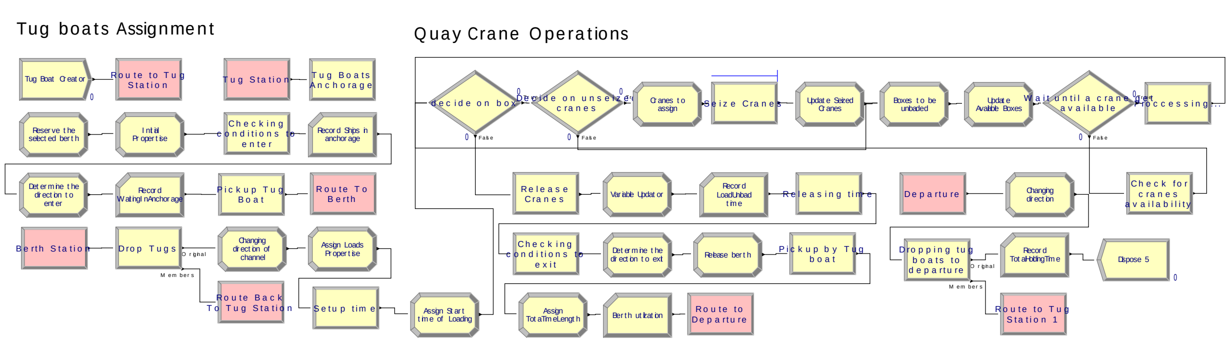

Figure 3 ARENA model of Tug boat assignment and quay crane operations

Most ports have safety restrictions on the draft of ships that are allowed to enter or leave the port, by which groundings of deep-draft ships are prevented. These draft restrictions usually depend on tide, and therefore vary cyclically by the passage of time. Draft is normally defined as the distance between the waterline and the capsize of ship, and it is a function of the size of containers loaded onto the vessel. As maintained before, when there is no available water depth for ships loaded fully at the quay, they have to wait until the sea level becomes higher than the required draft. [2][10]

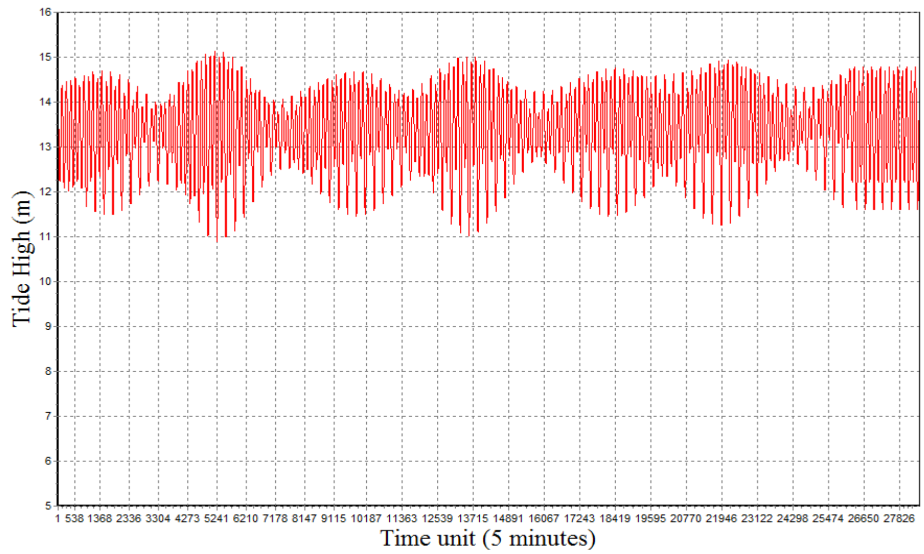

Figure 4 Tides at Rajaee port, IRAN during a 90 day period

Generally, tides are the periodic increase and decrease of sea levels affected by the mutual effects of the gravitational forces and the rotation of the Earth. In case of tidal variations, draft status depends on high tide levels-subsequently available depth at low tide condition is not adequate for the movement of vessels. [1][3]

Tides are typically described using tide charts. The peak points in the tide curve indicate high tides, and low points indicate low tides. A historical data graph on t Rajaee port is showed in

Figure 4. Tidal data for the study period has to be available in the simulation model. A complete tidal cycle is about 13.8 days with mean sea level of 2.345m. The highest high water level is nearly 4.131 (m). To model this time-varying draft situation, a step-wised adjust variable module is used to update the draft level every 5 minutes.

