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ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ:Παπαλεωνίδα Παρασκευή

ΘΕΜΑ:The ship-port interface:activities and facilities in a modern port

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Ο ΔΙΕΥΘΥΝΤΗΣ ΣΧΟΛΗΣ : Τσούλης Νικόλαος

Abstract:

This research focuses on the ship-port interface and the facilities and activities that are provided in a major modern port. It analyzes ship-port roles; effects and procedures. There are detailed procedures prior arrival and guidelines for the port of London; as well as listing of all modern port's perks and an analysis of the evolution of ports through the years. The ecosystem problems of many major ports and the water ballast systems are reviewed and compared to Europe's largest and most advanced port; Rotterdam. There is a general conclusion about the attributes that modern ports should have in order to be up to date with the advance of technology without being less eco-friendly.

Contents:

1.0 Introduction to ship-port interface

The world economy is highly dependent on sea borne trade as the later covers major area of exports and imports. However, the shipping trade cannot survive only with the help of ships, for is the use of ships if there are no ports. This means that ships need support from shore facilities such as ports, shipping offices, coastal, and governmental authorities and other types of shore support.

Without the involvement of shore support, it is not possible for a ship to perform all the operations on its own. This brings in the importance of ship-shore interface management.

1.1 Ship Shore Interface

Interface is the term used for coordination between two different departments. When it comes to sea-Shore Interface, obviously, one side is counted as the ship staff and the other is the shore facility.

The base of the ship-shore interface management deals with exchange of information and transparent communication before or during different operations carried out together so that the safety of the operation is maintained at all times.

The shore side interface comprises of several departments such as:

- port authority
- bunker supplier
- shore workshop
- shore fire fighting department
- Service providers for vetting, cargo handling etc.
- Security officials
- Surveyors
- Dry dock personals
- Other shore supports

The services provided by shore side departments are:

1. Infrastructure provision

2. Berthing services:

· Pilotage

· Towing, Tying

3. **Cargo handling**

· Stevedoring

· Terminals

· Storage

· Freezing (fish, others)

4. **Consignees:**

· Administrative paperwork for ships and cargo

· Permits (sanitary, customs, etc)

· Service hiring

5. **Ancillary services:**

· Supplies

· Repairs

· Cleaning, refuse collection

· Safety

1.2 Importance of Ship-Shore Interface

It is very important to maintain a clear interface while the two departments are working together, for any gap in communication can lead to inefficient operation, accidents, and even pollution.Both, ship and shore staff must be adequately trained about interface management so that the operation can be performed safely, efficiently and within the time limit.

Some basic examples of ship shore interfaces:

- Cargo loading and unloading in port
- Berthing and mooring of the ship in port
- Receiving bunker from shore support
- Arranging and setting security level in ship when in port
- Arrangement of survey when required
- Communication with dry dock personals when in dock

Ships visit various countries with different languages. Hence to maintain a standard for operational communication, training is required for both ship and shore staff under interface management. Such training is provided by several companies offering training courses for ship shore interface.

1.3 Analyzing port services and ship procedures

Besides the provision of basic infrastructure for the transfer of goods and passengers between sea and land, there are multiple services provided by different agents at ports, some of whom may even work outside the port area. These services cover all activities linked to the connection between port users and port, from the moment that a ship approaches a port until it ends all its operations. During this period, there are services provided to the ship, to passengers, to ships crews and to cargoes

First, there is a group of services related to *berthing*, which include pilotage, towing and tying. All these services can be directly provided by port authorities, or they can be offered by private firms. Pilotage is defined as those operations required for a ship to enter and exit a port safely, and it usually implies the presence in the vessels bridge (or at least a contact by radio) of an expert with sufficient knowledge of the zone to avoid risks.

Pilots can be independent private agents in some ports, licensed by the port authority, while in other cases they are public employees. Towage is the operation of moving a ship using small powerful boats (named tugs) to steer it more easily. Again, it is possible to have private firms providing services for these operations, while in other ports tugs and their operators are directly hired by the port authority.

One of the more important services provided to cargo ships is what is generically labeled as *cargo handling*. This encompasses all activities related to the movement of cargo from/to ships and across port facilities. There is a historic separation between the operations of moving goods from ships side until they are safely stored within the vessel (*stevedoring*), and those movements from berth to ships side (*loading*), as a result of these operations traditionally being performed by different workers. Today, however, there are specialized firms that provide all these cargo handling services, using equipment such as cranes and surface transport elements.

The process of cargo handling varies according to the type of goods involved. There is a trend toward the specialization of firms according to the type of cargo, since the equipment required can then be specially designed to be highly cost-efficient. Thus, specialization leads to the formation of *terminals*, defined as specialized berths where all operations are mainly concentrated on a given type of cargo. Container terminals constitute the best example of this trend, since the handling of containers requires large gantry cranes, and land storage is relatively easy with adequate trucks and lifts, but it is highly space consuming.

All these factors make it more convenient for a firm to have a specially designed berth in order to handle containers more efficiently than general cargo berths. Of the total cost involved in moving goods through a seaport, cargo handling charges are the most important (between 70% and 90% of total cost, approximately, depending on the type of goods).Therefore, this is one of the services that must be supervised more closely by a regulator in order to ensure cost-efficient port operations.

