Chapter 4

Port Congestion and Implications to Maritime Logistics

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Abstract

Ports are widely recognised as crucial nodes in international trade and transport. However, for various reasons, capacity does not always match demand: sometimes there is overcapacity, whereas in other cases, demand exceeds capacity and there is a shortage of the latter. This chapter therefore looks at where port congestion occurs, both globally and in the port-calling chain; it analyses actual responses by various chain actors, and it sheds some light on potential future evolution and reaction patterns.

Congestion, in general, can feature various forms of appearance: it can be more or less hidden, featuring congestion costs, or it can be visually present, featuring queues which are building up. The chapter discerns eight zones in the port-calling chain where congestion may emerge. As a result of a wide literature search, supplemented with a survey, it can first of all be observed that quite some congestion seems to occur, globally spread, and hitting larger as well as smaller ports. Most of the congestion is generated at the terminals, hinterland connection points and hinterland transport itself.

In terms of reaction patterns, one would assume that pricing throughout the system is adapted in such way that demand equals capacity. In practice, prices are hardly making any effort to make marginal revenue equal marginal cost. The reason is mainly that the power balance is quite strongly in favour of shipping companies, who impose on port and port operators the need to expand capacity at low fees. Port operators, in turn, apply various kinds of technical and procedural adaptations. The same is true for hinterland operators.

Looking towards the future, it seems that with the increase in world trade, the risk of port congestion will be even more outspoken, be it in some parts of

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the world more than in others. It is also very much likely that most problems will occur landside, as this is the part of the chain where solutions are least easy: who is going to take the initiative, how will co-ordination take place and where will the funding come from? Most actors seem to be aware of this trend, and seek for solutions like dedicated terminals and vertical integration or co-operation.

With the above observations, the chapter sheds some light on where the future needs and trends in the abatement of capacity will lie. It is therefore useful from a scientific point of view as well as with an eye on policy-making and operational port management.

Keywords: Port congestion; maritime access; berths; terminal; hinterland connection

4.1. Introduction

Ports more than ever before are important nodes in logistics chains. On the one hand, they are important as their core activity, loading and unloading of goods, is key to international trade and transport of goods. On the other hand, they are also important as their activity represents a relatively large share in the total chain cost. For these reasons, port activity is increasingly required to fit perfectly into the logistics chains of which seaports are an integral part. In practice, this is by far not always the case. One of the important phenomena preventing a match between ports and their logistics chains is congestion.

It speaks for itself that congestion will have a detrimental impact on the generalised cost and on the overall transport or throughput performance. After all, to a shipping company, congestion implies time loss and thus a higher generalised cost. However, congestion is also problematic for the other port actors. Vessels whose arrival at berth is delayed through congestion may be difficult to fit into the loading and unloading schedule of the terminal operator. This will have implications for capacity management and result in higher costs. The same holds for other actors, including in the fields of storage and hinterland transportation. Moreover, a knock-on effect may be felt elsewhere in the maritime transport chain: delays can have an impact on operations in other ports of call. Therefore, it is important that we should acquire adequate insight into how port congestion arises, the associated costs, and how it can be avoided or eliminated most effectively.

This chapter discusses the issue of port congestion in detail. More specifically, its purpose is to define the congestion issue in transport economics, with special focus on seaport activity (including types of congestion, the corresponding money and time loss (at locks, berth, etc.)). Next, the results are presented of a literature review of global port congestion reporting and a survey on congestion conditions in some European and American ports. Observations are made as to how congestion developed lately and what its causes are. Furthermore, a typology is made of reactions patterns by different actors. Finally, a number of future scenarios are dressed.

4.2. A conceptual Framework

Congestion implies that one transport user, i.e. a ship, impedes another. Consequently, a cost is imposed upon a third party. The busier traffic gets, the greater the imposed cost. Jansson and Shneerson (1982, p. 52) define this situation as follows: 'Congestion costs exist if the other short-run costs of port operations, per unit of throughput, are an increasing function of the actual capacity utilization. When actual demand exceeds capacity, extreme congestion costs arise, which we call queuing costs. When a port is said to be congested, it is commonly meant that ships are queuing, waiting to obtain a berth'.

Congestion costs are made up of time loss, additional fuel consumption, greater inconvenience and possibly even accidents. However, time loss is the most substantial contributing factor. An additional transport user imposes a time loss on others. The other losses are often proportional to those time losses.[1] In fact, congestion costs are a negative effect of a high capacity utilisation.

This means that it is necessary to calculate accurately how great a time loss an additional user imposes on third parties. This time loss may be caused in two ways: by slowing down the traffic flows or by generating a queue. In the former case, the congestion costs are calculated on the basis of speed–volume relationships, while in the latter one, it relies on queuing theory.

A seaport typically has a great number of internal bottlenecks, each of which can result in a queue: pilot service, towing service, locks, loading and unloading quays, bunkering, etc. In practice, it is sheer impossible to observe every bottleneck separately in order to conduct counts, let alone impose the appropriate congestion levies (Blauwens, De Baere, & Van de Voorde, 2010).[2,3]

1. In the case where a ship is delayed, one usually assumes additional fuel consumption to be proportional to the time loss. Fuel consumption is then regarded as a component of the time cost.

