Standing Committee
for Economic and Commercial Cooperation
of the Organization of Islamic Cooperation (COMCEC)

Evaluating the Ownership, Governance Structures and Performances of Ports in the OIC Member Countries

COMCEC COORDINATION OFFICE
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Abbreviations

ACT	Aqaba Container Terminal (Jordan)
ADC	Aqaba Development Corporation (Jordan)
ANOVA	Analysis of Variance (Statistical)
ANNPS	National Agency of New Ports (Senegal)
ANP	National Ports Agency /Agence Nationale des Ports (Morocco)
APC	Aqaba Port Corporation (Jordan)
APCT	Apapa Container Terminal (Nigeria)
APMT	AP Moller Terminals
ASEZ	Aqaba Special Economic Zone (Jordan)
ASEZA	Aqaba Special Economic Zone Authority (Jordan)
BOO	BOO Build-Operate-Own
BOT	Build – Operate – Transfer
CCO	COMCEC Coordination Office
CFS	Container Freight Station
CMHI	China Merchants Holdings International
CR	Concentration Ratio
CRS	Constant Returns to Scale
CT3	Container Terminal 3 (Hong Kong)
DCT	Doraleh Container Terminal (Djibouti)
DEA	Data Envelopment Analysis
DPFZA	Djibouti Ports and Free Zones Authority
DPW	Dubai Ports World
DWT	Dead Weight Tonnage
ECT	Delta Container Terminals (The Netherlands)
FTA	Free Trade Agreement
GDP	Gross Domestic Product
GRT	Gross Registered Tonnes
HCMLT	Holding Company of Maritime and Land Transport (Egypt)
HHI	Hirschman-Herfindahl Index
HIT	Hong Kong Int. Terminals 4, 6, 7, & 9N (Hong Kong)
HIT	Hong Kong International Terminals
HPH	Hutchison Ports Holding
ICD	Inland Container Depot
ICS	International Chamber of Shipping
ICT	Information and Communication Technology
ICTSI	International Container Terminal Services
ILO	International Labour Organisation
IMO	International Maritime Organisation
ISF	International Shipping Federation
ITO	International Terminal Operator

JBCT	Jeddah Northern Container Terminal (Saudi Arabia)
JICT	Jakarta International Container Terminal (Indonesia)
SCT	Jeddah Southern Container Terminal (Saudi Arabia)
KCT	Kumport Container Terminal (Turkey)
KPI	Key Performance Indicators
LOA	(Berth's/Ships) Length Overall
LPI	Logistics Performance Index
LSCI	Liner Shipping Connectivity Index
Marport	Main and West Terminals (Turkey)
MCLI	Maputo Container Terminal (Mozambique)
MDCT	Maersk Delta Container Terminal (The Netherlands)
MIP	Mersin International Port (Turkey)
MOT	Ministry of Transport
MOU	Memorandum of Understanding
MPI	Malmquist Productivity Index
MSC	Mediterranean Shipping Company
MTL	Modern Terminals 1, 2, 5, 8W, & 9S (Hong Kong)
MTS	Maritime Transport Sector (Egypt)
NPCT	North Port Container Terminal (Malaysia)
NPCT	Northport Container Terminals 1 & 2 (Malaysia)
NVOCC	Non-Vessel Operating Common Carrier
OIC	Organisation of Islamic Conference
PAID	Port Autonome International de Djibouti
PDSA	Port de Djibouti S.A.
PEC	Pure Economic Efficiency
Pelindo	Pelubahan Indonesia
PMO	Ports and Maritime Organisation (Iran)
PPP	Public Private Partnership
PSA	Port of Singapore Authority
PSP	Private Sector Participation
PTP	Tanjung Pelepas Container Terminal (Malaysia)
PTP	Tanjung Pelepas Port (Malaysia)
QICT	Qasim International Container Terminal (Pakistan)
ROPAX	Roll on Roll off Passenger
RORO	Roll on / Roll off
SEC	Scale Efficiency
SFA	Stochastic Frontier Analysis
SIDS	Small Island Developing States
SPCT	Salaalah Port Container Terminal (Oman)
SPV	Special Project /Purpose Vehicle
SWOT	Strengths Weaknesses Opportunities and Threats
STS	Ship-To-Shore (Crane)

T8E	Terminal 8 East (Hong Kong)
TC	Technical Change
TC1	Terminal Conteneurs 1 (Morocco)
TC2	Terminal Conteneurs 2 (Morocco)
TCD1	Terminal Conteneurs Dakar 1 (Senegal)
TCDD	Turkish State Railways Company
TCE	Casablanca Terminal Conteneurs East (Morocco)
TCW	Casablanca Terminal Conteneurs West (Morocco)
TEC	Technical Efficiency
TEU	Twenty-Foot Equivalent Unit
TIL	Terminal Investment limited
TMPA	Tangier Med Port Authority (Morocco)
TMSA	Tangier Med Special Agency (Morocco)
TOC	Terminal Operating Port Companies
TOPA	Terminal Operating Port Authorities
TOR	Terms of Reference
TOS	Terminal Operating Shippers
TOSL	Terminal Operating Shipping Lines
TPA	Tons per Annum
TTF	Trade and Transport Facilitation
UASC	United Arab Shipping Company
ULCS	Ultra Large Container Ship
UNCTAD	United Nations Conference on Trade and Development
VRS	Variable Returns to Scale
WP	Work Package
WPCT	Westport Container Terminals 1, 2, 3 & 4 (Malaysia)
WTO	World Trade Organisation
YICT	Yantian Container Terminal (Shenzhen, China)

Executive Summary

Ports constitute important gateways for the Organization of Islamic Cooperation (OIC) countries where maritime transport is the most important mode of transporting goods between OIC countries and the rest of the world, as well as among the OIC countries themselves. Due to their geographical locations and distance to markets, the integration of the OIC countries, both between themselves and into global supply chains, depends critically on port performance, competitiveness, governance and institutional reform. On the other hand, excessive port costs and inefficiencies hinder trade integration and economic development. Concern about poor efficiency, low competitiveness, and high trade and logistics in OIC ports has been highlighted in various studies, which pointed to inadequate organisational and institutional structures, inefficient port operations and services, low inter-port competition and integration, gaps in governance and regulatory frameworks, and a range of procedural and administrative bottlenecks.

The OIC member countries have over 200 ports used commercially and serve as either gateway or transhipment facilities, and sometimes as key transit points to other landlocked OIC countries. In 2013, the combined container port throughput of OIC countries has neared 100 million TEU representing about 15% of the global container throughput. While some OIC countries such as Malaysia and the UAE show high container throughput, most OIC countries depict low throughput volumes, either because of the small size of their economy or because of a low container penetration compared with the size of their economies and populations.

Furthermore, OIC ports are being impacted by changes in global trade, economic, technological and operating systems and thus face a number of global hurdles and challenges. Those range from technological developments in ship size and handling equipment, market concentration and globalisation, to new safety and regulatory requirements, and environmental and climate challenges.

The ownership structure of the port sector in the OIC countries shows huge variations from public to private ports on the one hand, and from centrally administered ports to those managed and administered at regional and local levels on the other hand. Broadly, most OIC ports have moved towards a landlord structure but only a handful of ports show a prevalence of the private service structure. Private-Public Partnership (PPP) has made its way to several OIC ports, but only a few countries have achieved an established system and a track record experience in port PPPs. Too often though, many OIC ports depict various cross-ownership arrangements between port authorities and public operating companies which blurs the separation between statutory activities and commercial activities of public port agencies.

At the same time, the port institutional set-up in most OIC countries has been organised in ways that reflect an orientation towards spatial, industrial or service fragmentation rather than towards functional fragmentation. Several instances of institutional gaps and institutional overlaps have been observed including absent or inexistent port economic regulators, missing industry and service components, and weak coordination processes between the various port agencies.

The regulatory framework of the ports and maritime sector in OIC countries show various degrees of compliance and regulatory performance. Particular areas which require urgent

attention include port safety, environmental port management, port labour and training, market access and liberalisation, port pricing and charging, inter and intra-port competition.

In terms of operational port performance, evidence shows that OIC ports and terminals are generally inefficient by international standards. There is however a wide variation across OIC ports, from internationally-comparable highly efficient ports to consistently low performing and service deteriorating terminals. Evidence also shows that there is ample scope to improve port performance with handful of OIC countries showing quantum leaps in their operational efficiency over a relatively short period of time.

The analysis of port performance also shows that there is a high correlation between institutional structure and port efficiency, traffic type and port efficiency, handling configuration and port efficiency, and terminal size and port efficiency. In a similar vein, productivity change analysis shows that changes in terminal size, institutional structure, traffic type, and operating conditions, among others, have a high impact on port efficiency.

The analysis of logistical efficiency shows varying degrees of liner connectivity across the OIC countries with those having large gateway and transhipment ports largely benefiting from a high shipping connectivity while those with poorly operated ports and those with relatively isolated locations suffering from poor maritime connectivity. In terms of logistics performance, various sources show that the OIC countries are still lagging behind the best international performers with a particularly high logistics and trade costs being born by landlocked countries and small-island developing states (SIDS).

A way forward for OIC ports

The current industry structure and regulatory framework of OIC ports encourages cross-ownership, cross-subsidisation and under-investment, eventually exacerbating existing bottlenecks and generating further loss of economic efficiency. International comparisons also suggest that OIC ports are generally under-performing by international standards.

Globally, Private Sector Participation (PSP) in port operations has been growing strongly; but change has been slow in many OIC ports. Countries leading the way in private participation have been able to attract significant private capital investment to refurbish port infrastructure and modernise cargo handling equipment. Under private management, ports usually improve operational productivity and service quality and reduce costs significantly. However, without adequate competition, or economic regulation, cost reductions and efficiency gains may not be fully realised. Achieving and sustaining productivity improvements depends on the extent to which competitive pressures can be brought to bear, either between or within ports. In particular, dominance by single or state-owned port operators needs to be avoided.

This study identifies a number of institutional and policy recommendations for OIC ports including the formulation of port policy statements and corresponding strategic orientations, the promotion of private sector participation, the encouragement of inter and intra port competition, the avoidance of institutional fragmentation and organisational overlaps, the establishment of port and maritime clusters, the creation of economic regulators, the formation of port users' councils, and the compilation of Key Performance Indicators (KPI) data and performance dataset.

1. Introduction

1.1 Study Background

Ports are critical maritime, trade and logistics infrastructure facilities and play a key role in the transportation of freight and people. From a public policy perspective, ports are viewed as economic catalysts for the markets and regions they serve whereby the aggregation of port services and activities generates socio-economic wealth and benefits such as in terms of tax income, job creation, business generation, supply of hard currency, inter-sector multiplier effect, as well as spatial, agglomeration, and other spill-over effects.

Along with their economic and social impacts, ports play a key role in a country's trade and logistics efficiency. Because they are controllable aspects of global supply chains, ports deserve particular attention as they can account for a significant proportion of trade logistics and transport costs. Efficient port operations significantly lower maritime and trade costs whereas port delays and inefficiencies impose excessive costs on logistics and supply chains.

For the OIC Member States, ports constitute important gateways and play a major role in economic development and in trade and logistics efficiency. The economies of most OIC countries are heavily dependent on international trade, the largest proportion of which transits by sea. Furthermore, many ports in OIC countries have a strategic importance given their location at the crossroad of international maritime and trade routes or as transit points to large hinterland markets. At the other end of the scale, several OIC member countries such as Afghanistan, Burkina Faso, Kazakhstan, Mali, Niger, and Uganda, are landlocked; while other member countries such as Comoros, the Maldives, and Suriname are Small Island Developing States (SIDS). Both sets of countries face clear disadvantages associated with small size, insularity, and distance from main markets.

The integration of OIC member states, both between themselves and into global supply chains, depends critically on port performance and competitiveness. Nevertheless, and despite differences among countries, studies have shown that many OIC member countries pay more for the transport of their exports and imports than the world average. The overall performance of the port sector in those countries is being hampered by several factors such as inadequate organisational and institutional structures, inefficient port operations and services, gaps in governance and regulatory frameworks, and a range of procedural and administrative bottlenecks.

1.2 Scope of the Study

This work is about the evaluation of the ownership, governance structures, and performances of ports in the OIC member countries. The main objectives of the study are to provide an overview on the competition, regulation, and the governance of the maritime ports in the OIC countries; analyse the efficiencies and performances of these ports with a focus on container terminal operations; identify the barriers (political, legal, institutional, regulatory, fiscal, and physical infrastructure) against improving the performances of these ports; and propose recommendations for improving port performances.

1.3 Approach and Methodology

Four types of analysis are used to assess the competitiveness, ownership structure, governance system, and operational performance of the OIC ports under study.

Market structure and competitive performance

In this analysis, this analysis starts with highlighting the main trends and future challenges faced by the port industry worldwide and examines their implications on the ports in the OIC countries. It then analyses the competitive performance of OIC ports through (i) reviewing their supply capacity and traffic structure, and (ii) analysing their market power and cargo concentration.

Institutional structure and ownership performance

The analysis of institutional performance will review the OIC ports' ownership and institutional structures, the nature and level of private sector participation (PSP), the extent and the conditions of service commercialisation. The Study will focus in particular on three areas of importance: ownership models, fragmentation, and service commercialisation.

Regulatory structure and governance performance

For the analysis of governance performance, an assessment of both technical regulation (safety, security, and environmental management) and economic regulation (market access, competition, and pricing regulation) of the port sector in the OIC member countries will be undertaken. A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis will be conducted to help with assessment of the regulatory port structure in OIC countries and compare it with international regulatory standards and industry best practice benchmarks.

Operational structure and productive efficiency

This will be based on measuring and benchmarking the productive efficiency of OIC ports both across time and vis-à-vis international comparators. Data envelopment analysis (DEA) and the Malmquist Productivity Index (MPI) will be used conjointly to assess the sources, changes, and variations in operational efficiency and their impact on port competitiveness and service quality. Furthermore, a comparative analysis of transport and trade logistics systems across OIC countries will be undertaken using indicators such as the World Bank's Logistics Performance Index (LPI) and UNCTAD's Liner Shipping Connectivity Index (LSCI) to assess how the direct and wider impacts of trade logistics on port performance and efficiency.

