CHAPTER 1

INTRODUCTION

Ports are critical infrastructure resources and serve a key role in the transportation of freight and people. With more than 80% of international trade by volume is being carried by sea, ports are vital for seaborne trade and international commerce. Ports are the critical nodal interfaces where maritime transport connects with other modes of transport and where trading, distribution, and logistics activities can take place. Efficient port operations significantly lower maritime and trade costs whereas delays in ports impose costs on logistics and supply chains through the cost of warehousing and inventory. Ports also serve as economic catalysts for the markets and regions they serve whereby the aggregation of port services and activities generates socio-economic wealth and benefits.

There are no confirmed statistics on the number of ports in the world. Some sources estimate the total figure to vary between 2,000 and 30,000 ports and terminal facilities. In 2007, world ports handled over 8 billion tons of estimated international seaborne trade of goods loaded (UNCTAD, 2009). Because of trade imbalances, transhipment practices, and other operational considerations, the global *port throughput* would have exceeded the volume of *seaborne trade*. For instance, global container trade in 2007 was estimated at around 1.24 billion tons or 143 million twenty-foot equivalent units (TEUs), which corresponded to a container throughput of around 500 million TEU handled by world ports and terminals (UNCTAD, 2008).

Year	**Liquid Cargo**	**Dry Cargo (million ton)**		**Total**
		Bulk	Break Bulk and Unitised	
1970	1442	448	676	2566
1980	1871	796	1037	3704
1990	1755	968	1285	4008
2000	2163	1288	2533	983
2007	2681	1997	3344	8022

Table 1.1: Growth of world seaborne trade in million tons (Compiled from UNCTAD)

Year	**World traffic**	**World**	**Full**	**Empty**	**Transhipme**
1990	28.7	88.0	70.2	17.8	15.5
1995	46.0	145.5	118.7	26.8	31.4
2000	68.4	236.2	186.1	50.1	60.9
2005	115.5	397.9	315.4	82.5	106.6
2007	142.4	496.6	392.6	104.0	136.4

Table 1.2: Growth of world container seaborne trade and throughput in million TEUs (Compiled by the author from different sources)

A port can range from a small quay for berthing a ship to a very large scale centre with many terminals and a cluster of industries and services. Ports are dissimilar in their assets, operations, roles and functions; and even within a single port the activities and services performed are, or could be, broad in scope and nature. This situation has led to a variety of operational, management, organisational, and institutional approaches to ports, and it is almost impossible to find a worldwide uniform definition of them. There is indeed a variety of terms describing ports such as interfaces between sea and land, nodes in the multimodal and intermodal transport network, distribution and logistics centres, maritime gateways and corridors, distriparks and maritime clusters, and free zones and trading hubs.

Sometimes, ports need not necessarily be only seaports. In some countries such as the USA, the term port usually includes airports and sometimes intermodal facilities such as railway and road connections. Today, ports are not only a transfer point between sea and land but also serve as distribution, logistics, and production centres. Ports can also serve leisure, fishing, and/or military ships, thus deviating from traditional commercial cargo-ship activities. In some ports, non-sea related activities can also fall under the wider definition of ports. For instance, dry ports are inland logistics centres not directly linked to sea or waterway connections.

1. PORTS AND THE MARITIME BUSINESS

Traditionally, ports have been regarded as a sub-system of the shipping and maritime industry, with their main roles being restricted to the provision of services to ships and their cargoes. Shipping or maritime business is mainly concerned with the transport of goods by sea and/or waterway connections. The economic approach treats maritime transport as a *derived demand* from international trade. The term *shipping* is a generic term often used interchangeably, and may be reduced to the sole provision of sea transportation or expanded to the provision of other logistics and trading services. Shipping markets may be divided into four main segments:

- *The freight market*: trades sea transport
- *The new building market*: trades new ships,
- *The sales and purchase market*: trades second hand ships, and
- *The demolition or scrap market*: trades old and obsolete ships.

Shipping services are usually determined by the nature of trade, or traffic, and more specifically by the type of transported cargo or commodity. The term *commodity* is frequently used in international shipping and port management, and denotes situations where there is little qualitative difference between the products of different suppliers. Unlike branded products, the markets of commodity products have little or no differentiation between them and are considered equivalent regardless of their supply base. Examples of commodity products include basic bulk products such as oil, grain, coal and iron ore. In shipping and ports many segments run the risk of *commoditisation*, for instance in the case of container shipping and transhipment terminals. This has several implications on the competitive, pricing, and marketing strategies of shipping and port services.

Typically, seaborne trade is categorised into bulk, break-bulk and general cargo trades, and this categorisation has also been used to classify different types of ships (see Table 1.3). Other criteria for ship classification include type of packaging (e.g. containers: containerships, trailers: Roll-on Roll-off or Ro-Ro ships), ship's size (e.g. Panamax versus Post-Panamax vessels, very large crude carriers -VLCC- *versus* ultra-large crude carriers -ULCC-), technological specifications (e.g., conventional *versus* cellular containerships, single-deck versus double-deck ships), and safety and security records (e.g. safety class for vessels, ISPS ship security levels).

As with ship's specialisation, modern port layout and operating systems are increasingly designed to serve a particular trade, ship or cargo type, although many ports around the world still operate multipurpose facilities. For instance, a bulk port provides berthing, cargo handling and processing facilities for ships carrying bulk (liquid or dry) cargo, while a container-port consists of a set of berths, yards, gates, and, sometimes, extended landside connections solely designed to accommodate containerships and their cargoes. Seaports must not be confused with terminals; the latter are specialised units within ports (see Figure 1.1).

MARINE STRUCTURES				
MERCHANT SHIPS	**Group**	**No.**	**Type**	**Subtypes**
	LIQUID	1	**Oil Tanker**	Crude oil; Crude products; Oil products; Oil/chemical
		2	**Chemical tanker**	
		3	**Liquefied gas carrier**	LNG; LPG; Other liquefied
		4	**Tank barge**	Single hull; Double hull; Double-side; Double-bottom; Other tank barge
		5	**Other tanker**	Asphalt, bitumen; Molasses; Vegetable oil; Other tankers
	DRY BULK	6	**Bulk/Oil carrier**	Ore/bulk/oil; Ore/oil; Bulk/oil
		7	**Bulk carrier**	Ore; Bulk/container; Other bulk
		8	**Specialised carrier**	Barge carrier; Chemical carrier; Irradiated fuel carrier; Livestock carrier; Other specialised carrier
	OTHER DRY CARGO	9	**Container ships**	
		10	**General cargo ships**	Ro-Ro passenger
		11		Ro-Ro containers; Other Ro-Ro cargo
		12		Reefer
		13		General cargo/ passenger
		14		General cargo / single deck
		15		General cargo/ containers; General cargo multi-deck
		16	**Dry cargo barge**	Deck barge; Hopper barge; Lash/ sea-bee barge; Open dry cargo barge; Covered dry cargo barge; Other dry cargo barge
		17	**Passenger ship**	Cruise
		18		Other passenger
	MISCELLANEOUS	19	**Fish catching & processing**	Fish processing; Fish catching
		20	**Off shore production & support**	Off-shore drilling; Off-shore support
		21	**Tow-boats and tugs**	Tug; Push-boat
		22	**Other ship types**	Research/survey
		23		Dredger
		24		Other
NAVAL & MILITARY CRAFTS				
NON-SHIP STRUCTURES				

Table 1.3: International ships' classification

Source: International Association of Classification Societies (IACS)

Dry Bulk Ports	 Amsterdam coal terminal	 Rotterdam iron ore terminal
Liquid Bulk Ports	 Milford Haven liquid port	 Rotterdam oil terminal
Break Bulk/ Multipurpose Ports	 Hamburg multi-purpose terminal	 Trieste multi-purpose terminal
Container Ports	 Guangzhou PSA container terminal	 Southampton container terminal
Car Ports	 Ulsan car terminal	 Zeebrugge car terminal
Ferry, Passenger and Cruise Ports	 Tallinn ferry port	 Genoa cruise and passenger terminal

Figure 1.1: Types of ports and terminals (Courtesy of Informa)

When shippers (cargo owners; senders or receivers) outsource the transport by sea or water of their cargo, shipping services are usually divided into *liner shipping* and *tramp shipping*. While liner shipping plies regular routes and ports according to published sailing schedules, tramp shipping is irregular in both time and space. Sometimes, shipping services are performed directly by the shipper (*industrial shipping*), for instance in the case of vertically integrated global oil firms and car manufacturing companies. Industrial operators may use their own fleet and/or charter in vessels, usually on a *voyage charter, a time charter,* or a *bareboat (demise) charter*. Generally, industrial shipping is treated as a separate market although it can account for as much as 35% of world's seaborne trade.