Another type of service demanded by port users are those related to administrative paperwork and permits (sanitary certificates, import/export documents, taxes, etc.). These are usually performed by specialized agents or *consignees*, who are hired by shipping companies to arrange in advance the paperwork and all matters related to the use of port facilities by a ship. Even before a ship calls at a port, consignees start working to arrange that all services required (handling, repairs, supplies, etc.) are contracted for the ship and performed in the shortest feasible period. It is essential for a modern port to have systems to minimize the burden of paperwork for port users, since delays originating in inefficiency in administrative procedures result in large economic losses to shippers, who do not receive their goods on expected dates and thus have to alter their productive plans, and to shipping companies, which have to keep their ships in ports for longer than necessary.

In the European Union, there are some guidelines established to promote ports investments in developing electronic data interchange systems (EDI). These systems are aimed at speeding up administrative paperwork and reducing waiting times for ships and land transport modes (trucks, railways) that deliver goods to/from ports

2.0 Arrival of Ships to a Port - Port regulations Guide to Ports Entry

Port definition:

Ports are points of convergence between two geographical domains of freight circulation (sometimes passengers); the land and maritime domains. While the maritime domain can involve substantial geographical coverage related to global trade, the land domain is related to the port's region and locality. The term port comes from the Latin *portus*, which means gate or gateway. Historically, ports emerged as safe harbors for fishing and those with convenient locations became trade hubs, many of which of free access and designed to protect trade. As such, they became nexus of urbanization with several becoming the first port cities playing an important role in the economic welfare of their regions. Today, many of the most important cities in the world owe their origin to their port location. The port is a multidimensional entity at start anchored within geography, but also dependent on its operations, governance structure and embedded within supply chains.

Prior arrival: Before arrival of a ship in the port of call the Master should notify his agent and the port control of the ship's ETA, giving particulars of the ship and her cargo. Depending on the distance of the ship from the port, the notice of arrival can be sent by satellite communication (telex or fax), e-mail and by VHF, when the ship is within the reach of VHF radiotelephony. The method of reporting the arrival of the ship at a port (from her port of departure all the way during the voyage to the port of call) is laid down by port regulations for each specific port and is given in various formats

2.1 Detailed procedures on arrival:

Every port has its own prearrival forms-procedures and regulations. All of those are provided from the local agent who is responsible to inform the ship's captain. For example port of London which is one of the largest on the world has the following procedures on arrival:

London arrival guideline

REPORTING - Vessels over 40m LOA or over 50 gt and tugs engaged in towing, must report to the relevant VTS Centre when passing Waypoints as indicated on approved charts. They must also inform London VTS before the vessel navigates the Thames and obtain clearance from the relevant VTS Centre so to do.

PILOTAGE - The requirements for compulsory pilotage in the Port of London are contained in the PLA's Pilotage Directions. The services of a pilot can be obtained through your Agent, or by calling the following pilot stations on VHF Channel 9, NE Spit Pilots (Ramsgate), Sunk Pilots (Harwich), Sheerness Pilots (Warp) and London Pilots.

NAVIGATION WITHIN PORT LIMITS - Masters must advise London VTS which approach channel they intend to use. Vessels with a draught of 6.0 metres or less should use the Barrow Deep or Princes Channel, waiting when necessary for sufficient height of tide to transit these channels. Any vessel uncertain of its position should call the relevant VTS Centre immediately. Large scale charts of the river may be obtained through local Agents.

"SPECIFIED VESSELS" - Are defined in General Directions and covers vessels carrying quantities of explosives, or flammable or toxic substances in bulk or non gas-free following discharge of such cargoes. These vessels are required to display a red flag by day and an all round red light by night. All vessels should maintain a half-mile separation from specified vessels. Permission is required from the Harbour Master before reducing that separation or overtaking a specified vessel.

RESTRICTED VISIBILITY (less than 0.5 nautical mile) - All vessels over 40m LOA must have an operational radar to navigate in restricted visibility. Additionally, all unpiloted vessels or vessels without a valid Pilotage Exemption Certificate holder in charge, having a draught in excess of 4.0 meters, are not permitted to navigate in Restricted Visibility. Vessels so prohibited, must proceed to nearest safe anchorage and wait until visibility improves to more than 0.5 nautical mile, or the arrival of a PLA pilot, if so requested.

DANGEROUS NAVIGATION - Masters are advised that navigating without due care and attention, or navigating in a manner liable to injure or endanger persons, other vessels or structures such as berths or jetties (this includes damage caused by wash or draw off due to excessive speed), is an offence liable to prosecution. The Harbourmaster will vigorously investigate any such infringements.

INCIDENTS - Vessels must advise the Harbourmaster immediately (through the relevant VTS Centre) if involved in any of the following incidents: Collision, sinking, fire, grounding, pollution, damage to vessel or structure, foul or lost anchor.

ANCHORING - Except in an emergency, vessels must only anchor in designated anchorages as shown on approved charts. An effective bridge watch should be maintained whilst at anchor.

DEFECTS - Vessels with structural, mechanical or equipment defects affecting their ability to navigate safely, must inform the Harbourmaster of the defect. Such vessels shall not move without having obtained the consent of the Harbourmaster.

