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International Association of Maritime Economists (IAME) 2008 Annual Conference

2nd – 4th April 2008, Dalian, China

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Introduction

The International Association of Maritime Economists (IAME) 2008 Annual Conference will be jointly organized by the University of Plymouth, the United Kingdom and Dalian Maritime University, China. This will be the first time in the history of the IAME conference that two prestigious universities, both strong in maritime economics and logistics, respectively located in Europe and Asia, have jointly sought to organize the IAME annual conference.

It is also the first time that the IAME annual conference will be held in mainland China, a country with long history and been through rapid economic development for the past several decades. Today China has significant impacts on international trade, the global economy and international shipping, port and logistics industries.

You are invited to come to China and attend IAME 2008 annual conference. You will feel this fascinating country by yourselves and have chance to meet with the colleagues from China and more than 30 other countries. The conference participants will be from academia, industry, international organizations and governments. You will find tremendous opportunities for cooperation and networking.

Conference themes

Sustainability in International Shipping, Port and Logistics Industries and the China Factor

How to strike a balance between economic development and environmental concerns is one of the most important topics for many industries today. Discussions of the topic have literally appeared in media and academic research very frequently. The topic, however, has been insufficiently studied in international shipping, port and logistics industries. We believe the topic deserves further attentions from maritime economists and worth to be one of the themes of the conference.

DAY 2 3 April 2008

2nd-4th April, Dalian, China

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MODELLING SHIP BERTHING AT IZMIR PORT CONTAINER TERMINAL THROUGH SIMULATION METHOD

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ABSTRACT

Within international supply chain and logistic system, ports are an important ring of the basic transport activities. Thus, any shortage in or lack of well-planned orders encountered in the port operation processes is most likely to effect the whole logistic system, which eventually caused undesirable delays in deliveries. Operating merchant ports at estimated capacity and minimum cost requires that port operation processes be run at optimal rates and orders. The order of processes at container terminals starts with moving goods either from the sea or from land to the port site. The processes carried out at port areas comprise intraport transport activities, warehousing, Container Freight Station (CFS) activities such as filling, emptying and stowing containers, cargo handling process and gate processes where container checks-in, checks-out are recorded. The purpose of this study is to model ship berthing processes which take a critical place in the whole terminal operation processes. The simulation modeling in question is thought to help measure such performance indicators as ship waiting time and average berthing rates.

Topic Areas: Measuring Container Port Performance/ Container Port Simulation
Keywords: Simulation modeling, Ports, Container terminal, Container Ship, Berth

1. INTRODUCTION

Due to a great deal of advantages it offers and thus its attracting an immense variety of goods with a steadily increasing rate, containerized shipping has recently and increasingly enjoyed being one of the most preferred means of transport. Such a high rate of popularization granted to containerization has eventually resulted in that container ships and container ports have been regarded the two fundamental aspects of containerized shipping. The recent years have witnessed those container ships of over 8.000 TEU operated on routes linking certain merchant hub ports. The primary cause for such rapid increases in tonnages and terminal handling capacities lies in such a rapid improvement in containerized shipping enabling door-to-door transport.

Certain basic processes of activities are carried out of container terminals. The very first step of such processes is initiated with movement of goods either from the sea or land to the port side. The prevalent contents of these processes could be highlighted as follows intraport transport operations comprising the movements of the container within the port area, warehousing operations, container freight station operations where in containers are stuffed and/or emptied and gate operations through which container entries and exits are recorded.

Through this study, the ship-berthing process, one of the basic processes carried out at terminals, is modeled by means of a simulation method. The data used in the study have been provided form the statistics issued in 2005 by Port of Izmir, Port Authority and Undersecretariat for Maritime Affairs. As for simulation modeling used, various models dissimilar to those seen in the relevant literature have been developed and practiced. The software used for the simulation model is ARENA. The primary focus is placed on the importance of ports in international trade, which is followed by a literature study underlining the importance of simulation modeling in measuring the efficiency and performances at ports. The case study of the research covers a modeling, through simulation method, formed for the ship-berthing at Port of Alsancak.

