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IMPACT OF GLOBALIZATION ON DEVELOPMENT OF MODERN CONTAINER TERMINALS

This article presents influence of globalization and container traffic growth on the development of modern and sophisticated container terminals. Due to the fast growing rate of the global container trade, every major port is under the pressure of meeting the projected capacity demand. An increasing size of container ships requires improving the port's ground handling and distribution systems. An increase in the efficiency of those systems is mandatory to achieve further reduction of terminal operating costs on the one hand and to ensure sufficiently short lay time for the ships in port on the other.

KEY WORDS

market globalization, container terminals, new handling technologies

1. INTRODUCTION

The elimination of international trade barriers, lower tariffs and shifting centers of global manufacturing and consumption lead to new dynamics in intermodal shipping. Global container shipment is currently experiencing a period of extreme growth. The three main reasons for this are: the trend towards containerization, globalization and increased exports from Far East economies – China in particular. Worldwide container trade is growing at a 9.5% annual rate. It is anticipated that the growth in containerized trade will continue as more and more cargo is transferred from break-bulk to containers. By 2010, it is expected that 90 percent of all liner freight will be shipped in containers.

Container lines will be bringing into service vessels that are bigger and faster than before, while current port facilities are insufficient to meet the demand in cargo handling capacity from the shipping industries. New massive container ships on one hand, and scarcity of the yard land on the other hand, put an enormous pressure on port authorities and operators to find and deploy effective container handling systems in order to increase the throughput of the current container terminals.

2. GLOBALIZATION IN CONTAINER TRANSPORT

In the year 2004, the world container trade achieved a record and the traffic is estimated to grow at an average rate of 7 to 9 per cent per annum over the next 10 years. It might even double by 2015. This has been spurred to a large extent by the growth of many Asian countries, most notable among them being China, Japan, Korea and Malaysia. Asian trade is expected to rise by 8 to 10 per cent annually until 2007 with China's exports leading the way. As more Asian and Latin American economies pick up, further growth of container trade looks inevitable.

With such large volumes, it is inevitable that ports also start competing with one another. Today, we find competition between Hong Kong and Singapore ports to be the No. 1 in the world in terms of throughput. Hong Kong emerged victorious in 2004 with 21.93 million TEUs in comparison to Singapore's 20.62 million TEUs. Singapore was affected by the commissioning of the Port of Tanjung Pelepas in nearby Malaysia, which ate into Singapore's volumes. The throughput of Hong Kong port is expected to increase to 30 million TEUs by 2010. The total container traffic volume of the top 10 container ports reached 120 million TEU in 2004 and increased by 13 percent compared with results in 2003.

In 2003, approx. 63 per cent of the world container traffic, in terms of TEU, were attributable to Asian ports, whereby the top 8 Chinese ports alone represent 25.9 percent of the total container traffic. Europe had a share of 20.2 percent of the world container port traffic and America 15.4 percent. The same share was maintained in 2004. The third world ranking port, now Shanghai, grew by 29 per cent up to a traffic volume of

14.55 mill. TEU in 2004. Sea container traffic through Shenzen (fourth in the world) rose by 28 percent in 2004. However, the growth of the city sea container traffic is expected to slow to about 10-14 percent in 2005 to 15-15.5 million TEU after rapid growth in the past few years.

During the last year (2004), container traffic between Asia and EU grew by 14.2 percent and the same growth is planned up to 2007. In 2004, Rotterdam, the top European container port, increased its traffic by 16 percent and overtook Los Angeles on position 7 in the world container port league. Once again the ports of Hamburg and Antwerp outperformed other ports in the range. They achieved TEU increases of 13.5 percent (Hamburg) and 11.2 percent (Antwerp) respectively. Taken together, this represents an increase of 1.6 million TEU. Container traffic of the top Mediterranean ports increased by 9 percent. This growth is mainly determined by Algeciras, Piraeus and Barcelona. All these data clearly show that container traffic is growing very fast and will grow even more in the coming years.