OIC Countries and Sample Ports

In this study, 15 ports belonging to 12 OIC countries have been selected as case studies for a detailed review and analysis of port's ownership structure, performance, and competitiveness. Where appropriate, a review and information about other OIC ports is also given.

Out of the OIC member countries with maritime ports, 12 countries were purposefully selected to reflect both the wider geographical distribution and varying levels of economic development within OIC member states. Those are:

- Africa region: Senegal and Nigeria, Djibouti, Mozambique.
- Arab region: Morocco, Jordan, Saudi Arabia, Oman.

- Asia region: Turkey, Pakistan, Malaysia, Indonesia.

In each of the 12 OIC countries selected above, one or two container ports are identified in ways that reflect the variety of port institutional and organizational structures and the variations in port's markets, competition dynamics, and operating conditions. Furthermore, the analysis of port performance has also been undertaken with reference to 4 world-class ports aside from the OIC countries; i.e. Hong Kong, Rotterdam, Shenzhen, and Singapore. The sample of 19 ports analysed in this study is given in the Table 1.

Table 1: Selected OIC and reference ports for this study

	Country	Port	OIC	Type
OIC selected ports	Senegal	Dakar	African group	Gateway
	Djibouti	Doraleh	African group	Transhipment & Transit
	Nigeria	Lagos	African group	Gateway
	Mozambique	Maputo	African group	Gateway & Transit
	Morocco	Casablanca	Arab group	Gateway
		Tangiers Med	Arab group	Transhipment
	Jordan	Aqaba	Arab group	Gateway & Transit
	Saudi Arabia	Jeddah	Arab group	Gateway & Transhipment
	Oman	Salalah	Arab group	Transhipment
	Turkey	Mersin	Asian group	Gateway
		Ambarli	Asian group	Gateway
	Malaysia	Tanjung Pelepas	Asian group	Transhipment
		Port Klang	Asian group	Gateway & Transhipment
	Indonesia	Tanjung Priok	Asian group	Gateway
	Pakistan	Port Qasim	Asian group	Gateway
Reference Ports	Singapore	Singapore	South East Asia	Transhipment
	Netherlands	Rotterdam	North Europe	Gateway & Transit
	China	Hong Kong	East Asia	Gateway
		Shenzhen	East Asia	Gateway

Source: Consultant

Within the sampled 19 ports, 26 container terminals have been selected for the purpose of performance benchmarking and analysis. Of these, 20 container terminals (of 15 ports) are from the 12 selected OIC countries and 6 container terminals (of 4 ports) are from the reference international ports. The port performance dataset consists of annual observations of sampled terminals and spans a 5-year period from 2009 to 2013 in order to capture the most recent performance benchmarks while avoiding the external (exogenous) impact of the 2008 financial crisis. Appendix 1 lists the selected OIC ports and terminals for this study, while Appendix 2 provides a detailed information fiche for each of the selected terminals.

1.4 Structure of the Study

This study is structured in terms of 7 main sections. Section 1 outlines the background and objectives of the study, the scope of the work, approach and methodology, and sample ports. Section 2 provides a brief introduction to port systems, their roles and functions, and their broad institutional and organisational structures. Section 3 reviews the market and traffic structure of the port sector in OIC countries, outlines contemporary challenges in the industry, and discusses their implications for OIC ports. Section 4 analyses the organizational and institutional structure of OIC ports focusing on such aspects as ownership models and levels of private sector participation (PSP). It then assesses the institutional performance of the selected OIC countries with a discussion on both institutional fragmentation and service commercialisation. Section 5 reviews regulatory and governance performance in OIC ports and assesses its adequacy vis-à-vis both technical and economic regulation. Section 6 provides the main backbone port performance analysis in this study. It sets to measure and benchmark productive efficiency of the sampled OIC container terminals while assessing the impacts of ownership models, institutional structures, and policy reform on port performance. Section 6 also provides an analysis of logistics performance in OIC countries to assess the impacts of trade logistics on port performance and efficiency. Section 7 summarizes the study main conclusions and provides a number of policy and institutional recommendations.

2. Introduction to Port Systems

Ports are very complex and dynamic entities that are often dissimilar from each other, and where various activities are carried out by and for the account of different actors and operators. The literature on port attributes provides a variety of terms such as waterfront, estuary and maritime bases, ship-shore and intermodal interfaces, distribution and logistics centres, corridors and gateways, maritime industrial development areas, and trade and distribution maritime centres, industrial clusters and distriparks, free zones, trading hubs and networks.

Ports are indeed very dissimilar in their assets, roles, functions and institutional organisation, and even within a single port, the activities or services performed are (or could be) broad in scope and nature. This section[1] outlines the main operational features, logistics and geographical extensions, and ownership and institutional structures of world ports and terminals.

2.1. Facilities and Services

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 need not necessarily be only seaports. In some countries, the term port denotes multimodal port facilities including seaports, airports and other intermodal facilities such as railway and road connections. In a similar vein, non-sea related activities can also fall under the wider definition of ports, for instance inland ports, intermodal terminals, inland clearance depots, dry ports, free ports, etc.

In the context of this study, the discussion is restricted to seaports, hereafter simply called ports, to commercial ports with a focus on container operations. Ports that deviate from commercial ship and related cargo handling operations, e.g. fishing ports, military ports, and cruise ports are outside the scope of this study.

Nevertheless, even within the boundaries of commercial ports, port assets, operations, services and functions, can be broad in scope and nature. Typically, ports are categorised by cargo (commodity) or ship type, for instance dry bulk ports, liquid bulk ports, break-bulk and general cargo ports. Further categorisation divides ports into specialised terminals. Modern port engineering, layout and operating systems are increasingly designed and operated to serve a particular trade, ship or cargo type, e.g. oil terminals, chemical terminals, coal terminals, container terminals, etc. although several ports around the world still operate multipurpose facilities.

Most ports systems can be divided into three main generic sub-systems: the marine or nautical infrastructure (access channels, breakwaters, jetties, etc.), the terminal infrastructure (quay walls, berths, yards, etc.), and port superstructure (port equipment, vehicles, sheds, warehouses, gates, etc.). Sometimes a port system can be extended to include intermodal facilities and connections, for instance in the case of dry ports and inland container depots. Table 2 provides a generic categorisation of the main port and terminal facilities and services.

[1] Drawn largely from Bichou (2009) and Bichou & Gray (2005)

Table 2: Categorization of main port assets and services

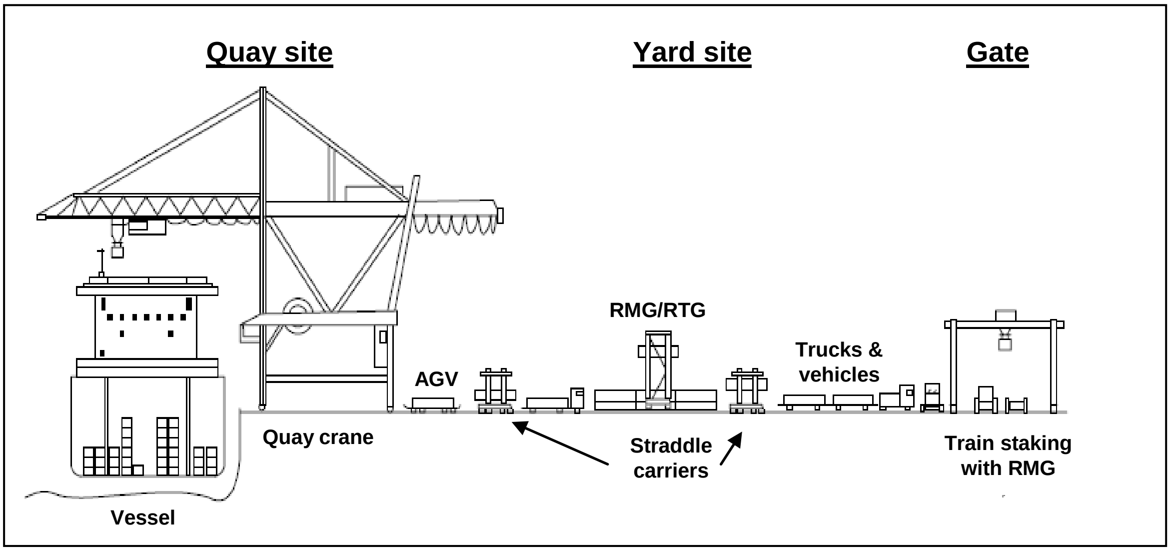
Port Infrastructure	Port superstructure	Marine services	Terminal services	Hinterland logistics
-Breakwaters -Entrance channels -Port and harbour lights -Jetties -Dolphins, buoys, mooring points -Locks -Docks / Piers, Quays -Yards and Terminals -reception facilities -Intermodal connections -Pipelines -River/ waterway connections	-Quay cranes -Mobile cranes -Yard cranes -Pumps, loading arms -Conveyors, wagons -Shore ramps -Trucks and vehicles -Storage warehouses -Tank farms -Refrigeration -IT and testing equipment -Scanners, security & safety equipment	-Conservancy & protection -Access & navigation -Dredging & maintenance -Vessel traffic systems -Pilotage and towage -Salvage and rescue -Ship repair and maintenance -Bunkering -Chandlers and supply -Ancillary services	-Berthing -Stevedoring -Ship loading/ discharging -Quay transfer operations -Cargo storage & stacking -Equipment services -Port policing, cargo security -HAZMAT & Health control -Environmental & waste	-Bonding, documentation, customs clearance -Processing, sub-assembly, cross-docking, consolidation, break bulk - Labelling, palletising/packaging, itemization, unitization, bar coding - Postponement, customisation, decoupling - Information services, tracking and tracing, port community systems - Quality control, testing, sampling, inspection, certification - Reverse logistics, recycling & repair

Source: Consultant

2.2. Terminal Operations

Seaports must not be confused with terminals; the latter are specialised sometimes multi-purpose units within ports. Within a single port, different terminals can share the same nautical infrastructure such as access channels, jetties and breakwaters, piers and quay structures. Yet, each terminal may be decomposed into three main operating sites namely the quay-site, the yard, and the gate (see Figure 1). All such sites must operate jointly for efficient cargo handling and transfer operations.

Figure 1: Container terminal sites and main handling equipment



Source: Consultant

- The physical infrastructure of the quay site includes berth's length, draft and structure, which may differ according to the type of ship and cargo handled. In modern container ports, ship-to-shore (STS) cranes (also called portainers or transtainers) are mostly used for container loading and unloading. STS cranes come in different shapes, sizes, and technologies to keep up with increasing containership's size and the requirement for faster handling and higher intensity. Some ports still use mobile cranes to handle container traffic while small ports with limited containerised traffic or those which are under-equipped heavily rely on ship-mounted cranes (gears or derricks).

- A terminal's yard is the area where cargo storage, stacking, and transfer takes place. Yard operations may be categorised into horizontal transport and storage-staking modules. In horizontal transport, the tractor-chassis system is widely used to move containers from/to yard. In the storage-stacking system, specialised equipment such as straddle carriers (SC), rubber-tired gantry cranes (RTG), and rail-mounted gantry cranes (RMG) are used to stack and retrieve containers in/from the yard. The total storage area of sheds and warehouses depends on a number of factors, in particular the cargo stowage factor, the average stacking height, and the floor space required for cargo handling and access by the relevant equipment in use. Containers are stacked and stored in the yard according to either segregation or scattering strategies, each using a range of classification criteria such as destination (inbound, outbound, transhipped), status (full container load -FCL, less than full container load -LCL, empty), type (special, refrigerated, dangerous, etc.), and size (twenty foot equivalent units- TEUs, forty foot equivalent units- FEUs, non-standards).

- Gate operations are designed to efficiently control access into and out of a terminal or port facility through land interfaces, which may be further subdivided into train and truck interfaces (or interchange points). Components of gate planning and management include advance booking, arrival schedule, pick-up and delivery, cut-off times, validation check and control, and gate-in/ gate-out monitoring. Conventionally, the gate process is manual where a lane clerk identifies the import/export cargo and feeds information via radio or another hand device to the terminal's management system. Today, modern gate operations are implemented and managed using electronic and automated solutions for truck and container detection, size recognition and verification, congestion status, cut-off control, and other relevant operations. Available technologies include CCTV cameras, card readers, radio frequency identification (RFID) tags and sensors, and other mobile data and digital imaging technologies.

2.3. Hinterland and Logistics Extensions

Spatially, the extent of the geographical market a port can serve is commonly called the hinterland. The size of the hinterland can 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, the number of competing ports for the same hinterland, etc. A port can therefore serve a local, a national, a regional or even an international hinterland. A good example of port competition for a shared hinterland can be found in the US Mid-West region, where cargo bound to this region is subject to an intense competition between East-coast and West-coast ports. Sometimes, ports can serve a far wider spatial market called the *foreland*. The latter is an area that a hub or a network port can serve through a series of feeder ports.

Ports can also be categorised according to their logistical and locational status within international shipping and trade patterns. The following taxonomy is representative but not exhaustive of current port logistics:

- *Network ports* provide high value-added services to both ships and cargo, and generate traffic from/to the port and its hinterland. Given their extensive facilities and 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 are more suitable for cargo concentration and distribution. They also provide fast turnaround time for ships.

- *Direct call ports* provide low value-added services to ships but higher 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 as they may not be economically suitable for direct call and may need to be linked to network or transhipment ports.

Ports act as maritime logistics centres when they provide logistics services at both sea and land interfaces. Typical logistics functions of ports include cargo handling and transfer operations, storage and warehousing, break bulk and consolidation, value added activities, information management, and other related services. Many ports have an established body of knowledge and experience in providing value-added logistics activities, yet not all ports can claim a logistics centre status.

Ports may also be seen as inland logistics centres when they operate as nodal and logistics interfaces intersecting the different segments of the inland transport system. In recent years, there has been a strong emphasis on the role and importance of inland ports, where all logistical operations not necessarily required to be carried out in the seaport area can take place. As a result, new concepts such as intermodal terminals, inland clearance depots (ICDs), dry ports, and distriparks have emerged. Often though, there is no clear-cut separation between all such facilities in terms of their spatial or functional attributes. The following categorisation may help underlining some of the differences between these concepts.