2. Jansson and Shneerson (1982, p. 52) opt for a restricted interpretation of congestion: 'We prefer to restrict the term congestion costs to effects that show up as increases in the cargo handling costs and/or the service time of ships (which, in turn, will influence the queuing time of ships'. They go on to explain that 'if empirical observations showed that the short-run total variable costs (excluding queuing time costs) increase progressively with rises in port throughput, this would be an indication that congestion costs exist. Conversely, if total variable costs increase proportionally to throughput, the inference would be that congestion costs do not exist' (Jansson & Shneerson, 1982, p. 52).

3. Moreover, it is important to guarantee that any congestion charge imposed is actually related to a specific congested unit. The charge shall be imposed on vessels if the problem is the number of berths, available quays, the use of locks, or a canal or river. If, however, the berths are causing capacity problems, then the charge should be imposed on the tonnages put through those berths, not on the vessel. The extent of substitution between various activities in the port operation and the extent to which use of congested particular facilities can be economised can be revealed only by detailed examination (Bennathan & Walters, 1979, p. 80). This has consequences for, among other things, the so-called dwell time. Owners of cargo, or their agents, who would previously leave their freight at the port terminal, as a relatively cheap storage option up to the point of sale or processing, will undoubtedly adapt their behaviour in response to a charge.

In practice, seaport activity is a very complex affair, not in the least because so too is the port calling process. After all, it involves ships of varying sizes and is therefore not homogeneous in terms of required assistance and handling needs. There are various possibilities for substitution: between cargo, between ship and cargo, between ship and port, between terminals within a port, and between berths within a terminal. The heterogeneity of vessels and cargo has efficiency implications for cargo handling. Cargo-handling performances are influenced strongly by various external factors, irrespective of volume of traffic.[4] It is the mismatch of this cargo-handling activity with other activities in the logistics chain which causes port congestion.

The consequence of this complexity is that congestion in a maritime and seaport context can be observed at different levels. A ship that is heading from open sea to a seaport may experience congestion consecutively in the following places or corridors, depending on the location and structure of the port:

- *Maritime access route*: In the case of capacity restrictions, e.g. because of tide dependence, congestion may occur on the river or canal between open sea and the port. Ships often adapt their speed in open sea to the expected slot.[5]
- *Locks*: For vessels whose docking destination lies behind a system of locks, congestion may arise if the number of vessels wishing to use a lock is greater than the lock capacity. In practice, however, vessels do not queue outside the lock, but rather adapt their speed out on the river or canal in order to approach the lock in accordance with the expected slot.
- *Berths*: A ship may be confronted with congestion at berths, i.e. the specific berth may be occupied because another ship is not ready to depart yet. In such situations, the waiting ship may be moored temporarily at another berth.
- *Loading and unloading*: Once all berths at a terminal are occupied, a shortage may arise in loading and unloading equipment (e.g. gantry cranes, straddle carriers). In practice, the response to such a situation would be to start loading or unloading the ship rather quickly, but using less equipment than is customary.
- *Storage*: Storage areas, through bad configuration but also through unexpected moves to be made, may impose waiting time upon cargo and vessel. The choice of automated versus manual handling is to be well considered.
- *Customs inspection*: The organisation and procedures of customs checks can cause congestion at the point where cargo enters or leaves the country. Enhanced security checks in the frame of international anti-terrorism measures may further worsen the fluent flow of cargo through the port.
- *Hinterland loading and unloading*: The use and operability of specific hinterland modes can feature disruptions or delays, impacting also on the maritime side

4. In the past, port authorities and even terminal operators used to collect little or no data on such aspects. This in part explains why very few ports imposed a congestion charge.

5. In the case of an Antwerp-bound ship on the river Scheldt, the vessel may choose to pull up to an anchoring buoy at the estuary into the North Sea.

of the port-handling process. In case of truck use, gate systems are often a bottleneck impeding normal terminal operations.

- *Hinterland connections*: Excessive capacity utilisation of hinterland infrastructure, often in combination with non-port-bound traffic where ports are located in crowded city environments, may cause delays in evacuating cargo from or delivering cargo at seaports, therefore holding up terminal processes. On Antwerp motorways, for instance, it was surveyed that in 2006 only 18% of all traffic was commodity related, and of that portion, only 23% had the port as an origin or destination. Moreover, the peaks in port-bound traffic seem to coincide with commuter rush hour peaks (Port of Antwerp, 2007).

4.3. Literature Review and Survey Results on Current State of Congestion

From a social welfare point of view, estimates should be made of all the elements of social marginal costs, including external congestion and scarcity costs. This requires first of all the identification and localisation of bottlenecks which result or may result in congestion in the port. Once the bottlenecks are identified, estimates of the increase in journey time of other traffic and a measure of the unreliability for other traffic caused by an increase in port traffic are needed.

For the identification of port competition all over the world, and its main causes, we relied upon existing, mostly business-oriented, literature covering the period 2009–2011. It is complemented with the results of a survey on congestion conditions in Europe and the United States, dating back to 2006.[6] The latter concerns a survey held among various actors in and/or related to seaports and a review of existing literature on the matter, especially with regard to quantification of existing congestion problems in the two continents' seaports.[7]

For the results of the 2011 literature review, we refer to Appendix B, whereas the survey results are summarized in Appendix A. Appendix B contains an overview of the ports mentioned featuring some form of congestion, the timing at which congestion was observed, and the nature of the causes of congestion. Appendix A features very brief characterisations of issues on traffic quality measurement,

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6. Research was carried out in the frame of the service contract by the European Commission No. TREN/05/MD/S07.53585 entitled 'Analysis of the contribution of transport policies to the productivity and competitiveness of the European economy and comparison with the United States—COMPETE'.