Both tramp and liner operators may be regarded as a third party transport operators. Traditional third party operators have focused their services on a single logistics operation (e.g. transport, warehousing, information management, audit and payment, etc.). Modern transport operators offer more than just transport services and can therefore be considered as *third party logistics* (3PL) providers. Core activities of 3PLs, also called *logistics outsourcing* or *contract logistics*, include transport, warehousing, inventory management, information systems, consolidation and distribution, freight management and consulting services. Other functions include value-added capabilities such as labelling, packaging, and telemarketing. A distinction should be made between asset-based logistics (3PLs) and non asset-based logistics (*fourth-party logistics: 4PLs*). The latter is performed by providers who do not have tangible assets or equipment. Instead, they offer management skills to the shipper such as by facilitating shipping documentation and coordinating intermodal services. Finally, *integrators* are those 3PLs who provide integrated services such as in the courier and express market.

A key feature in shipping and port markets is the use of *intermediaries* either between carriers or between carriers and shippers. The use of intermediaries may add unnecessary costs to cargo transport and logistics, but is often justified by the advantages of specialisation and efficiency. Depending on the services they provide, intermediaries may be called ship brokers, ship agents, freight forwarders, multimodal transport operators (MTOs), non-vessel operating common carriers (NVOCCs), export management houses, etc. In the context of logistics management, shipping and port intermediaries may be assimilated to 4PL providers.

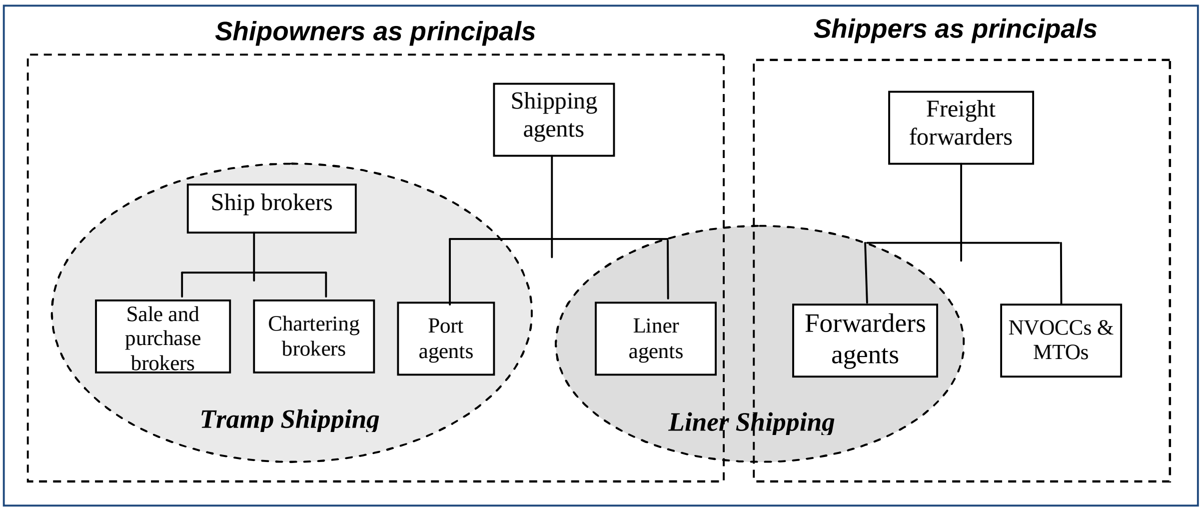

Figure 1.2: Main agents and intermediaries in international shipping (source: Author)

Unlike tramp ships, the *voyage* of which can link any two or several ports at any time, liner ships operate between designated trade routes or *lanes*. Typically, trade lanes follow cargo, commodity and/ or geographical classifications, for instance containerised *versus* non-containerised routes, inter-continental *versus* intra-regional routes, deep-sea *versus* short-sea routes, etc. Within the same route, ships are *deployed* to perform multiple consecutive trips between a series of ports, sometimes called *shipping string* which includes both loading and unloading ports. Because of significant economies of scale of ships (increasing ship size), their physical constraints (draft, length, width, etc.), cost structure (operating costs, time in port, space utilisation, etc.), trade imbalance and other factors, different *logistical patterns* of liner routing have evolved throughout the years. These include double-dipping, pendulum and hub-and-spoke services, among others.

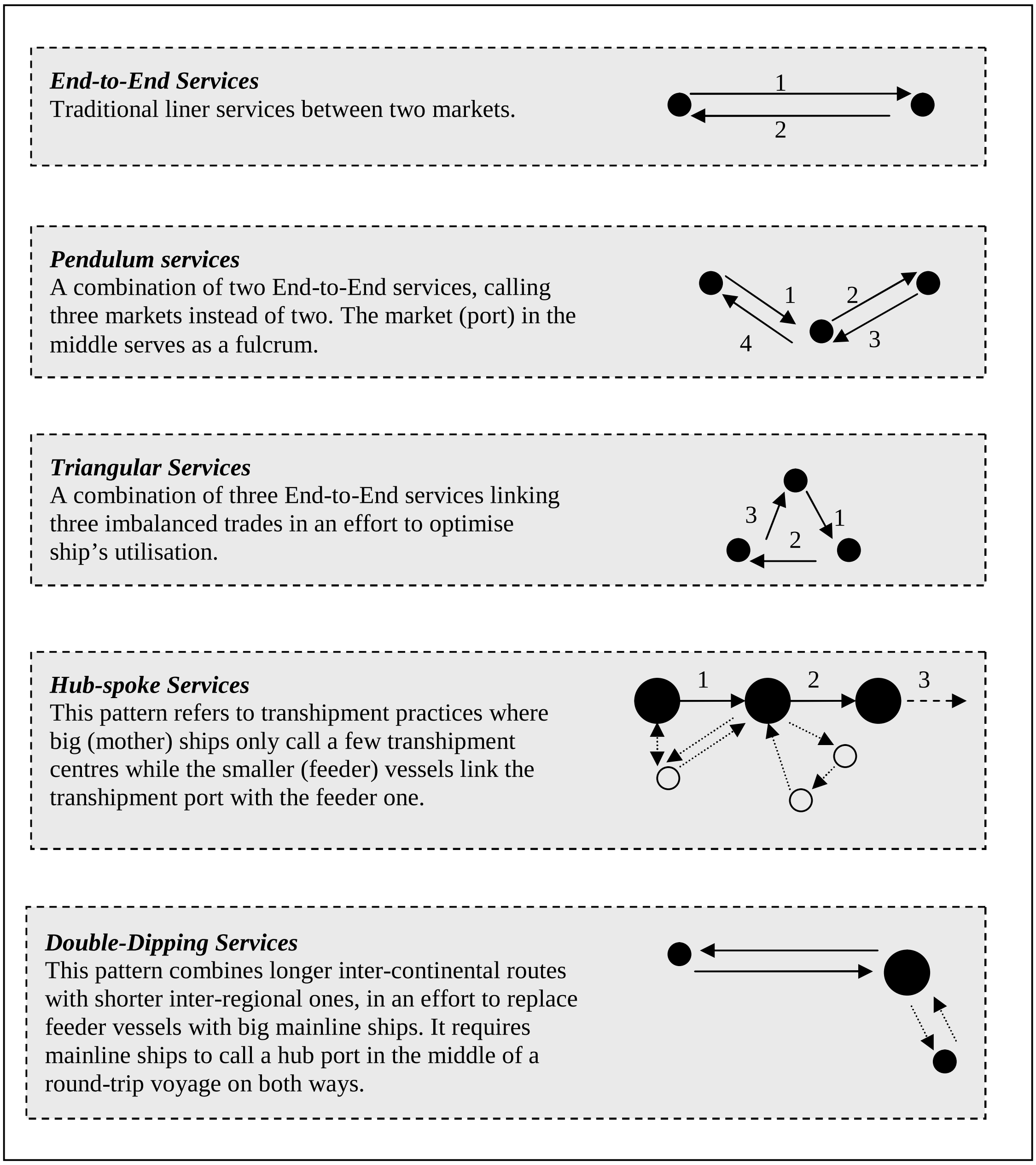

Figure 1.3: Selected operational patterns of liner shipping (source: Author)

