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Simulation Model on Determining of Port Capacity and Queue Size: A Case Study for BOTAS Ceyhan Marine Terminal

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ABSTRACT: Simulation programs are a useful and effective tool for analysis of projects requiring high investment costs, studies to improve the functioning of an existing system, and the analysis of the effectiveness and efficiency. They make it possible to control of system or substructure by less investment cost. Simulation models are often used in port modeling, capacity analysis, queue size and port efficiency.
In this study, simulation model of loading terminals of the BOTAŞ Ceyhan pipeline were done. For this reason, AWESIM simulation program was used. This modeling evaluated for 365 days and each ship has approached the port with intervals of 12-24, 12-36, 24-36 and 24-48 hours. Stormy days in a year have been assumed as 30. Each ship demands trailer and pilotage service when approaching and leaving the port. In this simulation model; ship types, capacities, coming frequencies, loading times, maneuvering time and transportation capacity of BOTAŞ Ceyhan Marine Terminal were investigated.

1 INTRODUCTION

Rapidly developing industry and technology since the 19th century lead to increased oil production which became the managing power of the economic structure and in turn today's large scale commercial oil circulation is emerged (Soylu, 2000). As one of the most significant elements of development, the energy and efficient use of such energy necessitated connecting the countries supplying the energy to demanding centers via various transportation ways, above all, via pipe lines in our world going through a rapid globalization process. Pipe line transportation is fast, economic and safe. Furthermore, the large scale investment is satisfied in a short time. Started at the end of 19th century with small scale and short distance lines, today, the oil and natural gas transportation turned towards for longer distances and at high pressures via pipe with wider diameters in parallel with the increased consumption, demand and technological advancements (Çubuk and Cansız, 2005).

While the pipe line transportation is a high cost investment compared to land and maritime transport, the pipe line transportation has advantages such as being faster, safer and more ecological compared to other transportation modes and not being affected by atmospheric conditions as well as having a shorter return on investment period. Therefore, transporting oil and natural gas to the consumption areas via pipe lines in the most economical way stands out (TUBİTAK, 2003).

Generally, pipe lines are examined in two groups as crude oil pipe lines and natural gas pipe lines. The oil is transported to ports or markets from regions with rich fields via crude oil pipelines (Çubuk and Cansız, 2005). Constituting the basis of the maritime system, ports are the locations where ships and marine vessels berth, and perform operations such as loading, unloading, maintenance and supply. It is difficult to solve the problems of ports analytically. The complexity of port functions has a complex structure dynamically, as in production systems. Utilizing simulation system in analysis of complex structure is inevitable (Demirci et al., 2000; Demirci, 2003). Simulation is a scientific methodology that is performed to understand the behavior of a real system without disrupting its environment. Simulation has been used in different systems such as urban, economic, production, transportation, and the maritime field (Hassan, 1993). In the maritime field, for example, simulation methods were constructed to analyze the impact of terminal layouts and to determine the optimum level of equipment investment (Hayuth, 1994).

2 LITERATURE REVIEW

Simulation applications are one of the most advanced and powerful in system analysis. The simulation approach would enable the designer and analyst to foresee the behavior of such system (Azadeh and Farahani, 1998). Simulation applications are often used on port modeling.

In the study conducted by Alan, B. Pritsker the frequency of vessels arriving at a tanker port in Africa, their duration at the port, days with stormy weather are assessed and the operability of the port and the tugboat activity are evaluated (Pritsker, 1986). Teo (1993) built an animated simulation model of a container port and investigated the movements of containers with automatic guided vehicles (Teo, 1993). Ramani (1996) has developed an interactive computer simulation model in order to support the logistic planning of container operations (Ramani, 1996). In the study conducted by Köse, Başar, Demirci, Güneroğlu and Erkebay, the traffic stream of the Bosphorus is modeled in AWESIM and investigated the effects of the new pipe line to be built on the strait traffic (Köse et al., 2003). In the study conducted by Yeo, Roe and Soak (2007), the maritime traffic congestion potential of Busan port is evaluated using an AWE-SIM simulation model. They concluded that one of the existing mooring berths within the harbor reach needs to be removed and two quays shall be expanded in order to prevent the traffic congestion (Yeo et al., 2007).

