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Part II - Ch 1 Challenges to port development

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Publication date
2021

Document Version
Final published version

Published in
Ports and Waterways

Citation (APA)
van Koningsveld, M., Lansen, A. J., Quist, P., & de Vriend, H. J. (2021). Part II - Ch 1 Challenges to port development. In M. V. Koningsveld, H. J. Verheij, P. Taneja, & H. J. de Vriend (Eds.), *Ports and Waterways: Navigating a changing world* (pp. 57-62). TU Delft OPEN Publishing.

Important note
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1 Challenges to port development

Part I gives a general introduction to ports and waterways and describes their function in supporting waterborne supply chains. Part II addresses ports and terminals in more detail. Before addressing port planning (Chapter 2), port layout (Chapter 3) and the functional design of terminals (Chapter 4 and Chapter 5), this chapter gives a basic introduction into the challenges of port development.

1.1 Historic importance of ports

Since ancient times, ports have played an important role in societies. They brought trade, wealth, contact with other societies and (military) power.

In ancient Egypt, long before the port of Alexandria was established, the port of Canopus on the west bank of the westernmost Nile branch enabled grain export from the fertile Nile basin, mainly to Greece. In about 1900 BCE the port of Alexandria (Figure 1.1) took over (although the city of Alexandria did not yet exist by the time) and continued grain export, first to Greece, later to Rome and Constantinople. An interesting observation reported by Strabo (64 BCE – 24 CE) is that the local inland port on Lake Mareotis (Figure 1.1) was busier than the sea port. Apparently, Inland Water Transport (IWT) also occurred in ancient Egypt.