Another way to look at maritime business in general, and at ports in particular, is to consider freight transport (or the transport of goods) as an integrated part of the logistics system. Unlike the economic and trade approach where maritime transport and ports are perceived as a *derived demand* from trade, the logistics and supply chain approach integrates the transport function with other business components of the firm such as purchasing, production, storage, and inventory management. In this approach, ports are categorised according to their logistical and locational status within international shipping and trade patterns, to their positioning and alignments within supply chain systems and configurations, and/or to the nature and extent of logistics and value added services they provide (see section 2.3 below). A thorough discussion on logistics and supply chain issues in port operations and management is provided in Chapter 10 of this book.

As far as shipping services and trading routes are concerned, ports may be classified as network ports, transhipment ports, direct-call ports, and/or feeder ports. However, this taxonomy is neither exhaustive nor comprehensive for modern port logistics:

- *Network ports* provide high value-added services to both ships and cargo and generate traffic from/to the port and its hinterland and foreland. Given their extensive channels of distribution, network ports are commercially attractive and offer low unit cost per ship.

- *Transhipment ports* provide high value-added services to ships but low value-added services to cargo. They are mainly dedicated to ship-shore operations and provide fast turnaround time for ships. They are also suitable for cargo concentration and distribution.

- *Direct-call ports* provide low value-added services to ships but high value-added services to cargo. They are particularly attractive to tramp shipping and some forms of liner shipping.

- *Feeder ports* provide low value-added services to ships but not necessarily cargo. They are not physically, or possibly, economically suitable for direct call and need to be linked to network or transhipment ports.

An alternative way to classify ports is to look at their geographical and spatial markets, specifically the extent of the land area a port can serve, commonly called the *hinterland*. Here ports can be classified as local, regional, national, or international. The size of the hinterland may vary considerably from one port to another due to several factors such as the scope of shipping services and port traffic, the quality of port facilities and services, the size and efficiency of the inland transport network, and the number of competing ports for the same hinterland. A good example of port competition for the same hinterland can be found in the US Midwest region, the seaborne trade of which is the subject of intense competition between East, West and Great lakes' US ports. In Europe, the main ports in the Le Havre-Hamburg range, also called the Banana range; Le Havre, Antwerp, Rotterdam, Bremen/Bremerhaven, and Hamburg, compete for the same hinterland. Ports can serve a wider spatial region beyond its immediate hinterland. This is often called the *foreland* and denotes the geographical area a hub or a network port serves through networking with other feeder ports or through an extended inland transport system. Unlike the hinterland, the foreland may be a discontinued area or a collection of several special components. As such, different orts may compete for the same foreland.

From a spatial and geographical perspective, the relationship between freight flows and port development is better understood through the concepts of gateways, articulation points, freight corridors, and distribution centres:

• *Gateways* are locations that bring together different modes of transportation along with warehousing, freight forwarding, customs broking and other logistics services. Many textbooks differentiate between *transport gateways* as hubs for major regions and *freight gateways* which serve cities and regional areas. An illustration of this categorisation may be found in the port of New York / New Jersey as an industrial and logistics hub (freight gateway) which is joined by the inland port of Albany (transportation gateway) designated to receive freight containers barged from the main hub port.

• *Articulation points* are nodal locations interfacing several spatial systems and serving as gateways between spheres of production and consumption, and may include terminal facilities, distribution, warehousing, and trading centres. The difference between gateways and articulation points is that the latter are viewed from an urban perspective, whereas gateways do not necessarily need to be located at city-interfaces. From this perspective, seaports are seen as hard terminals since they are immoveable, whereas inland terminals dispose of a great degree of locational flexibility.

• *Freight corridors* represent transport links of freight transportation supported by an accumulation of transport infrastructures and activities servicing these flows. Traditionally, flows in freight corridors tended to be fragmented and segmented since each mode tried to exploit its own advantages in terms of cost, service, reliability and safety. Hence, maritime corridors may be assimilated to geographical trade routes. However, evolving routing patterns, such as hub-spoke and transhipment networks, currently reduce the capacity of maritime corridors to accommodate operational and logistics patterns of maritime transport.

• *Freight distribution centres* serve as locations for cargo transfer and distribution to regional or extended markets, depending on corridor capacity and articulation point links. Traditionally, many distribution centres were located close to central areas mainly as a factor of market proximity, but are currently relocating to peripheral areas. Functionally, a freight distribution is the combination of a freight corridor and an articulation point or a gateway.

Another popular way to categorise ports is to classify them in terms of ownership and intuitional structure. Here ports can be classified by type of ownership (private port, public port, etc.), institutional structure (landlord port, tool port, service port, etc.), and/or a combination of these and other criteria. A detailed review of these models and others is provided in Chapter 2.

Criterion	Port category
Cargo/commodity type	Dry bulk port, Liquid bulk port, general cargo port, etc.
Ship type	Ferry port, Ro-Ro port, Multipurpose port, LNG port, etc.
Trade type	Import port, export port, transhipment port, transit port, etc.
Institutional model	Landlord port, tool port, service port, etc.
Ownership model	Private port, public port, semi-public port, etc.
Management model	Trust port, corporatized port, autonomous port, etc.
Organisational model	Centralised port, decentralised port, devolved port, etc.
Geographical scope	Gateway port, local port, coastal port, inland port, etc.
Logistics status	Feeder port, hub port, transhipment port, network port, etc.

Table 1.4: Different classifications of ports (source: Author)

2. MULTI-DISCIPLINARY APPROACHES TO PORT OPERATIONS AND MANAGEMENT

The literature on approaches to port operations and management is quite extensive since it cuts across various subjects and disciplines. It is noticeable in the current body of port literature that the conceptualisation of the port business has taken place at different disciplinary levels without producing a comprehensive and structured port management discipline. Much of the current literature on ports has been developed by international organisations and institutions in the field (UNCTAD, IAPH, the World Bank, etc.), and a resulting terminology has evolved depicting specific concepts hardly understood by professionals and academics outside the field (see Chapter 2). On the other hand, many areas of port operations and management still remain unexplored, and there are few references outlining the different features of operational, logistics, and strategic management in ports. Generally, the activities and operations of ports have been studies from four main perspectives: an economic approach, an engineering/operations approach, and an evolving logistics and supply chain management approach.

2.1 The Economic Approach

Standard economic approaches and theories on international trade and development, production output and capacity, geography and spatial organisation, market structures and industrial organisation, and policy and regulation have been applied to the economic activity of ports and terminals along with other transport infrastructures. A central tenant in the economic approach to ports is that freight and maritime transport is a *derived demand* from trade, essentially international trade. In other words there will be no need for transport if no trade takes place. Key economic characteristics of the port industry include, but are not limited, to the followings: multi-product/ multi-output system, multi-agent system, externalities and spill-over effects, natural monopoly and economies of scope and scale, location and network structure, requirements for market, safety and environmental regulation, and long-lead time for planning and project completion.