- *Intermodal terminals*: Their main function is to store and transfer goods from one transport mode to another (rail, road, sea, etc.) using standardised and interoperable tools and equipment such as ISO container types.

- *Inland clearance depots and dry ports*: Those are bounded warehouses where customs and border control agencies are present for final clearance of imported or transit goods and release to importers or transit agents. Customs will require either a bond or a sealed transit regime for the transfer of containers from the port inland.

- *Logistics zones and platforms*: Those are logistics and industrial facilities connected to the port and where a range of value added logistics activities take place, e.g. consolidation and break-bulk, packaging, ticketing, customisation, cross-docking, assembly, re-assembly, etc.

- *Free trade and special economic zones*: Those are free trade and economic zones operating under customs surveillance whereby products' inputs and outputs are exempt from import duty and other customs charges.

2.4. Ownership and Institutional Structures

Traditionally, ports have been owned, operated and regulated by state-controlled public organisations. However, both the introduction of private sector participation (PSP) in ports and the emergence of new forms of port administration have led to the adoption of new models of port ownership and institutional structuring. Current models for classifying port organisational and institutional structures are categorised by one or a combination of the following criteria: the ownership structure (public, private or both), the administrative organisation (national, regional, local, etc.), and the level of degree of devolution of port decision making (statutory independence, financial autonomy, etc.).

Due to the variety and dissimilarity in port assets, roles, functions and services; analysing the ownership structure of ports and terminals is not always a straightforward categorisation between public and private sector ownership. This has led to the emergence of generic port institutional models including the *landlord, public service, private service* and *tool models*, or a combination of some or all of these. The main difference between the three models refers back to the aspects of the ownership of port facilities (public or private), the management of port facilities (infrastructure or superstructure), the affiliation of port's workforce, and sometimes the regulation of port management and operations.

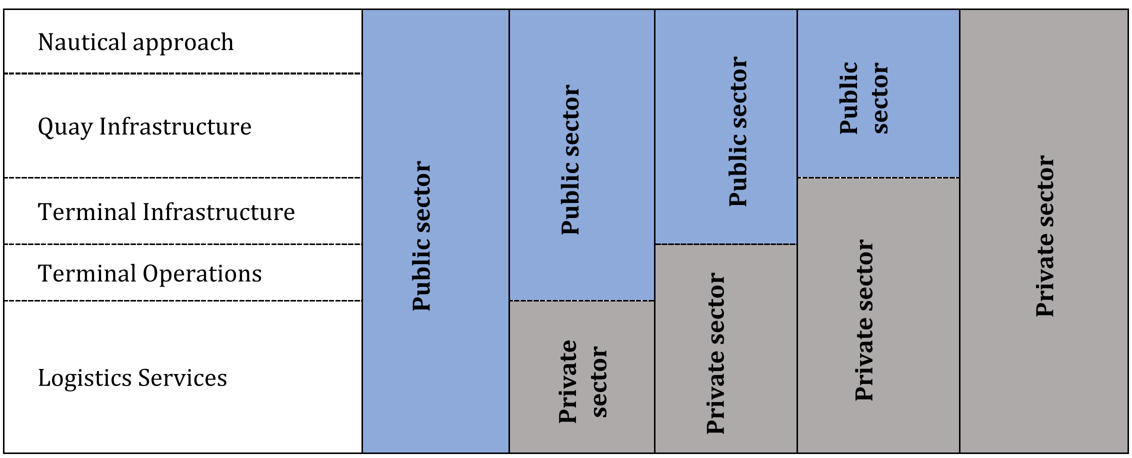
Table 3: Generic institutional port models

	Infrastructure	Superstructure	Workforce	Regulation
Landlord	*Public*	*Private*	*Private*	*Public*
Tool	*Public*	*Public (Private)*	*Private (Public)*	*Public/ Private*
Service Public	*Public*	*Public*	*Public*	*Public*
Service Private	*Private*	*Private*	*Private*	*Private/Public*

Source: Bichou, 2009

In the service model, the port (public or private) owns, maintains and develops both infrastructure and superstructure, operates all handling equipment, and performs on its own all other commercial port functions. Both landlord and tool ports own and develop their infrastructure, which is leased to the private sector. However, while the superstructure is owned and operated by private operators in the landlord model, the tool port still owns the superstructure but may lease it for operational purposes to private companies. This distinction is not always obvious in that some ports may restrict superstructure assets to cargo handling equipment, while others extend them to storage, warehousing and logistics facilities. Even where a landlord structure is in place; the extent of the private sector involvement in port development, operations, and/or service provision can vary widely across port facilities as shown in Figure 2.

Figure 2: Variation of private sector participation in landlord port model



Source: Consultant

Furthermore, the level of devolution of public decision making can vary widely between world ports and terminals. Here a variations of organisational port models exist; from centrally-controlled ports at national or state levels, to ports controlled at regional, local or municipality levels. Other models of port devolution include *autonomous, trust,* and *corporate* ports.

- The autonomous port, a model widely applied in France and French-speaking Africa, is a public enterprise which enjoys a high degree of autonomy and independence from the central government, but still pursues the objective of safeguarding and over sighting the general public interest.

- The trust port, a model mainly applied in the Great Britain and its former colonies, is an independent statutory corporation governed by its own legislation and controlled by an independent board of trustees. Although operating in a commercial way, trust ports do not necessarily seek profit maximisation and have no requirement to distribute dividends to their shareholders.

- The port corporation, a model widely used in Canada, Australia, and several South East Asian countries, is a public company that can be either government-owned or statutory-owned depending on the legislation and regulatory regime that govern its operations and management. The thrust of corporatisation is that it converts the traditional port organisation into a public company operating under the same legal rules as a private company.

A common institution found across various port ownership models is the *port authority* or agency. The latter may take several roles ranging from a landlord function to a port developer, promoter, operator, and regulator. There are and have always been conflicting viewpoints about the nature and extent of the port authority's roles and functions. As pointed out by Bichou and Gray (2005), there is no best model that fits all ports, and consideration should be given to port and stakeholder specific factors when deciding on the appropriate ownership and management structure.

3. Market Structure and Competitive Performance

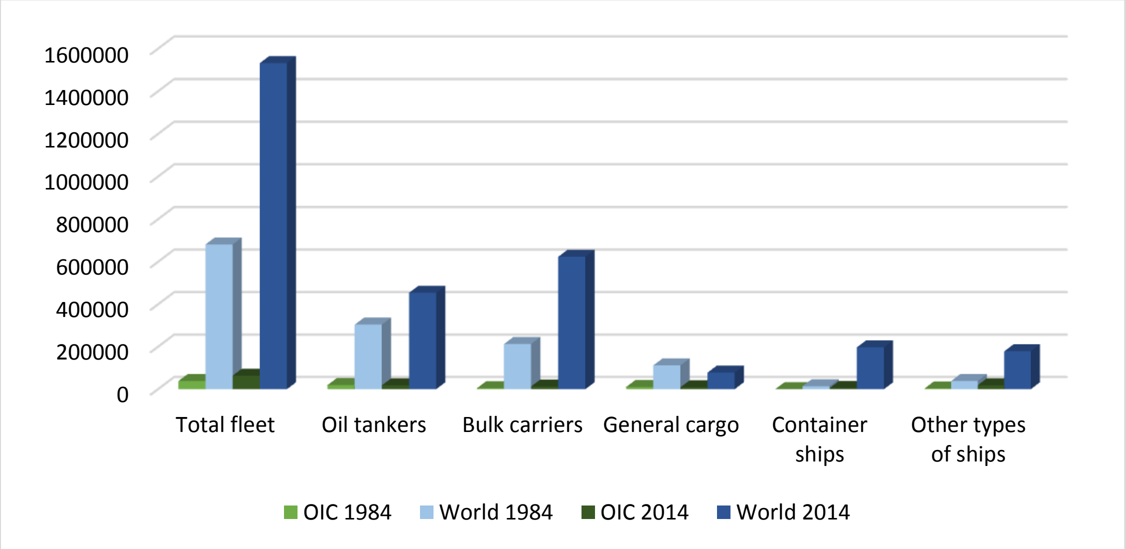
3.1. Sector Capacity and Services

This section examines the market and traffic structure of the port sector in OIC countries with a focus on container-port infrastructure and services. The section also outlines contemporary global trends and challenges in container-port operations and discusses their implications for OIC ports. Where possible, the analysis is extended to cover the both the port and maritime sectors in OIC member countries.

3.1.1. Maritime Transport

According to figures obtained from UNCTAD (2014a), the commercial fleet registered under the flags of the OIC member states was just under 64 million deadweight tonnes (dwt) in 2014 compared with 38.4 million dwt 20 years ago (in 1984). Oil tankers and bulk carriers dominate the fleet, while container ships only represent 9% of the total fleet. As a share of the world's fleet, the aggregated fleet of OIC countries represents 4.17% of the world's fleet in 2014, down from 5.6% in 1984. The OIC's share of world's fleet does not mirror its share in world trade which has averaged 10% over the past decade, meaning that the OIC fleet capacity is well below the demand generated by its merchandise trade. While such situation is not peculiar in the predominately globalised and liberalised shipping industry, it may be a cause of concern for OIC countries with a high reliance on maritime transport, particularly member countries with small-size economies and those with isolated geographical locations away from main markets. For those countries, the lack of national fleets and the dependence on a few foreign sea-going companies often translates into high maritime transport costs and low shipping connectivity.

Figure 3: Share of OIC commercial fleet in 1984 & 2014



Source: Consultant from UNCTAD (2014a)

Figure 3 compares the share of OIC fleet in the global fleet by ship's type in 1984 and 2014, respectively. It shows that the OIC's share of general cargo ships is currently just below 11.5%

of the world's general cargo fleet, while the OIC share in the global bulk and tanker fleet is only 2% and 4%, respectively. This is at odds with the structure of merchandise trade in many OIC countries where bulk and fuel commodities are largely predominant.

Between OIC countries, there is a great disparity in ship ownership and operation. In 2014, OIC Arab and Asian countries dominated fleet ownership, with each region holding 42% of the total OIC fleet. Turkey had the largest commercial OIC fleet with a total tonnage of 29.4 million dwt. Other countries with large fleets include the UAE (19 million dwt), Iran (18.3 million dwt), Malaysia (16.8 million dwt), Indonesia (15.5 million dwt), and Saudi Arabia (15.4 million dwt). At the other end of the scale, some OIC countries have no commercial fleet (Afghanistan, Benin, Burkina Faso, Côte d'Ivoire, Chad, Comoros, Guinea, Guinea Bissau, Mali, Niger, Tajikistan, Togo, Kyrgyzstan, and Uzbekistan); while others (Djibouti, Gambia, Mauritania, Mozambique, Senegal, and Suriname) have negligible tonnage despite the importance of their maritime trade and related and port sectors.

Table 4: Commercial fleet in OIC countries, in 1000 dwt

Country[2]	Number of ships	Tonnage	Real Nationality[3]
Turkey	1547	29266	29431
UAE	716	19033	13415
Iran	229	18275	18275
Malaysia	602	16797	16321
Indonesia	1598	15550	15475
Saudi Arabia	200	8073	15353
Oman	35	6923	6923
Kuwait	75	6861	6861
Qatar	109	5510	4564
Nigeria	24	4893	3714
Egypt	220	3536	3270
Libya	32	2444	2444
Bangladesh	90	2125	2125
Lebanon	159	1474	1227
Algeria	45	1380	1380
Syria	154	1237	1480
Pakistan	17	679	679
Azerbaijan	181	671	622
Yemen	19	566	566
Cameroon	3	429	429
Kazakhstan	23	364	356
Tunisia	13	330	330
Morocco	34	209	209
Jordan	18	177	177
Bahrain	31	147	139

[2] The countries listed based on their dwt.
[3] Reflects nationality of the shipowner, while the "nationality" of the ship itself is defined by the flag of registration.

Country	Number of ships	Tonnage	Real Nationality
Iraq	24	145	145
Albania	34	140	140
Gabon	3	76	76
Turkmenistan	18	72	71
Maldives	10	50	50
Guyana	19	47	47
Sudan	5	34	34
Brunei	9	23	445
Mauritania	1	9	9
Mozambique	4	9	9
Suriname	2	4	4
Djibouti	1	3	3
Gambia	1	2	2
Senegal	1	1	1

Source: Consultant from UNCTAD (2014a)

In container shipping, the combined share of shipping companies from OIC countries is less than 4% of the global container shipping market; which is far less representative than their aggregated share in world trade. Both the UAE and Indonesia are major players followed by Iran and Turkey. However, those statistics must be interpreted with caution given the ownership and operational features of the global container shipping industry. For instance, the Turkish conglomerate YILDIRIM Group has, as of November 2014, a 24% stake in CMA-CGM, the 3rd largest container shipping line. At the same time, container liners in some OIC countries such as Indonesia and Malaysia are more focused on domestic and regional trade, while other OIC countries still retain high public stakes in national shipping companies.

Table 5: Major container shipping companies in OIC countries

Operator	Global rank	Country	TEU	Ships
UASC	18	UAE	338,872	53
HDS Lines	23	Iran	88,608	22
Arkas Line / EMES	28	Turkey	54,753	37
OEL / Shreyas (Transworld Group)	41	UAE	31,072	22
Salam Pasific	44	Indonesia	29,020	45
Meratus	45	UAE	28,789	49
Tanto Intim Line	46	Indonesia	27,310	47
Emirates Shipping Line	54	UAE	20,917	6
Turkon Line	61	Turkey	13,568	8
Temas Line	62	Indonesia	13,442	23
MTT Shipping	79	Malaysia	7,918	7
Qatar Navigation (Milaha)	88	Qatar	6,651	8
Caraka Tirta Perkasa	93	Indonesia	6,103	9
CNAN	96	Algeria	5,316	9

Source: Consultant from Alphaliner (2015)

3.1.2. Ports

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 (Bichou, 2009). According to UNCTAD (2014b), world ports handled over 9.6 billion tons of estimated international seaborne trade of goods loaded in 2013. For containerised seaborne trade, the global port container traffic in 2013 was 1.58 billion tons converting into a globalised container trade of 130 million TEU. Because of trade imbalances (e.g. return empties), logistics and operational considerations (e.g. transhipment, stowage factors), a port's container throughput almost always exceeds that of containerised trade. In 2013, the global containerised trade of 130 million TEU generated a global container throughput of 651 million TEU.

