Analyzing Container Yard Layout for Maximizing Efficiency in Container Handling

Pushpika MDMM [1]
Dr. Perera LDRD [2]

ABSTRACT

Investigations were carried out at the Spence Shipping (Pvt) Ltd in order to provide solutions for issues arisen with the inland container depot of Spence Shipping (Pvt) Ltd. Currently, Spence Shipping (Pvt) Ltd faces a huge difficulty with the container yards. The major problems are longer queues to enter the yards, repairing, storing and picking containers, poor and inefficient handling of containers, congestion of containers, and damages occurring to the containers in the yards. This report presents a model layout based on simulation approach which improves the efficiency of container handling in the inland container depot by taking into consideration the work performed at the survey point, check point, repair stations and storage area.

KEYWORDS: Container handling, Container yard, Yard layout, Simulation, ARENA

INTRODUCTION

There are various modes of transport: transport by air, sea, road, river, rail etc. Today transport by sea is playing a major role in transporting goods between countries. So shipping has developed into a vast area. Sri Lanka has become a hub port which is used by many shipping lines because the country is situated at a very important geographical location.

Aitken Spence PLC (Est. 1868) is a leading Group which has been in the Maritime Transport sector since its inception and at present represents many major international shipping and freight forwarding principals including Hyundai Merchant Marine and Hapag-Lloyd (www. Aitkenspence.com).

Spence Shipping (Pvt) Ltd is the Sri Lankan agent for Hapag-Lloyd shipping line which is the fifth largest shipping line in the world. Since all the businesses related to the shipping industry are combined with containers and there are incoming and outgoing loaded and empty containers all the operations cannot be done within the port premises.

Handling containers coming under the Spence shipping supervision are directed to two inland container yards. The basic operation in the yards is storing empty and laden containers and fulfilling the requirements of shipping lines, freight forwarders, and container leasing companies, shippers and consignees by releasing the containers to those parties at the right time.

Customers use the container yards of Spence Shipping (Pvt) Ltd to pick up containers to export their cargo or hand over the empty containers which were the local imports. Currently the company handles high percentage of requirements of containers in Sri Lanka and works with valued customers who are the Major Container Shipping Companies like Maersk (MSK), Mediterranean Shipping Company (MSC), Evergreen Marine Corporation (Ever), Hapag Lloyd Container Line etc.

Currently, Spence Shipping (Pvt) Ltd faces a huge difficulty with the container yards. The major problems are longer

[1]Graduate, Department of Computing and Information Systems, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

[2]Senior Lecturer, Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

waiting queues to enter the yards, repairing and storing and picking containers, poor and inefficient handling of containers, congestion of containers and damages occurring to the containers in the yards.

RESERCH OBJECTIVE

The key objective of conducting this study is to enhance the efficiency of container handling in the yard by introducing a better layout. To meet this ultimate goal, it is needed to find out the issues that the container yard is currently facing. And also alternative layouts for the container yard which may reduce the problems and find ways to improve the efficiency in container handling within the yard should be developed.

LITRETURE REVIEW

Malcolm Mclean introduced the use of containers in commercial terms in the late 1960s. Containers are one of the main and most commonly used means of unitizing cargo. They are standardized in size and type to fulfill the need for faster and more efficient and effective transport. Consequently special facilities are designed for handling them.

The research paper "A Simulation Model with a Low Level of Detail for Container Terminals and Its Applications" reveals that the performance of container terminals is becoming more important than ever, as trade among countries grows. They had introduced a 3D real-time-visualization container terminal simulation model based on Plant Simulation. In their model, it had reproduced every detailed behavior of container-terminal equipment, including not only movements of yard tractors and cranes but also those of trolleys, spreaders, and other machinery. They also analyzed the performance of container terminals by varying the settings such as the speeds of trolleys and spreaders, in detail. (Byung-Hyun Ha, Eun-Jung Park and Chan-Hee Lee, 2007)

Author of the paper on "3D Virtual and Physical Simulation of Automated Container Terminal and Analysis of Impact on In Land Transportation", they had analyzed the impact of instituting Automated Storage and Retrieval Systems (AS/RS) on the operations of a prototype maritime container terminal. They used a 3D simulation model developed to measure the effectiveness of the proposed total system and compare it with existing practices. (Behrokh Khoshnevis, Ardavan Asef-Vaziri, 2000)