3 METHOD

Investigating the system behaviors using simulation technique aims to predict the future behaviors of the existing or future system to be built. In studies conducted using simulations, it is possible to see the results by applying strategies merely on the simulation model without making any changes to the actual system (Ali, 2008; Demirci et al., 2000). On the other hand designing simulation models is difficult and time consuming and allows making predictions regarding the actual system. Simulation studies generally consist of various stages. These well-arranged stages are monitored separately and the relations in each stage are investigated (Demirci et al., 2000). Simulation project adapting the general model to the specific problem situation plays essential role (Neumann, 2011).

This study is prepared in order to determine the handling capacity and usability of BOTAŞ Ceyhan Marine Terminal. Furthermore the following aspects of the BOTAŞ Ceyhan Marine Terminal are investigated: number of incoming vessels, queue values for berthing in the port, vessel waiting times for berthing, usability values of the ports, queue values for tugboat service, the time the vessels wait for getting tugboat service, total tugboat activity. Stay in port durations, frequency of arriving to the port, stormy days and the tugboat service rendered are the most critical criteria of this study. Accordingly AWESIM simulation modeling application is used in the present study.

3.1 *AWESIM*

AWESIM refers to the simulation language for problem solving. It may be used in courses, professional life, industrial engineering, managerial works, operational works and computer sciences. AWESIM is a simulation language for alternative modeling. High level understanding and compiling of AWESIM lead to an increase in worldwide simulation and modeling utilization (Pritsker, 1996). An AWESIM project consists of one or more scenarios, each of which represents a particular system alternative. A scenario contains component parts. AWESIM incorporates the Visual SLAM modeling methodology. The basic component of a Visual SLAM model is a network, or flow diagram, which graphically portrays the flow of entities (people, parts or information, for example) through the system. A Visual SLAM network is made up of "nodes" at which processing is performed, connected by "activities" which define the routing of entities and the time required to perform operations (O'Reilly and Lilegdon, 1999). Symbols frequently used in AWESIM are shown in Table 1 along with their descriptions.

The create node creates a new entity within the network at intervals defined by TBC (Time Between Creations) and can save the arrival time as an entity attribute. TF; time the first entity enters the system, MA; variable used to maintain mark time, MC; maximum number of entities to create. Activity determines the time of the activities. The duration of an activity is the time delay experienced by the activity. DUR; specifies the duration of the activity using either explicit time or a distribution, CONDITION/PROBABILITY; specifies under what circumstance / probability a particular branch will be traversed by an entity, N; represents the number of parallel identical servers if the activity represents servers, A; is the activity number within the model. A Queue node is location in the network where entities wait for service. When an entity arrives at a Queue node, its disposition depends on the status of the service activity that follows the Queue node. If the server is idle, the entity passes through the Queue node and goes immediately into the service activity. If all servers are busy, the entity waits in a file at the Queue node until a server becomes available. The sequence of occurrences in queue is evaluated in the priority node outside the network. FIFO (First In First Out) is the default priority for files. IQ; initial number in queue, QC; capacity of queue, IFL; file number. The Terminate node is used to delete entities from the network. It may be used to specify the number of entities to be processed on a simulation run. This number of entities is referred to as a termination count or TC value. When multiple terminate nodes are employed, the first termination count reached ends the simulation run. Assign node used as a method to assign values to entity attributes as they pass through the node. Also it can be used to assign values to system variables at each arrival of an entity to the node. VAR defines global or entity variable. The type of Value (expression) must agree with the variable being assigned. A maximum of M emanating activities are initiated. The resource block identifies a resource name or label, RNUM; resource number, RLBL; the initial resource capacity, CAP; number of units of the resource initially available, IFL; file to poll for entities waiting for a resource. Await node used to store entities waiting for UR units of resource to be available or gate to open (use resource or gate label names). Arriving entities are placed in file IFL. QC specifies the queuing capacity of the node. Rule specifies the resource allocation rule. M specifies the maximum branches leaving entities can take. Free node used to release resources previously allocated at an AWAIT node when an entity arrives at the node. Every entity arriving at a FREE node releases UF units of RES resource. A maximum of M emanating activities can be initiated from the node. The alter node is used to change to capacity of resource type RES by CC units. CC can be constant or an expression. If CC is positive, the number of available units is increased. If CC is negative, the capacity is decreased (Pritsker and O'Reilly, 1999; Pritsker et al., 1989).