For OIC countries, their combined container throughput has neared 100 million TEU in 2013 up from 72 million TEU in 2009. However, the share of OIC countries in the global container throughput has remained flat at around 15% in the 2009-2013 period. Both Malaysia and the UAE show high volume throughput of 21.4 million TEU and 19.4 million TEU, respectively. In Albania, Brunei, Gabon, the Maldives, and Mauritania, container throughput show very low throughput volumes, thus reflecting the small size of the port sector in those countries. Elsewhere, some OIC countries such as Algeria, Bangladesh, and Nigeria show low container volumes in comparison with the size of their economies and populations (UNCTAD, 2015b).

Out of the OIC countries listed in Table 6, all countries but two have registered positive container throughput growth in 2013. Among those, the countries that experienced the highest positive growth in 2013 are Morocco (38%), Nigeria (15%), Libya (17%), and Indonesia (11%). On the other hand, only two countries (Egypt and Oman) experienced negative growth in port throughput in 2013 compared with 2012. Egypt's decline in container throughput may be the result of political uncertainty, while in Oman the decline in container volumes appears to be a result of strong competition for transhipment cargo from neighbouring ports.

Table 6: Container-port throughput in OIC countries, in TEU

Country	2009	2010	2011	2012	2013 (estimated)
Albania	68,780	86,875	91,827	98,714	106,512
Algeria	250,095	279,785	295,733	317,913	343,028
Bahrain	279,799	289,956	306,483	329,470	355,498
Bangladesh	1,182,121	1,356,099	1,431,851	1,435,599	1,571,461
Benin	272,820	316,744	334,798	359,908	388,341
Brunei Darussalam	85,577	99,355	105,018	112,894	121,813
Cameroon	245,538	285,070	301,319	323,917	349,507
Côte d'Ivoire	677,029	607,730	642,371	690,548	745,102
Djibouti	519,500	600,000	634,200	681,765	735,624
Egypt	6,250,443	6,709,053	7,737,183	7,356,172	7,143,083
Gabon	132,349	153,657	162,415	174,597	188,390
Indonesia	7,255,005	8,482,636	8,966,146	9,638,607	10,790,450

Country	2009	2010	2011	2012	2013 (estimated)
Iran	2,206,476	2,592,522	2,740,296	2,945,818	3,178,538
Jordan	674,525	619,000	654,283	703,354	758,919
Kuwait	854,044	991,545	1,048,063	1,126,668	1,215,675
Libya	158,988	184,585	195,106	369,739	434,608
Malaysia	15,922,800	18,267,475	20,139,382	20,897,779	21,426,791
Maldives	56,000	65,016	68,722	73,876	79,712
Mauritania	62,269	65,705	69,450	74,659	80,557
Morocco	1,222,000	2,058,430	2,083,000	2,300,000	2,900,000
Mozambique	219,381	254,701	269,219	289,411	312,274
Nigeria	870,000	1,010,070	839,907	877,679	1,010,836
Oman	3,768,045	3,893,198	3,632,940	4,167,044	3,930,261
Pakistan	2,058,056	2,149,000	2,193,403	2,375,158	2,562,796
Qatar	410,000	346,000	365,722	393,151	424,210
Saudi Arabia	4,430,676	5,313,141	5,694,538	6,563,844	6,742,397
Senegal	331,076	349,231	369,137	396,822	428,171
Sudan	431,232	439,100	464,129	498,938	538,354
Syria	685,299	649,005	685,998	737,448	795,707
Tunisia	418,884	466,398	492,983	529,956	571,823
Turkey	4,521,713	5,574,018	5,990,103	6,736,347	7,284,207
UAE	14,425,039	15,176,524	17,548,086	18,120,915	19,336,427

Source: Consultant from UNCTAD (2014a)

At port level, 17 container ports in OIC countries have featured in the top 100 container ports in the world in 2013. The list includes 12 ports from Asia, 3 ports from North Africa, and 2 ports from Europe. This replicates the global port ranking list and reflects the importance of Asia in global movements and transhipment of containerised goods. Table 7 also shows that six OIC countries (Egypt, Malaysia, Indonesia, Saudi Arabia, Turkey, and the UAE) have two ports each in the top 100 global ranking. This implies that in those countries, there is a high degree of direct competition (e.g. Dubai v. Sharjah in the UAE), spatial concentration (e.g. Jeddah v. Dammam in Saudi Arabia), and/or traffic specialisation (e.g. Port Said for transhipment cargo against Alexandria for gateway cargo in Egypt).

In terms of cargo growth, Table 7 shows a combined increase of 3.7% in container throughput in 2013. Out of the 17 OIC ports in the table, one port shows a throughput decline of almost 8%, four ports experienced a small negative growth of 5% or less, seven ports experienced a small positive growth of 5% or less, and three ports registered a higher positive growth of 9% to 12%. The two remaining ports registered a marked percentage change of TEU throughput. On the plus side, Tangier-Med in Morocco made a significant progress with a growth of 40% in 2013 to recover the lost traffic during the 2012 industrial strikes. On the minus side, Shahid Rajaee experienced a steep decline with a negative growth of almost 24% in 2013 which has been linked to the impacts of recent economic sanctions on Iran.

Table 7: Top OIC container ports in 2013

Port	Country	OIC rank (2013)	Global rank (2013)	Million TEU		% TEU growth
				2013	2012	
Dubai Jebel Ali	UAE	1	9	13.64	13.28	2.7
Port Klang	Malaysia	2	13	10.35	10.00	3.5
Tanjung Pelepas	Malaysia	3	19	7.63	7.72	-1.2
Tanjung Priok	Indonesia	4	21	6.59	6.46	2.0
Jeddah	Saudi Arabia	5	29	4.56	4.74	-3.8
Port Said	Egypt	6	34	4.10	3.63	12.9
Sharjah	UAE	7	35	3.80	4.00	-4.9
Ambarli	Turkey	8	39	3.38	3.10	9.1
Salalah	Oman	9	41	3.34	3.62	-7.7
Tanjung Perak	Indonesia	10	47	3.00	2.86	4.8
Tangier Med	Morocco	11	55	2.56	1.83	40.1
Shahid Rajaee	Iran	12	76	1.76	2.32	-23.9
Dammam	Saudi Arabia	13	80	1.66	1.62	2.4
Karachi	Pakistan	14	84	1.56	1.49	4.9
Chittagong	Bangladesh	15	86	1.54	1.41	9.5
Alexandria	Egypt	16	89	1.51	1.46	3.1
Mersin	Turkey	17	95	1.38	1.26	9.1

Source: Consultant from Containerisation International

3.2. Sector Developments and Trends

In this section, the Study highlights the main trends and future challenges faced by the port industry worldwide, and discusses their impacts on OIC ports with a focus on container ports and terminals. Generally, there are ten global challenges faced by the port industry today:

1. Shifts in trade patterns and increased share of South-South trade
2. Larger ship's size and cargo specialisation
3. Containerisation, automation and technological change
4. Consolidation strategies in shipping and ports
5. Developments in international waterways and maritime routes
6. Customer's focus on performance differentials and competitive benchmarks
7. Focus on port landside logistics, intermodal and hinterland connections
8. Greater emphasis on port safety and security
9. Impacts of global climate changes and environmental policy agenda
10. Port skills gap and the lack of specialized and highly qualified workforce

3.2.1. Shifts in Trade Patterns and Increased Share of South-South Trade

The most recent financial crisis has highlighted the shift of influence from developed economies to emerging developing countries. From current and forecast growth rate of emerging and transition economies, it is expected that their share in global GDP to reach 45% by 2025 (Drewry, 2014). Around the same period, the biggest six transition economies of Brazil, China, India, Indonesia, the Republic of Korea and the Russian Federation are expected to account of 50% of global growth (UNCTAD, 2014b).

In line with economic growth, the share of developing countries in international trade has also increased over the past few decades. Much of this growth is being generated by South–South and intraregional trade with projections that by 2025 the world's largest trade corridor will not involve the United States or Europe, but will move to eastwards and South–South corridors. In maritime transport, developing and emerging countries contribute a larger share (61% in 2013) to international seaborne trade with Asia being the main loading and unloading area of merchandise trade. Such shifts in trade patterns have profound implications for shipping services and port infrastructure in OIC countries. On the one hand, OIC countries should re-orient their trade and shipping services towards large developing and emerging economies while at the same time benefiting from the growing trade on secondary container trade routes supporting South–South and intra-regional trade. On the other hand, OIC ports and shipping services should expect stronger and wider competition from ports of other developing nations.

3.2.2. Larger Ships and Cargo Concentration

Larger ships require intensive port investment; longer and deeper berths, bigger cranes and handling equipment, and better technology and operation processes. Over the past decade, there have been significant changes in container ship's size and technology. This has led to a widening gap between few large efficient ports that can benefit from the economies of scale and hub and spoke networks against many small and inefficient ports that remain unsuited to modern and large ships and became heavily relying on feeder services.

Table 8: Relationship between ship size, port infrastructure and equipment requirements

Generation	Ship name	TEU capacity	Ton dwt	Dimensions (metres) length x beam x draft	Arrangement (rows) under-below-across
Future design	22,000-24,000 TEU				
ULCS	Maersk Triple E	18,000	240,000	396 x 68 x 21	13-8-23
Post Suez Max	MSC Daniela	14,000	157,000	396 x 56.4 x 15.5	10-6-22
Suez Max/New Panamax	Emma Maersk	12,500	120,000	366 x 49 x 15.2	10-6-19/20
Post Panamax II	Sovereign Maersk	8,500	105,000	347 x 42.8 x 14.5	9-6-18
Post Panamax I	Rio Negro	5,900	74,000	286 x 40 x 13.5	9-5-16
Panamax	MV Providence	4,225	67,000	292 x 32.2 x 15	8-6-13
Feeder max	2,000-3,000 TEU				
Feeder	1,000-2,000 TEU				
Small Feeder	< 1,000 TEU				

Source: Compiled by Consultant from various sources

3.2.3. Containerisation, Automation and Technological Change

Historically, many OIC countries have had an average or lower than average container penetration intensity or propensity (share of containerisation in break bulk and general cargo traffic). In 2013, several OIC countries show very low container intensity, many times lower than the rate for the global market (~80 TEU per 1,000 capita), and far lower than that of the EU and US markets (~120 TEU per 1,000 capita). Few OIC countries show high container penetration levels (e.g. Oman, UAE) but even though their figures should be readjusted to account for the high transhipment incidence in their container cargo trade.

Table 9: Container trade penetration in OIC countries

Country	TEU/Thousand Capita	Country	TEU/Thousand Capita
Albania	3.8	Malaysia	72.1
Algeria	0.9	Maldives	23.1
Bahrain	26.7	Mauritania	2.1
Bangladesh	1.0	Morocco	8.8
Benin	3.8	Mozambique	1.2
Brunei Darussalam	29.2	Nigeria	0.6
Cameroon	1.6	Oman	108.2
Côte d'Ivoire	3.7	Pakistan	1.4
Djibouti	84.3	Qatar	19.6
Egypt	8.7	Saudi Arabia	23.4
Gabon	11.3	Senegal	3.0
Indonesia	4.3	Sudan	1.4
Iran	4.1	Syria	3.5
Jordan	11.7	Tunisia	5.3
Kuwait	36.1	Turkey	9.7
Libya	7.0	UAE	206.9

Source: Consultant (includes transhipment)

As container transport becomes more affordable, both technically and economically, many OIC countries have been witnessing a rise in their rate of containerisation propensity. While this is a positive trend, it also imposes additional challenges for countries to upgrade their port facilities, operating systems, cargo handling equipment, information and communication technologies (ICT), and related management processes. Modern terminal operations and processes are now largely automated with a high level of capital and technology resources. In the OIC countries, only a handful of ports have full automated facilities while the majority of OIC ports have inherited or are still using conventional systems. OIC ports must therefore adapt their port infrastructure, operations, equipment, and ICT systems accordingly while training and educating highly qualified and technically specialised port workforce.

3.2.4. Global Consolidation Strategies

Cooperation and consolidation arrangements have long been a feature of the shipping industry. Due to economic, commercial and operational pressures, shipping companies have often operated as part of joint conferences, alliances and consortia; while many companies have grown into large operators through mergers and acquisitions. Most recently, the impact of the global financial recession coupled with the squeeze on freight rates has forced the industry to seek further shipping consolidation, most recently the formation of the M2, Ocean three, G6, and CKYHE alliances between the largest container shipping operators. Consolidation strategies in the shipping and transport industry often lead to changes in transport networks, service routes, and choice of ports of calls. Therefore, OIC ports must adapt their development and planning accordingly.

3.2.5. Developments in International Maritime Infrastructure

A deeper Panama Canal, a wider Suez Canal, and the prospects of a new Nicaragua Canal, would have wide reaching impacts on maritime trading routes and services, hence offering opportunities but also posing constraints to many OIC ports. Such developments in international maritime transit routes are expected to provide economies of scale and cost reductions along the supply chain as well as growth opportunities for ports that have the potential to develop into large transhipment and hub centres and those which can benefit from the re-configuration of global shipping services. At the other end of the scale, many ports are set to lose if they do not upgrade their capacity, service provision, and operational efficiency in order to retain existing, or possibly gain, new market shares.

3.2.6. Focus on Performance Differentials and Competitive Benchmarks

Shipping lines, shippers, intermodal operators, logistics providers, freight forwarders and other port customers are now benchmarking ports' efficiency and require from ports higher levels of performance standards. Poor port efficiency is usually embedded in higher ship turnaround time, cargo dwell time, and queuing and congestion time; and translates into additional shipping and port surcharges as well as higher transport and trade costs. OIC ports will have to achieve major leaps in port performance and efficiency and significantly reduce congestion and ship's turn-around times. Many OIC ports particularly those in Sub-Saharan Africa and South Asia are experiencing severe congestions and long delays and unless extra capacity is provided, either through productivity improvement or through new expansion.

