The Changing Nature of Port Infrastructure and Port Management

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ABSTRACT

In order to remain competitive, container ports have to operate at high efficiency and provide the lowest vessel turnaround time possible. This will not be possible without the aid of state-of-the-art container handling equipment. Nevertheless, increasing containerisation, and changing trends in the global shipping industry often demand port infrastructure and superstructure to be upgraded in order to remain relevant. This paper discusses the essential superstructure and technology used in the container port operations as well as the factors that provide the impetus for upgrading port facilities and technology. The latest trends of private participation in port facilities and the emergence of terminal-operating transnational companies are also discussed to reflect the changes in port management in recent years and to highlight their effect on port competitiveness.

CONTAINER TERMINAL OPERATIONS, SUPERSTRUCTURE AND TECHNOLOGY

Although physically not the same, container terminal operations can be thought of consisting three operating areas (see Fig 1) (Steenken, Voß, and Stahlbock, 2004). The ship operating area consists of berths, when a vessel arrived at the port; it is allocated a berth equipped with quay cranes, to carry loading and unloading operations. The containers meant for export and import are held up in stacks in the yard. Certain stacks are reserved for special containers such as reefers that require electrical connection or dangerous goods. The truck and train operation area acts as the interface between the terminal and external transportation.

The sequence of events for handling import containers can be described as follows: After the arrival of the vessel at a berth, quay cranes will unload the containers from the vessel and load them to a transport vehicle, which will head for the yard. At the yard, yard cranes or lifting vehicles will lift the containers to specific rows, bays and tiers within blocks to be stored. After the designated trucks or train arrive, the containers are unloaded from the yard and then loaded on to the vehicles or rail.

Container terminals can be differentiated with respect to the type of container handling equipment and transporting vehicles employed. There are two types of quay cranes, single-trolley cranes or dual-trolley cranes. Dual-trolley cranes divide its operation into a man-driven component which lifts the containers to a platform before the automatic component that picks it up and carry it to shore. There are three types of yard cranes, either rail mounted gantry cranes (RMG) or rubber tired gantries (RTG) and overhead bridge cranes (OBC). Both RMG and OBC cranes are suited for fully automated container handling.
Horizontal transport vehicles include multi-trailers and automatic guided vehicles, which are meant for pure transport purposes and are not able to lift containers. The other category consists of straddle carriers, forklifts, and reach stackers. These vehicles are capable of transporting containers and also to stack them.

![Operation areas of a seaport container terminal and flow of transports. (Steenken et al. 2004, p 6)](image)

**Supporting Systems**

In order to record container moves and to ensure accurate positioning of containers, technology such as Differential Global Positioning System (DGPS) and Radio Frequency Identification (RFID) devices may be used. DGPS device is mounted on top of transport and stacking equipment. Every time a container is lifted or dropped, the position is feed into the computer.

The role of Information Technology (IT) in ensuring smooth communication is vital; it also goes a long mile in coordinating the numerous container movements that is taking place. The type of activities a container terminal may encounter includes planning/management of resources, yard/quay resources, to documentation, billing and accounting, security and customer/supplier interface. Therefore to cope with these tasks, two categories of software are usually used: Terminal operating systems (TOS) and Electronic Data Interfaces (EDI).

An Example of TOS is Computer Integrated Terminal Operations System (CITOS) used by PSA Corporation. CITOS is used to plan and direct all container handling operations in real time. It plans the use of berth, yard, equipment and manpower needed. An example of EDI is PORTNET, which provides port users with a 24-hour a day electronic information and communication link with PSA. The types of information and communication that are important include the container loading and discharging list, the bay plan and the stowage instructions. They have to do with which containers have be loaded or unloaded; their position in the ship, and where they will be stored at the terminal respectively.
UPGRADING OF PORT FACILITIES AND TECHNOLOGY

