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An assessment of the competitiveness level of Elsokhna container terminal in Egypt to the Middle East and east Mediterranean transhipment container market

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AN ASSESSMENT OF THE COMPETITIVENESS LEVEL OF ELSOKHNA CONTAINER TERMINAL IN EGYPT TO THE MIDDLE EAST AND EAST MEDITERRANEAN TRANSHIPMENT CONTAINER MARKET

By

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DECLARATION

I certify that all the materials in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of dissertation: **An assessment of the competitiveness level of Elsokhna container terminal in Egypt to the Middle East and East Mediterranean transhipment container market.**

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Globalisation of world economy, containerisation, privatisation of port industry and the substantial economic growth in the Far East have significantly intensified the competition between ports. This dissertation assesses and analyzes the competitiveness level of Elsokhna container terminal in Egypt to the hub ports and main container terminals in the east Mediterranean and the Middle East transhipment container market. The research discusses the conceptual meaning of port competition and the factors affecting port competitiveness from the port users' different perspectives. It also provides an overview of the methodologies that can be used to evaluate the competitiveness level of ports and pinpoints the areas of applicability of such techniques in relation to their pros and cons.

The author followed the Inductive method of the Industrial Organisation (IO) and the Structuralists (Harvard) school in order to assess the inter-port competition between ports in the defined market in terms of ports' throughput, market share, market concentration, location, accessibility and ports' infra/superstructure. The Data Envelopment Analysis (DEA) technique is also used to benchmark the efficiency of such ports while the port performance indicators are used to provide a profound analysis to the competitiveness level and the performance of Elsokhna container terminal. The conclusion shows that although there is a fierce competition between such ports, Elsokhna container terminal is able to compete and attract new traffic with its existing facilities.

KEY WORDS: Port competition, market share, location, port performance.

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
APL	American President Line
APM	A.P. Moller-Maersk Group
BCC	Banker, Charnes and Cooper (DEA model)
BCG	Boston Consultant Group
BOT	Build – Operate – Transfer
BSO	Tons per ship at berth
CCR	Charnes, Cooper and Rhodes (DEA model)
CMA CGM	Compagnie Maritime d'Affrètement - Compagnie Générale Maritime
COSCO	China Ocean Shipping Company
CRS	Constant Return-to-Scale
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
DP	Dubai Ports
DPI	Dubai Port International
ECHO	Egyptian Container Handling Co.
ECT	Europe Combined Terminals
EDI	Electronic Data Interchange
GOP	Average gang output per productive hour ratio
GOS	Average gang output per service hour ratio
GPS	Global Positioning Service
IO	Industrial Organisation
IT	Information Technology
JIT	Just-in-Time
LOA	Length over All
MCA	Multi Criteria Analysis
MCT	Medcenter Container Terminal (Gioia Tauro)
MIS	Management Information System

MSC/WEC	Mediterranean Shipping Company/West European Container line
MT	Maneuvering Time
NCT	North container Terminal (Jeddah)
P&O	Peninsular and Oriental Steam Navigation Company
PDA	Product Diversification Analysis
PIL	Pacific International Lines
PPA	Piraeus Port Authority
PPA	Product Portfolio Analysis
PSO	Tons per ship hours in port
RMG	Rail Mounted Gantry
RTG	Rubber Tyred Gantry
SBU	Strategic Business Unit
SCCT	Suez Canal Container Terminal
SCT	South Container Terminal (Jeddah)
SMS	Short Message Service
SPA	Strategic Positioning Analysis
SPDC	Sokhna Port Development Company
SPS	Salalah Port Services
SSA	Shift Share Analysis
ST	Service Time
STU	Strategic Traffic Unit
TEU	Twenty-foot Equivalent Unit
VAL	Value Added Logistics
VRS	Variable Return-to-Scale
WSO	Tons per ship per productive hours
WT	Waiting Time

CHAPTER ONE

INTRODUCTION

1.1 Background

Globalisation of international production, containerisation and the international division of work have significantly changed the world economy and have substantially led to an increase in mobility. Such change has considerably affected maritime transport, liner shipping in particular, and accordingly, competition between alternatives of goods and in consequence, between countries and regions has been intensified. This has on the one hand, introduced a trend towards more cost control, higher quality of logistics services and on the other hand, increased competition between ports which by nature are significant nodes in the transport chain (Notteboom, 2004)

Before such developments and changes, the hinterlands of ports were considered as captive markets due to the embryonic inland transport networks and the traditional practice of shipping lines of calling at all ports in a certain range. However, the development of inland transport enabled some ports to extend their hinterlands and gain part of the captive market of other ports. Similarly, transhipment ports (hubs) became able to access markets in another region by sea instead of land.

That has in turn, increased what is so called inter-port competition between ports not only those located in the same range, but also with others located in a different range. This type of competition, to a large extent, enhances the port productivity,

efficiency and increases its market share in a specific region. Nevertheless, maintaining the competitiveness level of a port could be difficult to achieve as ports' infra/superstructures are highly capital intensive, which might hinder port operators from achieving the maximum benefits of economies of scale (Canamero, 2007).

To be competitively attractive, ports have to establish and maintain a reputation for reliability and value added services besides their major targets for being efficient and profitable. This enables ports to maintain competitively low prices so that they can not only retain their existing customers but also attract new business (UNCTAD, 1990).

1.2 Thesis objective and scope

The objective of this research is to assess and to analyze the competitiveness level of the hub ports and main container terminals in the Eastern Mediterranean and Middle East regions with an emphasis on the present performance and the competitiveness level of Elsokhna container terminal in Egypt. The research also discusses the impact of such competition on the transhipment container markets in such regions.

In order to carry out such analysis, this research discusses port competition from the following aspects: it explains the conceptual meaning of port competition from different perspectives, studies the methodologies that can be used to assess port competitiveness and highlights their pros and cons, analyses the competitiveness level of the transhipment container terminals and ports in the defined market, assesses the performance and competitiveness level of Elsokhna container terminal to the container terminals in the defined market and finally provides a comprehensive conclusion followed by some recommendations that could enhance the competitiveness level of such ports and terminals.

1.3 Research methodology

The methodology used for the purpose of this research can be classified into three different methods. First, in order to assess the competitiveness level of the main container terminals and hub ports in the East Mediterranean and the Middle East, the author followed the Inductive concept of the Industrial Organization (IO) and the Structuralists (Harvard school) methodology that analyses the market condition, structures, conduct and performance of market players.

To apply such a methodology, the author has used some of the most important elements affecting competition between ports. These factors are; terminals throughput, market share, market concentration, port location, accessibility and port infra/superstructure. Such elements in particular, have been selected according to the availability of data gathered from different sources which are mentioned in the reference list of this thesis.

Secondly, the Data Envelopment Analysis (DEA) technique is used for the purpose of evaluating and benchmarking the efficiency of the terminal operators of the container terminals and ports concerned. Thirdly, in order to assess and analyze the present performance and the competitiveness level of Elsokhna container terminal in Egypt, the author uses a complete set of port performance indicators that can be used and applied to the data and information obtained from Elsokhna Port Authority and Elsokhna container terminal operator (Sokhna Port Development Company SPDC).

1.4 Limitations of the study

This thesis emphasises on the assessment of the competitiveness level of the main container terminals and transhipment ports (hubs) in the East Mediterranean and the Middle East Transhipment container market. The assessment and analysis will be limited to the performance and competitiveness level of the container terminal operators in the following ports; Dubai (including Jebel Ali), Khore Fakkan, Salalah,

Jeddah, Elsokhna, Suez Canal Container Terminal (SCCT), Damietta, Piraeus, Gioia Tauro and Marsaxlokk.

1.5 Thesis plan

Competition between ports in the East Mediterranean and Middle East is strongly affected by the number of sub-markets that each port and terminal is able to compete in. The ability of a port or terminal to compete depends on various factors such as throughput, market share, geographical location, accessibility, infra/superstructure, turn around time, cost, productivity and others. These factors form the suitable market (transhipment or origin/destination) for each port or terminal.

The author in this research emphasises on the assessment of the competitiveness level of the main container terminals and transhipment ports (hubs) in the east Mediterranean and Middle East regions. In order to carry out such assessment, chapter two provides an overview of port competition by demonstrating the driving forces and the importance of assessing port competition, illustrating the conceptual meaning and the different types of port competition. It also explains the various factors and elements that should be considered when assessing the competitiveness level of a port from port management, shipping lines and shippers' perspectives.

Chapter three discusses the different methodologies that can be used to assess port competitiveness such as Multi-Criteria Analysis (MCA), Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA), Strategic Positioning Analysis (SPA), port performance indicators and questionnaires. It also provides a brief explanation for the applications and the pros and cons of each methodology.

Chapter four assesses and analyses the competitiveness level of the hub ports and main container terminals in the defined regions in terms of terminal throughput, market share, market concentration, port location, accessibility and port

infra/superstructure. It also highlights the future investment plans of the ports concerned and their impact on the port attractiveness.

Chapter five assesses and benchmark the efficiency of the main container terminals and hub ports in the defined market by using the Data Envelopment Analysis (DEA) technique. Moreover, in order to provide a profound analysis to the competitiveness level of Elsokhna container terminal, the chapter illustrates the importance of the port location and assesses the container terminal performance in terms of turn-around time, berth occupancy and berth productivity by using the appropriate set of port performance indicators that can be used with the data available.

Chapter six provides a comprehensive overview of port competition from various perspectives. It also highlights the applicability of the methodologies that can be used to assess port competition in relation to their merits and demerits. Finally, it provides a conclusion for the competitiveness level of the hub ports and container terminals in the defined market followed by some recommendations that could enhance the competitiveness level of such ports and terminals.

CHAPTER TWO

PORT COMPETITION

2.1 Driving forces for port competition

Shipping lines and terminal operators encounter fast changing and uncertain situations. The port and shipping market are no longer stable due to the rapid changes in the work environment. Technological development, deregulation, logistics integration and the new organizational structure are significantly reshaped the port and maritime industries. Therefore, seaports that could not be able to be key players in the optimisation process are in danger of being disregarded as ports of call on the international freight routes (Notteboom, 2004).

The booming of container traffic, the consistent force for specialisation and the increase of container vessel capacity have resulted in shipping lines more emphasizing on a limited number of ports of call to get the maximum benefit from the economies of scale that their large vessels can offer at sea. Meanwhile, they are able to provide more flexible, reliable and faster transport services and sailing schedule. On the other hand, the horizontal integration (strategic alliances, mergers and acquisitions) has led to more concentration of demand for port services which accordingly, not only decrease the number of players seeking services from ports or container terminals but also drastically increase competition between ports (Song, 2003).

This chapter provides an overview about the conceptual meaning and types of port competition with an emphasizing on container ports. It also highlights the importance of assessing port competition and difficulties might be encountered when doing such assessment. Moreover, this chapter discusses the factors affecting port competition and the elements which should be considered when evaluating port competitiveness. It finally underlines port competition from port managers', shipping lines' and shippers' perspectives.

2.2 Importance of assessment the competitiveness level of ports

Ports have always been considered as vital gateways for the import and export of raw materials, semi manufactured and manufactured products form/to different markets located worldwide. The existence of such gateways has facilitated trade between nations and regions which accordingly has a great impact on the development of the economy of countries.

Therefore, from the macro economic perspective, ports always play an important role in the development of the national economy as ports are always seen as catalytic centers for the generation of economic resources through the industrial, commercial, value added and logistics activities. It means that ports are significant source for value added to the local, national and global economies and that port facilities, at both infra and superstructures levels, are crucial for achieving an efficient trading network (Cariou, 2006).

From the micro economic side, ports are seen as a transport, transit and operation centre where transfer and handling of cargo are taking place between sea and land. The main objective of a port in this context is to provide an efficient movement of cargo, with the shortest turn-around time for vessels and the lowest possible cost. Consequently, port competition has become fiercer since ports have become more costly and are always in the need for new investment in infra or superstructure to

keep pace with the potential demand and to maintain or to increase their market share (UNCTAD, 1992).

On the other hand, globalisation and the changing world economics have also increased competition between ports which make the success of seaports no longer dependent on its own performance. The degree of such a success is also determined by some external factors such as the networking and connections in and around the port's foreland and hinterland and by the support of the port community.

Therefore, and due to the above mentioned factors, assessment of port competition is crucial. Ports always need to ensure that they are able to accommodate larger customers as there is always a risk of losing customers, and not because of a lack or deficiencies in port facilities. Ports also need to secure their investments as they may encounter negative perception by their communities.

Moreover, evaluating the level of competition between ports helps ports to find new ways and alternatives to deal with the aggressive and new types of competition, for instance, the trend towards the dedicated terminals that have considerably changed the condition and rules of competition (Winkelmans, 2003, p. 10).

Furthermore, assessment of port competitiveness highlights the present situation of the port performance, productivity, market share and more important, the port costs and tariffs in relation to the other ports in the market (benchmarking) (Meersman & Voorde, 2002). Although port costs, to some extent, represent a small part within the logistic chain, the overall demand for port service in a particular market is rather inelastic, especially when there are no alternatives. Therefore, the probability for substituting one port for another is usually not an easy decision as the price elasticity for a particular port might have a great influence in port selection (Ma, 2006).

2.3 Port competition – definition

The market structure of the container port industry can be expressed from the nations (or region or even from a global) perspectives or from the point of view of an individual port. The former is related to a situation in which a port is considered to be a unit under a national or even higher level of administration and competes or cooperates with other ports. While the latter is related to the different parties and the nature of their relationship within the port (Wang & Cullinane & Song, 2005, p. 22).

Port competition can be defined as a struggling process to maintain customers, market share and hinterland over which ports might have complete or partial control (Marlow & Paixao, 2001). However, in general, Yeo and Song (2004, p. 35) state that "*port competition refers to the development and application of differentiated strategic alternatives so as to attract more customers to competitive ports"*. Therefore, it is crucial for a port to obtain and/or maintain a competitive boundary over its competitors.

On the other hand, Voorde & Meersman (2002, p. 777) referred to Verhoff's (1981) definition of competition who argues that seaport competition unfolds under four different levels which are, competition between port undertakings; competition between ports; competition between port clusters (a group of ports in the same region with common geographical characteristics); competition between ranges (ports located along the same coastline or with the same hinterland).

Therefore, these different levels of competition interact with each other so that they can not be evaluated individually. Moreover, such a definition does not consider the composition of traffic structure of port undertakings, which is very important as far as port competition is concerned. The definition also does not differentiate between different types of traffic in which ports and port undertakings are specialised. It treated them as if they were similar. But in reality, for instance,

container terminal operators do not compete with liquid bulk or bulk terminal operators (Voorde & Winkelmans, 2002). Nevertheless, a modern definition to port competition should include all the above mentioned aspects as ports are considered to be the competing bodies.

2.3.1 Conceptual definition of port competition

Seaport competition can be defined as the competition between ports undertakings involved in the same traffic and terminal operators who are involved in the organisation of the whole transport chain, with respect to certain transactions. It should be kept in consideration that every operator's main objective is to maximize his profit and to increase his throughput and market share (Voorde & Winkelmans, 2002).

According to the above definition port competition can be classified into three main types that from the one hand represent the comprehensive concept of seaport competition and on the other hand explain the relationship between ports and port undertakings. These types are: inter-port competition, intra-port competition and inter-port competition at port authority level.

2.4 Types of port competition

2.4.1 Inter-port competition

Inter-port competition can be defined as the competition between different ports (this study is limited only to container ports). The most important factor for determining whether two ports are competing with each other is to find out whether they serve the same or overlapping hinterland or foreland. There are many factors affecting competition between ports, which will be discussed later in this chapter, such as the geographic location and the type of cargo handled through the port.

Traditionally, before the revolution of containerisation, inter-port competition was not significant. Port markets used to be recognized as being monopolistic or oligopolistic due to the limited and fixed geographical location of the port and the concentration of port traffic. However, the fast developments of containerisation and intermodal transportation have dramatically changed this situation. Recently, terminal operators are not only concerned with their productivity but also whether they can compete or not.

Referring to Verhoff's definition, inter-port competition can accordingly be classified into three subcategories. The first type is competition between whole range of ports and coastlines; the perfect example of such a type of inter-port competition is the competition between the ports in the Hamburg-Le Havre range and the ports of the Southern Mediterranean.

The second type is the competition between ports in different countries such as the competition between Antwerp in Belgium and Rotterdam in the Netherlands or between Vancouver in Canada and Tacoma and Seattle in the United States. The third type is the competition between individual ports in the same country. Such kind of competition exists when there are similar ports in a country that have overlapped hinterlands such as the competition between Long Beach and Los Angeles in California or between Dalian and Qingdao in Northern China. (Wang & Cullinane & Song, 2005).

2.4.2 Intra-port competition

Intra-port competition can be classified into two types. The first is known as intra-terminal competition, where two or more operators within a single terminal compete with each other. It is considered to be a micro level of competition that offers high level cost efficiency. However, this type of competition does not provide the flexibility required for the terminal operator. Accordingly, the lower the level of intra

terminal competition, the higher the flexibility of the terminal as far as pricing is concerned.

The second type is the competition between operators and terminals within the same port. The best example of such a type of competition is the competition within the port of Antwerp between container terminal operators such as Hessenatie, Noord Natie and Katoenatie. Another example is the competition between APM and ECT in Rotterdam. However, intra-port competition can be recognized in a broader form. Port authorities and undertakings may indirectly compete within a single port if a port authority has shares in port undertakings or terminal operator (Voorde & Winkelmans, 2002, p.11).

2.4.3 Inter-port competition at port authority level

This type of competition can exist between port authorities on a national, local or regional level. It can be clearly identified when the competing ports share the same target market and handle the same type of cargo. A good example of such type of competition is the competition between ports within the Hamburg-Le Havre range as all of these ports, to a large extent, compete for containers and all of them are investing to keep pace with the future demand and to increase their throughput and market share. Another example of such a type of competition is the competition between Hong Kong and Singapore in the Far East and between New York and Halifax on the East coast of North America. However, the factors that affect port competition are numerous and depend on the type and level of competition between ports (World Bank, 2001).

2.5 Factors affecting port competition

The factors influencing competition between ports may vary from one level to another. The competitive strength of individual undertakings within a port is determined mainly by certain inputs such as skilled workers, capital and technology.

On the other hand, competition between ports, port clusters and port ranges is also affected by some regional factors such as the geographical location, the availability of infrastructure, the degree of industerialisation, the government policy, the level of port performance, which is normally measured in terms of alternative variables, such as the frequency of liner services, the transhipment cost, storage and hinterland transportation.