2.1.1 Multi-product/ Multi-output system

Port production, in economic terms, is highly heterogeneous with many attributes. This is because most ports handle different cargo and ship categories, hence providing different types of port services. Even within specialised ports or terminals, different port services may be provided such as in terms of services to ships and services to cargo, or in terms of nautical services, cargo handling services, and value added services. Traditionally, port services have been categorised into services to ships (pilotage, towage, mooring, bunkering, ship repair, etc.) and services cargo (e.g. loading and unloading, stacking and storage), but other complimentary and value-added services, such as consolidation and break bulk, packaging and labelling, repositioning and distribution, may be also carried out in ports or around their vicinity. Chapter 2 reviews the organisational structure of ports and list the different functions and roles of modern ports and terminals.

Because of the multi-output nature of port operations, the application of the single-productive theory to ports is clearly unsatisfactory but it was not until the last decade or so when the port literature started recognising the multi-productive nature of port processes. Even though, little consensus among port researchers seems to have been reached on the factors of production that should be considered in a production function; or on the related costs and factor prices that should be considered in a cost function. There is also little consensus on the extent to which non-controllable or exogenous variables should be included in the analysis. A detailed review of cost and production functions in ports and of the techniques for analysing port productive efficiency is provided in Chapter 9.

2.1.2 Multi-agent system

From a microeconomic perspective, ports are seen as entities producing private goods for which the levels of supply and demand and relative prices are determined by agents' behaviour, market mechanisms, and regulatory requirements. From a macro-economic approach, ports are critical infrastructure producing public goods that are hardly captured in market transactions but which create direct benefits to port operators as well as indirect effects, be they positive or negative.

Traditional microeconomic port models limit port agents to two main actors: ports and port operators, representing the supply side *versus* ocean carriers and shipping lines, representing the demand side. On the supply side, port services facilities may be provided by a single entity or by a myriad of firms and organisations. A key agent in port operations and management is the port authority whose role may be limited to the provision of basic nautical and operational infrastructure (landlord port) or extended to the provision, operation and management of all port facilities and services (public service port). However, with the growing scope and intervention of private sector participation in ports, some or all of port activities and services are increasingly being performed by the private sector. A detailed review and analysis of port ownership and institutional models is provided in Chapters 2 of this book. On the demand side, port economics has traditionally focused on the study of the economic behaviour of shipping lines and ocean carriers. This is usually conducted in terms of a cost-minimising exercise for shipping lines as opposed to a revenue-maximising exercise for ports, but sometimes a game simulation between the two objectives in undertaken.

Nonetheless, in a typical port setting several agents and stakeholders may influence decisions on port choice and on the selection of freight transport and shipping services. By way of illustration, a typical international movement of a container box is estimated to involve 25 parties on average. While not all these parties have a direct impact on ports, some actors such as shippers (cargo owners), third-party logistics (3PLs) providers, freight forwarders, and non-vessel operating common carriers (NVOCCs) certainly influence port demand, choice and selection. The extent to which those actors are involved in port management is described in the chapters on port operations (Chapter 6), and marketing and competition (Chapter 9).

As for modelling the economic behaviour of port agents, much of emphasis has been placed on the analysis of port demand and on the study of the competitive dynamics of port markets. For the former, the bulk of the literature on the subject has focused on the modelling of the behaviour of shipping lines, and more recently on the modelling of port choice and selection from the perspectives of shippers and other port agents. For the latter, the contemporary literature has focused on the growing intensity of competition and contestability within and between different port markets. The interactions between port demand and supply are at the core of the study of port planning, pricing, and competition, and these aspects will be thoroughly discussed in Chapters 3, 5, and 9, respectively.

2.1.3 Requirement for market, safety and environmental regulation

Since ports are public goods, port policy becomes an integral part of the country's general economic, trade and social policy. Generally, port policy is formulated based on two understandings: (i) the role of ports in the development of the country and (ii) the set of policy measures that are needed in order to support and further promote this role. It is these measures that constitute the components of a port policy. Key to port economics is the extent to which governments and public regulators are involved in the process of port planning and development, and in the aspects of safety, economic and market regulation. Governments and public authorities can use a range of policy instruments to either promote or hinder the development of port and shipping services, for instance in terms of a protection-oriented, a market-oriented, or a market regulated port policy. Even in situations where public agents adopt a neutral view of port planning and development, the market mechanisms through which the port sector is functioning may not be completely free or independent from the influence of the process of public decision making. For instance, in their quest to reduce congestion and promote environmental sustainability, governments may favour a transport mode against another or simply a port against another. Sometimes, port development and policy decisions are usually beyond the remit of a single public agent especially where local, national, and supra-national decisions interact, and sometimes conflict, in the shaping of port policy and development. The recent trend of globalisation of port operations and services suggest that many aspects of port policy will now be dealt with at the international level.

A central tenet of modern port policy is to ensure effective competition between and within ports so as to provide users with real choice. While modern port management in which commercial investment, whether private or public, drives port development is becoming the norm across many ports and terminals in the world, the regulatory intervention from Governments and other public authorities should aim at remedying potential or demonstrable market failures and other hindrances to the wider economic, social, safety, and environmental objectives. Port market regulation may also include such aspects as port prices and user's charging, market access, mergers and acquisitions, concessions and private sector participation, incentives and subsidy programmes, and efficiency and yard-stick benchmarking. Another important element of policy intervention is the assessment of port capacity and whether or not industry and market mechanisms alone should plan and finance current and future capacity of the port system.

Other issues of policy and regulatory intervention in ports are port's safety, security, and environmental sustainability. Examples of regulated activities in ports include port state control, harbour and traffic management, hazardous materials' (HAZMAT) handling and storage, port safety and security, environmental protection and impact assessment, health and occupational safety, etc. Several regulatory standards have been developed to ensure the safety, security, and environmental sustainability of ports and port operations. Many of these regulations are set at the international or regional levels such as through the International Maritime Organisation (IMO), the European Union's (EU) maritime safety agency, the World Customs Organisation (WCO), the World Trade Organisation (WTO), the International Labour Organisation (ILO), etc. International and regional professional associations in the field, e.g. the International Association of Ports and Harbours (IAPH), the American Association of Port Authorities (AAPA), the European Sea-Port Organisation (ESPO), and the International Association of Ports and Cities (IAPC/AIPC) also set professional standards for port's safety, security, and environmental sustainability These will be discussed in Chapters 11, 12, and 13, respectively.

2.1.4 Externalities, spillovers and wider effects

Externalities are indirect effects that can be passed on to third parties, other interests, and the wider economy beyond port firms and investors. External microeconomic benefits of ports include the improvement of the efficiency of the productive and trade-logistic system and the reduction of congestion and generalised port cost, which can then be transferred to port users (e.g. shipping lines) and their clients (e.g. shippers). External macroeconomic benefits include spatial spillover effects (e.g. higher accessibility, agglomeration economies, regeneration and redistribution), socio-economic and multiplier effects (e.g. increases in employment, earnings and consumption), and innovation and technological progress. Port externalities may also be negative arising from the costs of congestion, safety hazards, environmental degradation and pollution, as well as negative location effects on certain industries such as tourism and real estate development.

An important aspect in the study of the wider effects on port infrastructure is the direction of causation between economic growth and the port activity. Most studies assume that growth is caused by port infrastructure, but as economies spend more on port infrastructure, the latter may follow growth as well. Another key point is the level of excludability from indirect effects where, for instance, some third parties cannot be prevented from enjoying the effects of direct investments made by port firms and operators. Equally important are the market, regulatory and pricing mechanism that determine how much port users (and non users) should pay for using port facilities and enjoying their wider benefits, but also for recovering the costs imposed by negative effects.