Every day containers arrive at the terminal by train, ship or truck and are stored in the terminal area. Then, the same containers leave the terminal by train, ship or truck to reach their final destination. Aiming this, a methodology had developed to integrate simulation, forecasting and planning to support day by day and long term decisions for operators working in intermodal container terminals by the research paper on "Simulation and Forecasting in Intermodal Container Terminal". As disclosed, the amount of work a container terminal deals with depends on the quantity of containers in transit (I/O flow). They had solved the problems such as resources allocation and scheduling for ship loading and unloading tasks by proposing a system composed by different but strictly connected modules. (Behrokh Khoshnevis and Ardavan Asef-Vaziri 2000)

Dariush Nazari suggested a simulation and modeling approach in decision making. Design aspects of container terminals have gained a lot of attention since managers and researchers face a problem area that has a dynamic nature and stochastic behavior. In his research on "Evaluating Container Yard Layout a Simulation Approach", he focused on applying simulation for analyzing the differences between performance indicators in two typical container terminal layouts,

terminal with vertical stacks compared to a terminal with horizontal stacks. He stated that the layout of a container terminal is proved to have a direct effect on the travel time of the transfer cycle and it also affects the utilization of different equipment of a container terminal. In this paper he also mentioned that, as Hwarng (1998) pointed out, the good design of a container terminal involves not only hardware such as cranes, trucks etc., but also software such as operating procedures and policies. (Dariush Nazari, 2004/2005)

METHODOLOGY

Research design is the overall plan for the research study which conceptualizes an operational plan that comprises quality procedures and tasks for completing the research work. There are many research designs and among those some can be adaptable to the present work.

In Applied research, it investigates practical issues that have implications for everyday work. Correlational research measures two or more variables for the assessment of relationship among them. Since the present research is related with practical issues arising in the container yard, the "Applied research methodology" is suitable because it can be used for investigating practical issues that have implications for everyday work in the container yard.

And also it is related with "Correlational research" because it is expected to assess how the efficiency of operations in the container yard can be improved by changing the container yard layout. Finally, a suitable model layout for the container yard which will be a new approach for the container storage

DATA COLLECTION AND ANALYSIS

Literature review was done as an initial data/information collection method. Various researchers had found out how the efficiency of container handling in ports can be improved using some simulation approaches. It supported to be on the track of the research after the literature review.

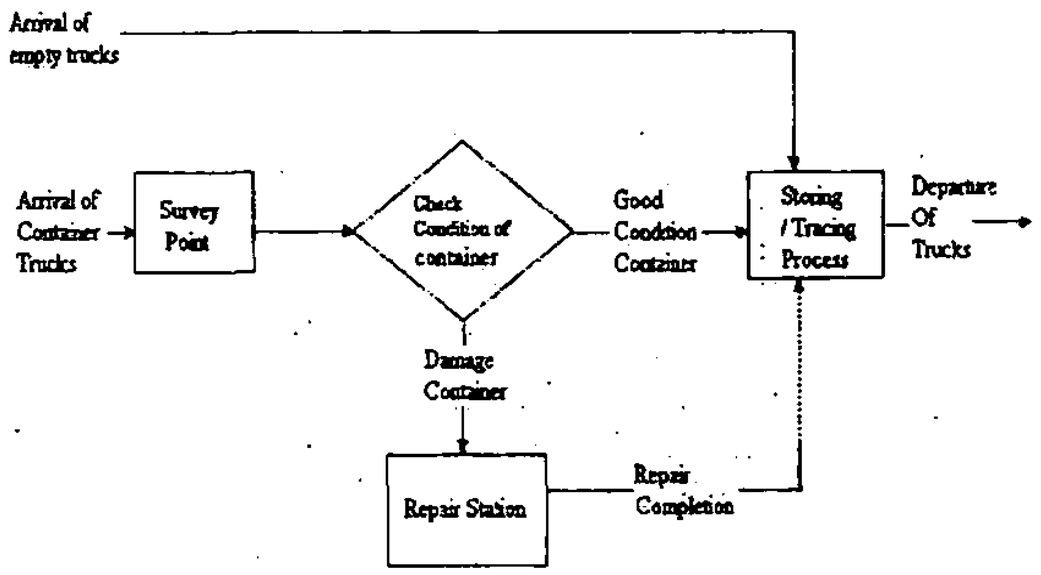
When the secondary data were collected, time period (for a particular month) was chosen. During that time frame, all the data collected by the yard and the Operations Department were gathered. There were mainly four data collection points at the container yard. They are the main gate, survey point, repairing point and storing area. From those points, all the details such as container details, arrival time, departure time, container condition, damage type, repair type needed were gathered.

