The next generation of container ships "Malacca-max" and alternative patterns of operation

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THE NEXT GENERATION OF CONTAINER SHIPS "MALACCA-MAX" AND ALTERNATIVE PATTERNS OF OPERATION

By

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DECLARATION

I certify that all material 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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………August 2000

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ABSTRACT

Title of Dissertation: **The Next Generation of Container Ships Malacca-Max and Alternative Patterns of Operation**

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The transport industry has forever pivoted around the well-known concept of economies of scale given the size of the capital involved and the necessity to minimise, as much as possible, the unit cost. The dissertation is a study of the effect of the growing size of container ships, namely the Malacca-max, by comparing the results of operation as mentioned in previous studies with those obtained in this study when applying a different operational pattern.

The approach started with a glance at the growth of the container trade through the evolution of world trade, then the potential of container trade, present routes and related operational patterns. The economies of scale are examined by looking at the capacity of present container ships and how the largest ship has almost doubled in size compared to the first post Panamax ship from twelve years ago. In addition, how container operator companies have joined to achieve bigger and bigger volumes is considered and the future development in containerisation is presented. The challenges that exist are discussed, in particular the deep draft of such a large ship. Alternative solutions to the dredging of the Suez Canal are introduced in the light of the use of the new ports under construction in Egypt. Likewise the use of a suggested land bridge is part of the solution.

The conclusion is based on the comparison of cost and time with the original study, alonge with a sensitivity analysis and transhipment comparison. The suggested solutions are found comparable with those in the original study. A number of suitable recommendations are made connected with the solutions.

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LIST OF ABBREVIATIONS

AD	Anno Domini, in the year of (our) Lord (used for dates in the Christian era as opposed to BC)
APL	American President Lines
ASK	North Al-Sokhna Port
Av.	Average
B	Beam
BC	Before Christ
BOT	Build Operate and Transfer
Cap.	Capacity
CEO	Chief Executive Officer
Cont.	Container
Cw	Coefficient of fineness
d	Day
D.	Diameter
D. Weight or DWT	Dead-Weight
Displac.	Displacement
E	East
E. Asia	East Asia
e.g.	exempli gratia, for example
ECHCO	Egyptian Container Handling Company
ECT	Europe Combined Terminals
F.O	Fuel Oil
FEU	Forty foot Equivalent Unit
GDP	Gross Domestic Product
GM	Meta-centric Height
GT	Gross Tonnage
Hr. or Hrs.	Hour or Hours

i.e.	id est, that is
ISO	International Standardization Organization
Km	Kilometer
Kn.	Knots
Kw	Kilo Watt
L. America	Latin America
LBP	Length Between Perpendiculars
LOA	Length Over All
Lwl	Length at Water Level
M	Million
m.	Meters
M. East	Middle East
MCR	Maximum Continuous Rating.
M.D.O	Marine Diesel Oil
Max	Maximum
Med.	Mediterranean
N. America	North America
N. Europe	North Europe
NCB	Negev Continental Bridge
Nr.	Number
NT	Net Tonnage
O/DK	On Deck
PPT	Pasir Panjang Terminal
PSD	East Port Said Port
Rdm	Rotterdam
RTW	Round The World
S. Asia	South Asia
SCA	Suez Canal Authority
SCNT	Suez Canal Net Tonnage
SDR	Special Drawing Right

Sng	Singapore
SPDC	North Al-Sokhna Port Development Company
SSA	Stevedoring Services of America
SUMED	Suez-Mediterranean pipelines company
t. Or T.	Tones
TCE	Time Charter Equivalent
TEU	Twenty foot Equivalent Unit
TPC	Tons Per Centimeter
U/DK	Under Deck
US$ or $	United States Dollar
USA	United States of America
VLCC	Very Large Crude Carrier
W	West
WPA	Water Plan Area

Chapter 1

INTRODUCTION

The growth in container ships size so far has been unlimited. Recently a Dutch professor and student team introduced a design of a container ship that carries 18000 boxes (more than twice the capacity of present vessels), the draft of which will be 21 meters when fully laden. The ship is named Malacca-max, after the Malacca strait which is the third natural water barrier for ships (after the Panama and Suez Canals). The ship will not be able to transit the Suez Canal with this draft.

Mega carriers usually operate between the two markets of Europe and the Far East, thus transiting the Suez Canal is essential for them, However, there are some restrictions with regard to the draft and beam of vessels. The limitation of container ships size has not been realised yet, but is foreseen to take place in the near future, therefore the search for alternatives is a necessity.

Finding alternatives will have an impact on the present known operational patterns, whereas container-trading markets will remain the same. The growth in the container trade encourages the upsizing of ships whereby economies of scale play a major role. The costs can be minimised and a bigger market share is achieved, especially for global players and alliances.

Based on the study made by the Dutch professor, a giant ship will not be able to pass the Suez Canal unless the Canal is dredged since the maximum permissible draft is 17.6 meters.

This paper presents suggested solutions to enable the ship to transit the Suez Canal. The solutions include introduction of different operational patterns through the use of new ports under construction in Egypt at both ends of the Suez Canal. By using Egypt's ideal location in the middle of main sea transport stream, no deviation will be required by ships from their main route. An impact on Egypt's national economy will be expected and also on the industry through the use of larger ships.

One of the suggested solutions is a land bridge in Egypt linking the Mediterranean to the Red Sea, through the use of multimodal transport. A similar solution for VLCCs, which have a draft and beam restriction to pass the Suez Canal was introduced by the SUMED company for pipelines, where crude oil or products are transferred from the Red Sea to the Mediterranean sea by means of pipe lines.

A cost analysis will be presented, and the best solution recommended.

The reason behind the selection of this topic stems from the vitality of the issue for Egypt as revenue from the Suez canal accounts for a big percentage of Egypt's total GDP and anything that affects it will pose a direct threat to the national economy.

Chapter 2

GROWTH IN CONTAINER TRADE

2.1 Evolution in world trade

World trade has grown more rapidly than world production since World War II. Due to the continuous diminishing of trade barriers in recent years such trade has been accelerating. In addition, the development in technology, communications and transport has continued this acceleration.

Barriers are known to be natural and artificial, the latter is concerned with trade policy matters and the natural barriers are related to the trade transaction process, in particular transport.

The formation of a global integrated market place is the result of the development of transport technology that has led to cost reductions and improved productivity. Ever since this improvement in transport began the world trade kept growing steadily.

The impact of new transport techniques and specialised shipping has been significant on world trade. In liner shipping, containerisation was introduced offering transport quality and faster transit times.

World trade has almost consistently outpaced the world GDP on account of the globalisation of trade on the one hand and a significant reduction in the cost of transportation and communication on the other. The carrying capacity of the world merchant fleet has increased with world trade, with more than 95% of world transportation being ship-borne.

In fact, it can be claimed that the development and realisation of shipping has been an important and contributing factor to the growth in world trade.

Table 2.1 Seaborne trade volume in tonne-miles

in billion tonne-miles

Year	Crude oil	Oil Prod.	Iron ore	Coal	Grain	Other cargo	% of Total	Total trade	% change over prev. Year
1975	8885	845	1471	621	734	***2810***	***18.3***	15366	-6.2
1980	8219	1020	1651	957	1087	***3720***	***22.3***	16654	-5.1
1985	4007	1150	1702	1473	1004	***3750***	***28.7***	13086	-3.0
1986	4640	1265	1699	158	914	***3780***	***27.3***	13856	5.9
1987	4671	1345	1761	1622	1061	***3840***	***26.9***	14300	3.2
1988	5065	1445	1950	1682	1117	***4040***	***26.4***	15299	7.0
1989	5736	1540	2012	1752	1095	***4250***	***25.9***	16385	7.1
1990	6261	1560	1978	1849	1073	***4400***	***25.7***	17121	4.5
1991	6757	1530	2008	1999	1069	***4510***	***25.2***	17873	4.4
1992	6977	1620	1896	2001	1091	***4650***	***25.5***	18235	2.0
1993	7251	1775	2001	1949	1038	***4840***	***25.7***	18854	3.4
1994	7330	1860	2165	2014	992	***5100***	***26.2***	19461	3.2
1995	7225	1945	2287	2176	1160	***5395***	***26.7***	20188	3.7
1996	7363	2040	2227	2217	1126	***5705***	***27.6***	20678	2.4
1997	7677	2050	2444	2332	1169	***6000***	***27.7***	21672	7.4
1998	7820	1970	2430	2215	1050	***5940***	***27.7***	21425	3.6
Av. Growth									
Rate 75/98	-0.6	3.7	2.2	5.7	1.6	***3.3***		1.5	
Rate 90/98	2.8	3.0	2.6	2.3	-0.3	***3.8***		2.8	

Source: Fearnleys Review, various issues

2.2 Container trade potential

The trading world changed in the 1950s as labour became more and more expensive. In liner shipping productivity became more important than flexibility. Liner companies lost many of the core trades with independence gained by the colonies.

The growth in the 1950s and 1960s in trade was between the prosperous industrial centres of Europe, North America and Japan. The need for fast reliable and secure transport became obvious. At this time cargo liners' costs and complexity became a barrier with increased time in port costing shippers a lot more through tied up capital.

Unitization, through the standardisation of cargo was the solution to raise productivity. This was done by liner companies investing in mechanised systems and equipment, which automated the transport process.
Containerisation started in the United States in the 1956. Containers were used by trucking and railway companies. The idea of an easily detachable single unit, which can be transferred from one transport mode to another, is known as intermodalism. Malcom McLean as an experienced trucker, had the idea of a cargo handling system that included the sea as a transport mode in addition to road and rail. The first regular service of deep-sea containers was started in the north Atlantic in 1966 by Sea-Land; a company set up by Malcom McLean.

European liner companies later set up their own container services. The development of all related activities such as standardising containers, ship building, trucks and port terminal facilities took place. By 1995 there were 9.6 million TEUs in the international container business.
The container system proved to be extremely effective with regard to cargo handling speed and time in port. In addition, the intermodality improved due to the standardisation of the unit handled.
Twenty years later major liner routes were containerised. Due to unitization liner companies started to compete and they were able to offer door to door service. A complete service from point of origin to point of destination became a part of this sector in the shipping industry. The fierce competition forced the industry to become more concentrated by consolidation and the merging of companies.
International Association of Ports and Harbors I.A.P.H 1999 mentioned "Drewry Shipping Consultants mentioned the global port throughput for 1997 was 170 million TEUs. A predicted growth of up to 2005 is estimated of an additional 100 million TEUs (6% per annum)." The growth figures show that container activity has grown year after year and will continue to grow.

The table below illustrates these figures in detail

Table 2.2 Global Port Throughput In Million TEU

		Expected Growth		Total at 2005	
	At 1997	TEU	Increase %	TEU	Increase %
Asia	73.40	43.60	59.40	117.00	37.26
Western Europe	38.60	23.70	61.40	62.30	38.04
North America	24.50	7.80	31.84	32.30	24.15
South America	11.50	9.20	80.00	20.70	44.44
Middle East	8.00	6.10	76.25	14.10	43.26
Africa	5.30	3.40	64.15	8.70	39.08
South Asia	4.30	4.90	113.95	9.20	53.26
Australia	3.80	1.30	34.21	5.10	25.49
Eastern Europe	0.90	1.00	111.11	1.90	52.63
Total	**170.30**	**101.00**	**59.31**	**271.30**	**37.23**

Source: Drewy Shipping Consultants

Container transport is the fastest growing market in maritime transport sector this growth is due to the following:

- The continued expansion of containerised shipping by developing countries.
- Increased trade in higher value goods.
- Trends towards globalisation by multinational manufacturers.
- The growth in deep-sea ship size and subsequent increase in feeder traffic and transhipments.

On 1st January 1999, the total capacity of the container vessel fleet was about 6 million TEUs, of which cellular vessels represented 4.2 million TEUs (70%). by 1st May 2000, the total capacity of the container vessel fleet had increased about 6.5 million TEUs, of which cellular vessels represented 4.5 million TEUs (70%). The table below illustrates these figures.

Table 2.3 Container Vessel Cellular Fleet

Size (Only Cellular)		1/1/1999			1/5/2000			Increase %	
Description	**Range**	**Number**	**TEU**	**% of Total**	**Number**	**TEU**	**% of Total**	**Number**	**TEU**
Post-Panamax	>5000	52	313075	7.4	72	434367	9.5	+38.5	+38.7
Panamax	3000/4999	342	1317194	31.0	359	1390688	30.5	+5	+5.6
Sub-Panamax	2000/2999	401	1001099	23.6	419	1042374	22.9	+4.5	+4.1
Handy	1500/1999	311	525154	12.4	347	589639	13.0	+11.6	+12.3
Handy	1000/1499	494	595418	14.0	491	584474	12.8	-0.6	-1.8
Feeder-Max	750/999	184	160626	3.8	200	174164	3.8	+8.7	+8.4
Feeder-Max	500/749	334	202870	4.8	337	204156	4.5	+0.9	+0.6
Feeder	100/499	412	127768	3.0	606	132579	2.9	+47.1	+3.8
TOTAL		**2530**	**4243204**	100.0	**2652**	**4552459**	100.0		

Source: compiled from Alfaliner & Y.L.G database, http://www.or.jp/shiptrends_99.htm

During the past twelve years, 1,317 container vessels over 1,000 TEUs have been built. As at 1st January 1999, 394 were able to carry over 3,000 TEUs and 52 exceeded 5,000 TEUs. There were 255 cellular container vessels on order on 1st January 1999 providing a total additional capacity of 617229 TEUs but by the end of year, the number of ships ordered had decreased by 8% while the total capacity of the new orders had jumped to 30%, meaning that the direction is towards larger sizes.