Container Traffic and Transportation Capacity of Ships

Over the years, container traffic has grown significantly. From 1990 to 1997, world container traffic grew by 10% per annum from 87.4 million TEUs to 170.3 million TEUs. In 1999, exports from Asia accounted for 46% of the global total of containerised exports. By 2011, this is expected to rise to around 51%. Another study predicts explosive growth for the ports of mainland China: from 12 million full TEU in 1999 to around 46 million in 2001. (Hayes, 2000)

Looking at the case of Singapore, in 1981, the number of containers handled by PSA Singapore Terminals crossed the one-million-TEU mark; by 1990 that number grew to 5 million TEUs (PSA International, no date). In 1998, Singapore handled 15.14 million TEUs (PSA Corporation Limited, 1999) and 23.2 million TEUs in 2005. In order to cope with the increasing container traffic, PSA will increase the capacity of Singapore’s port to 50 million TEUs by 2018.

At the same time, the transportation capacity of the worldwide container fleet has increased considerably, mega container ships of 1999 may have the capacity of 6000 TEUs but recent generation of ships are now capable of carrying 10000 TEUs. Experts also predict that the next generation of 15,000 TEU vessels will arrive very soon. A 10,000 TEU vessel can be single-propelled if it runs on new 16 cylinder engines. Though it is difficult to move the ship into port areas due to the inflexibility of powerful engines. The next step will be the 12,000 TEU vessel fitted with two engines and with a beam of 54.5m and a draft of 14m. Afterwards the time will be of 15000 TEU class, with a draft of 16.5 metres. Another prediction is that ship of the “Malacca-Max” developed by Professor Niko Wijnolst, Chairman of the Netherlands Maritime Network might be operational by the year 2010. The vessel boasts a length of 400m, a beam of 60 m and a draft of 21 m and deadweight of 243,000t. 18154 TEUs can be loaded into 24 rows and 8 tiers on deck and 20 rows and 13 tiers in hold. Bigger ships are even possible since there had been a time where tankships were in excess of 500,000 dwt, although mooring requirements may hopefully constraint the expansion of the latter class of ships. (Hayes, 2000)

As a result of the above factors, there have been heavy investments in seaport terminal and infrastructure expansion worldwide. Singapore for example, commissioned 8 berths between 2005 and 2006, and invested a total of USD 240 million in new port equipment; it includes 12 units of super-post-panamax quay cranes with an outreach of 22 container rows across and 122 units of rubber-tyred gantry cranes, so as to meet customers’ demand for faster turnaround and maximisation of ship’s capacity (Desker, 2005). Nevertheless, as the shipping lines continue in their experimentation for the next bigger or optimum class of ship, ports worldwide are facing the heat of having to come up with modernised equipment at an increasing fast rate. The high investment costs in port infrastructure are further compounded with the ecological percussions from dredging to provide adequate water depth. Other issues include the provision of new berths, new quay cranes, transport vehicles, yard cranes, finding new cargo handling methods and finding more space to be developed for terminal use.
Automation and Information Technology

Increasingly, there have been trends of automated equipment handling and transportation. From an economic viewpoint, when there is enough container traffic, it is more productive to have more specialised container handling equipment instead of multi-purpose ones (PSA Corporation Limited, 1999). Hence the combination of AGVs and automated bridge cranes are favoured over the use of reach stackers. Thus this calls for the upgrade of the existing IT infrastructure as well, so that there can be an integration of systems, process and equipment. Demand for better software with higher operational control logic intelligence will rise, so as to facilitate real-time tracking and communications.

Merger and Alliance of Shipping Lines

In order for large shipping vessels to be economically viable, there must be a critical size of cargo so that lower operating costs per slot can be achieved. Due to this reason, shippers in the industry have been pooling cargo together to fill bigger ships through mergers and alliances. NOL merged with APL, P&O with Nedloyd, CMA into CGM. In addition, there are many alliances such as the Grand Alliance, the New World Alliance, Maersk / Sealand and the United Alliance. These new trends pose new challenges to terminal operations as the exchange of containers between vessels within alliances and the interbilling needs to be coordinated differently, and terminals that are able to assist shippers in this facet will gain competitive advantage.