The innovation and contribution

In this section, a summary of the innovations and contribution of the proposed simulation model will be discussed. First it should be noted that most of the papers in the literature solve the BAP and QCAP separately and consider a static version of these problem. In this research, an integrated decision problem that deals with the concurrent simulation of berth allocation and dynamic quay crane assignment is investigated. Particularly this problem is a complex, stochastic and dynamic decision problem, moreover the tugboat availability assumptions added to the problem. Therefore, to the best of our knowledge, there is no study which considers the integrated simulation modeling of tugboat resources with berth and quay cranes. In other words, a dynamic resource allocation problem is investigated. The resource allocation model is studied in a dynamic environment with fluctuating availability of both berth and quay crane resources. This variability occurs because of the tidal variation that creates uncertainty on the availability of berths.

Gui and Yang (2013) recently developed a simulation system by using the object oriented software VC++ 6.0, Microsoft DAO and the common option BCG issued by Microsoft. In this paper, benefits from the flexibility of modeling in ARENA compared to the platform used in Gui and Yang (2013). This advantage can be used to create more complicated and integrated models of port simulation in ARENA. In Gui and Yang (2013) a queuing model in container terminal with only the liner transport is considered but in this paper, the container shipping includes both liner shippers which operate on a regular service for a number of ports in service-oriented manner and also feeder shippers. This research considers draft of vessels, tugboat availability and variation of tidal level. These factors make the proposed simulation model more effective and helpful than other studies. [19]

Main method

When a vessel occupies a reserved berth, the load and unload operations will be start. This procedure will be performed by available quay cranes (QC) in the berths. To consider load and unload operations, a recursive structure is implemented in the simulation model. This procedure will fail, only if no more containers were remained on vessel - therefore the loading and unloading process is finished. The flowchart of loading /unloading operations and quay crane assignment are illustrated in

Figure 5. [1][6][12]

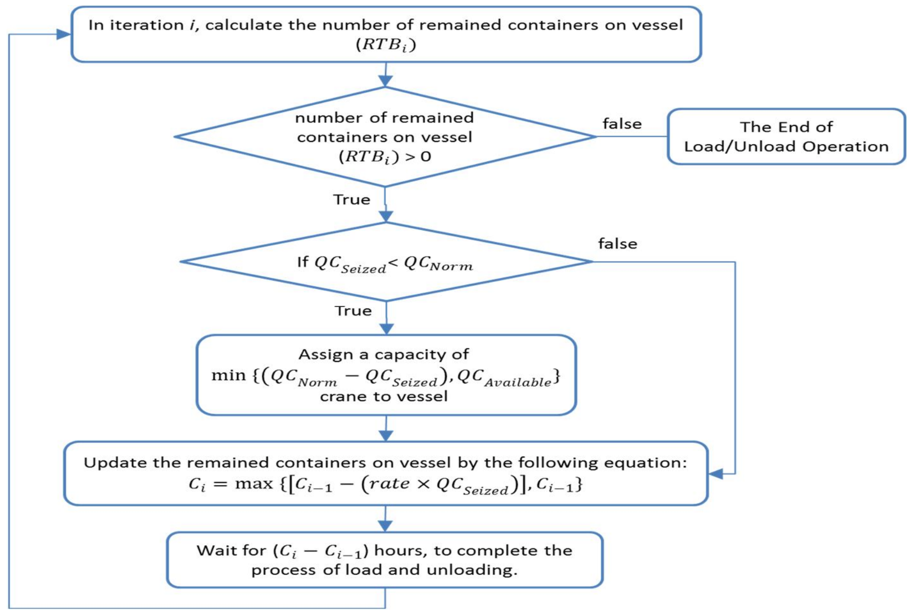

Figure 5 Flowchart of berth load/unloading operation

The terms and symbols used in quay crane assignment model are also summarized in Table 1.

Table 1 Terms used in modeling load/unloading operations

Symbol	Description
QC_{Seized}	The number of currently assigned QC
$QC_{Available}$	Idle available number of QCs in berth
C_i	The number of containers remained on vessel in iteration i
$rate$	QCs load/Unloading Rate per hour

The vessel start loading and unloading operations by assigned quay crane after a setup time. If the assigned cranes to vessel sustain unchanged, then the time for loading and unloading operations (OT) of vessel is calculated by the equation (1). In equation (1), the symbol TB denotes the total boxes of vessel, Rate is the average speed of loading /unloading box by a particular crane per hour and QC is the number of crane works on vessel.

$$OT = \frac{TB}{(Rate * QC)} \quad (1)$$

The remaining operation time (ROT) is calculated when a number of free craned triggered to assign to the vessel. At that moment, the remaining total box (RTB) and new assigned crane (QC_{new}) are the basis for calculation of remaining operation time. These norms will be replaced in original equation (Eq. 2).

