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DESIGN OF A SIMULATION MODEL TO SOLVE SHIPMENT CLEARANCE DELAYS IN SHUWAIKH PORT

Key Words

Simulation; Queuing and Waiting Time Analysis; System Utilization, Capacity Planning.

Abstract

As an important element in any supply chain network, ports are the backbone of logistics and transportation in today's global economy. The quality and promptness of services that ports offer are among the many factors that companies look for when choosing a port to fulfill their logistical needs. Any delay in releasing exports/imports from a port could mean financial loss for both the supplier and the customer. Therefore, improving the operational workflow is considered to be a critical success factor for any port to achieve competitive advantage over other ports in the region. Accordingly, this study will investigate the factors and reasons that affect the operational process and workflow of Kuwaiti ports, focusing specifically on Shuwaikh Port. A simulation model is designed here to identify bottlenecks and for effective workflow planning. Based on the simulation model results, recommendations can be offered to overcome the obstacles. This study is very important as it would enable the identification of weaknesses that cause customers to prefer working with other ports in the region. We hope to identify some opportunities that will enable the improvement and preservation of Kuwaiti ports.

Introduction

Present day organizations have realized that it is the effectiveness of the supply chains in which they participate that gives them a competitive edge over other organizations. The importance of reaching customers at the right time, with the right product and with the right quantity, cannot be underestimated. With the

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important role of logistics in today's global economy, choosing the right port can make all the difference.

As an essential part of any supply chain network, well-operated ports can increase a country's trade flows and its economy. Ports are either the beginning or the end of a product's journey. They are the meeting point for different modes of transportation and an intermediate step to many others in the logistics network for delivering products to their customers.

Although it is necessary for a port to be in an optimal location, location is no longer the primary factor in gaining a competitive edge through the supply chain network (Ryan, 2007). To speed up the delivery process of products to their customers, a port must provide the most expeditious and wide-ranging coastal services on land, such as warehousing, inventory management, and efficient coordination in intermodal operations (Quinn, 2005). These requirements are a necessity to attract customers. A port's ability to provide such services is a critical factor for a country's competitiveness and its trade prospects (Park & De, 2004). Thus, the ports that are effective and cost efficient, which can expand their capabilities and provide value-added services to its customers, will flourish in today's competitive environment. This improved operational performance can improve the country's economy by facilitating its access to the international market (Park & De, 2004; Tahar and Hussain, 2000).

In his research, Casaca (2005) suggests that every major container port is expected to double or even triple its throughput by 2020. This means that ports will be handling about 700 million Twenty Foot Equivalent Units of containers (TEUs) worldwide. Therefore, ports should adopt the concept of lean production and become agile to develop into lean ports, which will allow them to streamline their operational process (Casaca, 2005). According to Womack and Jones (1994), introducing agility into a port's operations can double their production with the same amount of resources and bring savings as they promote the reducing of existing and future bottlenecks (Casaca, 2005; Casaca, 2003; Piaxao and Marlow, 2003; Marlow and Piaxao, 2001).

To develop Kuwait into a financial center in the Gulf Cooperation Council (GCC) and the Middle Eastern regions, as part of its national strategies, it is important to renovate and improve the operations of its ports. Doing so will allow for a more efficient and effective workflow that will enable Kuwaiti ports to compete with other ports in the region and to achieve their strategic goal. Kuwait has three commercial ports: Shuwaikh, Shuaiba, and

Doha. Each one of these ports is an essential facilitator of the state's economic progress. Shuwaikh is considered Kuwait's primary port that handles around 80% of the containerized cargo imports and exports in Kuwait (Annual Report, Kuwait Ports Authority, 2007). However, there has been an increasing number of complaints from companies regarding delays in releasing exports/imports from this port. These delays can be very costly for both suppliers and customers. For example, it can cost as much as $1,500/ hour to keep a ship in commission. Thus, the main concern for the sea carriers is their turnaround time and the total costs of their cargo throughput; the total cost includes the cost of transiting the port, the cost of surface transportation within the port, and the cost of inland links provided at the port (Frid, 2002). On the other hand, the main concern for the companies that receive goods is to get them out of the port to their distribution centers as promptly as possible so that the companies can meet their customers' demand on time.

Accordingly, this study attempts to investigate the claims on Shuwaikh Port by developing a simulation model that can represent the workflow processes currently adopted. The findings of these simulation results can help the port managers to get a detailed understanding of the causes for the delays and thus propose the necessary solutions.

Literature Review

Simulation modeling has been widely used in ports in order to monitor the operations of different parts of container terminals such as automated guided vehicles (VGA), cranes, trucks, etc (Boer, 2005). However, previous research on ports has focused mainly on the productivity and the allocation of resources of individual terminals and not on the overall performance of port operations (Casaca, 2005). Therefore, to develop a new concept of a lean port, the overall performance of the port's operations needs to be evaluated and analyzed.

The Office of Naval Research in the United States has commissioned TranSystems Corp and Automation Associates Inc. to develop a simulation-based agile port system (APS), a concept that is based on transferring containers from vessels directly to inland facilities, which reduces costs and traffic congestion. The purpose of this commission is to increase the efficiency of United States ports (Kulick and Garcia, 2005). The concept of APS is the modern method used to increase a port's throughput as an alternative to the costly affair of building additional infrastructure.