7. The survey combined a paper questionnaire sent out, supplemented by a telephone survey to complete or clarify respondents' answers. In some cases, telephone answers were the only source of reaction as completing the written questionnaire often turned out to be a demanding exercise. Out of the total 32 contact persons that formally confirmed over the telephone to transfer their answers to the researchers, 26 effectively sent in their paper questionnaire and/or answered by phone. This number should be sufficient to draw significant conclusions. The validity of the answers is strengthened by the representativeness of the answers: respondents cover various businesses, from port authorities over cargo-handling companies and shipping companies to rail and inland navigation operators.

the current state of congestion of delays, the future expectation of the delay situation and policy plans envisaged to fight congestion for the port sector.

From Appendix B, it appears that congestion mainly originates from the terminals and the hinterland connections. This conclusion seems largely in line with the results from the earlier survey, as reported in Appendix A. Only in the identified case of Saint-Petersburg, where ice formation on maritime access ways occurs, the cause lies in the wet part of the port chain. In quite some of the cases, congestion originates from lack of berthing capacity. Impacts however in most of the cases spread out over various sections of the chain, and even on to other ports, where ships, for instance, miss their slots due to late arrival.

A strong indication of high congestion probability on the terminals side, especially at container terminals, is given by the terminal capacity utilisation figures in Table 4.1. It is found that especially terminals at the large North-European ports are operating very close to their capacity limits. Of course, one can go through the theoretical capacity border, but that usually implies a sharp rise in cost. Leach (2010) states that by 2015 container terminal utilisation levels can amount up to 80%, and in fast-growing regions (Far East + Middle East) up to 95%.

Other indicators of congestion can be, for instance, the utilisation of the road network in the neighbourhood of ports, and inland navigation lock capacity utilization. Fairplay refers to a number of other sections in the chain where congestion can occur. A first example is the Panama Canal, where congestion due to too big vessels is observed. Furthermore, it is identified that repair yards and scrapping facilities are becoming new sources of maritime congestion.

When comparing the results on expected developments of port congestion with the actual state of congestion from the current literature search, it turns out that whereas most actors and most ports in 2006 expected an improvement of the congestion situation, the number of cases of congestion at current actually is very long, as can be seen from Appendix B. In some of the cases where interviewed actors were pessimistic in 2006, like for Rotterdam, this pessimism actually turned into reality. Although congestion turns out to be a global phenomenon, it seems that the Middle and Far East seem to be worst hit.

Table 4.1: Terminal capacity utilisation in North European deep seaports—2004.

Port	**Capacity utilisation (%)**
Le Havre	89.6
Antwerp	92.9
Rotterdam	92.5
Bremerhaven	95.5
Hamburg	93.2
Southampton	99.3
Felixstowe	77.1
Others	41.9
Total average	86.6

Source: Drewry Shipping Consultants.

When looking at the causes of congestion, Appendix B shows that the weather very often is the cause of delays, either directly or indirectly. Directs impacts come through, for instance, floodings, winter conditions, shallow water due to drought, etc. Indirectly, the weather impacts on the speed at which certain crops develop, with concentrations of volumes of, for example, sugar, grain, etc. to be handled by ports, leading to congestion again. The latter in principle should be easier to plan, as the occurrence is not sudden. It turns out however that not all operators are planning in the same, efficient way. Lack of truck capacity in hinterland transport seems an additional big source of congestion. Furthermore, also equipment and labour shortages are causing congestion. All of these of course can be indirectly related to peaks in traffic, and linked, for instance, to weather conditions. But very often, they are just due to inability to find a sufficient number of skilled workers, to a strike or to a lack of capital to invest in additional equipment.

Interesting to note also is that no commodity seems to be free from congestion. Appendix B shows that next to containers, also dry and liquid bulk seem to be severely hit. For some commodity types, the weather is a much bigger cause of congestion than for other commodity types.

It is also interesting to see to what extent actual measurement of congestion exists. From Appendix A, it turns out that, in general, congestion is not well measured, and in the cases where a measurement is done, the latter is very fragmented. On the other hand, a general feeling and consensus is there on the existence of congestion, mainly at terminals and in hinterland connections.

When comparing port ranges, the picture is quite mixed. In terms of measurement, the United Kingdom seems to have the more structural data collection, which is more or less absent in Baltic ports and Mediterranean ports. In all port ranges, congestion on the maritime side turns out to be nearly non-existent, while nearly all ports report problems at terminals, gates and/or the hinterland. As to the future prospects, it can be observed that in all ranges especially the hub ports where no immediate initiatives are deployed expect a worsening.

4.4. Actor Reaction Patterns to Port Congestion

From Appendix B, the different reaction patters from different actors can be observed, involving different time ranges. They can be summarized into a typology as follows.

Time loss due to congestion during port calls overall generates enormous costs, cf. the high vessel operating costs coupled with high investment costs. Every effective measure to cut or avoid congestion therefore reduces cost and increases efficiency. On the other hand, the mere existence of congestion means that a port is a valuable and scarce good. Therefore, the solution to the congestion problem would seem straightforward: port authorities should increase port dues and consequently benefit from the scarcity of capacity. The benefits of a congestion charge are quite clear. First and foremost, they generate higher income. The charges are a source of funding for expanding port infrastructure and services, which will enhance the port's degree of self-sufficiency and make it less dependent on public subsidising. Moreover, a congestion charge will encourage the efficient utilisation of available port facilities.