Such a traditional approach to port competition paves the way for another approach based on competition between logistics chains in which seaports are links. The most important element that should be considered is the total cost of the transport chain. It is inescapable that, besides port throughput, the logistic factors such as warehousing, distribution of goods and hinterland transportation are also very vital and essential factors affecting competition between ports (Voorde & Meersman, 2002, p. 778)

Moreover, at managerial and port authority levels, port competition is also affected by some other factors such as the organisational and management structure, the political and regulatory framework, the socio-economic stability, the know-how of port authorities and their management system, the implementation of EDI, government intervention, the existence and volume of niche markets, port potential productivity, quality of facilities and the creation of added value. However, there are a variety of elements that should be considered when evaluating the competitiveness level of a port (Voorde & Winkelmans, 2002, p.10).

2.6 Elements to consider when assessing port competition

There are number of elements that should be put into consideration when assessing the competition between ports such as the expansion and new investment in port facilities, the renewal of equipment, the identification of the present and potential development of different routes and the improvement of port efficiency and effectiveness.

Song and Yeo (2004) classified the most important criteria for the assessment of port competition into five groups. The first group is the cargo volume which implies the ability of ports to handle more cargoes including import, export and transhipment. The second group is the port facilities which comprise both port infra and superstructure in the sense that the greater the capacity, the higher the competitiveness level of a port. The third group embraces port location which explains the importance of the geographical location and accessibility of a port in port competition.

The fourth is the service level as the higher the quality of services provided to the port users, the higher the competitiveness level of the port. The fifth group is the port expenses which includes port dues, tariff, terminal handling charges in the sense that the cheaper the port expenses, the higher the competitiveness level of a port. In this context Table 1 illustrates in details the elements that should be considered when evaluating the port competitiveness.

Table 1 - List of the elements of port competitiveness

Elements of port competitiveness	
Application of EDI system	Ability of port personnel
Average hours of port congestion	Port accessibility
Berth/terminal availability	Port congestion
Building port MIS	Port facilities
Capacity of transportation connectivity	Port marketing
Capacity/status of facilities available	Port operation
Cargo volume of handling transhipment	Port operation by government
Changes in social environment	Port operation by local autonomous entity
Changes in transport and cargo function	Port operation by private sectors
Complete preparation of multimodal transport	Port operation time
Concentration of volume by export/import	Port ownership
Customs clearance system	Port productivity
Dredging: yes or no (?)	Port service
Easy access to port	Port size
Economic scale of hinterland	Port tariff
Effectiveness of terminal operations	Possibility of mutual reference of electronic computation network
Existence of cargo tracing system	
Existence of port hinterland road	Price competitiveness
Existence of terminal operating system	Response of port authorities concerned
Existing pattern of navigation routes	Road network to be fully equipped
Extent of port EDI	Sea transportation distance
Financial factors of port	Securing deep draft
Free time of container freight station	Securing exclusive use of equipment
Frequency of ships calling	Securing fairway
Handling charge per TEU	Securing navigation facilities/equipment
Handling volume of export/import cargo	Securing railroad connection
Inland transportation cost	Status of national economy
Inter-linked transportation network	Sufficiency of berth
Internal politics	Sufficiency of securing information equipment
Loading time	Technical factors of port
Location factors of the port concerned	Terminal facilities
Market position within the area	Trade market
Mutual agreement of port users	Trade/commerce policy
Navigation distance	Transportation distance
Nearness to hinterland	Types of port operation/management
Nearness to main trunk	World business
Number of liners calling at ports	

Source: Song, D.W., & Yeo, K.T. (2004). A competitive analysis of Chinese container ports using the analytic hierarchy process. *Maritime Economics & Logistics, 6*, 41

Nevertheless, although there are a variety of elements that could be used to assess the port competition, there are also a number of obstacles that might be encountered when carrying out such an assessment.

2.7 Difficulties of evaluating port competition

In normal practice, the competitiveness level of a port depends on the way a large number of elements (Table 1) are used and brought into force. Efficiency oriented ports achieve their competitive advantage either by cost leader ship, by becoming the low cost service provider or by differentiation that can be achieved by offering specific port services in market niches different from those services provided by other ports (Winkelmans, 2003).

However, sometimes, it is difficult to assess competition between ports, as they are usually operated and managed in different economic, legal, social and fiscal environments. For example, until the present time, there are remarkable differences in the management of European ports such as the Anglo-Saxon tradition of independent port authorities, the centralising Latin concept in France, Spain and Italy and the municipal hanseatic custom in Germany, the Netherlands and Belgium (Meersman & Voorde, 2002).

Accordingly, these concepts have created completely different types of port management and operation. For example, there is a public service port, where the infra/superstructure and cargo handling operations are owned, managed and operated by the port authority. The tool port where the infra/superstructure are public utilities and cargo handling is operated by a private organization. The landlord port where only the infrastructure is owned by public entity (port authority), while the superstructure and all cargo handling operations are owned and operated by a private companies. The private service port where all infra/superstructure and cargo handling operation are managed and operated by private firms. Such a variety of operation and

management systems have also generated a multitude of variables that are difficult to identify and control (Cariou, 2007a).

On the other hand, the scarcity of information about port performance and productivity and the unavailability of statistical data, which are considered confidential in some ports, to represent the present situation of ports in terms of port throughput in addition to market share and investment plans makes the evaluation of port competitiveness even more difficult to predict.

2.8 Port competition – Various perspectives

2.8.1 Port managers' perspectives

It is very important for port managers to know who the port users are, who takes the decision of choosing a particular port and what are their perspectives in taking such a decision? However, the term port users contain quite different members such as shipping lines, shippers, cargo consigners and cargo handlers. Theoretically, such members would appear to depend on each other, but in practice, they are involved in a severe competitive struggle.

Accordingly, it is not always easy to determine who makes the choice of a port and what are the most significant variables affecting the decision process. These variables are diversified between strategic, legal and economic factors that depend on the assessor targets and perspectives in relation to port competition. In this respect, port competition from the port managers, shipping lines and shippers' perspectives should be considered (Meersman & Voorde, 2002).

From the strategic management perspective, the issue of port competition is very crucial. The port managers' ultimate objectives, in the first place, are to increase the port profitability, market share and to enhance the degree of traffic structure diversification. In this regard and in the context of fierce competition between transhipment container ports, the port managers, in most cases, try to minimize the

cost of transhipment as well as the port delay in order to be able to maintain their existing customers and to attract new clients to the ports (Lombaerde & Verbeke, 2002).

2.8.2 Shipping lines' perspectives

The degree of port attractiveness and the decisions on port selection by shipping lines are basically related to the structure of their networks. Moreover, the increase in container ship capacity and the development of hub-and-spoke networks have led carriers to search for economies of scale in both sea legs and ports. On the other hand, the carrier's main objective is to provide the most comprehensive door-to-door services in a cost effective way and to optimize their logistics and supply chain in order to be able to satisfy their customers and to maintain and enhance their position in a severe competitive market.

Therefore the attractiveness of a port from the shipping lines point of view can be classified into four main criteria. Cost of port transit is considered to be the most important criterion as carriers seek for ports with relatively low transit cost. Port services, including turn-around time is the second most important criterion as shipping lines are seeking a comparative advantage with shorter transit time.

However, port physical infra and superstructure including water depth, total quay length, number and capacity of cranes (to accommodate large vessels) and yard equipment are also the favorite criterion for some carriers because of their vital contribution in reducing ships' turn-around time in port. Nevertheless, a port's geographical location including, proximity to markets and main liner routes and port accessibility in both sea and hinterland sides are the primary concerns for the shipping line as far as transhipment ports (hubs) are concerned (Guy & Urli, 2006).

Moreover, apart from the monetary cost and time being the most important elements for shipping lines, there are also sub-criteria like the availability of

information, data flow, quality of services, port safety, port security, port congestion and the technology being used can also be equally significant to the carriers. However, although shipping lines and shippers are both port users, they have, to some extent, different perceptions on the significance of various factors determining the level of port attractiveness and competitiveness.

2.8.3 Shippers' perspectives

In practice, shippers' (importers and exporters) main concerns are to reduce the transportation cost and to save time. Therefore, they prefer to choose the closest port to their activities in order to minimize the cargo travel time and cost. In the context of port attractiveness, Nir, Lin and Liang (2003, p. 165) argue that the most significant factors that determine the competitiveness level of a port from shippers point of view are "*the shipment information, loss and damage performance, low freight charges, equipment availability, convenient pick up and delivery, claims handling ability, special cargoes handling ability, large volume shipment, large and odd-sized freight*". The shipment information, the loss and damage performance are the foremost important criteria from shippers' perspective.

Nevertheless, port reliability, efficiency, quality of service, shipping frequency, port congestion, port infra and superstructure and port location are still highly recognized factors for shippers. Moreover, in the era of globalisation of production, the value added service provided by ports, which significantly contribute in reducing cost and enhancing the logistics and supply chain, is considered to be one of the most important factors that makes a port having a competitive advantage over other ports in the same market (Ng, 2006a).

From the above illustration it can be noticed that there are a multitude of factors affecting port competition, and the concept of port competitiveness is varied from one port user to another according to their targets and their network structure. The methodology that can be used to assess the port competitiveness might also be varied

from one port to another and from one market or region to another. Therefore, the methodology that could be used for such assessment should be suited to the market condition, structure and performance in order to gain a realistic competitive position of a port or terminal.

In this context, next chapter discusses the methodologies and techniques that can be used to assess the competitiveness level of a port. It also illustrates the pros and cons of such methodologies and their applicability for evaluating the competitiveness level of a port and accordingly the degree of competition between ports in a specific market or region.

CHAPTER THREE

METHODOLOGIES AND TECHNIQUES BEING USED FOR PORT COMPETITIVENESS AND ANALYSIS

3.1 Introduction

It is very important for port managers to cautiously assess their port development plans to avoid unnecessary duplication or bad utilisation of ports facilities. The significant development in the shipping industry and the heavy capital investment requirements on one hand and the excessive competition between ports on the other hand have induced port managers to operate their ports on smaller profit margins. To improve port competitiveness, port managers are obliged to alter their attention from ports being effective and able to handle a specific amount of cargoes to whether ports have the ability to attract new customers and to increase their market shares.

Such changes have created substantial connotations on methodologies used in assessing port performance and competitiveness as this is where the issue of port choice is taking place. Port users are having options to choose between measuring physical output or port performance within a competitive market which should be measured through evaluating the economic cost. Moreover, to maintain their competitive level, ports must ensure that the increase in operation cost of port users does not lead to remarkable increase in the values of goods transported (Ng, 2006b).

This chapter provides an overview of the most common methodologies being used for assessing port competitiveness such as the Multi-Criteria Analysis (MCA),

Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA), Strategic Positioning Analysis (SPA), port performance indicators and questionnaires. It also highlights the strength and weakness of each technique and its applicability of assessing port competition.

3.2 Multi-Criteria Analysis (MCA)

Multi-Criteria Analysis was developed in the 1960s as a decision-making tool. It is used to make a comparative evaluation of different projects or various measures. With this technique, a number of criteria can be considered concurrently in a complex situation. The method is designed to assist decision makers to incorporate the different options, showing the opinions of different actors concerned, into a potential or conservative framework. The results are generally offering operational guidance or recommendations for future activities (Guy & Urli, 2006).

3.2.1 Multi-Criteria Analysis objectives and areas of application

In general, the MCA technique is used in evaluation of long term public projects and their variations such as the layout of highways and the constructions of new infrastructure (in ports for instance). It is also applied to a large extent, as a tool in intermediate assessments as an aid for making a judgment. It relates to a judgment on the success of the various measures in order to formulate synthetic conclusions. Such a judgment takes into consideration the main criteria for the parties concerned.

Multi-Criteria analysis is a technique usually used for comparing different points of view of several parties involved in a particular project. Therefore, it is largely helpful during the formulation of decisions on complicated problems, when there are ambiguous decision criteria such as comparing specific jobs with the environment or when it is hard to choose between the criteria.

Moreover, the MCA technique is widely used in several applications in relation to the decision making process such as making recommendations on the reallocation of budgets and resources, either when a projects in progress or during the preparation of the next phase of the project. It is also helpful in distribution of the best practice and improving the project selection process, by highlighting the area of success and the most effective elements of the project. Furthermore, the technique helps in getting feedback on project selection methods in order to articulate a clear and rational view about the plans and the priorities of the parties concerned.

On the other hand, Multi-Criteria analysis allows the assessor to concentrate on the strengths and weaknesses of the project plan on different stages which gives the decision makers the opportunity to enhance the strengths and offset the weaknesses in an ample time. However, there are several stages that should be followed in order to apply such a technique in a particular project (Tavistock Institute, 2003).

3.2.2 Stages for applying Multi-Criteria Analysis

The main steps used to apply the MCA technique can be classified into five stages. First is the definition of the project to be assessed, which comprises the list of the planned elements on which the comparative judgement will be made. Second is the designation of judgement criteria. This stage requires particular attention as it should present the decision maker's points of view, in order to summarise and assemble the different dimensions used to assess a plan or action.

The third stage represents the analysis of the impact of the actions. It provides quantitative and/or qualitative estimation and description of the impact of the defined project in the context of the designated criteria. The fourth step constitutes the judgement of the impacts of the actions or plans in relation to each individual criterion. Two main techniques are used in order to implement such stage, Multi-Criteria analysis by compensation or Multi-Criteria analysis based on outranking.

The last stage is the aggregation of judgements which is usually made by using a computer package in order to sort the actions in relation to each other. However, like any other method of evaluation, this technique has a number of pros and cons which determine the benefits and the drawback of its applications (Tavistock Institute, 2003).

3.2.3 Strengths and limitations of the MCA

As mentioned above, Multi-Criteria analysis offers a framework in which all parties can be involved in the decision making and problem solving process. Therefore, the strength of the technique can be realised by the fact that it permits the parties' various opinions to be taken into consideration. Moreover, the technique is to a large extent open and explicit; the choice of objectives and criteria that the decision making parties may take are open to analysis and to change if they find that it is improper. On the other hand, scores and weights, if used, are also plain and can be developed according to recognized techniques. Performance measurement can be sub-contracted to experts. Hence, there is no need to be left in the hands of the decision making parties. It can also provide vital channels of communication within the decision making parties.

However, apart from these advantages, Multi-Criteria analysis is rarely used for purposes other than those strongly related to the decision making process. Certain problems of applications may limit the use of the technique and in some cases a consultancy of experts is needed. Moreover, the method is not always implemented in an interactive manner and tends to fix criteria which are actually changeable.

Nevertheless, there are many types of Multi-Criteria analysis that can be used in order to widening the use of such tool in different conditions such as the direct analysis of performance matrix, Multi-Attitude utility theory, linear additive model,

outranking method and Analytic Hierarchy Process (AHP) (National Economic Research Association, 2000).

3.3 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a well know multicriteria methodology in decision making and in ranking priorities, with quantifiable and/or indefinable criteria. The AHP technique was established by Saaty in 1980, who defined it as a methodology used for *"combining both subjective and objective assessments and perceptions into an integrative framework based on ratio scales from simple pairwise comparison"*. It is considered as a flexible tool that can be used in any hierarchy of performance measures (Song & Yeo, 2004, pp.37).

3.3.1 Analytic Hierarchy Process (AHP) areas of application

AHP can simply be used in any complex situation that requires hierarchy structure, assessment and synthesis of alternatives. Therefore, the technique has shown great achievements in many areas such as prioritization, evaluation, resource allocation, benchmarking, forecasting, total quality management, strategic planning, quality function deployment, public policy and health care (Forman & Gass, 2001).

Moreover, the success of the AHP in different areas verifies its usage in solving transport problems. For example, it is used in studying job attractiveness in the airline industry, selecting the environmentally friendly transport system and assessing the competitiveness level of ports. The AHP is also used in creating a model that is able to evaluate the performance of shipping companies (Lirn, Thanopoulou, Beynon & Beresford, 2004).

3.3.2 Implementation of Analytic Hierarchy Process (AHP)

Like some of the multicriteria decision making processes (MCDM), the implementation of the AHP requires two main stages. First, is the combination of judgements in relation to all objectives and decision making alternatives. Second, is the ranking of alternatives according to the collected judgements. However, in order to accomplish these stages the following steps should be carried out (Schinas, 2005).

The first step is the creation of the decision making hierarchy. This can be done by putting an ultimate objective or evaluation at the top of the hierarchy, then placing the critical criteria for accomplishing the objectives in the middle of the hierarchy and listing recognised alternatives, which are linked together with such criteria and decision making objectives on the bottom of the hierarchy.

The second step is the determination of weights and alternatives. The essence of this process is that the more important criteria should have higher weights or values so that it will be paid more attention while making a decision or evaluation. Therefore, pairwise comparisons should be made to ascertain different weights on the identified criteria and alternatives. This step is basically carried out by using a computational process which was proposed by Saaty in 1980.

The third step is the assessment of the overall ranking of the alternatives. This step can be carried out by evaluating the multiplied weight values of every criterion and every alternative. Thus the relative competitiveness criteria, in the context of port competition for instance, can be ranked. The higher valued port for example is the more competitive one in the assessed sample. Nevertheless, applying the AHP model in reality has its merits and demerits which vary according to the criteria and alternatives of the decision making that would be assessed (Song & Yeo, 2004).

3.3.3 Advantages and disadvantages of the Analytic Hierarchy Process (AHP)

The foremost advantages and salient features of the AHP is the ability to measure the tangible and intangible criteria, to predict precisely the weight of each criterion and to estimate the quantitative and qualitative elements by using ratio scales (Vaggelas, 2006). Moreover, Saaty (2001) listed ten advantages for the AHP as a decision making technique which are: *"unity, complexity, interdependence, hierarchy structure, measurement, consistency, tradeoffs, judgement and consensus"*. In addition, the AHP can simply establish model simulations and modifications by using sensitivity analysis (Lirn, Thanopoulou, Beynon & Beresford, 2004, p.72-73).

Despite its large applicability and its great advantages, the AHP also has some disadvantages such as the participants of the research are some times reluctant to reveal their real opinions, particularly if they have some interest in the research results. On the other hand, using a limited scale in the pair comparison for the purpose of achieving maximum reliability and consistency is considered as a constraint in the implementation of the AHP (Vaggelas, 2006).