Van der Zee and Van der Vorst (2005) claimed that current simulation models lack some modeling capabilities such as the control structures and that the focus is mostly on the physical interaction of producers, distributers, and retailers. Therefore, the current models may not be complete and transparent to all of the parties involved. Thus, Zee and Van der Vorst proposed a modeling framework for the supply chain simulation, where the decision makers are considered agents who carry out control jobs. The purpose of their modeling framework was to guide analysts in building quality simulation models that are transparent and complete that would allow an improved decision support systems.

Tahar and Hussain (2000) used simulation modeling to improve the logistics processes at the port of Kelang in Malaysia. Although their simulation model considers only berth allocation and crane assignment, it revealed some important findings that could enable decision makers to better manage their operations at the port. The port of Kelang proved to have the capability to increase its throughput using current resources and through better coordination of its cranes, prime movers and straddle carriers.

The System of Shuwaikh Port

Most of the ports around the world consist of three main entities: berth areas, where containerships arrive to load/unload containers; a yard, where containers are stored to be routed to their next destination, and a gate, where trucks arrive to either pickup or drop off containers. Figure 1 is an abstract of a general port model.

The system of Shuwaikh Port is an integrated structure, which is run between two coordinating organizations: Kuwait Ports Authority and Kuwait Customs. The first is responsible for handling the arrival of ships, the allocation of cranes to berth areas, the loading/unloading of containers, the allocation and storage of containers in the stocking yards, and finally the delivery of containers to the customs areas. Kuwait Customs, on the other hand, is responsible for the final inspection procedures and the clearance of the containers before they leave the port.

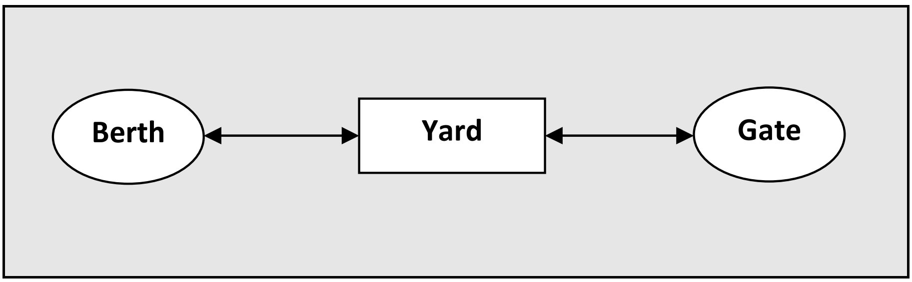

Figure 1: Container Terminal Model

Shuwaikh Port consist of 8 berth areas, only two of which have their own gantry/stationary cranes, namely, berth areas 12 and 13. There are 8 other mobile cranes ready to serve the containerships located at the other 6 berth areas: berths 9, 10, 11, 14, 15, and 18. There is also a marshaling area for containers that are waiting to be handled, and there are two stacking yards, where the containers either wait for customs clearances or wait to be loaded back to their designated containership. The stacking yards are organized in multiple container blocks based on container types. Containers are transported from one area to another via trucks that are outsourced from multiple contractors. Equipment that could help with the loading/unloading activities, such as straddle carriers, automated guided vehicles, and reach stackers, is still unavailable in Shuwaikh Port. Mobile cranes are used in the stacking yard for loading/ unloading activities. Although the Kuwait Customs inspection area is located right behind the berth areas, reaching it requires some traveling due to the layout of the port and the location of Kuwait Free Trade Zone area. The trucks parking area is unorganized, which delays the trucks from reaching their final destination on time. The layout of Shuwaikh Port is shown in Figure 2.

Figure 2: Shuwaikh Port Layout

Research Methodology

Ports are an important linking medium in the supply chain networks. They are the connection avenue for different products and modes of transportation. These facts introduce great interdependencies and variation among the port's system components. Thus, such systems are extremely complex and are very difficult to analyze using mathematical modeling techniques. Therefore, when such complexities exist, a discrete event simulation is the best approach to analyze a port's operations (Casaca, 2005; Dahal *et al.*, 2003; Pachakis *et al.*, 2003; Ridall *et al.*, 2000). The system of the Shuwaikh Port is thus analyzed using sophisticated simulation software such as Flexsim Container Terminal Software, which is specifically designed for port operations. Two different simulation models are developed. The first model represents a containership's movement, their loading/unloading activities, and the assignment of cranes to the containerships. The second model represents container movements and their journey within the port from the point of unloading to custom clearance and then to the departure area of the port. The detailed descriptions of each design model are described below.

i. The Containership Movement Model (SMM)

The SMM is used to analyze a port's operations by using a containership's handling capabilities to provide estimates of port performance measures, such as containership turnaround time, cranes stoppage times, and crane utilizations. Port productivity, expressed in terms of containership turnaround time, is an informative measure of performance for the purpose of assessing port competitiveness. This measure of performance can provide a total rather than a partial productivity indicator (Frida, 2002). Containership turnaround time in this model is defined as the total time a containership stays in the port starting from the time it berths until the time it departs from the port. Moreover, Bruzzone et al. (1999) suggested that equipment performance in terms of speed, reliability, and number of breakdowns can influence the behavior of the entire port system (Casaca, 2005).

