

The Mediterranean ports in the era of mega-carriers: a strategic approach

Orestis Schinas¹ & Dr. Stratos Papadimitriou²

I Introduction

The increase of international container movements during the last thirty years has been enormous as the market is experiencing a doubling of the volumes in every decade. Containerized shipping is the backbone of international trade and as trade volumes increase at a faster rate than the economy and as the effects of deregulation and globalization become more evident, containerized shipping is expected to increase its importance along the transport chains. Quite a few academics and professionals also assert that commodities traditionally shipped in bulk will soon be containerized as well, thus heightening the increase of unitized movements, which will impact decisively the role of the ports.

The introduction of bigger vessels does not only concern ports and carriers. Shippers and other members of the so-called port community, such as brokers, truckers, rail operators, insurers, agents are more than skeptical on the effects and the networking of the future. It is necessary for every player and actor to reevaluate his position and to foresee his role in the transport chains of the near future. The

¹National Technical University of Athens, PhD Candidate, Dept. of Naval Arch. & Marine Eng.

²University of Piraeus, Ass. Prof., Dept. of Maritime Studies

interface of the vessel and the port is only one of the many issues raised in the discussion. However the problem is not only the cranes and the depth, but also the efficiency of the nodal point in terms of port operations, local and regional conditions as well as the political formations within States and regions.

As expected the mega-carriers may follow the traditional routes of East – West and North – South, connecting continents and big regions, yet with fewer ports of call along their route. The limitations imposed by the Suez Canal, the Malacca Straits and the navigable channels close to ports are only some physical barriers limiting but also defining the size of the vessels as well as their connections. The dredging projects in the Suez Canal, the intention for the creation of new terminals in Asia and Europe are only some of the actions taken already for the shift to the new era. However, as it is very common in the history of technology and engineering achievements, many suggest that this size of the vessels is going to be the last frontier of their physical expansion, not because of technical restrictions and limits but because of the achieved economies of scale [15]. In various sources of transport engineering, the analogous of commercial aviation is presented.

The routes through the Suez Canal and the Mediterranean have historically been very important as they connect Asia and Europe. In the era of containerization the old Mediterranean ports have changed their traditional roles, the new ones have introduced relatively new concepts, such as transshipment and port networking, totally changing the commercial map. As landbridges are becoming more and more important in the logistics chains, the Mediterranean ports try also to find their position in the new map, either by connecting northern and southern European regions or by servicing the needs of ports and regions distant from the main route of Suez – Gibraltar. However each of them face different local conditions, institutional

pattern of operation and even more important most of them are not really prepared to compete for a niche in the global port market.

From a political point of view the Mediterranean 'space' [21] comes closer to the Northern Europe as well, as immigration, social interaction and regional cooperation develops into relations based on laissez-faire. Therefore the definition of the Mediterranean commercial area becomes more difficult, and the trade will follow complex networking based on efficiency and cost rather than national and ethnic 'fragmentation'. The Mediterranean ports shall find a new place in the market, as some of them shall serve as nodal points and others as national gates. Academics are also trying to answer the question, if the Mediterranean space is a unique case as such, in the sense that areas and spaces are usually defined by political formations and needs, thus affecting heavily the ideas of the nations served by the new trade networks and finally the adopted strategies of ports and entrepreneurs. In the contemporary European political and social context, the Mediterranean space is approached holistically and cohesion among nations and people is expected to replace the social barriers of the past. It is reminded that more than 250 million consumers are living closer than 150 km of the Mediterranean coastline, and the trade capacity cannot even be estimated yet.

The aim of this paper is to critically examine the effects of introduction mega – containerships in the routes through the Mediterranean to the ports and to attempt a forecast for their future, if possible, by examining the strategic points and trade patterns.

II The Era of Mega Carriers

The development of containerships has been very impressive in the recent years. Not many years ago, the first post-panamax vessels were introduced in the markets, changing radically the concepts and terms of transport. The seamless transfer of boxes at the ports either to other sea going vessels or to other modes has become integral part of contemporary logistics. In the post panamax era the cooperation of modes became a necessity and therefore the role of ports has considerably been upgraded.

The motive behind the design, construction and operation of these vessels was the achieved economies of scale. The cost per TEU and sea mile has been reduced, permitting the operator to keep the tariffs at a desired level or to increase the profit margin. However there were and still are restrictions for the vessels, which can be sorted as physical, technical and port-related.

In a shipping gazette, which expresses views of a large segment of the market, it was written lately that: *'The risk to build mega-containerships of 10,000 TEU and more is drawing fire. Critics see the threat of an arms race that they will make the winners envy the losers.'* [4]. That was only a comment originating from the hostility expressed by the shippers. More specifically shippers expect a cost increase and reduced services, in terms of flexibility, more nodal points along the chain, longer total transit times, greater risks. The source of worries is the same point that carriers try to achieve: economies of scale. A slowing growth in the world trade, as expected by WTO and other bodies and already experienced in the US, will also decrease, if not diminish, the profit margins achieved by the larger sizes and volumes. So as the expenses are relatively inelastic and the price of oil will be high enough, losses are expected at least in the sea leg of the transport chain. Consequently the lower level

of provided service and the red ink in the balance sheet of the sea carriers will be have a direct negative effect on shippers and consignees. At this point it is very interesting to note, that Gilman [12] estimates the capital costs of a super post-panamax 66% higher than those of a panamax vessel, while the fuel costs are 63% higher. Furthermore the large numbers of loaded/unloaded TEU in ports will create problems and delays, so the efficiency gained at sea will be lost on land. In general the worrying points of academics and professionals are the following:

- **Load / Unload time:** As the mega containerships shall reduce the number of ports of call, in order to achieve the necessary economies, the load and unload time in the ports will be increased. As long as these vessels stay at port they will not generate income for their owners and worsen their economic performance will worsen, in addition to the rest of the logistics problems they create to ports.
- **Congestion at ports and in roads:** Even if proved that these vessels are financially viable, the ports and their road connections will experience problems of congestion. Such problems incur heavy social and environmental costs and are usually dealt with infrastructure investments.
- **Cost of transshipment:** Logically these vessels shall call fewer ports, so the boxes shall go through more nodal points than necessary today. This will increase the cost of transshipment, even if the cost at the mega-hubs will be as low as possible. As the boxes leave the mega-hub ports then they are confronted with the inelastic local port dues, which are considerably higher and therefore the economies achieved in the vessels are diminished at ports and nodes.