3.4 Data Envelopment Analysis (DEA)

Data envelopment analysis can be defined as a linear programming technique and a nonparametric tool of evaluating the efficiency of a firm, decision making unit (DMU), with various inputs and/or outputs. This can be done by constructing a single virtual output to a single virtual input without pre-defining a product function. The method has two basic models. Following Farrell (1957), Charnes *et al* (1978) first proposed a model known as CCR (Charnes, Cooper and Rhodes) that had an input orientation and presumed constant returns-to-scale (CRS). Later in (1984) Banker *et al* first established another model known as BCC which had an assumption of variable return-to-scale (VRS) (Wang & Cullinane, 2006).

Furthermore, there are another four DEA models which are: the additive model, the multiplicative model, the Cone-Ratio DEA model and the Assurance-Region DEA model. The latter two models comprise priori information such as experts' opinions, opportunity cost or rate of substitution., in order to limit the results to the best DMU as in the Assurance-Region DEA model or to connect DEA with the multicriteria analysis as in Cone-Ratio DEA model. As an extension of the DEA model there are also other models such as the DEA-Malmquist model which untangles total productivity change into technical and technological efficiency change and the DEA-allocative model, which unravel technical and allocative efficiency (Barros, 2006).

3.4.1 Data Envelopment Analysis (DEA) applications

DEA as a benchmarking and efficiency measuring technique is widely used in various fields such as education, health care, banks, management evaluation and maritime transport (Anderson, 1996). In the context of the maritime industry and seaport efficiency measurement in particular, many researchers have been using the DEA models (Wang, 2004). For example, Martinez *et al* (1999) estimated the efficiency of Spanish ports, Coto Millan *et al* (2000) predicted a translog cost frontier for Spanish ports, Song and Cullinane (2001) used the DEA ratio analysis model to evaluate the efficiency of the Asian container ports, Barros (2003) assessed the technical and allocative efficiency of Portuguese ports (Barros, 2006).

3.4.2 Data Envelopment Analysis (DEA) implementation

The DEA is a linear programming process that allows decision makers to compare between the best practice decision making units (DMUs). In order to find a solution for the linear programming problems, the assessor should identify three main features of the DEA technique which are: the input/output orientation system, the returns-to-scale and the relative weights of the evaluation system.

In the context of the first feature, the selection of the DEA inputs or outputs criteria is highly related to the DMUs market condition. For instance, in competitive markets, DMUs are output criteria, presuming that inputs are under DMU control, which aims to increase its output. In contrast, in monopolistic markets, the DMUs are input criteria (exogenous) while the outputs are considered as endogenous.

In relation to the return-to-scale, it might be either constant or variable. Therefore, the CCR and the BCC models should be calculated in order to carry out a comparative assessment. On the other hand, the relative weights might be considered as inputs or outputs which to a large extent, are affected by unequalled constrains such as the cost and production functions formulations (Barros, 2006).

However, the main objective of using the DEA is to find the most efficient DMUs which belong to the production frontiers and the least efficient which need proper adjustments to the inputs and outputs in order to enhance the efficiency. In addition, the DEA permits a quantitative measurement for the relative efficiency of DMUs and planning of targets in various aspects to improve efficiency in every DMU.

To achieve such objectives, the efficiency measurement applied in the DEA technique is the ratio between a weighted sum of outputs and a weighted sum of inputs. The DEA choose the weights that increase the result of efficiency of every DMU. Therefore, there is no negative weight. Moreover, every DMU can use the same group of weights to assess its own efficiency. However, the resulting efficiency ratio should not be greater than one for each DMU. Generally, some DMUs will gain higher weights in those inputs they utilise less and those outputs that they produce more (Rios & Macada, 2006).

3.4.3 Pros and cons of Data Envelopment Analysis (DEA)

Having an overview on the DEA implementation techniques can give an idea about the main characteristics that give strengths to this method. For example, the DEA allows analysts to avoid converting all inputs and outputs into monetary values, the efficiency ratio is based on realistic data and it is considered to be an alternative or complement to central tendency and cost/benefit analysis and takes into account that the efficient DMUs not only denoting deviations in terms of the average behaviour, but also potential benchmarks that can be carried out by other DMUs.

Moreover, contrary to the traditional techniques, the DEA optimises every specific notice so that it can identify a linear frontier of parts compiled of the group of the efficient DMUs. In addition, it is considered to be a method that supports the multicriteria decision making so that it has the ability to simulate the complexity of the real situation (Rios & Macada, 2006).

However, some of the features that make DEA powerful might cause some weaknesses in specific circumstances. Therefore, the evaluator should keep in mind the following limitations when using the DEA technique. For instance, although DEA is beneficial in estimating relative efficiency, it congregates very slowly to absolute efficiency. DEA is a nonparametric method therefore statistical hypothesis tests are complex. Moreover, standard formulation of DEA establishes a separate linear program for each firm so that wide computational problems can occur (Anderson, 1996).

In addition, DEA should be used with caution when selecting the DMUs as it is only reasonable in comparing various firms with similar production functions. Moreover, the choices of inputs and outputs variables are very critical in the implementation of DEA as the classification of the inputs and outputs in the evaluation of DMUs is very crucial and tricky (Wang, Cullinane & Song, 2005).

3.5 Strategic Positioning Analysis (SPA)

The Strategic Positioning Analysis (SPA) is considered to be one of the most specialised techniques being used in assessing and analysing the traffic structure and the competitiveness level of seaports. It allows comparing the different component of port traffic with each other and with those components of other ports in a specific range or market. The SPA comprises three main interconnected techniques which are used in evaluating the competitiveness level of ports. These techniques are: product portfolio analysis (PPA), shift share analysis (SSA) and product diversification analysis (PDA). The combination of the results of these techniques can provide an overview of the present and potential competitiveness level of a port in a particular market (Haezendonck & Winkelmans, 2001).

3.5.1 Product Portfolio Analysis (PPA)

The PPA model was introduced in 1968 by the Boston Consulting Group[1] in order to provide a strategic corporate planning. The technique provides an explanation of project results by using only two variables which are the market share and relative growth. In the context of port competition, the model can analyse the relation between the increase of the market share of a port in a certain market and the traffic growth rate during the evaluation period (Haezendonck**,** Coeck & Verbeke**,** 2002).

The main advantages of choosing the PPA for assessing the competitiveness level of a port are: it is clear and easy to use, the data required for assessment can easily be obtained and above all, it is considered to be an effective methodology for analysing the development of a long term strategic plan through its contribution in the identification and the evaluation of objectives and alternatives.

[1] The Boston Consultant Group (BCG) establishes the so called Strategic Business Units (SBUs) in a decision matrix on the bases of their market share and relative growth. The SBUs of the BCG matrix can present different types of traffic such as liquid bulk, dry bulk and containers. These goods may be regarded as strategic traffic units (STUs). Subsequently, one can determine the relevant traffic flow for each port in terms of market share and growth rate (Haezendonck & Winkelmans, 2001, p. 18).

3.5.2 Shift Share Analysis (SSA)

The Shift Share Analysis (SSA) is the second instruments of the SPA. It provides an assessment of the constitution and development of traffic flows in terms of port competition. Using the technique makes it possible to determine to what extent the attraction of certain cargo or emphasizing in specific traffic may affect port performance. Although, SSA does not provide instant and clear interpretation for the changing factors that influence the competitive position of a port, it relates the rise or fall of a certain variable to three main effects which are: the share effect, the commodity effect and the competitiveness effect.

The share-effect signifies the presumable growth of certain traffic in a specific port with an assumption that the port market share will not change. Thus it illustrates the changes in traffic volume presuming that all traffic change in the same manner as the average traffic developed in a particular market. The difference between the actual and calculated growth represents an increase or decrease in market share which is denoted by the shift effect that can further be divided into a commodity effect and competitiveness effect.

The commodity effect signifies the level of specialisation of a port in certain traffic. It also takes into consideration the effect of the diversity of traffic structure of every port. The positive commodity effect indicates the port in favourable growing traffic, while the negative commodity effect shows that the port traffic structure is hostile. On the other hand, the competitiveness effect signifies the struggling for a greater market share in specific traffic. It also explains whether there is an increase or decrease of the port market share (Haezendonck & Winkelmans, 2001).

SSA is a technique that offers information about shifts in the strength of the competitiveness level of a port and the development or deterioration of the port traffic. However, in order to offer sufficient and detailed information about port

traffic, it would be better if it applied separately to every individual traffic so that the changes of the commodity effect and the competitiveness effect and their impacts on port performance can be determined.

3.5.3 Product Diversification Analysis (PDA)

The third tool of SPA is the product diversification analysis. This method is generally used to determine the relative weights of different types of traffic and evaluate the component of each traffic of a specific port. The technique uses the Hirshman-Herfindahl index[2] to evaluate the extent of diversification in a port and consequently, the relative changes of different types of traffic in the overall port traffic structure. The index determines the level of concentration between the different types of traffic in the port concerned (Haezendonck & Winkelmans, 2001).

3.5.4 Merits and demerits of Strategic Positioning Analysis (SPA)

In general, the major advantage of SPA is that it provides a comprehensive technique for analysing the competitiveness level of a port among others in the same market. However, it does not provide a profound analysis to explain why such competitiveness level has taken place and why a certain development has occurred. Moreover, although the methodology is based on realistic traffic flow in seaports, the main disadvantage is that it ignores to what extent a certain traffic flow of a particular port may contribute in creating an added value.

Nevertheless, SPA is recognised as a descriptive and observational technique that offers a number of results. Therefore, in the context of port competition, it will be very helpful if another methodology is used in combination with it in order to achieve a realistic and significant assessment of ports' competitiveness level (Haezendonck & Winkelmans, 2001).

[2] Herfindahl index technique definition and uses will be discussed in details in Chapter four.

3.6 Port performance indicators

Port management is a complicated and multidisciplinary activity where port managers have to deal with a multitude of issues that comprise macro-economic, micro-economic and physical considerations. Therefore, they always need to implement tools to consistently control and evaluate the evolution and development of ports (Cariou, 2007b). To fulfil such objectives, port managers are using port performance indicators which provide them an insight to the operation of key areas.

Port performance indicators are tools being used for measuring different aspects of port operations. They are mainly used to compare the actual performance with the targeted one and to monitor the trend in performance level, so that they help port managers to take the right decision in the right time in order to enhance the port performance and services quality. The indicators can also be used as elements contributing in negotiation on port congestion surcharges, port development plans, port tariff determination and investment decisions (UNCTAD, 1976).

3.6.1 Port performance indicators classification

Port performance indicators can be classified into five main groups which are as follows; financial, operational, commercial, quality and security indicators. Table 2 presents a summary for each group of indicators that can be used separately or collectively with each other. However, the decision regarding to which set of indicators should be used depends on the port authority's main objectives and requirements.

Table 2 – Summary of Port Performance Indicators

Port Performance Indicators	
Financial indicators	**Units**
Tonnage worked	Tons
Berth occupancy revenue per ton of cargo.	Monetary units/ton
Cargo handling revenue per ton of cargo.	Monetary units/ton
Labour expenditure per ton of cargo.	Monetary units/ton
Capital equipment expenditure per ton of cargo.	Monetary units/ton
Contribution per ton of cargo.	Monetary units/ton
Total contribution.	Monetary units
Operational indicators	
Average waiting time (WT).	Hours
Average manoeuvring time (MT).	Hours
Average Service time (ST).	Hours
Total time in port.	Hours
Average productive ratio.	%
Average Grade of waiting	%
Berth occupancy ratio.	%
Berth productive time ratio.	%
Daily working time rate.	%
Tons per ship per productive hours (WSO).	Tons/hour
Tons per ship at berth (BSO).	Tons/hour
Tons per ship hour in port (PSO).	Tons/hour
Average gross productivity per gang per hour.	%
Average gang output per productive hour (GOP) ratio.	%
Average gang output per service hour (GOS) ratio.	%
Rate of utilisation of cranes/gang.	%
Rate of utilisation of workers.	%
Commercial indicators	
Litigation indicator.	%
Agreement rate.	%
Monthly litigation delay indicator.	%
Quality indicators	
Co-ordination indicator.	%
Reliability indicator.	%
Punctuality indicator.	%
Security indicators	
Security indicator.	%
Loss in value indicator.	%
Loss in volume indicator.	%
Casualties' indicator.	%

Source: Author, derived from various sources.

3.6.2 Strengths and weaknesses of port performance indicators

As a matter of fact, it is difficult to quantify the real benefits that can be achieved from using port performance indicators. The selection of a suitable set of indicators is a necessary step for ports to achieve effective control which is a complementary stage for port planning and neither element is useful without the other (UNCTAD, 1976). However, the most important advantages of the performance indicators are that they highlight potential bottleneck within different stages of port operations (berthing, cargo handling, transfer, stowage and receipt and delivery) which allows port managers to take the right decision to improve performance and to achieve the best utilisation of the resources.

That accordingly improves the quality of services being provided to port users and reduces the unit cost which consequently provides an added value in port operations and maintains or even enhances the competitiveness level of a port. Moreover, using the proper set of indicators, with a consistent monitoring and documenting process helps in various areas of decision making. For example, they help in selecting the best time for adjusting port tariffs and providing convenient justification for capital development and new investment (UNCTAD, 1987).

Nevertheless, using port indicators requires continuous and precise recording of all details and information related to different port operations. That in turn, needs well trained labourers and employees who are aware of the various types of port operations and the interrelation and the impact of each operation on the others. However, the introduction of the information technology (IT) and computer programs, in most of the ports, have been helping a lot in making the implementation of port indicators relatively easier and reliable.

3.7 Questionnaire technique

The questionnaire is one of the most famous and largely used methods of conducting researches. It provides a convenient way of collecting information from a specific population. Rojas and Serpa (2007, p. 2) defined the questionnaire as *"A tool for collecting information to describe, compare or explain knowledge, attitudes, behaviors and/or sociodemographic characteristics on a particular target group"* The methodology is fairly flexible in measuring different types of data (subjective, objective, qualitative and quantitative). In general, there are different types of questionnaires that can be used when conducting research such as mail questionnaire, group administered questionnaire, house hold drop-off, personal interview and telephone interview (Westers, 2006).

The selection of any of these methods depends on a variety of factors including the type of information to be collected and the available resources for the research. However, the questionnaire is a very useful tool when the resources and budget assigned for the research are rather limited or when it is important to protect the confidentiality of the participants. The technique is also beneficial when the time factor is significant for conducting a survey for certain research or when confirming other findings or results is essential for the accuracy and reliability of a research (Georgia Tech. College of computing, 2007).

3.7.1 Steps to developing questionnaire

The questionnaire is a multi-stage process that requires several steps in order to be conducted. These steps include identifying the objectives of the research survey, deciding the samples groups, writing the questionnaire, administrating the questionnaire and finally, analysing and interpreting the results. In the context of the first step, a questionnaire that is introduced without a well defined and clear objectives may deviate and bypass the important issues and waste the participants'

time by asking useless questions. Consequently, the data collected and results analysis might not be realistic.

In order to determine the samples sizes and groups, there are mainly two steps that the researcher should take to determine the target population (type of participants) and the number of participants (population size). However, the decision should be based on some influential factors such as time availability, budget and the degree of precision required (Creative research system, 2006).

When it comes to writing a questionnaire, researchers should take into consideration that every question should have a specific purpose. There are different types of questions that can be used when writing a questionnaire such as fixed alternative questions which provide multiple-choice answers. This type of question is quite useful when using a small sample of population. Open-ended questions allow the respondents to explain their opinions. They are sometimes difficult to analyze. However, this type of question is much suited for exploratory research. The last question technique is the projective methods which use vague questions and try to project a person attitude. This method is also suited for exploratory researches (QuickMBA…, 2007).

The pre-final stage is administrating the questionnaires. This step can be carried out through personal or telephone interviews, mail questionnaires or electronically by e-mails or websites. The final stage of conducting a questionnaire is the analysis and interpretation of results which comprises different analytical techniques such as descriptive or inferential statistics using tables, graphs and charts. The usage of such methods is highly depending on the type of data gathered (Qualitative or Quantitative) and the objectives and limitations of the research (Burgess, 2001).

Although the questionnaire technique is the most commonly used methodology for conducting different types of research, it also comprises a number of advantages that

give the methodology a significant strength and a few disadvantages that should be taken into consideration to avoid any deviation from the main objectives of the research.

3.7.2 Advantages and disadvantages of questionnaires

The most important advantage of using questionnaires is that it is easy to analyze as most statistical analysis software can process them. It is also cost effective when compared to interviews especially when the research is involved in large sample sizes and large geographical areas. It is easy to be implemented to various types of research as most of the people are familiar with it. Unlike in-person interviewing, the uniformity of written questionnaires reduces interviewers' bias as there are no verbal clues that might affect a respondent answer or opinion. Moreover, questionnaires and e-mails surveys in particular, offer a significant saving in time as several hundreds of people concerned can respond in a few days. However, what is more important is that it provides confidentiality, which is necessary to ensure that participants will respond honestly (Trochim, 2006).

Nevertheless, respondents to questionnaires often like to qualify their answers which make questionnaires sometimes lose the essence of the response. However, by providing reasonable space for comments, researchers can, to some extent, conquer this problem. On the other hand, low response rate of written questionnaires, mail surveys in particular, is the most common problem which might cause a dramatic reduction in the confident level of the survey results. Not to mention, mail surveys might not be answered by the persons concerned which causes another negative effect on the questionnaire results (Walonick, 2007).

From the above illustration of the different methodologies that can be used to assess the competitiveness level of ports, it can be argued that researchers should be in cautious when selecting any of these techniques. The selection should be based on

the research type, research main objective and limitation, the budget assigned, the data available, the time limits and the amount of population. Moreover, they also have to take into consideration that every methodology has its pros and cons that significantly affect the research or survey results and accordingly has a profound impacts on the decision making process and the entire development of the analysis or the assessment of a particular project.

Later in Chapter five of this thesis the author will use the Data Envelopment Analysis (DEA) methodology for assessing and benchmarking the efficiency of the terminal operators of the hub ports and container terminals of the market concerned. Moreover, the port performance indicators technique shall also be used to analyze and assess the performance and competitiveness level of Elsokhna container terminal in Egypt to its counterparts in East Mediterranean and the Middle East transhipment container market.

However, the author, in the next chapter, assesses the competitiveness level of the main container terminals and hub ports in the East Mediterranean and the Middle East transhipment container market. The inductive concept of the Industrial Organization (IO) and the Structuralists (Harvard school) methodology will be used in order to carry out such assessment. The technique assesses the market condition, structures, conduct and behaviour of the different players in the marked concerned.