There are, however, also some downsides to take into consideration. There is, for instance, the administrative complexity of imposing a charge: demand — and thus congestion — may fluctuate seasonally, and may moreover contain a random component, such as the weather. Relatively strong shipping companies may pass on the congestion charges to third parties, possibly with a mark-up, which would have an indirect negative effect on demand for port services.

In practice, most port authorities seem not to operate in this manner. Port charges are deliberately kept low, even in congested ports. The reason is that port authorities are usually convinced that higher charges will cause not only loss of traffic, but also higher prices for imported goods. Port authorities will usually not adopt charges, even in situations when congestion is putting substantial pressure on the cost level. To a considerable degree, this economic cost is passed on to goods handlers or so-called terminal operating companies (TOCs). The latter are expected by port authorities and, even more so, by shipping companies to load and unload more quickly, resulting in a higher cost per unit of output. A number of actions through which they try to achieve this are mentioned in Table 4.2. If this higher cost is passed on through higher rates for the customer, i.e. the owner of the freight, then this will equally generate downward pressure on the competitive position of the port in question.

Shippers, next to shifting port, may also engage in cargo redistribution, transportation demand planning, virtual warehousing and solving communication problems to government (Blanchard, 2007).

It is clear that, in the economic power struggle, the port authorities occupy a relatively weak position vis-à-vis the shipping companies, as is apparent from the fact that the latter often impose congestion surcharges on the owner of the cargo.[8] Bennathan and Walters (1979, p. 84) assert the following in this context: 'The shipowner would rather suffer the average normal delay than pay for the additional cost of immediate service. A balance between the incremental cost of providing more capacity and the consequential reduction in the cost of ship delays is the criterion for defining normal capacity'. Appendix B shows that congestion surcharges do indeed get applied more and more often. The balance between normal delay and the additional price of service may have changed, but the principle about defining normal capacity is still fully valid (Stopford, 2002).

A pattern emerges in the observed competitive struggle between shipping companies and port authorities in recent decades. In the scheduling of operations and in pricing, the shipping companies took as their starting point a normal level of congestion. Abnormal congestion, i.e. any congestion on top of whatever was assumed to be the normal level, was passed on by those shipping companies as a congestion surcharge. The long-term strategy of the port authorities, on the other hand, was aimed at continuously increasing capacity, often with financial support from the public authorities. This way, normal congestion was kept very low, or even reduced to zero, but at the cost of substantial overcapacity. Extra capacity is also indirectly

8. The manner in which shipping companies can pass on the costs associated with congestion obviously depends on the demand elasticity of shipping services.

Table 4.2: Terminal optimization measures.

Type of measure	Example
Multi-pick lifting	Twin (two 20-in. containers) and tandem (two 40-in. containers) lifting are concepts that are rapidly being introduced at many terminals worldwide, since about 2005.
Truck appointment systems	Common procedure at most Asian terminals, U.S. and European ports have since 2005 started applying truck appointment procedures, in an attempt to reduce hinterland delay and increase terminal velocity. A similar initiative was the synchronised time slot use for trans-loading cargo from ocean vessels to barges.
Extending gate opening hours	In Europe, for most terminals, it is quite common for the waterside to be operating around the clock. On landside, however, there are often limited terminal opening hours. In 2004, Antwerp stevedore Hessenatie has taken the initiative to have longer gate opening hours but got insufficient co-operation from other chain partners. In the same year, South California ports have developed a similar plan, initially meeting labour shortage obstacles however.
Electronic document transmission	Many ports worldwide have introduced various electronic document transfer systems. Customs as well as payment documents can be transferred through this kind of system. Australia was a primer by introducing such a system in 2000.
High-speed gates	At West Basin Container Terminal, Los Angeles, automated gate systems, using, for instance, optical character recognition, have allowed in 2009 reducing the number of data entry clerks required to process up to 5100 transactions per day from 18 to 9, resulting in over $1million in saving/year, through higher speed as well as accuracy.
Automated yard marshalling	ECT Rotterdam used to have fully automated terminal operations since its start, although the low flexibility was often detrimental to productivity. DP World Antwerp is testing a semi-automated system, where waterside activities would still be performed manually, whereas terminal and hinterland (un-)loading would be automated.

Source: Own composition.

generated by port authorities through allowing for yard extensions and improved space utilisation, through concession conditions, for instance (Thongrung, 2011).

Almost all shipping companies are constantly implementing measures to try and reduce operational cost. They often do so in response to exogenous influences, such as higher bunkering rates and/or growing port congestion. During 2010, a number of shipping companies or alliances decided to apply slow steaming and to deploy an additional ship on

Table 4.3: MSC Europe–Far East loop restructuring, May 2011.

Service	Vessels deployed	Ports of call
Lion	From 10,000 to 14,000 TEU average vessels	Felixstowe added to Le Havre, Antwerp, Bremerhaven and Hamburg
Silk	11 vessels of 13,500 TEU average	Antwerp, Felixstowe, Hamburg, Bremerhaven, Rotterdam and Antwerp

Source: DynaLiners.

certain loops. The envisaged goals were smoother port operations with less congestion, more port calls and reduced fuel consumption through lower speeds. At the same time, transit time obviously increases. Beginning of 2011, DynaLiners observes that shippers start calling for a share of the gains made by shipping companies.

A permanent analysis of the operational decisions taken by shipping companies and/or alliances can yield information with regard to possible congestion problems in various ports and at various terminals. By way of illustration, we consider Mediterranean Shipping Company (MSC), which reorganised its loops between Europe and the Far East beginning of 2011. The purpose was to enhance efficiency and reduce cost. Avoiding congestion was one of the means of achieving these goals. For ports, there is the additional struggle to be either the first or the last port of call in the range. In the MSC case, Antwerp occupies an important role, particularly in the Silk route, being the first and last European port of call in the loop (Table 4.3).