Table 2.4 Container ships on Order

Size (Only Cellular)		Jan. 99		Dec. 99		Change %	
Description	**Range**	**Ships**	**TEU**	**Ships**	**TEU**	**Ships**	**TEU**
Post-Panamax	>5000	42	240668	74	429190	+76	+78
Panamax	3000/4999	31	127654	44	169074	+42	+32.5
Sub-Panamax	2000/2999	33	75172	42	103164	+27	+28
Handy	1000/1999	105	150082	54	81902	-48.6	-45
Feeder	<1000	44	23653	33	19811	-25	-16
TOTAL		255	617229	247	803141	-8	+30

Source: Compiled from Alphaliner & Containerisation International

These figures confirm the growth of the fleet with an amount of 803141 cellular slots under construction.

Cellular container ships are divided into segments each serving a specific part of the market achieving optimum productivity. The first three segments are feeder, feeder-max and handy-size; they are mainly concerned with the short sea and draft restricted trade. The second three segments are Sub-Panamax, Panamax and Post-Panamax all serving the longer haul and deep-sea trade.

In recent months Post-Panamax tonnage dominated the order book compared with Panamax, as seen from the following table.

Table 2.5 Structure of container Ship Fleet 1980 – 2000 (TEU x 1000)

Type	1980	1985	Inc. %	1990	Inc. %	1995	Inc. %	2000	Inc. %
Post Panamax	0	0	0.0	20		150	650.0	434	189.3
Panamax	20	90	350.0	310	244.4	750	141.9	1390	85.3
SubPanamax	230	350	52.2	550	57.1	700	27.3	1042	48.9
Handy	300	420	40.0	550	31.0	850	54.5	1174	38.1
Feeder Max	60	80	33.3	95	18.8	110	15.8	378	243.6
Feeder	100	155	55.0	160	3.2	220	37.5	132	-40.0
TOTAL	710	1095	54.2	1685	53.9	2780	65.0	4550	63.7

Source: Compiled from Clarkson Research Studies & other

The decision of the owners / operators to increase their fleets with large container ships is driven by:

- the powerful economies of scale of Post-Panamax compared to Panamax vessels,
- the highly competitive pricing regimes of shipyards for large container ships,
- the growth in global operating alliances which has meant that larger cargo volumes are being moved by individual grouping justifying the deployment of bigger ships.

2.3 Container Trading Routes

The three main stream trade routes in container trade are transpacific, transatlantic and East Asia to Europe. In addition, there are the North-South and the intra-regional routes.

2.3.1 Trans-Pacific route

The biggest deep-sea liner route is between North America and the Far East with 7.5 million TEUs of trade representing 22% of the world total. The type of container ships used on this route is Post Panamax because of the long transit time. To run a weekly service this route requires 5-6 ships.

2.3.2 East Asia / Europe route

This route links East Asia from Japan to North Europe as far as Sweden. On this route the trade amounts to 5 million TEUs.

2.3.3 Trans-Atlantic route

This links the East Coast of North America with Europe, the trade amounting to 3 million TEUs on this route.

2.3.4 The North-South route

Trade on this route is between the industrial centres of Europe, North America and the Far East and the developing countries of Latin America, Africa, or developed countries in the Far East and Australia. The ships used on these routes are the handysize of 1,600 TEUs and multi-purpose vessels, in addition to conbulkers.

2.3.5 The intra-regional route

This is concerned with the distribution of cargo for base port to out-ports. The major trade is intra Asia and intra Europe. Feeders and feedermax are running on these routes.

The following table illustrates main container traffic

Table 2.6 Main Container Traffic in thousand TEUs

Intercontinental Trade	**TEUs**	**% in Route**	**% of Trade**	**% of Grand Total**
East /West Routes				
Trans-Pacific	7470	44.3	30.0	20.1
E. Asia/Europe	4895	29.0	19.6	13.2
Trans-Atlantic	3030	18.0	12.2	8.2
Europe/M. East	645	3.8	2.6	1.7
Asia/M. East	625	3.7	2.5	1.7
N. America/M. East	205	1.2	0.8	0.6
Total	**16870**	**100.0**	67.7	45.4
North/South Routes				
L. America/N. America	2000	24.8	8.0	5.4
L. America/Asia	725	9.0	2.9	2.0
N. America/S. Asia	250	3.1	1.0	0.7
L. America/Europe	1150	14.3	4.6	3.1
Europe/Africa	950	11.8	3.8	2.6
N. America/Africa	100	1.2	0.4	0.3
Asia/Africa	425	5.3	1.7	1.1
Europe/S. Asia	475	5.9	1.9	1.3
Asia/S. Asia	425	5.3	1.7	1.1
Europe/Australia	400	5.0	1.6	1.1
Asia/Australia	875	10.9	3.5	2.4
N. America/Australia	275	3.4	1.1	0.7
Total	**8050**	**100.0**	32.3	21.7
Intercontinental Total	**24920**		**100.0**	67.0
Intra-Regional Trade				
Intra-Asia	6750	55.1		18.2
Intra-Europe	4250	34.7		11.4
Intra-N. America	1250	10.2		3.4
Intra-Regional Total	**12250**	**100.0**		33.0
Grand Total	**37170**			**100.0**

Source: Drewry Shipping Consultants 1996

2.4 Container operational Patterns

The main reason behind operational patterns is the variance between different trading routes in terms of volumes of cargo, trade balance and traffic stability. The search for cost competitiveness and the deployment of different sized ships have led to new operational patterns

The operation system can be defined as a network of nodes and links. Ports are the nodes and ship routes are the links. A network is a link between 2 nodes. To take advantage of economies of flow accumulation (bus principle), most operational patterns are multi nodes; thus, by accumulating several inter-nodal flows a service can use larger ships with lower slot costs. Operators use the following major operational patterns:

End-to-end: A-B-A itinerary

The pendulum: A-B-C-B-A Itinerary

Round the world: A-B-C-D-E-…-A itinerary one-way or two-way

However, the integration of operations and the co-operation between lines has led to the combining &/different operational patterns into a service pattern.

2.4.1 End-to-end

This pattern exists between two markets. The stability and the balance in traffic in two directions are important. It can be operated on many routes, east-west or north-south, with any size. End-to-end is an easy pattern to manage. It can be made with one ship or more, but the disadvantage of it is the imbalance trade, where ships must carry empty containers. The repositioning of empty boxes increases the costs of the carriers. The other disadvantage is the need to call at a port once on the inbound voyage and again on the outbound voyage.

2.4.2 Pendulum

Pendulum is a combination between two end-to-end patterns with the advantage of elimination of double port calls. It covers 3 markets, with middle market serving as a fulcrum. It is widely used on east-west routes and lager ships are usually deployed in this pattern. The disadvantage is that the size of vessel could be too big for one market at one end. However, the pendulum pattern serves as a partial remedy to reduce the end-port effect by devising a liner service. The opportunity for accumulation of flow in multi-trade leg pendulums is higher than a single service, thus, operators tend to employ larger ships on this pattern.

2.4.3 Round-the-world

An attempt to close the gap and convert the pendulum pattern into a continuous service round the world linking three markets in one direction. This pattern requires about 12 ships for weekly service, and the whole voyage can be made in about 80 days. The circular route in round the world service allows for more uniform and higher utilisation of ship's space. it also allows unbalanced flows to be coped with by separation of services by direction, thus employing ships of different capacity on east bound and west bound services.

The advantages of the round the world service are found to be as follows:

- The cost advantage is substantial where this service diminishes the adverse cost effect of trade imbalance or traffic volume disparities by combining flows from three major trades, thereby sustaining reasonably high achieved load factors despite these imbalances.
- Additional opportunities to earn revenue by way porting (double dipping) wherein a slot is used more than once on a given leg of the voyage.
- The advantage of allowing a stronger sequence of the itinerary to subsidise a weaker sequence.
- Considerable savings can be secured in the container inventories and logistics within the global system. Empty container flows and equipment inventory levels can be reduced. Overall the directional imbalances of trade are more easily accommodated in this service.

The disadvantages of round the world service are found to be as follows:

- The service requires an extensive feeder network and transhipment service where costs can be considerable. Sometimes the scale economies of large vessels are not sufficient to offset the costs of large-scale feeding and transhipment operations.
- A serious imbalance of container inventory can develop due to the difference in cargo volume and marketing success between the traffic generating regions.

However, a new round the world service is suggested, pending on the expansion of the Panama Canal, together with agreed related service patterns. This will involve a massive conversion of end-to-end, pendulum and traditional round the world patterns into a new equatorial round the world service, which will employ even larger ships.

Furthermore there is a number of sub-systems related to the basic operational patterns. These subsystems are found to be as follows:

- Hub-spoke:

Is concerned mainly with transhipment activities. It joins the big ships with small feeders. In order to avoid longer time spent in ports by bigger ships, they can call at a few transhipment hub ports with feeders moving between hubs and other ports to cover a bigger range. The disadvantage of this pattern is the higher cost incurred due to transhipment and containers' longer transit time.

- Double dipping:

Is a combination between 2 routes intercontinental and intra-regional, where the latter is more profitable than the former one. This is done by calling at hub ports on main lines on both ways of a round trip taking the advantage of relatively higher paid intra-regional market. Meanwhile slots will be utilised more than once and marginal costs drop significantly for larger ships than regional ships.

- Triangle:

Is the combination of three end-to-end operations to counter the trade imbalance problem between three markets, for example, the trade between Asia, Japan and Australia. To avoid the trade imbalance, the ship's rotation goes from Asia to Japan

to Australia and back to Asia again. This pattern enables the operators to overcome trade imbalance in a certain direction, thus achieving better utilisation.
The balance

Although in the last ten years the balance preference has changed remarkably with pendulum routing, it now accounts for almost one quarter of all the main weekly east-west services compared to just 9% in 1990. The Following Table illustrates that

Table 2.7 Evolution of routing preferences on East-West trades
(number of weekly services)

	N.Europe-Far East	Tranpacific	Transatlantic
		1990	
End-to-End	9	26	11
Pendulum	1	3	1
RTW	2	2	2
Total	12	31	14
		1998	
End-to-End	18	28	16
Pendulum	2	13	3
RTW	1	1	1
Total	21	42	20
		1999	
End-to-End	19	33	15
Pendulum	4	14	4
RTW	1	1	1
Total	24	48	20

Source: Drewry Shipping Consultants Ltd

Chapter 3

ECONOMIES OF SCALE

3.1 Economies of Scale in the Container Trade

The increase in size of vessels has been greatest in the specialised trades where transport integration has provided the investment in ports and cargo-handling facilities needed to operate large vessels.

A substantial saving in cost could be achieved by using large vessels; the size of these savings depending on the size of vessel and the length of voyage. The aim is to move the cargo as cheaply and efficiently as possible.
Reduction of unit cost is one of the basic principles in the shipping industry. This can be done by increasing the size of the cargo on the shipping leg. Bigger ships have lower unit costs, and unit cargo handling and storage are also cheaper at high throughput volumes. As a result the container trades are under constant economic pressure to increase the size of cargo consignments.

The choice of strategy for a firm can improve or erode its position within an industry thereby yielding a return on investment or achieving losses. In coping with a competitive force the three generic strategic approaches to outperform competitors as defined by Porter are: overall cost leadership, differentiation and focus. Cost leadership is self-explanatory, differentiation is a unique product or service and focus implies finding a market niche.

For container shipping there are limits for the differentiation and focus especially in the main line trades. However, cost control is a constant concern and cost leadership is a worthwhile goal, thus it is associated with economies of scale, where capacity addition is now taking place the increase in size of the ships rather than any increase in number.

Based on the theory of scale economies, the size of container ships has increased continuously. For larger vessels the break-even factor will be lower due to lower unit costs that are achieved by them through economies of scale. As the unit costs of transport service decrease with the increase in ship size the earnings per unit of transport service increase (if freight rates are steady). Equally building costs do not increase in direct proportion to cargo capacity increase. Accordingly larger vessels are more economical and competitive, both in operation and in building costs.
A comparison between different container ships cost shows the relation between ship size and unit cost in the following table.

Table 3.1 Container Ships Cost Comparison

		Cost US$		
Ship	Capacity TEU	TEU/Day	TCE TEU/Day	Transport Sea days
Tokyo Senator	3017	10.74	5.16	225.71
Hannover Express	4407	10.84	6.00	228.57
Hyundey Admiral	4411	10.19	5.59	213.71
Hanjin London	5302	9.89	5.68	210.00
P&ON Southampton	6674	9.26	5.00	192.86
Maersk K-class	7500	9.05	5.20	191.43
Maersk S-class	8600	8.74	5.05	182.29

Source: Wijnolst N., Malacca Max, Delft University Press, the Netherlands

An evolution in the shipping industry was produced following the free market capitalist's model. This evolution is reflected in the trade of today's global economy as follows:

- Growth of market
- Competition for customers

- Economies of scale
- Consolidation of industry

This evolution will continue well into the 21st century in the light of the current political and socio-economic environment.

Out of these four trends we find that economies of scale is the one that is shaping the future of the shipping industry. The natural struggle for bigger, thus more efficient, economies is driving an internal industrial revolution – one that is already changing the size and shape of things in the commercial shipping industry. Bigger ships are being put into service today. Mega ships are causing port managers to think about the way they do business, and as a result this evolution of mega ports is being introduced to serve these mega ships.