2. THE IMPORTANCE OF PORTS IN INTERNATIONAL SUPPLY CHAIN

A supply chain is essentially a business process that links manufacturers, customers, and suppliers in the form of a 'chain' to develop and deliver as one 'virtual' organization of resources (Lee *at al.* 2003). The purpose of supply chain is to provide a value at every movement of the goods with in the whole process starting from the production stage including providers up to point where customers buy the products. Throughout the supply chain, many business carry out certain tasks they charged with. Minimizing the period between the point where the customer places order for the product and the point where he/she buys the product is possible only when the whole supply chain system provides and practices a well-planned performance. With the important contribution of the fact that three fourths of the Earth is covered with seas and that it offers a high capacity of safe transport, shipping has gained an outstanding prestige/attraction. Ports are one of the noticeable rings of the international supply chain.

Apart from their role as the traditional sea/land interface, ports are a good location for value-added logistics, in which members of different channels can meet and interact. Thus, the port system not only serves as an integral component of the transport system, but is also a major sub-system of the broader production and logistics systems (Bichou and Gray 2004).

3. MEASUREMENT OF PORT EFFICIENCY AND PERFORMANCE

Due to the fact that ports, as briefed above, have become intensively operating plants providing a great wealth of services to a member of parties and that the quality of the services provided has increasingly been raised, their structure has eventually become so sophisticated and complex that it has begun to act as a source of various activities all together.

Ports are very dissimilar and even within a single port the current or potential activities can be broad in scope and nature, so that the choice of an appropriate tool of analysis is difficult (Bichou and Gray 2004).

Simulation methods have been widely used and applied for measuring port performance in papers. Some of them are Collier, 1980; Borovits and Ein-Dor, 1990; Tu-Cheng (1992); Hassan, 1993; Hayuth 1994; Merkuryev et al., 1998; Geert and Janssens, 1998; Gambardella et al. (1998; 2001), Legato and Mazza (2000), Tahar and Hussain (2000), Nam and Ha (2001), Nam *et al*. (2002), Shabayek and Yeung (2002), Kia et al. (2002), Pachakis and Kiremidjian (2003), Sgouridies et al. (2003) Demirci (2003) and Dragovic *et al. (* 2005).

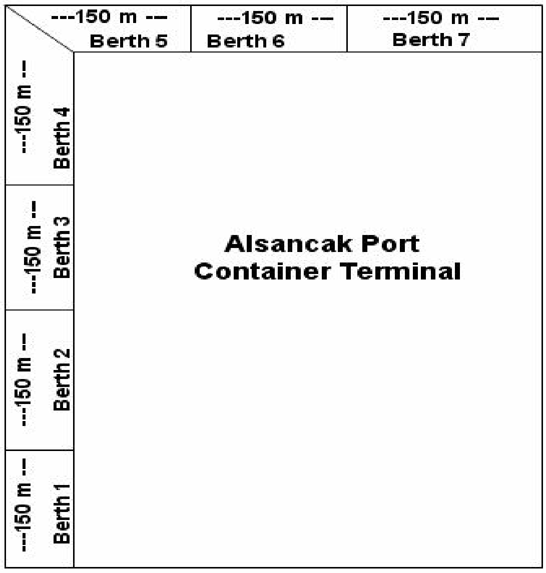
A typical port management system includes in its body such subsystems as ship operations, intraport cargo movement and warehousing activities, and certain gate operations comprising checks in and out. The main aim of all such subsystems is to provide port users with the best possible quality services. It is possible for port managers to provide and analyze certain relevant statistical data so as to measure/estimate port performance and take certain required steps to promote the quality of the services provided. There have been too many performance indicators used to estimate port performance. Yet, it is difficult to point to one particular scale that has received a common acceptance for port performance measurement. In fact, since every port on earth has certain unique features of its own, it is rather unlikely to standardize the great number of performance indicators.