EMERGENCY PROCEDURES - When a Port Emergency or Major Incident is in progress, the Master of every vessel must for the duration of the incident:

· Minimize transmissions on VHF.

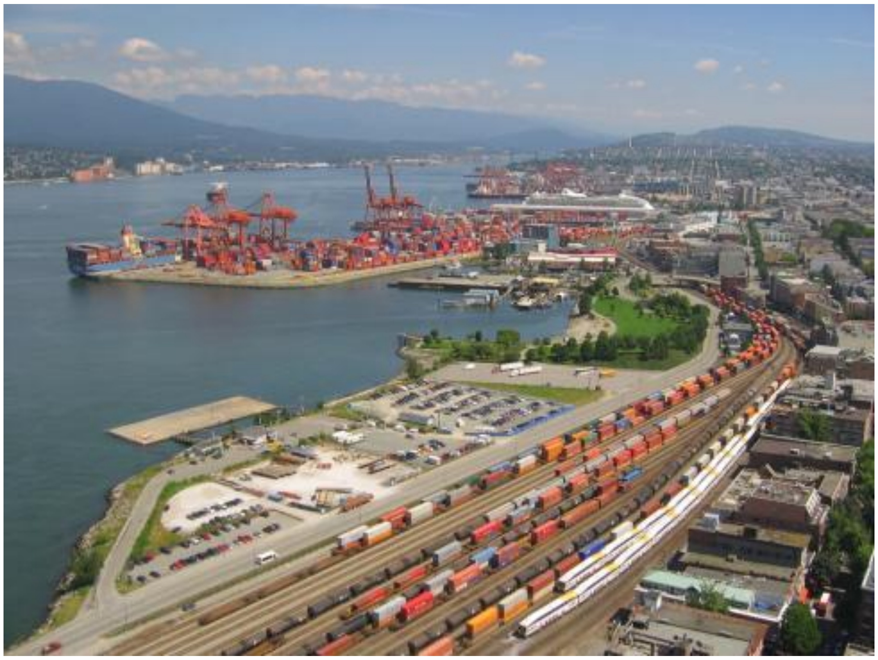
· Proceed with caution when near the incident and follow directions as given by London VTS or the on-scene coordinating vessel.

· Give assistance as required.

3.0 A modern port's facilities and activities

Introduction

The maritime sector has considerable influence on the volume and conditions of trade and the capacity for economic development of developing countries. It has long been recognized that transport costs form a significant part of the final costs of exports and imports. More important is the way in which transport is organized, as it affects the ability of exporters to reach their markets under satisfactory conditions, as well as to open up new markets. The port community plays a vital role in economic growth by attracting and generating trade.



Today's maritime sector is confronted with many challenges, such as newly imposed standards in safety and environmental management, radical change in the information systems, new cargo handling and commercial practices, privatization and restructured shipping services and substantial potential traffic growth through globalization. Countries which are unable to cope with such rapidly advancing realities, will find that they are not in a position to foster the development of their trade sector.

Background

Ports are a decisive element in the production and trade structure and they have an impact at local, national, regional and international level; therefore, they play a core role in any country's productivity and competitiveness in the context of globalization.

By globalization, it means large process of commercial, institutional and technological changes that have been taking place in the international economy, which required to new concepts of development in port activities, which also requires exposure to: What are the requirements or/ and features of modern port, in the light of new concepts.

Modern Port

A modern port is one which can provide safe and efficient services to the exporters and importers in a cost effective manner, thus contributing to the economic development of the country. It should have achievement of high degree of mechanism and automation for its operation, thus making it less labour intensive and becoming eco-friendly

The activities required at port level are sometimes crucial for international trade transactions. These include not only activities that depend on port infrastructure, like pilotage, towing and tug assistance, or cargo handling (among others), but also activities related with new modern concepts of development of port activities, and number of the most importance issues as follows:

The competitive advantage of ports:

A large number of recent publications in the field of maritime and seaport management analyse the fierce competition for market share that is unfolding between ports, operators and port authorities, located in the same port range and serving approximately the same hinterland.

But the fact that a port's overall competitiveness is determined by its competitive position in individual traffic categories, such as conventional cargo, containers, dry bulk, liquid bulk and roll on-roll off traffic, specialized in container trade in particular are now confronted with intense international competition.

In port competition requires competitiveness, which means that in the conditions in which competition exists on the market one has to be competitive. In case of port competitiveness, an important question is who (which port) is competitive towards whom (which port). And it can determine the Competition and competitiveness understand through Port economies.
So that finally, the decision-making process in the selection of a certain port by the port user is not based only on the integration of the production or transportation chain, but has to take into consideration various market factors.

Privatization

Ports, on the other hand, are a public service for excellence, since they may satisfy needs of general interest and for that reason the interest of the State to regulate its activities.
The large number of ports owned and operated by different government and private entities indicates, and The poor financial performance of many international ports, the poor financial condition of state and local governments, the likelihood of government interference in port operations, and growing international competition, suggest that both ports and port's governments may benefit by transferring greater operational responsibilities and port assets to the private sector.

Safety and security of a port

As a one of the most importance services by the port, through the Safety and Environment Department in any port there a set of strategic functions which proactively contribute toward the sustainable improvement of the port.