The model was built using the historical data collected during the year of 2008 by the Kuwait Port Authority, based on the daily activities at the berths, 24 hours and 7 days a week, for a period of one year. Two types of containerships arrive at Shuwaikh Port: geared and gearless containerships. Geared containerships are ships that have a built-in crane, whereas gearless containerships are ships without built-in cranes. Regardless of the type of containerships and their order of arrival, berth areas with stationary cranes always have the priority to serve the containerships. On the other hand, if the berth areas with stationary cranes are already occupied or are shutdown for maintenance, the containerships are also allocated to other berth areas, with mobile cranes assigned to them. Figure 3 shows the flow diagram of the SMM.

Based on the historical data collected, 55% of the containerships that arrive at Shuwaikh Port are geared containerships and the other 45% are gearless. Also, all of the containerships arrive based on an exponential distribution with a mean of 1 day between arrivals. Given this relatively low arrival rate for the containerships, the number of berth areas available, and the number of mobile cranes, it is rare that a containership has to wait in an anchorage area. Shuwaikh Port is designed to handle cargo containerships with relatively medium to small cargo size. The data shows that the number of moves that depict the loading/unloading activities required per containership that arrives at Shuwaikh Port follows a normal distribution with a mean of 1500 and a standard deviation of 130. The loading/unloading time follows a uniform distribution with a minimum value of 1.5 minutes and a maximum value of 5 minutes per container. Cranes go through some stoppage periods for different reasons, such as maintenance, breakdowns, and operators' shift changes. Cranes stoppage that occurs due to shift changes happens every 12 hours and follows an exponential distribution with a mean of 30 minutes between arrivals of new operators. The stoppage period due to maintenance and breakdowns follows an exponential distribution with a mean of 24 days between stoppages. The restoration of the cranes in these cases, however, was estimated to follow a triangular distribution due to difficulties in fitting the exact data since reasons for shutdowns varies based on the reasons that cause them to begin with, and the type of work that needs to be performed on the cranes. Accordingly, three different scenarios with a triangular distribution are used to depict the restoration period of cranes after the shutdowns:

1 - Triangular distribution with a minimum value of 3 days, a most likely value of 4 days, and a maximum value of 6 days.

2 - Triangular distribution with a minimum value of 2 days, a most likely value of 3 days, and a maximum value of 5 days.

3 - Triangular distribution with a minimum value of 1 day, a most

likely value of 2 days, and a maximum value of 4 days.

These three scenarios were found to reflect all possibilities ranging from the worst case scenario, where cranes experience a major defect and spare parts or technicians need to be allocated from outside the port, to the best case scenario, where customary maintenance needs to be performed. Then, an average of the results of these scenarios will be included in the output to reflect an estimate of the operations of the cranes.

ii. The Container Movement Model (CMM)

The main purpose of the CMM is to analyze port operations in terms of container handling capabilities. Bottlenecks and the causes of their existence will be identified in this model, which are the main drivers behind the increasing number of complaints related to delays in releasing the containers from the port. The model starts from the point that the container is unloaded from the containership to the point that it is released from the gates.

Once a container is unloaded from a containership, it travels through the port via truck to be loaded and stored into the stacking yard. Due to the port's layout and the narrow roads that are used for vehicles to move within the port, traffic is a serious issue for trucks during busy working hours. It takes an average of 20 min for trucks to reach the stacking yard from the berth areas and about 10 min to reach the customs area from the stacking yard during busy hours. Moreover, the stocking yards are not fully utilized and are unorganized. The designed capacity for the stacking yard is about 10,000 (TEUs), but the effective capacity is about 60% to 50% of the designed capacity.

After the container reaches the stacking yard, it must then waits for a forklift in order to be unloaded from the truck and stacked in the yard. Then, when a customer claims his containers, a container must then wait again for a forklift and a truck in order to be transported out of the yard and into the customs area, where it must pass through customs inspections before it is cleared for release from the port. As mentioned earlier, the customs area is an independent unit of the port, and it operates under the Kuwait customs regulations. The customs area operates 24 hours a day and 7 days a week, excluding breaks and shift changes. Shift changes occur every 12 hours and can take around an hour. Breaks occur 3 times a day for meals, which last for 1 hour each, and an additional 5 times for prayers, which last for an average of 30 minutes each. There are 3 to 4 inspection points (i.e. service points) available