4. SHIP-BERTHING SIMULATION MODEL

Simulation models have been used extensively in the planning and analysis of ship-berth link in port (Dragovic *et al.* 2005). The case study comprising a ship-berthing simulation model, this research has been carried out at Port of Alsancak Container Terminal, Izmir, Turkey. The overall specifications of and facilities at this terminal can be briefed as follows: The relevant data released in 2006 indicate that the container handling at the terminal was amounted to 847.926 TEU. The terminal consists of two main block perpendicular to each other. One of these blocks has four berths and three quay cranes while the second block has three quays with two quay cranes.(Fig.1)

The length of each berth is 150m, and there is no physical distinction between any two berths. In other words; any container ship with length over 150m berthing at one quay can also exceed to the adjacent quay. Such an excession, however, is not possible with the fourth quay positioned at the first part and the first quay positioned at the second part (5th quay) as they are perpendicular to each other with a right angle. Besides, with ship safety and security, concerns, and for fear of encountering certain difficulties in loading and discharging operations, while berthing, ships try not to exceed quays numbered four and seven.

Figure 1: Quay Positioning at Port of Alsancak Container Terminal



4.1 DATA COLLECTION

The data used in this research have been compiled from 2005 records issued by Harbor Master of Port of Alsancak. The data compiled could be categorized into such three basic groups as the intervals of the arrivals, the ship lengths and the periods of ship waiting at the quay (SWQ). For the intervals of the arrivals, the data used are the dates and the times of the arrivals of the container ships recorded in the "Ship Traffic Report" issued by the Harbor Master for the months of October, November and December in 2005. As a consequence, for the three months, 375 intervals of arrivals were gained and using data analysis model of ARENA simulation software, the most appropriate allocation of intervals was found to be GAMMA (440, 0.744) minutes. According to the data received from the Statistics Department of Port of Alsancak, 1333 calls were provided with port services at the container terminal in 2005. All these calls were made by a total of 186 ships which are operated in liner shipping and periodically calling certain ports one of which is Port of Alsancak. A prototype of research has revealed that the lengths and SWQ's of the ships serviced at the container terminal in 2005 are correlated. Such an observed correlation required that the ships be classified according to their lengths. The same classification was also realized in terms of their SWQ's and the SWQ allocation within each class was established, using the input analysis model of ARENA. The ship types according to the lengths and the SWQ allocation within these ships can be seen in Table1.

Table1. Ship Classes and Allocation of Class-Related Waiting Period at Berths

Ship Classes	Ship Length (m)	Number of Ship	Ratio (%)	*SWQ Distributions* (hour)
1	$50<U\leq100$	185	13.88	***SWQ* 1**, 1.5+*ERLANG*(5.73,2)
2	$100<U\leq150$	528	39.61	***SWQ* 2**, -0.5+*ERLANG*(3.27,5)
3	$150<U\leq200$	460	34.51	***SWQ* 3**, -0.5+*ERLANG*(4.06,5)
4	$200<U\leq250$	111	8.33	***SWQ* 4**, 6.5+*ERLANG*(7.26,3)
5	$250<U\leq300$	49	3.67	***SWQ* 5**, 29.5+52**BETA*(1.17,1.68)

4.2 MODELLING APPROACH

What is revealed by the ship-berthing simulation studies mentioned in the relevant literature is the supposition that every one of the ships calling the port berths at one quay. Such a supposition is valid for the quays each of which can host one ship only, considering the physical structure and length. In other words, according to this particular supposition, port are regarded to be a one queue and one engined/ many engined system, which makes it easy for performance criteria to be estimated through establishing the related simulation model. At some other terminals, like Port of Alsancak Container Terminal, where there exist no physical boundaries among the quays and where a ship can approach/berth at more than one quay, the above mentioned supposition would not be practicable/valid/true. On the other hand, however, rejecting the mentioned supposition and instead using a simulation software like ARENA in modeling Port of Alsancak Container Terminal is likely to bring about certain difficulties. Through this study, modeling approach has been developed and applied for those terminals, similar in structure to Port of Alsancak Container Terminal, where the above stated supposition is out of question. The modeling approach developed through this research is based on subdividing the quays into smaller quays and thus reaching a much more accurate measurement of performance. Figure 2 is thought to help comprehend the modeling approach better.