2.1.5 Natural monopoly and economies of scale and scope

Ports have large sunk assets and therefore tend to exhibit increasing returns to scale (cost per unit traffic tends to fall as a port expands) and increasing returns to scope or density (cost per unit traffic usually falls when more vessels and cargo are handled by existing facilities). Sometimes, economies of scale are defined as being associated with the efficiencies associated with supply-side changes of a single product type such as increasing or decreasing scale of production; for instance when a port achieves higher container throughput. On the other hand, economies of scope are often defined as being associated with demand-side changes of multiple products such as increasing or decreasing scope of distribution and marketing, for instance when port facilities are used to handle more than one type of cargo or when ports offer various port services, e.g. handling, storage, cargo consolidation, etc. While in the single-output case, economies of scale are a sufficient condition for the verification of a natural monopoly, in the multi-output case, they are neither necessary nor sufficient. Economies of scope are, however, a necessary condition.

Traditionally, ports have been viewed as natural monopolies, justifying public involvement in both the provision (to ensure adequate investment) and the operation (to prevent monopoly exploitation) of port services and facilities. Nevertheless, not all port assets entail a long-lived and largely sunk cost structure. Several port facilities, such as port equipment and superstructure, can be easily assigned to specific port users and may therefore attract private investors and bring about competitive market features. Take the example of towing and related port services where most of the capital costs relate to tugs. As there is an active international market for tugs, these may be bought, sold or leased quite easily. Thus towing is a contestable activity as the cost of acquiring a tug is not a significant barrier to entry. Furthermore, the multi-product character of modern ports creates greater scope for unbundling and competition. Even when some ports have natural monopoly characteristics, several port segments and services may be perfectly competitive.

2.1.6 Location and network structure

Ports are immovable assets and their exclusive location attribute has been used to explain the monopolistic nature of ports although this is no longer the case in modern port systems where the traditional captive hinterland is now being contested by different ports as well as other transport infrastructure systems.

An equally important aspect in port economics is the network structure of the port system. Here ports may be viewed as infrastructure facilities which are part of a wider transportation economic network for moving goods and people. From a network economics approach, the port network is comprised of network users (port users), service providers (ports and port operators), and the rest of the economy. This should not be confused with the engineering approach of network systems where transport networks are defined as flow (e.g. traffic) networks of links (mode and path) and nodes. In a simple presentation of a marine transport system, the mode represents maritime transport, the path corresponds to the maritime route, and the node represents the port or terminal.

A third definition of network systems is given by the supply chain management theory whereby a supply chain network is comprised of a series of firms and organisations that pass goods and materials forward from upstream suppliers to downstream customers, but also sometimes backward (reverse logistics) such as in the case of export containers returning as empties. From this perspective, the port and marine transportation network is an integral part of the total supply chain network (see section 2.3).

A central feature of network economics is the creation of network effects, that is the effect that one user of certain goods or services has on the value of those goods to other users. This is particularly the case of network industries (telecommunication, electricity, transport, etc.) where the more people use a product or a service, the more valuable that product or service becomes to each user. In this sense, network effects correspond to positive network externalities but network effects may sometimes lead to negative externalities such as congestion. The study of congestion effects and increased queuing in ports is particularly important since it directly impacts decisions and strategies of port planning, operations, and competition. Network effects are sometimes confused economies of scale and economies of scope, but the latter refer to the efficiencies associated with the supply-side and demand-side changes, respectively, rather than the benefits resulting from network interoperability.

2.1.7 Long-life assets and long lead times for planning and project completion

The long-term time of port planning and project completion also impact the determinants of economic decision-making in ports. The long lead-time for port construction, including a lengthy planning and design period, and for superstructure and equipment procurement has always meant that short-term matching of the supply of port facilities to the expected demand is difficult to achieve, particularly in times of uncertainty and for unstable port markets. Port assets, in terms of both infrastructure and superstructure, have a long economic life and therefore entail a long pay-back period for investment and project appraisal.

2.2 The Operations Approach

From the engineering and operations approach, ports are seen as fixed assets and operations systems. Engineering applications in ports are mainly associated with the aspects of port design, construction, modelling, planning, operations, maintenance, optimisation, and performance measurement. The sub-branches of engineering that are mostly concerned with port operations, planning and logistics include transportation engineering, environmental engineering, and industrial engineering. The latter is often used to study ports from a system's and process approach, and is therefore closely related to the fields of logistics and supply chain management. The conceptualization of ports as logistics and supply chain systems forms the basis of a new approach to ports which is introduced in the next section and discussed extensively in Chapter 10.

A system is often defined as a set of components standing in interrelations among themselves and with the environment. A port's internal system is composed of at least four components: physical assets (infrastructure and superstructure), labour and human resources, technology and information systems, and management and workflow processes. Because of the complex nature of port operations, relevant research on the subject is usually undertaken at disaggregated operational levels, e.g. terminal, site, equipment, technology, etc. A further distinction is also made between the types of engineering and operations decisions. The latter can be categorised into strategic, tactical, or operational decisions according to their scope and time horizon.

Outside the nautical infrastructure, key port operations that have been mostly examined in the literature include ship and berth scheduling, stowage plan and quay-crane efficiency, vehicle-flow dispatching and scheduling, staking and storage in the yard, empty container management, automated operating systems, and intermodal transport operations. A good review of these and other operations problems in terminal operations is provided in Chapter 6 of this book. Even though, many operational features of port systems remain under-researched including such aspect as network structure, reliability, and interoperability.

2.2.1 Network structure

Most transport and freight distribution systems follow a node-link network structure, although the nature and properties of the network differ greatly between and within systems. For instance unlike rail and road systems, maritime links may be established between any two or more seaport locations subject to a number of infrastructural (ports, canals, locks, etc.), operational (volume, capacity, price, etc.), and organisational (liner shipping versus tramp shipping) constraints.

From an engineering and operations perspective, ports are a central node of the maritime and intermodal transport networks. Mathematically, a transport network can be represented by a graph consisting of a set of *links* (edges) and a set of *nodes* (vertices). The links represent the transport movements between the nodes, which in turn represent points, e.g. ports, in space and sometimes in time as well. A *path* is a collection of links and nodes specifying both the route and the mode(s) of transport. In the graph theory, a network is pure when only topology and connectivity properties are considered. When flow properties are considered as well, a network is then referred to as a flow network, in which case capacity constraints and other related factors become key features of network analysis. Random graphs are one of the earliest and most extensively studied network models. They are defined as networks where nodes and links which are assigned at random. In the opposite side of the network model spectrum, one encounters regular networks where link creation adheres to strict rules.

Much of the models and concepts developed in the graph and network theory can be applied to ports, at least in two separate areas of interest depending on how ports are perceived as network structures. When ports are viewed as nodes of the shipping and intermodal transport network, the graph theory can be used to study certain shipping and related port aspects such as path flow estimation (freight flow modelling and traffic forecasting), network equilibrium (deterministic or stochastic user equilibrium), port and depot location, and route and mode choice (traffic assignment). When ports are analysed as individual spatial networks, the graph theory can be used to study several issues of port operations and short-term (operational) planning such as the routing, deployment, and scheduling of port equipment and vehicles as well as labour and manpower. The network structure can also be applied to port planning, design and construction through the study of project networks and industrial scheduling.

The study of port's network topology is also relevant to port operations and logistics, but the literature on the subject is relatively scarce. This may be due to the conventional thinking that the location of ports in spatial networks is exogenous, i.e. ships follow ports. On the other hand, the more specific study of the topology of port and shipping networks (e.g. scale-free networks, complex networks, and small world networks) has received little attention from the academia and the profession alike. Traditionally, port planning and capacity expansion schemes have relied on the volume/capacity ratio to identify highly congested links resulting in localised solutions. In a similar vein, international shipping networks have followed a trade-led pattern where new routes are opened and operated to link two or multiple market, but traffic and operational constraints have forced shipping lines to develop new operational patterns in an effort to optimise ship utilization and efficiency. As a result, the issue of liner network routing has been reduced to a ship's scheduling problem. The key point is that port and maritime network patterns have evolved from micro-level and fragmented decisions that do not always consider global network performance and system-wide impacts. With the evolving complex shipping networks (transhipment routes, hub-and-spoke systems, increasing use of hierarchical networks and multiple line bundling arrangements, etc.) and the recent trends in port choice and logistics (shifts in global distribution patterns, changes in supply chain segmentation and planning processes, the general trends in outsourcing and the emergence of global terminal operators, etc.), network design and capacity in shipping and ports require a new approach and systemisation.