3.2.7. Emphasis on Port Safety and Security

Over the past decade or so, there has been a greater emphasis on port security and most ports around the world must now have security plans, systems and procedures in line with international and local security regulations, most notably the ISPS Code (IMO International Ship and Port Facility Security Code). Even though, many trading nations and industry operators require further port security systems and procedures that go beyond the ISPS Code standards, for instance the Container Security Initiative (CSI) for ports with direct services to the USA and the ISO PAS 28,000 (specification for security management systems for the supply chain) for ports wanting to adhere to high security management systems and to establish global credibility. The adoption and implementation of those and other security measures would have direct implications on port operations and management, for instance in terms of secure terminal design and layout, security equipment and machinery, cargo integrity, electronic seals and scanning technology.

In port health and safety, there is no internationally enforceable port safety standard despite growing evidence of risks and incidents from ship's safety in ports, the quality of port pavement and pathways, the handling and storage of hazardous materials (HAZMAT), port traffic hazards, and the operations and maintenance of port equipment and machinery, electrical and chemical installations. One major exception is in the area of container excess weight where verification of container weights for loading packed export containers aboard ships will become an IMO mandatory requirement and is due to enter into force in late 2016.

In several OIC ports, safety and security incidents are either too high or often go unreported. At the same time, many OIC ports are becoming major load and hub centres of container cargo. Enhancing port safety and security requires adherence to higher levels of infrastructure build, terminal design, equipment and operational standards, ICT, and human and management processes.

3.2.8. Relationship to Landside Logistics, Hinterland and City-Interface

Along with the trend of optimisation and standardisation of quay-side operations, physical and capacity constraints at berths and the interplays between freight distribution requirements and urban and city plan, all suggest that more focus must be placed on port inland interface and intermodal connectivity. On the one hand, the increase in trade volumes and the emergence of new distribution patterns, means that the demand on port seashore infrastructure (and the immediate land behind it) is nearing capacity, hence the need to expand land-wise to and connect to hinterland and intermodal systems. On the other hand, reported inefficiencies in ports indicate that landside operations are far behind their

In most OIC countries, ports are embedded in capital or commercial cities often resulting into port and city congestions and disruptive impacts on land use and urban congestion, waterfront management, and environmental sustainability. In some OIC countries, port access to and from land transport corridors are poor due to insufficient or inadequate intermodal and hinterland infrastructure and connections. Even when hinterland connectivity is achieved, communication and IT interoperability between port and intermodal system is not always adequate. As will be shown later in this study, the lack of interoperability between ports and intermodal connections in some OIC ports is a major impediment against developing successful and competitive port systems.

3.2.9. Port Environmental Concerns and Climate Change Impacts

Over the last few decades there has been an increasing concern on the negative effects of port development and operations in climate change, human health, eco-system and wider environmental sustainability. Environmental factors associated with port development include land reclamation, dredging, construction, maintenance, and any related activity such as material's disposal, waste, and release of contaminants. Nautical and cargo handling operations can also create environmental concerns. Sources of environmental degradation caused by ships in port areas include ship stress and vibration, emissions and noise, waste production and disposal, storm and ballast waters' discharge, spill and leakage, and grounding and collision. For cargo handling operations, environmental risks include dust, toxic and hazardous materials from cargo, emissions, noise, and vibration from handling equipment and vehicles, spills and leakages from pipelines and storage tanks, and any adverse impact or accident during cargo handling, storage and distribution.

One area that has received particular attention in the past 5 years or so is the pollutant emissions in port areas. Several regulations and industry-led measures have been, or are currently being, introduced in order to improve the environmental performance of ports and reduce pollutant emissions generation. Among these, worth noting the introduction of limits on air pollutants from ships exhaust gas and on sulphur's content allowed in marine fuel, the establishment of geographical emission control areas (ECAs), the launch of the world ports climate initiative (WPCI), and a number of other local and regional initiatives.

In view of these challenges, OIC ports must therefore adapt their environmental strategies and operational practices. This includes the provision of ballast water treatment and reception facilities, ship's biofouling, sulphur-capped and LNG bunkering facilities, energy efficient systems (equipment electrification, automation, speed reduction, etc.) and market-based mechanisms (taxation, subsidies, etc.) to cut cargo footprint and improve air quality.

Another environmental concern for ports is the impact of climate change and extreme weather conditions on port systems. Climate change risks for ports include accelerated coastal erosion, port and coastal inundation and restrictions on access to docks, increased run-offs and situations requiring further dredging, and deterioration of conditions and problems with the structural integrity of pavements. Many OIC ports, particularly those in small-island developing States (SIDS), are located in sensitive coastal zones, low-lying areas and deltas, an must design and implement appropriate adaptation and mitigation strategies to global climate change risks and impacts.

3.2.10. Ports Skills Gap

Port companies and operators around the world are reporting problems in obtaining enough qualified staff. Over the past year, surveys conducted in the Brazil, India, Korea, China and the UK have confirmed that there is a skill shortage in port operations and related logistics management. Historically, port staff has been mostly composed from a pool of temporary workers, shipping professionals and/or public civil servants, but as the port industry becomes more globalised, technology and logistics-driven, there is a need for a new breed of port professionals with the right skills in port finance, operations, management, logistics, and technology. To shed new light on the problem several surveys have been conducted (e.g. LMA, 2008; Bichou 2009) and the results revealed that two thirds of the respondents have trouble finding enough qualified staff. Many respondents complained about the low profile given to ports in universities and specialised maritime schools. There are nevertheless initiatives by many operators (APMT GDTTP programme, DP World Gold programme) aimed at offering graduate training schemes to potential port recruits and development of port-centred skills.

4. Ownership Structure and Institutional Performance

4.1. Organisation of the Port Sector in OIC countries

Until recently, most ports in OIC countries followed the public service model where the development of port infrastructure, the operation of port superstructure, and the provision of port services were under the control of port authorities. Over the past two decades or so, there has been a general shift towards the landlord function, yet several OIC ports still retain a service (public or private) orientation while others operate on autonomous basis. In terms of administrative organisation and devolution, there is an even split between centralised and decentralised port systems, but in many OIC countries both systems are still being implemented concurrently. Table 10 depicts typical variations in the institutional and organisational structures in the 25 OIC countries that have commercial seaports. Despite common features, most ports depict hybrid structures and there exist wide variations both between and within OIC countries.

Table 10: Variations in institutional and organizational structures in the OIC countries under study, excluding countries with no commercial seaports

	Bahrain	Benin	Cameroun	Djibouti	Egypt	Gambia	Indonesia	Iran	Iraq	Jordan	Kuwait	Malaysia	Mauritania	Morocco	Mozambique	Nigeria	Oman	Palestine	Pakistan	Qatar	Saudi Arabia	Senegal	Suriname	Turkey
Landlord	■			■	■		■	■		■		■		■		■		■	■		■		■	
Public service					■	■	■		■	■	■			■			■		■	■				■
Private service												■			■		■							■
Tool																								
Central	■			■		■	■		■		■			■	■	■		■		■			■	
Regional					■		■			■		■		■										
Local		■	■				■					■	■				■		■			■		■
Trust																			■					
Corporate												■										■		
Autonomous		■	■										■									■		

Source: Consultant

4.1.1. The Landlord Model

The full landlord port status is mostly found in Bahrain, Iran, Nigeria, Saudi Arabia, and Suriname. In those countries, a clear distinction is made between the landlord port authorities whose role is limited to infrastructure provision, asset management, administrative supervision and regulatory oversight; whereas terminal and cargo handling services are managed and operated by private operators. At the same time, ports in the above OIC countries are currently managed by a single national port authority; Bahrain Ports Authority, Nigeria Ports Authority, Saudi Ports Authority, and Suriname Port Management Company (N.V. Havenbeheer Suriname). Iran has 5 port authorities and complexes but they all report to a single authority, the Ports and Maritime Organisation (PMO), which supervises and regulates the activities of all the ports in the country.

4.1.2. The Public Service Model

The public service port model still exists in many OIC countries most notably Gambia (Gambia Ports Authority), Iraq (General Company of Ports of Iraq), Kuwait (Kuwait Ports Authority) and Qatar (Qatar Ports Management Company: Mawani Qatar). Worth noting though that with the development of new port projects in Kuwait (Boubyan) and Qatar (new port project), there are plans in both countries to move towards a landlord-based port model.

4.1.3. The Hybrid Landlord-Public Service Model

A hybrid combination between landlord and public service models exist in 4 OIC countries.

- In Egypt, the port sector is organised in terms of four port authorities (Alexandria Port Authority, Port Said General Port Authority, Damietta General Port Authority, and Red Sea Ports Authority), which all report to the maritime transport sector (MTS), a central governmental department. The port authorities perform a landlord function and have both administrative and regulatory control over operating entities inside the ports under their jurisdictions. However, they also hold shareholding stakes both in private port operating companies and in the Holding Company of Maritime and Land Transport (HCMLT), the latter is an affiliate to the Ministry of Investment and a major port operator in the country.

- In Jordan, the Aqaba Special Economic Zone (ASEZ) was inaugurated in 2001 as a liberalised, low-tax, and multi-sector development zone that encompasses Jordan's only seaport and entire coastline. This has been followed by the creation of ASEZA, the statutory authority responsible for the management, regulation, and the development of the Aqaba zone and its ports. In 2005, the Aqaba Development Corporation (ADC) was created in 2005 as the investment arm of AZESA and has since then acted as the port landlord, infrastructure owner and developer.

- In Indonesia, the four port corporations (Pelubahan Indonesia, usually abbreviated to Pelindo) that controlled the commercial ports in the country have been acting as both the landlord and the operator of port facilities, although the central Government retained control of port tariffs and pricing. In 2008, a new shipping law has been introduced and aimed at the separation between the port regulatory and operating functions, the formation of new port authorities, and the introduction of port competition through the removal of Pelindo's monopoly. However, there was no time limit for the port reform measures to be implemented. To-date only four port authorities have been created and their relationship to the four Pelindos has not been properly clarified yet.

- In Morocco, the Government launched a major port reform in 2006 that have seen the dissolving and break-up of the country's monopolistic port operator and regulator (ODEP) and its activities transferred to two new institutions: ANP (National Ports Agency) and SODEP (branded as Marsa-Maroc). The former acts as a landlord port authority while the latter operates as a public corporation, having inherited all of ODEP's commercial activities. However, ANP also acts as operator in ports where operating contracts have not (yet) been entrusted to 3rd parties. In addition to ANP and Marsa Maroc, the Tangiers-Med Special Agency (TMSA) was created in 2004 to oversee the development, promotion, and monitoring of port and related trade logistics projects in Tangiers-Med economic and trade zone. TMSA operates outside the remit of ANP and was recently restructured with the creation of a designated

Tangiers-Med Port Authority (TMPA). A similar setup is currently being pursued in the new port development of Nador West Med Port.

4.1.4. The Autonomous Model

Autonomous ports are mostly found in OIC African countries of Benin, Côte d'Ivoire, Cameroun, Mauritania, and Senegal. Theoretically, the autonomous port model goes further than the landlord model by offering a decentralised port structure with a higher degree of devolution of public decision making. This is however not always the case in the autonomous ports in OIC countries.

- In Benin, the move towards the landlord-based autonomous model marks a major shift from the previous port's status as a tool port.

- In Cameroun, the port of Douala was one of four ports (together with Kribi, Limbe and Garoua) to be granted a port's authority status, while the role of the Cameroon National Ports Authority was reduced to technical regulation including the elaboration and control of the application of norms on port security.

- In Mauritania, and despite their autonomous status, the control and management of the two main ports (Nouakchott and Nouadhibou) are under the oversight of different ministries, while operations at the mineral pier at Nouadhibou Port are under the supervision of a third ministry.

- In Senegal, the autonomous structure of Dakar port has also evolved over time and currently resembles a corporation structure. On the other hand, the secondary ports of Kaolack and Ziguinchor in Senegal are controlled by a newly created port agency (National Agency of New Ports- ANNPS) under the General Secretariat of the President's Office.

4.1.5. Other Models

In other OIC countries such as Djibouti, Malaysia, Mozambique, Oman, Palestine, Pakistan, and Turkey, the port sector depicts a wide variation of port institutional models:

- In Djibouti, the Port Autonome International de Djibouti (PAID) was until recently a an autonomous public entity under the management of the Djibouti Ports and Free Zones Authority (DPFZA), where both entities acted as a landlord authority for port and free zone infrastructure and assets. In late 2012, China Merchants Holdings International (CMHI) acquired 23.5% of the issued share capital in Port de Djibouti S.A. (PDSA). As one of the conditions to the share purchase agreement, PAID will be transformed from a public entity into a private company limited by shares and will be renamed as PDSA. One of the key assets and operations of PDSA will be 66.6% of the issued share capital in Doraleh Container Terminal (DCT).

- In Malaysia, the port sector is organised in terms of six federal ports and several state ports. For federal ports, port operations were either corporatized or privatized with the port authorities assuming a regulatory function. For state ports, those in Sabah were privatized under a single operator, with the port authority assuming a regulatory role, while those in Sarawak remain owned and operated by their respective port authorities.

- In Mozambique and Oman, the port organisation resembles the private service model where national private companies were set up through joint ventures between local Governments (or public enterprises) and selected international port investors in order to build, manage, and operate the countries' major ports (Maputo, Sohar, Salalah, Duqum).

- Palestine has had plans to develop the port of Gaza into a commercial port and logistics complex based on the Palestinian Seaport Authority assuming a landlord role. Those plans did not materialise as yet due to the political conflict in the region, but there are currently attempts to revive them.

- Pakistan stands as the only OIC country to have a trust port authority in Karachi, while the other ports in the country operate on landlord structure. Pakistan also stands as the only OIC country that has a dedicated sector Ministry (The Ministry for Ports and Shipping).

- Turkey currently has no public port authority. The Turkish port sector is comprised of private and public sector ports, the latter have traditionally been owned and operated by the state railways company (TCDD). Since the year 2000, 4 TCDD operated ports have been privatised while another three are yet to be privatised.