- **Increase risk of damage and theft:** It is not necessary to analyze this point, as common sense implies that as more movements and handling the cargo experiences the more it becomes vulnerable to damages and malicious acts. Shippers and insurers are aware of this fact, and therefore they will strongly fight for less transshipment or increased carriers' liabilities.
- **Missed transshipment connections:** As the system becomes more complex and more means and factors are involved, uncertainty is also increased and boxes will miss their specific destination and time goals. This complexity imposes very strict operational targets for the shippers as well, who at the bottom line are the customers, and they do not feel very comfortable in changing their business habits unless a major improvement or cost reduction can be achieved.
- **Heavy terminal investments:** Finally port authorities, operators and stakeholders, including the carriers, are afraid that the introduction of these vessels will demand heavy investments. Extreme quay and channel depth, new cranes, expanded yard and storage areas, more handling equipment is necessary along with continuous upgrading of IT systems. Even though the ports are not really sure that these vessels will make use of their equipment, unless the cost is extremely low and the efficiency levels at maximum. Such investments capture the capitals of ports, making them vulnerable to market fluctuations as well, and shifting inelasticity to ports by creating a situation of demand oligopoly³ – the demand for port service exercises the pressure and influences the demand.

³ oligopsony

Last but no least, the success of mega carriers is strongly based on two more factors. The first one is the current global political environment that promotes free trade, deregulated markets and free movements of goods and capitals. In several cases States are becoming only parts of wider federal-like regional schemes, such as EU, NAFTA, ECOWAS, MERCOSUR, etc. This evolution transforms international economics to a game of regional trade and relations, as well as harmonizes the terms of operation all over the region, as in the case of EU, where decisions taken by European bodies affect operations in all member States. The second factor is the further promotion of advanced logistics solutions, where supply and distribution chains become international, complex and more important in the profit structure of companies. Modern IT and especially the Internet have in many ways assisted logistics in improving their status in the list of corporate priorities. Nevertheless such IT solutions change consumers' habits and reveal the incapability of networks designed on global logistic chains to serve local needs [1]. In conclusion modern politics and modern logistics have to keep on evolving as the creation of political barriers will decrease the volumes and a stagnation of logistics development will reduce the annual ton-miles.

II.1 Vessels Considerations

Academics and professionals are currently arguing on the success of the introduction of mega carriers. Some of them argue that the capacity of the mega-containerships increase the oversupply of tonnage and therefore prices will be suppressed as more mega-vessels come into operational action. Others argue that even if the vessels enter the main routes, very few ports can undertake the load to service them and therefore the ports will also show the routes for the vessels, as long as no other mega-hub ports appear on the map. Finally others argue that these vessels have already reached their economic limits and further increase of size is probably

doomed to failure [15]. It has to be noted that in 1990 less than 6% of the US containerized cargo was moved with ships of 4000 TEU slots or more. In 2010 it is expected that almost 30% of the cargo will be handled by ships of a size ranging from 4000 to 6000 TEU slots and about 10% of the cargo by ships with about 6000 to 8000 TEU slots [28].

As container shipping is a very complex system of players, factors and parameters, various sources [12], [26] base the analysis on the port sector and the efficiency of the network, among others. It is very interesting to note that all sources highlight the role of the ports, not only as container handling performance and cost but also as connections to the hinterland, provided that the vessels can physically access their berths.

The post panamax era proved that operators have followed the bus (trunk) principle and routed their vessels in the transpacific and transatlantic connections. This service was either a clear 'end-to-end' or a pendulum, depending on the operator, and the vessels were servicing two markets basically. This was also the reason for the increase of the importance of specific hub-ports, such as Long Beach, Seattle, Tacoma, New York / New Jersey terminals, Rotterdam, Bremen, etc. It is reminded that panamax vessels had a draft of maximum 38ft, fully loaded, and a maximum capacity of about 3200 TEU, at a maximum total length of 950ft. The post panamax vessel, which in recent literature are referred as post panamax, mega-carriers, or jumbo-carriers appeared in mid '80s and are currently into discussion as designs of almost 9000 TEU have been already ordered. As Panama Canal cannot impose any more physical restrictions, these vessels face only the next physical barrier, which is the Suez Canal.

The points of concern for the ports are mainly the draft, the length, the width and the capacity of the vessels. The draft of these vessels is close to 46ft (14m) fully loaded thus requiring a channel depth of 50ft (15.24m). For comparison reasons a typical panamax had a draft of 38ft (11.6m) and required a channel of 42ft (12.8m) and the first generation of post panamax vessels (those in the range of 4,000-6,000 TEU) have a draft of 42ft and require 46ft in the channels. The length of the vessels has not been a major problem up to now, but as it surpasses the range of 980ft ($\approx 300\text{m}$) some terminals are excluded, especially those at the deltas or rivers.

The beam of these vessels is close to 140ft ($\approx 42.8\text{m}$) and is often 17 containers wide. That means that special cranes of 136ft beam shall be employed. Some designers have already proposed ships of 21 to 28 containers wide, thus making the future needs for port investments even fiercer than it is currently with the post panamax vessels.

As far as it concerns the technical considerations regarding the mega-carriers, the following issues are under discussion and examination by the classification societies:

1. **Stack weight:** as more boxes are stacked on top of the others the weight increases and dynamic loads, or even static ones sometimes, exceed the limits allowed. Currently the feasibility of intermediate supports in the holds using a cantilever concept is under examination.
2. **Container lashing on deck:** This is very hot and difficult issue, which is not resolved yet. It gains more and more the attention of engineers and mariners, as US Authorities have banned stevedores from climbing on boxes in port. Some owners have adopted low or high lashing bridges in certain

parts of the ship but on larger vessels they can become serious obstacle to speedy cargo handling.

3. **Bow damage:** The mega-carriers are high-powered hulls with optimized steelwork, and are normally pushed to catch up with the tide schedule. Classification Societies report serious structural deflection in new ships and conduct research on this issue. [2], [3]

As technology matures, vessels of larger size, even of 18000 TEU slots may come up in the drawing boards and in the industry. Haralambides argues that although it is possible to design, construct and route vessels of 18000 TEU, it is more possible that the contemporary post panamax vessels of 6000 to 9000 TEU have reached the economic limit, and therefore planning shall be based on this vessel size [15]. However, there is always the trigger of economies of scale. In container shipping cost leadership indicates economies of scale, in other words larger size of vessels rather number of ships. Capacity is added to the fleet and oversupply of available slot leads to price-cutting.

Commercially the only way for a carrier to survive is to capture and lock specific shippers or markets and simultaneously to discourage competitors from entering into the market. This is not very easy as the container capacity is expected to increase almost 40% in the coming years [18]. Normally breakeven load factors shall be lower for larger vessels due to lower unit costs. Assuming that the breakeven factor is counter proportionate to the volume of the vessel then the number of TEU for the breakeven point is the same, yet there are higher margins for profit for the bigger vessels, as every TEU more will incur higher profits. Nevertheless, not always the breakeven factors are proportionate and even a difference of 10% can demand

higher volumes, which are not always available at the logistics hubs. In several routes, where imbalances are dominant, such considerations cannot be ignored.