3.2 *Technical Specifications of BOTAŞ Terminal*

BOTAŞ Ceyhan Marine Terminal, the termination of Iraq – Turkey Crude Oil Pipeline, located within the district borders of Ceyhan at 36°51,9'N 35°56,7'E is discussed in the present study. BOTAŞ Terminal is owned and operated by BOTAŞ. It is in the BOTAŞ Ceyhan Port Authority management area. The first loading operation of this terminal was performed in 1977. It consists of 4 quays. The loading arms in loading-unloading facilities are hydraulic system operated via the crane tower located on the quay. Quay 1 and quay 2 are suitable for berthing vessels with 100.000-300.000 deadweight tons and quay 3 and quay are suitable for berthing vessels with 30.000-150.000 deadweight tons (Figure 1).

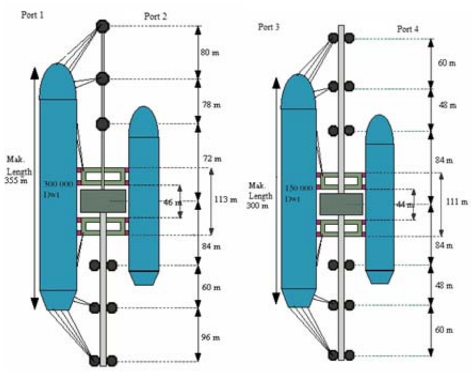


Figure 1. BOTAŞ Ceyhan Marine Terminal quay dimensions

Table 1. Symbols frequently used in AWESIM

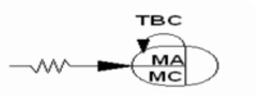
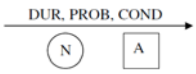
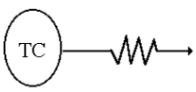
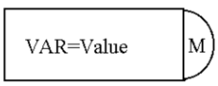
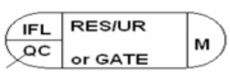
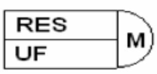
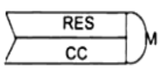
Symbol	Node Names	Description
	Create	Creates entities
	Activity	Specifies delay (operation) time and entity routing
	Queue	Holds entities until a server becomes available
	Terminate	Terminates the routing of entities
	Assign	Assigns values to attributes or global system variables
	Resource	Resource definition and initial capacity
	Await	Holds entities until a resource is available or a gate is open
	Free	Makes resources available for reallocation
	Alter	Changes the capacity of a resource

Table 2. Capacities of BOTAŞ Ceyhan Marine Terminal loading arms (BOTAŞ, 2005)

Port number	Numbers of arm	Diameter of the manifold	Loading rate m3/hours	Maximum Draft (meter)	Maximum LOA (meter)	Minimum LOA (meter)	Maximum Dwt. Tons
1	4	20"-18"-16"	4x5000	23	355	200	300000
2	4	20"-18"-16"	4x5000	23	355	200	300000
3	4	16"-14"-12"	4x2500	18	300	168	150000
4	4	16"-14"-12"	4x2500	17	300	168	150000

4 AWESIM SIMULATION APPLICATIONS

AWESIM simulation network model is used in the present study for Ceyhan Marine Terminal. There are 4 quays in this model. Vessels arrive at the port with 4 different scenarios with intervals of 12-24 hour, 12-36 hour, 24-36 hour and 24-48 hour. It is assumed that same amount of vessels arrive at these four quays. Waiting times of the vessels at the terminal are calculated as 24 hours minimum 64 hours maximum for quays 1 and 2 taking into account the vessel dimensions, ballast capacities, coast loading rate and document processing prior to and following the operation. On the other hand, tankers with smaller dimensions compared to quays 1 and 2 berths at quay 3 and quay 4. Therefore, waiting times of the vessels at the terminal are calculated as 16 hours minimum 64 hours maximum for quays 3 and 4. Tugboat and pilotage service are required for berthing and unberthing. Tugboat and pilotage service cannot be rendered for other vessel before a vessel berthing or unberthing. Tugboat and pilotage service are considered as one hour each for berthing and unberthing operations. This port is unable to offer tugboat and pilotage service on days with stormy weather (Uğurlu, 2006). It is known that there are 30 days with stormy weather in one year for Ceyhan Marine Terminal (BOTAŞ, 2005).