4.1.6. Institutional Structure of Port Terminals under Study

The institutional categorisation shown in Table 10 and the discussion that followed outlines typical structures at the level of OIC countries not at the level of individual ports. As discussed above there exist wide port institutional variations within the same country, and many terminals under study deviate from the general organisation of the port sector in their respective countries.

As shown in Table 11, most ports under study are either landlord or private service ports. None of the studied ports fall under a public service model, while the trust and the autonomous models are represented with only one port each, QICT (Port Qasim) and TCD1 (Dakar), respectively. DCT of Djibouti is currently in a transition phase from an autonomous port to a private corporation. Sometimes, a port's organisation is blurred between two or more institutional structures. This is the case for example of ACT (Aqaba), MCLI (Maputo), and SPCT (Salalah) where there is a hybrid structure between landlord and private service models. Another hybrid structure, this time between the landlord model and the corporatized mode, is found in JICT (Jakarta) and NPCT (Northport). Sometimes, a single port can depict more than a one institutional structure, for instance in Casablanca, one container terminal (CTCE) operates on a corporatized basis while another (CTCW) operates on a landlord basis.

Table 11: Institutional structure of the 20 OIC terminals under study

	Aqaba	Ambarli Kumport	Ambarli Marport	Apapa	Casablanca East	Casablanca West	Doraleh	Jakarta Internationa	Jeddah Northern	Jeddah Southern	Maputo	Mersin	Northport	Qasim Internationa	Tanjung Pelepas	Salalah	Dakar 1	Tangier Med 1	Tangier Med 2	Westport
Public service																				
Landlord				■		■			■	■								■	■	
Private service		■	■				■					■			■					■
Corporatized					■															
Autonomous							■										■			
Trust														■						
Hybrid landlord-private	■										■					■				
Hybrid landlord-corporatized								■					■							

Source: Consultant

4.2. Private Sector Participation and OIC Ports

Ports have large sunk assets and therefore tend to exhibit increasing returns to density (cost per unit traffic usually falls when more vessels and cargo are handled by existing facilities) and increasing returns to scale (cost per unit traffic tends to fall as a port expands). Thus, ports are traditionally viewed as natural monopolies, justifying public involvement in both the provision (to ensure adequate investment) and operation (to prevent monopoly exploitation).

Nevertheless, while ports themselves may have natural monopoly characteristics, this is less so for many of the services provided within ports, for instance in such areas as marine services, stevedoring, and value added logistics activities. Bichou (2009) points to the multi-product character of ports, creating scope for unbundling and competition. He categorises port infrastructure and associated activities into maritime access infrastructure, port infrastructure and superstructure, and landside access infrastructure. Maritime and land access entails long-lived, largely sunk assets with costs that cannot be easily assigned to specific port users. Thus, these assets are not likely to be attractive to private investors and are typically owned by governments or a consortium of port operators. Although a lot of non-access port infrastructure and superstructure are also long-lived assets, their costs can be more easily assigned to port users. Accordingly, there is much greater scope for PSP in such infrastructure and superstructure.

Relative to private owners and operators, there is a view that public owners and operators are less able (and have fewer incentives) to control costs, are slower to adopt new technologies and management practices, and are less responsive to the needs of port users. It is important to note, however, that no general consensus has been reached yet among port researchers on the relationship between ownership structure, private or public, and port efficiency (see for instance Notteboom et. al, 2000; Cullinane et. al, 2002; Estache et al, 2004; Bichou, 2013). Nonetheless, state owned ports have been moving away from the public service model described above, where a public port authority provides all the services, to the landlord model, where the port retains ownership of the basic infrastructure such as berths and breakwaters but divests itself of managerial and financial responsibility for commercial facilities such as terminals and equipment.

4.2.1. Forms of Private Sector Participation in Ports

PSP in ports can take a number of forms; management contracts, partial divestiture to strategic equity partnerships, joint ventures, full divestiture, and concessions of various kinds. Management contracts are generally unattractive to terminal operating companies because of the inability to control factors which influence performance, like staff retention and employment conditions. Strategic equity partnerships are also unattractive to terminal operating companies in the absence of the ability to make investment and operational decisions considered necessary to achieve desired levels of performance. Joint ventures, however, hold considerable attraction as they exploit complementary resources and skills. Concessions imply a degree of transfer of responsibility and therefore risk to the private sector. In the case of build-operate-transfer (BOT) concessions, responsibility for building and operating infrastructure is transferred to the private sector, while overall control and ultimate ownership of port infrastructure remain in public hands.

Most public-private partnership (PPP) models in the ports sector sit within a landlord port structure in which a public sector authority enters into a PPP contract for one or a series of individual terminals. The operators of the terminals are usually, but not always, different, and the PPP model used may differ from one terminal to the next. The role of the port authority is to provide and manage common facilities like the breakwater and entrance channel, utilities and road and rail access; to regulate the individual PPPs; and to plan and implement the expansion and development of the port. The most common PPP models for individual business units are:

4.2.1.1. The management/investment model for existing public assets

The private operator manages publicly owned assets and makes additional investments in them, in exchange for being given the right to use them for a specified period of time. Ownership of the public assets remains with the public sector throughout this period; privately-funded fixed assets are usually (but not always) taken into public ownership immediately after construction, whilst privately-funded mobile assets such as mechanical equipment usually (but not always) remain in private ownership. This is reflected in the 'transfer-back' arrangements at the end of the contract period, when the right to use the assets (now a mixture of public and privately provided) reverts to the public sector, which may then re-assign them to another operator.

Various arrangements exist for compensating the private operator for the residual value of any investment made during its period of tenure. For fixed assets "no compensation" transfers are probably still the most common. Mobile assets paid for by the private operator, in contrast, can usually be withdrawn or sold-on to the public sector, reflecting assumptions about ownership which are either explicit or implicit in the contract.

4.2.1.2. The development rights model for new private assets (BOT)

Here the private investor buys the right to build new port assets and have exclusive use of them for a fixed period of time before transferring them over the public sector. This is a model which has been increasing in popularity in the ports sector as the stock of public assets suitable for private management has dwindled. However it raises the question of why private investors should have to give back their assets to the public sector, often free of charge.

One of the surprising things about the ownership structure of the ports industry is how few freehold private ports there are. Those are freehold captive user terminals, usually part of vertically integrated oil, mining, agricultural or forestry enterprises, but common user terminals and multipurpose ports are usually both competitive free market business environments with long coastlines and lots of ports. There seems to be four main reasons why the BOT (Build-Operate-Transfer) concession model prevails over the private freehold model:

- The Latin legal tradition that the seabed up to the high water mark belongs to the State, and cannot be transferred irrevocably to any private enterprise. This has been a very important concept in port development in countries in Latin America, North Africa and the Mediterranean.

- The high costs of shared infrastructure such as breakwaters and dredged channels, which need to be partially recovered from the shore-based terminals which benefit from them, as well as from ships. BOT contracts give public authorities a continuing claim on port assets and revenues which would not be possible if freehold terminal development was allowed.

- The limited number of sites which are suitable for port development in some countries. Here the State may seek to retain a permanent stake in their development for strategic or monopoly profit reasons, without putting up any of the necessary investment.

- Safeguarding of the value of State-owned ports, in the face of competition from lower cost private freehold sites. In this context, BOT schemes can be used to ensure that ports compete under conditions established by governments rather than markets. This type of PPP model is associated with green-field site developments in many different countries, but has been particularly important in Western Europe where there is a long-established landlord port tradition.

4.2.1.3. The public-private joint venture model

In this model, the public sector has an influential or controlling stake in the Special Project/Purpose Vehicle (SPV) which is set up to hold either a management-investment contract or a development rights contract for new port facilities. These contracts otherwise operate broadly as described above, although the existence of a large public sector stake in the SPV has a significant effect on the detailed provisions of the contract.

4.2.1.4. The divestiture model

Port divestiture involves the Government or public sector existing port assets being sold fully or partially to the private sector. The divestment programme of port assets and facilities usually starts with the reorganisation of port assets and liabilities along commercial lines, which can facilitate the valuation and sale process, followed by a public or restricted share offering. Port divestiture may lead to either a partial or full privatisation, although in some countries the term divestiture is sometimes reserved to cases of partial privatisation. Port divestiture and privatisation may also be the results of BOO (Build-Operate-Own) contracts which basically provide freehold private terminal development and ownership.

4.2.1.5. International Terminal Operators and PSP in Ports

In the last two decades, there has been a trend towards the internationalisation and consolidation of port operations, which has led to the emergence of international terminal operators (ITOs) with extended bargaining power, higher performance levels, and global management practices. Bichou and Bell (2007) list four current types of market player in international port operations (Figure 4).

4.2.1.6. Terminal operating port authorities (TOPA)

Service operating port authorities such as Singapore and Dubai ports which have expanded their activities, usually through new organisational entities (PSA and DPW respectively) to ports and terminals beyond their initial spatial bases.

4.2.1.7. Terminal operating shippers (TOS)

Shippers involved directly, or through subsidiaries, in the management of terminals mainly for non-containerised cargo operations such as for handling oil and car shipments. Against the trend of logistics outsourcing, many global shippers have decided to retain full control over their distribution channels, including such activities as transport and port operations. Global firms such as Shell, Cargill and Hyundai own their own fleet of vessels (industrial shipping) or operate them through long-term lease (bareboat chartering), and so is also the case for dedicated terminals.

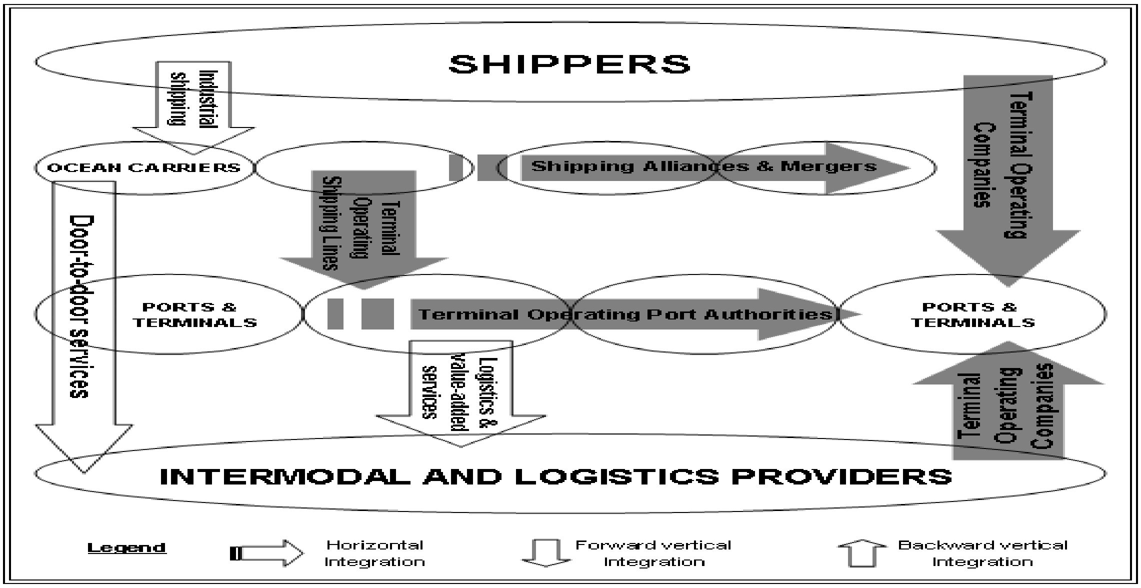
4.2.1.8. Terminal operating shipping lines (TOSL)

Those are ocean carriers that operate a range of port facilities, predominantly container terminals, either through single agreements or joint long-term lease and concession agreements. Depending on the nature of the agreement, terminals are operated either on dedicated or common-user bases although variations to these arrangements exist. The management of such terminals is usually separated from that of the shipping line (e.g. TIL of MSC) and is sometimes undertaken by established subsidiaries (APMT, COSCO Ports).

4.2.1.9. Terminal operating companies (TOC)

Firms, other than shippers, ocean carriers or port authorities, whose origins are in logistics operations, property development, and/or any other related business but have expanded their activities into international port operations and management. Firms such as HPH, Eurogate, SSA Marine, ICTSI, ABP, and Groupe Bollore belong to this category.

Figure 4: Variations of channel structures in global shipping and ports



Source: Bichou & Bell, 2007

4.2.2. Economic Benefits of Private Sector Participation

There is plentiful evidence of the economic benefits of restructuring, deregulation and privatisation. The following summarises four experiences with private sector involvement:

- Malaysia: In 1986, Kelang Port Authority divested its container operations. Crane handling improved from 19.4 moves per hour in 1985 to 27.3 in 1987, bringing Kelang's performance close to that of Singapore. The return on fixed assets grew at an average annual compound rate of just 1.9% in 1981–86 prior to divesture, but thereafter jumped to 11.6% in 1986–90, due to improvements in productivity and throughput rather than higher prices. By 1990 port workers were paid 60% more an hour in real terms, worked on average 6% more hours each, and produced 76% more than before privatization (Galal et al, 1994).

- Colombia: In 1993, Colombia concessioned its four main ports to separate regional port authorities, which then contracted with operators that use the facilities. New laws abolished most restrictive labour practices and allowed stevedoring services to compete freely at each port. Average waiting time per vessel dropped from 10 days before 1993 to nothing afterwards, container moves per vessel per hour increased from 16 to 25, bulk cargo shifted per vessel per day increased from 500 tons to at least 2500 tons, working hours per day increased from 14 to 24, and working days per year increased from 280 to 365 (Gaviria, 1998). Although the initial concessions involved little investment, the main reason for their success was the removal of restrictive practices and the development of effective competition within and between ports.

- Mexico: In the mid-1990s Mexico began a decentralization program that led to the concessioning of the country's major ports to private operators. In addition to lower tariffs and improvements in efficiency (see Estache et al, 2001), privatization enabled the port system to cover its costs, which it was not doing beforehand. Indeed, the system now generates substantial tax revenue for the government whereas before it depended on public support.

This improvement in the finances allowed the port authorities and concessionaires to undertake substantial investment in expansion and modernization.