3.2 Development in ship size

The developments of large container ships started years ago in 1980 but only recently have vessels come close to 8000 TEUs. Efforts are being aimed at an improving economy by increasing ship size. The first generation constructed in 1956s was able to carry 700 TEUs and by the 1970s the 3rd generation was able to carry 3000 TEUs with Panamax dimensions. In 1984 the Panamax Jumbo Econships were able to carry 4432 TEU. Due to the constant innovation in container ships design, the new Panamax design can carry approximately 4500 TEUs. Such an increase of 50% reveals the efforts made in developing of an efficient container ship.

Demand is affected by the world economy and the growth of global trade has been substantial in the period since World War II. In addition, the price of commodities, the length of haul, political events and transport costs affect demand.

Variables that affect supply are the number of vessels in the world fleet, fleet productivity, shipbuilding, scrapping and losses, interest rates and subsidies and freight rates.

In general, there is an excess of cargo carrying capacity; thus, the fleet capacity is growing faster than world trade. Between 1996 and 2000 the world container fleet was predicted to grow by 10% while growth in world trade is targeted at 6.3% which virtually guarantees excess capacity.

The current size of ships varies quite dramatically. In recent years, the barrier of the Panama Canal, which limits vessel beams to less than 110 feet, was surpassed. While several container shipping companies have chosen to build ships too large for the Panama Canal there has not been a wholesale shift in this direction. These vessels are referred to as post-Panamax and the largest can carry 8700 TEU and are limited to a few ports with sufficient infrastructure.

The Panamax vessel, which was designed to be able just to pass the locks of Panama Canal, was optimised to accommodate more cargo within the same dimensions. The scale of operation of this type of ship has significantly increased due to the growth in trade and the tough competition between liner operators. The only way to survive and compete was to cut costs continuously through the use of larger vessels which can transport containers in a cheaper and more efficient way than smaller ships.

In 1980, some operators abandoned the Panamax design and the tendency was toward building even bigger ships than the Panama Canal can accommodate which were to sail only in the Pacific.

Later, other operators followed and large number of post panamax ships were built. Some operators are still operating the panamax due to the flexibility of this size which they believe is more important than the scale advantage of the bigger ships.

The Maersk S-class is the largest ship so far with an official capacity of 6600 TEU (able to carry 8700 TEU depending on container weight)

3.3 Limitations on economies of scale

There are several reasons that limit the economies of scale and which are considered as barriers to the shipping industry. These are:

- ship size increase at the expense of service frequency
- longer turn around time is necessary for cargo discharge
- inefficiencies generated by inadequate cargo handling infrastructure (both pier side and further inland) at the port further erode the benefits derived from increased size
- increased or non-competitive land transport costs
- physical limitation of port geography (inadequate channel size and depth, insufficient pier space)
- uncertainty over future trade volumes and routes.

These substantial barriers for shipping companies represent a counter force to the realisation of economies of scale. Shipping lines do not exercise complete control over these barriers and there will always be the risks of guessing given the available information as to what an efficient solution might be.

Speed is another barrier to the ever-increasing size of container vessels as with each step up in size, the speed increases due to the correlation between the length of haul and size of vessel. Higher speed brings the cost upward dramatically. With the high proportion of fuel costs in the total cost, the operators target is to find the optimal speed.
The physical constraints of many harbours represent an impassable barrier. Many ports do not have an adequate infrastructure, such as dockside cranes and inland transportation connections, to move the volume of cargo these ships are capable of offloading. The ability of the port to handle cargo quickly and efficiently becomes a constriction point for the large vessel. Excess time spent on the dock begins to undermine economies realised by an increase in size.
Mega ships can only utilise a handful of ports around the world. Even in the ports with sufficient channel depths, the inland transportation inadequacies create bottlenecks and lag times that are substantial. Consequently, not only the flexibility of the shipping line is reduced but also the threat of increased time in port handling.

3.4 Other ways to achieve economies of scale

The trend towards consolidation in the form of mergers is a recurring theme among major shipping lines. They are able to realise economies of scope and scale by merging as well as reducing certainties.

The consolidation into larger companies with bigger ships will accomplish more frequent services and bigger market share. Several companies in 1990 were formed by pooling their ships. The global alliance was formed by APL, OOCL, MOL & Ned Lloyd. In 1994, the alliance had 187 container ships with 375000 slots. The grand alliance was formed by Hapag-Lloyd, NOL, NYK and P&OCL with 182 ships and 371000 slots. In 1995 a third alliance between Maersk and Sea-Land was formed with a total of 206 ships.

Recently the merger of Maersk with Sea-Land and the American President Lines with Neptune Orient Lines had a substantial impact on the quantity and type of infrastructure that the ports they are calling at must provide. In the past two dedicated terminals would have been needed to serve two operators, where as post merger only one is needed. This reduces both the land and equipment requirement at the pier face but tends to transfer the point of constriction to the inland transport costs.

A consortium is a form of co-operation, mainly between container carriers to rationalise operations technically and commercially.

The development of liner consortia was in two stages. The first stage started in 1970 and featured vessel/space sharing and slot chartering, co-ordination of sailing schedules and port of call, a prefixed traffic quota for each carrier, harmonisation of commercial activities and maintenance of a common co-ordination office.

When the market situation changed in the eighties, the too rigid structure of consortia became a disadvantage vis-à-vis independent carriers. In 1980 the consortia began to fall apart.

Heavier capital investment requirement, poorer freight rates and fiercer competition has accentuated the old problem of technical and commercial harmonisation of lines to rationalise the use of assets.
The second stage is the alliance, where liner shipping co-operation takes shape by grouping big shipping lines trading on the main world maritime routes. Alliances are a kind of consortia with the main objective based on technical agreements. Container lines with a similar scale of operation supported by feeder services are forming alliances. They are less restrictive than the first stage of consortia and they target cost cutting and improving quality of service.
The cost cutting on the sea leg seems to be more and more limited; therefore the competitive edge remains on the land-side. Members of an alliance co-operate in transport equipment and port terminal facilities that account for 70% of the cost for a typical door to door container delivery.
The volume created by the alliance members gives much more negotiating weight when discussing rates with port service and inland transport providers.

In an alliance each party gains a specific advantage from a joint operation. thus by working together these parties create a competitive advantage.
Shipper requirements have driven the development of alliances. Bigger vessels and global alliances are needed to cater for multinational companies which are producing and assembling their products in a large number of countries.
In a joint production the alliance achieves cost savings and gives its members access to more services, like terminal sharing and shore based services, without having a lot of costs. The cost reduction and the growth of revenues are the value added to a successful alliance.

The CEO of Hapag Lloyd revealed that “the Grand alliance (of which Hapag Lloyd is a member) has achieved about $40 million in savings for its members since it was started in 1996 and much more savings are possible in the field of container logistics”.

Mergers and acquisitions are other forms of co-operation between carriers. Many companies change hands, some disappearing in the process. Most of the carriers acquired have been second or third tier operators.

Mergers and acquisitions have played a part in the concentration of ownership in the liner shipping industry. This was driven by the faster rate of growth of the major lines. The advantage of mergers and acquisitions over alliances is the savings in the administrative costs as well as in the operational sphere, as they are basically cost driven.

Cost saving can be made by pooling and rationalising equipment, co-ordinating container logistics and collaborating on landside activities.

The levels of co-operation where carriers have commitments differ a great deal, while the mixture of strategies differs according to the condition of each route. It can be concluded that the degrees of co-operation are as follows:

- Slot purchase
- Slot exchange
- Vessel-sharing agreement
- Joint services
- Alliances
- Merger/acquisition

Table 3.2 Liner Industry consolidation

Company Acquired	Purchaser	Date	Annual TEUs Carried
FMG	TMM	1996	
CGM	CMA	11/1996	
DSR-Senator Lines	Hanjin Shipping	1997	800000
Lykes Lines	CP Ships	7/1997	275000
Contship containerlines	CP Ships	10/1997	270000
APL	NOL	11/1997	
Blue Star Line	P&O Nedlloyd	2/1998	186000
Ivaran Lines	CP Ships	5/1998	110000
SCL	Safmarine**	7/1998	
South Seas Steamship	Hamburg Sud	8/1998	
Llod Triestino	Evergreen	8/1998	
Italia di navigazione	D'Amico	8/1998	117000
Anzdl	CP Ships	10/1998	
Alianca	Hamburg Sud	11/1998	
ANL*	CMA-CGM	11/1998	85000
Safmarine Container Lines	Maersk	12/1998	600000
Tasman Express Line	P&O Nedlloyd	1/1999	
Barbican line (part)	Hamburg Sud	1999	
Barbican Line (part)	Safmarine		
Grupo Libra*	CSAV		
Montemar*	CSAV		
Transroll	Hamburg Sud	7/1999	
South Pacific Container	Hamburg Sud	7/1999	
Sea-Land	Maersk	8/1999	3000000
Crowley Am. Trans.(part)	Hamburg Sud	8/1999	

** Liner interests only* *** Purchase of 25% of company not already owned*

Source: Drewry Shipping Consultants Ltd

Table 3.3 Evolution of the Alliances

Original Grouping	**Global Alliance**	**Grand Alliance**	**Maersk/Sea-land**	**Hanjin/Tricon**	**KLine/YangMing/ Hyundai(HMM)**
Original Line-up	APL - MOL Nedlloyd- OOCL	P&O - NYK Happag Lloyd - NOL	Maersk/Sea-land	Hanjin - DSR Senator - Cho Yang	K Line - YangMing - Hyundai (HMM)
Revised Grouping	**New World Alliance**	**Grand Alliance 2**	**Maersk/Sea-land**	**United Alliance**	**K Line/YangMing /Cosco**
revised Line-up	APL(NOL) - MOL Hyundai	P&O NedLloyd - NYK Happag Lloyd - OOCL MISC	Maersk/Sea-land	Hanjin - DSR - UASC Senator- Cho Yang	K Line - YangMing Cosco

Source: Drewry Shipping Consultants Ltd

3.5 Individual operators

Despite the heavy costs involved in purchasing and operating larger container vessels, some operators prefer to operate independently rather than through co-operation with other lines. The idea behind this is to avoid the organisational complexity existing in an alliance because of too many participants.

Evergreen and the Mediterranean Shipping Company are two carriers that prefer to operate independently, believing that decision making is the key.

By introducing bigger ships and offering lower rates, independent operators win enough cargo to fill their ships and cut down their average costs. Consequently their voyage profit increases. On the other hand the members of the alliance will be left with less cargo and rising average cost. Consequently their profit will be wiped out.

The main area that remains for competition is the inland services where alliances can achieve a better cost reduction when moving containers to their final destination.

Smaller operators focus on specific regions with more flexibility towards customer wishes. Meanwhile they can respond quickly to the market.

Table 3.4 Alliances and Global Players February 2000 (TEUs/ slots in thousands)

Rank	Name of Alliance	Comprising	Capacity		Order Book		Share per			3.000		4000		5.000		6.000	Total		% of
			TEUs	1 Y. Growth	TEUs	Growth	Group	World	Nr.	3.999	Nr.	4.999	Nr.	5.999	Nr.	6.999	Nr.	TEU	Total slots
1	Grand Alliance	Hapag Lloyd	91								6	4.422							
		MISC	39								2	4.469							
		OOCL	115								8	4.960							
		NYK	155										5	5.700					
		PONL	283												4	6.690			
		Total	683	8%	177	25.9%	20.9%	12.4%									25	130.410	19.09
2	Maersk Sea-Land	Maersk Sea-Land									9	4.354							
															9	6.000			
															6	6.200			
															3	6.418			
		Safmarine																	
		Total	527	0%	120	22.8%	16.1%	9.7%									27	149.640	28.39
3	New World Alliance	Hyundai	105										7	5.551					
		MOL	137								5	4.700							
		APL	191								6	4.832							
		Total	433	5%	89	20.6%	13.2%	7.9%									18	91.349	21.10
4	United Alliance	UASC	71						10	3.800									
		Cho Yang	52								4	4.545							
		Hanjin/Senator	256								6	4.545	5	5.300					
		Total	379	7%	28	7.4%	11.6%	6.9%									25	109.950	29.01
5	Evergreen	Total	319	11%	68	21.3%	9.8%	5.8%					13	5.364			13	69.732	21.86
6	Cosco	Total	221	-3%	55	24.9%	6.8%	4.0%					6	5.200			6	31.200	14.12
7	MSC	Total	217	16%	75	34.6%	6.6%	3.9%			2	4.000					2	8.000	3.69
8	L-L/YML	Yang Ming	87										5	5.000					
		K-Line	111						8	3.456									
		Total	198	2%	85	42.9%	6.1%	3.5%									13	52.648	26.59
9	CP Ships	Canmar,CAST,Contship,ANZDL	72																
		Americana (Lykes,Contship Med)	71																
		Total	143	8%	0	0.0%	4.4%	2.6%									0	0.000	0.00
10	CMA/Norasia	Norasia	27																
		CMA	123								2	4.000							
		Total	150	24%	61	40.7%	4.6%	2.7%									2	8.000	5.33
	Total		3270		758	23.2%	100.0%	59.5%	18	65.648	50	228.278	41	219.789	22	137.214	131	650.929	19.91

Source: Compiled from Hapag Lloyd container line and Containerisation International Year Book 2000

3.6 Future Developments in Containerisation

The growth in containerisation since 1956 till now has been spectacular. The volume handled and the increase in trade has been characterised from the very beginning by two factors: optimisation of ship design to carry the maximum possible number of containers and improvement in economy by increasing the size of ships. As world trade continues to grow, container trade volume follows. This growth is obvious in European and Asian ports and it will continue to grow even faster in some regions like the Baltic and China.