CHAPTER FOUR

ASSESSMENT OF THE COMPETITIVENESS LEVEL OF HUB PORTS AND MAIN CONTAINER TERMINAL IN THE EASTERN MEDITERRANEAN AND THE MIDDLE EAST TRANSHIPMENT CONTAINER MATKET

4.1 Introduction

Global economic development has significantly increased the demand for container trades. As a result, liner shipping companies have used larger vessels and offered more comprehensive services in terms of geographical coverage and market restructuring. It has led to an intensive increase in the popularity of the hub and spoke systems, which accordingly creates new criteria for port competition and generates more and more factors that influence port attractiveness and competitiveness (Ng, 2006a).

In this context, inter port competition in the East Mediterranean and Middle East is strongly affected by the number of sub-markets that each port and terminal is able to compete in. As it has discussed in chapter one the ability of a port or terminal to compete depends on various factors such as location, accessibility, port infra/superstructure, draft, connections, productivity and others. These factors form the suitable market (transhipment or origin/destination) for each port or terminal (Drewry Shipping Consultants, 2000).

Following the inductive method of Industrial Organization (IO) and the Structuralists (Harvard school) methodology (Cariou, 2007a), the objective of this

chapter is to assess the competitiveness level of the hub ports and main container terminals in the Eastern Mediterranean and Middle East transhipment container market such as Dubai, Khore Fakkan, Salalah, Jeddah, Elsokhna, Suez Canal container terminal (SCCT), Damietta, Piraeus, Marsaxlokk and Gioia Tauro.

The competitiveness level will be assessed by analyzing the present condition, characteristics and structure of that market and the ability of such ports and terminals to compete in terms of the terminal throughput, port location, accessibility and infra/superstructure. The analysis will also focus on elements that the port operators emphasize in order to improve a port's competitiveness.

4.2 Market characteristics

4.2.1 Geographical location

Geographically, Eastern Mediterranean and Middle East regions are considered to be not only links between East and West markets but also intersection points with Asia, Europe and Africa. This enables such regions to become transhipment and logistics bases between markets in Europe, the Far East and India. Moreover, these regions are now growing markets that can offer and absorb containers and commodities due to the economic growth in North Africa and the Middle East (Francesetti & Danila, 2001).

4.2.2 Development of market demand

The Eastern Mediterranean and Middle Eastern container transhipment market has been characterized by strong long term growth rates. The driving forces of such growth are well known and refer to the increased penetration of containerized cargo, the increasing focus on port efficiency and effectiveness in port management, the growing trend towards privatization, the new investment in high quality equipment

and container terminal facilities, the increasing trend in consolidation (merger and acquisition activities), the change in the operational strategies of shipping lines and the use of transhipment to achieve savings in time (Francesetti, 2004). Meanwhile, the increase in cargo volume on routes from China and Southeast Asia to the regions and the booming of consumers' buying power also has its impact on the market growth (Woodbridge, 2006c).

4.2.3 Market segmentation

As far as port competition is concerned the Eastern Mediterranean and Middle Eastern container ports can be segmented into two main types with different commercial and operational requirements: the origin/destination (hinterland) and transhipment market. For the former, containers are transported directly onto/from a deep sea container vessel to the hinterland via barges, trucks or rails. This type of ports should be located at the centre of population and industry and offers deep water and equipment to handle large container vessels. The latter, transhipment ports (hubs) should be close to the main shipping routes and should also offer deep water and facilities to accommodate and handle large vessels. It can be sub-divided into two types, feeder traffic (hub and spoke) where containers move from deep sea vessels to short sea vessels (feeder) and relay traffic where containers move from deep sea vessels to deep sea vessels. Differentiation between transhipment traffic from hinterland traffic is a key element to consider when assessing the level of competition between ports (Drewry Shipping Consultants, 2000).

4.3 Assessment of port competition

The degree of port competition within a region can be assessed using different indicators. This section discussed various elements such as throughput, market share, market concentration, location, accessibility, port infra and super structure.

4.3.1 Ports Throughput

One of the most important factors that express port competitiveness is the port throughput. Table 3 shows the development of the ports throughput for 2000 and 2005. In the Eastern Mediterranean region, Gioia Tauro is the biggest hub port in the region. Its throughput was almost 2.7 million TEU in 2000 and reached 3.2 million TEU in 2005 with an average annual growth of 3.9%. The terminal (MCT) has however encountered a 3.1% drop in its throughput in 2005, and another drop of about 14% in the first half of 2006 (Woodbridge, 2006b).

The main reason for such a drop is the emergence of new competition from the Suez Canal container terminal (SCCT), which opened in 2004 and is operated by APM. Maersk, a key customer to Gioia Tauro, has switched a remarkable amount of transhipment services to eastern Mediterranean and Black Sea. Eight of Maersk weekly services moved to SCCT for instance (Woodbridge, 2006b). The port achieved a throughput of 0.6 million TEU in 2005, while its current capacity is 2.2 million TEU.

Another hub with a massive feeder connection to the eastern Mediterranean is Malta free port (Marsaxlokk). The container terminal is managed by port synergy, a joint venture between CMA CGM and P&O ports, which is now part of DP World group. The terminal achieved an annual growth of about 5% between 2000 and 2005. In 2005 the terminal handled around 1.32 million TEU which represents a small decline in its throughput to1.46 million TEU in 2004. However, the terminal handled about 1.6 million TEU in 2006 (Degerlund, 2007) thanks to the terminal operators' success in attracting new traffic and to the privatization of the terminal which enhanced its productivity by almost 65% (Woodbridge, 2006a).

Table 3 - Development of Eastern Mediterranean and Middle East hub ports container throughput, 2000:2005 (1000 TEU)

Port	Terminal operator	2000	2001	2002	2003	2004	2005	Av. Growth
Dubai (Jebel Ali)	DP World	3,059	3,502	4,194	5,152	6,429	7,619	20.0%
Dubai (Port Rashid)	DP World							
Khore Fakkan	Gulftainer Co.	1,014	1,084	1,266	1,449	1,819	1,930	13.7%
Salalah	Salalah Port Services	1,033	1,188	1,259	2,001	2,128	2,492	19.3%
Jeddah (NCT)	Gulf stevedoring Co.	12	145	430	701	1,018	1,232	152.5%
Jeddah (SCT)	Siyanco DPI	980	1,002	899	1,086	1,344	1,548	9.6%
Sokhna	SPDC	0	0	0	122	234	260	46.0%
SCCT	SCCT	0	0	0	0	19	600	---
Damietta	Damietta container & cargo handling Co.	0	0	748	1,263	1,146	1,133	---
Piraeus	Port of Piraeus Authority	1,161	1,166	1,405	1,605	1,542	1,395	3.7%
Marsaxlokk	Malta Freeport Terminal	1,033	1,165	1,244	1,305	1,461	1,321	5.0%
Gioia Tauro	Medcenter Container terminal SpA	2,653	2,488	2,955	3,149	3,261	3,209	3.9%
Total		10,945	11,740	14,400	17,833	20,401	22,739	

Source: Compiled from ISL shipping statistics yearbook, 2006 & Containerization International yearbook, 2007.

Piraeus in Greece also offers a remarkable competitive position in the eastern Mediterranean. The container terminal, managed by Piraeus Port Authority (PPA), achieved an annual growth rate of 3.7% in the period between 2000 and 2005. Although the terminal handled about 1.6 million TEU in 2003, its throughput dropped by 4% in 2004. In 2005 another decline of 9.5% to 1.4 million TEU was incurred due to the problems of continuous strikes and berth congestion. Nevertheless, the terminal returned to grow again during the first half of 2006 as it handled about 0.74 million TEU due to the improvement of the terminal productivity and to a noticeable reduction in ships waiting time (Woodbridge, 2006a).

One of the growing competitors in the East Mediterranean transhipment market is Damietta container terminal operated by Damietta container and cargo handling Co. The port recorded a throughput of 1.15 million TEU in 2004 but slightly declined to 1.13 million TEU in 2005 due to the strong competition of SCCT (Woodbridge, 2006a).

Across the Middle East Gulf, ports are achieving a massive growth of container throughput due to the significant economic development in the region. Dubai's two ports, Jebel Ali and Port Rashid which are managed and operated by DP World are taking the lead as a regional hub. DP World recorded a throughput of almost 3.1 million TEU in the year of 2000 when they handled about 7.62 million TEU in 2005 with an impressive annual growth of 20% in that period (Woodbridge, 2005b).

However, Dubai's ports are still vulnerable to competitive pressures on transhipment traffic from hub ports located outside of the Gulf such as Khore Fakkan and Salalah. For instance, there is a rapid growth of transhipment traffics at Khore Fakkan Container Terminal, operated by Gulftainer Co. The terminal handled 1.93 million TEU in 2005 with an annual growth of about 13.7% (Lloyds List, 2006).

Salalah Port in Oman is also a strong competitor for both Dubai and Khore Fakkan. The container terminal is operated by Salalah Port Services (SPS) and recorded a double digit growth in its throughput between 2000 and 2005. It handled about 1.03 million TEU in 2000 and 2.5 million TEU in 2005 with an annual growth of about 19.3%. Such growth has further increased following the establishment of the Maersk dedicated terminal in 2006 (Woodbridge, 2006a).

Jeddah Port in Saudi Arabia is the leading hub in the Red Sea. The port has two container terminals operated by concession agreement. The South container terminal (SCT) is operated by Siyanco DPI and the North terminal is (NCT) operated by Gulf Stevedoring Co. The privatization of the port was the driving force to explain the increase in the throughput of the terminals. Both terminals handled about 2.84 million TEU in 2005 with an average annual growth of 22.1%. The transhipment traffic accounted for 60% of the port's throughput in 2005 (Woodbridge, 2006c).

In the Northern part of the Red Sea on the Egyptian side, Elsokhna Port is a relatively new port which has been operated by Sokhna Port Development Company (SPDC) since 2002. The port recorded significant growth as the container terminal handled about 122,000 TEU in 2003 and increased to 260,000 TEU in 2005 (Woodbridge, 2006b).

From the above illustration, it is clear that the container terminal throughput plays an important role to assess the level of competition among ports. Next section focuses on respective market shares of terminal operators.

4.3.2 Market share

The market share of each hub ports is calculated as a percentage from the total throughput of the ten mentioned ports and is presented in Table 4. Dubai is the Market leader in the Middle East with a consistent growth of market share form

27.8% in the year of 2000 to 33.4% in 2005. However, a strong competition still exists between hub ports outside the gulf. In 2005, Khore Fakkan and Salalah recorded a market share of 8.5% and 10.9% respectively. Meanwhile, Jeddah terminal operators (Gulf stevedoring Co. & Siyanco DPI) together recorded a remarkable growth of their market share from 9.5% in 2000 to 12.4% in 2005.

Table 4 - Development of Market share of the hub ports in East Mediterranean and Middle East Container markets. 2000 – 2005 (%).

Port	Terminal operator	Market share					
		2000	2001	2002	2003	2004	2005
Dubai (Jebel Ali)	DP World	27.9%	29.8%	29.1%	28.9%	31.5%	33.5%
Dubai (Port Rashid)	DP World						
Khore Fakkan	Gulftainer Co.	9.3%	9.2%	8.8%	8.1%	8.9%	8.5%
Salalah	Salalah Port Services	9.4%	10.1%	8.7%	11.2%	10.4%	11.0%
Jeddah (NCT)	Gulf stevedoring Co.	0.1%	1.2%	3.0%	3.9%	5.0%	5.4%
Jeddah (SCT)	Siyanco DPI	9.0%	8.5%	6.2%	6.1%	6.6%	6.8%
Sokhna	SPDC	---	---	---	0.7%	1.1%	1.1%
SCCT	SCCT	---	---	---	---	0.1%	2.6%
Damietta	Damietta container & cargo handling Co.	---	---	5.2%	7.1%	5.6%	5.0%
Piraeus	Port of Piraeus Authority	10.6%	9.9%	9.8%	9.0%	7.6%	6.1%
Marsaxlokk	Malta Freeport Terminal	9.4%	9.9%	8.6%	7.3%	7.2%	5.8%
Gioia Tauro	Medcenter Container terminal SpA	24.2%	21.2%	20.5%	17.7%	16.0%	14.1%

Source: Author, derived from various sources.

In the Eastern Mediterranean, Gioia Tauro is still leading, although its market share dropped from 24.1% in 2000 to 14.1% in 2005 due to the emergence of new competition from Damietta and SCCT. The former recorded a 5% market share and the latter recorded 1.1% in 2005. Moreover, the operation of SCCT by APM not only affected the Piraeus market share, which declined from 7.1% in 2004 to 6.1% in 2005 but also Marsaxlokk which dropped from 7.1% in 2004 to 5.8% in 2005 (Woodbridge, 2006a).

4.3.3 Market concentration

The Herfindahl index (H) measures the degree of competition among firms in the market. It is defined as the sum of the squared market shares of (n) individual company. As such, it can range from (1/n) to 1 moving from a large amount of small firms to a single monopolistic organization where H=1. A decrease in the Herfindahl index generally indicates a decrease in concentration (Cariou, 2007a).

Table 5 indicates that in 2000 the Herfindahl index was relatively small (0.1825), which means that although DP world in Dubai and MCT in Gioia Tauro together account for about 52.1% market share, the market was highly competitive in such a period. It might be due to the high degree of competition among the other terminal operators such as Gulftainer in Khore Fakkan, Salalah port service in Salalah, Siyanco DPI in Jeddah, port of Piraeus authority and Malta Freeport terminal with similar market share around 10%.

Table 5 - East Mediterranean and Middle East transhipment container market concentration – Herfindahl index (H) in 2000

Port	Terminal operator	Throughput 2000 (1000) TEU	Market share 2000 %	H
Dubai (Jebel Ali) **Dubai (Port Rashid)**	DP World	3,059	27.9%	0.0781
Khore Fakkan	Gulftainer Co.	1,014	9.3%	0.0086
Salalah	Salalah Port Services	1,033	9.4%	0.0089
Jeddah (NCT) **Jeddah (SCT)**	Gulf stevedoring Co. Siyanco DPI	12 980	0.1% 9.0%	0.0000 0.0080
Piraeus	Port of Piraeus Authority	1,161	10.6%	0.0113
Marsaxlokk	Malta Freeport Terminal	1,033	9.4%	0.0089
Gioia Tauro	Medcenter Container terminal SpA	2,653	24.2%	0.0588
Total		10,945	100.0%	0.1825

Source: Author derived from various sources

However, although DP world market share increased to 33.5% in 2005, competition between terminal operators has significantly increased as the Herfindahl index decreased to 0.1694 in 2005 (Table 6). The increase in the number of players in the market implies that the market is going towards less concentration and more competition among terminal operators. It may have a positive impact on ports' clients in terms of service being provided, port dues and terminal handling charges.

Nevertheless, although the ports throughput and market share are influential factors that indicate the competitiveness level of a port, the port location also has a significant impact on its attractiveness and competitiveness.

Table 6 - East Mediterranean and Middle East transhipment container market concentration – Herfindahl index (H) in 2005

Port	Terminal operator	Throughput 2005 (1000) TEU	Market share 2005 %	H
Dubai (Jebel Ali) **Dubai (Port Rashid)**	DP World	7,619	33.5%	0.1123
Khore Fakkan	Gulftainer Co.	1,930	8.5%	0.0072
Salalah	Salalah Port Services	2,492	11.0%	0.0120
Jeddah (NCT)	Gulf stevedoring Co.	1,232	5.4%	0.0029
Jeddah (SCT)	Siyanco DPI	1,548	6.8%	0.0046
Sokhna	SPDC	260	1.1%	0.0001
SCCT	SCCT	600	2.6%	0.0007
Damietta	Damietta container & cargo handling Co.	1,133	5.0%	0.0025
Piraeus	Port of Piraeus Authority	1,395	6.1%	0.0038
Marsaxlokk	Malta Freeport Terminal	1,321	5.8%	0.0034
Gioia Tauro	Medcenter Container terminal SpA	3,209	14.1%	0.0199
Total		22,739	100.0%	0.1694

Source: Author derived from various sources

4.3.4 Port Location

The geographic location of a port from the main trade routes is also an important consideration to assess the competitiveness of a port (Lu & Marlow, 1999). The carrier's main objectives are to provide the most comprehensive door to door coverage with minimum transit time and cost. Therefore, the closer the port is to the main route, the higher is its competitive advantage in the market (Guy & Urli, 2006). For example, Gioia Tauro and Marsaxlokk (Figure 1) have very advantageous positions as hub ports located in the centre of the Mediterranean. However, Gioia Tauro is about 73 nm from the main east-west route, while Marsaxlokk is just 6 miles off (Table 7).

Moreover, Gioia Tauro is located at the southern part of Italy, north of Sicily. That means container vessels heading to the port from the eastern Mediterranean should pass the straight of Messina which requires a reduction of sailing speed causing a longer transit time and extra cost for the shipping lines. Such a delay in sailing time constitutes about three to four hours on an average speed of 20 knots which in practice does not affect the sailing schedules of large container vessels but it does affect the sailing schedules of feeders calling the port of Gioia Tauro.

Table 7 - Deviation distance from the main East-West liner route and the main hub ports in the Eastern Mediterranean and Middle East region.

Port	Dev. Distance (nm)
Dubai	1267.0
Khore Fakkan	1019.0
Salalah	135.0
Jeddah	9.0
Sokhna	3.0
SCCT	0.0
Damietta	46.0
Piraeus	107.0
Marsaxlokk	6.0
Gioia Tauro	73.0

Source: Lloyd's Register-Fairplay, (2007). Distance tables. Fairplay world shipping Encyclopedia [electronic source]. Coulsdon, Survey, UK: author.

Similarly, Piraeus in Greece is less competitive than Damietta and SCCT in Egypt as transhipment hubs serving the East Mediterranean when it comes to deviation form main routes. Unlike Piraeus which is 107 nm off the main liner route, Damietta is just 46 nm off route. But nevertheless, SCCT has the most competitive advantage due to its location at the tip of the Suez Canal with no deviation from the main route.

Figure 1 - Location of main hub ports in the East Mediterranean and Middle East transhipment container markets.
Source: http://earth.google.com/

In the same context, although Dubai is the leading transhipment hub in the Middle East, its location inside the Gulf makes it less competitive than some other ports outside the Gulf. Container vessels coming from the Far East proceeding to the Middle East following the east-west route should deviate for a distance of about 1267 nm to proceed to Dubai Port while the deviation distance required to reach to Khore Fakkan is about 1019 nm.

However, vessels need to deviate just 135 nm to reach Salalah, which gives the port a competitive position in terms of port location in the region. Nevertheless, Jeddah and Sokhna in the Red Sea are in very attractive positions for container lines. The former is just 9 miles off the main route while the latter is only 3 nm off (Lloyd's Register-Fairplay, 2007). However, from the shipping lines perspective the port competitiveness level not only depends on the port location but also on the port accessibility.