Figure 2: Modelling Approach

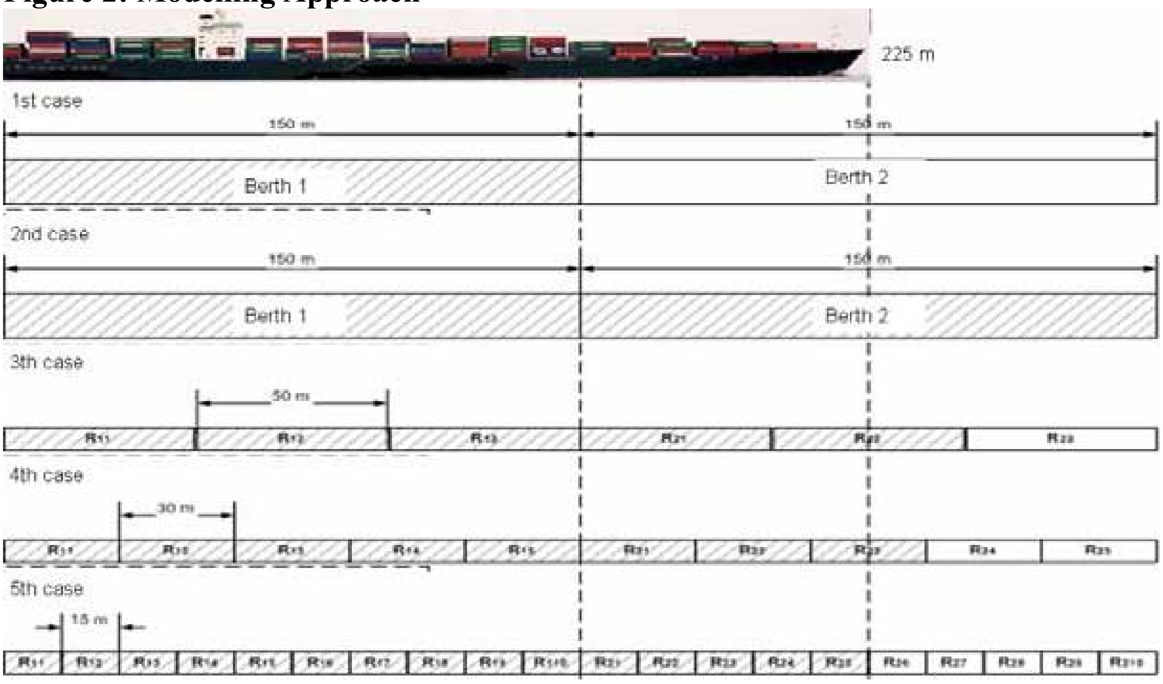


Figure 2 provides five alternatives of approach at quays from the view point of simulation modeling. A ship with a length of 225m (ship type no4) is assumed to approach the first two quays (Figure 1) of Port of Alsancak Container Terminal.

The first two cases indicated in Figure.2 stand for the cases reviewed in the relevant literature whereas the last three reflect the modeling approach presented through this study. These five cases could be highlighted as follows.

Case1: Any ship calling the terminal can approach one quay only, regardless of her length. This situation frequently seen in the literature corresponds to the assumption that any ship can approach one quay only. Utility rate for the 1st and the 2nd quay are 100% and 0% respectively.

Case2: Any ship calling the terminal can approach one or two quays in accordance with the ship length. The ship types 1 and 2 are berthed at the 1st quay, and ship types 3, 4 or 5 at the 1st or the 2nd quay. The utility rate for the 1st and the 2nd quays is 100%.

Case3: Each quay is subdivided into three equal ports each of which is 50m long (R_{11}, R_{12}, R_{13} and R_{21}, R_{22}, R_{23}) and each ship approaching the terminal is berthed at any of these parts, depending upon her length. The utility rates for the 1st and the 2nd quay are 100% and %66 respectively.

Case4: Each quay is divided into 5 parts each of which is 30m long (R_{11},..,R_{15} and R_{21},..,R_{25}) and each ship approaching the terminal is berthed at any parts. The utility rates for the 1st and the 2nd quay are 100% and 60% respectively.