Under permanent threat of potential reshuffling of port calls, port, terminal and hinterland operators are taking measures to relieve congestion on the port access ways, often still at own initiative and without co-ordination along the logistics chain. Table 4.4 summarizes the most important types of measures occurring, with examples. It should be noted that also a number of actions from Table 4.2 should improve hinterland congestion. Each of the measures can, on their own or in combination, deliver an important contribution to the diminishing or avoiding of congestion.

Finally, it can also be observed that in most cases, neither port authorities nor operators are fully prepared for tackling the congestion problem. Co-ordination and co-operation among actors is in most cases insufficient.

4.5. Future Evolution

It is clear that the port and maritime sector evolve very quickly and are facing a number of challenges; each of those developments will have consequences in terms of capacity utilisation and will therefore possibly relate to port congestion.

The world economy continues to be the driving force behind the maritime sector (Meersman, Van de Voorde, & Vanelslander, 2010). The world economy is, however, subject to enormous change, cf. the enormous growth in international trade, the international redistribution of labour and capital, and the integration and globalisation of markets. The strong growth of the BRIC's and other Asian countries will continue to generate huge volumes of maritime trade with considerable

Table 4.4: Operational measures in the hinterland.

Type of measure	Example
Hinterland traffic diversion	End of 2007, China Shipping has diverted a large part of its traffic to the Port of Ipswitch in order to avoid strong congestion at other UK ports.
Congestion pricing	Tolling attempts have been existing for quite some time in some European countries (for instance, France), or were recently introduced (for instance, Germany in 2005, Poland in 2011). Time and place flexibility is however to be introduced. The Port of New York/New Jersey has taken such initiative in 2005 for diverting rush hour traffic in the wider port zone. By crossing overnight, truckers in 2011 pay per axle costs of \$3.50, compared to \$6 at peak times, and \$5 during afternoon and evening off-peak times. Cars pay \$4 each during all off-peak hours, \$1 less than during peak hours. In the meantime, various ports and regions are considering introducing road pricing. Examples in Europe are Antwerp and Rotterdam.
Off-dock container yards	Hanjin Shipping has started operating off-dock container yards in 1994, and now operates six of them, in co-operation with local partners each time. In Felixstowe and Southampton, Kuehne + Nagel has established a rail service for moving cargo as quickly as possible off the docks to inland yards.
Fast rail shuttles	European Rail Shuttle since 1994 connects four of Europe's most important seaports to 20 inland terminals, often located in Eastern Europe. Shuttles run several times a week.
Expanded rail connections	The Betuwe line connecting the Port of Rotterdam to the German Ruhr area and the Iron Rhine connecting the Port of Antwerp to the German Ruhr area are examples of rail projects aiming at faster bridging the distance between large seaports and important hinterland load centres.

Source: Own composition.

imbalances, especially in the container trade. According to UNESCAP (2007), 1264 new container berths will be required to meet the anticipated world demand in 2015, the majority of which will be needed in East Asia and the Pacific. This will clearly require large investments in port infrastructure. To improve their competitive position, port authorities and port operators will try to avoid congestion by providing as much as possible available capacity to the shipowners.

Shipowners are large and strategically significant customers of seaports and they have increased their market power considerably. Moreover, in recent times we have witnessed scale increases in the shipping sector, first and foremost through horizontal co-operation and/or mergers and acquisitions. An example of the latter is the takeover in 2005 of P&O Nedlloyd by Maersk. A recent example of co-operation is the slot exchange agreement between Maersk and Evergreen on the Asia–Europe trade. In the second instance, shipowners have been showing greater interest in terminal operations and hinterland transportation, a consequence of the growing tendency to think in terms of complex logistics chains, whereby each link must contribute to a continuous optimisation of the chain as a whole. This development has tipped the market balance in favour of shipowners, as they now control some powerful logistics chains (Heaver, Meersman, & Van de Voorde, 2001).

The future of the ship-owning sector may be summarised in three core notions: rationalisation, mergers and company scale increases. Especially in the container business, ship owners are continuing to invest heavily in additional capacity in the hope of deploying it at a lower operational cost per slot.[9] Moreover, they regard a mixed fleet as a way of spreading risk (Det Norske Veritas, 2007). Additional cost control may be achieved through mergers and acquisitions and ensuing capacity reductions. Pressurised by the strategic and financial considerations of the holdings that control the shipping companies, capacity will be further kept in check through strategic alliances, new partnerships and the rerouting of vessels. This will give rise to shifts in terms of direct port calls, which could, in turn, impact on existing congestion or indeed create new congestion (Peters, 2001; Song & Panayides, 2002).

Landside, the following rule will apply: the economic benefits that shipowners seek through substantial ship scale increases and ensuing cost reduction must not be wasted through potential bottlenecks and the loss of time and money that they entail, neither on the quay, nor in the terminals, nor indeed during hinterland transportation. As regards capacity, there is clear evidence of heavy growth, associated with a concentration movement among terminal operators.[10] As far as the shipping companies are concerned, a further concentration of terminal operators represents an evident danger: less mutual competition, lower productivity growth, longer turnaround times for vessels and, above all, higher handling rates.[11] One may readily assume that shipowners will not continue to undergo this development passively. As their relative market power is under threat, they may be expected to make greater efforts to acquire so-called dedicated terminals, be it under a joint venture with locally active terminal operators or otherwise.[12]

Even in larger ports, certain shipping companies can occupy a relatively dominant position. MSC, for example, carried out a total of 4,500,000 movements in 2009 at its

9. Overcapacity is not necessarily perceived negatively by shipowners, as they assume it will be partly absorbed by the problem of port congestion. This expectation is then coupled with the notion of longer haul cargoes, which would change the tonne/mile ratio.