This simulation program is assessed for each scenario over 8760 hours in total, i.e. 365 days. Accordingly the number of vessels arriving at the port, port queue volume, waiting time for berthing, waiting time for tugboat and pilotage services, operability of tugboat and pilotage services and operability of berths are evaluated.

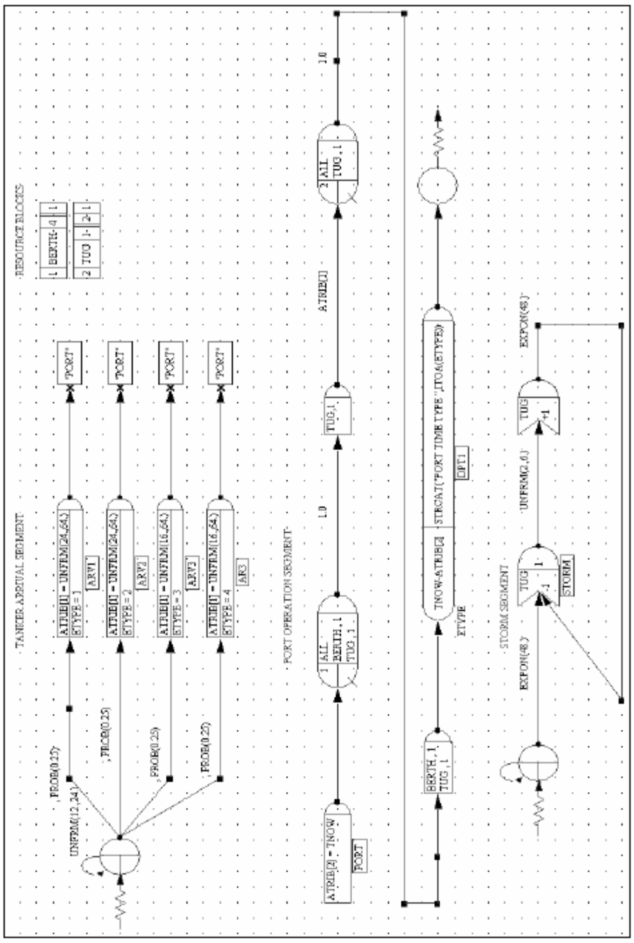


Figure 2. BOTAŞ Ceyhan Marine Terminal Scenario 1 simulation flowchart (12-24 hours)

4.1 *Scenario 1*

Scenario 1 is simulated as vessel arriving at BOTAŞ Ceyhan Marine Terminal in 12 to 24 hours (Figure 2).

According to simulation outputs, it is observed that 486 vessels arrived in total being 118 at quay 1, 114 at quay 2, 140 at quay 3 and 114 at quay 4. Any vessel arriving at the berthing is able to commence berthing after an average waiting time of 12 minutes. It is seen that 1 queue is formed for four quays. The quays operate at 2,449 efficiency on the In terms of tugboat service, any vessel arriving at the terminal receives the tugboat service after an scale of 4; in other words with 61% efficiency.

Average waiting time of 13 minutes and there is a queue of 2 vessels for such tugboat service. The activity of the tugboats is 11% in total (Table 3).

4.2 *Scenario 2*

Scenario 2 is simulated as vessel arriving at BOTAŞ Ceyhan Marine Terminal in 12 to 36 hours (Figure 3).

According to simulation outputs, it is observed that 372 vessels arrived in total being 94 at quay 1, 90 at quay 2, 97 at quay 3 and 91 at quay 4. Any vessel arriving at the berth is able to commence berthing after an average waiting time of 11 minutes. It is seen that 1 queue is formed for four quays. The quays operate at 1,885 efficiency on the scale of 4; in other words with 47% efficiency. In terms of tugboat service, any vessel arriving at the terminal receives the tugboat service after an average waiting time of 10 minutes and there is a queue of 2 vessels for such tugboat service. The activity of the tugboats is 8,5 % in total (Table 4).