2.2.2 Reliability

Another area of interest in network analysis is network reliability which aims at studying the vulnerability and robustness of a transportation network including topics of connectivity, link failure, disruption and redundancy, vulnerability and security. However, reliability in ports include aspects that go beyond the field of transport network reliability, for instance terminal reliability, capacity reliability, operational reliability, transit (travel time) reliability, and encounter reliability.

A widely accepted definition of reliability is the one provided by Wakabayashi and Lida (1992) who define reliability as 'the probability of a device performing its purpose adequately for the period of time under the operating conditions encountered'. Obviously, the extent to which a system or device is reliable depends on the interests and perceptions of different users, for instance between those who focus on cost reliability versus those who favour time reliability, or simply between high risk averse users versus less risk averse users.

The potential sources of disruption to port systems and networks are numerous, ranging from routine events such as congestion and equipment failure to exceptional disasters such as earthquakes, terrorist attacks, ship collisions, and other major accidents. The cause, scale, impact, and frequency of such events will vary extensively, but it is possible to design and manage port systems and operations in ways that enhance the predictability of such events, minimise the disruptions they may cause, and improve the robustness and redundancy of the port system against such disruptions. Here, the concept of risk assessment and management becomes a key element in the study of a system's reliability.

Risk assessment and evaluation is a well-established engineering process for identifying hazards, identifying their probabilities and consequences, assessing the acceptability of risks, and taking remedial actions to address unacceptable risks. Vulnerability is another concept closely related to risk in that it encompasses both probability and consequences. Generally, vulnerability is defined as the likelihood of severe adverse consequences. Therefore, vulnerability may be interpreted as the opposite to reliability.

Superior port design and redundancy improves system's reliability. For instance, enhancing the methods and execution of port planning, operations and maintenance would improve the quality of services provided with a view of satisfying users' expectations. In a similar vein, developing systems and processes of quick recovery and resilience in the event of failure reduces the adverse consequences of disruption. Therefore, both the design and redundancy components of port equipment, operational procedures, and management systems must be taken into account when assessing port safety and security. However, while port safety is based on the assumption of unintentional human and system behaviour to cause harm, port security involves a high degree of malevolence. Current maritime transport and port networks have been designed to respond to an extensive set of market and operational requirements, but their robustness and reliability vis-à-vis random or targeted failures have for long been taken for granted. In the post-9/11 era, the robustness and survivability of the maritime network against node or port failures is a high priority. Even though, the topic of network reliability in ports is surprisingly still under-researched and only a few relevant works on the subject exist. The topics of port safety and security will be discussed in detail in Chapters 11 and 12, respectively.

2.2.3 Interoperability

Interoperability refers to the capability of diverse systems and organizations to inter-operate and work together. In seaports, interoperability must be achieved at operational, communication, and technology levels. Operational interoperability refers to the ability of port operators to handle various types and sizes of ships and their cargoes. While some ports have a higher interoperable capability, many ports have lesser interoperability for conforming to operating requirements and working standards, for instance in terms of equipment and labour capability. The capability to integrate various intermodal systems is also a key to achieving a high degree of operational interoperability in ports. Communication and business process interoperability between various members of the port community is a key to successful port operations. The use of standard communication systems such as VTS, EDI, and ERP systems ensures the exchange of documentation, data and information in interoperable semantics, communication protocols, and file formats. In the areas of port safety, security and environmental protection, interoperability communication between various port stakeholders and public agencies is a key to successful management response during wide-scale emergencies. From an economic perspective, a lack of interoperability creates conditions for negative network externalities such as in terms of monopolistic behaviour, market failure, and congestion effects.

2.3 The Logistics and Supply Chain Management Approach

Logistics had long been exclusively used by the military and was only integrated into operations and business management in the mid 1960s. There are almost as many definitions of logistics as the number of books and articles written on the subject. This, to some extent, reflects the underlying characteristics of logistics, which has been undergoing a constant evolution during the last three decades or so. The basis of logistics management is the integration and optimisation of a firm's functions and processes for the dual purpose of overall cost reduction and customer satisfaction. Logistics seeks to deliver the right product or service, in the right quantity and condition, at the right price, to the right place, and for the right customer. Typically, the logistics process encompasses inbound, in-house, and outbound logistics and spans the flows of goods, services, people, and information from point of origin till point of consumption (forward logistics) and vice-versa (reverse logistics). Logistics functions are usually categorised into two main components: materials management and physical distribution, and may include a range of activities such as purchasing, planning, production control, inventory management, materials handling, storage and warehousing, transport and distribution, sales and marketing. Most concepts of logistics and supply chain management also apply to ports. They include:

2.3.1 Customer service

Much of the emphasis of business logistics is placed on effective customer service which, combined with the objective of cost reduction, opposes business logistics to military logistics. The concept of customer service associates many aspects of logistics closely with marketing. It can be broadly described as the measures of how well the logistics system satisfies its customers and their expected levels of service. Customer service must be viewed as an integral part of the design and operation of any logistics system. In ports, much of the debate to-date is on how to perform efficient operations while still satisfying a wide range of port users and customers.

In SCM, the concept of customer service takes on another dimension since it assumes that the network of organisations in a port supply chain should work collaboratively in order to ensure superior customer service and competitive advantage vis-à-vis other supply chains. This means that port competition is moving to a further level: ports are not only competing against other ports on the basis of operational efficiency, price and location, but also and more importantly on the basis that they are embedded in quality supply chains that offer shippers, shipping lines and other customers a greater value than alternative ports, routes, and supply chains. Today competitive advantage depends less on a port's internal capabilities but rather on its supply chain competitive potentials where long-term success depends upon the competitiveness of entire port supply network.

2.3.2 Value added

In logistics, the term value added is closely related to customer's satisfaction. The most appropriate customer service level is the one that gives the customer the maximum value added. The performance of a logistics system is assessed based on how well it performs in creating value added benefits to the customer in a cost effective way. While the value of port services to shipping lines may be reduced to the aspects of operational efficiency and turn-around time, the value of port services to shippers may be extended to the aspects of product conversion, process decoupling, inventory management, market customisation, postponed manufacturing, modal shift, and regional distribution.

Value added also means the value newly created or added to traditional services. Logistics activities are key elements in the value chain, and thus contribute greatly in the creation of value added. Apart from their traditional function as a sea-land interface, ports are a good location for value-added logistics activities such as consolidation and break bulk, sequencing and order processing, packing and packaging, postponement and customisation, promotion and market intelligence, facilitation of contacts and procedures, etc. From a logistics approach, ports should be conceived as logistics and distribution centres that not only optimise the movement of goods and services within the maritime and multimodal transport system, but also provide complimentary services and add value to members of the larger logistics and supply chain network. The role of ports as logistics centres has been fully recognised in recent years with many ports worldwide expanding their activities into a wide range of logistics and value added services. Thus, the port system not only serves as an integral component of the transport system, but is also a major sub-system of the broader logistics and supply chain systems.

2.3.3 Process and integrated approach

Much of the logistics philosophy is based on a process approach to business. This means that logistics is not an isolated activity, but rather a series of continuous and interrelated activities whereby planning, organisation, operation and management apply. One of the main benefits of logistics is that it offers an integrated approach to a range of activities and functions (e.g. purchasing, production, transport, warehousing, etc.), and enables manufacturers and other organisations to identify the total cost of the system, and balances (or trades-off) one aspect against another.