Within this scope, the Port Authority guarantees the safety of people, vessels, merchandise, the environment and also the port facilities under its control, supported by vanguard systems and technology and together with the most demanding international codes.

Including Vessel Traffic Management System, the quality management system implemented in the pilotage and maritime and port traffic control services, the innovative system of dynamic evaluation of the protection under the hull of the vessels, the powerful maritime signaling systems, the Internal Emergency Plan, the ambitious environmental management plan, the ISPS certification and the sophisticated system of non-intrusive inspection of different cargo are only some of the instruments which support the extraordinary rigor with which safety and the environment are preserved at the port.

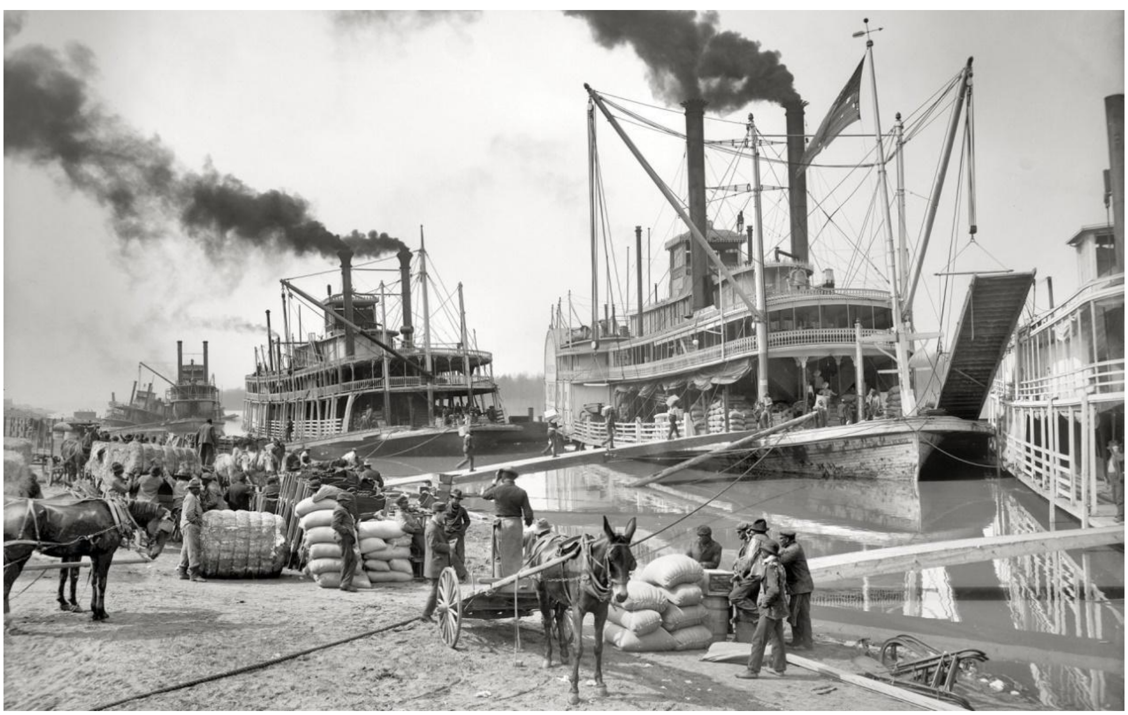
Future modern port:

The future of the ports is challenging but bright since innovation will have a greater role to play and will enable the port to generate significant value for customers, shareholders and employees The regulator and port authority must strive to guide ports through these turbulent times as well as facilitate them in this process of change Collaboration is critical on both a horizontal and vertical level and nurturing an ecosystem where innovation can truly thrive is now essential. All the loading discharging operations will be automated with minor chances of mistakes. Accidents will be reduced to none per year and ports and ships will be eco friendly

3.1 Port Evolution and Development

Old ports progression throughout the years:

Conventionally, port terminals where located close to city cores as many where the initial rationale for the existence of the city. The proximity to downtown areas also insured the availability of large pools of workers to perform the labor intensive transshipment activities that used to characterize port operations. But these activities tended to have low productivity levels as a stevedoring team could handle 10 to 15 tons per day and a berth could handle 150,000 tons per year. At their peak in the early 1950s ports such as London and New York each employed more than 50,000 longshoremen. Containerization had the dramatic impact of lowering the need for labor for port operations. For instance, the number of longshoremen jobs in the Port of New York and New Jersey declined from 35,000 in the 1960s to about 3,500 in the 1990s. Over time, changes in ships and handling equipment gave rise to new site requirements. By the post World War II period a growing specialization of vessels emerged, especially the development of bulk carriers. These ships were the first to achieve significant economies of scale, and their size grew very quickly. For example, the world's largest oil tanker in 1947 was only 27,000 dwt, by the mid 1970's it was in excess of 500,000 dwt. There was thus a growing vessel specialization using semi-automated transshipment equipment and increase in size which resulted in new site requirements, especially the need for dock space and greater water depths.