10. This concentration movement, coupled with the market entry of new players, such as PSA, HPH and DP World, has also created a buffer against possible vertical integration on the initiative of shipowners.

11. The latter is due primarily to the fact that shipowners are no longer confronted with different, vehemently competing terminal operators, but rather with larger players who are active in different locations and are therefore able to negotiate package deals covering various ports and longer periods of time.

12. As far as port authorities are concerned, this need not be a negative evolution, as it would make shipowners a lot less footloose, in the sense that a longer term relationship may develop that will reduce their urge to relocating (Heaver et al., 2001). In the short term, the use of 'dedicated terminals' may lead to lower capacity utilisation rates for terminals.

Home Terminal at Delwaide Dock in Antwerp, amounting to 3.9 million TEU. This means that MSC accounted for almost 48% of overall container traffic in the port of Antwerp in that year.

Yet strikingly, MSC was also interested in acquiring a terminal at Tweede Maasvlakte in Rotterdam. However, it failed. Shipping companies such as COSCO, K Line and Yang Ming, who are also involved in a terminal at Deurganck Dock in Antwerp, have set up a joint venture with the Rotterdam-based cargo handler ECT (a subsidiary of HPH) with a 49% stake in the Rotterdam Euromax Terminal.

These kinds of developments show that if a shipping company or an alliance acquires a significant stake in a particular port, this does not necessarily result in diversion of traffic. The main concern of companies is simply to be present in the principal traffic-generating ports. At the same time, such a strategy allows shipping companies to gain degrees of freedom, among other things, with a view to avoiding congestion in ports and at terminals.

With regard to ports, there have been some significant structural changes. The characteristic make-up of the traditional stevedoring business has evolved towards more complex TOCs, often because the need for capital has given rise to mergers, takeovers and externally funded expansion projects. External capital has in some cases been provided by shipping companies. Port authorities, for their part, initially looked on rather passively as this trend unfolded.

As a result of scale increases, takeovers and mergers, especially among shipowners, an increasingly small number of customers are accounting for a growing share in turnover achieved by terminal operators. Often, this implies a concentration of throughput, i.e. higher peaks in demand for handling capacity (Fusillo, 2003). As shipping companies invariably expect there to be sufficient capacity, at increasingly high productivity, terminal operators are forced to invest in more and bigger cranes.

Some terminal operators therefore seek cooperation with shipping companies. A recent example of such a development is Antwerp International Terminal, a joint venture created in 2005 involving the shipping companies K Line, Yang Ming and Hanjin on the one hand and terminal operator PSA Antwerp on the other hand. Also in Antwerp, PSA, together with MSC, operates the MSC Home Terminal.

In Singapore, PSA has in 2008 set up a dedicated container terminal for Pacific International Lines. This type of strategy was not at all found before 2002, when the company used to take a common user approach. After being confronted with significant competition from the Malaysian concern Tanjung Pelepas, a choice was made for intensive cooperation with shipowners, in the hope of achieving greater integration. One example of this new policy is the joint venture with COSCO. This was followed towards the end of 2005 by a joint venture with MSC for the purpose of operating three berths at the Pasir Panjang Terminal.

The sums involved in investments in vessels and port terminals are enormous. The traditional companies, often being family businesses (such as the former Antwerp-based stevedore Noord Natie), are no longer able to raise the required capital for the extensive scale of operations that feature at container terminals nowadays, where profit margins per unit are rather low moreover, and thus inevitably become takeover targets.

Initially, the purchasers, such as HPH and PSA, belonged to the sector itself (Wiegmans, Ubbels, Rietveld, & Nijkamp, 2001). Subsequently, however, capital was increasingly found beyond the traditional maritime and port industry. Apparently, port infrastructure is seen to offer a strategic value added, with an almost guaranteed return. Moreover, it is expected to become increasingly difficult to build additional port infrastructure. It will, in other words, become a scarce good.

The relationship between port competition and shipping companies always boils down to the same one key concept: available capacity. Capacity seems to be a crucial factor in the analysis of port competition, and turns out to play at various levels.

In port competition, and, in particular, competition in container traffic, available capacity is not only an important factor in attracting new flows, but surely also for keeping freight transport. Shipping companies choose ports without congestion and bottlenecks. They think ahead, choose open space, with growth potential. This means that freight transfer from sea to port and vice versa needs to be performed in an efficient way, but the way hinterland transport enrolls (mode choice) is an important factor (Aronietis, Van de Voorde, & Vanelslander, 2010; Huybrechts et al., 2002).

From certain fast-growing ports like Rotterdam, Antwerp and Hamburg, new port and hinterland projects need to be seen primarily as addition of available capacity that needs to enable future port growth. In a number of European ports, container traffic grew by about 11% between 2000 and 2010. This implied that all elements in the maritime logistics chains need to prepare for continuous growth figures. If one does not take this into account, congestion will show up, or existing congestion will move on to an unacceptable high. Maritime flows risk getting moved to other ports.