4.3.5 Port accessibility

Transhipment ports can obviously have a competitive advantage by being sea ports and having efficient land access. The introduction of larger ships has led to demand for container terminals close to the open sea in order to minimize transit time and to reduce costs. On the hinterland side, direct connections to highways, rail and inland navigation system is also strengthening the hub port competitive position (Fleming & Baird, 1999).

Following the deployment of ever-larger vessels, the Eastern Mediterranean and Middle East transhipment ports have increased the depth of their approach channels and terminals to accommodate large container vessels. Table 8 shows the design development of large container vessels. For example, the ultra large container carrier has a draught of 14.5 m.

Table 8 - Design development of large container vessels

V/Ls generation	TEUs	LOA (m)	Beam (m)	Design draught (m)
First generation: 1968	1,100			8.5
Second generation:1970-80	2-3,000	213	27.4	10.8
Panamax: 1980-90	3-4,500	294	32.0	12.2
Post-Panamax: 1988-95	4-5,000	280-305	41.1	12.7
Fifth generation: 1996-2005	6,400-7,500	300-347	42.9	14.0-14.5
Current development stage	8,000-9,000	330-380	43-47	14.5
Ultra large container carriers: 2007 &later	12,500	380-400	58-60	14.5-15.0

Source: Ocean Shipping Consultants, (2004). OSC (2004). Marketing of container terminals. London.

Accordingly, in the East Mediterranean region, transhipment ports such as SCCT and Piraeus have dredged their channels and terminals to reach 16.5 m in depth while

Marsaxlokk and Gioia Tauro terminals are 15 and 15.5 m in depth respectively; whereas, Damietta terminal depth is 14.5 m. Meanwhile, hub ports in the Middle East such as Dubai, Khore Fakkan and Salalah have container terminals of 16 m in depth. In Jeddah the North container terminal depth is 15 m and the South terminal depth is between 10.7 m and 16.5 m.

Another element that plays an important role on port competitiveness and the total time in port for ships is the availability and the optimal utilization of the port infra/super structure. Next section focuses on this issue.

4.3.6 Terminal infra/superstructure

The growth of container traffic and the introduction of ever-larger container vessels have put further pressures on terminal operators to introduce measures to improve the ship turnaround time and to reduce the container's dwell times. Meanwhile, at the time of increasing port competition, terminal operators have to reduce their operating costs and to invest in new facilities such as quay length, quay cranes, yard equipment and yard stacking area (Drewry shipping consultant, 2000).

Table 9 and 10 shows that terminal operators in the East Mediterranean and Middle East transhipment market are highly competitive in terms of terminal infra/super structure. MCT in Gioia Tauro is the largest terminal in the East Mediterranean with an area of 130 hectares, quay length of 3011 m, storage capacity of 60,000 TEU and 18 quay gantry cranes (Degerlund, 2007). The port authority together with the terminal operator (MCT) is highly investing in the terminal by adding 400 m to the quay length with an additional area of 394,000 sq.m; at the same time, they are enlarging the channel by 70 m and have also ordered four super post-Panamax gantry cranes in order to be able to accommodate more and larger vessels (Woodbridge, 2006b).

Piraeus is also competing as its terminal length is about 3980 m with a total storage capacity of 30,500 sq.m and 15 quay gantry cranes. The terminal operator (PPA) has decided to expand its capacity by around one million TEU to reach more than 2.5 million TEU per annum by 2010 (Woodbridge, 2006b).

Marsaxlokk in Malta also has a competitive advantage with a terminal length of about 2258 m equipped with 18 quay gantry cranes. The terminal operator has been investing to expand the terminal length to 3000 m, purchased new yard equipment and developed an area of 65,000 sq.m to be completed at the end of this year.

Meanwhile Damietta has a relatively shorter terminal of 1050 m in length equipped with 9 quay gantry cranes. However, the terminal area of 60 hectares and the storage capacity of 30,000 TEU encouraged the port to invest in new facilities. The port has ordered ten tractors and two RTGs to enhance the terminal productivity (Degerlund, 2007). In order to keep pace with the development of the competitive hub ports in the region, the SCCT operator has decided to expand the terminal length to 2400 m by 2008 instead of the present length of 1200 m (Table 10). Moreover, they have ordered three new super post-Panamax gantry cranes and nine RTGs. Such investments will double the terminal throughput to around 4.5 million TEU annually (Maersk helps SCCT…, 2006).

In the Middle East, DP World has assigned a significant amount of investment to expanding the existing Jebel Ali terminal, raising the capacity to about 9.5 million TEU annually. At the same time, the new investment on Jebel Ali 2 project is now in progress. It includes 1200 m of quay with a 17 m draught and a number of twin lift super post-Panamax gantry cranes, giving DP World additional capacity of 2.2 million TEU and allows Jebel Ali 2 to handle around 5 million TEU annually (Dubai intent…, 2006).

Table 9 - Eastern Mediterranean and Middle East main container terminals and hub ports future investment plan.

Port	Terminal operator	Future investment plan		
		Infrastructure		Superstructure
		Berth	Yard	
Dubai (Jebel Ali)	DP World	1200 m		4 super post-Panamax gantry cranes - RMGs
Dubai (Port Rashid)	DP World			
Khore Fakkan	Gulftainer Co.	400 m		RTGs
Salalah	Salalah Port Services	960 m - 2.85 km break water		34 RTGs - tractors & trailers
Jeddah (NCT)	Gulf stevedoring Co.		432 reefer points	2 super post-Panamax gantry cranes
Jeddah (SCT)	Siyanco DPI			2 super post-Panamax gantry cranes - 5 RTGs
Sokhna	SPDC	300 m		2 super post-Panamax gantry cranes - 5 RTGs
SCCT	SCCT	2400 m	600,000 m2	3 super post-Panamax gantry cranes - 9 RTGs
Damietta	Damietta container & cargo handling Co.	New yard for import container.		10 tractors - 2 RTGs - 1 forklift.
Piraeus	Port of Piraeus Authority	expansion of quays		
Marsaxlokk	Malta Freeport Terminal	700 m	65,000 m2	
Gioia Tauro	Medcenter Container terminal SpA		394,000 m2	4 super post-Panamax gantry cranes

Source: Author derived from various sources

Khore Fakkan has also expanded its terminal to 1860 m from 1460 m with 16 m draught. The new berth is equipped with four super post-Panamax gantry cranes and is able to accommodate up to 8000 TEU container vessels.

Moreover, Salalah terminal operator together with Oman government decided to invest in two new berths, 960 m in length, with 18 m draught. This will raise the terminal handling capacity by about 1.75 million TEU annually making the total

capacity 4 million TEU. The terminal will be able to accommodate eight container vessels at the same time (Woodbridge, 2005a).

In Jeddah, Siyanco DPI is upgrading the South container terminal facilities by ordering five RTGs and two new super post-Panamax gantry cranes. Further, last year, Gulf Stevedoring, the North container terminal operator delivered 30 terminal tractors and trailers, 15 RTGs and 6 empty container handlers. Moreover, due to the increase in transhipment traffic, another container terminal will be developed within the next three years in Jeddah with a capacity of 1.5 million TEU annually (higher imports…, 2006).

In Egypt, the Sokhna container terminal operator (SPDC) has also invested in new facilities in order to enhance the terminal productivity. He ordered two super post-Panamax gantry cranes and five RTGs. The present length of the terminal is 750 m with 17 m draught able to accommodate the mega container carrier with 15 m draught (Degerlund, 2007).

Table 10 - Eastern Mediterranean and Middle East hub ports infra/superstructure comparison

Port	Terminal operator	Terminal throughput (2005) 1000 TEU	Terminal area (ha)	Storage capacity (TEU)	Quay length (m)	Terminal depth (m)	No. of gantry cranes	Yard equipment
Dubai (Jebel Ali)	DP World	7,619	100.61	61,876	1810	13.25-16	39	RTG
Dubai (Port Rashid)	DP World		61.5	40,000	1350	11.5 - 12.8	9	Reach stacker
Khore Fakkan	Gulftainer Co.	1,930	45	30,000	1460	12.5 - 16	15	RTG/RMG
Salalah	Salalah Port Services	2,492	54	40,000	1260	16	12	RTG/RMG
Jeddah (NCT)	Gulf stevedoring Co.	1,232	80	90,000	1000	15	8	RTG
Jeddah (SCT)	Siyanco DPI	1,548	141	37,000	1680	12 - 16.5	17	RMG
Sokhna	SPDC	260	18	24,200	750	17	2	RTG
SCCT	SCCT	600	60	41,159	1200	16.5	9	RTG/RMG
Damietta	Damietta container & cargo handling Co.	1,133	60	30,000	1050	14.5	9	RTG
Piraeus	Port of Piraeus Authority	1,395	90	30,500	3980	10-16.5	15	Straddle carrier
Marsaxlokk	Malta Freeport Terminal	1,321	27.4	N/A	2258	15.5	18	RTG/RMG
Gioia Tauro	Medcenter Container terminal	3,209	130	60,000	3011	13.5-15	18	Straddle carrier

Source: Containerization international yearbook, (2007).

4.4 Competitiveness level of the main hub ports and container terminals in the East Mediterranean and Middle East transhipment container market

The dynamic characteristics of the eastern Mediterranean and Middle East transhipment container market have a significant impact on determining the competitiveness level of hub ports and container terminals in such a market. In the context of inter port competition, there are many elements that should be considered when assessing the port competitiveness such as throughput and market share, port location, accessibility and terminal infra/superstructure.

However, when evaluating the competition between ports, such elements should be used collectively rather than individually. For instance, from the above analysis it can be noticed that although Gioia Tauro is the market leader in the East Mediterranean in terms of throughput and market share as well as terminal infra/super structure, it has less competitive advantage than Marsaxlokk and SCCT in terms of port location and accessibility.

Similarly, Dubai port is taking the lead in the Middle East with a massive throughput, market share and significant infra/superstructure but due to its location inside the Gulf it might be less attractive compared to Salalah and Jeddah in terms of location and accessibility. However, it should be kept in mind that the main objective of evaluating the port competition is not only getting more traffic and volume to the port but also creating substantial added value for the industry.

Next chapter analyzes and benchmarking the efficiency of the main hub ports and container terminal in the defined market by using the Data Envelopment Analysis (DEA) Technique. The chapter also assesses the performance and the competitiveness level of Elsokhna container terminal to its counterparts in the market concerned by using the appropriate set of port performance indicators that suit the data obtained from Elsokhna port authority and Elsokhna terminal operator (SPDC).

CHAPTER FIVE

ELSOKHNA PORT PERFORMANCE AND COMPETITIVENESS LEVEL

5.1 Introduction

Recently, changes in shipping economics and in the geography of maritime transport have intensified inter-port competition and the need to provide high quality service to port users. The economies of scale attained through the use of bigger and more sophisticated vessels have effectively decreased the tonne-mile cost of sea transport. However, these economies highly depend on the vessel being kept sailing as much as possible and its time in port to be as short as possible.

Therefore, the trend for line-haul vessels has been to cover larger markets per voyage, increasing their lifting capacity per call but at the same time, to call fewer ports on their ways. This has expanded the use of transshipment services and has made traffic, to a large extent, less captive to traditional ports of call. That is why inter-port competition has increased, making ports more conscious of the need to provide good service to their customers (UNCTAD, 1990, p.6).

In this context, this chapter measures the efficiency of the container terminals and hub ports in the market concerned. The Data Envelopment Analysis Technique is used in order to carry out such assessment. Moreover, it provides a profound analysis for the performance and the competitiveness level of Elsokhna container terminal in

Egypt in terms of ships total time in port, berth occupancy and berth productivity by using a complete set of indicators that can be used with the data available.

5.2 Elsokhna port

Elsokhna Port in Egypt is considered to be one of the most sophisticated ports in Africa. It is inaugurated in October 2002. It was constructed by a Build-Operate-Transfer (BOT) concession for 25 years contract between the Egyptian government that invested in the port infrastructure and Elsokhna Port Development Company (SPDC) that invested for the development of the port superstructure. SPDC is 70% owned by the Egyptian Container Handling Co. (ECHO), 20% owned by individuals and 10% owned by Coral Holdings Investment Ltd of the UK (Abdelnour, 2004). The port comes under the third generation ports and is privately managed and operated by Sokhna Port Development Company (SPDC) (Woodbridge, 2005c).

5.3 Port location

Elsokhna Port is a seaport which lies in the Red Sea on the west cost of the Suez Gulf in an area of 22.3 Km2 and 43 Km away from the Suez Canal (Figure 2), which makes the port an attractive option for container lines moving cargo from Asia to Egypt, where by calling the port they can avoid the expensive Suez Canal transits dues (Traffic growth…., 2006). Moreover, the port has a unique position as far as the logistics and supply chain is concerned. It is the closest port, just about 90 minutes, to Cairo which is not only the Egyptian capital but also the main production and consumption centre in Egypt.

Elsokhna is considered to be a gateway port that presently handles mainly Egyptian import and export cargoes. While about 52% of its throughput is export, most of these are empty containers and around 40% of its throughput is transhipment

containers. Therefore, its key importance as far as containerized goods are concerned is as a route for imports into the Egyptian market (Woodbridge, 2005b).

Figure 2 - Elsokhna port location
Source: www.mapsofworld.com/indexmaps/egypt.jpg

5.4 Port layout and characteristics

The port is constructed on an area of 1,000 hectares. It consists of four basins with a total quay length of 7,500 m. The marine structures of the first basin were completed in 2001 (Figure 3). The present port facilities are designed to handle more than 500,000 TEUs and about 8 million tons of general and bulk cargoes per annum as an initial phase of development. Three more basins will be added in the future, considering the increase in the cargo throughput to over 50 million tons and container throughput to around 4 million TEUs per year.

The port contains one general cargo terminal, two RoRo terminals, one bulk terminal and one container terminal. Water depth in the port and its approach channel is 17 m and quays are designed to accommodate capsize bulk carriers as well as super post-Panamax container ships. Adjacent to the cargo terminals is an area of 40 hectares available for the development of a logistical centre. It is reserved for warehousing, distribution and value-adding cargo operations (Elsokhna Port, 2006).

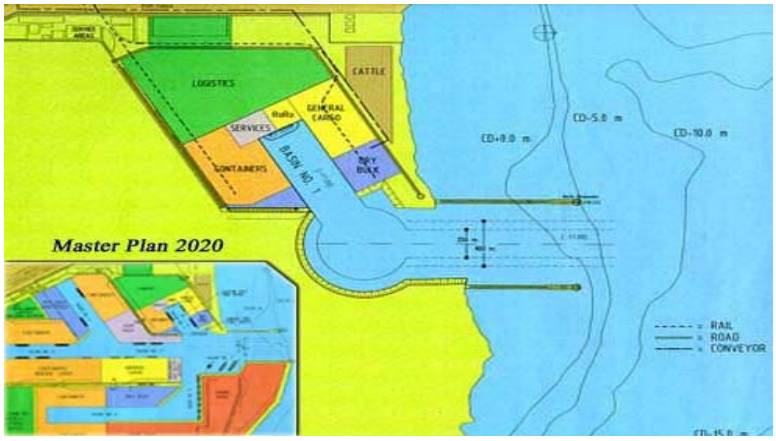


Figure 3 - Elsokhna Port layout
Source:http://images.google.com/images?q=%22el+sokhna+port%22&gbv=2&ndsp=20&svnum=10&hl=en&start=0&sa=N

5.5 Elsokhna container terminal characteristics

The container terminal with an area of 18 hectares and a quay length of 450 m has a depth of 17 meters and storage capacity of 24,200 TEUs. It is equipped with 2 Post Panamax ship to shore gantry cranes, 3 mobile cranes, 3 (5+1) RTG stacking cranes, 6 Reachstackers, 6 forklifts, 20 tractors and 34 trailers. The terminal has 560 ground slots for import/export containers, 96 ground slots for reefer containers and 60 parking slots for dangerous and oversized cargoes (Degerlund, 2007).

The terminal's biggest clients are APL and PIL which together account for about 75% of the terminal's throughput. APL, which has a joint service with CMA CGM, PIL, Evergreen, Hapag Lloyd and Cosco has a weekly service to the port while MSC/WEC has a fortnightly service. Delmas, which is also part of the CMA CGM group, began to call at Elsokhna container terminal with a sailing frequency of ten days by its Indian Ocean line service (Traffic growth…, 2006).

As shown in chapter four the increase in Elsokhna container throughput widely reflects the strong growth that has been taking place in container traffic which is

being flourished both by growth in the Egyptian economy, and a shift in imports sourcing towards Asia and China in particular (Woodbridge, 2005d).

The container terminal had a throughput of 121,554 TEU in 2003, 234,382 TEU in 2004 (Degerlund, 2007) while it has achieved a throughput of 264,000 TEU in 2005 with an increase of almost 12%. In the first eight month of 2006 the port handled 200,000 TEU, a 16% increase in throughput compare to the equivalent period in 2005 (Wood bridge, 2005a).

5.6 Benchmarking the efficiency of the main container terminals and hub ports in the East Mediterranean and Middle East transhipment container market

In this section the efficiency of the main container terminals and hub port in the east Mediterranean and Middle East transhipment container market is assessed using the Data Envelopment Analysis technique. In order to apply such a methodology and to solve the linear programming problem, the data mentioned in chapter 4 (Tables 6 and 10) are used as benchmarking criteria. Terminal area, storage capacity, quay length, terminal depth and number of gantry cranes are used as inputs (Table 10) and terminal throughput in 2005 (Table 6) are used as output criteria. The Constant Return-to-Scale (CRS) model is used as a DEA model for the purpose of benchmarking.

The DEA technique uses a 0 to 1 scale in order to benchmarking the efficiency of different firms (DMUs) in the market concerned. Table 11 shows that, both Dubai and Jebel Ali container terminals operated by DP world and Salalah container terminal operated by Salalah port services as well as Marsaxlokk container terminal operated by Malta free port terminal are the most efficient container terminals in the defined market with score equal to 1.0 in the DEA Scale. Gioia Tauro and Khore Fakkan container terminals are relatively less efficient with scores of 0.97 and 0.91 simultaneously.

The table also shows that the container terminals in Jeddah, Elsokhna, Damietta and Piraeus have relatively the same efficiency with scores between 0.6 and 0.74 except for Jeddah South container terminal (SCT) as it has the second lowest score in the DEA scale. Finally, SCCT is the most inefficient terminal in the defined market with 0.32.