The next critical issue of the operation of the mega-carriers is the frequency. In modern logistics, frequency equals to flexibility and customer satisfaction. Customers care about their logistics schedule and not of the carrier. They have to adapt to the needs of the carrier, but at the same time they are not willing to experience delays or higher storage and opportunity costs. Therefore the frequency at the port of their convenience and the available connections is more than a marketing point for the carrier; it is an imperative need to keep the customer satisfied.

The cost structure of the mega carriers is also different than the common one in the container shipping operation. As the capital burden is far too high; a mega carrier will cost almost \$100m, while a panamax costs about \$60m, and this is translated as \$41,477 per day instead of 24,886 [12]. Furthermore the feeder cost for a mega vessel using hub ports at both ends could amount to \$600 per TEU, which is considered as extremely high by the shippers and logistics managers. Other market sources estimate the savings about \$46 per TEU on 7000 sm round trip voyage, when a carrier replaces a 4000 TEU slots vessel with a 6500 one [4]. So it is not really clear that the economies of scale achieved in the mega-carriers minimize the total cost along the chain.

Although it is technically feasible to built vessels with a carrying capacity of more than 7000 or even 8000 slots it becomes increasingly difficult to achieve the required speed of 24 knots using today's single engine propulsion system. A second shaft increases the cost of the vessel dramatically but the cost per TEU slot can be minimized by making the ship as large as the propulsion allows. However the most critical factor is the deployment factor that would allow the shipping company to keep

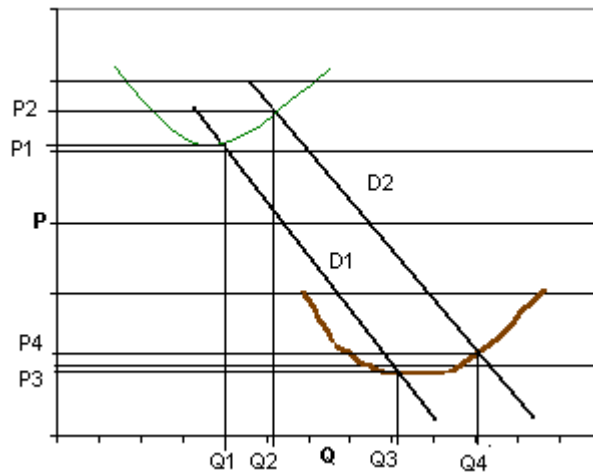
the vessel full enough and in motion often enough to pay for itself. Secondly, there are some considerations regarding the terminal, and more specifically the sufficiently deep water in ports and channels, allowing the vessel to meet the deployment scenario, and the location of the terminal along the route. These vessels can only be deployed in high traffic corridors in a pendulum network combined with a hub and spoke local system.

Finally, apart from physical or technical consideration, there is always the question of capacity, as these mega-ships will load and unload many boxes within very short time, thus requiring advanced handling techniques, yard space, adequate hinterland connections for fast turnout of the boxes and capable IT system. The ability of the port to offer these services will be crucial not only for the selection of the terminal as a port of call but also for the viability of the employment of these vessels in various routes.

11.2 Port Considerations

As mentioned above the time spent in port incurs costs. As costs are very high and frequency shall adequately serve the customers' need, port calls cannot really be the minimum ones and not earning revenues, while at port, will be a critical factor in the mega-container routes chosen by the owners. This means that ports improve their role in the logistics chains, and the level of services they offer has to be adequately high as the carrier and the market demands. It has to be noticed that this is not only a game of prices and quantities as it used to be, but a shift in approaching the customers. Ports have to re-orient their efforts to the services, as well as to invest heavily in infrastructure, if they want to attract such demanding customers, as the mega-carriers are.

From a microeconomic point of view, a port shall choose its role in the global logistics market. Very few ports will become hubs for mega-carriers, while some others will clearly become local (regional) nodal or ending points, servicing specific markets and hinterlands. It will be not possible for a port to attract occasionally transshipments, as it has occurred in several cases in the past. For example Piraeus was not a transshipment port till 1997, when almost 80% of the cargo was consigned for local needs, and the last four years, transshipments represent close to 50% of the movements. This was possible, just because the same infrastructure could serve almost all calling vessels, and no restriction or limitation was imposed to the carriers, apart from the commercial agreement. In the era of mega-carriers, ports shall choose a role and decide a strategy for their prosperity. The abstract microeconomic approach can be really very helpful in understanding the differences between these two categories of ports (fig.1) [16]:



As the conventional port optimizes the economic result and the efficiency by servicing Q_1 boxes at a price of P_1 , when the demand curve is D_1 , the mega-hub cannot cope with such low volumes. Nevertheless in case that demand experiences an increase to D_2 , the conventional port cannot serve large volumes and the economic result is deteriorating for the niche it serves. On the other hand, the mega-

hub, which needs Q_3 boxes at the average price of P_3 to optimize the economic performance, can easily serve the market and therefore attract customers and cargo. Point (Q_2, P_2) is inappropriate for load center, as the curve of the conventional port cannot be flattened as the curve of the mega-hub may be. Therefore, when the demand is high, market fluctuations can be absorbed by the mega-hub at relatively constant prices. Economic analysis of that type can help determining strategies at regional level and assist in extracting the marginal cost curves of various terminals. As ports are considered as business units, competition demands such type of analysis and it is expected that interesting results and improvements will come up in the near future.

As it is easy pretty easy to understand the efficiencies gained for the carrier, provided that demand is growing, when shifting from a conventional port to a mega-hub, it is expected that a competition between ports will be fiercer in the coming years. However the hypothesis that demand is growing cannot be valid in all cases of ports along the mega-container routes, as regions experience different economic growths. On the other hand not all ports along the routes will proceed in the necessary investments. In short, the impacts of mega-carriers on port infrastructure are analyzed on three major points of concern. The first one is the increased complexity of the necessary infrastructure. Recalling the first years of the containerization, the revolutionary equipment of gantry cranes, spreaders, etc. changed the perspective of the port, the labor relations and conditions, the cost structure and definitely the market conditions. The mega-hubs demand very complex, highly sophisticate state of the art equipment, for the speedy service of the vessels, with no human interaction if possible, smooth and seamless cooperation of all transport means involved and simultaneous transfer of information, necessary for the logistics needs. It is not only that the speed of the operations, but also the necessary space of the yard and the size of the handling equipment, that changes the terminal.