- Argentina: Between 1990 and 1993, the Argentine government abolished most of the restrictive working practices at ports and on vessels. Argentine shipowners were allowed to temporarily register their ships under foreign flags and so benefit from lower requirements on crew size. Contracting arrangements with stevedore companies were freed up, pilotage and towage services were deregulated, and operators were allowed to set their own tariffs. An important reform authorized the private sector to build and operate ports for public use, undermining the market power of existing ports. The port of Buenos Aires was split into three areas with separate functions and administrations, one of which was further split into six terminals that were concessioned to compete with each other (Estache and Carbajo, 1996). Although this was subsequently regarded as too much fragmentation, privatization increased port investment and performance significantly. In the port of Buenos Aires, between 1991 and 1997 annual container traffic jumped from 300k TEUs to more than 1 million TEUs, the number of cranes increased from 3 to 13, labour productivity almost quadrupled, and the average stay for a full container dropped from 2.5 to 1.3 days. As a result the port was able to successfully compete with Santos in Brazil surpassing it in 1997 (Hoffman, 1999).

4.2.3. Private Sector Participation in OIC Ports

Globally, private sector participation (PSP) in port operations has been growing strongly. Countries leading the way in private participation have been able to attract significant private capital investment to develop port infrastructure and modernise superstructure and terminal services. Under private management, ports usually improve operational efficiency, labour productivity, and service quality. Specific drivers behind the development of PSP in OIC ports include:

- The rapid growth in world trade, which has put great pressure on existing facilities, coupled with only limited success of state owned ports in improving operational, labour, and other practices required to increase the productivity of existing facilities.

- Economies of scale in the shipping industry have led to the emergence of global lines able to dictate ports of call and the location of gateway and transhipment activities. To stay competitive, ports are forced to upgrade their facilities and improve their operating practices.

- Economic and budget constraints with some OIC countries having low levels of savings to invest in large scale port projects. There is also a growing trend of perceived fiscal (immediate) benefit from PSP in some cash strapped OIC countries, although the loss of port revenues may result into negative fiscal benefits in the long-run.

- Suitable institutional and regulatory frameworks allowing PSP in the port sector. As outlined above, changes in port institutional and organisation structures in OIC countries have allowed a more supportive framework to private investment in the sector.

In OIC countries, early port privatizations were launched in the mid-1990s and were concentrated in the Asia region (Malaysia, Indonesia, and Pakistan), Europe (Turkey), and Southern Africa (Mozambique). According to the World Bank PPI database, there were 71 public-private-partnership (PPP) seaport projects in the OIC countries between 1991 and 2013, as shown in Table 12.

Table 12: PPPs in OIC ports

Country	Financial Closure	Project Count	Country	Financial Closure	Project Count
Benin	2009	1	Mozambique	1993	1
Cameroon	2004	1		1996	1
Djibouti	2000	1		1998	1
	2004	1		2003	1
	2007	1		2004	2
Egypt	2000	2	Nigeria	2005	19
	2005	1		2006	3
	2008	1		2011	1
Indonesia	1995	3		2013	2
	1999	2	Pakistan	1995	2
	2003	1		1997	1
	2009	1		2002	1
Iraq	2010	1		2007	1
Jordan	2004	1		2008	2
	2006	1		2010	1
Malaysia	1992	1	Senegal	2008	1
	1993	1		2013	1
	1994	1	Turkey	1994	1
	1995	2		2004	1
	1997	2		2006	1
	2004	1		2007	1
	2006	1		2010	2
Morocco	2004	1		2011	1
	2008	1		2013	1

Source: World Bank PPI database (accessed on 01/11/2014)

From the analysis of some OIC port concession agreements that was made available to us, it is clear that a two-tier approach of PPP models currently apply. On the one hand, some countries, e.g. in Egypt, Malaysia, Morocco, Mozambique, Turkey, have already an established system and a track record experience in PPP which has been reflected in their port PPP models. Elsewhere, e.g. in Benin, Cameroun, Indonesia, Jordan, Nigeria, and Senegal; a true PPP design and implementation in the port sector do not seem to exist at present. Instead, several concession agreements related to PSP in ports have the characteristics of lease contracts which appear to be regulated under procurement laws rather than PPP laws. Table

13 shows the type of PPP concessions and International Terminal Operator (ITO) for the 20 OIC terminals under this study.

Table 13: PPP and investor type for the OIC terminals under study

	Aqaba	Ambarli Kumport	Ambarli Marport	Apapa	Casablanca East	Casablanca West	Doraleh	Jakarta International	Jeddah Northern	Jeddah Southern	Maputo	Mersin	Northport	Qasim International	Tanjung Pelepas	Salalah	Dakar 1	Tangier Med 1	Tangier Med 2	Westport
Management of existing facilities	X			X	X	X			X	X	X			X			X			
Development of new facilities															X			X	X	
Joint venture model							X	X								X				
Divestiture model		X	X									X							X	X
Type of ITO: TOS											X									
Type of ITO: TOSL	X			X		X									X	X		X	X	
Type of ITO: TOC		X	X		X			X	X				X		X		X		X	
Type of ITO: TOPA					X		X			X	X	X		X			X			X
Type of ITO: Other		X					X					X						X		

Source: Consultant

4.3. Analysis of Institutional Port Performance

The success of any port depends heavily on the adequacy of the institutional structure in place and the capabilities of public agencies in charge of the port sector. This section assesses the adequacy of the current port institutional framework in the OIC countries, focusing on three areas of importance: fragmentation, ownership models and service commercialisation.

4.3.1. Institutional Structure and Fragmentation

From the outset, it seems that many OIC countries have decided to organise their port sector based on a clear path towards pursuing market-oriented policies by separating the role of the public sector as a policy maker, promoter, and sector regulator from that of the private sector as investor, operator, and service provider, as outlined in Table 14.

Table 14: Public and private roles in a port-liberalized economy

Public	Private
• Policy and strategy maker • Sector developer and promoter • Implementing policy principles and strategies • Regulator (economic and technical)	• Capital financing and development • Operations of port assets and facilities • Provision of port activities and services • Improving efficiency and service quality

Source: Consultant

While managed liberalisation in ports means delineating private and public roles and their involvements in the sector, it also leads to the fragmentation and dilution of responsibilities among public entities themselves. In this respect, fragmentation has four distinct meanings.

- *Industrial fragmentation* means separating different activities according to the degree of industrial specialisation such as in terms of basic infrastructure development, terminal operations and services, intermodal and logistics activities, etc. To some extent, there is a wide use of industrial fragmentation in OIC countries.

- *Spatial fragmentation* refers to the geographical and spatial organisation of the sector, e.g. local versus national, decentralised versus centralised, etc. This is the case for instance of the port sector in the OIC countries of Malaysia, Indonesia, Senegal, Egypt, and Turkey. Elsewhere, the management and organisation of ports remain quite centralised in the hand of a national port agency such as in Bahrain, Kuwait, Nigeria, Qatar, Saudi Arabia, and Suriname.

- The combination of industrial and spatial fragmentation is often referred to as *service fragmentation*. It aims at separating port activities according to their strategic importance. Service fragmentation also means the unbundling of port services to create competition in monopolistic markets. This form of fragmentation is not widely used in OIC ports.

- *Functional fragmentation* means allocating policy (strategy) decisions, regulation, and operations to separate entities. This form of fragmentation is common and desirable, but the effectiveness of separating policy, regulation, and operations is often constrained by competition between various public agencies and the lack of clear rules as to who does what and why. This is particularly the case of Indonesia, Jordan, Morocco, Senegal, and Turkey.

In many OIC countries, the port institutional set-up is not organised in a way that reflects an orientation towards spatial, industrial or service fragmentation, and less towards functional fragmentation. Instead, the type of fragmentation used points to problems of institutional gaps and institutional overlaps:

i. Noticeable institutional gaps in the OIC countries include gaps in the area of market regulation for port services as well as for the organisation and management of port concessions and PSP. Less than a handful of OIC countries have established independent port regulatory bodies in charge of economic and PSP regulation in the sector (Malaysia, Oman, Saudi Arabia; Egypt and Nigeria currently in progress). Other institutional gaps also exist in the areas of technical regulation for port safety, port labour, and port environmental management, where most OIC countries, except Malaysia, seems to have not developed appropriate port occupational health and safety systems.

ii. Institutional overlaps are observed across several industrial and service components of the port sector in several OIC countries, most notably in landlord port functions, in port terminal operations, and in the provision of nautical and marine services. In any case, this form of fragmentation is clearly obstructive and undesirable because it can create competition and tensions among agencies with missing functions or overlapping missions, thereby blurring the lines that separate regulation, operation, and policy decision making.

The main problem with the various forms of fragmentation observed several OIC countries is that it causes frictions, inefficiencies, and delays to strategy formulation and implementation.

- On the one hand, because the port sector serves wider national and policy goals (sustainable development, trade and logistics integration, etc.) and contributes in other sectors of the economy (trade and industry, regional development, job generation, export promotion, development of nautical tourism, etc.), coordination among public agencies and governmental departments is essential. In practice though, coordination across public agencies could be weak and sometimes inexistent. A case in point is that of Morocco where the Ministry of Transport (in charge of shipping) does little coordination with the Ministry of Agriculture (in charge of fishing) to coordinate on issues related to port and maritime technical regulations given that the latter Ministry has far much resourceful regional departments of maritime affairs than for the Ministry of Transport.

- On the other hand, because many public port agencies perform policy, development, and regulatory functions, the ability of central government Ministries and agencies to formulate area-specific strategies and integrate them within a global port and maritime strategy is very limited. The result is either a lengthy and inefficient process or a hasty decision with no appropriate due diligence. In the context of OIC countries, this is quite problematic because some port agencies do not appear to have the financial and human resources necessary to carry out their mandate for strategy formulation and implementation across many segments of the port sector. The issue of port development is a case in point whereby several port projects seem to have been proposed and approved authorities with no reference to a national strategy for port planning and development (where it exists) and no adequate consultations with industry stakeholders and port users. Examples of such shortcomings can be observed in Bahrain, Kuwait, Morocco, Oman, and Nigeria, to name a few.

4.3.2. Ownership and Service Commercialisation

Other contentious issues in the institutional structure of the port sector in OIC relate to the practice of cross ownership and partial privatisation in state enterprises, as well as the separation between commercial and statutory activities in public agencies.

- Under cross ownerships, public agencies concurrently act as owner, developer, operator, and sector regulator. Existing cross-ownership arrangements between port authorities and public operating companies (see Tables 5 and 6 above) effectively blurs the boundaries between policy, regulatory and commercial functions; and makes it difficult to identify and allocate responsibilities across institutional stakeholders. Here, abolishing cross-ownership by corporatizing public companies and/or transferring public shareholding stake in operating companies into the private sector can be recommended.

- A Government or public authority that retains a financial stake in an operating company has a conflict of objectives between enhancing the profitability of the incumbent versus improving the quality and quantity of maritime services. The current strategy of several OIC countries and their public port authorities to retain control shares in terminal operating companies not only creates a barrier to entry for the private sector but may also inhibits port competition and efficiency.

- Several public agencies in the port sector carry out both statutory and commercial activities, thus encouraging cross-subsidisation and inefficiency and putting an unnecessary financial and ethical burden on public authorities to support them. In many OIC countries where price control and regulation is under the hand of central public agencies (see for instance the case of Indonesia above), the current industry structure and regulatory framework encourages the cross-subsidisation by loss-making enterprises from surpluses earned by profit-making enterprises. More generally, cross-subsidisation leads to a loss of economic efficiency. Furthermore, there is little evidence of service unbundling being implemented as a strategic objective in the current port institutional structure.

- The separation between statutory activities and commercial activities is essential not only to ensure that commercial activities operate under a competitive environment, thus not discriminating against competitors from the private sector, but also to promote business development, research and innovation in those organisations. For example, successful terminal operating companies have all expanded their businesses both vertically (scope of activities beyond traditional services to provide intermodal and logistics services) as well as geographically (bidding for and operating ports even outside their home base).

5. Regulatory Framework and Governance Performance

5.1. Regulatory Performance

Key to maritime and port performance is the extent to which governments and public entities are involved in the aspects of technical and economic regulation. Regulators are public authorities empowered by legislation to licence and monitor the sector's operators and regulate their activities with regards labour, safety, security, and environmental sustainability (technical regulation). They are also in charge of market or economic regulation, which includes aspects such as market access, competition, pricing and the regulation of private sector participation (PSP) through public-private partnership (PPP) concessions, in particular prescribing the terms and conditions for pricing and performance and arbitrating disputes that may occur before, during and after PSP in port operations and management.

5.1.1. Technical Regulation

A major component of policy and regulatory intervention in seaports is the state of port safety, security, labour regulation, and environmental sustainability. Examples of regulated activities in the sector include, but are not limited to port state control, port health and safety, port and maritime security, port environmental management, port training and labour regulation. Several regulatory standards have been developed to ensure the safety, security, and environmental sustainability of maritime and port operations. Many of these regulations are set by international organisations such as the International Maritime Organisations (IMO), the International Labour Organisation (ILO), and regional and national agencies.

Table 15 shows the status of compliance of OIC member states to some key maritime and port regulations. Overall, most OIC countries are up to-date with the main international regulations but improvements are needed particularly in the areas of container safety (CSC convention), insurance and liability (PAL protocol), and environmental management (HNS, ballast water, London convention). On the other hand, some OIC member states such as Guinea Bissau, Iraq and Djibouti are lagging well behind and must step-up their efforts in regulatory compliance. Several OIC member states are landlocked and it is therefore understandable that they may not be signatory or complaint with some or most of maritime and port regulations.

Table 16 outlines the latest performance tables for flag state and port state control as published by the International Chamber of Shipping (ICS) and the International Shipping Federation (ISF). The table point to Malaysia as the most performing OIC member while other countries such as Turkey, Iran and Bahrain also feature well in the performance league table. Maritime countries within the OIC which are least performing include Albania, Côte d'Ivoire, and Lebanon. Areas of particular shortcomings for these countries include port state control, reporting requirements, and maritime labour and training.