$$ROT = \frac{RTB}{(Rate * QC_{new})} \quad (2)$$

Quay crane capacity and their assignment plan to vessels and also carriers' tonnage determines the service time of vessels in berths. After the berth operations were accomplished, the ship will be prepared to depart from berth. The procedure for departure of ships is similar to their arrival. [1][2]

DISCUSSION AND RESULT ABOUT THIS SIMULATION

We consider the Berth allocation problem in Rajaee container terminal that liner feeder a service is seen in this terminal. The Rajaee Port is located at a distance of 1500 kilometers from Tehran, the capital city of Iran and there is a 23 kilometer distance between this port and Persian Gulf. This port connects to more than 80 ports worldwide and the highest rate of cargo transit through the country and towards the Central Asia passes through this port, and it is considered as the most active container terminal in the country. Putting this information into perspective, it can be concluded that this terminal plays a vital role in trading between Iran and other countries which it has a substantial effect on the economy of the country. The information of Rajaee port is summarized in Table 2. [13][14]

Table 2 The summarized information of Rajaee port

Terminal No.	Berth No.	Berth length (m)	base draft of berth	The number of available quay cranes
1	4	340	12	10
	5	300	12.5	
	6	270	12.4	
	7	250	11.7	
2	25	365	15.8	8
	26	370	16	
	27	375	16.2	

Terminal number 1 of Rajaee port consists of 850 meters of berths with depth of 17 meters and 70 hectare of yard, which it is able to accept even 7th generation container ships. The current capacity of the port for transportation is about 2 million TEU per day. This capacity is not able to meet all the incoming demands considering the remarkable growth of container operations, and consequently, the containers have long stops time there which this is the underlying problem for the port performance. In order to tackle this problem, a new terminal is going to be constructed including 2050 meters of berths with depth of 16 meters and 140 hectare of yard.
All types of Liner and Feeder ships are provided with services in the container terminal of Rajaee port which 21 shipping channel of Liners are active there. The statistics related to container loading and unloading indicate that the Rajaee port is the only port in Iran connected to the container transport information network, and by considering the importance of container transportation in international transit, the crucial role of this port in north-south corridor becomes more clear. The information of incoming vessels according to a historical data is summarized in Table 3. The distribution of containers carrying by Liner feeder vessels are also provided and classified. [4][15][16]

Table 3 Categorizing entering ships and probability distribution of their length and required depth

Vessel type(%)	Vessel type	(%)	Average Length (m)	Average Draft	QC norm	Percentage (%)	Total Operation (Boxes)
Liner 65.80%	type 1	35.26%	173	8.6	1.95	38.27,35.15, 19.89, 6.69	288, 736, 1218, 1867
	type 2	38.28%	222	12.8	2.51	12.31,30.84,29.09,27.76	351, 756, 1221, 2229
	type 3	21.37%	279	14.5	348	1.75,11.12,26.01,61.12	380, 854, 1247, 2727
	type 4	5.09%	316	14.5		8.88, 13.9, 77.22	797, 1229, 3164
Feeder 34.20%	type 1	13.42%	77	5.1	0.88	38.27, 35.15	137, 539
	type 2	37.34%	136	6.7	1.53	19.89, 6.69, 12.31	314, 729, 1084
	type 3	33.60%	165	8.2	1.87	30.84,29.09,27.76, 1.75	284, 745, 1169, 1640
	type 4	15.65%	216	12.5	2.44	11.12,26.01,61.12, 8.88	338, 728, 1245, 2079

Comprehensive historical data about the ship arrivals and operations are available. The collected data are investigated to fit appropriate probability distributions, find averages, and other input parameters which these are later used to generate the input for the simulation model. Arrival pattern of ship at the anchorage follows the negative exponential distribution as expected (

Figure6). Therefore, the simulation model assumes that the ship arrival at the anchorage follows an exponential distribution function as depicted in

Figure6 . [16][8]

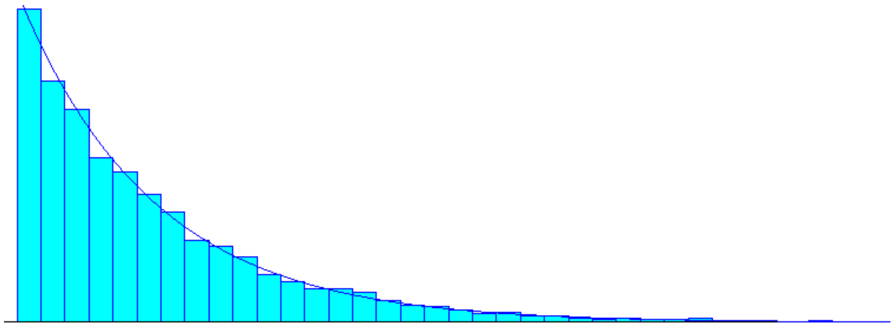

Figure6 The histogram of vessel's inter arrival times using input analyzer in ARENA