4.6. Conclusion

Congestion implies loss of time and money, and therefore undermines the competitive position of ports and maritime logistics chains. Consequently, maximum efforts must be made to avoid such maritime congestion. To this end, insight is required into present and future developments in maritime transport and port throughput, as well as into the strategic behaviour of the various market players involved.

With respect to that behaviour, it is clear that shipping companies opt for ports with sufficient available capacity. This avoids the risk that the huge amount of capital, which is embedded in their vessels, get used sub-optimally. Available capacity implies not only berths, but also efficient terminal operations and good hinterland connections. It is up to all actors involved in terminal and hinterland operations to safeguard the provision of sufficient free capacity.

The most likely future scenarios, which therefore deserve to be studied in depth, are more or less known. However, some uncertainty remains as regards the timeframe in which the expected developments will unfold. The speed at which the various market players within the maritime logistics chain will take specific initiatives shall depend on a battery of exogenous and endogenous variables. As is the case with pricing in the maritime sector, and with successfully covering oneself against price fluctuations and other risks, timing is what ultimately determines who will emerge as the winner.

Further quantification of decisions taken by various chain actors is needed. This should help understand why they take certain decisions, but also where congestion occurs, sometimes in a hidden way. This will reflect in higher operator costs, implying action to be taken.

References

Aronietis, R., Van de Voorde, E., Vanelslander, T. (2010). Port competitiveness determinants of selected European ports in the containerized cargo market. Paper presented at IAME 2010.

Bennathan, E., & Walters, A. (1979). *Port pricing and investment policy for developing countries*. United Kingdom: Oxford University Press.

Blanchard, D. (2007). Five strategies to avoid port congestion. *Industry Week*. October 1.

Blauwens, G., De Baere, P., & Van de Voorde, E. (2010). *Transport Economics* (4th ed.). Belgium: De Boeck Ltd.

Det Norske Veritas. (2007). Port congestion and loading speed. Retrieved from http://www.dnv.com/industry/maritime/shiptypes/orecarrier/portcongestionandloadingspeed.asp

Fusillo, M. (2003). Excess capacity and entry deterrence: The case of ocean liner shipping markets. *Maritime Economics and Logistics*, *5*, 100–115.

Heaver, T., Meersman, H., & Van de Voorde, E. (2001). Co-operation and competition in international container transport: Strategies for ports. *Maritime Policy and Management*, *28*(3), 293–306.

Huybrechts, M., Meersman, H., Van de Voorde, E., Van Hooydonk, E., Verbeke, A., & Winkelmans, W. (Eds). (2002). *Port Competitiveness. An economic and legal analysis of the factors determining the competitiveness of seaports*. Belgium: De Boeck Ltd.

Jansson, J., & Shneerson, D. (1982). *Port Economics*. United States of America: MIT Press.

Leach, P. (2010). Port congestion could resume in some sectors. *Journal of Commerce Online*. Retrieved from www.joc.com

Meersman, H., Van de Voorde, E., & Vanelslander, T. (2010). *Future challenges for the port and shipping sector*. United Kingdom: Informa.

Peters, H. J. F. (2001). Developments in global seatrade and container shipping markets: Their effects on the port industry and private sector involvement. *International Journal of Maritime Economics*, *3*, 3–26.

Port of Antwerp (2007). *Analyse hinterlandverkeer Haven van Antwerpen*. Antwerpen.

Song, D.-W., & Panayides, P. M. (2002). A conceptual application of cooperative game theory to liner shipping strategic alliances. *Maritime Policy and Management*, *29*(3), 285–301.

Stopford, M. (2002). *Maritime economics*. United Kingdom: Routledge.

Thongrung, W. (2011). Shippers irked by port congestion. *The Nation*, May 28.

UNESCAP (2007). *Container traffic forecast—Regional shipping and port development—2007 update*. Thailand: UNESCAP.

Wiegmans, B. W., Ubbels, B., Rietveld, P., & Nijkamp, P. (2001). Investments in container terminals, public private partnerships in Europe. *International Journal of Maritime Economics*, *4*, 1–20.

Appendixes

Appendix A: Survey Country Reviews on Congestion

Table 4.A.1: Synthesis of survey country reviews on congestion.

Port	Measurement and data used	Current state of congestion	Expected development of congestion	Policy plans
Miami	No structural measurement	Problem landside: gate, location close to city	Increasing	Major port redevelopment, new gate system
Antwerp	Time registration for every vessel	Sometimes congestion, especially at terminals	Situation will improve: new quays, better rail, inland navigation and trucking system	Barge Traffic Services, new rail system, trucking assignment
Gdynia	No structural measurement	No congestion, at least not on maritime side	Worsening if no measures	Better hinterland connections
London	Every vessel is registered by the Port Authority	No structural congestion on maritime side	Probable worsening in hinterland	No structural plans
Rotterdam	No vessel registration	Only congestion on hinterland side	Pessimistic	No new infrastructure plans
Humber	Time measurement for every vessel	No congestion	No immediate worsening	No plans needed at this stage
Hamburg	No measurement	Congestion occurs, but not quantified	No worsening	No plans available
Long Beach	Some measurement, not structural	Road and rail increasingly congested, terminals equally congested	As traffic increases, problems may worsen	No immediate plans
Felixstowe	Shipping companies do measurements	No congestion	No worsening expected	No plans
Barcelona	Measurement of time that goods spend in port	Some inland congestion	No worsening expected	Discussion groups, no plans yet
Kotka	Data are collected for ships and at terminal	No real congestion	No worsening expected	No plans

Table 4.A.1: (*Continued*)