3.2 Evolution of major ports

The mechanization of cargo handling and the storage requirements because of greater vessel capacities have greatly extended the space demands for port activities. Many ports, such as Rotterdam and Antwerp are larger in area than the cities they serve. The expansion of Chinese ports, such as Shanghai, has required altogether the use of entirely new sites outside central areas. Further, growing ship sizes have implied several new constraints for port sites such as deeper waterways, larger terminal space, both for ship handling and warehousing, and more efficient inland road and rail access. Modern port infrastructures are often intensive in capital and several port authorities are struggling to keep up with large infrastructure investment requirements. However, the presence of infrastructures does not necessarily guarantee traffic as maritime companies can select the ports they service as business opportunities changes. Over this, three recent mega projects are particularly revealing:

- **Maasvlatke II (Rotterdam)**. For decades, the port of Rotterdam, Europe's largest port, has expanded downstream. The growth of container traffic along with continued expansion of bulk traffic caused the port to consider expansion out in the North Sea. This led to the construction of an entirely new facility on reclaimed land at Maasvlatke in the 1980s. However, subsequent traffic growth in the 1990s resulted in the port authority proposing a new facility further out in the North Sea: Maasvlatke II. The project began construction in 2008 and operations began in 2013, with full completion expected by 2030. Once completed, this terminal facility would likely mark the end of the geographical expansion for Rotterdam, outside the reconversion of existing terminal sites into more productive uses.

- **Deurganck dock (Antwerp)**. Like Rotterdam, the expansion options of the port of Antwerp are limited. With the right bank of the River Scheldt, where the bulk of the port's facilities are located, reaching capacity a new dock complex was built on the left bank. The Deurganck dock opened in 2005 and can add about 9 million TEUs to the existing capacity of about 10 million TEUs.

- **Yangshan container port (Shanghai)**. A rare case where a completely new facility has been built from scratch, and this well outside the existing port facilities in the Changjiang delta to a facility located in Hangzhou Bay, 35 km offshore. It opened in 2005 and was built for two purposes. The first was to overcome the physical limitations of the existing port facilities, too shallow to accommodate the latest generation of containerships. The second was to provide additional capacity to meet traffic growth expectations as well as room for new terminal facilities if container growth endures. The fully completed port would have an expected capacity of 15 million TEUs. To link the port to the mainland, the world's third longest bridge with a length of 32.5 km was built.

3.3 Eco friendly ships-ports

Introduction:

Back in the mid-1960s, environmental concerns focused on the impacts of wind, waves, tide and currents as they influenced the day-to-day operations of port activities and shipping operations. Environmental considerations were restricted to selected areas of preservation of landscape and wildlife. By the same token, environmental considerations by port authorities were largely restricted to the quay-side alone.

Nowadays, the definition and scope of environmental management itself has evolved from the act of pure conservation and protection of habitats, ecosystems and natural resources, to also include the objective of sustainable development measured in terms of economic costs, benefits and overall efficiencies.The area over which functional control or influence by the port authority may reasonably be expected to be applied has expanded dramatically in order to take into account the management of impacts throughout the port area, significant zones of cities and increasingly, into the control of the impacts of the logistic chain itself.

Traditionally, the main driver for the implementation and operation of an effective port Environmental Management System (EMS) was that of compliance with legislation and regulation (and it may be argued that these provisions, of course, remain non-negotiable). Increasingly, however, considerations of cost and risk reduction and the overall goal of sustainability act as catalysts for enhanced environmental performance.

Today, EMS requires a far more comprehensive and integrated approach as environmental issues must be also be addressed in the context of safety, health, security and the plethora of stakeholder claims at a scale that varies from local to global.

Environmental issues of ports:

Based on the EcoPorts' database, it is possible to identify the top ten environmental issues for the sector as reported by port authorities in their responses to the Self-Diagnosis Methodology:

1. Air quality

2. Port garbage/waste

3. Energy consumption

4. Noise

5. Ship waste

6. Local community

7. Dredging operations
8. Dust
9. Water quality
10. Port development (land)

3.4 Port ship-related emission sources and solutions:

Ship source:

The emission sources directly associated with ship operations in port include those due to propulsion engines, auxiliary engines and auxiliary boilers plus Volatile Organic Compound (VOC) that is associated with bulk liquid cargos and various Ozone Depleting Substances (ODS) due to refrigeration system. From an air pollutant perspective, vessels can produce significant amount of NOx, SOx and PM from burning fuel in the propulsion engines, auxiliary engines and auxiliary boilers/steam plants. Depending on the geographical configuration of the port area and type of vessels, these three combustion systems can have varied level of emissions. It is important to know for the vessel in question, which of these plays a more important role in ports when it comes to emissions and energy efficiency reduction measures.

Most emissions from ships in ports are the result of diesel engines burning heavy fuel oil. Compared to land-based transport, the marine engines are not as strictly regulated as their land-based counterparts. National and regional regulatory authorities have limited control over international ships other than on their own flagged ships and to some extent ships visiting their ports. Reducing emissions from ship-board diesel engines is therefore one of the significant challenges and opportunities related to improving air quality in port areas.