Such large infrastructure projects and superstructure needs demand capitals and time, not only for the construction or the supply, but also for the maturity of the technology. In other terms the first ports to become mega-hubs undertake high risks, while the competitors may learn from their mistakes and the maturity of the technology. Time is also pressing as the mega carriers are currently being built and ports have to react to the challenge. The capital needs are also very high, and only State owned or controlled ports can invest free from investors' interventions and worries. As the ports become more and more important for the economic feasibility of a logistics link, carriers and shipping lines are entering the port business. These schemes can also invest in the necessary infrastructure and undertake the risks. The rest of the ports can specialize on specific commodities and market niches.

The modern container ports shall offer a minimum depth of 50ft (15,3m) for the modern mega-carriers. In case that the Malacca-max vessels come up in the market this depth is not enough, as they are designed at 21m [29]. However this futuristic approach, which is extremely possible, if only the Suez Canal gets a final depth at 21m, as is planned for the year 2010, and it will change once again within very few years the port competition, especially in the Mediterranean. So port access is one of the key factors for the selection of port of call in the near future. Dredging and dredging rights is a relatively difficult problem for most ports, as it envisages high capital expenditures and environmental considerations, regarding the soil disposal. Furthermore the channel and the harbor characteristics have to offer adequate turning basins of at least 1500ft (500m), and finger piers. Referring to finger piers, engineers plan slips among two finger piers, where the vessel may come into and be served by as many cranes as necessary or possible. This evolution will bring the accommodation and the bridge of the vessel close to the bow of the ship and increase productivity of the loading / unloading operations. Port operation, land access, equipment and IT sophistication are the rest key factors.

Even if the productivity of the loading / unloading operation increases, there are always worrying issues regarding the yard operations. Normally a truck needs 52 minutes for entering the port and leaving the box, yet no peak times or stagnation of the flow is taken into account. What will happen when three or even four times larger volumes are disposed or shall be loaded within few hours? Even if intermodal means are available and promoted, the load factors for the trucks and the necessary yard space for the disposal of the boxes is extremely higher than today's. Landside accesses concern not only operators and carriers but also policy makers and social groups, because of the negative effects, which can be summarized as:

1. Congested truck routes and highways,
2. Numerous at grade rail - highway crossings,
3. Lack of land to develop adequate accesses as ports are close to inhabited areas,
4. Low clearance for double - stacked trains (not existent in Europe) and
5. Unavailability of on-dock rail in most ports.

In addition to the above the productivity of the crane shall increase; in key Asian ports such as Singapore and Hong Kong the productivity is currently at 30 to 40 lifts per hour and crane. Experience shows that in other ports the productivity level is about 22 to 25 lifts per hour and crane. Economic feasibility calculations demand crane productivity at about 70 lifts per hour and crane, which is currently achieved in special occasions only, as in the case of Singapore, where 144 moves per hour have been reported, and will be possible if only the design concept of cranes improves [29], [28]. However these calculations are based on the assumption that the port dwell time is about 20 hours and the carrier shall calculate 24 hours per stop.

High crane productivity results also and to increased storage and terminal backland requirements, as the number of TEU at port increases. Some typical solutions are the following:

1. Higher - denser stacking
2. Longer operating hours
3. ITS
4. On-dock rail

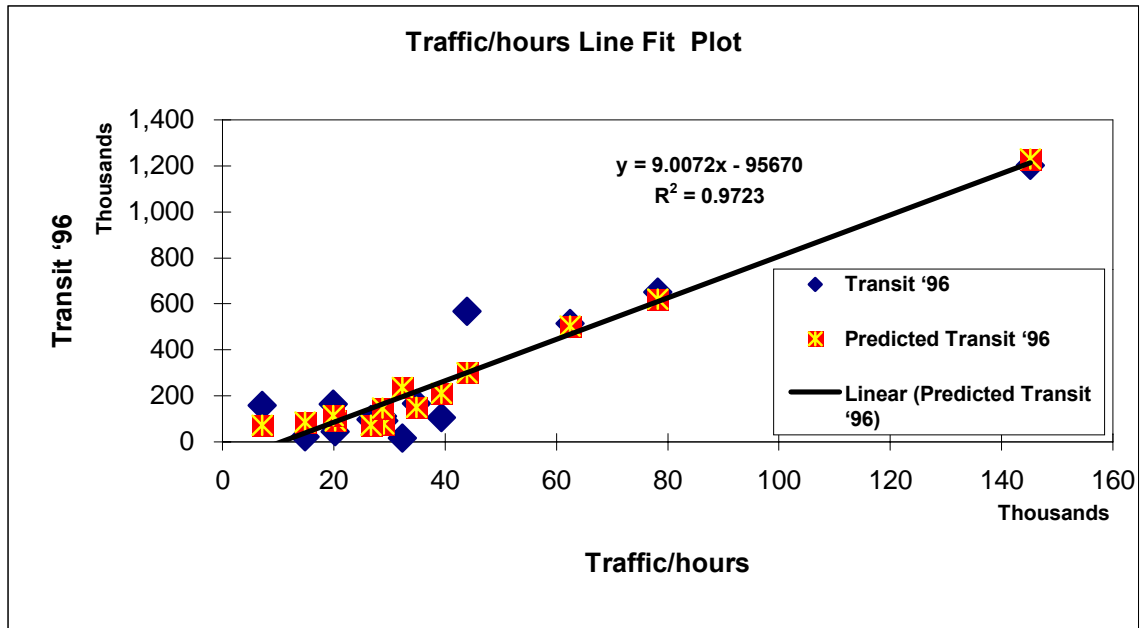
It is estimated that 50 acres per ship-berth are required for a post - panamax and 75 acres per ship-berth for beyond post panamax vessels. In addition to the infrastructure requirements, staffing problems may come up. A shortage of qualified drivers at ports is expected as it could take up to 52h and 11000 container moves to unload a 10,000 TEU ship at a hub port generating about 15,000 to 20,000 truck pick ups [4]. Such figures and working condition will definitely result new labor practices.

Finally the intermodal connections and the percentage of cargo unloaded / loaded at one call to the various means is a point of concern. The availability of capable rail connections may shift cargoes from trucks decreasing congestion and environmental side effects, but very few regions offer this infrastructure. As sea-carriers create strategic alliances and get into the business of ports, land carriers, the market experience consolidation and ports will become the most critical nodes at logistic networks.

11.3 The Mediterranean Ports in the current international logistics network

The Mediterranean ports are mainly gates to the national hinterland, due to political and geographical reasons. Some ports are also servicing as hub centers, and more specifically the Spanish ports of Algeciras, Valencia and Barcelona, the Italian ports of Gioia Tauro, La Spezia and Genoa, Malta, and the ports close to the Suez Canal, Damietta and Alexandria. Despite the fact that Piraeus has increased its share in the transshipment market, it is though not possible to consider it as a consolidation center, as there is a very short track record and only one major carrier. Cypriot, and Israeli ports are quite distant to the main routes and their traffic is more inelastic from the usual transshipments. A detailed table with all available infrastructure data is given in the appendix, as well as the total traffic in TEU.