Port	Measurement and data used	Current state of congestion	Expected development of congestion	Policy plans
Rostock	No structural measurement	Congestion at gates and at terminal	Road situation may get worse	Regular check-ups with road authorities
Portuguese ports	No measurements by ports	No congestion	No worsening	No plans
Aarhus	Measurement by port and terminals	Minor congestion at terminals	Worsening through overflow from other ports	Terminal extension
Corck	Statistical ex-post measurement	Constant inland congestion	Sharp rise	Downstream extensions
Rauma	No structural measurement	No recurring congestion	No worsening	No action plans
Genova	No measurement by port authority	Minor congestion in hinterland	No clear view	Planned reinforcing of rail
Marseille	For ships: no structural measurement; for hinterland: structural measurement	Only congestion for tankers	Other commodity types may be affected too	Terminal extensions plans
Zeebruges	Only ships followed by port; terminal situation assessed by terminal operators	Mainly congestion in hinterland	No immediate worsening	Port authority has entrance improvement plans and lobbies for better roads
Tacoma	Measurement for ships	Strong hinterland congestion	Problems may rise without action	Freight Action Plan, involving all actors

Appendix B: Literature Search on Global Port Congestion

Table 4.B.1: Synthesis of literature search on global port congestion.

Port	Date	Type of congestion and/or reaction
Nava Sheva (India)	Since early 2010	Yard congestion and rail delays
	July 2010	Maersk levies surcharge
	July 2010	APL levies surcharge
	July 2010	OOCL, NYK and HMM levy surcharge
	June 2010	Maersk Line and CMA-CGM divert traffic to Mundra and Pipavav
	July 2010	COSCO levies surcharge
Australia	July 2010	Delays to sugar exports
	April 2010	Congestion at coal terminals
	End 2007	10–14 days waiting offshore for bulk vessels
Port Botany, Sydney (Australia)	February 2011	Port congestion surcharge introduced
	December 2010	Months of delays for vessels, aggravated by successful grain + coffee crops; in March 2011, penalties were installed by Sydney Ports Corporation.
	August 2009	Sydney Ports Corporation gives up plans for voluntary behaviour change by road operators, and introduces PierPass system.
	June 2009	New performance and penalty system introduced.
Colombo (Sri Lanka)	Halfway 2010	Terminal congestion through lack of equipment, especially for transhipment from Bangladesh, India and Pakistan; SLPA to build freight village
Chittagong (Bangladesh)	Halfway 2010	Terminal congestion through lack of equipment
Brazil	September 2010	Delay mainly for sugar vessels caused by heavy rains
	End 2007	6–8 days waiting offshore for bulk vessels
Newcastle (Australia)	October 2010	Congestion for coal export
Jebel Ali (UAE)	September 2008	Several days of delay

Table 4.B.1: (*Continued*)

Port	Date	Type of congestion and/or reaction
Bangkok	June 2011	Congestion due to port closure, due to union problems
Suez	April 2011	Terminal congestion due to political unrest, with lack of labour and fuel
Bremerhaven	July 2010	Increasing vehicle exports + staff shortages lead to congestion for ro/ro services
Kolkata	October 2009	Port traffic slowed. Surcharges imposed by NYK and MISC.
Dar-es-Salaam	January 2011	Tanzania Revenue Authority urged better pre-arrival declaration processing.
	First half 2009	Port congestion. New inland container depot to be built as from January 2011.
Itajai	November 2008	Congestion due to flooding with consequential shallow depths
Los Angeles/ Long Beach	September 2008	Congestion risk due to potential truck capacity lack due to clean truck program
Barcelona	May 2008	Construction of 9th cruise terminal to alleviate cruise congestion
Singapore	April 2008	Imminent cruise congestion
East-Malaysia	April 2008	Congestion due to lack of terminals
Otay Mesa	April 2011	Road corridor project to alleviate road congestion
Chennai	January 2011, since mid-November 2010	Hampered road connectivity. As of February 2011, port congestion charge introduced.
Seattle	December 2010	Congestion relief measures decided
Buenos Aires	October 2010	Congestion due to lack of barge capacity on Rio de la Plata due to shallow water, and to increased scanning in view of drug control.
Rotterdam	July 2010	Congestion due to increasing volumes, labour shortage during summer, unability of shipping companies to keep schedules, empty container pick-ups and overflow from Le Havre where strikes occur; Feeder lines threaten with surcharge
Miami	April 2009	Lacking tunnel leads to hinterland congestion
Saint-Petersburg	May 2011	Ice formation caused congestion for vessels during winter again
	May 2010	Congestion impacts through heavy winter

Table 4.B.1: (*Continued*)

Port	Date	Type of congestion and/or reaction
China	August 2010	10% of dry bulk fleet absorbed in congestion
	June 2010	Congestion at Chinese petrol discharging terminals
Durban (South-Africa)	July 2010	Congestion due to labour dispute
Singapore	October 2009	Cruise terminals impose high docking as ships in congestion need to berth
Lagos	March 2009	Congestion with impact on jobs
Melbourne	August 2010	Two road projects launched to alleviate congestion around the port
Papua New Guinea	April 2010	Efforts taken by government
Manila (The Philippines)	January 2011	South Harbor and Manila International Container Terminal
Johor Port (Malaysia)	April 2011	
Jeddah (Saudi-Arabia)	April 2009	Port mismanagement of concession contracts

Source: Journal of Commerce Online, World Cargo News Online, Lloyd's List, TanzaniaInvest, Global Van Lines.