Over the past two decades or so, the integration of the international logistics chain has become a focal issue in developing strategic plans and long-term objectives for 3PLs, shipping lines, and even port operators. Today, third-party logistics providers (3PLs) offer packages that include full coverage of logistics services from origin to destination. In a similar vein, advances in containerisation, intermodal integration, and information technology have allowed shipping lines to extend the scope of their activities from traditional sea transport services to integrated door-to-door transport and logistics services including such activities as inland transportation, consolidation, freight forwarding, and even cargo handling and port services. Yet, total logistics integration is achieved by few mega-carriers while most shipping lines limit their services to sea transport and related shore-based operations. In ports, the process of port privatisation and deregulation being widely implemented during the last two decades or so has gradually lifted the barriers against logistics integration in the port industry. Nowadays, many port operators are capable of offering a range of logistics services beyond the traditional package of services to ships and cargo. There is also a growing trend from the part of ocean carriers, logistics service providers, and even shippers towards port ownership and management. Recent strategies of vertical and horizontal integration evolving around port ownership and operations have produced new institutional port structures capable of offering integrated port and logistics services.

2.3.4 Total costs and cost-trade off analysis

A key element of integrated logistics is total cost analysis. The essence of logistics is to minimise the total cost rather than the cost of individual activities. Any change made in one aspect of an organisation is likely to impact other aspects as well as the total cost of the entire logistics system. Cost trade-off analysis is a key feature of total logistics costs and consists of comparing different combinations of cost elements so as to achieve an overall optimal solution. Examples of cost trade-off analysis include transport costs against inventory costs, warehousing costs against transport costs, and production costs against inventory costs. It is obvious that these costs are inherently interrelated with each other. Cost trade-off analysis is also a useful tool for strategic decisions. A typical illustration is when a firm decides to move production to a cheaper place in order to reduce the cost per unit of the product at the factory, but the new production site would imply an increase in transport and other related costs.

While the objective of shipping lines is to minimise total door-to-door transport costs, including cargo handling and port costs, shippers seek to minimize total logistics costs which include transportation costs, warehousing costs, order processing and information costs, lot quantity costs and inventory costs. Even though, the literature on port planning, choice, and freight flow modelling often overlooks the costs of shippers and limits the analysis to a trade-off exercise between a cost-minimisation for shipping lines versus a revenue maximising objective for ports.

2.3.5 Ports as logistics systems

Despite the widespread recognition of the logistics and supply chain dimension of ports, the bulk of the practical and theoretical literature on ports has studied port systems from either an economic approach or an operations approach. However, these approaches neither fully justify the evolution of port systems nor integrate various functional port units into the wider freight logistics and supply chain network:

✓ On the one hand, the economic approach treats freight and maritime transport as a derived demand from trade. Here, maritime transport and port activities are perceived as an afterthought, i.e. something which is considered only after the main activities of the firm such as purchasing, production, and inventory, have been undertaken. We believe that the economic and trade approach justifies only part of the evolution of freight distribution systems. The focus on the nature, origins and destinations of freight movements disintegrates port management from logistics and supply chain structures.

✓ On the other hand, the operations approach disaggregates the port system into individual units and components and seeks to optimise their individual operations rather than that of an overall port system. Here, operational fragmentation may result into conflicting objectives and disintegrated port operations. An integrative approach is therefore required.

✓ The logistics approach integrates both transport and cargo handling functions with other logistics components such as purchasing, production, storage and inventory management, promotion and marketing. In this approach, ports should be conceived as logistics and distribution centres that not only optimise the movement of goods and services within the entire transport and logistics chain, but also provide and add value to ultimate customers and users. Chapter 10 introduces a new conceptualisation of seaports as logistics and supply chain systems and discusses its implications on port decisions such as for planning, operations, marketing, competition, choice and selection.

2.3.6 Ports and international logistics

Most of the logistics concepts discussed above are also relevant in the international sphere. However, there is a great degree of complexity and uncertainty in international logistics compared with domestic logistics. The areas of complexity listed below also apply to international port and terminal management:

- ✓ *International trade complexities*: Different terms of sale and documentation, terms of payment, problems with the use of different currencies and the fluctuations of the exchange rate, etc.
- ✓ *The international and changing nature of markets*: Involvement of supra-national trading blocs (EU, NAFTA, ASEAN, etc.), different national/regional tastes, languages, traditions, regulations, etc.
- ✓ *The nature of international supply chains, procurement and sourcing*: Multiple choice of production, inventory location and management, difficulty of control over deliveries and inventories, different expectations for customer service.
- ✓ *The involvement of multinational and global corporations*: Aspects of channel control and power, footloose strategies and risk of mobility, the growth of intra-firm trading, etc.
- ✓ *The general trend of outsourcing transport and logistics activities*: Through contracting out with third and fourth party logistics (3PL/4PL) providers.
- ✓ *The frequent use of transport agents and intermediaries*: including brokers, agents, NVOCCs, freight forwarders, and other intermediaries.

As the world economy becomes more integrated through an accelerated process of globalisation of production, consumption and services, the market place for an increasing number of port users and customers is now simply the globe. In international logistics, the relentless striving for greater economies of scale, global coverage, higher efficiency and improved service quality have leveraged port competition for cargo and shipping services to a global market level. Logistics integration and network orientation in the port and maritime industry have redefined the functional role of ports in value chains and have generated new patterns of freight distribution and new approaches to port hierarchy. Successful ports have realised that in order to survive and prosper in today's business environment, they have to adopt a global view. Today, many port operators have reached a global status through extending their activities to international port markets. The international consolidation of the port industry will be discussed in detail in Chapter 10 of this book.

2.3.7 Ports and supply chain management

Supply chain management (SCM) extends the logistics concept of integration to a network of organisations by advocating trust, closer collaboration, and partnership arrangements. SCM corresponds to external integration where a system's approach is used for managing the entire flow of information, materials, and services from raw materials suppliers through factories, warehouses and distribution centres, retailers, to the final customer or end user. Key SCM decisions include supply chain configuration, planning and forecasting, suppliers' selection, process and product design, plant and warehouse location, demand management, supply chain risk and security, IT integration and enterprise systems, e-commerce and electronic markets, etc. Partnership arrangements in SCM require an abatement of conflictual attitudes in favour of long-term trust and co-operative relationships. Nevertheless, traditional relationships in the international logistics and shipping industry, including ports, have been more adversative than collaborative and where arms' length arrangements seem to prevail over integration.

2.4 Marketing Channels and Port Management

In marketing management, a channel is defined as the network of organisational contacts a firm operates to achieve its distribution objectives. In other words, it is the physical route taken by goods from producer to consumer or the route of the transfer of ownership (or title) of the goods. Sometimes, the two routes are the same, but often they are not, particularly in international trade where payment, information, and sometimes ownership, may be associated to entities other than the exporter and the importer. A marketing channel can be identified by the types of institutions associated with the *ownership and transaction* of goods. For instance, merchants (buyers and sellers) have the ownership of the goods and agents act on behalf of merchants, but sometimes negotiate the ownership. On the other hand, transport and logistics providers do not take ownership of the goods but only facilitate their efficient passage through the channel. As such, logistics operators/ providers are not member of the marketing channel.

The literature on channel management has its roots in marketing management, and latterly in logistics and supply chain management (SCM). A channel can be loosely defined as a set of organisations that have banded together for trade, distribution and/or marketing purposes. In logistics management, channels are often reduced to the physical routes taken by goods as they move from producers to customers. In marketing management, a channel may be defined as the network of organisational *contacts* a firm operates to achieve its distribution objectives. Members of the marketing channel are entities that take part in the various marketing flows including title, information, promotion and payment while members of the supply chain include all the organisations involved in the sourcing, production, transport, storage, delivery, sales and even return of the product or the service. Two distinctive features of the marketing channel approach are worth underlining: (a) its focus on channel *control* and (b) the appreciation of *conflict* between organisations. Such features differentiate the marketing channel approach from the supply chain approach, the latter requiring co-operative relationships and integration of organisations.

Another distinction between the two approaches stem from the way each of them focuses on inter-organisational relationships. The marketing channel approach deals with the control of the channel and focuses mainly on external organisational arrangements. The SCM approach, on the other hand, seeks optimal efficiency by focusing on organisational integration including internal arrangements within a single company. In either case, it is crucially important not to confuse between *institutions* and *functions*. Institutions refer to what channel members (shippers, ocean carriers, ports, freight forwarders, regulators, etc.) are while functions describe what channel members do (production, transport, cargo handling, storage, regulation, etc.). Often, this distinction is blurred given that many functions of port management are operated by channel members other than ports, for instance when a shipper or a shipping line own or operate ports and terminals. A thorough discussion of channel structure and design in ports from marketing and supply chain perspectives is provided in Chapter 9 and 10, respectively.