The result of chi-square test demonstrates that the data is consistent with a specified distribution. The P-value (0.438) is greater than the significance level (0.05), we cannot reject the null hypothesis that available sample frequencies differ significantly from expected frequencies.

Findings

The simulation model could be used to identify the bottlenecks in the process, and perform scenario analyses aimed at evaluating the impact of berth allocation strategies. Identifying the causes of delay in berth operations and eliminating non-value added times will yield more efficient plan. In this way, the total waiting time in anchorage and total service time are two critical performance measures for evaluation of different scenarios. Average service time is the average waiting time at the berth and anchorage plus the average service time. Average service time of vessels (hour) at port and average wait time of vessels per replication are shown in Figure 7 and Figure 8.

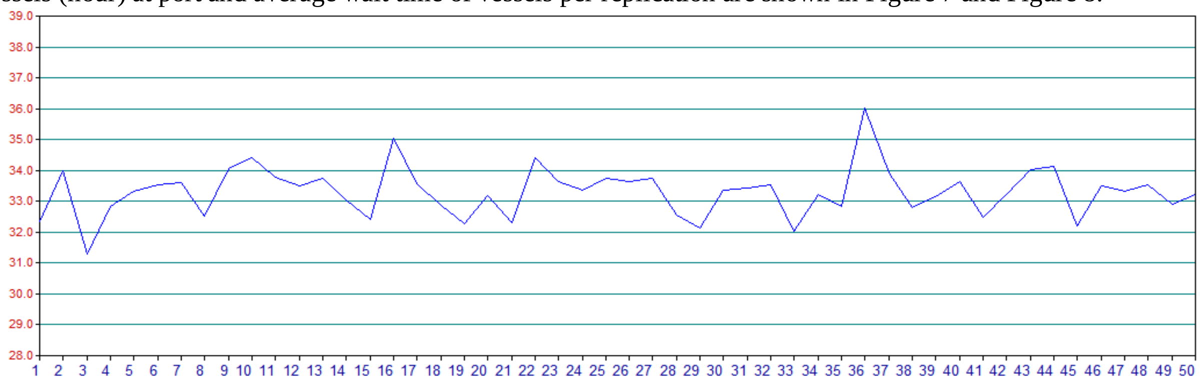

Figure 7 Average service time of vessels (hour) at port per replication

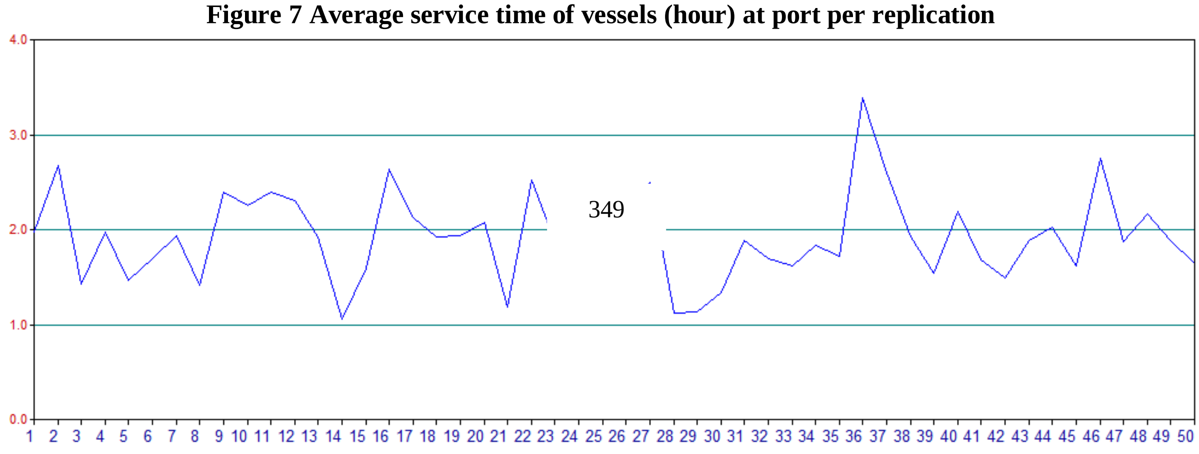

Figure 8 Average wait time of vessels (hour) at anchorage per replication

Average wait time of vessels will decrease by increasing the number of liner vessels (

Figure 9).