The very first characteristic of the Mediterranean port industry is that there is a direct relationship between the diversion distance from the main route connecting Suez and Gibraltar, and the transshipment volumes. Zohil and Prijon [30] proved that it is possible with multivariable linear regression, using as independent variables the diversion distance, the total port traffic throughput and a quotient resulting from these two variables to estimate the number of transshipped volumes. In the next figure an approximation based on '96 figures is presented, where it is clear that there is relationship. Unfortunately no accurate data were fully available for more recent years.



By applying this rule, only few ports deviate; Goia Taurus was growing fast and it was not possible to satisfy the rule and Limassol has lost major niche of the total market in the Mediterranean. In conclusion, carriers do not bias ports distant to the main route Gibraltar – Suez and large throughput volumes attracts them, as higher efficiency due to economies of scale is expected.

The storage density presented in the following table shows the more efficient use of this productivity factor in the hub ports.

Port	Area [acres]	1996	1997	1998	1999	2000
Piraeus	222.4	2,587	3,076	4,196	4,339	5,171
Alexandria	134.2	2,423	2,902	3,695	4,010	
Valencia	424.8	1,668	1,958	2,142	2,755	
Genoa	228.3	3,617	5,168	6,132	5,404	6,573
Algeciras	161.5	8,094	9,524	11,310	11,365	12,443
Thessaloniki	44.5	3,627	3,510	3,927	4,606	
Marseilles	168.0	3,253	3,699	3,833	3,970	
Istanbul (Kumport)	66.7	2,287	2,287	2,939	2,563	
La Spezia	123.5	7,051	4,983	5,666	6,825	7,365
Damietta	234.7	2,496	2,574	1,319	1,690	
Limassol	112.9	3,530	2,101	1,890	2,062	
Goia Tauro	230.8	2,478	6,276	9,210		

Marsaxlokk	58.3	10,169	11,363	18,377		
Barcelona	22.2	34,500	43,704	46,271		
Izmir	84.6	4,087	2,430			
Haifa	27.2	21,313	25,165	27,924		
Port Said	111.2	3,258	4,137			

Table 1: Storage Density (Total TEU traffic / storage area m²). Source: Containerization 2000 and the Internet

As studies on the impact of the introduction of mega-carriers on the port infrastructure estimate that the mega-terminal shall offer 150 acres of yard, it becomes obvious from the above table that the main Mediterranean ports satisfy this criterion [28]. Furthermore the productivity of the port shall be in the range of 3,000 to 6,000 TEU/acre annually, which is also achievable in most Mediterranean ports. In other sources, [29], relevant data are presented for other important ports; Rotterdam has a throughput 4400 TEU/acre/year, Asian ports 8,834 and European ports 2,974 in average. It seems that some Mediterranean ports are very efficient. Nevertheless it is useful to notice that the above sources estimate the annual throughput, due to calls of a mega-carrier, in the range of 450,000 to 900,000 TEU per year, thus making the successful negotiation with a mega-carrier equal to a merger with a big feeder port in terms of volume, but not necessarily in revenues.

A very interesting observation in the Mediterranean box movements is the imbalance between East and West as well as the resulting feedering cost. According to the data the western ports handle almost 60% more cargo than the eastern port. This is the direct effect of the location of specific hub ports, such as Algeciras and Genoa, as well as of the local character of the eastern ports. In addition to that, western ports serve a borderless hinterland, while this is not the case in the east.

As the Mediterranean space has only two gateways, Gibraltar and Suez it would be reasonable to expect higher volumes in the nearby ports. Algeciras and the ports of

Damietta and Suez support the belief. Nevertheless, as trade has as origin and destination Central European markets, the ports in Italy are attracting more carriers. Malta is favored as well, but in the contemporary logistics web, direct rail connections will make the impact. In these hub centers, consolidated cargo is transshipped and forwarded to other Mediterranean ports. As the volumes are not so sufficient to maintain direct links under the trunk principle, carriers operate using pendulum networking. This characteristic justifies also the imbalances and the high feeding costs. Studies reveal that the replacement of two or three smaller vessel from a bigger one to serve eastern destinations may lead to substantial decrease of cost, though feeding cost increase disproportionately.

Last but no least the real consideration of all port authorities in the Mediterranean is the hinterland connections. Most of the terminals are poorly connected to the land networks and congestion or other social costs downgrade the image and the efficiency of the industry. Intermodality becomes more than a policy decision and becomes imperative when dealing with the volumes of mega-carriers. A ship of 7000 boxes, assuming a 75% rail and 25% road split has the capacity of filling more than 9 double-stack trains with imported and exported goods [29]. It is needless to say that moving containers by train is far more efficient than moving them by road, as it is commonly achieved lower unit cost by 20-30%. The importance of adequate intermodal split is also the case in the US, where west-coast terminals are more efficient than those of the east-coast, as the intermodal infrastructure is superior. This issue becomes more complicated when ports are located close to highly populated areas. The road connections are usually congested and if not, then the truck movements will create traffic problems. A terminal of a 450-900,000 TEU annual throughput through the gate has almost 1,000-2,100 truck trips on a typical

day, given 40% rail and 60% road split. Other sources estimate this figure from 1,730 to 3,460 trips per day. Ports have dealt with this problem by keeping the gates open longer (even 24 hours per day) or by introducing advanced rail and road haulage systems. Most commonly on-dock rail systems have reduced the truck pick-ups, but they are expensive and envisage high volumes for the breakeven. It is expected that at least in coming years trucks will keep on undertaking the most of the volumes of drayage. In the US, very large trucks, capable of moving two or even three boxes have been introduced, but their success is at stake, where the infrastructure is poor or congested. Having all these in mind it becomes obvious that only western and central Mediterranean ports can become mega-hubs, and it is very likely carriers to exclude Malta, as there is no hinterland connection. At least this is a major handicap for Malta, which has to find another competitive advantage than its strategic location. In addition it seems that carriers will bias a port with adequate rail connection, and even better with on-dock rails and double-stack capabilities. As there are no double-stack trains in Europe yet, rail systems have to be extremely efficient and adequately connected to the trade centers. In case that there is no intermodal split, then a port of annual 450-900,000 TEU throughput, has to estimate 2,880 to 5,770 truck trips per day, instead of the figures presented above. This estimation makes the policymakers in ports with poor or no rail connection chill, when evaluating the environmental burden and the deterioration of the nearby urban areas. Piraeus is the typical example.