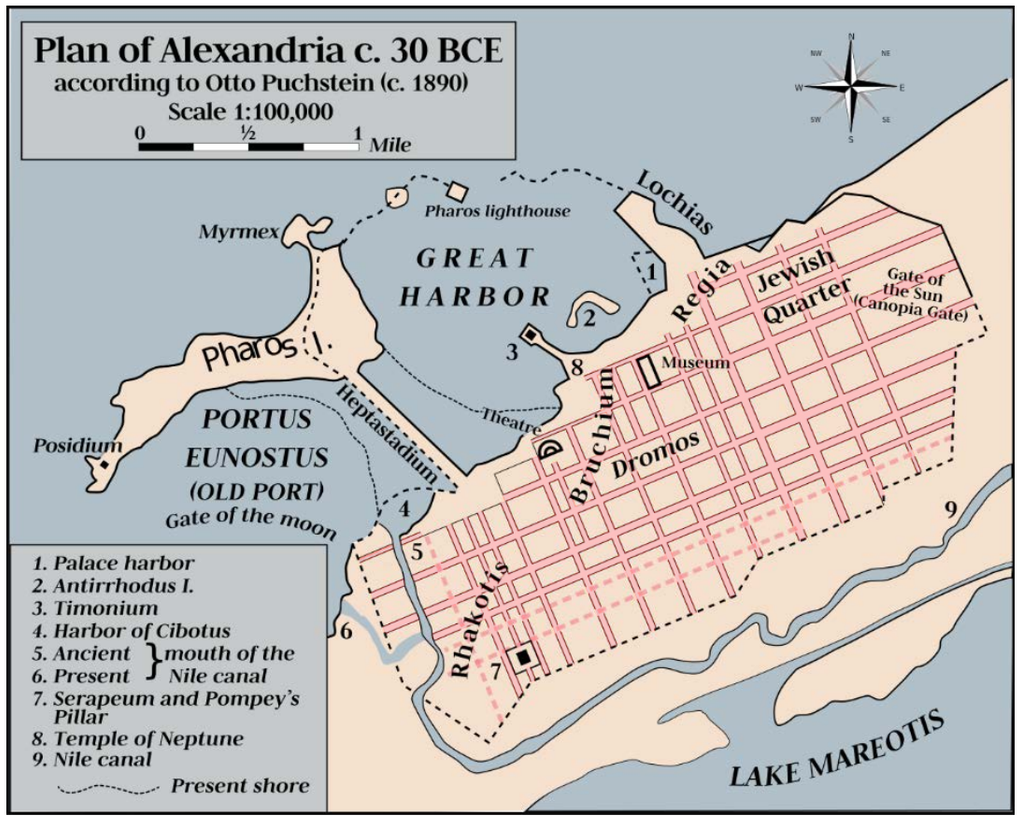

Figure 1.1: The ancient port of Alexandria (by Philg88 is licenced under CC BY-SA 3.0).

Around 400 BCE the city of Athens created a military and commercial port at Piraeus. It has played a key role in the establishment of Greek power in the Mediterranean (Lambert, 2018), and at the same time became a trade centre for a wide variety of goods. From 300 BCE Rome had its port at Ostia Antica, on the mouth of the river Tiber, first only commercial, later also military.

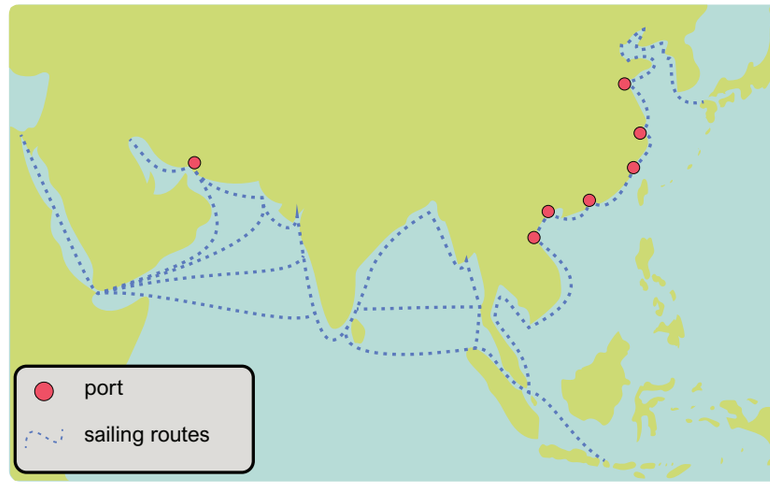

Figure 1.2: The "Silk Road on the Sea" (by TU Delft – Ports and Waterways is licenced under CC BY-NC-SA 4.0).

In China the port of Guangzhou, established during the Qin Dynasty (221 – 206 BCE), served for many centuries (till around 1500 CE) as a node of the "Silk Road on the Sea", a trade route which extended from Korea, all along the Asian coasts, to Africa and Europe (Figure 1.2).

Later on, between the years 1000 and 1500 CE, the port of Venice became a leading European port, which was instrumental in developing trade in the Mediterranean and beyond. The city of Venice thrived along with the port and became a prominent centre of power and culture in Southern Europe.

Another, more recent example is the spectacular development of Singapore (see Figure 1.3) since its independence in 1965, the success of which is attributed to its port. In the old days it was a hub for European and Chinese merchants, and now one of the world's biggest ports, which attracts foreign companies and functions as an international centre for maritime-related business and commercial services.

Figure 1.3: The port of Singapore, left: around 1900 (Port in Singapore by Lambert & Co., G.R. / Singapore is licenced under CC0 1.0); right: at present (Bestand:Keppel Container Terminal, Singapore by Noel Reynolds is licenced under CC BY 2.0).

The influence of sea trade and ports on economic development has grown and developed through the centuries. In fact, ports and cities (and the countries around them) have always developed in a self-reinforcing relationship, where growth in port activity led to economic growth and vice versa.

The above examples illustrate the mutual interaction between cities and their ports. While ports profit from knowledge and business services concentrated within the city, the port is a source of employment and global commercial and cultural contacts for the city.