The developments of large container ships started years ago in 1980 but only recently vessels have come close to 8000 TEUs. Efforts are aimed at an improvement in economy by increasing ship size. Each generation of container ships is characterised by the factors indicated in the following table.

Table 3.5 Generations of Containerisation

Generation	First	Second	Third	Fourth
Period	Domestic coastal service, before 1966	Short international service across one ocean, since 1966	Long international services over two or more oceans, since 1971	Round-the-world services, since 1984
Territory	USA, Australia	Advanced countries, such as USA, Europe, Australia, Japan etc.	Developing countries in South East Asia, Middle East, South America, etc	World-wide, including China, India and Countries in Africa
Containers	Pre-ISO, size 17’,24’,35’ long	ISO standard 8/8’6”*8’*20’/40’	High cube type 9’,9’6” high	Deviation from ISO standard sizes, e.g. 45’
Ships	Mainly converted ships with onboard cranes	Purpose-built ships of 700-1500 TEU	Purpose-built ships of 2000 TEU	Purpose-built ships over 3000 TEU

Source: Wijnolst N., 1999 Shipping Industry Structure, Delft University

The effect of economies of scale have led to a rapid increase in ship size from feeders to post Panamax. The limits of development of the 8000, 12000 and 15000 TEU container ship are now not in the design, but come from the following aspects:

- the cargo handling facilities and logistics requirements for the ports
- the water depth in ports and port entrance
- the fluctuation in fuel prices

More efforts are being made on the cargo side as well. Commodities that used to be shipped in bulk or break-bulk form are now routinely being containerised; not only high value cargo but low value as well. This means that all market segments are heavily influenced by logistics arrangements.

The lack of port infrastructure to load and unload bulk commodities in some markets has meant the use of containers enabled them to trade. Moreover, containerisation suited the markets that can deliver smaller volumes on a regular basis rather than in bulk.

Fast container ships of 40 knots are due to start in 2002, allowing time sensitive cargo to be moved in a more efficient way. This will have an impact on the handling facilities at ports receiving such kinds of ships. Conventional handling cranes will slow the transport process but a new handling system is being developed to cope with these fast ships in order not to lose the time gained at sea by reducing time at port. The system uses a container pallet train to load and unload the ship, and can unload a fast ship of 1423 TEUs in about 4 hours instead of 30 hours by conventional handling systems.

The physical restraint for a further increase in container ship size remains in the Suez Canal. Suez-max container ships of 12000 TEU capacity are already being planned. It remains to be seen how far the scaling up of container ships will continue.

Chapter 4

CHALLENGES

4.1 Container vessels of the next generation

The steady downward pressure on freight rates, coupled with the impending requirement for carriers to replace outdated tonnage can mean only two things:

1) Lines are constantly searching for greater economies of scale (through upsizing) in an effort to reduce unit costs.
2) As a significant fleet replacement programme is imminent anyway, the next few years will be when the entry of big new ships should be most expected. Older and slower ships will be scrapped in fairly large numbers over the next few years and this will pave the way for a new generation. As illustrated in the table 4.2, 12% (526113 TEUs of capacity) of the global container fleet is 20 years and older and could be retired very soon.

Ship design development went very fast after the delivery of the 1st post PANAMAX ship took place in 1988. Thereafter the first 5000 TEU ship was delivered in 1995, the first 6000 TEU ship in 1996 and the first 6600 TEU ship in 1997 (8700 if empty containers on deck are taken into account)

A comparison in table 4.1 between an optimised Panamax container ship, the first post-Panamax container ship and the 6600 TEU container ship shows that the advantages of first Post-Panamax container ships were very limited.

Although the container ships built so far can easily pass the Suez Canal, a further size increase will reach the limit of this canal.

The concept of Suez-max container carriers is already being planned. The design was made according to the current maximum dimensions allowed within the Suez

Canal today, which are, both in breadth and draft, for ships with a breadth of over 48.16 m and a maximum draft is 58 feet (17.67 m).

Table 4.1 Comparison of Container ship designs

	Optimized Panamax	First Panamax	6600 TEU
Length	294.0 m	275.2 m	347.0 m
Breadth	32.3 m	39.4m	43.0 m
Molded Depth	21.4 m	23.6 m	24.1 m
Draft	13.5 m	12.5 m	14.5 m
Deadweight	67680 t	54655 t	77000 t
Speed	23.8 kn	24.2 kn	25.0 kn
Power	36497 kw	41882 kw	55000 kw
Capacity	4422 TEU	4340 TEU	6600 TEU

Source: Wijnolst N. (1999), *Shipping Industry Structure*, Delft University

The following table illustrates container fleet age profile (for fully cellular vessels)

Table 4.2 Container Fleet Age Profile

Fully Cellular	*Number*						*,000 TEU*						*Fleet Ratio*	
Container Ships	**Age Profile (years)**						**Age Profile (years)**						*May*	*Fleet /*
Fleet Profile	**25+**	**20:24**	**15:19**	**10:14**	**5:9**	**0:4**	**25+**	**20:24**	**15:19**	**10:14**	**5:9**	**0:4**	*2000*	*20 Yrs.+*
100/249	66	40	14	4	6	17	10.2	6.9	2.5	0.7	1.0	3.3	**24.6**	***70%***
250/499	32	64	59	28	51	91	10.6	22.8	23.8	10.5	18.5	33.2	**119.4**	***28%***
Total Feeder	**98**	**104**	**73**	**32**	**57**	**108**	**20.8**	**29.7**	**26.3**	**11.2**	**19.5**	**36.5**	**144**	***35%***
500/749	14	33	56	18	55	144	9.2	20.3	32.6	11.4	33.2	89.1	**195.8**	***15%***
750/999	12	36	29	23	24	70	10.9	31.9	24.7	19.7	21.5	59.9	**168.6**	***25%***
Total Feedermax	**26**	**69**	**85**	**41**	**79**	**214**	**20.1**	**52.2**	**57.3**	**31.1**	**54.7**	**149**	**364.4**	***20%***
1000/1499	33	50	63	47	114	165	41.7	60.0	78.5	52.8	136.7	193.9	**563.6**	***18%***
1500/1999	6	28	33	45	74	148	10.4	47.7	58.8	79.5	125.0	244.6	**566**	***10%***
Total Handy	**39**	**78**	**96**	**92**	**188**	**313**	**52.1**	**107.7**	**137.3**	**132.3**	**261.7**	**438.5**	**1129.6**	***14%***
2000/2499	13	30	34	9	27	101	28.6	68.2	73.8	18.8	61.8	226.8	**478**	***20%***
2500/2999	2	29	26	48	20	45	6.0	79.9	70.7	130.3	55.5	126.8	**469.2**	***18%***
Total Sub-Panamax	**15**	**59**	**60**	**57**	**47**	**146**	**34.6**	**148.1**	**144.5**	**149.1**	**117.3**	**353.6**	**947.2**	***19%***
3000/3499	4	2	10	45	38	32	12.6	6.2	31.1	144.1	120.8	106.9	**421.7**	***4%***
3500/3999			6	20	37	36			23.1	75.4	137.1	136.1	**371.7**	
4000&+(Panamax)			9	3	32	68			41.5	12.7	135.5	292.2	**481.9**	
Total Panamax	**4**	**2**	**25**	**68**	**107**	**136**	**12.6**	**6.2**	**95.7**	**232.2**	**393.4**	**535.2**	**1275.3**	***1%***
4000/4499				5	10	1				21.7	43.9	4.5	**70.1**	
4500/4999					9	13					42.8	63.8	**106.6**	
5000/5499						30						157.8	**157.8**	
5500/5999						17						94.8	**94.8**	
6000+						25						167.6	**167.6**	
Total Post-Panamax				**5**	**19**	**86**	**0**	**0**	**0**	**21.7**	**86.7**	**488.5**	**596.9**	
TOTAL	**182**	**312**	**339**	**295**	**497**	**1003**	**140.2**	**343.9**	**461.1**	**577.6**	**933.3**	**2001.3**	**4457.4**	***11%***

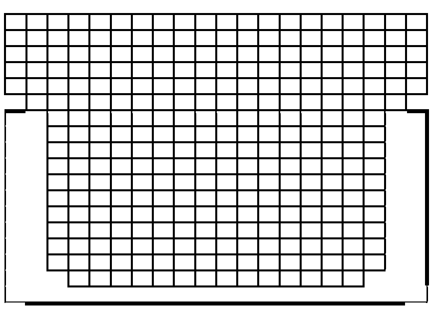
Source: Clarkson container intelligence

The main characteristics of the Suez-max and Malacca-Max container vessels as described in a recent study by Wijnolst, (1999) and a student team are as follows:

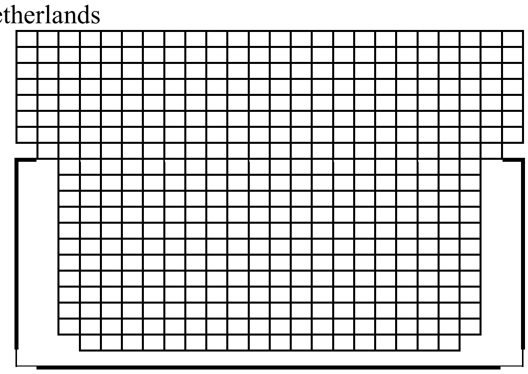
Table 4.3 Characteristics of Suez-max and Malacca-Max container ships

Specification	Suez-Max	Malacca-Max
L O A (m.)	400	400
LwL (m.)	390	390
L B.P (m.)	380	380
Breadth (m.)	50	60
Draft (m.)	17.04	21
Depth (m.)	30	35
Block Coeff.	0.62	0.62
Displac. (t.)	212194	313571
D.Weight (t.)	157935	242800
Speed (knots)	25	25
Capacity (TEU)	11989	18154
Layout	Forward bridge and pram-shaped stern	Forward bridge and pram-shaped stern
General Plan	25 blocks of 40'containers. U/Dk 17 box wide. O/Dk 19 box wide. 3 m. wide double skin	26 blocks of 40'containers. U/Dk 20 box wide *12 tiers O/Dk 24 box wide * 8 tiers 5 m. wide double skin
Propulsion	2*5 blades propeller D.8.6 m.	2*5 blades propeller D.8.6 m.
Engines	2*45768kw Consumption/day 328 t. f.o	2*62810kw Consumption/day 430 t. f.o
Stability	12 t. Homogenous * 11989 TEU GM is 0.31m 12 t. „ * 11723 „ „ 1.10m 14 t. mix * 11989 „ „ 1.33m 14 t. „ * 10281 „ „ 2.16m	12 t. Homogenous * 18154 TEU GM is -0.84m 12 t. „ * 17482 „ „ 1.00m 14 t. Mix 14/10 t. * 18154 „ „ 1.02m 14 t. Homogenous* 10281 „ „ 0.98m
Hatches	Open hatch	Open hatch

Source: Wijnolst N., Malacca Max, Delft University Press, the Netherlands



Cross-section in Suez-max



Cross-section in Malacca-max

The following table indicates the maximum allowable dimensions of vessel sizes and draft to pass Suez Canal.

Table 4.4 Suez Canal Beam and Draft

Beam		**Draft**	
Meter	Feet	Meter	Feet
48.16	158.00	17.07	56.00
50.00	164.00	16.45	53.96
55.00	180.33	14.94	49.00
60.00	196.83	13.11	43.00
60.96	200.00	12.65	41.50

Source: Fairplay Ports guide

- Loading and Discharging Malacca-Max container ship

A new design, which boosts the loading and discharging speed, has developed a new concept capable of doing 70 moves per hour. The outreach of this crane is 74 meters. This design is made by crane builder Huisman-Itrec. The unloading is on stages as follows:

Vertically out of hold, backwards to be delivered to an automatic trolley which takes the container to the quayside to place it down on an elevator. This elevator places the container at the bottom of the crane. The crane has a small storage area underneath, which acts as a buffer to smooth the movements of containers away from the quay.

A significant cost-reduction is achieved through up scaling of ship size. A comparison between large container ships is shown in the following table:

Table 4.5 Comparison of container ships Transport Cost (deep see only)

Ship Type	Av. TEU Capacity	Capacity Increase (than Panamax)	Transport Cost US$/TEU/Day	Savings (than Panamax)
Panamax	4000	0.0%	210	0.0%
Maersk s class	6600	65.0%	185	12.0%
Suez-max	12000	200.0%	178	15.0%
Malacca-Max	18000	350.0%	150	28.5%

Source: Wijnolst N., Malacca Max, Delft University Press, the Netherlands

A considerable saving for Malacca-Max design accounts to anywhere between 16% and 30% if compared to (Maersk S-Class) and Panamax design respectively in over all cost reductions. The transhipment costs and through transport, which constitute 80% of the total costs, are not included. However, if the cost savings are calculated over the total container transport costs, the cost savings are somewhere between 3% and 6%. Therefore, the costs savings that are made by using larger ships are not offset by higher costs on shore.

The main challenge of Malacca-Max container ships lies in three areas:

1) Commercial:
A weekly service requires a number of ships and that is means very high investment costs. The dimension of this design limits its flexibility and prohibits its employment in certain operation patterns like round the world where it cannot transit the Panama Canal.
For employment in the Europe-Far East trade, even if it can pass the Suez Canal, it will be dependent on one trade only and any economical problem (like the Asian crisis in 1998) will have a severe impact by putting freight rates under pressure.

2) Technical:
If a vessel has to be taken out of service, this will result in an expensive replacement, if any.