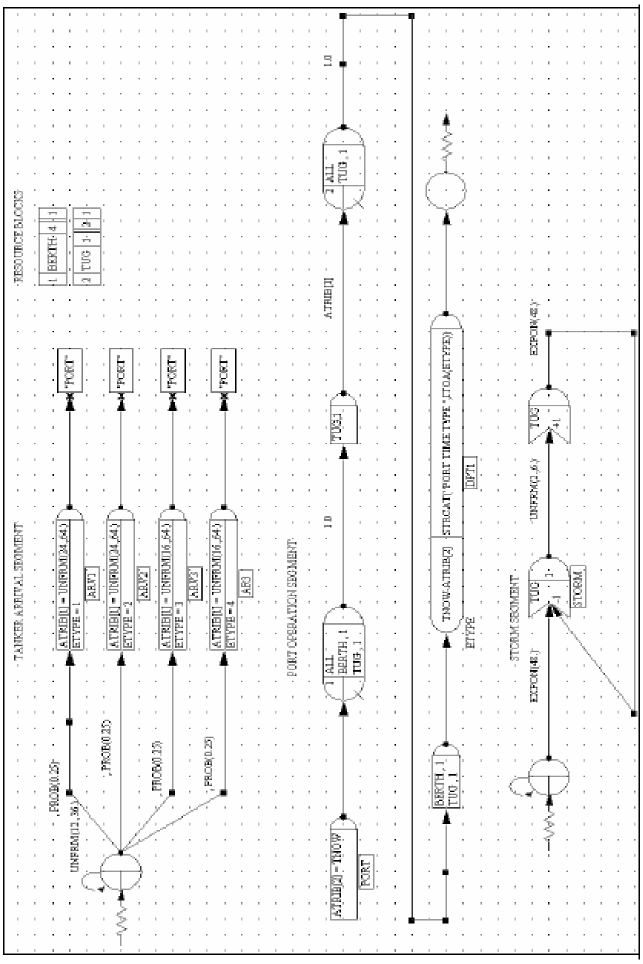


Figure 3. BOTAŞ Ceyhan Marine Terminal Scenario 2 simulation flowchart (12-36 hours)

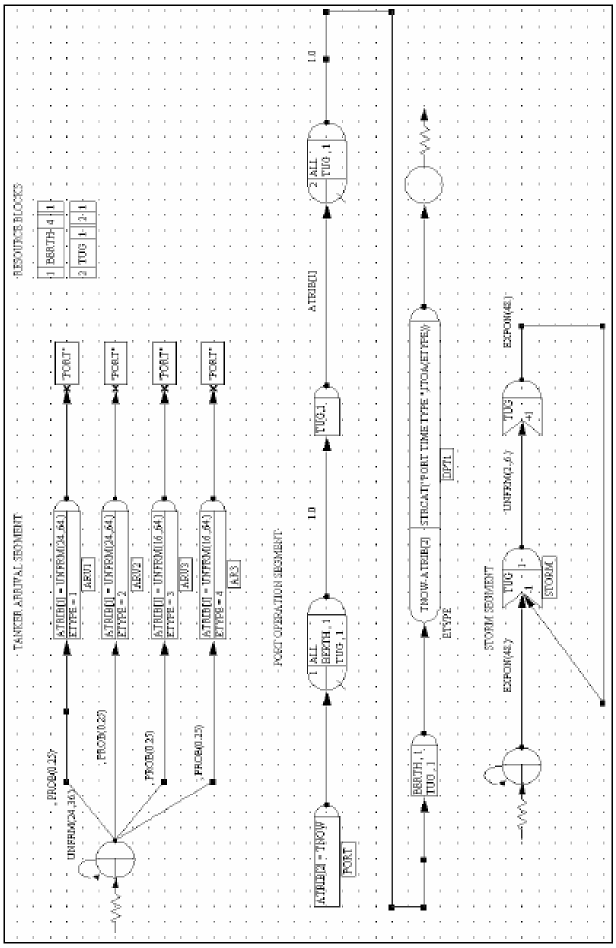


Figure 4. BOTAŞ Ceyhan Marine Terminal Scenario 3 simulation flowchart (24-36 hours)

4.3 *Scenario 3*

Scenario 3 is simulated as vessel arriving at BOTAŞ Ceyhan Marine Terminal in 24 to 34 hours (Figure 4).

According to simulation outputs, it is observed that 294 vessels arrived in total being 73 at quay 1, 71 at quay 2, 80 at quay 3 and 70 at quay 4. Any vessel arriving at the berth is able to commence berthing after an average waiting time of 8 minutes. It is seen that 1 queue is formed for four quays. The quays operate at 1,466 efficiency on the scale of 4; in other words with 36,6 % efficiency. In terms of tugboat service, any vessel arriving at the terminal receives the tugboat service after an average waiting time of 13 minutes and there is a queue of 2 vessels for such tugboat service. The activity of the tugboats is 6,7 % in total (Table 5).