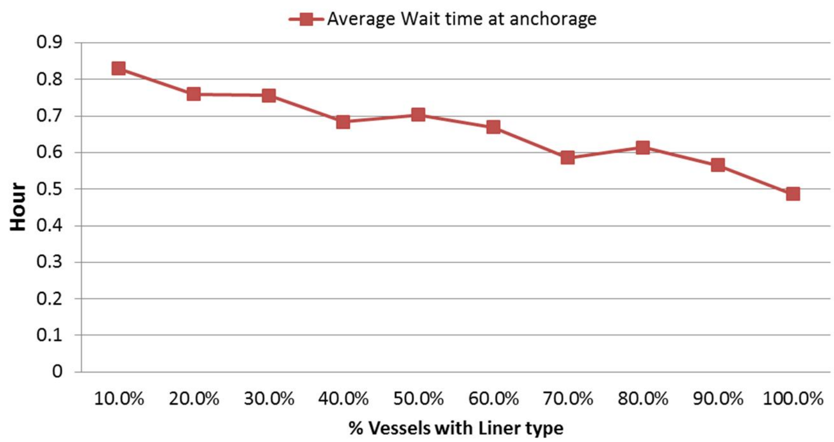

Figure 9 Averages waiting time of vessels by increasing the liners

Important statistical indices for 40 replications are summarized in Table 4. The simulation results contain the number of vessels served, average queue length at anchorage, handling time and crane utilization for the period of simulation.

Table 4 Important statistical indices for 40 replications

Statistics	Average	Half With (95%)	Minimum Average	Maximum Average
Number of served vessels	598.73	7.03	554.00	**640.00**
Anchorage queue	4.3227	0.07	4.0721	**4.5723**
Number of waiting vessels to leave berths	0.6126	0.02	0.4902	**0.7608**
Crane Utilization	0.4726	0.01	0.4481	**0.5025**
Total Holding Time (Hour)	30.1317	0.18	28.6196	**31.3963**
Total Number waiting in anchorage	1.9368	0.16	1.0618	**3.3863**

In this section, we study the effects of berth length, load rate of cranes and quay crane deployment options on overall performance at a seaport container transshipment terminal. A fundamental analysis is also conducted on simulation model in order to verify model and obtain interesting results. Figure 10 shows the number of ships, which are waiting at the anchorage for berthing during the simulation run. At some moments, port faces congestion in anchorage but the average number of vessels in anchorage is about 2 vessels. [1]