Table 11 – Benchmarking the efficiency of the main container terminals and hub ports in the east Mediterranean and Middle East transhipment container market using DEA technique.

DMU No.	Port	Terminal operator (DMU)	Input-Oriented CRS Efficiency
1	**Dubai & Jebel Ali**	DP World	1.00000
2	**Salalah**	Salalah Port Services	1.00000
3	**Marsaxlokk**	Malta Freeport Terminal	1.00000
4	**Gioia Tauro**	Medcenter Container terminal SpA	0.97314
5	**Khore Fakkan**	Gulftainer Co.	0.91013
6	**Jeddah. NCT**	Gulf stevedoring Co.	0.74157
7	**Elsokhna container terminal**	SPDC	0.62600
8	**Damietta**	Damietta container & cargo handling Co.	0.60621
9	**Piraeus**	Port of Piraeus Authority	0.59888
10	**Jeddah. SCT**	Siyanco DPI	0.56551
11	**Suez Canal Container Terminal**	SCCT	0.32103

Source: Own calculation using Zhu, J. (2003) Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets. Kluwer Academic Publishers, Boston: Author.

It is important to highlight that inefficiency is seen as a ratio between inputs employed and the output achieved in 2005. It means that the container terminals in Dubai, Jebel Ali and Marsaxlokk as well as Gioia Tauro and Khore Fakkan are very efficient in terms of infra and superstructure as they reach the maximum level of utilization of their facilities. At the same time, it could also interpreted as the fact that they need to invest in new facilities which could play against their attractiveness. Furthermore, the different level of development (throughput) of ports induces the use of different technologies that could also explain why bigger ports reach higher level

of efficiency. Finally, the composition of port throughput (especially transshipment) is also an important factor to explain efficiency and was not considered in the estimation.

These limitations have led us not to rely solely on the results from DEA and to calculate port performance indicators to analyze and understand the main factors that affect the efficiency and the competitiveness level of Elsokhna container terminal.

5.7 Elsokhna container terminal key performance indicators

5.7.1 Data provided, assumptions and methodology

As far as port performance is concerned, ship operators always look for a reliable port service, consistent high cargo handling rate with a short ship turnaround time in port (UNCTAD, 1990, p.6). Therefore, port managers always need to analyze and assess the services they are providing to their customers and the way that they are using their facilities to know whether they are improving or worsening so that they can establish polices and procedures that could efficiently and effectively enhance their port performance and port attractiveness accordingly (UNCTAD, 1973).

In order to evaluate Elsokhna Port performance and assess its competitiveness level a set of information has been gathered from Elsokhna port authority. Such information relates to 1023 container ships calls between years of 2003 to 2006. The data was classified into two groups: ship's time in port and containers handling figures. These two groups were aggregated in one table on a yearly basis to facilitate the calculation and comparison of indicators.

Appendix, A presents the main assumptions concerning missing data on vessel's LOA, arrival and departure time, number of gantries assigned for each vessel, idle time details (changing gangs, break downs…etc.). Moreover, 515 vessels

representing 50% of the whole population were recorded as “anonymous” where for 436 of them representing 42.6 % no information was provided on time.

The raw data given by Elsokhna Port authority is analyzed on a quarterly basis for time in port indicators (Appendix D & E), berth indicators, crane output (Appendix F) and ship output indicators (Appendix G) Moreover, a comprehensive and integrated analysis of all the indicators was made in order to have a precise evaluation of the port performance.

5.7.2 Time in port indicators

The total time in port has noticeably decreased over the period of study (Figure 4). The average ship’s turn-around time in the first quarter of 2003 was about 52 hours while it was reduced to around 14 hours in the fourth quarter of 2006. Such a reduction in ship’s turn-around time can be related to the remarkable decrease in both service time (from about 51 hours in the first quarter of 2003 to 13.7 hours in the fourth quarter of 2006), and to the reduction in idle time (from 5.3 hours in the first quarter of 2003 to 1.5 hours in the fourth quarter of 2006).

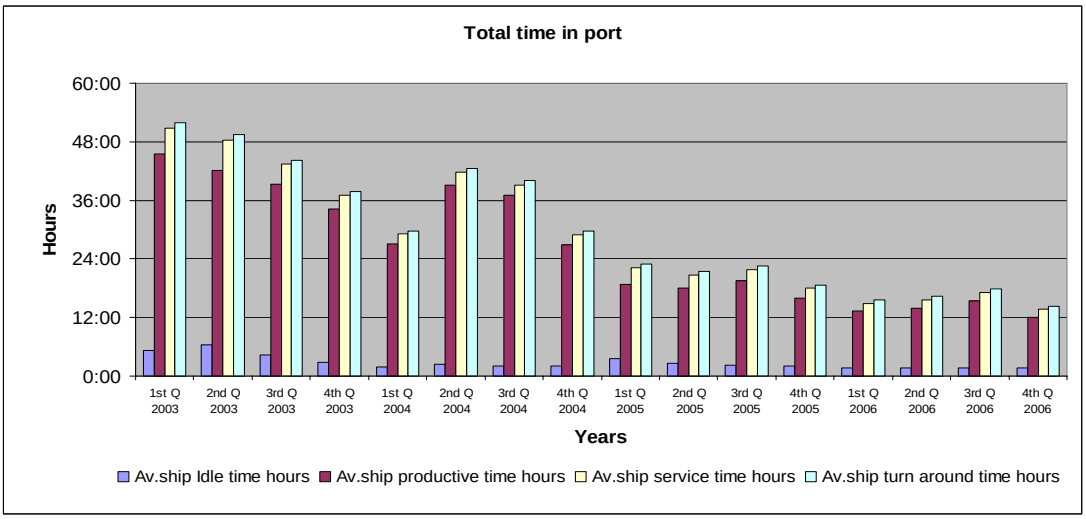


Figure 4 - Total time in port indicators
Source: Author, derived from Elsokhna port raw data.

On the other hand, the reduction in the turn-around time, service time and idle time could be explained by the improvement in both berthing and cargo handling operations. Moreover, as can be noticed from Figure 4 the effect of both waiting time and manoeuvring time was insignificant and neglected due to two main reasons. Firstly, the usage of window system that allows vessels to go for berthing as soon as it arrives to the port, which makes the waiting time almost zero. Secondly, the short manoeuvring time from the pilot station to the berth that does not exceed 30 minutes in most of the cases (Elsokhna Port, 2006).

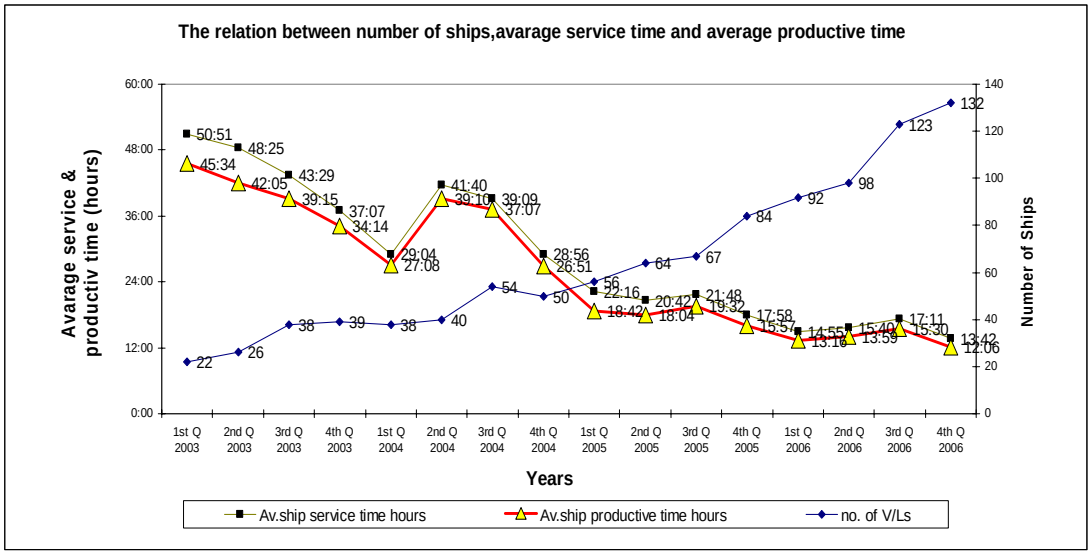


Figure 5 - The relation between number of ships, service time and productive time
Source: Author, derived from Elsokhna port raw data.

Figure 5 shows the relationship between the number of ships, average service time and productive time, and indicates that the terminal's productive and service time declined with the increasing number of ships due to the improvement in quay operation. It is confirmed by the increase in the number of moves per ship per productive hour from 21.4/hr moves in the first quarter of 2003 to 34.1 moves/hr in the fourth quarter of 2006.

Figure 5 also illustrates that a high correlation exists between the service time and productive time, both following the same trend. It is related to the consistent reduction in the idle time over the period of study, which reflects the effectiveness and the efficiency of both the quay and yard operations. Moreover, the remarkable reduction in both service and productive time and the turn-around time accordingly has its positive impact on the berth occupancy ratio, rate of utilization of cranes as well as cranes output.

5.7.3 Berth occupancy and crane output

Figure 6 stresses the relationship between berth occupancy ratio, rate of utilization of cranes and average gang output per hour. It can be noticed that although the rate of ships calling increases from about 22 to 132 ships in each quarter through the study period (Appendix C), the berth occupancy ratio varies with a slight increase from 25% in the first quarter of 2003 to 49% in the third quarter of 2006. It might reflect improvements in the cargo handling for quay and yard operations.

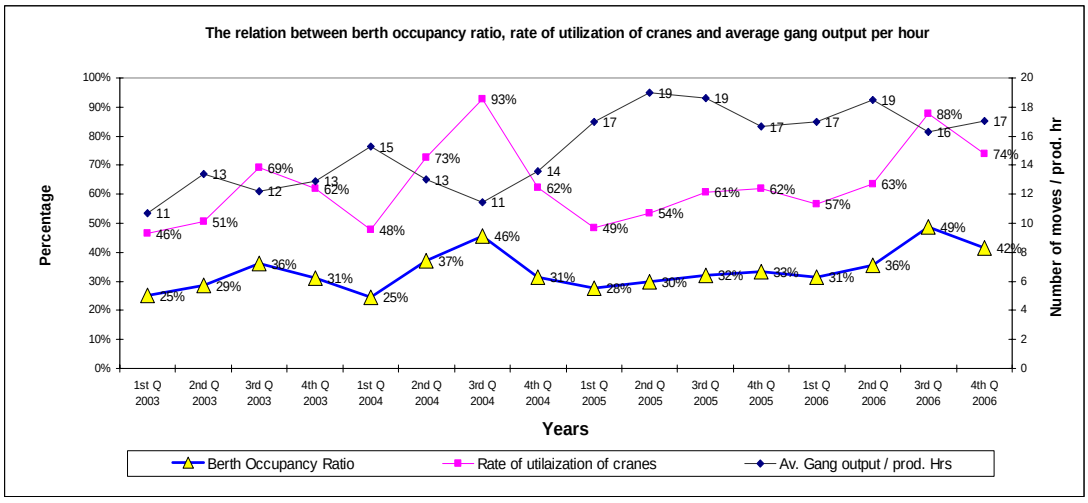


Figure 6 - The relation between berth occupancy ratio, rate of utilization of cranes and average gang output per hour.
Source: Author, derived from Elsokhna port raw data.

However, the average gang output per hour, which is nearly inversely proportional to the crane utilization rate, has remarkably increased from 11 moves per hour in the first quarter of 2003 to 17 moves per hour in the fourth quarter of 2006. Despite such increase in the gang output, the rate of improvement is still relatively low and highlights the need to improve productivity per gang in order to lower the crane utilization and to provide more windows for handling the expected increase in throughput if no more investment in cargo handling gears is done.

Moreover, the improvement in gang output per hour will not only increase the terminal throughput but will also enhance the ship output and reduce the ship total time in port.

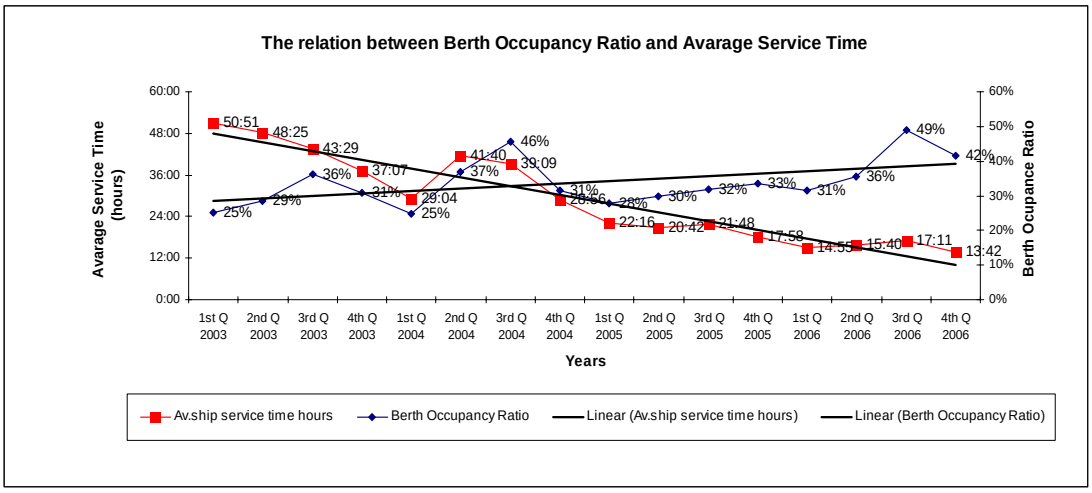


Figure 7 - The relation between berth occupancy ratio and average service time.
Source: Author, derived from Elsokhna port raw data.

Figure 7 also shows that the berth occupancy ratio is negatively correlated to the average service time. While the berth occupancy ratio was 25% in the first quarter of 2003 and the average service time was 51 hours, in the fourth quarter of 2006 the berth occupancy ratio was 42% and the average service time was around 17 hours.

The inverse relation between the berth occupancy ratio and the average service time reflects the proper and adequate utilisation of the berth and terminal equipment that reduced the idle time and service time accordingly. It allows the terminal to provide a consistent service to vessels and overwhelms the increasing number of vessels calling the port over the period of study. Nevertheless, the berth occupancy ratio is not only affected by the service time but also by the ship output.

5.7.4 Ship output indicators

Figure 8 presents the ships' output indicators expressed in moves per ship per productive hours (WSO), moves per ship at berth (BSO) and moves per ship in port (PSO). It shows that there was a strong correlation between the WSO, BSO as well as the PSO in the period between the first quarter of 2003 and the third quarter of 2004. It can also be noticed that there is a remarkable improvement in moves per ship per productive hour, per berth hours and per port hours started at the fourth quarter of 2004 which reflects the continuous improvement of the terminal productivity.

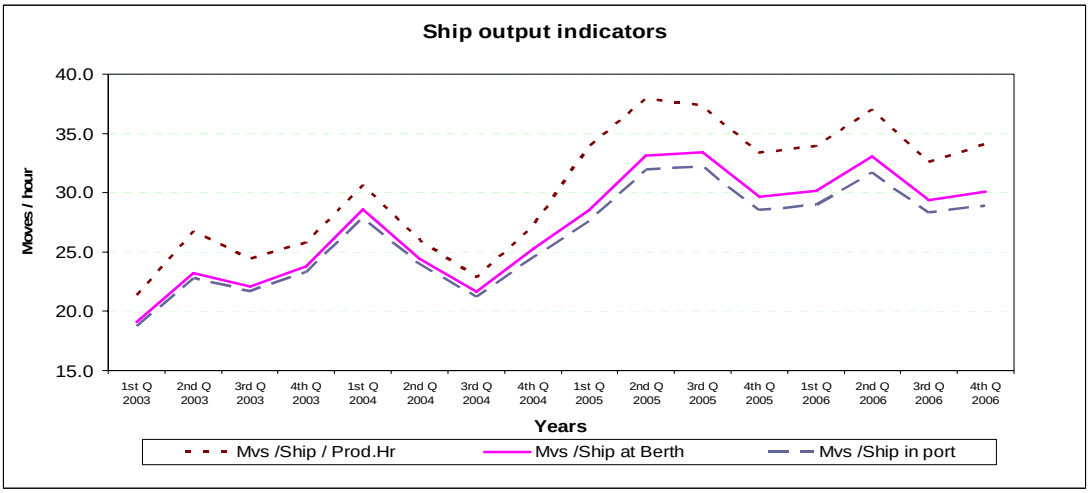


Figure 8 - Ship output indicators
Source: Author, derived from Elsokhna port raw data.

However, the productivity level at berth, starting from the fourth quarter of 2004, is noticeably increasing more than the moves per ship at berth and moves per ship in port. It reflects the need for more improvement in port procedures other than the ship handling process such as formalities and documentation process, lashing and unlashing operations and gate operation which are not improving at the same pace than the handling process.

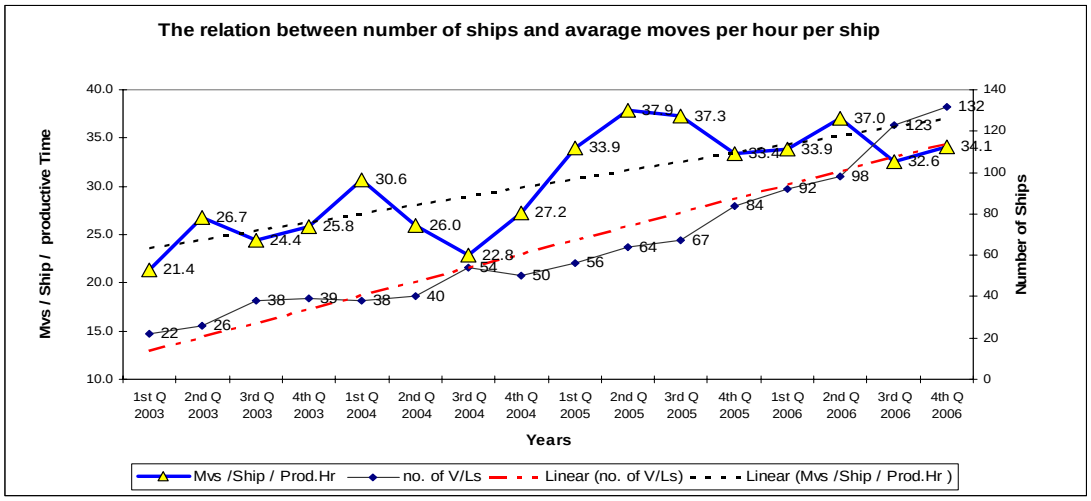


Figure 9 - The relation between number of ships and average moves per ship per productive hour (WSO).
Source: Author, derived from Elsokhna port raw data.