3. RATIONALE OF THE BOOK

From the above discussion, it is clear that ports are complex and dynamic entities, often dissimilar from each other, and where various services and activities are carried out by and for the account of different actors and organisations. Such a multifaceted situation has led to a variety of operational, organisational and strategic management approaches to port systems.

It is noticeable in the current body of port literature that the conceptualisation of the port business has taken place at different disciplinary levels without producing a comprehensive and structured port operations and management discipline. Furthermore, many areas of port operations and management still remain unexplored, and there are few theoretical and practical references outlining the different features of operational, strategic, and logistics management in ports.

'*Port Operations, planning, and Logistics*' is designed to offer a comprehensive, integrated, and detailed analysis of the complex and multi-faceted port system. As shown in Figure 4, the port system is portrayed in terms of four core components: agents, operations, markets and services, and impact. The focus of the book is on the interplay between those components and on the types of decisions they generate namely; planning and operations decisions, marketing and logistics decisions, and economic and policy decisions. In so doing, the book provides a unique and multi-disciplinary reference that cuts across different research fields; economics, engineering, operations, technology, management, logistics, strategy, and policy.

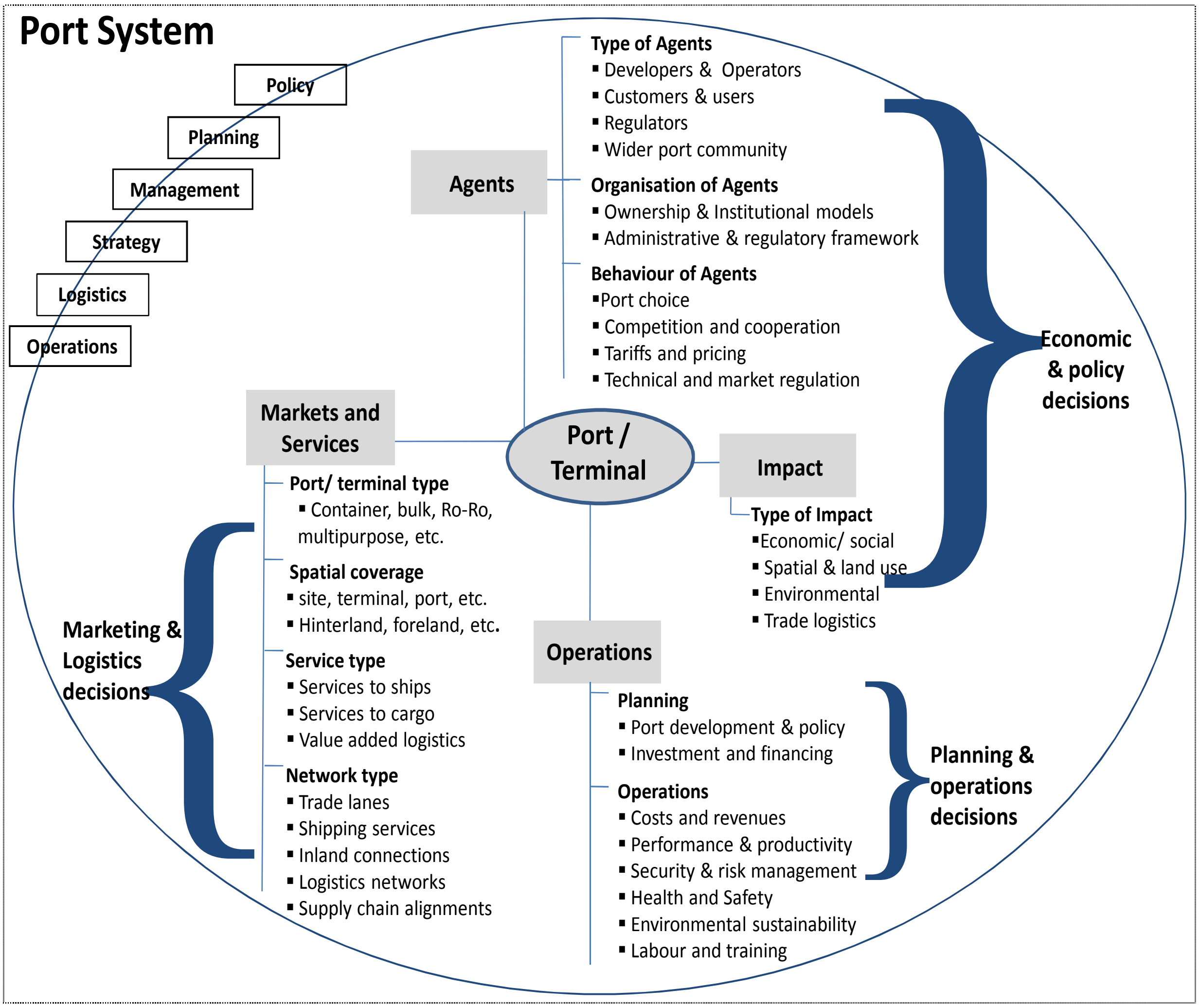

Figure 1.4: Scope of this book (source: Author)

3.1 Contents of the Book

This book reviews theoretical and practical applications in port operations, planning, and logistics and addresses the various needs, challenges, and risks in port operations and management. The book explores various port topics; planning, operations, logistics, institutional organisation, investment and financing, pricing and asset management, efficiency and performance benchmarking, marketing and competition, information and communication technology, human resource management, safety and security, and environmental management, each supported with case studies, practical examples and illustrations of the latest developments in the field.

The first chapter points out the link between ports and the maritime business and presents alternative ways of port definitions and classifications. In particular, it outlines the different approaches to modern port systems and highlights the current and future trends in port operations and management. The second chapter reviews various port roles and functions and examines the traditional and evolving forms of port organisation, institutional structure, and development. The third chapter reviews the various topics and elements of port planning; operational, strategic, and long-term planning, while analysing the issue of port capacity in terms of both capacity planning and capacity management. It goes on to describe in details the different models of port demand modelling, network design, and traffic forecasting. The fourth chapter deals with port investment and finance with a particular emphasis on port costs and costing, economic and financial appraisal of port investment, and the nature and modes of private sector participation in ports.

The fifth chapter introduces the subject of port pricing, lists the different port dues and charges, and reviews the different approaches to port pricing and user charging. The sixth chapter discusses various aspects of port operations; queuing and congestion, terminal configurations, terminal processes and procedures, equipment and handling systems, and maintenance and repair, with particular emphasis on containerised operations. Topics discussed in greater length include. The seventh chapter is dedicated to the subject of port productivity, performance and benchmarking. The various approaches and methods for measuring and benchmarking port performance and efficiency are described in detail supported by theoretical applications and practical case studies. Chapter eight investigates the use of information and communication technology applications in ports from EDI and port community systems to RFID and automation. Chapter nine addresses the issues of port competition and marketing focusing on the topics of market structure and analysis, competition and cooperation strategies in ports, port choice and selection, tools for port marketing and promotion, and instances of channel conflict and power in ports.

Chapter ten investigates the logistics and supply chain dimensions of ports and discusses their applications and wider implications on inland systems and supply chain strategies. Chapters eleven, twelve, and thirteen review the subjects of port safety, security and environmental management, respectively. Throughout the three chapters, the operational, economic, and policy frameworks of technical regulation in ports are discussed and their contemporary impacts on port operations and planning are assessed and analysed. The final chapter, chapter fourteen, reviews the historical and contemporary organisation of port's labour and workforce and assesses its impacts on port productivity. In addition, the chapter outlines modern human resource (HR) management approaches and their applications in port operations and management, and highlights the need for global standards of port education and training.