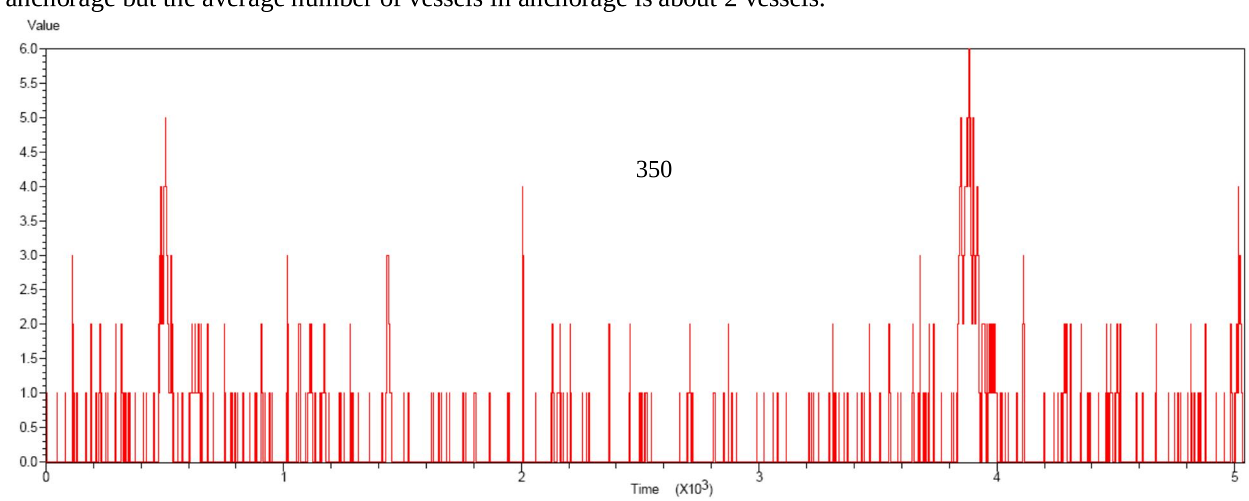

Figure 10 Number of vessels waiting in anchorage during the simulation run

Before evaluation of different scenarios using designed simulation model, some fundamental analyses were made in parameters for examining validity of model. These manipulations were made in such a way which their effects in model results can be inferred logically. First, we observe the effect of the increasing number of tug boats on waiting time in anchorage. As stated previously, the availability of required number of tug boats for carrying vessels to berths is a restrictive factor. So it is logical that this increase in capacity would have the result of decreasing waiting times in anchorage. A fundamental analysis on number of tug boats was made and

Figure 11 shows the results of that. This figure shows that the change in model caused decreasing in both waiting time for entrance and departure. This comparative simulation experiments have been performed by helping the process analyzer module (PAN) in ARENA. The control variable is defined as the number of tug boats and the response is the wait time and number of waiting vessels at anchorage and berths. [15][17]

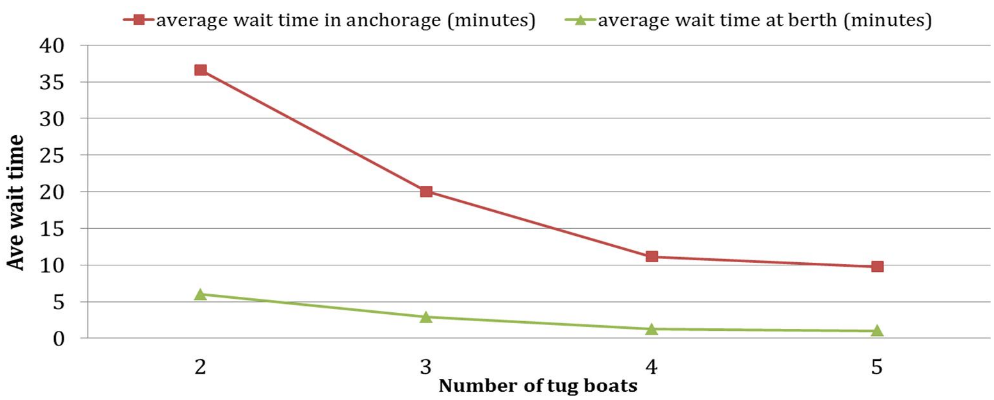

Figure 11 Decrease in wait time of vessels at both anchorage and berths by increasing tug boats

Equipping berths with more QCs should reduce the waiting times in this system since more cranes can work on vessels and the process times will decrease. The results obtained by simulation model in

Figure 12 are a proof for this hypothesis as well. It can be also concluded from the results that no significant improvement can be achieved by increasing the number of cranes up to 20. [1][18]