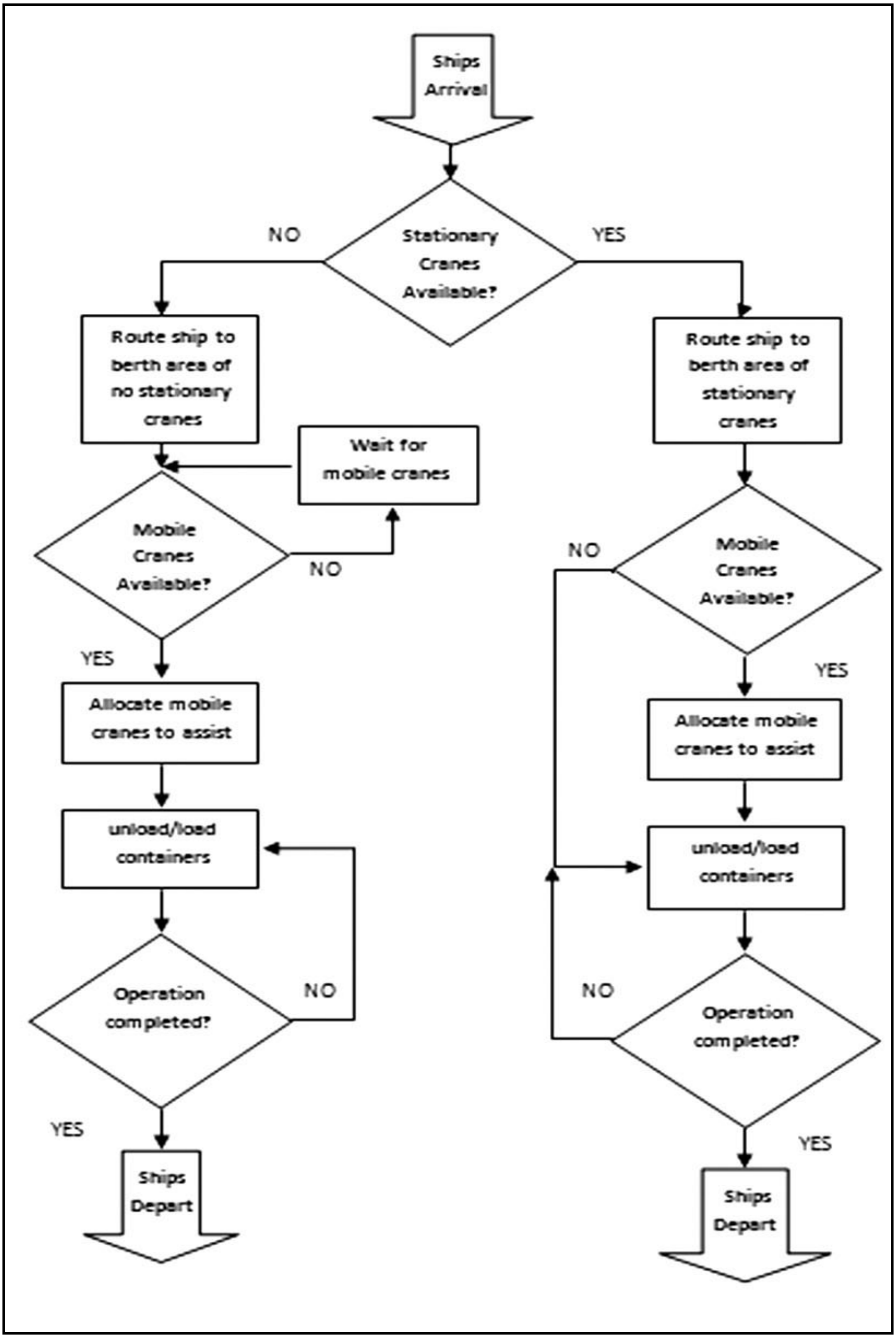

Figure 3: Flow Diagram of the Containership Movement Model

for operation at a time. Since customs inspections are done manually, service time varies depending on the load of the container and the expertise of the customs officer. Based on the observation of customs operations, a triangular distribution with a min, max, and most likely value of 0, 450 minutes, and 120 minutes are used, respectively. The flow diagram of the CMM is shown below in Figure 4.

The operation of Shuwaikh Port for the container movement model is monitored for one month with 5 runs of the model. Results and findings of the model are discussed below. A couple of snap shots of the Shuwaikh Port simulation model using Flexsim CT software is shown in Figures 5 and 6.

Figure 5 represents the stocking yard and the loading/unloading process of containers. Figure 6 represents the customs area, were trucks are checked for clearance.

Results & Analysis

Since the simulation of Shuwaikh Port was divided into two separate models, the SMM and the CMM, results from each of the models were analyzed separately. Five different runs were made for each model with 95% confidence, and their average was used in the analysis. Three different scenarios were tested in the SMM, each representing a different restoration period for the cranes after breakdowns. The main variables that were analyzed for stationary and mobile cranes are cranes utilization rate, total number of breakdowns, total down time, average containership turnaround time, and maximum containership turnaround time.

The CMM was used to track the containers journey within the port after a containership was unloaded. The main variables that were analyzed were the utilization rate of customs area, the average number of containers waiting in the yard for clearance and the average stay time for containers before clearance. In addition, 17 different scenarios were made with a different number of customs checkpoints to optimize the required number of customs checkpoints and to reduce the bottleneck problem.

It is important to note that the results were based on the data collected through personal observations, interviews, and historical data provided by Kuwait Port Authority. Both the SMM and CMM were verified by comparing the actual operations of Shuwaikh Port to the computer representation, and all input parameters and logical structure of the model were found to be correctly represented. Moreover, the models were validated by going through multiple iterative processes of comparing the