3. IMPACT OF MEGA CONTAINER SHIPS ON DEVELOPMENT OF MODERN CONTAINER TERMINALS

Since the introduction of containerization over 40 years ago, the size of container ships has increased dramatically. Until the mid-1980s, the size was limited by the dimensional constraints of the Panama Canal (principally, 32.2-metre beam). Since then, the development of the post-panamax fleet has been dramatic; today over 35% of the world's fleet, by capacity, is post-panamax. The largest of the ships currently on order have capacities of more than 8,500 TEUs, and there is clearly scope for even larger ships.

Carriers are looking at bigger and bigger vessels to improve their economies of scale. Maersk Sealand, as leading container carrier alone, has about 31 vessels that can carry over 6,000 TEUs. Their "S"-Class Post Panamax vessels can carry nominally 6,600 TEUs, but it is rumored that their actual capacity is 8,000 TEUs. The Maersk Sealand fleet comprises more than 300 vessels with a total capacity of more than 750,000 TEU. Cornelius Maersk, an S-type vessel and one of the largest container vessels in the world is capable of carrying over 6,600 containers, has an overall length of 347 meters and a cruising speed of 24.6 knots. Other lines having over 6,000 TEU vessels in their fleet are MSC, P&ONL, Hanjin, Hyundai Merchant Marine, and CMA-CGM. The world fleet at present consists of 49 vessels of 7,500 TEU and above, with another 148 on the orderbooks and many more to follow. Hapag-Lloyd, COSCO and OOCL have placed orders for 9,000 TEU vessels to be delivered in 2007 and 2008 respectively and China Shipping Group has ordered two vessels of 9,800 TEU capacities.

That is not all. The shipbuilding companies are already designing 15,000 and 18,000 TEU mammoth vessels. These vessels of 15,000 TEU and more should be deployed on the main East-West routes and North-South linkages should be maintained with feeder ships of anywhere from 250 to 6,000 TEU. The role of 15,000 TEU ships will be very different to that of the present large containerships. They will be used exclusively for maintaining the East-West/West-East long haul maritime segment; all containers carried will therefore have to be transshipped. The most likely locations for the four "mega hubs" in the world are Southeast Asia, the western exit of the Mediterranean, the Caribbean and the West Coast of Central America. Such "mega hub" ports could offer two berths for 15,000 TEU ships and six berths for large feeders or up to eighteen berths for small feeders.

Since the Post-Panamax barrier was broken, vessel size has increased steadily and the largest vessels currently in service have capacities of over 7,500 TEUs, lengths of up to 347m, beams around 47m (seventeen 20' containers) and draughts of 15m. Vessels of this size are already putting extra demands on ports and berth structures in terms of increased berth, lengths, depths alongside and higher capacity quay cranes with outreaches for vessels 22 boxes wide.

Dimensions of mammoth vessels (Malacca Max ships) are impressive. The deadweight of these ships would be approximately 240,000 tones, with an expected overall length of 400 m, a beam of 60 m and would need around 18-21 m draught. This calls for special port facilities. In order to accommodate these large ships, ports are also chalking out massive expansion plans. Inadequate water depth is a problem. An increase in the depth of pilotage waters is required to be examined carefully in view of the enormous costs involved and possible ecological consequences from dredging.

3.1. Bigger ships means bigger cranes and higher efficiency

Together with the upgrading of container bridge capacities the increasing size of container ships requires improvement of the ground handling and distribution systems. An increase in the efficiency of those systems is mandatory to achieve further reduction of terminal operating costs on the one hand and to ensure sufficiently short laytime for the ships in port on the other. For an 8,000 TEU container ship a port has to be capable of an effective handling speed of about 330 moves per hour. The performance of an average terminal presently is 120 to 150 moves per hour. New ideas and concepts are needed here to keep pace with the developments of large container vessels. Unloading simultaneously with more than one gantry crane is common practice already today. The practical limit for a ship of more than 300 m in length is about 5 to 6 gantry cranes simultaneously. Further increase in handling capability requires increased speed for the crane movements, double trolley cranes and possible servicing the mega ships from both sides in a berth.

Proposals for further improvements of productivity, include servicing from both sides with the ship moved in a berth, with six double cranes per side, each dual hoist (trolley) crane producing 55 moves per hour, with the total productivity of 660 moves per hour. This may be the necessary way to make full use of the pronounced economic advantages of a mega container ship of more than 10,000 TEU. There are proposals for servicing from both sides, either with gantry cranes arranged on both sides of the berth or bridge cranes spanning across.