3) Land-side:
A limited number of ports will have the capability to handle the number of boxes carried by these ships. Not only loading and unloading these huge vessels will create a hurdle but also the logistical challenges in distributing the containers into the hinterland.

4.2 Ports Capabilities

Amongst the ten largest ports, which account for more than 30% of the global volumes in container, very few will be able to handle large ships due to physical constraints of the water depth. Principal options considered for handling large vessels might be dredging, offshore terminals, new deep-water ports and lightening.

The choice of one of these options depends on how much traffic a port might be willing to attract. In addition, the port should have the necessary infrastructure and enough land area, for the logistical operation and transhipment activities needed to handle these ships. For economical reasons, the deployment of Suez-max and Malacca-Max ships will be in the East-west trade, transpacific or Europe/Far East.

Even by dredging operations and using the high water of the tide effect, major container ports in North-western Europe like Hamburg, Antwerp, Felixstowe, Bremerhaven will have draft restrictions for ships with a 15m draft.

Rotterdam is the only major port in North-western Europe that will be able to accommodate such container ships of the next generation. Rotterdam is developing a new container terminal to become operational in 2003. The partners in this project are ECT and P&O Nedlloyd which have chosen the northernmost part of Maasvlakte for further terminal expansion until 2010. The site covers about 55 hectares with an 850 m quay. Water depth is 16.65 m and the capacity is about 1M TEU a year. The future expansion could be 110 hectares, with 1500 m quay, 19 m water depth and 2M TEU capacity. Recently, more dredging has taken place to enable 5500 TEU ships with 13.5 m draught to reach ECT home terminals.

Far East Singapore is a main container port where developments into a mega container terminal facility is taking place. In time to come Pasir Panjang Terminal PPT will be the home of Singapore's mega container facility. The area dedicated for this development is 84 hectares and contains 6 main berths with 15 m draft. An important part of the East-west trading route is passing via the Suez Canal. There is a good chance for ports under construction in this area, having a strategic location, to take advantage by attracting such mega ships by considering their requirements, while under construction (in dredging and equipment). At both ends of the Suez Canal, East of Port Said Port and Suez, mega ships could be served without any deviation in their voyage in two ways:

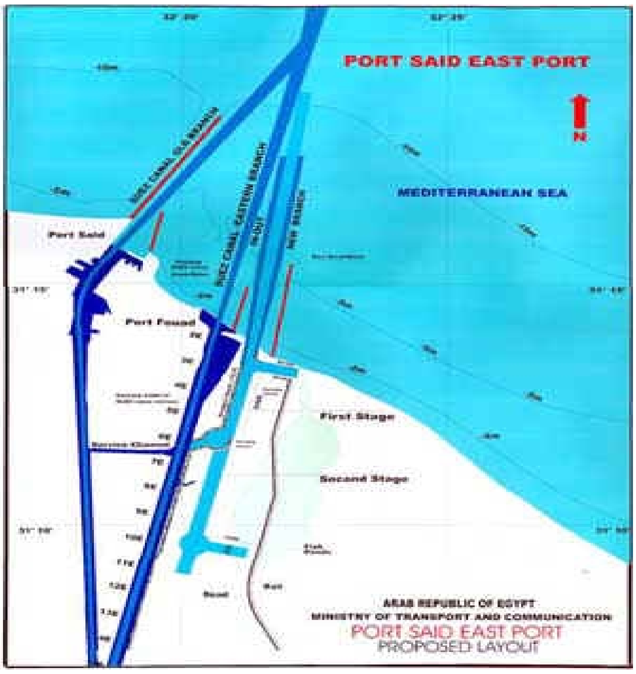
1) Transhipment activity
2) Lightening activity

The two interrelated activities will serve large container ships of the next generation with a deep draft to achieve two goals. The first is to have more containers to be transhipped to the Mediterranean and Middle East region on both east and westbound voyages. This will give the ships more chance to utilise their huge capacity instead of carrying only containers to/from the Far East. The second is lightening the Malacca-max, which in addition, will enable it to transit the Suez Canal.

East of Port Said Port will have an initial capacity of 250000 TEU with a potential for 1 million. The construction of the new harbour has already begun by a consortium of contractors. Phase one, now well underway, consists of a 1200 m of container-handling quay, dredging the approach channel, northern and middle turning circles, and inland channel; constructing a new break water, shortcut, berthing channel and widening the canal by-pass; and constructing a 1200 m x 500 m container terminal and other general cargo/dry bulk terminal. Phase two consists of a further 1200 m of container quay wall, the construction of two Basins and expanding the container terminal.

The container terminal infrastructure, equipment and operation are funded by private investment. A road tunnel beneath the Canal, from the East port industrial area, is also privately funded. The contract to build and operate the container handling terminal for 30 years has been awarded to the Suez container terminal company, which is a joint venture between Europe Combined Terminals (ECT) and Maersk, together with a group of Egyptian investors. An estimate of US$130 million will be invested in the Terminal. Completion slated for the end of 2002.

Figure 4.1 East Port Said port lay-out



Source: Egyptian Ministry of Transport and communication

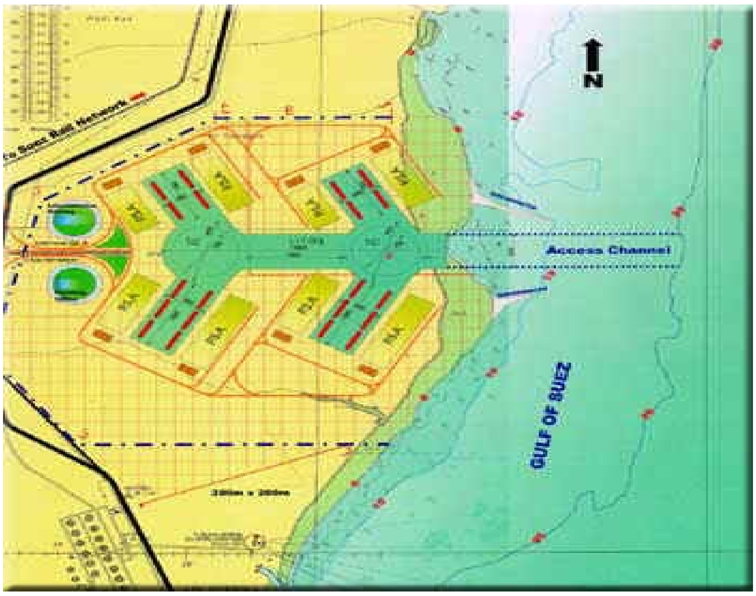
The port will be connected to the rest of the country by road and rail bridges, over the Suez Canal, set to open at the end of 2000 and early 2001 respectively. These links have an effect on the success of the port to capture a slice of some 12 million TEU per annum that is expected to be transhipped in the region in the future.

In addition, an industrial area and free zone is being developed adjacent to the port which is expected to add an incentive to attract international ship owners/operators to the new port.

On the southern side of Suez Canal, the site of new port North Al-Sokhna has been chosen in the vicinity of the free industrial zone Northwest Suez Gulf. The location leads to the main road network through Suez. The area of the port is about 22 square km, with 8700m. of berth length. It consists of 4 main docks; the first one allocated is planned to begun operation in the first half of 2000. The port has a navigational channel 3325 m long, 350 m wide and 17 m deep with 2 breakwaters 960 and 770 m in length respectively and a 650 m diameter turning circle. The two Northern docks are 750 m in length, 350 m in width each and the two southern docks are 100 m in length and 350m and 250 m in width with a depth of 17 m which can be deepened in future stages.

A concession by the Egyptian government was awarded to North Al-Sokhna Port Development Company (SPDC) to manage the port with a renewable 2-year Build Operate and Transfer (BOT) agreement. The agreement requires that SPDC furnish the terminal cranes and container handling equipment, manage the port operations and promote the advantages of the port internationally. Other partners in SPDC include the Stevedoring Services of America (SSA), which specialises in designing, constructing and operating port and rail facilities, and the Egyptian Container Handling Company (ECHCO) which primarily provides terminal handling services for the fleet of American President Lines (APL) calling on Egypt from the USA and Far East, (ECHCO has a 60% stake in SPDC)

Figure 4.2 North Al-Sokhna port lay-out



Source: Egyptian Ministry of Transport and Communication

4.3 The Suez Canal

The importance of the Suez Canal in the service of world trade is clearly demonstrated by the volume which passes through it. The saving in distance sailed between Europe and Asia is significant, consequently, the saving in fuel costs will have a direct effect on freight rates. Thus, the canal has an impact on the world economy.

The first canal to link the Mediterranean Sea and the Red Sea is believed to have been in 1874 BC built by Farao Senaurset III. Ever since, modification of this canal has taken place until it was filled in by the Caliph Abu-Jafar-Al-Mansour in 767 AD for strategical reasons.

On 30 November 1848 the Viceroy of Egypt issued a "Firman of Concession" to construct a canal based on the request of the French engineer Ferdinand de Lesseps. A final concession was granted in January 1856 and the constructing work on the canal begun in April 1859. The concession to operate the canal was awarded to a limited company, Compagnie Universelle du Canal Maritime de Suez, with shares to subscribers in Egypt, France and Great Britain, primarily governmental but also private investors. It took 10 years to complete the construction of the canal.

On 26 July 1956 President Nasser nationalised the Suez Canal, the previous British and French shares in the operating Company received from Egypt being compensated for on the basis of the value of their shares. An international furore followed and the Canal was closed for 165 days from 26 October 1956 to 10 April 1957.

On 5 June 1967, the Canal was again closed for 8 years untill 5 June 1975. However, the first ship could transit the Canal from November 1974. Development of the Suez Canal has taken place ever since the beginning in 1869, but over the last 30 years enlargement has been significant.

Table 4.6 Enlargement of the Suez Canal

Year	Area (Sq. m.)	Max. Draft (m.)	Av. Width (m.)	Max Dwt (tones)
1869	310	6.76	45.86	7000
1900	460	7.8	58.97	10000
1908	680	8.53	79.72	14000
1912	720	8.53	84.41	14000
1914	870	8.84	98.42	16000
1954	1200	10.67	112.46	32000
1961	1600	11.28	141.84	45000
1964	1800	11.58	155.44	65000
1980	3700	16.16	228.96	150000
2010				280000

Source: Wijnolst N., Malacca Max, Delft University Press, the Netherlands

Due to the constant expansion of the Canal the maximum dimensions are increasing. At the moment (august 2000), the maximum allowable draft is 17.63 m. The width of the Canal is 3 times the breadth of the largest expected vessel at that draft.

The following factors are taken into account when calculating the minimum required depth of the Canal

- Maximum accepted ship's draft
- Squat effect (maximum 1.07 m)
- Dynamic trim (maximum 0.15 m)
- Keel clearance (1 m)
- Dredging tolerance (0.91 m)
- Tidal range
- Seasonal influences

The Suez Canal Authority (SCA) expects to reach an allowed draft of 18.85 m by this year. Further plans of achieving a depth of 22 m will take place between 2000 and 2013.

Fairplay Daily News (18 August 2000) mentioned “Egypt has given the go-ahead for the work to widen and deepen the Suez Canal which would allow the passage of VLCCs, according to news agency reports. The $441M project will allow 250,000 DWT ships with 66-foot draughts to use the canal in 2005, and by 2010, 350,000 DWT vessels of 72-foot draught will be allowed through. The expansion work will increase the width of the Suez Canal from 345 to 400 m and its depth from 22 to 25 m”.

Transit dues are calculated on the basis of Suez Canal net tonnage (the gross tonnage-enclosed spaces for machinery, equipment, crew and void spaces). Pilotage tugs (if applicable) and surcharge (for deck containers in container ships) are additional. Loaded vessels over 170.000 DWT will be escorted by two tugs. Rates of Escorting Tugboats (a Unified Canal Passenger rate of 6600 SDR is to be paid for each escorting tug. This table illustrate an overview of the dues in 1998.

Table 4.7 Suez Canal dues

	Suez Canal net tonnage											
	First 5000		Next 5000		Next 10000		Next 20000		Next 30000		Rest of	
Vessel Condition	Laden	Ballast	Laden	Ballast	Laden	Ballast	Laden	Ballast	Laden	Ballast	Laden	Ballast
Vessel Type	SDR/ SCNT											
Crude oil	6.49	5.52	3.62	3.08	3.25	2.77	1.40	1.19	1.40	1.19	1.21	1.03
Product	6.75	5.52	3.77	3.08	3.43	2.77	1.93	1.19	1.93	1.19	1.93	1.19
LPG Carrier	6.75	5.75	3.77	3.21	3.43	2.92	2.42	2.06	2.42	2.06	2.42	2.06
Dry Bulk	7.21	6.13	4.14	3.52	2.97	2.53	1.05	0.90	1.00	0.85	1.00	0.85
Container	7.21	6.13	4.10	3.49	3.37	2.87	2.42	2.06	2.42	2.06	1.83	1.56

Source: Wijnolst N., Malacca Max, Delft University Press, the Netherlands

The dues of fully laden Malacca-max, Suez-max and Maersk s-class container ships with Suez net tonnage (SCNT) 190000, 122000 and 60000 tonnes respectively are estimated as follows:

Table 4.8 Suez Canal Dues Calculation

	Fees	Malacca	- Max	Suez	- Max	Maersk	s-class
Item	**in SDR**	**Dues in SDR**	**Dues in US$**	**Dues in SDR**	**Dues in US$**	**Dues in SDR**	**Dues in US$**
For the first 5000 SCNT	7.21	36050	49749				
For the next 5000 SCNT	4.1	20500	28290				
For the next 10000 SCNT	3.37	33700	46506				
For the next 20000 SCNT	2.42	48400	66792				
For the next 30000 SCNT	2.42	72600	100188			24200	33396
Total							
For each additional SCNT	1.83	311100	429318	95160	131321	0	0
Total		430850	594573	306410	422846	162850	224733
Surcharge	14%	60319	83240	42897	59198	22799	31463
Total		491169	677813	349307	482044	185649	256196
Each escorting Tug	6600	13200	18216	13200	18216	0	0
Grand Total		504369	**696029**	362507	**500260**	185649	**256196**

Source: Based on Suez Canal Authority tables and circulars

The cost of a single passage of 6000 TEU vessel is about US$ 256196. This is a significant cost element for the ship-owner, but against it, a voyage between Northern Europe and the Far East would take about 6 days more if the vessel had to proceed via the Cape of Good Hope. In bunker alone the cost would be some US$40000, about an extra 1344 tons being required.