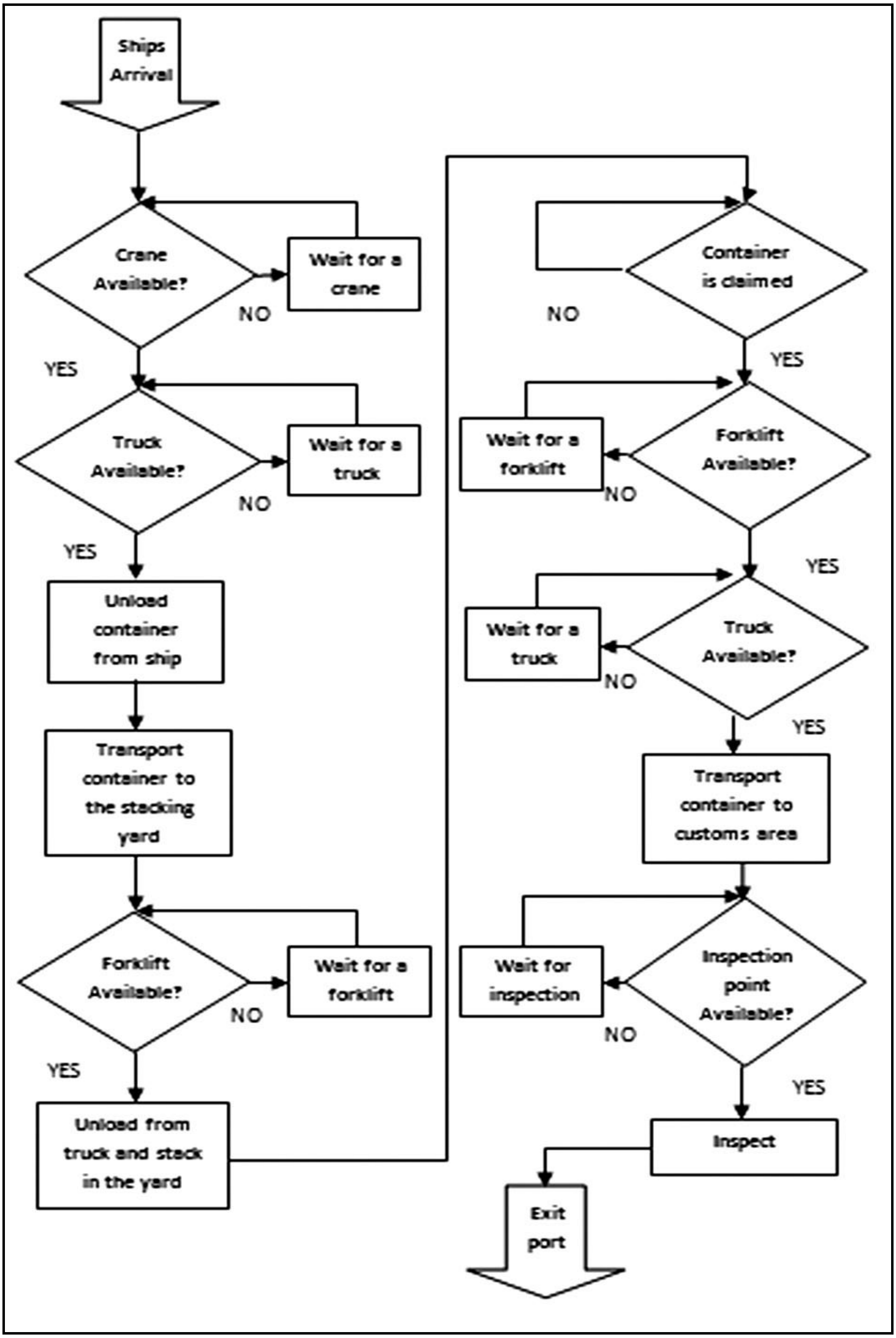

Figure 4: The Flow Diagram of the Container Movement Model

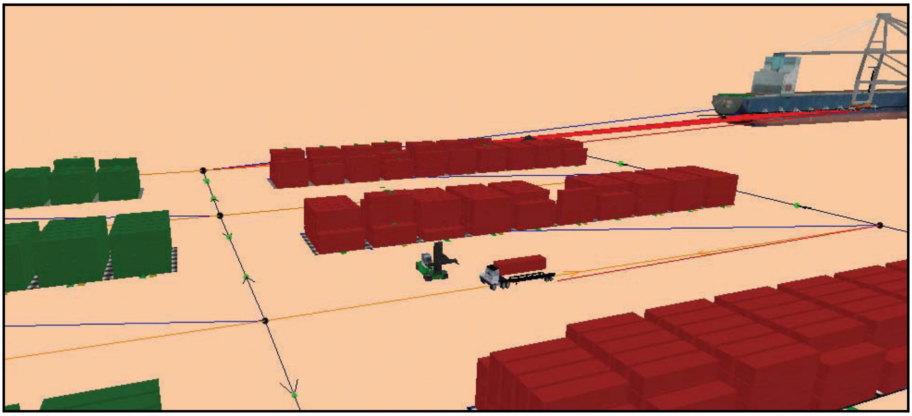

Figure 5: The Storing of Containers in the Stocking Yards

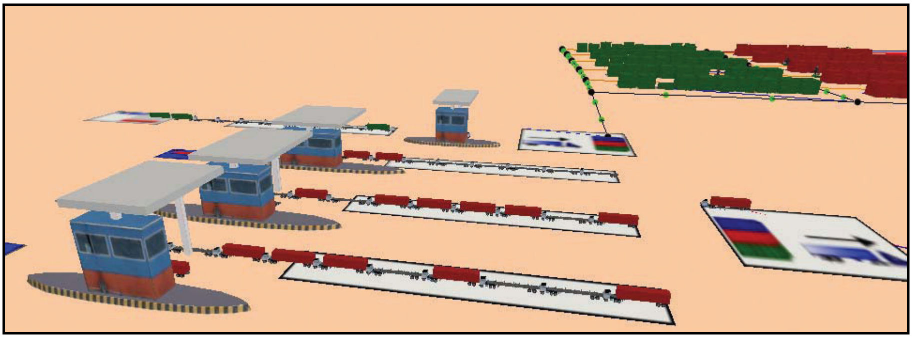

Figure 6: The Customs Service Points

models to actual system behaviour. Then, using the discrepancies between earlier drafts of the models, and the insights gained, corrections were made repetitively. This process was repeated until model accuracy is judged to be acceptable.

i. Results of the SMM

Summary of the results of the SMM are shown in Table 1.