4. NECESSITY OF INVESTMENTS

The maritime industry has similar economic characteristics to other transport modes in that the mobile unit, the ship, has a comparatively short economic life and is inexpensive compared to the industry's main infrastructural investment, the port. These terminals often have extremely long economic lives and only extremely limited alternative uses. Within these characteristics, the most important economic aim or benefit of investment in the ports is to reduce the ship turnaround time. In such investments, economic principles will embrace technical ones in the sense that the minimum amount of productive resources should be used to fulfill the purpose of the investment. In other words, limited resources are used to achieve maximum results.

Before embarking on investment, the question must be asked: "What are the specific costs required in terms of factors of production in order to produce a particular quality and quantity of port services?" the cost of resources is the cost of the highest and most attractive alternative use. This is generally termed the opportunity cost. Opportunity cost is the amount sacrificed or foregone, should the resources be used in another project. In this way, the measure of costs of port investment is the value of the next most useful investment that could have been created with the same factor of production. For example, rather than terminal investment, investment in a quantity of railway track inside the port. This is the essence of the concept of opportunity or alternative cost.

As with much other transport investment, investment in ports is in highly specialized equipment that has single efficient purpose of function, that of assisting in the cargo transfer between land and sea. It has no alternative use. Once such an investment is made, there is no opportunity cost; the equipment is valueless.

Port investment is embarked upon to promote and develop the port itself or its facilities. It is an attempt to make it more efficient by, for example, removing or lessening the amount of queuing and congestion on both the land and sea approaches to the facilities. The basic criteria for such investments is as follows:

- to choose between a range of projects proposed;
- to decide on the most appropriate time of projects proposed;
- to decide whether to renew the old equipment, to continue to use it, or to expand the facilities with totally new equipment.

The immediate benefits of such investment are felt immediately by the port or container terminal users, which, in some cases, could be foreign-based shipping companies. Positive returns for the investor, however, are subject to a time-lag, emerging when the revenues start to exceed the costs. Numerous approaches may be adopted, in order to assess the investment potential.

4.1. Impact of managing philosophies on development of container terminal

The two most common and extreme managerial ideologies are the European or Continental, and the Anglo-Saxon or Peninsular. European and Continental philosophies see the ports and container terminals as an important part of the regional infrastructure, beyond the parameters of the port economic and social activities. Ports are public service, a philosophy which is reflected in management ethos, institutional and regulatory factors. The value of the port is perceived in terms of the development and progress of industry and trade within its region of influence. Port management will support this, and consequently, there will be a comprehensive Port Authority influencing the whole operation. In European countries, like Greece and Latin nations, this would be the typical approach.

The Anglo-Saxon or Peninsular approach sees the port and container terminal simply as a commercial activity, like any other commercial activity. Management control of the port is a private undertaking. The objective should be to earn appropriate profits or avoid unnecessary commercial losses. According to this approach, public intervention by any form of state administration has to be severely curtailed, limited to general duties such as land planning permissions, safety, environmental problems, pilotage and navigation. This is also a measure to assure fair and competitive practices. Such a formulation of commercial services being in private hands operates in the United

States and in Northern Europe, particularly in the United Kingdom, Denmark and Ireland.

While both the European and Anglo-Saxon are useful models, what must be emphasized is that they are an over-simplification. In reality, there are no pure examples of these philosophies to be found, but rather groups of ports situated near both ends of the spectrum. Where European or Continental philosophy is adopted, the state has the power to decide when, and if the infrastructure of container terminal will be modernized and sophisticated. All these philosophies are playing crucial roles in the modernization of container terminals, because in some areas, commercial operators have taken over virtually the entire port industries, and now they are deciding when and how the container terminal will be modernized.

5. NECESSITY OF NEW TECHNOLOGIES IN THE PORTS

In the last four decades the container as an essential part of a unit-load-concept has achieved undoubted importance in international sea transportation. With ever increasing containerization the number of seaport container terminals and competition among them have become quite remarkable. Operations are nowadays unthinkable without effective and efficient use of automation, information technology as well as appropriate optimization methods.