The economies of scale in shipping make it relatively cheap for larger vessels to sail around the Cape of Good Hope. Thus, lower rates are offered to them when transiting the Canal. This explains the increase in transiting net tonnage and the drop in net income.

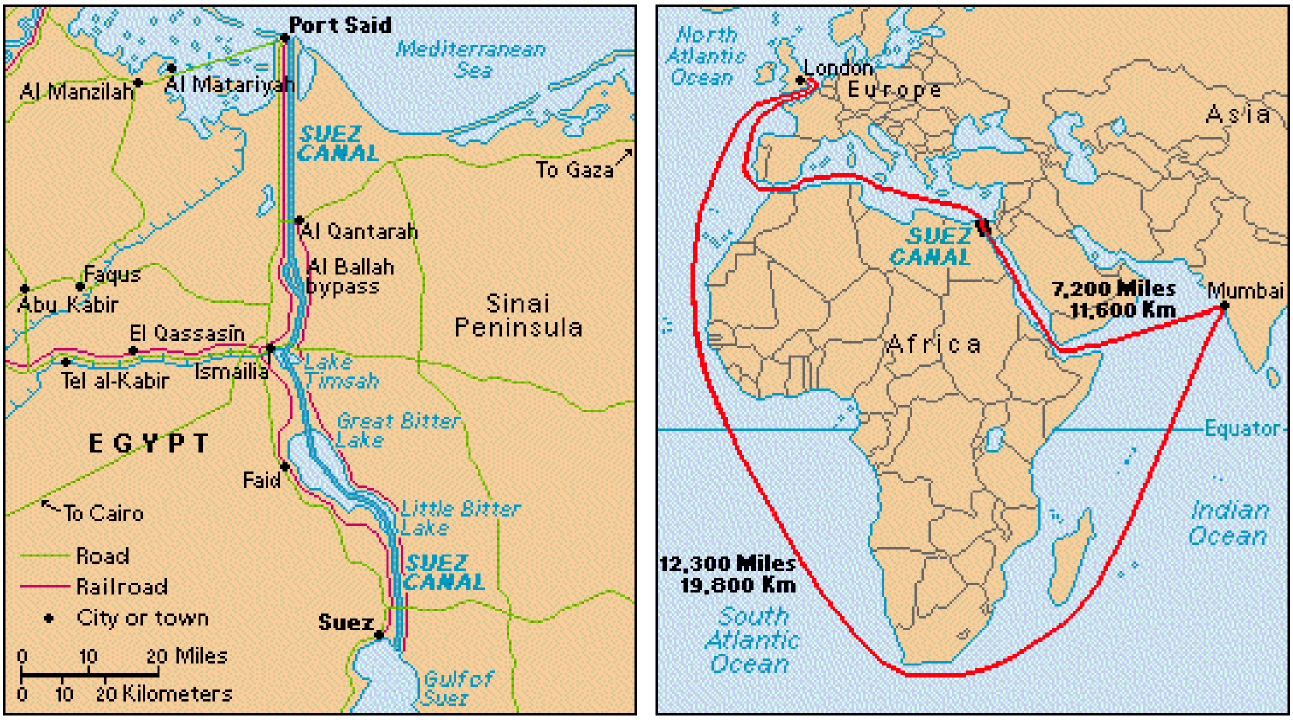
Table 4.9 Suez Canal Traffic

Year	Number	Of ships	Net Ton.	in 1000	% of total	Traffic
	Container	Total	Container	Total	In number	In Net ton
1994	3713	16370	108217	364487	22.7	29.7
1995	3765	15051	116276	360371	25	32.2
1996	4082	14731	130164	354974	27.8	36.7
1997	4012	14430	138839	386720	27.8	37.7
1998	4049	13471	154095	386069	30	39.9
1999	4375	13490	168245	384994	32.4	43.7

Source: Suez Canal Authority Yearly reports 1994-1999

As shown in the table in the last six years the total number of ships transiting the Canal dropped by 2880 ships (17.6%), while the net tonnage increased by 20507000 tons (5.6%) indicating that the average ship size increased. Container traffic in particular has increased both in ships' number by 662 ships (17.8%) and in net tonnage by 60028000 tons (55.5%). The percentage of transiting container ships through the canal of all other vessels is considered high (43.7% in 1999), which reveals an increase in trading volumes on the East-West trade route.

Figure 4.3 Suez Canal Lay-out



Source: http://school.discovery.com/students/homeworkhelp/worldbook/atozgeography/s/538160.html

4.4 Land Bridging

The development of land bridges is highly related to integrated transport systems. Equally containerisation is highly related to multimodal transport.
The concept of land bridge is not recent, the idea going back several hundred years when trade between Europe and Asia, by the ancient caravan trade, used the "Silk route". Land bridge means using land transport for a part of an ocean voyage for the purpose of reducing transit time and cost.

The important land bridges in the world exists in 3 main regions in the world; North America, Russia and Middle East. Long ago, Europe used land bridges in trading with China and India. The "Silk route" was used to transport goods from Europe through ports in Turkey and by road in Asia to China. The Egyptian land bridge to transport goods from Europe was through the ports of Rossetta and Damietta on the Mediterranean Coast, then by road to Suez then by sea to India.

The economical aim of land bridging is to save both cost and transport time. Liner operators save cost in using land bridges by concentrating on calling at fewer ports which have good connections to the hinterland by road, rail or inland water modes, thus saving on cost and time by calling at fewer ports. Also they can achieve better service in reaching land-locked countries.

There are five important land bridges are:
1) North American land bridge
This serves both the international trade and US foreign trade. By using the land bridge, international trade transits the United States from west to east or from east to west. For the foreign trade of the United States a mini-bridge and a micro-bridge are used. The mini bridge ends with a port (e.g. Hong Kong -New York) and the micro bridge ends at an inland point (e.g. Hong Kong - Chicago).

2) Canadian land bridge

This was operated before the American land bridge. It acted as a joint between the Atlantic and Pacific Oceans by using railroad.

3) Mexican land bridge

This joins the port of Coatza Coulos on the Gulf of Mexico and Salina Cruz port on the Pacific Ocean. This land bridge saves about 1000 miles in voyage distance from New York to Los Angeles if compared with Panama Canal transiting. It competes with the American and the Canadian land bridges.

4) Trans-Siberia land bridge

This land bridge joins Europe with the Far East. It consists of 4 main mutlimodal systems as follows:

a. Ocean-Rail route

   Containers are transported by ships from Japan to Nakhoda then Vostochny ports in Eastern Russia, then by rail through Siberia to Moscow then to Chop in Slovakia, Brest in Poland, Djulfa in Iran, Kushka in Afghanistan, Urgeny in Romania or Luzakia in Finland.

b. Ocean-Rail-Ocean route

   Containers are transported from a Japanese port to Nakhoka or Vostochny in Eastern Russia, then by rail to Baltic Sea or Black sea ports, then by ship Scandinavia and Europe or Mediterranean ports

c. Ocean-Rail-Truck route

   Containers are transported from Japanese ports to Eastern Russian ports then by rail to Moscow then by trucks to Germany, France or Switzerland.

d. Ocean-Truck-Air-Truck route

   Containers are transported by sea from Japan to Eastern Russia then by trucks to Vladivostock then by air to Luxembourg then by trucks to final destination in Europe.

5) Middle East land bridges

The political instability in the Middle East, in addition to the successive closure to the Suez Canal, resulted in the initiation of intermodal land bridges.

The search for an alternative was essential especially for the Gulf States, which was greatly affected by the closure of the Canal. The alternative route for shipping, around the Cape of Good Hope, was an expensive one due to the high cost of using more fuel and more transit time. Meanwhile when the sudden demand on shipping to import goods to the oil-rich countries took place, the Gulf Peninsula lacked port facilities. The use of a land bridge was the most cost-effective way to trade.

The four main land bridges in the Middle East are:

a. The Turkish land bridge

Cargo is shipped from Europe to a Turkish port in Mediterranean then by trucks to Iraq, Kuwait, Bahrain, or Saudi Arabia. This land bridge was still operating even after the reopening of the Sues Canal and the vast improvement of port and shipping facilities in the Gulf Peninsula. The reason for this was the safe passage, due to the Iraq-Iran war and the considerable savings both in transit time and transport cost.

b. Lebanon land bridge

This was used like the Turkish land bridge but due to the political instability in Lebanon and the reopening of the Suez Canal it did not develop.

c. Israeli land bridge “Kedim”

Another land bridge formed because of the closure of the Suez Canal is the Negev Continental Bridge (NCB). The main purpose of this land bridge is to transport containers between Europe and the Mediterranean at one end and the Indian Ocean and Far East at the other end. After the reopening of the Suez Canal this land bridge did not cease operation. Kedem Land Bridge Company, a subsidiary of the Zim Navigation Company, operates the Kedem land bridge. It is part of a worldwide intermodal transport system operated by Zim.

This land bridge links the port of Ashdod on the Mediterranean cost with port of Eilat on the Red Sea (Gulf of Aqaba). The length of the bridge is about 300 km.

Chapter 5

SUGGESTED SOLUTIONS

5.1 Introduction

The further dredging of the Suez Canal to achieve a depth of 72 feet is expected between 2010 and 2013. The dredging is an expensive operation and unless its cost is offset by the income generated from the transiting of larger ships it will not be urgent. However, the Suez Canal Authority has this operation planned.

For a large container carrier like Malacca-Max the transiting of the Suez Canal is an essential part of its voyage. As mentioned before, it will be deployed in the East-West trading route because of its size. With a draft of 21 metres it will be impossible for it to pass the Canal at the present time. The only way to do that is by lightening it to reach the maximum permissible draft of (17m.).

The modes of transport on the suggested land bridge are Road and Rail. The major features of the infrastructure for both modes exists apart from the rail connections to ports which are still under construction. Both ports are not yet operative, therefore the tariffs and dues of other similar ports of the Red Sea ports and lighthouse administration is applied. Similarly the rail and road tariffs are approximate from the Egyptian rail authority and from private contractors.

The suggested solution is composed of two parts. The first part deals with a cost analysis of the Malacca-Max container ship. The result is a cost comparison of the slot cost, slot cost per mile and transport cost per TEU of this ship and other container ships. This is demonstrated in two scenarios of operational patterns.
The second part deals with the cost of the land bridge. The result is a cost comparison between using the land bridge and using the Suez Canal.

5.2 Cost analysis of two Malacca-max scenarios

- First scenario:

The voyage starts at Rotterdam (Europe) and is bound for Singapore (Asia). In addition to the containers being carried to the Far East, other containers are to be carried to the Mediterranean and the Middle East in both directions. This part will be discharged at East of Port Said port, on the eastbound leg, until it reaches the required draft. A transhipment operation, either by using the suggested land bridge or direct by feeders, will then take place to deliver these containers to their final destination.

Similarly on the west bound leg some containers will be carried to the Mediterranean and the Middle East. These containers will be transhipped at the new North Al-Sokhna port at the Red Sea (Gulf of Suez) either by feeders or by using the suggested land bridge.

The majority of the containers, which will be discharged at East of Port Said Port on the eastbound leg, will be destined for Mediterranean ports. Similarly, on the west bound leg the majority of the containers, which will be discharged at North Al-Sokhna, will be destined for Red Sea ports. However, the land bridge can be used to serve the opposite side as well.

- Second scenario

Similar to the first in concept but achieving a higher utilisation ratio, the vessel will call twice at each of East of Port Said Port and North Al-Sokhna port as follows.

The voyage starts at Rotterdam East bound for East of Port Said Port for the lightening operation, then passing through the Canal and calling at North Al-Sokhna port to load again containers transhipped via the land bridge from Damietta on the Mediterranean side to North Al-Sokhna on the Red Sea side for destined Singapore.

Similarly, on the west bound leg, which starts at Singapore, the vessel will call at North Al-Sokhna port for lightening then transit the Canal and call at East of Port

Said Port to load transhipped containers from the Mediterranean bound for Rotterdam in northern Europe.