Simulation results for the three different scenarios show that the stationary cranes located on berth areas 12 and 13 are fully utilized with an average utilization rate of 86% and 81%, respectively. Mobile cranes, on the other hand, have an average utilization rate of only 40%. This result can be explained through the fact that Shuwaikh Port has a relatively low arrival rate, an average of 1 containership per day, which means that containerships have the chance to wait in berth areas 12 and 13 most of the time. Mobile cranes alone are not used as often to load/unload a containership. They are mainly used to support

Table 1
Simulation Results of the Containership Movement Model

Cranes Restoration Period Based on Scenario	Utilization of Stationary Crane in Berth 12	Total Number Down of Stationary Crane 12	Total Down Time of Stationary Crane 12 (Days)	Avg. Ship Turnaround Time of Stationary Crane 12 (Days)	Max. Ship Turnaround Time of Stationary Crane 12 (Days)
1	0.86	20	80	5.3	14.9
2	0.85	15	47	4.9	13
3	0.87	21	55	4.6	10.11
Average	**0.86**	**18.67**	**60.67**	**4.93**	**12.67**
Cranes Restoration Period Based on Scenario	**Utilization of Stationary Crane in Berth 13**	**Total Number Down of Stationary Crane 13**	**Total Down Time of Stationary Crane 13 (Days)**	**Avg. Ship Turnaround Time of Stationary Crane 13 (Days)**	**Max. Ship Turnaround Time of Stationary Crane 13 (Days)**
1	0.8	7	31	4.6	12.5
2	0.8	14	43	4.5	12.16
3	0.82	15	34	4.45	10.8
Average	**0.81**	**12.00**	**36.00**	**4.52**	**11.82**
Cranes Restoration Period Based on Scenario	**Utilization of Mobile Cranes**	**Average Number Down of Mobile Cranes**	**Average Down Time of Mobile Cranes (Days)**	**Avg. Ship Turnaround Time of Mobile Cranes (Days)**	**Avg. Max. Ship Turnaround Time of Mobile Cranes (Days)**
1	0.44	12	39.5	4.5	11.3
2	0.39	10	32.2	4.2	10.3
3	0.38	15	33	4.12	9.55
Average	**0.40**	**12.33**	**34.90**	**4.27**	**10.38**

the loading/unloading of containerships that are berthed in areas 12 and 13, which are the areas with stationary cranes.

A total of shutdown times for stationary cranes in berth areas 12 and 13 and for mobile cranes are 60.67, 36, and 34.9 days, respectively.

The shutdown periods of the cranes, which are based on maintenance and breakdowns, are different for the different cranes as each shutdown depends on the type of work done on it, which is based on the random distribution mentioned earlier.

An important measure of performance is the containership turnaround time. The average turnaround times for containerships located in berth areas 12 and 13 and those that use mobile cranes for the three different scenarios are 4.93, 4.52, and 4.27 days, respectively. The maximum average turnaround time for containerships using the three different scenarios for containerships located in berth areas 12 and 13 and for those that use mobile cranes are 12.67, 11.82, and 10.38 days, respectively. These numbers convey that the average turnaround time for containerships that use mobile cranes for loading/unloading is not much different from containerships that uses stationary cranes, which could be due to the flexibility of the mobile cranes to move freely around containerships. This result means that the priority rules used to locate containerships in berth areas 12 and 13 provide no advantage to containerships' turnaround times. These figures should be compared with the industry averages of other ports in the GCC region to fully understand how well Shuwaikh Port is operating.

ii. Results of the Container Movement Model

The results of the CMM were based on a month's worth of operation data with a total of about 4200 container per week. Since the intention is to monitor the steady state effect of the system, the simulation model launches with an initial value of number of containers waiting in the yard, which is around 3700 containers. The results indicate that the customs area was the main cause for a delay in a container's release. With 3 to 4 inspection points at the customs area, the utilization rate of each service point was found to be around 80%, as shown in Figure 7. This result shows that the customs service points were over utilized, i.e. there was always a constant demand for their services. The average service time at customs is about 161 minutes per container. With this kind of a workflow, a container has to wait in the port for about 11 days before it can be released. Thus, customs created a bottleneck in Shuwaikh Port. Figure 8 shows the number of containers waiting in the Yard for service. The figure indicates that the number of containers waiting for service increases with time as soon as a containership arrives to the port, and such containers take a relatively long time before they can be cleared.