Changes in Logistical Roles

Shipping lines today have attempted to position as a one-stop logistics solutions provider, thus they are integrating vertically downwards the logistic chain (Seet-Cheng, 2000). They have formed new agreements with MNCs to handle their intermodal transportation, warehousing and distribution needs. Therefore, it is has now be in the interest of ports to shift their policies to take into account new logistical needs of their client and cater to them accordingly in the design and development of ports. Additional facilities like new warehouses and distriparks will have to plan for so that terminals remain attractive to shippers.

Competition and Port Privatisation

Increasing competition among ports, and given that shipping lines like Maersk are expanding into terminal operations, ports have to constantly upgrade their infrastructure in order to remain attractive as ports of call. The increasing trend of privatisation also means more funds are available for investment in port infrastructure.

PRIVATE PARTICIPATION IN PORTS AND EMERGENCE OF INTERNATIONAL TERMINAL OPERATORS

Private Participation can be defined as “The private company assuming operating risk during the operating period or assume development and operating risk during the contract period. In addition, the operator must consist of one or more corporate entities with significant private equity participation that are separate from any government agency. A foreign state-owned company is considered a private equity.” (Sommer, 1999).
According to Grosdidier de Matons (1996), there are primarily two types of ports, the landlord port and the service port. For the landlord port, “infrastructure is financed by the port authority.” The private parties financed part of the entire superinfrastructure and are often associated with the management of port authority. This kind of structure is common in the United States and in continental Europe. The service port on the other hand, is built and totally operated by the port authority. The private sector is plainly users of the facilities.

In the late 1970s, and early 1980s, the desire to introduce more efficient port practices triggered a chain of deregulation. The shortage of the available government funding in developing and the high cost of terminal development further encourage private participation, i.e. more ports were becoming landlord ports. One of the main arguments is that private terminal operators will have better incentive to manage and operate ports efficiently and profitably. According to P & O Ports Division, Australia (Cargo Systems, 1998), “there are a number of complex, social, economic and national goals involved in the privatisation of port facilities, but in general these objectives are:

a) to relieve the financial burden on government of undertaking capital expenditure;
b) to relieve government of the administrative burden of maintaining services;
c) to improve efficiency and the productivity of services rendered;
d) to stimulate private entrepreneurs and investment in the economy;
e) to assist in reducing the size of the public sector, particularly in the debt attached to assets.
f) to transfer technology in the form of equipment and management systems;
g) to improve the quality of staff through training and motivation; and
h) to contribute to national economic policy targets.

In juxtaposition to the above mentioned objectives, the roles between the government and of the private sector were defined in the French Parliament in 1971 which may shed a light on the new trend that is happening. According to Grosdidier de Matons (1996), the Minister of Transport then declared that “private-sector participation had as an objective the mobilization of the maximum amount of resources so that French ports could compete with other European ports”. It signified a “rational redistribution of duties and responsibilities”. The government contributed to the financing of the infrastructure to establish initial operating environment and to regulate monopolies while the private sector took care of the superstructure and other services. Such a partnership may be the key for terminal operators to cope with the bludgeoning problems highlighted in the previous section.

Data from The World Bank’s Private Participation in Infrastructure (PPI) Project Database (Sommer, 1999) lends strength to affirm such a relationship formed between port authority and the private sector. In between 1990 and 1998, the database recorded 112 projects with private participation reached financial closure in twenty-eight developing countries, with investment commitments totalling more than US$ 9 billion. One of the distinct patterns noted in the database of private participation in port projects was, “long-term concession contracts involving private operation and management and significant private investment in existing public assets have been the most common arrangements; the ownership of land has in most cases remained with the public port
authority. Private investment has fostered the rehabilitation of terminals and the renewal of superstructure, such as cranes and yard equipment.”