By the method of observation the progress in the container yard was practically observed by attending all the points. That there is a huge delay on arrival of containers into the yard. By the customer point of view they have to spend lot of time out of the gate with containers. By the yard view, there is a long queue for processes like surveying, repairing, storing.

Two interviews were conducted with the members of operations department and staff member of the yard'. It was begun by asking a general question like asking about the process of the yard and encouraged the respondent to talk freely. An unstructured format was used for the interview. They explained how the works are carried out in the container yard, what the current situation of the container yard is, issues arise etc.

The following figure shows the main functionalities and process of the present container yard.

Figure 1. Present process of the container yard



There are huge number of customers waiting at the front gate with their trucks (Empty or with container/s) willing to pick containers or handover containers every day. All the containers coming into the yard have to pass the survey point for the purpose of checking the condition of the containers. This process takes some time and only one survey point is available with the yard. The trucks with no containers pass the survey point without surveying and directly point to the storage area to trace containers.

If the survey point gets a damage condition container, that container is directed to the repair station. There can be many types of repairs to be completed. So it may take lot of time according to the damage. After repair is completed containers are sent to the storage. If survey point finds an available condition container, containers with no damage, they are directed for the storing/stacking.

RESULTS AND DISCUSSION

Since there are damaged containers among the incoming trucks to the yard they should be directed to the repairing process. So, average probability of damaged container incoming to the yard is approximately 0.7137 per month. This implies that about 71.4% of the containers damaged of the daily inward of containers should be directed to the repairing process.

Table 1. Distribution Summary for Repair

Function	Squared Error
Lognormal	0.003004
Gamma	0.011760
Erlang	0.014056
Exponential	0.014056
Weibull	0.014232
Beta	0.059376
Normal	0.304722
Uniform	0.741230
Triangular	0.627650

The distribution of the repair progress was fitted according to the several distributions. The distribution which has minimum squared error is the best fitted distribution for a particular process. So, the repair process of the containers fits with "Lognormal" distribution {28 + LOGN (1.82, 1.57)}. This has 0.003004 Squared Error.

Table 2. Distribution Summary for survey point

Function	Squared Error
Beta	0.016732
Uniform	0.023416
Weibull	0.047180
Gamma	0.048963
Erlang	0.049004
Exponential	0.049004
Normal	0.057420
Triangular	0.071166
Lognormal	0.076485

The above table shows several fitted distribution for the process in the survey point at the container yard. "Beta" distribution best fits with the process with {8 + 10 * BETA (0.692, 0.84)} since it has minimum squared error (0.016732).

Table 3. Distribution Summary for storing/tracing

Function	Squared Error
Uniform	0.007133
Weibull	0.028505
Normal	0.030913
Triangular	0.036763
Erlang	0.038235
Exponential	0.038235
Lognormal	0.085220
Beta	0.490467
Gamma	0.672221

The above table summarizes how the storing / tracing of containers are performed at the storage area of the container yard. In view of the fact that the "Uniform" distribution best fits with the process as it has the minimum squared error, UNIF (8, 18) with 0.007133 squared error is the distribution of storing / tracing of containers.

Table 4.Utilization of work stations of the present container yard layout

Check Point	Repair Station	Survey Point	Storage Point
Available stations	5	3	1	2
Station busy time	2.3095	2.1447	0.9241	1.8902
Station utilization	46.19%	71.49%	92.415%	94.51%

At the end of the simulation run, the check point queue has 12 containers to be checked and the storage point queue has 56 containers waiting for storing and picking containers and both working stations are busy more than 92% of the time. This implies that the check point and storage point do not have enough capability/capacity to handle their works or there is a great deal of unpredictability at the station.

At the survey point also there are 7 containers in queue after the simulation has completed and 71.49% of time, the survey point is busy. This entails that this server has the capacity to survey the containers incoming moderately.

The number of containers in the repair queue is zero at the end of the simulation and the repair area is busy only 46.19% of the time. This implies that the repair point is capable of handling the damaged container repairing and has enough capacity.

Survey point and Check point have many problems such as only one surveyor working at a time and it takes longer time for checking one container which result longer waiting queues at those stations.

Since the Storage area tackle the stacking procedure and tracing procedure they have some problems as follows.