4.4 *Scenario 4*

Scenario 4 is simulated as vessel arriving at BOTAŞ Ceyhan Marine Terminal in 24 to 48 hours (Figure 5).

According to simulation outputs, it is observed that 247 vessels arrived in total being 63 at quay 1, 57 at quay 2, 69 at quay 3 and 58 at quay 4. Any vessel arriving at the berth is able to commence berthing after an average waiting time of 11 minutes. It is seen that 1 queue is formed for four quays. The quays operate at 1,251 efficiency on the scale of 4; in other words with 31,2 % efficiency. In terms of tugboat service, any vessel arriving at the terminal receives the tugboat service after an average waiting time of 9 minutes and there is a queue of 1 vessel for such tugboat service. The activity of the tugboats is 5,7 % in total (Table 6).

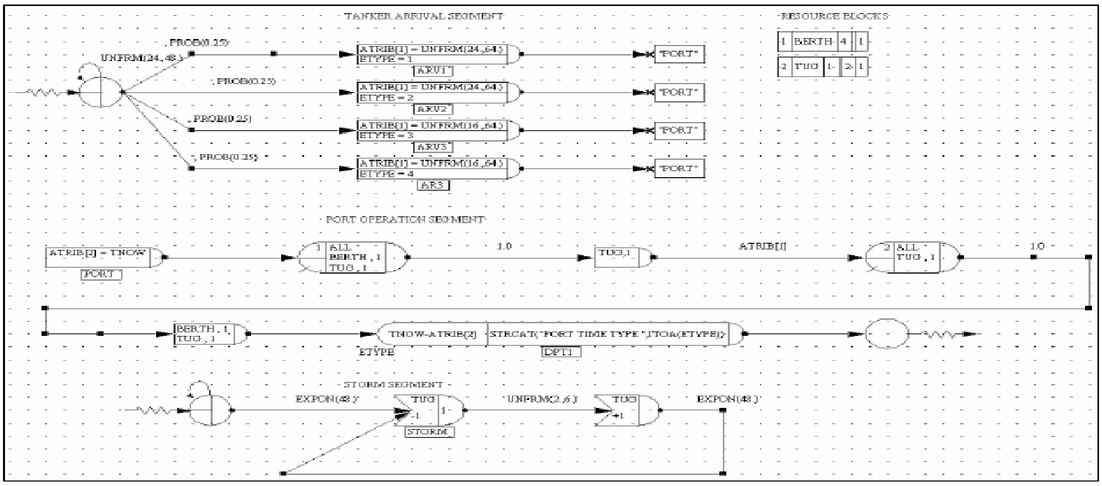


Figure 5. BOTAŞ Ceyhan Marine Terminal Scenario 4 simulation flowchart (24-48 hours)

Table 3. BOTAŞ Ceyhan Marine Terminal Scenario 1 simulation outputs (12-24 hours)

Statistics for Vessels Based on Observation					
Quay Number	Mean Value (hours)	Standard Deviation (hours)	Number of Observations (pcs)	Minimum Value (hours)	Maximum Value (hours)
Quay 1	47,350	11,031	118	28,282	69,093
Quay 2	44,982	11,798	114	26,350	68,383
Quay 3	41,372	12,737	140	20,648	66,776
Quay 4	43,571	13,610	114	18,087	66,974
File Statistics					
File Number	Label/Type	Average Length (pcs)	Standard Deviation (pcs)	Maximum Queue (pcs)	Average Waiting Time (hours)
1	Quay	0,010	0,101	1	0,186
2	Tugboat	0,012	0,112	2	0,217
Resource Statistics					
Resource Number	Resource Label	Average Utilization (pcs)	Standard Deviation (pcs)	Current Utilization (pcs)	Maximum Utilization (pcs)
1	Quay	2,449	0,758	2	4
2	Tugboat	0,111	0,314	0	1
Resource Number	Current Available	Average Available	Minimum Available	Maximum Available	
1	4	1,551	0	4	
2	1	0,809	-1	1	

Table 4. BOTAŞ Ceyhan Marine Terminal Scenario 2 simulation outputs (12-36 hours)