Due to the fast growing rate of the global container trade, every major port is under the pressure of meeting the projected capacity demand. The scarcity of land at ports in many metropolitan areas makes it difficult, if at all possible to improve the capacity by expanding the terminal area. As a result alternative solutions have been sought for improving capacity and meeting the growing demand for container storage area and terminal capacity. There are a number of interesting developments underway which seek to make these operations much more efficient. These initiatives include the use of Automated Guided Vehicles (AGVs), Multiple trailer systems, automated container stacking systems; inland terminals combined with a highly efficient ship interface, and linear motor-driven conveyance systems.

All these solutions must be part of investment strategy and terminal operators must have a clear idea on how to apply these new technologies, in order to achieve optimal commercial results.

5.1. Automated transport and handling systems for container terminals

One of the most interesting cargo handling equipment developments are those related to the Automated Guided Vehicles (AGVs). AGVs have enjoyed a period of explosive growth in the last decade, primarily in the area of industrial automation. The promise in AGVs lies in their high controllability, and the degree to which they can perform the same tasks that currently require significant labor. In the case of container operations, AGVs are well suited for interfacing with an automated storage and retrieval facility. There are currently applications of AGVs in ports such as Rotterdam, Thames port, Ports of Singapore and Kaoshiung.

The AGV system consists of the vehicle, an onboard controller, a data link with a centralized management system, and a navigation system. The vehicles are typically electrically powered, and constructed from off-the-shelf components. The onboard controller manages the propulsion, steering, braking, and other functions of the vehicle. The vehicle for guidance to final destination uses the navigation system. While operating within a manufacturing or service environment, the AGVs require on-board and/or centralized computer control to coordinate the movements relative to other material handling devices or other AGVs. The lowest level in this hierarchy belongs to the vehicle control, which consists of the drive system control and navigation system. The higher-level system control is responsible for management and vehicles interaction. It consists of the planning, the scheduling, and the execution function. The navigation systems of AGVs are transitioning from wire guided to free ranging. Until recently, AGVs followed an inductive guide wire or an optical visible line, painted or made with tape, on the floor. Modern AGVs are now utilizing new methods such as laser scanners, microwave transponders, inertia gyros, ultrasonic sensors, embedded magnets or camera vision systems.

The most automated container terminal, the Deltaport terminal at Rotterdam, uses AGVs in transporting containers from the stacked storage area (served by rail-mounted gantry cranes) to the apron. The total fleet size consist of more than a hundred vehicles. Electronic positioning devices align the wharf gantry crane with the units for rapid loading and discharging of the vessel. An onboard computer in each AGV communicates with a control center to enable free ranging navigation to any point within the terminal. AGVs are less subjected to environmental interference. The unmanned vehicle can work in bad weather or other tough environments, 24 hours a day and 365 days a year. In practice, the said terminal works 363 days a year.

Also, AGVs can perform functions considered unsafe for human labor. Security is also easier to maintain in an automated container-handling yard. AGVs offer safe, reliable alternative to human operators in environments where material transport requirements are well defined and reasonably static. The paths, however, are difficult and expensive to change, particularly in the case of wire-guided systems. In dynamic environments, the fixed-path vehicles may not be practical. Toward that end, a new generation of material handling vehicles is emerging which are more autonomous than the AGVs of the past. These machines do not require that a continuous guide path be installed, but find their way around the plant by means of internal maps and periodic sighting of landmarks whose position in the environment is known.

We can expect that with time, increasingly sophisticated and "intelligent" control systems onboard AGVs will allow more autonomous operations, and better system performance. Over time, automated systems may be accepted into many terminal operations, but currently these technologies do not appear to be feasible everywhere from a political standpoint because of labor use.

Linear Motor Conveyance Systems (LMCS) are among the technologies that have recently been considered for cargo handling. A prototype of a linear motor conveyance system has been constructed and successfully tested in Eurokai Container Terminal, Hamburg. The promise of employing linear motor technologies lies in its very high positioning accuracy, reliability and robustness of equipment. A linear induction motor operates on the same basic principles as a conventional, rotary induction motor, except that instead of the coils being wound around a shaft, the entire assembly is "unwound" into a linear configuration. Running current through the unrolled, flattened stator moves a metal flat blank, which is placed above the stator, as though it is a rotor. By controlling an array of linear motors that are placed underneath a platform, one can accurately move the platform (given that it is on a sliding or rolling surface).