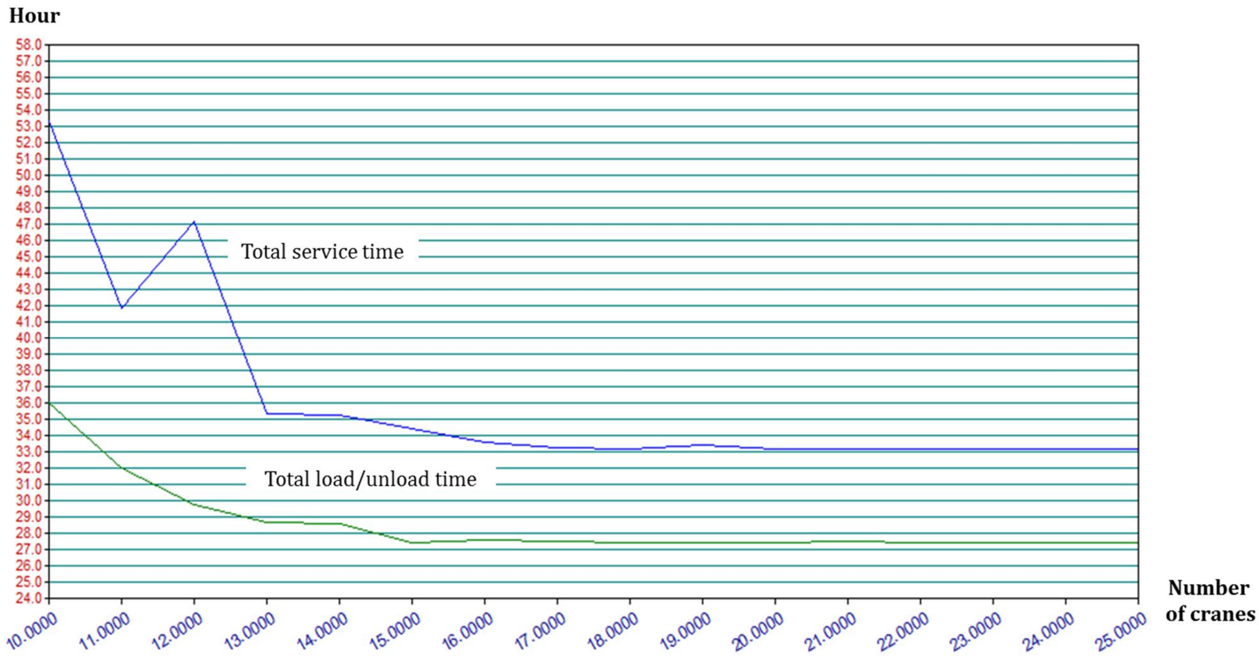

Figure 12 The effect of increasing the number of cranes on total service time and handling time

The results of experiments considering number of cranes as control variable by using PAN is summarized in Figure 13. The results obtained by simulation model in Figure 13 show an oscillation behavior of total waiting time in anchorage by increasing the number of cranes at the first stages. But it is notable that expansion in capacity reaches to an asymptotic value and after that it doesn't affect the "Total waiting time in anchorage" and other components of system become critical.

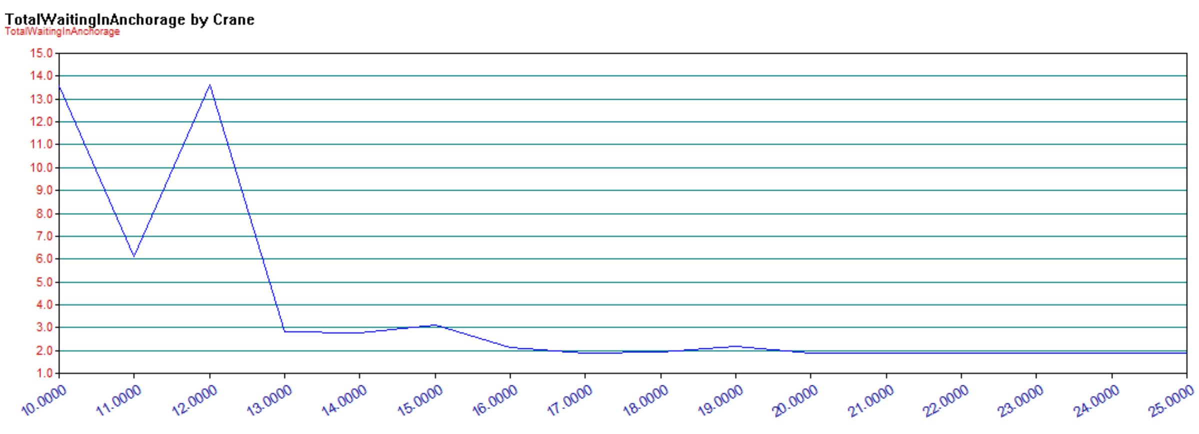

Figure 13 The total waiting in anchorage of vessels according to number of cranes operation

Besides the increasing number of QCs, increasing loading/Unloading rate of cranes should have similar results on model as the increase in their capacity. According to data collection, QCs operate 18 lifts per hour on average. Sensitivity analysis on this parameter confirms this idea and the results are shown in Figure 14.