The unique challenge associated with the port area, with regard to reducing ship emissions, is how the emission sources listed above associated with various modes of ship operation in the port area. Generally a ship in port area has two general modes of operation:

Transit and manoeuvring: During this mode, a ship is typically operating within confined channels and within the harbour approaching or departing its assigned berth. The distance associated with this mode is unique for each port and varies depending on geographical configuration of the port. During this mode of operation:

- The ship is moving at its lowest speeds, thus propulsion engines are operating at low loads.
- Auxiliary engine loads are normally at their highest compared to other modes because of the need for running additional machinery on-board, such as thrusters (for maneuvering), air scavengers/blowers (due to low main engine load), etc.
- An additional auxiliary engine (diesel generator) is online for safety reasons in case one auxiliary engine's trip/failure does not lead to dangerous situations or blackouts.
- Auxiliary boilers are on because the economizers are not producing enough steam due to low propulsion engine loads and resultant lower engines' exhaust temperatures (this does not apply to large diesel-electric ships with central electric power generation).

In such a mode, still most of fuel consumption will happen in main propulsion engines but boilers and auxiliary engines will consume fuel more than the normal sea going levels. The other aspect is that all the above combustion systems are working off-design at part loads. This is not good as such systems tend to be less efficient and more polluting under such low-load operating conditions.

At berth or anchored: During this mode, a ship is secured and not moving. Typically under this condition:

- Propulsion engines are off.
- Auxiliary engine loads can be high if the ship is self-discharging its cargo, as with general cargo vessels, auto carriers and roll-on roll-off (RoRo) vessels and oil tankers.
- Auxiliary boilers are operated to keep the propulsion engine and fuel systems warm in case the ship is ordered to leave port on short notice and also for other purposes. In some tankers, steam is used for discharge of cargo through the use of steam turbine driven pumps.

Vessel fuel consumption can be low, medium or high for auxiliary engines and can be low, medium to very high for boilers (for example for tankers when discharging), depending on ship types and if it uses energy for cargo operations. Again, both auxiliary engines and boilers will be operating at part load with low efficiency and high specific levels of emissions.

Port source:

If the land-based side of marine transport operations is taken into account, it would include cargo handling equipment, stationary power sources, locomotives and heavy-duty trucks operating within the port area. These are non-vessel related emissions from ports. To reduce emissions in such cases, the following may be considered:

- **Clean Fuel:** Change to advanced clean diesel fuel, such as low or ultra low sulphur diesel (LSD) (ULSD), emulsified diesel, bio-diesel, compressed natural gas, liquefied natural gas, liquefied petroleum gas (propane, which requires a dedicated engine) and so on. All of these will provide direct benefit to port air quality and at the same time some reduction in GHG emissions.

- **Technology Retrofit:** Installation of "after treatment" devices on existing diesel engines such as diesel particulate filters, oxidation catalysts, closed crankcase ventilation, selective catalytic reduction, lean NOx catalyst, exhaust gas recirculation and so on. Trucks could be retrofitted with some of these technologies.

- **New technologies:** Use of hybrid-electric technologies as replacements for pure diesel engine vehicles and equipment.

- **Operation management:** This could include a large number of measures that helps to reduce fuel consumption and emissions including:
  - Implementation of policies that would reduce the idle operation of vehicles such as reduction of port congestion and start-stop technologies.
  - Include incentives for emissions reduction in leases and contracts with tenants, contractors and transportation service providers;
  - Expand operating hours to reduce truck queuing, idling and traffic congestion;
  - Promote other aspects that would reduce port area traffic congestion and emissions.

The above include a summary of the important pollution reducing measures. For reduction of energy consumptions, port need to follow energy management system and develop energy management plan that could be applied to all aspects of port operation.

Port harbour crafts:

Apart from ships calling a port, there are a significant number of harbour crafts that provide support services to ships and port. Although not directly related to international shipping emissions, such crafts contribute to port air quality as they are mostly powered by diesel engines.

For harbour crafts and in order to save fuel and reduce pollutants to port, similar general measures as larger ships are applicable. Measures that can be applied to address emissions from harbour crafts are often adapted from those developed for on-road and non-road equipment. These measures include. Some of the measures that may apply for harbour crafts are:

- **Engine Replacement:** Replacement of a harbour craft engine is not an easy option as it normally will require all sort of different auxiliary machinery, space and fuel requirements. However, retrofit of engine can be an important consideration for harbour crafts in view of changing technologies, move to hybrid electric options as well alternative fuels. Replacing main-propulsion engines with cleaner engines will provide great emission benefits that compound over the remaining life of the equipment. For harbour craft, this can be significant because the total operating life can be up to 30-40 years. Cleaner engines are, however, costly and capital costs may be a major barrier.

- **Clean Fuels:** The second option that may require less capital cost but will have implications on operating costs is the use of cleaner alternative fuels. The most obvious one is the use of low sulphur fuel in a similar fashion as road transport that uses ultra-low sulphur fuels these days. Additionally, other options could include emulsified diesel fuels and biodiesel. The more promising alternative fuel is natural gas in the form of LNG as LNG fuelling infra- structure is being developed. Move to LNG will require capital investments but the longer term the return could be via cheaper fuels, and a reduction of all types of air emissions. Use of biofuels, CNG or LNG would benefit the climate change as they would reduce overall discharge of CO_2 to atmosphere.

- **Technology upgrade:** This option relates to retaining the engines but opting for more advanced available engine controls, fuel additives and after-treatment emission control technologies such as diesel oxidation catalyst, diesel particulate filter and selective catalytic reduction.

