IMPROVING THE EFFICIENCY OF A CONTAINER TERMINAL USING SIMULATION TECHNIQUES

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Introduction

Container terminal operations play a pivotal role in the industry of shipping and transport in today's world. A container terminal is a facility where cargo containers are transhipped between different transport vehicles, for onward transportation. Because of the need for continuous improvement, there has been ample research in the field of container terminal operation in the past. However due to the limited amount of research carried out in the area of an integrated terminal planning, there is an opportunity to conduct research with specific focus on this aspect to increase overall productivity.

The main problem involves to focusing on using simulation techniques to improve the overall efficiency of an integrated container terminal model by reducing the turnaround time of a vessel. Amongst the many research studies carried out given below are a few examples;

D. Steenken et. at., (2004), have described and classified the main logistical processes and operations in container terminals and have presented a survey of methods for their optimization. C.H. Yang et. al., (2004), have conducted research on Simulation-based performance evaluation of transport vehicles at automated container terminals (ACTs) and have investigated the usage of Automated Lifting Vehicles (ALVs) over the usage of Automated Guided Vehicles (AGVs). They concluded that the usage of ALVs over AGVs is superior in container terminals. Van der Meer (Van der Meer R., 2000) has studied the performance of several well-known on-line dispatching rules and some case-specific dispatching rules for container transhipments in terms of pre-arrival information. E Kozan (Kozan E., 1997) discussed the transfer efficiency of multimodal container terminals. A network model reflecting the logistic structure of a terminal and the progress of containers was developed by him. Its objective was the minimization of the total throughput time as the sum of handling and travelling times of containers.

Up to now what appears to be lacking is research in addressing the problem of improving the overall efficiency of an integrated terminal model and the utilization of queuing theory to enable smoother operation. It has addressed a range of issues dealing with this problem in this paper.

Modelling Methods of Terminal

The problem was formulated by constructing a flow chart of the entire operation by breaking down of the events into three major operations; containers handling within ships by Quay Cranes (QCs), container shifting between Quayside and Yard and container handling in the yard. Thereafter an integrated model was designed in Arena 10.0 by utilizing queuing theory to the instances where empty prime movers are routed to available quay crane stations, where incoming vessels are routed to available berthing stations.

To incorporate smooth operations it needs to reduce buffer stocks at QCs, minimize the number of containers at the QCs queue, Prime movers must be underneath the operating QCs and QCs need to operate without delay when ships arrive to the berth. After developing many models for observation, two main models were developed incorporating queuing theory and without including queuing theory.

Results

Following parameters were measured to analyse the model: output (container units processed), waiting time in queues and total times of processes (per entity). Results showed an improvement of 9.2% in terms of increase in output. It also showed a decrease of waiting time at Quay Cranes where prime movers load (Shown in Table1). When Automated Terminal Container (ATC) was concerned there was an average increase of 8.1%.

Table 1. Results obtained using simulation model

Measured Parameters	Without Introducing Queues	With the introduction of Queues	Percentage Change
Output Containers	551.00	607.00	9.2 (Increase)
Trucks Number In	1074.00	1148.00	6.4 (Increase)
Ships Number In	567.00	694.00	18.3 (Increase)
Waiting Time ATC Process.Queue	45.20	8.35	441 (Decrease)
Waiting Time Ship Process.Queue	10.77	13.58	20.7 (Increase)
Waiting Time QC1 Empty Truck	123.34	8.39	1370 (Decrease)
Waiting Time QC2 Empty Truck	626.58	0.00	(Decrease)
Number Waiting ATC Process.Queue	2.11	0.42	403 (Decrease)
Number Waiting Ship A Process.Queue	0.03	0.05	37.0 (Increase)
Number Waiting QC1 Empty Truck	1.60	0.25	534.9(Decrease)
Number WaitingQC2 Empty Truck	9.95	0.00	(Decrease)
ATC Process Out	442.00	481.00	8.1 (Increase)
QC1 Process Out	13.00	33.00	60.6 (Increase)
QC2 Process Out	14.00	0.00	(Decrease)

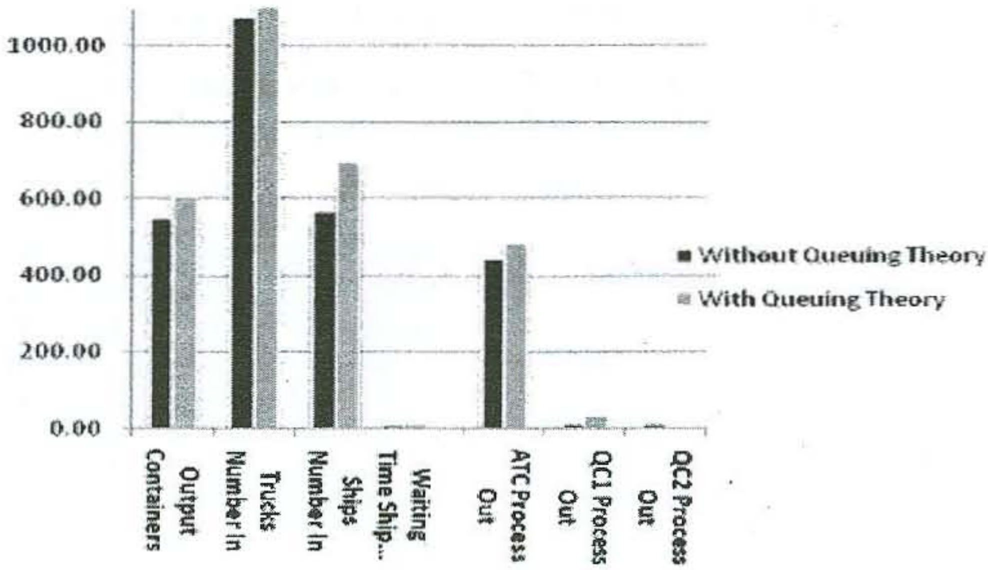

Figure 1. Variation of parameters when applying queues

Discussion and Conclusion

The most significant result here is the additional number of units processed in the given time period. The improvement is not only limited to the output but also shows a considerable reduction in the waiting times (process, queue and entity), value added time and total time of those operations that take place when queues are introduced with correct servicing times.

Based on the results obtained from the two simulations for the integrated models using queuing theory and without using queuing theory we can confidently say that using queuing theory had a positive outcome in terms of efficiency and productivity.

References

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