Today, the growth and economic prosperity of many cities around the world, such as Barcelona, New York, London, Hong Kong, Hamburg or Antwerp, can be attributed to shipping and ports. The Netherlands, for instance, have been able to sustain a relatively high economic growth rate because of the Port of Rotterdam, which in the 15th century used to be just a fishing port. In China, the export-driven industries have enabled small fishing towns to turn into the world's largest metropolitan regions and biggest ports, and China's economy into one of the fastest growing in the world.

On the other hand, ports are part of a closely-knit network of actors and facilities that keeps the worldwide supply chains going. In order to function optimally, all elements have to stay sharply tuned to each other, while the world is constantly changing: new players step in, new technologies emerge, demands change, transport facilities evolve, transport corridors develop, worldwide economic relations change, the balance of political power shifts, a disruptive pandemic breaks out, et cetera.

An example of how this system can get (temporarily) destabilised is the disruption of the oil supply chain, due to the Corona-pandemic 2020-2021. Oil production has a certain inertia, either physical (shale oil production), or political (Saudi-Arabia vs. Russia, OPEC). So a sudden collapse of the market means a large temporary overproduction, a sharply increasing demand for storage capacity and tumbling oil prices. In 2020 this even led to negative prices for crude oil. A port may temporarily profit from this by selling its excess storage capacity, but in the longer run it will suffer from the reduced trade.

Getting out of tune with the other elements in the supply chain goes at the expense of a port's efficiency and maybe even its service level and reputation. On the other hand, a timely response to changes may enable a port to strengthen its position and maybe even outcompete nearby competitors. The large investments involved make this a game of high stakes and high risks, which explains the importance of sensible and well-informed port planning and development.

1.2 Port development

1.2.1 Generations of ports

As illustrated above, development of ports is a continuously ongoing process, rather than an incident at the start of their lifecycle. In the period after World War II, globally a number of distinct stages of port development have been identified, often referred to as 'generations' (e.g. UNCTAD, 1999):

- *1st generation* – Until about the 1960s, the services of a port were limited to transporting goods between land and sea through a local or regional hinterland.
- *2nd generation* – As processing industries were installed in the vicinity of the ports, they became transport hubs and centres of industrial and commercial activity.
- *3rd generation* – After the 1980s the development of containerised transport accelerated and international networks of intermodal connections along with it. In response, ports extended their services with value-added logistics.
- *4th generation* – Fourth-generation ports carry out core, value-added and industrial activities, but are also nodes in a network of ports/terminals supporting supply chains and port-city interactions, and focus on a wider ecosystem and a sustainable existence.

In the literature there is even mention of fifth- and sixth-generation ports (e.g. Lee and Lam, 2016).

1.2.2 External changes

Game changers affect the development of ports worldwide abruptly. Ongoing competition, on the other hand, triggers an incremental process of upgrading and improvement.

A most important game changer in recent transport history is containerisation in combination with globalisation (see also Chapter 4). Containerisation involves a degree of unification, which has boosted handling productivity and facilitated interchange between transport modes. This has led to efficient network connections, reliable delivery and lower costs. It has also fostered a unique expansion of trade, while at the same time spurring globalisation.

Globalisation, in turn, has been instrumental to changes in consumption patterns and production locations, as well as to decreasing costs of commercial transport. The result of this mutual interaction: increasing world trade and cargo volumes. All this has been accelerated and drastically influenced by developments in information and communication technology.

Ports have of course played a key role in these revolutionary developments. They have made sure to facilitate and stimulate containerisation by establishing efficient container terminals and related services. Also, they adapted to the (cost-reducing) trend towards ever larger vessels, by making sure they could accommodate and handle them safely and efficiently. Foresight and pro-active planning are key factors enabling them to make these adaptations on time (i.e. before competitors have taken over their market share).