- **Hybrid electric systems:** The harbour crafts are good candidates for use of more advanced technologies such as hybrid technologies to include batteries and electric motor / generators in the same way that land-based vehicles are moving into hybrids domain. Also, these vessels can be connected to onshore power when at berth for on-board electrical generation for hoteling functions. Hybridization is best for harbour crafts when they are away from the berth and have fluctuating energy demands. Hybridizing for harbour crafts has become much more feasible in the past several years as several demonstration projects have illustrated the feasibility and benefits of the technology.

3.5 Ballast water management on ports

Recognising the potential effects on marine ecosystems from introductions of harmful non-native animals and plants from ballast waters, the IMO has taken action by developing guidelines which aim to minimise the risks of environmental damage, whilst maintaining ship safety. These guidelines were prepared to assist port and harbour authorities and ships' masters, operators and owners in providing a precautionary approach to the management of ballast water in order to avoid and minimise the risk of introducing harmful non-native species and disease-causing micro-organisms. In the USA, guidelines on the control of the introduction of non-native species by ships' ballast water "s*temming the tide*" has been prepared by the Committee on Ships' ballast operations of the National Research Council (1996). This guide identifies the safety of the operation as being of paramount importance and provides detailed guidance on the three stages of control options which are:

- On or before departure control is based on preventing or minimising the intake of organisms during the loading of ballast water at the port of origin,
- During the voyage control is based on the removal of viable organisms prior to the discharge of ballast water at the destination port either by treatment or by open ocean ballast water change. Shipboard treatment could commence immediately upon departure and continue throughout the voyage.
- On arrival control at the port of arrival begins when the vessel's master intends to discharge all or some of the ballast water on board. Control strategies are aimed at preventing the discharge of unwanted organisms that could survive in the target environment.

The feasibility of using various control options varies depending on vessel size and type. Technology for the onboard treatment of ballast water is developing, although proven methods are not yet available. The IMO recommendations for action to be taken by ports and harbours today include the following:

- inform local agents and/or ships of areas and situations where uptake of ballast water should be avoided, such as near sewage outfalls, areas known to be contaminated with harmful organisms or in very shallow water where there is a risk of sediment being introduced to the ballast tanks,

- encourage the exchange of ballast water at sea (where it is safe to do so), and
- discourage unnecessary discharge of ballast water.

The arrangements for the control of ballast water transfer will eventually be supervised by classification societies and the MCA through the port state control mechanism, and not by ports. Ballast water management plans are proposed as the main way of implementing these measures in the future, and the discharge of ballast waters to port waste reception facilities has been suggested as a further option to minimise the potential risk of unwanted introductions. An emphasis has also been placed on the promotion of new technology used in ballast water exchange and the possible treatment of ballast waters using various methods, including ultraviolet light or heat to remove disease-causing micro-organisms where necessary. However, it is generally considered impractical and unnecessary for ports to undertake shore-side ballast water treatment at present, although in the future ports may have to provide reception facilities for materials filtered out of ballast waters.

4.0 Rotterdam Europe's most modern and automated port:

Largest port of Europe:

Having an area of over 100 square kilometers, the Rotterdam port has a length of 40 kilometers with a pier length of about 89 kilometers. Along with more than 20 moorages and over 120 bulwarks, the Rotterdam port has nearly 95 depots disambiguated for liquid and dry cargo, cruise liners and also for vessels navigating internally. Along with this, the port also has tug boat facilities and piloting boat facilities. In terms of accessibility, the port is well connected through rail networks and road networks. In the latter part of the 19^{th} century, in order to connect the Southern part of Netherlands to the port, a rail route was built from the port across to the River Meuse as a part of the port's development plans. This over-bridge accentuated the port's connectivity and outreach.

Ports planed automations:

Ships and port activity will be monitored through IoT sensor technology and tracked in real-time by satellite. The data will be used to improve operations and logistics, ease port congestion and develop predictive analytics to detect malfunctions and threats.

In the automation of the Port of Rotterdam, a dashboard application "will collect and process real-time water (hydro), weather (meteo) sensor data and communications data, analyzed through the IBM IoT platform [to] enable a new wave of safer and more efficient traffic management at the port."Once the port is automated, it is estimated that shipping companies will reduce docking time by one hour, for a saving of approximately $80,000.

Many unique opportunities come with smarter, more connected ships, as well as with the "World's Smartest Port," but they come with security challenges as well, once weakly encrypted automated ships reach open seas. A fully digital shipping industry will prompt hackers to come up with new, more complex attack methods, probably specifically designed for this ecosystem

4.1 Rotterdam's advanced and eco-friendly container facility:

APM Terminals has officially opened its new Maasvlakte II Rotterdam facility, the world's most technologically advanced and environmentally sustainable container terminal, claims the operator.

APM Terminals CEO Kim Fejfer said: "We are honored to officially dedicate our new terminal with you today. APM Terminals Maasvlakte II is clearly a game-changer port in the shipping industry designed to exceed our customers' expectations. It is significantly safer for our people and all users of the port.

"It runs on a zero emissions, sustainable business model using renewable energy, benefitting the people of Rotterdam and Europe. And, equally important, our shipping line customers will experience 40 percent higher productivity – thanks to automation."