Figure 9 illustrates the relationship between the number of ships and the average moves per ship per productive hour (WSO). It indicates that the number of ships increased from 22 ships in the first quarter in 2003 to 132 ships in the fourth quarter of 2006 whereas, the average moves per ship per productive hour increased from 21 moves in the first quarter of 2003 to around 34 moves in the fourth quarter of 2006.

The average moves per ship per productive hour dramatically dropped to about 23 moves in the third quarter of 2004 while the number of ships increased to 54 ships in the same period. This was related to the increase of the berth occupancy ratio that reached 46% and the rate utilization of the cranes which reached 93% in the same period. In general, the increasing trend in the number of moves per ship per

productive hour reflects the effectiveness of quay operation but on the other hand, highlights the importance of enhancing crane productivity and the need for reducing the crane utilization and berth occupancy ratio in order to be able to meet the future demand.

5.8 Elsokhna Port competitiveness level

From the above assessment of the port performance it appears that the port performance is improving with regards to throughput over the study period. Moreover, the reasonable occupancy ratio which did not exceed 49% in the third quarter of 2006 shows the ability of the port to meet future demands.

On the other hand, the crane productivity need to be enhanced (it reaches a maximum 19 moves/hour, far from any global figure) and the crane utilization rate which can be easily performed by improving productivity per gang to be reduced. It also goes without saying that the pace in improvement in the ship handling process is going faster than the rest of port procedures, which could also be improved.

However, Elsokhna port has a consistent development of port operations, especially the improvement in container handling operations and the unique port location in the Red Sea with a minimum deviation (3 nm) from the main container routes. In order to minimize ships' turn-around time and to provide a reliable and efficient service for its customers the Port uses the state-of-the-art technology such as Electronic Data Interchange (EDI), SMS messaging to inform customers of the status of their cargoes and prompt messaging of cargo arrival and inspection times, Bar Codes to classify and distinguish files and folders, container scanning equipment to guarantee the security of cargoes and the port, electronic banking and GPS technology for container tracking (Abdelnour, 2005).

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Globalisation and containerisation are the major factors that have significantly affected the operational and organisational structure of ports. The horizontal and vertical integration between the different actors in the maritime industry as well as port privatisation have drastically magnified the competition between ports. Inter port competition for instance is no longer limited to competition between ports in the same range but also to other ports in different regions (Vaggelas, 2006).

The objective of this dissertation was to examine these issues and to offer an assessment of the competitiveness level of Elsokhna Container Terminal in Egypt. This led to examining firstly what factors should be considered and what methods are available to assess the level of port competitiveness and competition.

As explained in Chapter 2, competition between ports can be regarded as a fighting process in order to maintain or if possible, increase market share and to gain more customers. However, the meaning of port competition varies from one port user to another. While shipping lines select ports that have the optimum locations and facilities to accommodate their vessels and can offer efficient, reliable and high quality of services that can achieve the fastest turn-around time of ships in ports at the lowest costs, shippers are more interested in ports that provide reliable shipment information, consistent loss and damage performance and value added services in

relation to their cargoes. At the same time, from the port manager's perspective, the most important factors that determine the competitiveness level of a port are the port's throughput and market share as well as the port's physical condition (infra/superstructure) that can meet the customers requirements and enhance economies of scale.

A multitude of elements therefore determines the competitive position of a port. These factors are either qualitative such as reliability, quality and efficiency of port services or quantitative such as throughput, market share and ports' infra and superstructure. Nevertheless, the increasing trend towards the integration of supply chains has forced ports to compete not as individual firms but within supply chains as port users are no longer choosing a port for itself but rather a supply chain – a package of logistics services in which a port is just a node in such chains (Magala & Sammons, 2007).

Moreover, the generalization of new logistics concepts such as just-in-time (JIT) and value added logistics (VAL) which focus on the optimisation of prices, quality and customer service level that satisfy the customer's wants and needs, have also made some factors such as availability, reliability, quality and consistency of services provided by ports more significant than other factors like port location or even port tariffs (Marlow & Paixao, 2001).

That has in turn, intensified the competition between ports and induced port managers to continuously assess and analyze the competitiveness level of their ports. Such assessment and analysis can be carried out, as is illustrated in Chapter 3, by different tools and techniques such as the Multi Criteria Analysis (MCA), Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA), Strategic Positioning Analysis (SPA), port performance indicators and questionnaire.

Having discussed such methodologies, it appears that each of them is used for a specific purpose. For example, the multicriteria analysis (MCA) is used to help decision makers to evaluate the different stages of a particular project while the analytic hierarchy process (AHP) is mainly used to construct a hierarchy of competitors. The data envelopment analysis (DEA) is used as a benchmarking technique while the strategic positioning analysis (SPA) is more relevant when it comes to assessing the traffic structure and the competitiveness level of a port. Furthermore, port performance indicators are used to assess the performance of every operation inside the port and the effect of each operation on the overall performance of the port. Finally, the questionnaire is relevant to collect information or expert opinion on the competitiveness level of a port.

The choice of each method is therefore highly dependent on many vital factors such as the objectives of the assessment and analysis, the type of research (area of study), the budged limitation and the availability of information. Nevertheless, each of these methodologies has its advantages that can strengthen and enhance the accuracy and the reliability of the research but it also has its limitations and disadvantages that the researchers should keep in mind to avoid any deviation from the research goals and to minimize the risk of having any unrealistic results.

To illustrate these pros and cons, this dissertation offers an application to the container port industry in the east Mediterranean and the Middle East regions. The attractiveness of the container ports and terminals in this region has increased due to many reasons and notably their unique location which became trade centers and links between the east-west trade routes following the significant economic growth in the Far East and in particular China (Mediterranean container ports…, 2000).

Moreover, the consistent development in ports facilities, efficiency and services and the privatization of port industry, port operations in particular and the deployment of very large container vessels has encouraged the use of hub and spoke

system within the regions. It has resulted in large shipping lines choosing one or two hub ports in the regions in the process of optimizing their supply chain and to get the best benefits of economies of scale. That has in turn, intensified the competition between container ports in the defined market.

In order to analyse the competition level, the market has first to be defined. For example, as explained in Chapter 4, if Dubai and Jebel Ali in the Middle East or Gioia Tauro in the east Mediterranean are attractive ports for shipping lines, they are not directly competing with each other. Dubai and Jebel Ali are considered the market leader in the Middle East region, while Gioia Tauro is considered the main hub in the Mediterranean region.

Secondly, a distinction between port attractiveness and port competitiveness has to be made (Ng, 2006a). While Dubai and Jebel Ali are for instance leaders in the Middle East in terms of throughput, market share and infra and super structure, they encounter a severe competition from Khore Fakkan, Salalah and Jeddah in terms of port location and accessibility which are relatively closer to the main shipping routes. Similarly, although Gioia Tauro is the market leader in the east Mediterranean market in terms of throughput, market share and infra/superstructure, it faces a fierce competition from some ports like Marsaxlokk, Damietta and in particular SCCT in terms of port location and accessibility. It explains the drop in Gioia Tauro's throughput and market share since the inauguration of SCCT.

Chapter 5 analyses the efficiency of ports using DEA technique, and stresses that the high efficiency of ports like Dubai (including Jebel Ali), Salalah, Marsaxlokk, Gioia Tauro and Khore Fakkan also induces that these ports have reached their maximum capacity and that an urgent need for investment in new facilities to overwhelm the potential congestion exists. It explains why such ports are recently heavily investing in new infra and superstructure.

In contrast, if other ports like Jeddah, Elsokhna, Piraeus and SCCT are considered relatively less efficient, it also underlines that the facilities of such ports are still under capacity and there is still a room for these ports to attract new customers and increase their throughput without new investments. However, these ports are still investing in new facilities to be able to encounter the dynamic characteristics and the increased competition among ports in the market.

At the same time, the benchmarking analysis, or DEA emphasized only on technical factors rather than other influential elements that should be considered when assessing the efficiency of ports such as the human element (laborers), the port management and operation systems, the usage of IT and the future plans of the ports. This leads to the development of a detailed analysis of Elsokhna Port to show that a number of factors could provide a competitive advantage to this port.

The competitive advantage of Elsokhna Port is recognized, for example, in the usage of a fully computerized terminal handling and planning system for all key clients for which vessels, shipping lines and port processes are fully automated and integrated into Elsokhna information technology systems. The port is also providing added value in terms of cargo inspection thanks to internationally approved laboratories located at the port which provide one-stop-shop for testing the safety and quality of imported and exported cargoes in general, and food products in particular. It allows the port to offer a rapid clearance and delivery of cargoes, quick documentation process and reasonable tariff policy.

Furthermore, Elsokhna Port dwell time average is matching the international standard with three days on average. On the other hand, the availability of trucks, combined with suitable on site railway links allows the port achieving maximum cost efficiency and improving the speed of container handling. As a result of providing an efficient service, the logistics cost, especially of manufactured products, has been reduced to 8% at Elsokhna Port compared to 30% in traditional regional ports. This

has put the port as an attractive option for container lines seeking a reliable and cost effective service in such a market (Sokhna Port, 2006).

6.2 Recommendations

In order to survive and prosper in such a fierce competition and challenging environment, port managers and terminal operators in the east Mediterranean and Middle East container market should continuously assess their internal (strengths and weaknesses) and external environments (opportunities and threats).

From the internal perspective, port operators should efficiently utilise their existing facilities to their maximum economic and technical efficiency, to optimise their customers' service level and to plan for future investment in an ample time. Moreover, in order to achieve the planned productivity and the required efficiency, port managers and terminal operators should pay a great attention to IT and EDI developments. The former gives ports the opportunity for instance to minimize the queuing time in port and to plan vessels' schedule in a more efficient way while the latter enhances the communications between terminals and customers (Francesetti, 2004).

To enhance port reliability and service provided to customers, ports should also establish quality systems such as ISO 9002 and ISO 14000. It includes the design and the implementation of procedures that match the port's needs in the most efficient and cost effective way. A particular attention should also be given to the ports human resources. Ports should establish systems that provide a consistent training and development program for their laborers and employees.

From the external perspective, port managers and operators need to adapt to the uncertainty of the customers demand. Therefore, they have to pay significant attention to the marketing of their facilities and services and at the same time offer value added services that enhance and develop the whole supply chain and attract

new customers. However, in the short term, ports can attract new customers by reducing the port tariffs while in the long run, ports have to monitor and recover their costs specially those related to investments. Therefore, ports need to be productively efficient (Wang & Cullinane, 2006).

In general, ports and terminals of the 21st century should be customer oriented ports and provide reliable and efficient services. In order to maintain and enhance their competitive positions, port managers should identify and promote their core competencies. It can be achieved by consolidating the ports facility and resources into competencies that enhance the ports flexibility and enable them to strengthen their weaknesses and change their threats into opportunities (Haezendonck & Notteboom, 2002).

REFERENCES

Abdelnour, J. (2004). *Development of the new port of Elsokhna.* Retrieved February 6, 2007, from the World Wide Web: http://strategis.ic.gc.ca/epic/site/imr-ri.nsf/en/gr123342e.html

Anderson, T. (1996). *A Data Envelopment Analysis (DEA) Home page*. Retrieved June 19, 2007, from the World Wide Web: http://www.etm.pdx.edu/dea/homedea.html

Barros, C. P. (2006). A benchmark analysis of Italian seaports using Data Envelopment Analysis. *Maritime Economics & Logistics, 8* (4), 347-365.

Beddow, M. (2006, November). Eastern delights. *Containerisation International Regional Review: Italy & Eastern Med.*, 3-5.

Burgess, T. (2001). A *general introduction to the design of the questionnaire for survey research: Questionnaire design*. Retrieved July 2, 2007, from the World Wide Web: http://www.leeds.ac.uk/iss/documentation/top/top2.pdf

Canamero, C. (2007). *Strategic port pricing*. Unpublished lecture handout, World Maritime University, Malmö, Sweden.

Cariou, P. (2006). *Port management: What are the elements to consider?* Unpublished lecture handout, World Maritime University, Malmö, Sweden.

Cariou, P. (2007a). *Port economics II – port competition.* Unpublished lecture handout, World Maritime University, Malmö, Sweden.

Cariou, P. (2007b). *Port performance indicators and analysis.* Unpublished lecture handout, World Maritime University, Malmö, Sweden.

Creative Research Systems. (2006). *the survey system*. Retrieved July 1, 2007, from the World Wide Web: http://www.surveysystem.com/sdesign.htm

Degerlund, J. (Ed.) (2007). *Containerisation international year book, 2007*. London: Informa. UK.

Drewry Shipping Consultants (2000). *Mediterranean container ports and shipping: Traffic growth versus terminal expansion – An impossible balancing act?* (2000). London: Author

Dubai intent on increasing its strength. (2006, October 24). *Lloyd's List.* Retrieved March 17, 2007, from the World Wide Web: www.lloydslist.com.

Egypt Government. (2003). *Elsokhna port: Egyptian maritime data bank*. Retrieved February 3, 2007, from: the World Wide Web: http://www.emdb.gov.eg/english/insidee.aspx?main=ports&level1=commercial&level2=elsokhna&level3=specification

Egypt map. (2005). Retrieved June 14, 2007, from the World Wide Web: www.mapsofworld.com/indexmaps/egypt.jpg

Elsokhna port. (2004). Retrieved June 14, 2007, from the World Wide Web: http://images.google.com/images?q=%22el+sokhna+port%22&gbv=2&ndsp=20&svnum=10&hl=en&start=0&sa=N

Forman, E.H. & Gass, S.I. (2001). The Analytic Hierarchy Process – An Exposition. Retrieved June 15, 2007, from the World Wide Web: http://links.jstor.org/sici?sici=0030364X(200107%2F08)49%3A4%3C469%3ATAHPAE%3E2.0.CO%3B2-9

Fossey, J. (2005, November). Racing ahead. *Containerisation International Regional Review: Mid-East*, 13.

Francesetti, D.C. (2004). The success or failure of the Mediterranean ports is influenced by the logistic/intermodal services. In *Proceedings of IAME, The International Association of Maritime Economists Annual Conference IZMIR'04: Vol.2* (pp.1198-1207). Izmir, Turkey: Dokuz Eylul University.

Francesetti, D.C., & Danila, F.A. (2001). Shipping companies strategies and Mediterranean ports competitiveness. In P*roceeding of IAME, The International Association of Maritime Economists Annual Conference, Hong Kong, 200.* (pp.314-332). Hong Kong: Hong Kong Polytechnic University. Dept. of Shipping & Transport Logistics.

Georgia Tech. College of Computing (2007). *Questionnaire design.* Retrieved July 1, 2007, from the World Wide Web: http://www.cc.gatech.edu/classes/cs675197winter/Topics/quest-design/

Google Images (2006). *Elsokhna port.* Retrieved February 22, 2007, from the World Wide Web: www.mts.gov.eg/english/inside_e.aspx?maininvestment&level1=investport&level2=redsea&level3=sokhna

Guy, E. & Urli, B. (2006). Port selection and multicriteria analysis: An application to the Montreal-New York alternative. *Maritime Economics & Logistics, 8* (2), 169-186.

Haezendonck, E. & Notteboom, T. (2002). The competitive advantage of seaports. In W. Winkelmans (Ed.), *Port competitiveness* (pp. 17-31). Antwerp: University of Antwerp.

Haezendonck, E., & Winkelmans, W. (2001). Strategic positioning as an instrument for competition analysis. In W. Winkelmans (Ed.), *Port competitiveness: An economic and legal analysis of the factors determining the competitiveness of seaports* (pp.17-33). Antwerp: University of Antwerp.

Haezendonck, E., Coeck, C., & Verbeke, A. (2002). Green port portfolio: A basis for substantial strategic decisions in port policy and management. In *Proceedings of IAME Panama 2002 conference, Panama City.* Retrieved July 3, 2007, from the World Wide Web: http://www.eclac.cl/transporte/perfil/iamepapers/proceeding /Haezendoncketal.doc

Heideloff, C. & Zachcial, M. (Eds.) (2006). *Shipping statistics yearbook, 2006*. Bremen: Institute of Shipping Economic and Logistics (ISL).

Higher imports drive volumes at Saudi ports. (2006, October 24). *Lloyd's List.* Retrieved March 17, 2007, from the World Wide Web: www.lloydslist.com.

Lirn, T., Thanopoulou, H., Beynon, M. & Beresford, A. (2004). An application of AHP on transhipment port selection: A global perspective. *Maritime Economics & Logistics, 6* (1), 70-91.

Llmer, M. (2005). Enhancing container terminal productivity: A co-maker approach between carriers and operators. *Port Technology International,* (pp.117–119). London: Henley Media Group

Lloyd's Register-Fairplay, (2007). Distance tables. *Fairplay world shipping encyclopedia* [electronic source]. Coulsdon Surrey, UK: Author.

Lombaerde, P.D., & Verbeke, A. (2002). Assessing international seaport competition: A tool for strategic decision making. In M. Brooks, K. Button, & P. Nijkamp (Eds.), *Maritime transport* (pp. 530-548). UK, Northampton: Edward Elgar Publishing.

Lu, C. & Marlow, P. (1999). Strategic groups in Taiwanese liner shipping. *Maritime Policy and Management, 26* (1), 1-26.

Ma, S. (2006). *Maritime economics*. Unpublished lecture handout, World Maritime University, Malmö, Sweden.

Maersk helps SCCT to capture market share. (2006, October 24). *Lloyd's List.* Retrieved March 17, 2007, from the World Wide Web: www.lloydslist.com.

Magala, M., & Sammons, A. (2007). A new approach to port choice modelling. In Proceeding *of IAME, the International Association of Maritime Economists, July 4-6, 2007, Athens, Greece.* Athens, Greece: IAME.

Mapsofworld.com (2005). *Map of Egypt*. (2005). Retrieved June 14, 2007, from the World Wide Web: www.mapsofworld.com/indexmaps/egypt.jpg

Marlow, P.B. & Paixao, A.C. (2001). Agility, a key enabler in port competition. In proceeding *of IAME, the International Association of Maritime Economists Annual Conference* (pp. 102-114) Hong Kong: Polytechnic university.Dept. of shipping and transport logistics.