Statistics for Vessels Based on Observation					
Quay Number	Mean Value (hours)	Standard Deviation (hours)	Number of Observations (pcs)	Minimum Value (hours)	Maximum Value (hours)
Quay 1	44,787	11,496	94	26,158	66,861
Quay 2	47,568	10,088	90	28,282	65,613
Quay 3	43,689	13,801	97	19,291	65,983
Quay 4	42,121	13,845	91	19,358	65,808
File Statistics					
File Number	Label/Type	Average Length (pcs)	Standard Deviation (pcs)	Maximum Queue (pcs)	Average Waiting Time (hours)
1	Quay	0,008	0,089	1	0,187
2	Tugboat	0,007	0,085	2	0,159
Resource Statistics					
Resource Number	Resource Label	Average Utilization (pcs)	Standard Deviation (pcs)	Current Utilization (pcs)	Maximum Utilization (pcs)
1	Quay	1,885	0,709	2	4
2	Tugboat	0,085	0,279	0	1
Resource Number	Current Available	Average Available	Minimum Available	Maximum Available	
1	4	2,115	0	4	
2	1	0,840	-1	1	

Table 5. BOTAŞ Ceyhan Marine Terminal Scenario 3 simulation outputs (24-36 hours)

Statistics for Vessels Based on Observation

Quay Number	Mean Value (hours)	Standard Deviation (hours)	Number of Observations (pcs)	Minimum Value (hours)	Maximum Value (hours)
Quay 1	45,738	11,627	73	26,072	65,840
Quay 2	46,352	11,873	71	26,197	67,786
Quay 3	41,893	13,231	80	20,744	65,858
Quay 4	41,331	12,688	70	20,094	66,040

File Statistics

File Number	Label/Type	Average Length (pcs)	Standard Deviation (pcs)	Maximum Queue (pcs)	Average Waiting Time (hours)
1	Quay	0,005	0,068	1	0,136
2	Tugboat	0,007	0,089	2	0,223

Resource Statistics

Resource Number	Resource Label	Average Utilization (pcs)	Standard Deviation (pcs)	Current Utilization (pcs)	Maximum Utilization (pcs)
1	Quay	1,466	0,573	1	3
2	Tugboat	0,067	0,250	0	1

Resource Number	Current Available	Average Available	Minimum Available	Maximum Available
1	4	2,534	1	4
2	1	0,852	-1	1

Table 6. BOTAŞ Ceyhan Marine Terminal Scenario 4 simulation outputs (24-48 hours)

Statistics for Vessels Based on Observation

Quay Number	Mean Value (hours)	Standard Deviation (hours)	Number of Observations (pcs)	Minimum Value (hours)	Maximum Value (hours)
Quay 1	45,490	11,029	63	27,888	68,800
Quay 2	46,161	10,818	57	29,986	67,528
Quay 3	44,079	13,514	69	18,614	65,948
Quay 4	41,707	13,710	58	18,087	66,680

File Statistics

File Number	Label/Type	Average Length (pcs)	Standard Deviation (pcs)	Maximum Queue (pcs)	Average Waiting Time (hours)
1	Quay	0,005	0,071	1	0,180
2	Tugboat	0,004	0,066	1	0,155

Resource Statistics

Resource Number	Resource Label	Average Utilization (pcs)	Standard Deviation (pcs)	Current Utilization (pcs)	Maximum Utilization (pcs)
1	Quay	1,251	0,580	2	3
2	Tugboat	0,057	0,231	0	1

Resource Number	Current Available	Average Available	Minimum Available	Maximum Available
1	4	2,749	1	4
2	1	0,867	-1	1