- Limited forklifts available
- Some machines are not having the proper condition for lifting the containers
- There is a higher probability of breaking down of older forklifts
- Limited number of workers
- These workers have to switch for the tracing & stacking procedures
- Lack of land & not enough storage area
- Sometimes, the containers were not properly stacked
- Very much time consuming on tracing the required conditioned container
- Cause the jargon of containers and damages to the containers
- Condition of roads in the depot is poor
- Machines can't move efficiently

The following table shows the alternative solutions and number of service stations needed to minimize the above mentioned difficulties

Table 5. Summary of Alternative Solutions

Stations	Number of Stations		
	Solution 1	Solution 2	Solution 3
Survey points	2	3	3
Check points	2	3	3
Repair stations	3	4	5
Storage area	2	3	3

Services	Utilization of Stations		
	Solution 1	Solution 2	Solution 3
Survey points	99.515%	82.363%	76.736%
Check points	95.625%	81.150%	73.440%
Repair stations	92.573%	85.905%	75.400%
Storage area	85.280%	72.903%	72.056%

Queues	Number of Containers at the Waiting		
	Solution 1	Solution 2	Solution 3
Survey points	28	0	0
Check points	6	1	0
Repair stations	3	6	0
Storage area	4	2	1
Capability of -Departure trucks	101	125	125

Above summary tables indicate that the *solution 1* layout is not having enough capability to handle the containers effectively and efficiently since all the service stations are busy more than 85% and there are longer waiting queues.

The servers at the service stations of the alternative *solution 2* are not more than 86% of time busy. This entails that the servers has moderate capacity to handle the

containers and there are moderate number of containers at the waiting queues.

Not more than 75% of simulation time, (Approximately) any of servers at the service stations are busy. So, solution 3 layout is also has the moderate capacity to handle the containers in the yard and it has no waiting queue at the three stations and only one at the remaining queue.

Although *solution 2 and 3* have moderate capability, the *solution 3* is more feasible than the *solution 2* because there is one more repair station than in the *solution 2* and it reduces the busy time at all the stations. And, there will be only two or three workers assigned to the extra repair station. So, the *solution 3* layout has enough capability and will handle the containers efficiently than the other two alternative solutions.

Therefore, the best feasible layout for the container yard is the solution 3.

CONCLUSION

The current layout of the container yard at Spence Shipping has not enough capacity to handle all the incoming containers at the survey point, check point and storage area. But the repair station currently has enough capacity for containers directed by the check point. At the end of simulation run time three servers, apart from the repair station, have long waiting queues. So, the current layout is not efficiently handling containers in the yard.

The main objective of the research project was to improve the efficiency of the container handling in the container yard by analyzing the layouts. So, the proposed layout (solution 3) for the container yard consists of three servers in the survey point, three check points, five repair stations and three machineries at the storage area simultaneously.

The best feasible layout has the capacity to handle 125 departure-trucks at the end of the simulation time. Any of the servers at the service stations are not more than 75% of time (Approximately) busy. So, this layout also has the moderate capacity to handle the containers efficiently in the yard. Also, the proposed layout has separate paths for arrival of empty and container trucks in order to reduce the waiting time at the entrance. The survey point and check point will have more servers or surveyors to handle incoming containers. Check point directs the containers to the repair point and it may consist of more repair stations. Storage area should have suitable method to separate the containers by the condition and by the owning shipping line which must be improved in the future.

The proposed layout will be able to provide better efficiency in container handling, reduce the busy time of the service centre in the container yard and attract more customers.

REFERENCES

- www.aitkenspence.com, *about Aitken Spence*, viewed July 2009, <http://www.aitkenspence.com/about_us/hotels_logistics_power_sri_lanka.asp>.
- Behrokh Khoshnevis, Ardavan Asef-Vaziri, (2000). *3D Virtual and Physical Simulation of Automated Container Terminal and Analysis of Impact on In Land Transportation*, University of Southern California
- Byung-Hyun Ha, Eun-Jung Park and Chan-Hee Lee, (2007). *A Simulation Model With A Low Level Of Detail For Container TerminalsAnd Its Applications*, Winter Simulation Conference, Dept. of Industrial Engineering, Pusan National University.
- Dariush Nazari, (2004/2005). *Evaluating container yard layout A simulation approach*, Erasmus University Rotterdam.
- David Kelton W, Randall P. Sadowski, Deborah A. Sadowski, (1998). *Simulation with ARENA*, 03rd Edition, McGraw Hill, New York.
- ARENA 3.0 software manual.