No doubt, containerisation has been a game changer in commercial transport, but it is not the only one. An unprecedented globalisation has also taken place in other sectors, such a oil, gas, coal and agribulk, often with major discontinuities due to political or social factors. Australia, for instance, is a major source of iron ore, gas and coal, and since China's economy has started growing explosively, Australia's iron ore, gas and coal export to China has grown accordingly. This has evoked such an increase of port activities, that environmental restrictions became a limiting factor.

Changes in infrastructure may also lead to sudden changes in transport networks. A classic example is the opening of the Panama Canal, which suddenly made a number of ports obsolete, especially in South-America. At the same time, the much shorter route provided major competitive opportunities, which triggered the development of the so called Panamax and New Panamax vessel classes, referring to the maximum dimensions that could just fit through the original Panama Canal and the later expansion. This in turn triggered ports worldwide to adapt their infrastructure to accommodate vessels of this size. In Part I – Section 2.1.2 we briefly described the example of the temporary closures of the Suez Canal, in 1956-1957 initiating the construction of larger tankers and dry bulk vessels, and between 1967-1975, which forced the oil sector to develop and use Very Large Crude Carriers (VLCCs) in order to make transport around Africa economically feasible. This accelerated the trend towards larger vessels, which did not reverse after the Suez Canal had been opened again. Every major oil port had to invest in facilities to accommodate these vessels, or otherwise lose its position.

1.2.3 Internal changes

Apart from external changes, there are also internal ones. Every port and terminal goes through a number of stages of life (Figure 1.4), from initiation via growth to maturity and ageing and – if no action is taken – obsolescence. Note that ageing can be technical (infrastructure nearing the end of its lifecycle), but also economic (inadequate response to market changes). Awareness of this lifecycle is crucial for proper port management, if it were only because thinking about and investing in restructuring has to start during the heydays of the port's functioning. This means taking risks at a moment that other people think that everything is going fine.

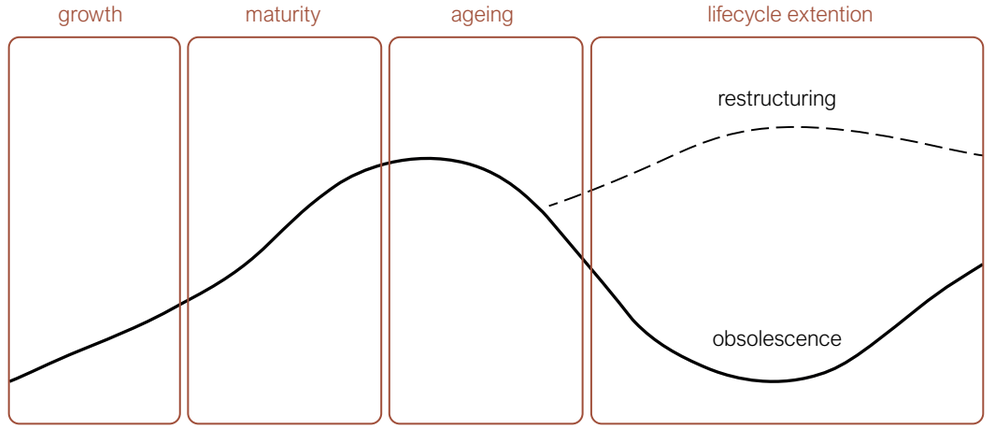

Figure 1.4: Various stages in a port's lifecycle (modified from Charlier, 2013, by TU Delft – Ports and Waterways is licenced under CC BY-NC-SA 4.0).

1.3 Port planning

1.3.1 Port development means taking risks

Port infrastructure requires investments that are timely, huge, irreversible, highly risky, and typically have a very long payback period. On the other hand, ports operate in a volatile market and are much more affected by political factors, international trade, and overall world economic conditions than most other enterprises. Ports often have difficulty meeting changes in functional requirements, due to physical limitations and existing infrastructure. Either drastic and costly adaptations are required, or infrastructure has to be decommissioned long before its economic lifetime is over. The overall consequences for the port are, in the best case, inefficiency and loss of competitive position, and in the worst case redundancy and obsolescence. Many older port projects exemplify this. As containerization came with ever larger vessels and required larger areas of land for (un)loading and storage, these ports had to close down or change their function, while new ports in the vicinity took over (Taneja, 2013). One example is the migration to another location of the entire port operation at Helsinki (Figure 1.5, left). The right part of this figure, on the other hand, gives an example of a terminal that completely changed its function.