This solution is based on the idea of maximum utilisation of the ship on both the east and westbound legs. The containers to be loaded or unloaded at both ends of the Canal are to and from the Mediterranean and Red Sea markets as follows:

Table 5.1 Suggested operational pattern of Malacca-Max

Port	Operation	Container Origin	Container Destination
East bound			
Rotterdam	Loading	N. Europe	Med. / Red Sea / Far East
East Port Said Port	Unloading	N. Europe	Med.
North Al-Sokhna	Loading	Med. / Red Sea	Far East
Singapore	Unloading	N. Europe / Med. / Red Sea	Far East
West bound			
Singapore	Loading	Far East	N. Europe /Med. /Red Sea
North Al-Sokhna	Unloading	Far East	Red Sea / Med.
East Port Said Port	Loading	Med. / Red Sea	N. Europe
Rotterdam	Unloading	Far east / Med. / Red Sea	N. Europe

To begin with, the number of containers to be unloaded, for the lightening operation, can be calculated as follows based on the ship's specifications the Tons Per Centimetre Immersion (TPC):

TPC = WPA/97.56 (where WPA is water plan area in Sq. metres)

WPA = L *B *Cw (length at water level *Breadth *Coefficient of fineness)

Cw = Area of water plan/area of rectangular having the extreme dimensions

= 380*60/390*60 = 0.974

WPA = 390*60*0.974 = 22791.6 Sq. metres

TPC = 22791.6/97.57 = **233.62** ton

Number of containers to be discharged

Draft difference = present draft- required draft

= 2100 – 1700 = **400** centimetres

Tonnes to be unloaded = TPC * draft difference = 234 * 400 = **93600 tonnes**

Number of containers (based on average load 12 t. / TEU) = 93600/12 = **7800 TEU**

The vessel loads 75% FEUs and 25% TEUs (assuming that the containers to be unloaded here are of the same ratio)

The Number of TEUs to be discharged = 7800*25% = **1950 boxes**

The Number of FEUs to be discharged = 7800*75% / 2 = **2925 boxes**

Total Number of Boxes to be discharged = **4875 boxes**

The time needed to unload this number of containers in each port at both ends of the Canal (assuming that there are 3 gantry cranes each capable of doing 70 moves per hour) will be:

Time for unloading or loading = Number of boxes / total capacity of 3 gantry cranes

= 4875/210 = **23.2 hours**

Calculations are based on the following economic evaluation of the design done by Wijnolst N., Scholtens M. and Waals F. in "Malacca-Max the ultimate container Carrier". The author has noticed that the Suez Canal dues were mistakenly used in US$ while they are in SDR units and should have been converted to US$. He has avoided this in his calculations. This is why some differences exist.

In addition, the following assumptions are taking place in both scenarios

1) Suez Canal:[1]
   a. Dues are as per table 4.8 in chapter 4, no surcharge for deck containers is added.
   b. Two escorting tugs in any Suez canal Passage are added (DWT. is over 170000 t.)
   c. Consumption during passage is only M.D.O
   d. Transit time is 24 hours (actual steaming is only 16 hours)
   e. Speed is variable during transiting
   f. Surcharge for deck containers is eliminated in both scenarios
2) Number of containers used in cost calculations is the weighted average
3) Egyptian port:
   a. Dues are based on the tariff of the Egyptian Authority for Red Sea Ports.
2) Distances between ports are in nautical miles.
3) All the numbers are rounded up to 0 decimal.

[1] Canal dues in table 5.2 are different than in table 5.3 (original scenario) because dues in table 5.2 are written in US$ while they are in reality in SDR

Table 5.2 Economic evaluation of Malacca-Max

Voyage costs	US$/ton	Costs(US$)	Duration (Hours)
Rotterdam			
Pilotage		30370	4
Towage		12500	2
Tonnage dues	0.45	93600	0
Loading costs	0		48.6
Mooring dues		4720	1
Agency fees			0
Other expenses		10000	0
Idle time in port			1
Total costs/time	Rotterdam	**151190**	**57**
Suez Canal dues		**1070338**	**48**
Singapore			
Pilotage		30370	4
Towage		12500	2
Tonnage dues	0.3	62400	0
Loading costs	0		48.6
Mooring dues		4720	1
Agency fees			0
Other expenses		10000	0
Idle time in port			1
Total costs/time	Singapore	**119990**	**57**
Trip Length	Fuel costs	**729132**	**846**
Voyage costs + Terminal handling		**2070650**	**1007**

Costs per TEU	(US$)
Slot costs (US$/TEU/day)	7.31
TCE (US$/TEU/day)	4.29
Cost/slot/mile (US$/TEU/mile)	0.019
Transport cost/TEU	153

Ship Particulars	
Loa	400
B (m)	60
T (m)	21
Speed (Kn.)	25
Light ship weight (ton)	70771
DWT (ton)	243800
GT (ton)	208000
NT (ton)	110000
Suez Canal Net (ton)	190000
TEU capacity	18154
Cargo capacity (containers)	11346
Crew No.	25
Building price (US$000)	181500
Engine power (kw.)	120000
Service speed	25

Round trip costs	(US$)
Capital costs	2079406
Operational costs	861972
Voyage costs	2070650
Terminal handling charges	0
Miscellaneous costs	0
Total costs	5012028

Voyage characteristics	
Type of cargo	Cont.
HFO price (US$/ton)	75
HFO Consum. (ton/sea day)	513
MDO price (US$/ton)	130
MDO Consum. (ton/port day)	36
Sailing speed (kn.)	19.5

Cargo characteristics	
Load factor W/E bound	90%
Loading Cap. (moves /hr.)	420
FEU % in load	75%

Source: Wijnolst N., Malacca Max, Delft University Press, the Netherlands

Scenario	**Original**			**1**					**2**						
Dep.	Rdm	Sng	**Total**	Rdm	PSd	Sng	Ask	**Total**	Rdm	PSd	Ask	Sng	ASk	PSd	**Total**
Dest.	Sng	Rdm		PSd	Sng	Ask	Rdm		PSd	ASk	Sng	ASk	PSd	Rdm	
TEUs	16339	16339	**32678**	16339	12439	16339	12439	**57556**	16339	12439	16339	16339	12439	16339	**90234**
Utilization	90%	90%		90%	69%	90%	69%		90%	69%	90%	90%	69%	90%	
Distance	8250	8250	**16500**	3274	4729	4927	3274	**16204**	3274	30	4729	4927	30	3274	**16264**
Speed	19.5	19.5		19.5	19.5	19.5	19.5		19.5	19.5	19.5	19.5	19.5	19.5	
Times															
At sea	423	423	**846**	168	243	253	168	**831**	168	2	243	253	2	168	**834**
Loading/U	49	49	**98**	39	23	39	23	**124**	39	23	23	39	23	23	**170**
Clearing	8	8	**16**	8	8	8	8	**32**	8	8	8	8	8	8	**48**
Canal	24	24	**48**		24		24	**48**		24			24		**48**
Total	504	504	**1008**	215	298	300	223	**1035**	215	57	274	300	57	199	**1100**
W.Av.TEU	8170	8170	**16339**	3393	3576	4731	2679	**14378**	3192	639	4062	4451	639	2954	**15938**
Costs															
F.O	349038	349038	**698077**	138515	200073	208450	138515	**685554**	138515	1269	200073	208450	1269	138515	**688092**
M.D.O	15795	15795	**31590**	9165	10725	9165	10725	**39780**	9165	10725	6045	9165	10725	6045	**51870**
Port	151190	119990	**271180**	151190	100096	119990	100096	**471372**	151190	100096	100096	119990	100096	100096	**671564**
Canal	696029	696029	**1392058**		612789		612789	**1225578**		612789			612789		**1225578**
Voyage	1212052	1180852	**2392905**	298870	923683	337605	862125	**2422284**	298870	724879	306214	337605	724879	244656	**2637104**
Capital	1040919	1040919	**2081838**	443763	614364	618812	460283	**2137222**	443763	116752	564804	618812	116752	410723	**2271606**
Operation	431490	431490	**862980**	183952	254671	256515	190800	**885938**	183952	48397	234127	256515	48397	170256	**941644**
Total	2684461	2653261	**5337722**	926586	1792718	1212931	1513209	**5445444**	926586	890028	1105145	1212931	890028	825636	**5850354**
Per slot	7.82	7.73		6.33	11.63	5.95	13.10		6.33	30.37	5.94	5.95	30.37	6.10	
/TEU/mile	0.020	0.020		0.017	0.030	0.015	0.037		0.017	2.385	0.014	0.015	2.385	0.015	
Transport	329	325	163	273	501	256	565	189	290	1392	272	273	1392	279	184
Total															
Costs	5337722			5445444					5850354						
W.Av.TEU	16339			14378					15938						
Time	1008			1035					1100						
Distance	16500			16204					16264						
Av. Cost															
/ slot/day	7.78			8.78					8.01						
/TEU/mile	0.020			0.023					0.023						
Transport	163			189					184						

Rotterdam: Rdm - East of Port Said Port: PSd - North Al-Sokhna: ASk - Singapore: Sng

Table: 5.3

The cost evaluation for different container ships is illustrated in the following table.

Table 5.4 Cost comparison of large container ships

			COSTS in US$					
Ship	Cap. TEU	*Change % Of previous*	TEU/Day	*Change % of previous*	TCE TEU/ Day	*Change % of previous*	Transport Sea days	*Change % of previous*
Tokyo Senator	3017		10.74		5.16		225.71	
Hannover Express	4407	*46.07%*	10.84	*0.93%*	6.00	*16.28%*	228.57	*1.27%*
Hyundey Admiral	4411	*0.09%*	10.19	*-6.00%*	5.59	*-6.83%*	213.71	*-6.50%*
	5000	*13.35%*	10.00	*-1.86%*	5.47	*-2.15%*	210.00	*-1.74%*
Hanjin London	5302	*6.04%*	9.89	*-1.10%*	5.68	*3.84%*	210.00	*0.00%*
P&ON Southampton	6674	*25.88%*	9.26	*-6.37%*	5.00	*-11.97%*	192.86	*-8.16%*
Maersk K-class	7500	*12.38%*	9.05	*-2.27%*	5.20	*4.00%*	191.43	*-0.74%*
Maersk S-class	8600	*14.67%*	8.74	*-3.43%*	5.05	*-2.88%*	182.29	*-4.77%*
	10000	*16.28%*	8.53	*-2.40%*	4.86	*-3.76%*	178.57	*-2.04%*
Suez-Max	12000	*20.00%*	8.42	*-1.29%*	4.95	*1.85%*	177.14	*-0.80%*
	15000	*25.00%*	7.68	*-8.79%*	4.65	*-6.06%*	162.57	*-8.23%*
Malacca-Max	**18154**	*21.03%*	**7.78**	***1.26%***	**4.25**	***-8.60%***	**163.34**	***0.48%***

Malacca-Max	**18154**		**7.78**		**4.25**		**163.34**	
Malacca-Max scinario1	18154	*0.00%*	**8.78**	***12.93%***	4.25	***0.00%***	**189.37**	***15.93%***
Malacca-Max scinario2	18154	*0.00%*	**8.01**	***2.97%***	4.25	***0.00%***	**183.53**	***12.36%***

Source: Wijnolst N., Malacca Max, Delft University Press, the Netherlands

The table shows the savings achieved by increasing ship's size. However, these savings are not evident if compared to Time Charter Equivalent. The transport cost in this table is only for the deep sea leg which constitutes the smaller part of the transport cost, the major part being transhipment and through transport costs (80%).

The table shows the increase in cost in the case of applying any of the suggested two scenarios. However, the saving is still comparable to the largest vessels running today (Maersk K-class and Maersk S-class), and the amount in slot cost to –13% & 9.8%, and in transport cost to –2.8% & an increase of 2% respectively.

5.3 Land bridge cost analysis

The proposed land bridge will join the northern side of Egypt in East of Port Said Port with the Southern part at North Al-Sokhna at the Red Sea.

The suggested intermodal component of the land bridge will be as follows:

1) New East of Port Said Port – North Al-Sokhna by means of direct rail transport
2) New East of Port Said Port – North Al-Sokhna by road transport

This land bridge will facilitate the trade of Malacca-max container ship by moving containers for transhipment southward from Damietta port on the Mediterranean coast to North Al-Sokhna port on the Red Sea coast or vice a versa.

Calculation method:

The calculations of this example will compare the cost of transporting containers unloaded at North Al-Sokhna to Damietta to be transhipped to Mediterranean ports.

The following is the given data for the example application:

The distance between North Al-Sokhna port to Damietta port by road is 200 Km, while the distance is 180 Km by rail transport.

The train's specifications used for this example are:

Number of trains	2
Number of wagons	60 per train
Max. load per wagon	60 T.
NR. of TEUs per wagon	1x40' + 1x20' or 3x20'
Voyage length	180 Km
Voyage time	3 Hrs.
NR. of round voyages per train	2 per day

Cost by rail

Cost of transport per 20’ loaded box	97.0$
Cost of transport per 40’ loaded box	193.0$
Total cost per wagon (loaded boxes)	290.0 $
Total cost per train	20300$
Cost per 20’ empty box	34.0$
Cost per 40’ empty box	68.0$
Total cost per wagon (empty boxes)	102 $
Total cost per train	7140

The truck specifications used for this example are:

Container truck capacity	1x40’ or 2x20’
Maximum load	40 T.
Voyage time	3 Hrs.
NR. of Voyages per day	6
NR. of trucks available	as needed
Cost per truck	150$

<u>Example:</u>

Assumption:

The number of boxes at North Al-Sokhna port to be transported to Damietta is 4875 boxes divided into 2925 40’ containers and 1950 20’ containers. Required cost and time of transport cost and time between the two ports by using Suez Canal.

<u>Solution:</u>

By combining both modes, rail will transport 1950 20’ containers and 1950 40’ containers. The remaining 975 40’ containers will be transported by truck. However, the solution will show the cost and time of transporting the whole number of containers by train only.