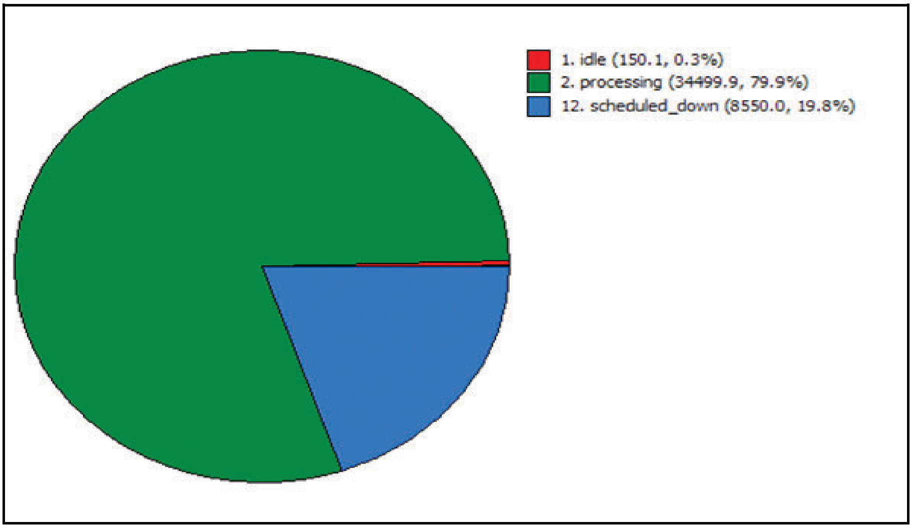

Figure 7: Utilization Rate of Customs with 3 to 4 Service Points

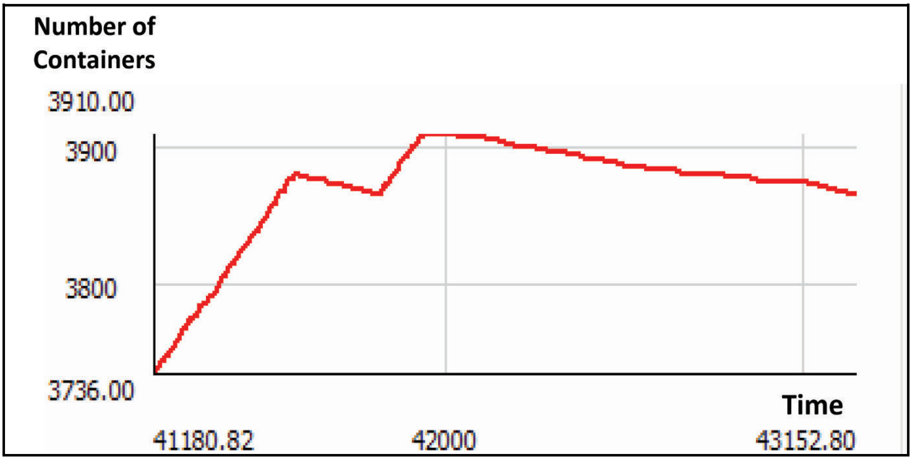

Figure 8: Number of Containers in the Yard vs. Time

Using the simulation model, the bottleneck problem from customs can be solved with the following strategies: increasing the number of customs points, improving the service time at each customs point, or a combination of both solutions. Table 2 shows 10 different scenarios for the above mentioned solutions.

Waiting time and the average number of containers waiting for service can be dramatically improved by implementing the above solutions. The solution of improving the customs service time is implemented by using a similar triangular distribution but with an improved service time, e.g. using the values of 0, 350, and 60 minutes for the minimum, maximum, and most likely value. These are only hypothetical values for the same triangular distribution used in the base case indicating an estimate of possible service time improvements. Figure 9 shows the average waiting time in days for containers using current customs service times compared with the improved customs service time and the improved number of customs service points.

Table 2 also shows that despite the improved waiting time of the containers at customs when the number of customs service points and their service time were reduced, customs would still create a bottleneck at Shuwaikh Port due to their overutilization. Therefore, different runs were made for the simulation model using current customs service times to find the exact number of customs service points that would be required to reduce the utilization rate and reduce the bottleneck problem. Figure 10 shows that utilization rate of the customs service points remains around 80% until 15 customs service points, and the rate starts to drop as the numbers of service points were further increased. Having 17 service points of customs could reduce the utilization rate to 55%, therefore, much reduce the bottleneck problem. Current average waiting time for containers in customs area is around 12.7 days. This can be dramatically reduced to only 2.2 days with 10 customs check points and improved customs service time.

Conclusion & Recommendations

Since Shuwaikh Port is operated by two separate organizations, Kuwait Port Authority and Kuwait Customs, both organizations need to take significant measures to help optimize the workflow of the port and to reduce

Table 2
Scenarios for Applying Different Solutions to Customs Service Points

	Current Customs Service Time			Improved Customs Service Time		
No. Customs Check points	Avg. Stay time (Days)	Avg. Content (Containers)	Gates Utilization %	Avg. Stay time (Days)	Avg. Content (Containers)	Gate Utilization %
3	12.7	1194	79.8	11.2	1114	79.8
4	10.9	1108	79.8	9.9	962	79.8
5	10.4	1023	79.8	8.7	856	79.8
6	9.5	880	79.7	7.1	695	79.8
7	9	851	79.8	6	608	79.8
8	7.2	775	79.8	5.2	502	79.8
9	6.1	708	79.9	3.1	300	79.8
10	5.3	593	79.8	2.2	193	79.8

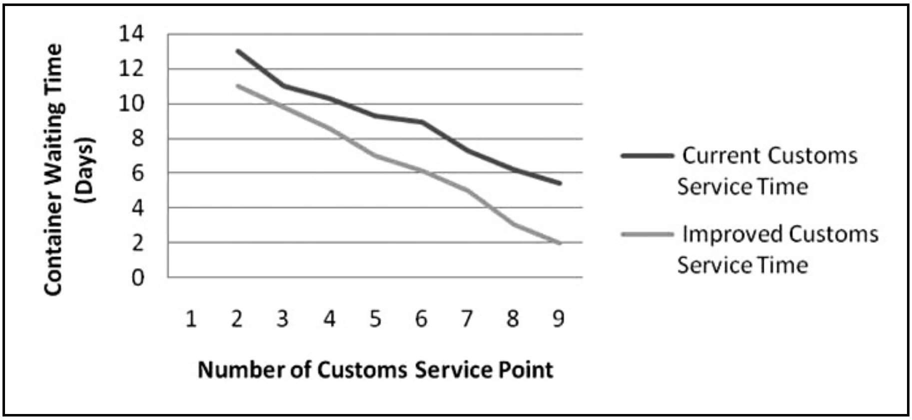

Figure 9: Comparison of Containers Waiting Time for Different Customs Service Time Scenarios