Figure 1.5: Major port adaptations. Left: the Vuosaari Harbour Project, Helsinki, Finland, where the entire port operation was transferred to a new location in 2008 (Cargo habours to Vuosaari by Pekka Kontiala is licenced under CC BY 4.0); right: Jawaharlal Lal Nehru Port, India, a bulk terminal converted to container terminal in 2006 (View from Cannon Hill on Elephanta Island, Maharashtra, India by A. Savin is licenced under LAL-1.3).

1.3.2 Port master planning and stakeholder involvement

Efficient ports are an important economic, financial and strategic asset to a country. Therefore much attention is paid to port planning in a multi-disciplinary and multi-stakeholder setting. The strategic objectives of government, port authority and other stakeholders, the requirements of port users and operators, environmental issues, the needs of local communities and the embedding in overarching spatial plans are all reflected in a Port Master Plan (Taneja et al., 2008). This includes a layout that allocates land to various uses, reserves space for the future, and outlines the implementation process. Clearly, the Port Master Plan not only serves to prepare the development of the port, but also to win the support of authorities, stakeholders, users and the public at large. This support is instrumental in creating the right conditions for realisation.

A striking example is the extension of the Port of Rotterdam with Maasvlakte 2. Feasibility studies were carried out in the last decade of the 20th century and the government issued a spatial planning decision in 2003. This led to opposition concerning the environmental impacts and in 2005 the Council of State, the highest administrative court in the Netherlands, annulled the decision. Only after an extensive in-depth study of the environmental effects and early involvement of environmental groups, a new planning decision and the Environmental Impact Assessment (EIA) were accepted in 2008. The appeal procedure ended in 2009 with the permission to start the construction. The whole experience was one of the triggers to develop a more nature-inclusive method for infrastructure development, culminating in the Building with Nature (BwN) philosophy (De Vriend and Van Koningsveld, 2012; De Vriend et al., 2015).

1.3.3 Functional designs and order-of-magnitude dimensions

Port planning is more than determining the general layout of a port. Once it is clear which throughputs and which commodities the port is supposed to accommodate, the necessary terminals have to be outlined in a functional design. This means that even this early design stage requires much information, enabling to determine what type of facilities (quays, cranes, storage areas, etc.) are needed and how much space this requires. The results are different for different types of terminals (container, liquid bulk, dry bulk, general cargo, etc.), and also for sea ports and inland ports.

Not every port development is 'greenfield', so starting from scratch. More often it concerns the extension or modification of an existing port, or a 'brownfield', i.e. an obsolete or derelict industrial area, often environmentally polluted. In the case of a 'brownfield' development, the plan must make clear how the required space will be cleared and remediated before becoming available to the new development. The costs involved may be significant and even prohibitive, leading to a different choice of location or a less ambitious plan.

An often arising question is to what extent existing facilities and infrastructure can be used for the envisaged port, under conditions for which they were not designed originally. One example are existing quay walls. They date back a number of years, may on the one hand have been designed with safety margins larger than at present, and on the other hand have degraded through the years. Present-day computer models enable assessment of the actual strength and reliability of these structures, as well as simulating their ageing process (Roubos, 2019). This can save the costs of unnecessary demolition and reconstruction, or the risk of incorporating an unsafe quay wall in the extended port.

It is clear that ports are strategically important and their continuous development is challenging and risky. The best way to cope with this risk is by careful and adaptive planning. The next chapters further elaborate this.