1) By using train only (cost and time calculations):

Train cost calculations

Day	Nr. Of Trips	Nr.of 20'	cost $	Nr. of 40'	cost $	Total $
1	4	280	27160	280	54040	81200
2	4	280	27160	280	54040	81200
3	4	280	27160	280	54040	81200
4	4	280	27160	280	54040	81200
5	4	280	27160	280	54040	81200
6	4	280	27160	280	54040	81200
7	*4*	*270*	*26190*	*285*	*55005*	*10150*
8	4	0		280	54040	10150
9	4	0		280	54040	10150
10	4	0		280	54040	10150
11	2	0		120	23160	10150
Total		1950	189150	2925	564525	**753675**

The combination of rail and road will be as follows:

960 40' containers will be transported by road and 1965 by rail in addition to 1950 20' containers by rail. The cost by rail will be US$568395 (until day 7 only).

The cost of trucking is as follows:

Total NR. of trips needed 960, cost per truck is US$150. Therefore total cost by road is US$144000. the total cost when a combination of rail and road is used will be:

568395 + 144000 = US$712395 (cheaper than rail only)

Truck time calculations.

Time calculation is flexible as it depends on the number of used trucks but the following can be assumed:

By using 100 trucks, each truck makes 3 trips per day; i.e. there are 300 trips a day.

Total time needed for containers = total trips/ trips per day = 3 days

2) By transiting the Suez Canal (cost and time calculations):

Transport 7900 TEU needs a large ship (assuming Maersk s-class)

Time: 24 hours

Cost of transiting Suez Canal = US$230000.0

Transport cost = 182.3*7900 = US$1440170.0

Total cost = US$1670170.0

Table 5.5 Cost comparison between land bridge and sea transport

Mode	Cost US$	Time
Rail	753675	10.5 days
Rail & Road	712395	7 days
Sea transport	1670170	1.0 day

The final result shows that the combination of rail and road is more feasible than using only one mode. Similarly, the land bridge is more feasible than the Suez Canal.

5.4 Sensitivity analysis

Since the quantity of twenty and forty feet containers is always changing and the assumptions, in both scenarios, deal only with certain percentages, (25% & 75%) therefore a sensitivity analysis is needed to see the impact of the change in box size, in addition to the impact of the reduced productivity of gantry cranes.

This analysis will deal with the quantity of containers and the discharging rate either at East of Port Said Port or North Al-Sokhna Port. The impact of these changes will be noticed on loading / unloading time (time in port), thus increasing the whole round voyage time which, in turn, will result in an increase in capital, operation and voyage costs.

Table 5.6 Sensitivity Analysis

Ship's Load		Load/ Unload				Port	Impact % 1st Scenario			2nd Scenario		
Quantity	Mixture		Total	Rate	Time	Time	Cost			Cost		
In TEUs	%	FEU/TEU	Boxes	Box/Hr	Hrs.	Hrs.	Total	/slot/d	Trans	Total	/slot/d	Trans
8700	100/0	3900/0	3900	210	18.6	-20	5418023	8.80	188	5795513	8.05	182
8700	**75/25**	**2925/1950**	**4875**	**210**	**23.2**	**0**	**546690**	**8.78**	**189**	**5852847**	**8.01**	**184**
8700	50/50	1950/3900	5850	210	27.9	20	5475981	8.76	191	5911428	7.96	186
8700	25/75	975/5850	6825	210	32.5	40	5504648	8.74	192	5968762	7.92	188
8700	0/100	0/8700	7800	210	37.1	60	5533315	8.72	193	6026097	7.88	190
				157	24.8	7	5456662	8.77	190	5872789	7.99	184
				157	31.1	34	5495923	8.75	192	5951313	7.94	187
				157	37.3	61	5534562	8.72	193	6028589	7.88	190
				157	43.5	87	5573200	8.69	195	6105866	7.83	193
				157	49.7	114	5611838	8.66	196	6183143	7.78	196

This table is in two parts. The upper part deals with the maximum loading/unloading rate of 210 boxes per hour, while the lower part deals with the lesser rate (75% utilisation). In both parts the same mixture of boxes is dealt with. The bold line represents the base for comparison (case illustrated in table 5.3).

As seen in both tables the box size and the loading/unloading rate has a direct impact on both time in port and costs. The ideal case will be all boxes of forty feet and using the maximum loading/unloading rate of 210 boxes per hour.

5.5 Transhipment comparison

The differences between the two main alternatives, dredging the Suez Canal or not, can be summarised as follows:

1) In the case of dredging the Suez Canal, Malacca-max will transit the canal and transhipment of the Mediterranean cargo, if any, will be done through Rotterdam by different means (i.e. short sea shipping or by land or by combination).

2) In the case of the Suez Canal not being dredged, Malacca-max will unload the Mediterranean cargo loaded at Singapore at North Al-Sokhna port then transhipment will take place from there as follows:
   a. By the suggested land bridge, and in this case the cargo will be transported multimodaly to Damietta port on the Mediterranean coast, then by feeders to its final destination
   b. By using feeders direct from North Al-Sokhna port to the final destination, or to a Mediterranean hub port, thereafter to the final destination. In both cases transiting the Suez Canal will be part of the cost.

In addition, some factors are to be considered as well like the ship size which will be deployed in the transhipment operation and finding suitable employment afterwards.

It can be concluded that the most suitable way to tranship the Mediterranean cargo is by the land bridge. Despite the cost and time involved, the cargo itself will increase the utilisation factor of this ship. The size of cargo required to fill the Malacca-max is too large, especially if only serving two markets.

The following assumptions are made for the purpose of the comparison:

1) Number of containers FEU/TEU = 2925/1950
2) Different ship sizes are used in comparison
3) Terminal handling charges are not included in calculations.
4) Time calculation is 24 hours for loading and 24 hours for the passage including transiting the Suez Canal.
5) In the case of using a ship that cannot accommodate all the quantity, the total cost is multiplied by a factor = (total load/actual ship's load).
6) The Suez Canal dues are based on approximate SCNT.

Table 5.7 Transhipment comparison (North Al-Sokhna to Damietta)

	Transport Mode	Time Hrs.	TCE	Costs Total US$	/TEU/day US$	Transport US$
Train and truck	Land	168		712395	11.7	82
Ship of 3017 TEU	Sea	138	5.16	548321	11	63
Ship of 4407 TEU	Sea	95	6	455768	13.1	52
Ship of 5302 TEU	Sea	79	5.68	402508	14	46
Ship of 6674 TEU	Sea	63	5	357162	15.6	41
Ship of 7400 TEU	Sea	56	5.20	301695	15	35
Ship of 8700 TEU	Sea	48	5.05	344066	20	40

As illustrated in the table, the differences in transhipment costs between the land bridge and the sea transport is not large when the cost per TEU per day is considered. However, one can argue that the major difference is in time.

From a different perspective it can be said that the use of a ship in transhipping this large quantity of containers for this distance is not practical. On the other hand, if smaller vessels are used, the increase in time will be very high, besides finding employment for such vessels in the area.

In the case of transhipment taking place from Rotterdam to the Mediterranean, as this may be the case in the original scenario, there will be no need to do any comparison. The purpose of the comparison is to find out the cost and time involved in the transhipment operation from one point to another by different modes. If Mediterranean cargo is transhipped from Rotterdam, evidently there are different cost and time elements that do not match the first and the second scenarios.

Figure 5.1 Land bridge illustration

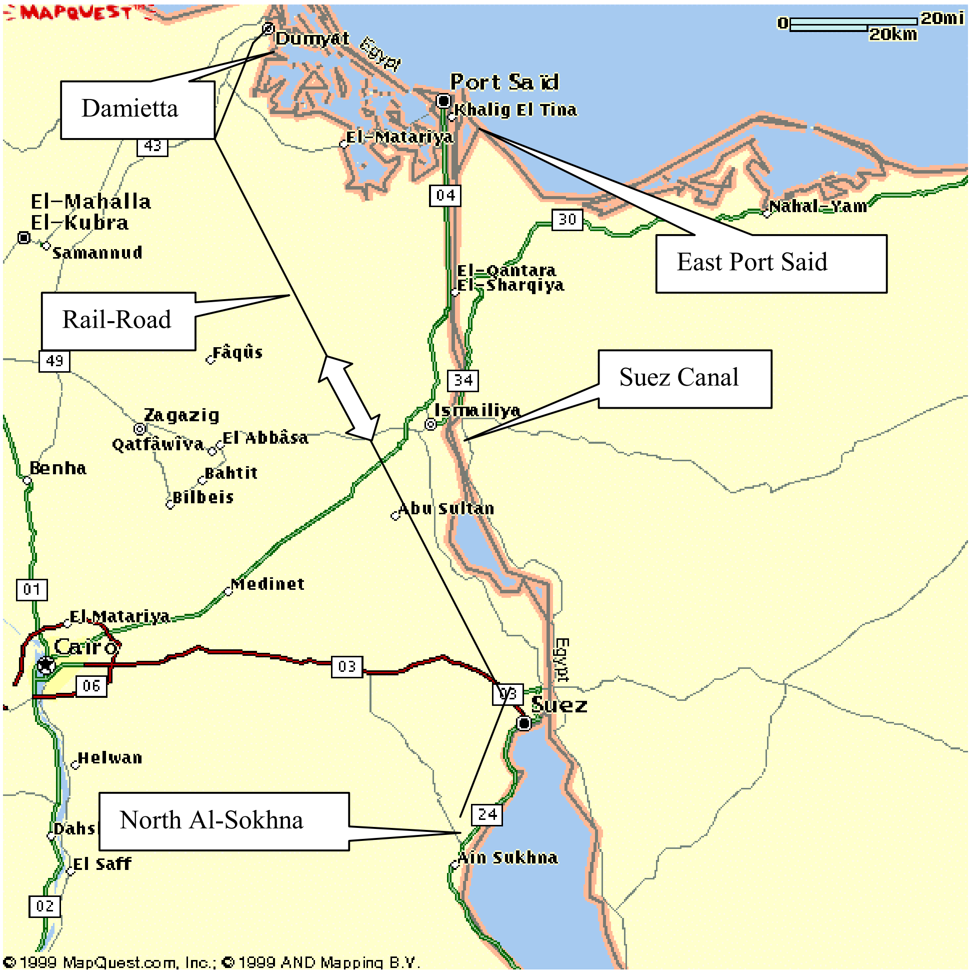
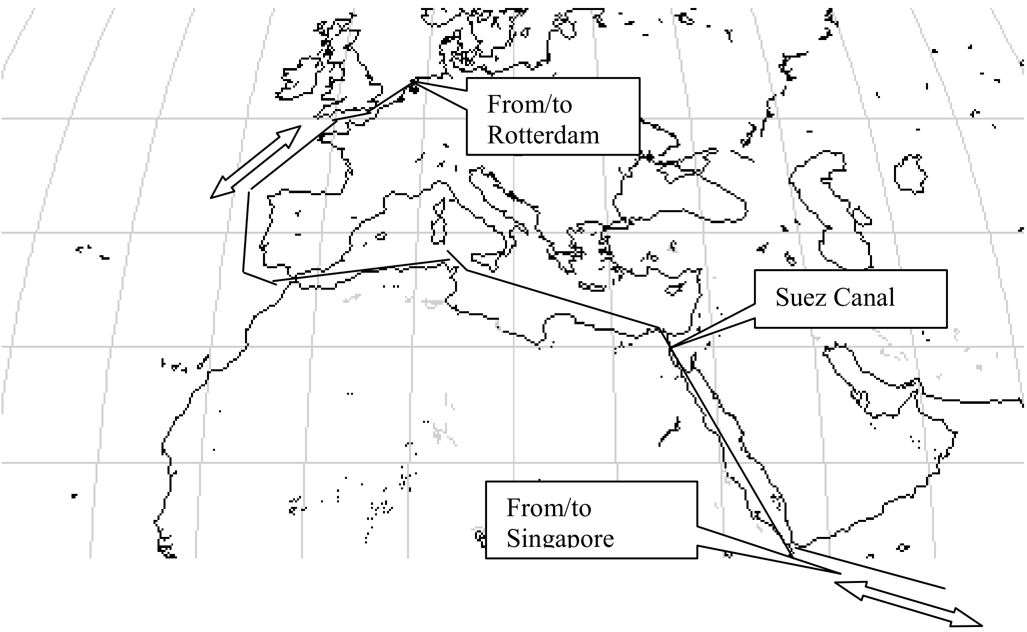


Figure 5.2 Malacca-max main trading route



Chapter 6

CONCLUSION AND RECOMMENDATION

The investigation in this dissertation is on the effect and the possible future of very big container ships. The choice was the Malacca-max and the study that has been done has involved the dredging of the Suez Canal.

The topic of this dissertation is to investigate an alternative to dredging, namely to seek different operational patterns and to establish a land bridge by the use of different ports that enable the Malacca-max to pass through the Suez Canal without dredging.
The conclusion is that it appears that if the figures are examined carefully, the total cost per TEU will be comparable to the total cost of a Malacca-max passing fully laden through the Suez Canal, which indicates that it might not be necessary to dredge the Suez Canal.

The cost of transhipment was also calculated given some assumptions as to how many containers originated in Rotterdam and Singapore that end up in the Middle East and the Mediterranean. It shows that the cost of transhipment by land bridge, if compared with feeder ships, is comparable but it is not practical to use ships because of the difficulty of finding suitable employment that matches this size.

When considering the solution, which involves the preparation of Egypt's new ports at both ends of the Canal the following is recommended

1) A suitable infrastructure that serves this massive container movements.
2) Suitable arrangements for handling this size of ships and which includes the size of container handling cranes, shore handling equipment and staking yards.

3) Suitable depths both at the navigational channel and at the quay side.
4) Suitable technology that matches the requirements of reliable and fast handling of transhipment operation.
5) Professional personnel.
6) Well planned marketing.

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