Meersman, H., & Voorde, E.-V. (2002). Port management, operation & competition: A focus on North Europe. In C. Grammenos (Ed.), *The handbook of maritime economics and business* (pp.765-781). London, Hong Kong: Informa Professional.

National Economic Research Associates (NERA) (2000). DTLR multi-criteria analysis manual. Retrieved June 16, 2007, from the World Wide Web: http://www.communities.gov.uk/pub/252/MulticriteriaanalysismanualPDF1380Kb_id1142252.pdf

Ng, K.Y. (2006a). Assessing the attractiveness of ports in the North European Container Transhipment Market: An Agenda for Future Research in port competition. *Maritime Economics & Logistics, 8* (3) 234-250.

Ng, K.Y. (2006b). *Theory and structure of port competition: A case study of container transhipment in North Europe.* Unpublished Ph.D. thesis, University of Oxford, Oxford, UK.

Nir, A-S., Lin, K., & Liang, G-S. (2003). Port choice behaviour-from the perspective of the shipper. *Maritime Policy and Management, 30* (2), 165-173.

Notteboom, T.-E. (2004). Container shipping and ports: An overview. *Review of Network Economics, 3,* (2), 86-106.

QuickMBA.com. (2007). Marketing: Questionnaire design. Retrieved July 1, 2007, from the World Wide Web: http://www.quickmba.com/marketing/research/qdesign/

Rios, L. R., & Macada, A. C. G. (2006). Analysing the relative efficiency of container terminals of Mercosur using DEA. *Maritime Economics & Logistics, 8* (4), 331-346.

Rojas, L., & Serpa, F. (2007). *Questionnaire design: An introduction.* Retrieved July 1, 2007, from the World Wide Web: http://www.pitt.edu/~super1/lecture/lec0971/001.htm

Schinas, O. D. (2005). *Application of multicriteria decision making techniques in finance: The case of the Greek coastal shipping companies.* Unpublished Ph.D. thesis, National Technical university of Athens, Athens, Greece.

Sokhna port. (2006). *Rapid clearance and distribution.* Retrieved May 27, 2007, from the World Wide Web: http://www.spdc.com/home.php?go=locating/competitive.php

Song, D.W. (2003). Port co-opetition in concept and practice. *Maritime Policy and Management, 30* (1), 29-44.

Song, D.W., & Yeo, K.T. (2004). A competitive analysis of Chinese container ports using the analytic hierarchy process. *Maritime Economics & Logistics, 6*(1), 34-52.

Stenvert, R., & Penfold, A. (2004). *Marketing of container terminals*. Chertsey, Surrey: Ocean Shipping Consultants.

Tavistock Institute (2003). *Evaluating socio-economic development source book 2: Methods & techniques: Multicriteria analysis*. Guide developed for the European Commission. Retrieved June 17, 2007, from the World Wide Web: http://www.evalsed.info/downloads/sb2multicriteriaanalysis.doc

Traffic growth lifts Sokhna's standing in Red Sea region. (2006, October 24). *Lloyd's List.* Retrieved February 5, 2007, from the World Wide Web: www.lloydslist.com

Trochim, W.M.K. (2006). *Research methods: Knowledge base*. Retrieved June 30, 2007, from the World Wide Web: http://www.socialresearchmethods.net/kb/survtype.php

UNCTAD, (1990). *Improving port performance: Port equipment policy, management and maintenance: IPP-3 -- A seminar for policy-makers.* Geneva: Author.

UNCTAD, (1992). *Port marketing and the challenge of the third generation port*. Geneva: Author.

UNCTAD. (1976). *Port performance indicators*. Geneva: United Nations.

UNCTAD. (1987). *Measuring and evaluating port performance and productivity*, (UNCTAD monographs on port management, No.6). Geneva: UNCTAD.

UNCTAD. (1990). *Port equipment: Policy, management and maintenance*: *IPP-3, A seminar for policy-makers.* New York: United Nations.

United Nations Conference on Trade and Development [UNCTAD] (1973). *Berth throughput: Systematic methods for improving general cargo operations*. Geneva: Author.

Vaggelas, G. K. (2006). *Identifying public and private benefits from port services provision.* Paper Presented at the International Conference International Conference "Shipping in the Era of Social Responsibility, in Honour of the Late Professor Basil Metaxas (1925-1996), 14-16 September 2006, Argostoli, Cephalonia, Greece. Retrieved June 15, 2007, from the World Wide Web: http://www.stt.aegean.gr/metaxasconf/ Publications/3.4-Vaggelas.pdf

Voorde, E.-V., & Winkelmans, W. (2001). A general introduction to port competition and management. In W. Winkelmans (Ed.), *Port competitiveness* (pp.1-13). Antwerp: University of Antwerp.

Walonick, D. S. (2007). Everything you want to know about questionnaires but were afraid to ask. Retrieved June 23, 2007, from the World Wide Web: http://www.statpac.com/research-papers/questionnaires.htm

Wang, T. F., & Cullinane, K. (2006). The efficiency of European container terminals and implications for supply chain management. *Maritime Economics & Logistics*, *8*(1), 82-99.

Wang, T.F. (2004). *Analysis of the container port industry using efficiency measurement* [electronic resource]: *a comparison of China with its international counterparts.* Unpublished Ph.D. thesis, Hong Kong Polytechnic University, Dept. of Industrial and Systems Engineering, Hong Kong.

Wang, T-F., & Cullinane, K., & Song, D.W. (2005). *Container port production and economic efficiency*. New York, Palgrave Macmillan.

Wester, P. (2006). Questionnaires. Retrieved June 30, 2007, from the World Wide Web: http://www.bio.uu.nl/~biostat/QuestionnairesBW2006.ppt#317,1, Questionnaires

Winkelmans, W. (2003). *Port Competitiveness and port competition: Two of a kind?* Paper presented at the IAPH conference, Durban, May 2003. Retrieved January 27, 2007, from the World Wide Web:

http://www.npa.co.za/PDF%20Documents/IAPH%20Speaker%20Papers/Tuesday%2027%20May%2003/Port%20competitiveness%20and%20competition-paper_Winkelmans.doc

Woodbridge, C. (2005a, December). Building up Oman. *Containerisation International Regional Review: Middle-East,* 19-20.

Woodbridge, C. (2005b, December). Dubai deluge. *Containerisation International Regional Review: Middle-East,* 14-17.

Woodbridge, C. (2005c, December). Return of the Jeddah. *Containerisation International Regional Review: Mid-East,* 10-13.

Woodbridge, C. (2005d, November). Mixed fortunes for Med hubs. *Containerisation International Regional Review: Mid-East,* 3-7.

Woodbridge, C. (2006a, November). Foreign affairs. *Containerisation International Regional Review: Italy & Eastern Med,* 19-20.

Woodbridge, C. (2006b, November). The road to recovery. *Containerisation International Regional Review: Italy & Eastern Med,* 12-15.

Woodbridge, C. (2006c). *Dynamic region where shipping can thrive*. Retrieved March 17, 2007 from the World Wide Web: www.lloydslist.com/art/1161572221747

World Bank (2001). *Port reform tool kit: Module 3: Alternative port management structure and owner ship models*. Washington DC: World Bank/IBRC.

Zhu, J. (2003). *Quantitative models for performance evaluation and benchmarking: Data Envelopment Analysis with spreadsheets* (International series in operations research & management science, Vol.51). Dordrecht; Boston: Kluwer Academic Publishers.

APPENDICES

Appendix A - Assumptions used for assessing Elsokhna container terminal performance.

Missing data	Assumption
Waiting time	No waiting time is considered as per port information that they use window system with nearly zero WT.
Maneuvering time	According to the port information MT varies between 25 to 30 minutes. Consequently assumption is considered to be 30 min. MT for each arrival and departure.
Cargo handling idle time	Calculation was made with assumption of no idle time within cargo operations based on the new condition of the handling equipments which does not exceed 4 years old.
No. of gantries / VL	Assumed that cargo operation was handled all the time by 2 gantries with equal productivity.
Ships LOA	Extracted from Fair play data base by using the ships' name.
50% Ships' LOA	216.45 m was considered to all missing data based on the average LOA ships represents 50% of the data given.
Periods of study	Assumed that each month equal 30 days and each year divided into 4 quarters each equal 90 days.

Missing data	Assumption
Operational time	DUE to unknown operational time for 42.6% of ships given, we assumed that the missing time is equal the total number of moves of ship divided by the average time of known data. Ex. The missing turn-around time is calculated by dividing the total moves of the ship by the average moves per ship per hour in port. (Total number of moves divided by the total time in port for the whole data given). This average is calculated on yearly bases in order to have as accurate average as possible for each period of time. Consequently, the same process is made to calculate the service time and productive time.

Source: Author, derived from Elsokhna port raw data.

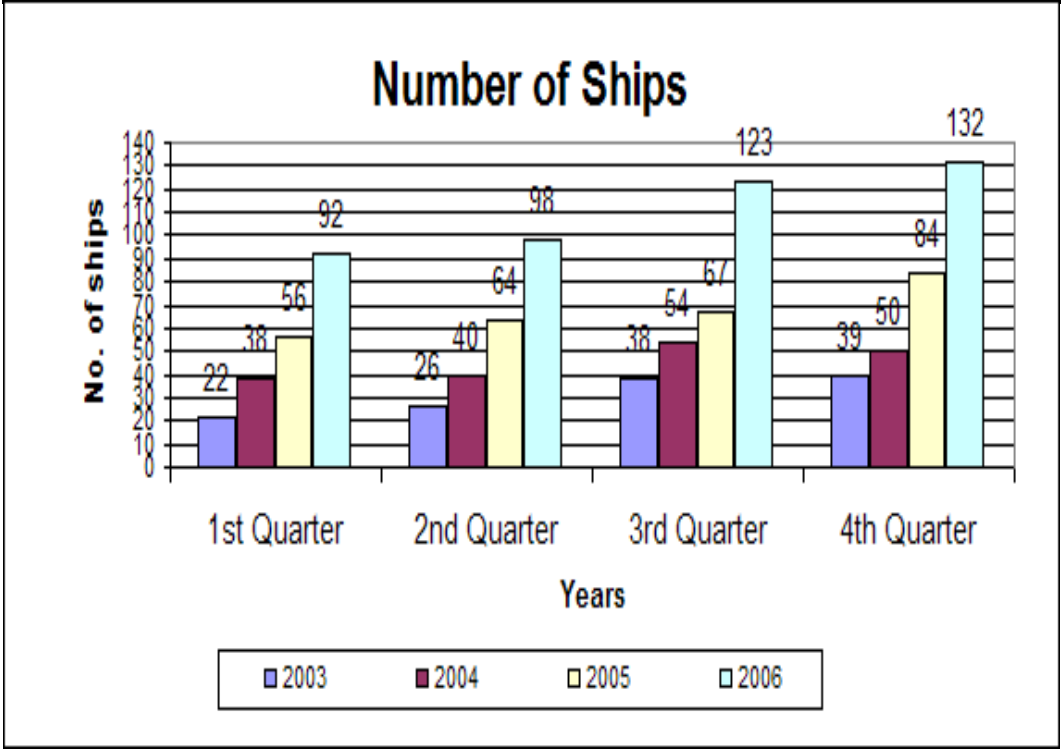
Appendix B - Elsokhna port performance indicators

Duration	Berth meter X Service hours	Gangs X Service hours	Gangs X Productive hours
1st Quarter 2003	245634	93	84
2nd quarter2003	278031	105	91
3rd Quarter 2003	350446	138	124
4th Quarter 2003	301307	121	111
1st Quarter 2004	239704	92	86
2nd Quarter 2004	359154	139	131
3rd Quarter 2004	443798	176	167
4th Quarter 2004	305104	121	112
1st Quarter 2005	269788	104	87
2nd Quarter 2005	288921	110	96
3rd Quarter 2005	310699	122	109
4th Quarter 2005	324992	126	112
1st Quarter 2006	304858	114	102
2nd Quarter 2006	345962	128	114
3rd Quarter 2006	474251	175	158
4th Quarter 2006	403697	151	133

Source: Author, derived from Elsokhna port raw data.

Appendix C - Number of vessels calling Elsokhna terminal (2003:2006)

Number of Vessels				
Year	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
2003	22	26	38	39
2004	38	40	54	50
2005	56	64	67	84
2006	92	98	123	132



Source: Author, derived from Elsokhna port raw data.

Appendix D - Elsokhna container terminal - Total time in port indicators

Duration	No. of V/Ls	Total turn-around Time	Total service time	Total productive time	Total Idle time	Total Moves
1st Quarter 2003	22	1140:53	1118:53	1002:29	116:24	21412
2nd Quarter2003	26	1285:01	1259:01	1094:31	164:30	29260
3rd Quarter 2003	38	1680:17	1652:35	1491:33	161:01	36441
4th Quarter 2003	39	1477:24	1447:35	1335:06	112:29	34441
1st Quarter 2004	38	1131:59	1104:45	1031:18	73:26	31576
2nd Quarter 2004	40	1698:12	1667:01	1566:43	100:17	40705
3rd Quarter 2004	54	2158:48	2114:34	2004:35	109:58	45766
4th Quarter 2004	50	1485:44	1446:44	1342:43	104:00	36522
1st Quarter 2005	56	1289:17	1246:58	1048:03	198:55	35559
2nd Quarter 2005	64	1373:34	1324:48	1156:25	168:23	43857
3rd Quarter 2005	67	1515:18	1460:52	1308:55	151:56	48792
4th Quarter 2005	84	1568:27	1509:51	1340:28	169:22	44736
1st Quarter 2006	92	1430:57	1372:49	1220:44	152:04	41396
2nd Quarter 2006	98	1599:53	1536:34	1371:22	165:11	50755
3rd Quarter 2006	122	2174:12	2098:10	1892:18	205:52	61631
4th Quarter 2006	132	1884:15	1810:06	1598:08	211:58	54458

Source: Author, derived from Elsokhna port raw data.

Appendix E - Elsokhna container terminal - Average time in port

Time in port indicators									
year	**Duration**	**No. of V/Ls**	**Av.ship turn-around time hours**	**Av.ship service time hours**	**Av.ship productive time hours**	**Av.ship Idle time hours**	**Av.No. of moves per V/L**	**Idle time ratio**	**Daily working time ratio**
2003	1st Quarter 2003	22	51:51	50:51	45:34	5:17	973	10%	46%
2003	2nd Quarter 2003	26	49:25	48:25	42:05	6:19	1125	13%	51%
2003	3rd Quarter 2003	38	44:13	43:29	39:15	4:14	959	10%	69%
2003	4th Quarter 2003	39	37:52	37:07	34:14	2:53	883	8%	62%
2004	1st Quarter 2004	38	29:47	29:04	27:08	1:55	831	7%	48%
2004	2nd Quarter 2004	40	42:27	41:40	39:10	2:30	1018	6%	73%
2004	3rd Quarter 2004	54	39:58	39:09	37:07	2:02	848	5%	93%
2004	4th Quarter 2004	50	29:42	28:56	26:51	2:04	730	7%	62%
2005	1st Quarter 2005	56	23:01	22:16	18:42	3:33	635	16%	49%
2005	2nd Quarter 2005	64	21:27	20:42	18:04	2:37	685	13%	54%
2005	3rd Quarter 2005	67	22:36	21:48	19:32	2:16	728	10%	61%
2005	4th Quarter 2005	84	18:40	17:58	15:57	2:00	533	11%	62%
2006	1st Quarter 2006	92	15:33	14:55	13:16	1:39	450	11%	57%
2006	2nd Quarter 2006	98	16:19	15:40	13:59	1:41	518	11%	63%
2006	3rd Quarter 2006	123	17:49	17:11	15:30	1:41	505	10%	88%
2006	4th Quarter 2006	132	14:16	13:42	12:06	1:36	413	12%	74%

Source: Author, derived from Elsokhna port raw data.

Appendix F - Elsokhna container terminal - Berth and cranes output indicators

Year	Duration	No. of V/Ls	Berth indicators		Crane output		
			Productive ratio	Berth Occupancy ratio	Rate of utilization of cranes	Av. Gang output / prod. Hrs	Av. Gang output / service. Hrs
2003	1st Quarter 2003	22	90%	25%	46%	11	10
2003	2nd Quarter 2003	26	87%	29%	51%	13	12
2003	3rd Quarter 2003	38	90%	36%	69%	12	11
2003	4th Quarter 2003	39	92%	31%	62%	13	12
2004	1st Quarter 2004	38	93%	25%	48%	15	14
2004	2nd Quarter 2004	40	94%	37%	73%	13	12
2004	3rd Quarter 2004	54	95%	46%	93%	11	11
2004	4th Quarter 2004	50	93%	31%	62%	14	13
2005	1st Quarter 2005	56	84%	28%	49%	17	14
2005	2nd Quarter 2005	64	87%	30%	54%	19	17
2005	3rd Quarter 2005	67	90%	32%	61%	19	17
2005	4th Quarter 2005	84	89%	33%	62%	17	15
2006	1st Quarter 2006	92	89%	31%	57%	17	15
2006	2nd Quarter 2006	98	89%	36%	63%	19	17
2006	3rd Quarter 2006	123	90%	49%	88%	16	15
2006	4th Quarter 2006	132	88%	42%	74%	17	15

Source: Author, derived from Elsokhna port raw data.

Appendix G - Elsokhna container terminal - ships' output indicators

Year	Duration	No. of V/Ls	Ship output		
			Mvs /Ship / Prod. hour WSO	Mvs /Ship at Berth BSO	Mvs /Ship in port PSO
2003	1st Quarter 2003	22	21.4	19.1	18.8
2003	2nd Quarter 2003	26	26.7	23.2	22.8
2003	3rd Quarter 2003	38	24.4	22.1	21.7
2003	4th Quarter 2003	39	25.8	23.8	23.3
2004	1st Quarter 2004	38	30.6	28.6	27.9
2004	2nd Quarter 2004	40	26.0	24.4	24.0
2004	3rd Quarter 2004	54	22.8	21.6	21.2
2004	4th Quarter 2004	50	27.2	25.2	24.6
2005	1st Quarter 2005	56	33.9	28.5	27.6
2005	2nd Quarter 2005	64	37.9	33.1	31.9
2005	3rd Quarter 2005	67	37.3	33.4	32.2
2005	4th Quarter 2005	84	33.4	29.6	28.5
2006	1st Quarter 2006	92	33.9	30.2	28.9
2006	2nd Quarter 2006	98	37.0	33.0	31.7
2006	3rd Quarter 2006	123	32.6	29.4	28.3
2006	4th Quarter 2006	132	34.1	30.1	28.9

Source: Author, derived from Elsokhna port raw data.