5 DISCUSSION AND RESULTS

BOTAŞ Ceyhan Marine Terminal is investigated under 2 conditions since the tonnage of the vessels berthing at quays 1-2 differ from the tonnage of the vessels berthing at quays 3-4. There are four different vessel arriving values each being 232, 184, 144, 120 vessels at quays 1 and 3 and 254, 188, 150, 127 vessels at quays 3 and 4 according to four investigated scenarios and based on the arrival frequency of the vessels. It is observed that maximum 232 and minimum 120 vessels will arrive at quays 1 and 2 and maximum 254 and minimum 127 vessels will arrive at quays 3 and 4. When the four scenarios are investigated in terms of queue volume occurring due to setbacks at moorings and tugboat-pilotage service taking into account the values of Scenario 1, Scenario 2, Scenario 3 and Scenario 4, it is seen that a queue of 1 vessel for all four situations is formed. Accordingly, it can be said that there shall be a queue at the port in every case. The queue volume to be formed shall be 1 maximum based on the arrival frequency of the vessels. The fact that vessels arriving at the port encountering waiting times such as 12 minutes, 11 minutes, 8 minutes, 11 minutes based on the 4 scenarios for berthing is in question. It is observed that the operability of the port varies 61% to 31%. The waiting times occurring in the port due to tugboat-pilotage service setbacks are respectively 13 minutes, 10 minutes , 13 minutes and 10 minutes. Any vessel arriving at the port will be required to wait for 13 minutes maximum and 8 minutes minimum. The tugboat activity varies 11% to 5%.

It is seen that a maximum queue of 1 will form for BOTAŞ Ceyhan Marine Terminal regardless of the vessel arrival frequency in four scenarios and the queue volume is not a long value. It is seen that the vessels arriving wait for a short period of time such as 12 minutes maximum for receiving berthing service. Furthermore, it can be said that tugboat-pilotage service shall not be disrupted for a long period of time and accordingly the existing tugboats shall be able to render the terminal service.

It is observed that maximum 486 vessels and minimum 247 vessels shall arrive at BOTAŞ Ceyhan Marine Terminal in total. Scenario 4 values show the minimum number of vessels that shall berth at BOTAŞ Ceyhan Marine Terminal within 1 year. According to Scenario 4 120 vessels berth at quays 1 and 2 in total and 127 vessels berth at quays 3 and 4 in total. Quays 1 and 2 export minimum 12.000.000 ton and maximum 36.000.000 ton of crude oil in 1 year. According to Scenario 4, minimum 3.810.000 ton and maximum 19.050.000 ton of crude oil is exported from quays 3 and 4 export in 1 year. According to Scenario 4 value, it is possible to export minimum 15.810.000 ton and maximum 55.050.000 ton crude petrol from BOTAŞ Ceyhan Marine Terminal in 1 year.

Scenario 1 is the maximum number of vessels arriving at BOTAŞ Ceyhan Marine Terminal in 1 year. Taking into account the fact that according to Scenario 1, 232 vessels arrive at quays 1 and 2 in 1 year in total, it can be said that it is possible to export minimum 23.200.000 ton and maximum 69.600.000 ton of crude oil from the terminal. Taking into account the fact that according to Scenario 1, 254 vessels arrive at quays 3 and 4 in 1 year in total, it can be said that minimum 7.620.000 ton and maximum 37.100.000 ton of crude oil shall be exported. According to Scenario 1 values, taking into account the four quay altogether, it shall be possible to export minimum 30.800.000 ton and maximum 106.700.000 ton of crude oil in 1 year.

6 CONCLUSIONS

Iraq-Turkey crude oil pipeline is in operation for 36 years. It consists of two pipelines. . According to BOTAŞ (2008) data, BOTAŞ Ceyhan Marine Terminal has a handling capacity of 70.000.000 ton provided that it is operated under normal conditions. The most significant obstacle of this line is war and political uncertainties. There were setbacks on Iraq-Turkey pipeline from time to time due to political uncertainties. According to result of AWESIM simulation modeling, it is possible to export minimum 15.810.000 ton and maximum 106.700.000 ton of crude oil via Iraq-Turkey crude oil pipeline. It is seen in the four investigated scenarios that there shall not be any intense congestion at BOTAŞ Ceyhan Port in terms of berths and tugboat-pilotage services and BOTAŞ Ceyhan Marine Terminal shall meet this transportation capacity provided that there is no arrest or deceleration in the pipeline. In this regard, the most significant step to take for Iraq-Turkey crude oil pipeline is to eliminate the negative aspects on the pipeline such as political uncertainties. If the political uncertainties are removed on the pipeline There will be a substantial increase in exported crude oil volume in İskenderun Gulf with BOTAŞ Ceyhan Marine Terminal and the ship traffic in İskenderun Gulf shall increase substantially.

In this study it is seen that AWESIM simulation model can be effectively used for determining port handling capacity, efficiency analysis and queue size. Therefore AWESIM simulation model can be used easily for optimizing of port operation in container, bulk and liquid cargo terminals.

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