Case5: Each quay divided into 10 equal parts each of which is 15m long (R_{11},..,R_{110} and R_{21},..,R_{210}) and any ship calling the terminal is berthed at any parts. The utility rates for the 1st and the 2nd quay are 100% and %50 respectively.

As clearly seen in the above cases, the utility rate of the 2nd quay, in the 5 distinctive modeling approaches, seems to rank from 0% to 100%. The 5th case seems to be most accurate approach. Besides, in the firs case, for example, when ship calls the terminal, the 2nd quay seems to be free, which would decrease the ship waiting period in queue and lessen the number of ships waiting in the queue. All in all, the more the quays are divided into equal parts the more accurate the performance estimates are likely to be.

4.3 SIMULATION MODELING PRACTICES

In order to put forward the distinction of modeling approach proposed, simulation models were formed with regard to the previously mentioned situations models were formed with regard to the previously mentioned cases, using the data recorded at Port of Alsancak Container Terminal. The performance criteria considered were the utility rates (FKO) of the seven quays, the average period of ship waiting in queues, and the average number of ships waiting in queues. The simulation software used was ARENA. Each case was practiced with an assumption of 50.000 calls and a warming period of 2.500 hours, and the practice was repeated 20 times. The values/results with respect to the performance criteria can be seen in Table 2. The values displayed in Table 2 are the averages of the 20 repeatations.

Table 2. The Experimental Results

Measuring Performance		1. Case	2. Case	3. Case	4. Case	5. Case
Utility Rates	Berth 1	0.777	0.885	0.793	0.767	0.746
	Berth 2	0.713	0.900	0.761	0.735	0.716
	Berth 3	0.635	0.907	0.766	0.733	0.710
	Berth 4	0.543	0.791	0.518	0.471	0.438
	Berth 5	0.443	0.858	0.704	0.669	0.643
	Berth 6	0.341	0.890	0.693	0.648	0.617
	Berth 7	0.246	0.586	0.432	0.378	0.347
Ship Waiting in Queue (hour)		0.71	63.00	16.50	13.30	11.40
Number of Waiting Ship		0.06	10.80	2.52	1.99	1.68

As can be seen in Table 2, the 1st case displays a value for the ship waiting period in queues smaller than the actual period, whereas the 2nd case displays value greater than the actual one. The interview with Alsancak Pilot confirmed that these values could not be regarded to be accurate. As for the utility rates are concerned, in the 1st case, they seem to get lessened more and more through the 1st toward the 7th quay. This lessening can be attributed to the fact that berthing operations start with the 1st quay and move towards the 7th quay. The 2nd case reveals that the utility rates proceeds steadily lowering but rising while passing from the 4th quay to the 5th. This increase is attributed to the right angle between the 4th and the 5th quays. When a ship so long as to cover both of these quays calls the terminal, berthing approach is started with the 5th as she cannot approach the 4th and the 5th quays, which causes the 5th quay to be used more extensively than the 4th quay is. Such relations can be seen in the same manner with the modeling approach proposed. Besides, the smaller ports the quays are divided into, the more accurate performance estimations are reached. As an overall result, the average utility rate for all the berths was found to be 60.24%, the number of the waiting ships 1.68 and the average ship waiting period at the gulf 11.40.

5. CONCLUSION

One of the most important rings of the basic transport activities within the international supply chain is ports. Containerized shipping has recently become popular due to a number of advantages it offers. From this particular view point, it wouldn't be overestimating to remind that terminal processes are to be run well and smoothly, for any deficiency in these processes is most likely to affect the whole supply chain system. Bettering and perfecting the smooth run of these processes can be achieved if and only if their performances are accurately measured. And with respect to the ship-berthing process, one of the most important terminal processes, one of the most effective means of performance measurement is the simulation modeling method. Through this research, certain estimates were reached for such performances carried out at Port of Alsancak Container Terminal Utility Rates, the average period for ship waiting in queues and the average number of ships waiting in queues. In this estimation, the recorded data with the regard to Port of Alsancak was used. The simulation models drawn for the purpose of reaching these estimates are based on the simulation approach that is based on the assumption/supposition that the existing quays are divided into smaller units. Besides, this approach was compared and contended with other approaches that are dealt with in the relevant literature.

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