Under private management, ports have usually significantly improved their performance, boosting labour productivity and service quality and reducing handling costs, which is an important factor in increasing port competitiveness. This is illustrated by Tongzon and Heng (2005), their empirical results show that private sector participation is useful for improving port operation efficiency. However, full port privatization is not an effective way to increase port operation efficiency. The best extent of port privatization in container terminals is between Private/public (0.67) and the Private (1.00) mode, implying that it is better for private sector participation to be limited within the “landowner and operator” function and for port authorities to take over the regulatory function. The study also concludes that operation efficiency is very important for port authorities and port operators to gain a competitive advantage.

Emergence of terminal operating Transnational Companies

As ports opened up to the private sector, it also attracted foreign direct investments. A general trend has occurred whereby there has been a consolidation of players in the terminal operator markets leading to a new emergence of terminal-operating transnational companies (TNCs). There are two groups of players, basically the international terminal operators (ITOs) and ocean carriers entering into terminal operations. Examples of ITOs are Hutchison Port Holdings and PSA Corporation, both of which based their experience and expertise on long standing strong home ports performance.

For PSA Corporation, the reasons for internationalisation include: the need to compete on a different territorial basis, the opportunities to exploit the deregulation of the port sector worldwide and to channel more traffic to the port of Singapore (Fossey, 1998). From 6 projects in 18 months since PSA Corporation embark on its international strategy, PSA now participates in 26 port projects in 15 countries across Asia, Europe and the America with a global capacity of 111 million TEUs.

Ocean carriers, like Evergreen MC and NOL on the other hand, invest into terminals to improve turnaround times, control cost and secure access to key markets.

The way ports compete will most likely change because of such a trend. Firstly, ITOs in procuring their international business not only base on policy of management contracts but also in the forms of joint ventures and mergers. That means there will be a consolidation of market power in the hands of a few TNCs. It remains to be seen whether this will erode inter ports competitions especially if any routes is being monopolised by any TNC.

The second issue concern the new entrant of ocean carriers as competitors to ITOs, which may surface in the form of intra port competition, especially when ocean carriers may want to make use of spare capacity they have in the terminals they manage.

Finally, it remains to be seen whether the emergence of ITOs will give port terminal operators the power to negotiate with shipping lines to come to terms to a optimum class of ship instead of having to continuously modernise quay crane equipment to meet bigger ship sizes, a problem that has plagued container terminal operators for a very long time. Yet the participation of ocean carriers in terminal operations also brings with it the hope that they may invest also in the superstructure of the terminals which they manage, thus providing a solution to the problem. In which then international port competition may be
less of being between ports but between of ITOs against ocean carriers that also invest in terminal operations.

CONCLUSION

This paper has examined the key infrastructure, superstructure and the assisting systems that are required for sustainable container terminal operations. By purveying the trends of the growth of container traffic and projecting the future size of container ships, it can be seen that port authorities and container terminal operators faced the imperative to constantly upgrade their existing port facilities and technologies in order to remain favourable ports of call. The expansion often comes with high costs and sometimes with great ecological consequences.

In trying to cope with the increasing demand on container terminal operators to be productive, efficient and capable of modernising port equipment at large capital outlays, the port authorities have seek financial and management help of the private sector and port authorities have fallen back to the role of owners and regulators. Such a partnership is encouraged by empirical analysis and operational efficiency is increased on the part of the container terminals and gaining them an edge in competing with other ports.

Finally, the emergence of TNCs has brought about many questions about how the competition dynamics will change with the advent of oceans carriers in the terminal operation business. On one hand, TNCs may bring about a global enhancement in efficiency in ports worldwide in the short term, due to the application of best practices, on the other the reduction in the number of players may lead to a decrease in competition in the long term. With the restrictions of size of container ships nowhere in sight, ocean carriers of huge ships that operate terminals will be looked upon to solve the superstructure problems they will create.

REFERENCES