III How will ports face the challenge – Strategy

The very first question is if the Mediterranean ports can become hub ports for the new mega-carriers. It is generally accepted, that container shippers generally favor fast and direct transport, although not all cargoes are time-sensitive. Transshipment

is actually a carriers' need seeking higher load factors and fewer port calls. This becomes necessary on main line voyages. The solution of this problem has always been the coordination of the main line and of the feeding services, while keeping port call frequency at a tolerable level for the shippers. From a geographical perspective hub ports have the following characteristics [11]:

1. Hubs are special nodes facilitating connectivity between interacting places,
2. In a hub network, the decision of the carrier on the location of the hub nodal point and the routing of the cargoes is critical,
3. Hubs consolidate cargoes and therefore achieve economies of scale
4. Nodes are commonly natural intersections. However the geographic situation, location and intermediacy are relative concepts, as hub ports experience slumps and booms, usually caused by the carriers' decision or shippers' requests.

According to this rational the Mediterranean ports can become hub ports for the mega-carriers, if only:

1. Existing routes keep on undertaking cargoes and maintain their significance in the world trade, and
2. Carriers will decide to use a Mediterranean port as their consolidation center.

Nevertheless, there are some basic assumptions hidden above. First of all mega-ships can access the terminal. The second point is that the service will be of adequate level of quality and at a competitive price. As almost all main ports in the Mediterranean offer access to Suez-max vessels as their reported depth is close or

over 50ft (15.3m). The ports of Piraeus, Alexandria, Valencia, Genoa, Algeciras, Thessaloniki, Marseilles, La Spezia, Damietta, Gioia Tauro, Marsaxlokk, Barcelona, Izmir, Istanbul (Kumport) are expected to compete. Some ports, such as Damietta, Goia Tauro and Genoa report depths lower than 15.3m, and Malta is very close to the limit; it is expected that these ports may proceed in dredging activities, in order to attract carriers. Furthermore these ports are seaports, and are easily accessed by the sea-going vessels.

Consequently the critical point is competitiveness. In the literature the focus of competitiveness has lately shifted from the analysis of comparative advantages to the study of factors determining the advantages. In the case of port business, Porter's ideas, and specifically the 'diamond' framework has been evaluated academically and evolved to a 'double diamond' by Rugman et al [14]. The creation of two sets of factors reflects the nature of the business, as local and international characteristics affect the performance of the port, as well as the contemporary logistics concept, that the chain is as strong as its weakest part. Haezendock et al. proved that at least in the case of the northern ports, the use of port's superstructure by 'actors' involved in freight forwarding activities as well, is considered as real competitive advantage. This lies in the increased flexibility and productivity of the workers in such a case. Furthermore, nautical issues and marine access can really hamper port efficiency, as carriers avoid river ports, like Antwerp, but this is not the case for the Mediterranean ports. Haezendock suggests inter alia that Porter's framework can be adopted as a tool for the identification of seaport's international competitiveness. As the above are more or less known, lately published sources draw the following conclusions regarding the competitive position of ports around Europe [20]:

1. Northern European terminals are more efficient than the southern ones,
2. Larger terminals are more efficient than smaller ones,
3. Terminals located in hub ports are more efficient than those of feeder ports,
4. Privately run terminals are more efficient than public operated ones.

In other words, large and private terminals located in hub ports will be the dominant ones. Sources and market opinion argue that the dominance of northern ports in handling European container flows is partially a result of the lower service levels in the Mediterranean ports. Notteboom has tested this hypothesis by using Bayesian stochastic frontier models [20]. According to the same source, in the Mediterranean port space there is higher dispersion of efficiencies and heterogeneity. Some ports are highly efficient, such as Algeciras and other Spanish ports and some other are really inefficient, such as Venice [20], [25]. Furthermore the average efficiency of the northern ports is higher than the southern ones, which merely explains the bias of carriers to northern ports, even for cargoes destined to the Mediterranean space. Notteboom argues that there is no clear relation of efficiency with the ownership of the port, but at least experience shows that private ports are more competitive than the public ones; the terminals in Algeciras and Goia Taurus provide excellent examples as well as the case of Genoa. However Notteboom argues that as all ports shall become more market-oriented and the owner, whether public or private, has to adopt such strategies. Small ports are not necessarily less efficient than bigger ones. Small terminals located in big ports are usually more efficient than the bigger ones as they learn-by-doing effect and the cargo generating activity assist them gaining know-how and preserve several competitive advantages. With that in mind Algeciras, Goia Taurus and Malta are only expected to attract carriers. To the same conclusion

can one jump into, if the following four criteria for the characterization of port as a hub one are to be taken into account:

1. High total container traffic,
2. Large share of direct transshipments,
3. Calls from round-the-world service providers,
4. Reasonable growth of container throughput.

Teurelinx suggests that conventional traffic analysis is not sufficient to evaluate the competitive position of a port [26]. Research is necessary to extract the reasons and the causes. However it is necessary to identify first the trends and then to pursue detailed analyses. The most blatant result of research and market experience is that Mediterranean ports have to become flexible business units. Of course there are exemptions, but most of them were well covered under the umbrella of national protectionism. Their model of operation was based on the needs of their national economies, as well as on locally production and captured trade. Therefore there was a strong focus on the port infrastructure and hardware, which would allow economies of scale and consequently an increase of profit margins and competitiveness. Notteboom and Winklemans [19] suggest that in the contemporary context of port operations the source of competitiveness shifts to economies of scope based on advanced production factors, such as know-how and procedures. This is also obvious in the port industry, where northern ports acquire stakes in the local enterprises, as is the case of ECT and the port of Trieste.

The driving force for this change is that as economies of scale increase competition by spreading fixed costs, economies of scope promote dynamic response to

customers' needs increasing flexibility and adaptation to current market needs. Thus shippers, i.e. the customers of the transportation system, expect an increase on product variety revealing and bolstering the general trend for more new, customer-tailored products with consequently shorter life cycle and higher market risks. Additionally they express the belief that the orders per client will increase, thus consolidation of cargo will increase, as there is always a need for lower transport and warehousing cost per unit, making shippers' stand more demanding and stronger at negotiation [19].