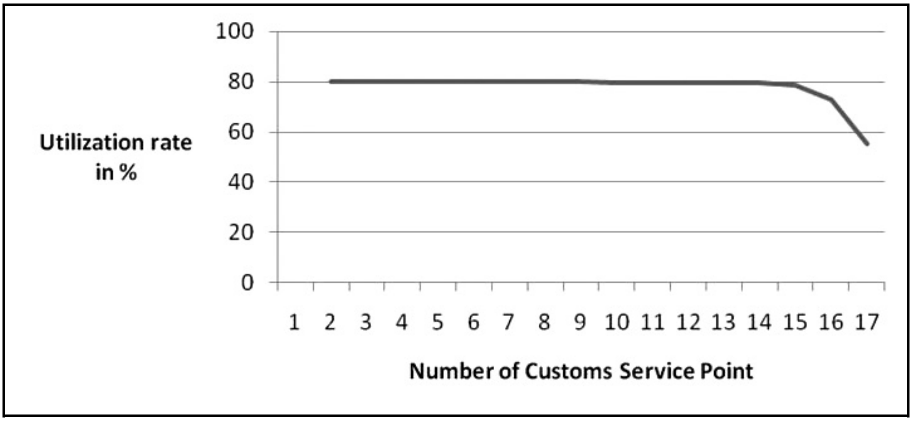

Figure 10: Customs Utilization Rate versus Number of Customs Service Point

the bottlenecks. Considering the current arrival rate of the containerships and their average load, Shuwaikh Port is currently considered a medium to small-sized port that can provide the following adequate operations: sufficient berth areas, stationary and mobile cranes, and trucks to transport containers from one area to another within the port. However, the current adequate number of berth areas, cranes, and trucks might not be sufficient enough if Kuwait would transfer to a financial center in the GCC region. Kuwait Port Authority has a long way to go to renovate the infrastructure of Shuwaikh Port to improve workflow processes. The current layout design of Shuwaikh Port can be a major obstacle and may be a disadvantage if the demand of the port increases. The major layout design issues were as follows: long distances between the stocking yard and berth areas, narrow streets within the port, disorganized parking areas for moving vehicles, and the inadequate location of the customs area.

As mentioned earlier and as shown in Figure 2, the stocking yard for the containers in Shuwaikh Port is located far away from the berth areas. Thus, the trucks that transport containers have to travel long distances within the port. Furthermore, the narrow streets within the port and the vehicles parked along the road make traffic nearly impossible for the moving trucks. The data based on the observations of the moving trucks in this study show that the trucks take an average of 20 min to reach the stocking yard from the berth areas.

Recommendations

Currently, the Kuwait customs checkpoints for containers are located in only one area of Shuwaikh Port, thus worsening to what is already poor infrastructural problems created by the narrow streets and chaotic parking. This persisting problem within Shuwaikh Port is obstructing customs from doing their job and thus is a major cause of bottleneck. Looking at the results, adding additional customs checkpoints can reduce containers delay time to an average of one day per additional checkpoint. Therefore, adding additional customs checkpoints and improving Shuwaikh Port's infrastructure can greatly improve the workflow and can thus minimize delays.

Adding checkpoints and improving the infrastructure in the customs area of Shuwaikh Port has had great impact on the workflow in our model, and improving the inspection processes within customs area would be important as well. Currently, inspections are done manually, which results in waiting times of 7 hours before containers are cleared and released. The simulation results of the CMM show that the improved customs inspections procedures could reduce a container's delay time by an average of 2 days, depending on the number of checkpoints it has to go through. Improving inspections service time could be achieved by providing automated customs testing procedures, utilizing inspection machinery, and improving human resources skills.

Future Research

An important question remains is how much does this congestion of Shuwaikh Port cost for both customers and suppliers. Specifically, how much does the containership turnaround time cost for carriers, and how much the container waiting time, before customs clearance, costs customers. What are the effects of these costs on Kuwait's economy. Looking into the future, and realizing the intention of Kuwait to become a financial center in the GCC region, can Shuwaikh Port cope with the increase of future demand. The next step would be to develop cost models that address the above issues.

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الملخص

تصميم نموذج محاكاة لحل مشكلة التأخير في عملية تخليص البضائع في ميناء الشويخ

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تعد مشكلة التأخر في عملية تخليص البضائع إحدى المشكلات الشائعة التي تواجه الموانئ البحرية، وتتسبب في خسائر مادية للمورد والمستهلك على حد سواء. ولذلك فإن تطوير انسيابية مراحل تخليص البضائع يعد أحد أهم عوامل النجاح في أي ميناء بحري. من هذا المنطلق تسعى هذه الدراسة إلى تحديد العوائق التي تتسبب في تأخير عملية تخليص البضائع في ميناء الشويخ، وذلك من خلال تصميم نموذج محاكاة لهذه العملية حتى يتم التغلب على هذه العوائق.

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