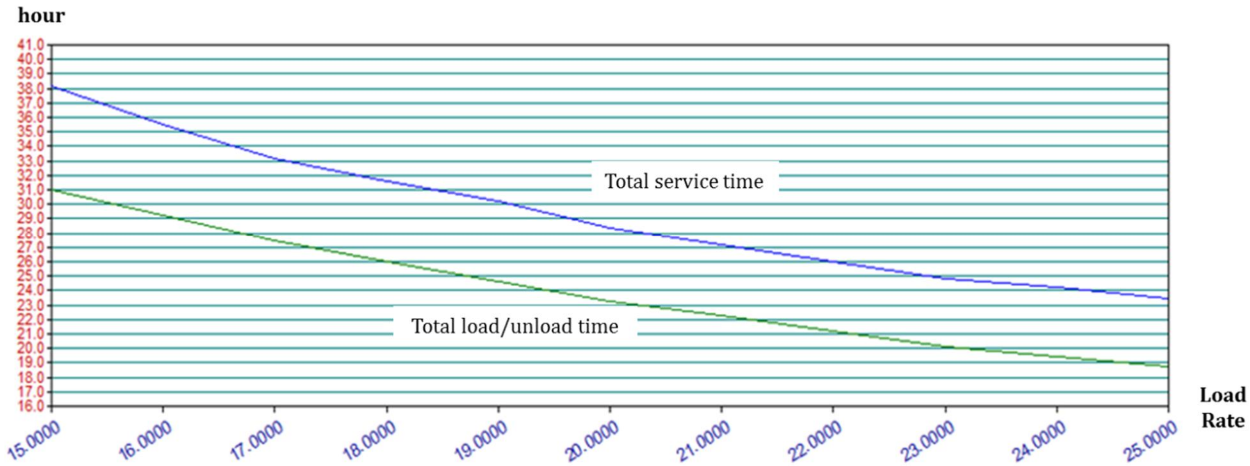

Figure 14 Effect of increasing the rate of load/unload of cranes on total service time (hour)

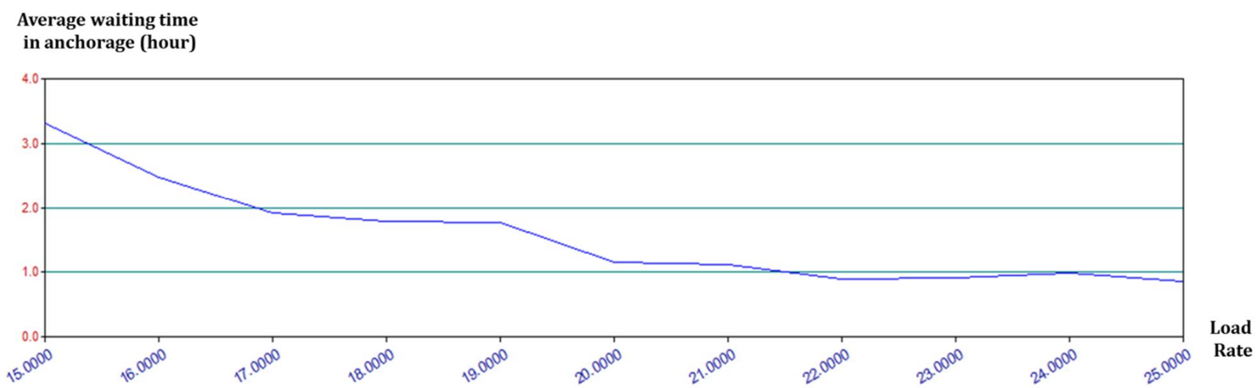

Figure 15 Effect of increasing the speed of cranes on total waiting time of vessels in anchorage (hour)

Evaluation of greedy and random berth allocation strategies

The different policies can be used in allocation of berths to arriving vessels. In this section, berth allocation strategies were examined by simulation model. Randomized allocation means if more than one berth was available for an arriving vessel, a random selection will be carried out. Two greedy berth allocation strategies are proposed to test the simulation model. These two greedy rules are based on length and draft. In length-based allocation, the available berth with best fitted length among other available berths will be reserved for the vessel. In draft-based allocation, the berth with minimum difference between water level requirement of vessel and current sea draft, among other available berths for vessel will be chosen. A comparative performance result of berth allocation plans obtained by running an experiment by 100 replications is summarized in Table 5. The result obtained by simulation model in Table 5 suggests that the two greedy berth allocation plans are dominated by the random allocation scenario according to wait time and average anchorage queue length. [14][6][7]

Table 5 A comparative performance results of berth allocation plans (100 replications)

Scenario Name	Number of served vessels	Works In Process (WIP)	Waiting Time in Anchorage (hour)
Randomized Selection	600.200	4.324	1.921
Length Based Selection	615.900	4.452	2.075
Draft Based Selection	616.100	4.555	2.516

Conclusion and future research

In this research, a dynamic and discrete berth allocation problem was studied which the vessel type, tidal effect, allocation of tug boats to transfer vessels and a simulation model to deal with these stochastic processes, were taken into account. A real case is used to illustrate the effectiveness of the proposed simulation model. Based on results from the simulation experiments, it was concluded that greedy berth allocation are dominated by random berth allocation and this is because of unpredictable variations and disruptions. In this research, several important berthing constraints have been ignored. Future research will attempt to address some of the limitations. Further researches are identified as berth allocation problem to improve timeliness and robustness of solution. Port disruption management is also a new critical topic of research. The options for port expansion and development are different impacts and costs. Another further research should be conducted on the cost optimal optimization of port expansion problem.

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