Apart from this shift in customers' approach and market characteristics, the current logistics trends are summarized as outsourcing of services and value-added logistics (VAL). As companies shift from economies of scale to economies of scope, they have to find ways to keep costs at desired levels, so they outsource services not related to their core-business or with a low economic/technical performance. This trend results to the creation of dense global and local co-makership networks, enabling the enterprises to transform fixed costs to variable ones as well as to achieve the desirable size of the enterprise according to the wishes and the needs of the investors. Outsourcing however is not only restricted to production networks but is also widely adopted for the key logistics functions: warehousing and transportation. Globalization and outsourcing, as well as the formation of regional economic and political communities, such as the EU, NAFTA, etc. amplify the importance and significance of logistics as the interaction between producers and customers becomes more complicated. The enhancement of logistics and supply networks results also a major change of the role of ports along the chains. The new role of ports obliges them to become more active and 'smarter' nodal points, which is not usually possible, unless there is a strong economic or regional interest. In other

words ports lose their 'national identity' and become more international. In the Mediterranean context, this sounds easy as the northern ports are integrated in the trans-European networks and serve the common market, but this is not the case in the Arabic African coastline and the Middle East. Furthermore the Black Sea ports, if considered as Mediterranean ones, serve specific national hinterland and is quite difficult to connect them with other transport networks, apart from the political puzzles.

The most common development in the industry is the vertical integration along the transport chain, where carriers, forwarders and ports come into agreement and cooperative schemes [17]. Smooth cooperation is necessary as contemporary door-to-door needs require the efficient integration of all related services. Deregulation in various policy fields is also an effort towards this direction. The realization of the integration is expressed with several schemes, but the most common ones are the formation of agency networks, the cooperation of carriers (sea-road-rail) and the use of specific ports, either dedicated terminals or on an agreement base.

The cooperation of carriers leads also to horizontal integration as economies of scale and global logistics coverage is achieved through mergers and alliances. This trend has also affected the port industry, where ports come into agreements with other ports or buy stakes of their capitals. The formation also of land and sea-bridges between them changes dramatically the map and complicates the identification of main routes and flows. So it becomes obvious that ports extend their geographical interests as well as they try to compromise the new needs of logistics chains with the necessary economies of scale, necessary for their profitable operation.

III.1 Strategic Rethinking

The needs of mega-containerships and of their operators create also a blatant need for mega-ports. Some ports will act as mega-hubs and the others shall become the intermediate nodal points to other final port destinations or act as the final points servicing specific region and hinterland. Notteboom sets the goal of port management as following [19]:

1. Accommodation of large port clients,
2. Investment security,
3. Successful deal with competition,
4. Instabilities of the industry,
5. Unfair distribution of costs and benefits, and last but not least in the era of mega-hubs
6. Diseconomies of scale

Most of the above mentioned goals are thoroughly covered in the literature [19], but the suggested policy for coping with these issues is described as:

1. Innovative competitiveness of core operations,
2. VAL,
3. Advanced IT systems,
4. Active role in the creation of logistics chains, and finally
5. Port networking

The first three points are considered as prerequisites but the expected active role and networking consists innovative strategic thinking in the port sector.

Substantial differences can be observed as regards the definition of VAL concept. Inter-port comparisons reveal many different ways calculating intrinsic cargo handling or value tons. [13]. The application of weighting coefficient and the calculation of the value tons may shift the attention of ports from nominal tonnage to the concept of VAL.

Ports have built their strategies, primarily as an aggregation of individual business initiatives, deals, as well as a compromise with the local labor, social and political conditions. The latter was a direct effect of the institutional framework, where ports used to belong to the States and serve special needs and services apart from commerce and trade. The aggregation of individual deals was very seldom encountered as a portfolio of risks and therefore of returns. In most cases the dipoles of risks and returns were never complimentary and therefore ports suffered from low returns and low levels of productivity. Lorange [10] considers the strategy originating from deals as bottom-up view, while the portfolio of risks as top-down one, suggesting that the compromise between them provided a balanced strategy of the firm. In this model two controlling issues are also introduced: the vision for the future and the performance results. Lorange acknowledges that day-to-day operations along with firefighting drive out visionary considerations, and in most cases the upper management misses the point, as imbalances are overwhelming. When port management cannot balance the strategies, it fails to identify new customer needs and to mobilize the resources in that direction. In the new business context, ports have to focus on three main areas, permitting efficient restructuring and deal with the contemporary issues:

1. Entrepreneurship,
2. Networking, and
3. Learning

As most port where State-owned they were not acting as enterprises but as a part of the State. That means that income as well as the expense policy was strongly monitored by the State, so ports could not shape marketing and business strategies as common enterprises. In addition they could not react within adequate time frame as the public sector has an inherently slower response time in business issues. In other words ports were not operating as business units. Nowadays ports have to operate as such either due to a deregulated institutional pattern, as in the case of EU ports or even more blatantly because of the market conditions [8], [9].

The next point is that ports shall understand and enter actively the business of logistics and therefore they have to create networks with other ports, regional or not, currently competing or not, with sea and land carriers and with the port community in general. The ports are not 'alone' any more and they have to bridge differences, create synergies and find their place in the market.

Finally the ports shall learn from the experiences of other business sectors and more specifically from the liner-shipping sector; in shipping the crucial ability of the survivors was always forecasting and ports have never learned forecasting, because of the stable and protected environment they were previously obliged to operate. Practices of other sectors, for example innovative financing, may act as a trigger for inefficiencies and increased effectiveness.

III.2 Prospects and Strategies for the Mediterranean ports

The latter analysis melts down to some conclusions and suggests strategies for the various actors in the mega-port niche of the market:

1. The currently hub ports of Algeciras, Malta, La Spezia and Goia Taurus is expected to trench their position and discourage potential entrants, such as Piraeus to enter in the business of mega-terminals.
2. These ports will experience the threat of substitution, as carriers cannot make business with all of them and ports have specific characteristics attracting cargoes and customers. It is considered as more than probable that carriers will bias the port with the best rail connection and higher efficiency level. This will shift cargoes from the less competitive ports to the 'chosen' one, creating a real mega-port in the Mediterranean.
3. The bargaining power of customers is increasing extremely as ports risk capitals for investments that may never be paid off. This oligopsony situation has forced ports to adjust to the customers needs. Ports that won't adjust adequately will experience heavy losses, as the investment for attracting mega-carriers is high.
4. The bargaining power of the ports is currently at a low level. This will increase after the first round of the 'conflict', where some ports will encounter the results of victory and some others of the defeat. It is not really clear who will be the winner at the end of the day, as the commercial, environmental and the social costs will be high enough. The victorious ports will dominate the market and then they can negotiate from an improved position.

5. The rivalry between the competitors will be extremely fierce, and the only winner will be the carrier, under the assumption that mega-ships will end up profitable and viable.

It is considered as very a possible scenario the set-up of new terminals. As Goia Taurus appeared in the map several years ago, there are similar plans for highly sophisticated terminals on Crete and other locations. While it is not really clear the rational and the targeted outcome, a new competitor, operated by carriers may directly hit the Maltese clientele and shift the center of the Mediterranean trade eastwards. In case that piece and economic development replaces war and conflicts in the Middle East, this part of the Mediterranean will attract most of the attention. However, there are always the options of Cypriot and Egyptian ports.