The facility launches the world's first container terminal to utilize remotely-controlled STS gantry cranes. The cranes move containers between vessels and the landside fleet of 62 battery-powered Lift-Automated Guided Vehicles (Lift-AGVs) which transport containers between the quay and the container yard, including barge and on-dock rail facilities. The Lift-AGV's also represent the world's first series of AGV's that can actually lift and stack a container.

A fleet of 54 Automated Rail-Mounted Gantry Cranes (ARMGs) then positions containers in the yard in a high-density stacking system. The terminal's power requirements are provided by wind-generated electricity, enabling terminal operations, which produce no CO2, emissions or pollutants, and which are also considerably quieter than conventional diesel-powered facilities.

The facility, constructed on land entirely reclaimed from the North Sea, has been designed as a multi-modal hub to reduce truck traffic in favor of barge and rail connections to inland locations. Construction began in May 2012, with the first commercial vessel call in December 2014.

Successful systems testing and ramp-up have been completed to bring the first phase of APM Terminals Maasvlakte II into full operational status. The 86 hectare (212 acre) deep-water terminal features 1,000 meters of quay, on-dock rail, and eight fully-automated electric-powered Ship-to-Shore (STS) cranes, with an annual throughput capacity of 2.7 million TEUs, representing an APM Terminals investment of EUR 500 million.

At planned full build-out, the terminal will cover 180 hectares (445 acres) and offer 2,800 meters of deep-sea quay (19.65 meters/64.5 feet depth), with an annual throughput capacity of 4.5 million TEUs.

ARMGs

APM Terminals Rotterdam Maasvlakte II uses 54 Automated Rail Mounted Gantry (ARMG) Cranes and two rail cranes.

Maasvlakte II's innovative design is based upon using ship-to-shore (STS) cranes to unload containers from vessels and place them directly on the Lift AGVs, which can carry two containers at a time, and automatically bring them from the quay to the container yard using an onboard navigation system following a computerized transponder grid.

Once the Lift AGV arrives at its programmed destination, it places the containers into a series of storage racks. The ARMG then arrives to move the container from the rack to its next designated location: the rail terminal, a waiting truck or another area of the storage yard.

The ARMGs use a fully automated system to safely load/unload a container onto a truck chassis. When not operating in support of vessel loading or unloading, the system features a "grooming" capability that re-stows/restacks containers for easy access for the next vessel load plan. This feature of automated yard optimization of the container yard during quiet times allows for better efficiency at peak times.

Lift-AGVs

APM Terminals placed an order for 62 Battery-powered Lift-AGVs, 87 battery packs and two, robotic Battery Exchange Stations, enabling an automated exchange of the battery pack.

In principle, the Battery Lift-AGV is quite similar to the traditional diesel-electric Lift-AGV. In both types the drive system is electric, but the difference lies in the power source. With the dieselelectric Lift-AGV, a diesel engine generates power. With the Battery Lift-AGV, the energy is supplied by a battery pack.

The Battery Lift-AGV allows APM Terminals to achieve higher levels of performance while minimizing environmental impact. With diesel-electric Lift-AGVs, the diesel engine produces CO_2/NO_x/particulate emissions at the terminal. By removing the diesel engines, APM Terminals has removed all local emissions (CO_2 / NO_x / particulate matter) at the terminal, as well as eliminating diesel engine noise.

The Lift-AGVs use a battery pack that allows eight hours of driving time. To switch battery packs, the Lift-AGVs drive to the Battery Exchange Station and begin a fully automated process in which the Battery Exchange Station completes the procedure through robotic automation.

4.2 Rotterdam’s automated dry bulk terminal:

EMO Rotterdam:

EMO is one of the largest dry bulk terminals in Europe. It is strategically located in the Port of Rotterdam. The biggest seagoing vessels from all over the globe berth along the EMO quays. Almost 80% of the dry bulk commodities are transported either via the extensive rail links or water networks to the German hinterland. EMO is a logistical partner for customers in the steel industry, silicon metal industry and the energy sector. The steel industry processes iron ore and coal, supplied via EMO into numerous products such as passenger cars, wind turbines, bridges including Rotterdam's fabulous Erasmus Bridge, and other steel structures for the construction industry. The silicon metal industry uses coal as a raw material for example in solar panels.

Coal is also used for power generation. In addition to loading, unloading, storage and transshipment of various dry bulk commodities, the EMO terminal offers at the request of the product owners added-value services such as screening, blending and washing coal (for the silicon metal industry).

Continuous investments over the past years have led to a highly automated dry bulk terminal which is unique in its operational flexibility and efficiency. A large part of the equipment is electrically powered. EMO has chosen to use durable, high quality machines and components with a long lifespan, built with responsible production methods. EMO set standards for ethical, social and environmental performance.

5.0 Conclusion of a modern's port activities and facilities:

A modern port:

A new port or a port in development should have all the attributes and technologies of Rotterdam's port and many more as long as it is keeping up with new innovations and technological achievements. The ideal port would be one that will have increased speed which means faster deliveries of the products, large space to simultaneously load/discharge many ships, and be able to berth larger ships within their docks. . It should have achievement of high degree of mechanism and automation for its operation, thus making it less labour intensive and becoming eco-friendly

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