Linear motor systems have several attractive characteristics. The motors are very reliable and last a long time. Platforms, which are conveyed via linear motor technology, are unmanned and have very few moving parts. The wheel assembly on the platform is the only moving part. In addition, no power is required onboard the platform. Linear motors are currently used widely for smaller scale, manufacturing applications, such as conveyance systems for sorting systems or assembly plants. However, the technology is scalable to larger tasks. A system such as this could be ideally suited for port and terminal operations. Once the necessary infrastructure is in place, and the shuttles to carry the containers are constructed, the system could be operated autonomously without any constraints on the hours of operation, and at an expected lower maintenance cost.

The concept of loading and unloading containers in the yard using overhead rail and shuttles is another attractive way of utilizing yard space more efficiently. An example of this concept known as GRAIL was designed by Sea-Land and August-Design. It uses linear induction motors, located on overhead shuttles that move along a monorail above the terminal. The containers are stacked beneath the monorail and can be accessed and brought to the ship as needed. Sea-Land has a portion of this system running in its highly successful Hong Kong terminal but the shuttles are driven manually.

Automated container terminal using automated storage/retrieval system (ASRS) is also attractive way of utilizing yard space. By the year 2020, it is projected that the amount of cargo transferred between container terminals will have doubled. The scarcity of land in many areas makes it almost impossible for many container terminals to respond to this increasing demand by expanding their yard facilities. AS/RS with high-density storage capabilities could play an important role in the future container terminal activities. AS/RS can store and retrieve containers automatically. It can be built on a small piece of land and add capacity by increasing the number of floors. The promise of high productivity of the AS/RS lies in its capability to permit access to any container within the storage structure randomly (random access), without having to reshuffle containers.

This high productivity property together with the ability to have a high storage capacity makes the AS/RS concept very attractive in places where land is very limited or very costly. An AS/RS module has four major components: the storage and retrieval machine (SRM), the rack structure, the horizontal material handling system, and the planning and control system. The SRM simultaneously moves horizontally and vertically to reach a certain location in the rack structure. It travels on floor-mounted rails guided by electrical signals.

6. CONCLUSION

The future is with the ports that can meet the requirements of the Suez Max and Malacca Max vessels. They necessitate not only a deeper channel, but also higher productivity levels, bigger cranes that have a reach of more than 25 TEUs across and other improved handling equipment besides having modern information and communication systems. At present the productivity level of around 75 - 100 TEUs per hour is required to keep a 6,000 TEU vessel on schedule. The leading ports are gearing up to increase productivity levels to 200 moves per hour to turn around an 8,000 TEU in less than 24 hours.

Advances in crane and cargo storage and retrieval technologies such as mega cranes, robotic cranes, smart spreaders, cell elevators and others that are in the design or experimental phase could have a significant effect on the efficiency of terminal operations once properly implemented. Estimates of the expected throughput of the most advanced cranes can be as high as 75 to 100 moves per hour. Automated guided vehicles for terminal operations offer potential for improving throughput considerably if properly used with other equipment. The interface of automated and manual operations should be designed properly in order to avoid delays that could significantly reduce the benefits of automation and maintain safety. The use of automation in terminal operations will eliminate most of the randomness due to manual operations and allow the use of optimization techniques to further improve performance.

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POVZETEK

VPLIV GLOBALIZACIJE NA RAZVOJ MODERNIH KONTEJNERSKIH TERMINALOV

Članek opisuje vpliv globalizacije in rasti kontejnerskega trasporta na razvoj modernih kontejnerskih terminalov. Skorajda vsa velika pristanišča se dnevno srečujejo s pritiskom hitre rasti globalnega kontejnerskega trga. Vsevečje kontejnerske ladje pogojujejo nadgradnjo obstoječih pristaniških pretovornih in transportnih sistemov. Rast zmogljivosti in učinkovitosti slednjih, predstavlja nujo za doseganje nižjih pretovornih stroškov in zagotavljanje krajših postankov kontejnerkih ladij v pristaniščih.

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