For the other ports of the Mediterranean, those willing to avoid the battle of the mega-carriers, the future will be considerably better and less risky, if only they follow the trends of modern logistics. The key for their survival and financial viability will be the active role in the creation of logistics chains and networking. The formation of groups of ports shall be expected. The strategy followed by most ports used to be cost leadership. The total prices of the port services should have been more competitive than those of the rival – competitor. As prices are low enough and the operating margins are extremely low to attract financial interests, cost reduction cannot satisfy the port management. In contrary there is enough space for the creation of new services, which other ports cannot offer currently. Advanced and compatible IT systems along with other advanced logistics services, such as reverse logistics considerations, can create needs and make the user willing to pay.

As ports come into a form of logistic alliance, every port will contemplate on specific markets and cargo niches. As revenues will be split accordingly, the efforts of every port will concentrate on the reduction of operating cost and the service of the specific market or segment. Within a port a network, a port may handle all the boxes and cargoes with a specific origin, currently served by feeder vessels from the hub port. Then frequent connections with the other ports of the network will redirect the cargoes to the specific market. Feeder services will act more or less as trunk services between two or three ports. The cargoes in the main port or the destination ports may undergo specific value-added procedure, which may consist also the core-business for the network, as the profit margins are greater than that of the handling.

Such a network can also handle and attract other cargoes as well in benefit of the total equation of time and price for the carrier and the shipper, as well as for the revenues accrued by the network. Furthermore the negotiation power of the ports will increase as the network serves more than one network and offers advanced services against any other competitor in the region. This port alliance can also follow tactics for aggressive marketing, by creating new logistics chains, as shippers and carriers may find reasons to respond to the call. Frequency and service may be of high levels and volumes can be sufficient for the employment of existing vessels, and not necessarily big and expensive ones, as mega-ships are.

IV Conclusions

The era of mega-carriers will impose very radical changes to the port industry. Few ports qualify to become mega-hubs; these ports will have to invest to the new necessary yard and handling equipment. This means also a shift to a new equilibrium, as ports have to get into the logic of elastic demand and the carriers will

become the dominant player enhancing their right to choose. On the other hand ports shall evaluate the real economic impact from the operation of a mega-hub in the specific region, as the environmental and social impacts can be extremely heavy. Ports will follow the example of other industries that have gone through the procedure of gigantism in the past and currently their units are scaled down, due to the change of economics from scale-based to scope-based ones, as well as due to environmental and social constraints.

The Mediterranean ports are positioned along a critical leg of the route connecting Asia and Europe. The ports are efficient enough to undertake larger volumes, though there is always the handicap of inadequate hinterland connection and of the distance up to the main European markets. As the Mediterranean space becomes more harmonized and borderless, these ports are about to serve hinterlands with adequate development potential and therefore attract more cargoes. In the era of mega-carriers it is expected that only few ports will choose a role as mega-hubs. It is reasonable to expect efficient and successful ports, such as Algeciras, Damietta, Malta, Gioia Tauro to compete in this market. The rest of ports is expected to create logistics networks and offer new services in order to attract carriers and find an active role in the contemporary complex global logistics context.

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The source of all tables and figures is Containerization 2000 as well as the official sites of the ports in the Internet.

VI Appendix

VI.1 Total Port Traffic in the Mediterranean

Port	1996	1997	1998	1999	2000	$\Delta(96-99)$	96-99 %	96-00 %
Piraeus	575,256	683,969	933,096	964,902	1,150,000	67.7%	18.8%	18.9%
Alexandria	325,129	389,378	495,777	538,000		65.5%	18.3%	N/A
Valencia	708,332	831,510	910,000	1,170,191		65.2%	18.2%	N/A
Genova	825,752	1,179,954	1,400,000	1,233,817	1,500,632	49.4%	14.3%	16.1%
Algeciras	1,306,825	1,537,627	1,826,000	1,835,000	2,009,000	40.4%	12.0%	11.4%
Thessaloniki	161,335	156,101	174,648	204,863		27.0%	8.3%	N/A
Marseilles	546,667	621,580	644,000	667,000		22.0%	6.9%	N/A
Istanbul (Kumport)	152,577	152,577	196,091	171,000		12.1%	3.9%	N/A
La Spezia	871,100	615,604	700,000	843,233	909,962	-3.2%	-1.1%	1.1%
Damietta	585,946	604,176	309,671	396,820		-32.3%	-12.2%	N/A
Limassol	398,600	237,300	213,440	232,800		-41.6%	-16.4%	N/A
Gioia Tauro	571,951	1,448,531	2,125,560			N/A	N/A	N/A
Marsaxlokk	593,013	662,648	1,071,669			N/A	N/A	N/A
Barcelona	767,236	971,921	1,029,000			N/A	N/A	N/A
Izmir	345,924	205,691				N/A	N/A	N/A
Haifa	579,292	684,011	759,000			N/A	N/A	N/A
Port Said	362,311	460,003				N/A	N/A	N/A

VI.2 Description

Port	Maximum Draught (m)	Berths (m)	Storage Area of Cont. Yard (m ²)	Number and Type of Gantry Cranes				Rail Connection	Comment	
				Panamax	Post Panamax	Super Post Panamax	Other			
Piraeus	16,5	3.885	900.000	6	6			No	1 terminal	
Alexandria	14,0	1.691	543.000		3		3	Yes	2 terminals	
Valencia	16,0	2.940	1.719.000	6	5		2	Yes	3 terminals	
Genoa	15,0	1.926	924.000		8		4	Yes	2 terminals	
Algeciras	16,0	1.534	653.412		14		5	4	2 terminals	
Thessaloniki	12,0	600	180.000				4	Yes	1 terminal	
Marseilles	14,0	2.970	680.000						2 terminals	
La Spezia	14,0	1.297	270.000					Yes	2 terminals	
Damietta	14,5	1.050	500.000				6	Yes	1 terminal	
Gioia Tauro	15,0	3.011	950.000		14			Yes	1 terminal	
Marsaxlokk	15,5	2.360	457.000	1	15			No	2 terminals	
Barcelona	16,0	4.160	934.000		2		2	4	Yes	6 terminals?
Izmir		600	236.000					Yes	1 terminal	
Istanbul (Kumport)	17,0	1.130	90.000						1 terminal	
Limassol	14,0	1.580	342.500		2		2		1 terminal	
Haifa	13,8	1.960	110.000		3		4	1	Yes?	2 terminals
Port Said	13,8	1.315	450.000		2		4		1 terminal	