Table 15: OIC countries status of compliance with IMO regulations in 2014

	IMO Convention 48	SOLAS Convention 74	SOLAS Protocol 78	SOLAS Protocol 88	SOLAS Agreement 96	LOAD LINES Convention 66	LOAD LINES Protocol 88	TONNAGE Convention 69	COLREG Convention 72	CSC Convention 72	CSC amendments 93	SFV Protocol 93	Cape Town Agreement 2012	STCW Convention 78	STCW-F Convention 95	SAR Convention 79	STP Agreement 71	Space STP Protocol 73	IMSO Convention 76	INMARSAT OA 76	IMSO amendments 2006	IMSO amendments 2008	FACILITATION Convention 65	MARPOL 73/78 (Annex I/II)	MARPOL 73/78 (Annex III)	MARPOL 73/78 (Annex IV)	MARPOL 73/78 (Annex V)	MARPOL Protocol 97 (Annex VI)	London Convention 72	London Convention Protocol 96	INTERVENTION Convention 69	INTERVENTION Protocol 73	CLC Convention 69	CLC Protocol 76	CLC Protocol 92	FUND Convention 71	FUND Protocol 76	FUND Protocol 92	FUND Protocol 2003	NUCLEAR Convention 71	PAL Convention 74	PAL Protocol 76	PAL Protocol 90	PAL Protocol 02	LLMC Convention 76	LLMC Protocol 96	SUA Convention 88	SUA Protocol 88	SUA Convention 2005	SUA Protocol 2005	SALVAGE Convention 89	OPRC Convention 90	HNS Convention 96	HNS PROT 2010	OPRC/HNS 2000	BUNKERS CONVENTION 01	ANTI FOULING 01	BALLASTWATER 2004	NAIROBI WRC 2007	HONG KONG CONVENTION
Afghanistan										x																			x																		x	x												
Albania	x	x	x			x		x	x					x		x							x	x	x	x	x						d	x	x	x	x	x			d	d	d	x	x	x	x	x			x	x				x		x		
Algeria	x	x	x	x		x	x	x	x					x		x			x	x			x	x	x	x	x				x	x	d		x	d		x							x		x	x	x	x	x	x								
Angola	x	x	x			x		x	x	x				x		x								x	x	x	x			x	x				x			x														x	x							
Azerbaijan	x	x		x		x	x	x	x					x									x	x	x	x	x	x	x				x	x	x										x		x	x			x	x				x				
Bahrain	x	x				x		x	x					x					x	x				x			x						d	x	x	d	x	x									x	x												
Bangladesh	x	x		x		x	x	x	x					x		x	x	x	x	x			x	x	x	x	x	x			x																x	x				x								
Benin	x	x	x			x		x	x	x				x									x	x	x	x	x	x	x		x		x		x	x		x							x		x	x				x								
Bosnia & Herzegovina	x																		x	x																											x	x												
Brunei Darussalam	x	x	x			x		x	x					x					x	x				x									d	x	x	d		x									x	x												
Burkina Faso																																															x	x												
Cameroon	x	x				x			x					x		x			x	x			x	x	x	x	x				x		d	x	x	d		x														x								
Chad																																																												
Comoros	x	x	x			x		x	x					x					x					x	x	x	x								x			x									x	x				x								
Cote d'Ivoire	x	x	x			x		x	x					x		x							x	x	x	x	x		x		x		x		x	x		x									x	x	x	x		x			x	x				
Djibouti	x	x				x			x															x							x		d		x	d		x									x	x	x	x		x								
Egypt	x	x	x	x		x	x		x					x			x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x						x		x		x		x	x			x	x			x	x	x	x		
Gabon	x	x				x		x	x					x					x	x			x	x	x	x	x		x		x		d		x	d		x		x												x								
Gambia	x	x				x		x	x					x		x							x	x	x	x	x						x			x											x													
Guinea	x	x	x			x		x	x	x				x									x	x	x	x	x								x			x									x	x			x	x								
Guinea-Bissau	x																																														x	x												
Guyana	x	x	x			x		x	x	x				x									x	x	x	x	x				x		x			x					x				x		x	x			x	x								
Indonesia	x	x	x			x		x	x	x				x		x	x	x	x	x			x	x	x	x	x	x					x		x	d																				x	x			
Iran	x	x	x	x		x	x	x	x	x				x		x			x	x			x	x	x	x	x	x	x		x	x			x			x									x	x			x	x			x	x	x	x	x	
Iraq	x	x						x						x					x	x			x																								x													
Jordan	x	x		x		x	x	x	x	x				x		x							x	x	x	x	x		x				x								x						x	x			x	x				x	x	x		
Kazakhstan	x	x	x	x		x	x	x	x	x				x										x	x	x	x						x														x	x												
Kuwait	x	x	x			x		x	x					x					x	x				x	x	x	x	x			x		x	x	x	x											x	x												
Kyrgyzstan																																																												
Lebanon	x	x	x			x	x	x	x	x				x		x			x	x			x	x	x	x	x				x		x		x												x	x				x					x	x		
Libya	x	x	x	x		x	x	x	x					x		x			x	x			x	x	x	x	x		x				x								x	x					x	x				x								
Malaysia	x	x	x	x		x	x	x	x					x					x	x				x	x	x	x	x					d		x	x		x								x						x			x	x	x	x	x	

	IMO Convention 48	SOLAS Convention 74	SOLAS Protocol 78	SOLAS Protocol 88	SOLAS Agreement 96	LOAD LINES Convention 66	LOAD LINES Protocol 88	TONNAGE Convention 69	COLREG Convention 72	CSC Convention 72	CSC amendments 93	SFV Protocol 93	Cape Town Agreement 2012	STCW Convention 78	STCW-F Convention 95	SAR Convention 79	STP Agreement 71	Space STP Protocol 73	IMSO Convention 76	INMARSAT OA 76	IMSO amendments 2006	IMSO amendments 2008	FACILITATION Convention 65	MARPOL 73/78 (Annex I/II)	MARPOL 73/78 (Annex III)	MARPOL 73/78 (Annex IV)	MARPOL 73/78 (Annex V)	MARPOL Protocol 97 (Annex VI)	London Convention 72	London Convention Protocol 96	INTERVENTION Convention 69	INTERVENTION Protocol 73	CLC Convention 69	CLC Protocol 76	CLC Protocol 92	FUND Convention 71	FUND Protocol 76	FUND Protocol 92	FUND Protocol 2003	NUCLEAR Convention 71	PAL Convention 74	PAL Protocol 76	PAL Protocol 90	PAL Protocol 02	LLMC Convention 76	LLMC Protocol 96	SUA Convention 88	SUA Protocol 88	SUA Convention 2005	SUA Protocol 2005	SALVAGE Convention 89	OPRC Convention 90	HNS Convention 96	HNS PROT 2010	OPRC/HNS 2000	BUNKERS CONVENTION 01	ANTI FOULING 01	BALLASTWATER 2004	NAIROBI WRC 2007	HONG KONG CONVENTION
Maldives	x	x		x		x		x	x					x										x			x						x	x	x	x		x									x	x										x		
Mali																							x																								x	x												
Mauritania	x	x	x			x		x	x					x	x									x	x	x	x				x	x	d	x	x	x		x									x	x	x	x		x								
Morocco	x	x	x			x		x	x	x				x	x	x			x					x	x	x	x	x	x		x	x	d		x	d	x	x	x								x	x				x	x			x	x		x	
Mozambique	x	x				x		x	x					x		x			x	x				x	x	x	x						d		x	d		x									x	x				x								
Niger																																															x	x												
Nigeria	x	x	x			x		x	x	x				x		x			x	x			x	x	x	x	x		x	x	x		d		x	d		x			x				x		x				x	x				x	x	x	x	
Oman	x	x	x	x		x	x	x	x					x		x			x	x				x	x	x	x		x		x	x	d	x	x	d		x									x	x			x	x								
Pakistan	x	x	x	x		x	x	x	x	x				x		x			x	x				x	x	x	x		x		x	x			x												x	x				x								
Qatar	x	x				x		x	x					x		x			x	x				x	x	x	x				x		d	d	x	d		x									x	x	x	x		x								
Saudi Arabia	x	x	x			x		x	x	x				x		x	x	x	x	x				x	x	x	x	x		x			x	x	x												x	x	x	x	x	x								
Senegal	x	x	x			x		x	x					x		x			x	x			x	x	x	x	x				x		x		x			x									x	x				x								
Somalia	x					x																																																						
Sudan	x	x				x		x	x					x																																	x	x												
Suriname	x	x				x								x									x	x	x	x	x		x	x	x																													
Syria	x	x	x	x		x		x	x	x				x	x	x							x	x	x	x	x	x	x		x		x		x	d		x						x	x	x	x	x			x	x	x		x	x	x	x		
Tajikistan																																															x	x												
Tunisia	x	x	x	x		x	x	x	x	x				x		x			x	x			x	x	x	x	x	x	x		x	x	d		x	d		x									x	x			x	x				x	x			
Turkey	x	x	x			x	x	x	x	x				x		x			x	x				x	x	x	x	x							x			x	x						x	x	x	x	x		x	x			x	x		x		
Turkmenistan	x	x				x		x	x					x										x	x	x	x						x		x												x	x												
Uganda	x																																														x													
UAE	x	x	x			x		x	x					x		x			x	x				x	x	x	x		x		x		x	x	x	d		x							x		x	x			x									
Uzbekistan																																															x	x												
Yemen	x	x		x		x	x	x	x	x				x			x	x	x				x							x	x	x	d	x	x					x	x	x			x		x	x			x	x			x		#			

Source: Consultant from IMO (as of 17/10/2014)

Table 16: Flag state performance tables for OIC countries in 2013/14

	Port State Control [a]						Non Ratification of Conventions							A.739	Age [b]	Reports [c]		IMO [d]
	Not on Paris MoU white list	On Paris MoU black list	Not on Tokyo MoU white list	On Tokyo MoU black list	Not on USCG Qualship (Qualifying registries)	On USCG target list (safety)	SOLAS 74 (and 88 protocol)	MARPOL (including annexes I, II)	MARPOL Annexes III-VI	LL 66 (and 88 protocol)	STCW 76	ILO MLC	CLC Fund 92	Number of no IACS bodies	High age (ship numbers)	Not in latest STCW White list	Not completed full ILO reports	IMO meeting attendance
Albania	●	●	●		●		●		●	●		●		N/S				●
Algeria	●		●		●				●			●						
Azerbaijan	●	●	●		●		●			●				N/S	●	●		●
Bahrain	○		●		●									N/S				
Bangladesh	●		○	●	●										●			●
Cote d'Ivoire	●		●		●		●		●	●				N/S				●
Egypt	●		●		●	●			●				●	●				
Indonesia	○		●	●	●		●					●	●					
Iran			○		●							●						
Jordan	○		○		●				●			●	●					●
Kuwait	●	●	●		●		●					●	●					
Lebanon	●	●	●		●		●		●			●	●		●			
Libya	●	●	○		○				●			●	●				●	
Malaysia	●																	
Morocco	●		●		●		●			●								
Nigeria	●		○		●		●		●	●								
Pakistan	○		○		●			●				●	●					●
Qatar	○		○		●		●		●	●		●						●
Saudi Arabia	●		●		○		●			●		●	●					●
Syrian	●		○		●					●								●
Tunisia	●		○		●						●		●					●
Turkey			●		●		●		●	●		●						
UAE	●				●		●		●	●		●						●

Source: Consultant from ICS and ISF

●: suggests possible negative performance indicators. N/S: no data submitted to IMO, regarded as negative indicator.

○: indicates where a flag administration suffered no detentions within the particular PSC region for the period, but did not meet the relevant minimum requirement of inspections/arrivals to be included in an MOU white list or the USCG Qualship 21 programme.

a: indicates a failure to achieve confirmation of the reports of independent evaluations confirming compliance with STCW necessary to maintain IMO STCW 'white list', and a failure to submit all compliance and proper reports requested by ILO.

N/S: Not submitted

5.1.2. Economic Regulation

A central tenet of efficient port systems is to ensure effective competition between and within port markets. Governments and public authorities should aim at remedying potential or demonstrable market failures and other hindrances to the wider economic and social objectives. Economic (or market) regulation is only required when there is not enough competition in order to ensure that prices can be set by the market. Where there is *competition in the market* such as the case of inter-port competition and market liberalisation, the Government's role should focus on reducing or preventing intervention and ensuring neutrality so that the market functions properly.

Where there are few suppliers or in case of a monopoly such as in the markets for the provision of marine services or for ports with a natural monopoly, the Government may introduce *competition for the market* through competitive bidding between potential suppliers. Sometimes, *yardstick competition* may also be introduced in order to oversee the operations of regulated industries, for instance as a tool to regulate pricing and tariff arrangements. The scope of economic regulation also include the areas of market access, mergers and acquisitions, concessions and private sector participation, tariffs and pricing, incentives and subsidy programmes, and efficiency and yardstick benchmarking. In the sections below, the Study focus on key regulatory themes relevant to the port sector in OIC countries.

5.1.2.1. Liberalization

In the past two decades, several OIC countries have introduced market-oriented policy and regulatory measures which have resulted in the liberalization of many segments of the port's industry. While full privatization of port services generally leads to lower costs per unit of output and to substantial improvements in service quality, partial privatization is less effective at achieving both goals. In several OIC countries, many segments of public port monopolies were partially privatized or corporatized; however some countries still retain a significant stake in port infrastructure and services. This is particularly the case of public port authorities, state-owned companies, and other public agencies which either hold a near monopoly in their respective sectors and/or provide both statutory and commercial services. The lack or absence of port economic regulation in the sector has enabled these public port companies to gain monopolistic positions and encouraged them to cross-subsidise the loss-making activities from surpluses earned by profit-making activities.

5.1.2.2. Market access

Market access regulation in the context of OIC country ports refers to the conditions, regulations, tariff, and non-tariff measures put upon service providers to enter and compete in port markets. For domestic service providers, the measures of market access are usually embedded in the conditions and limitations put in place for accessing the port (and shipping) profession; for instance in the case of national companies or individual citizens who want to exercise ship and port agency, freight forwarding, and other intermediary services. For foreign providers, the measures of market access usually refer to the limitations put in place on the nationality of service providers or on the participation of foreign capital in national and domestic companies. Regarding market access, the Study concludes that port markets in OIC countries do not impose any particular barriers against WTO (World Trade Organisation) rules of market access in cargo handling and auxiliary services (11.H 741 and 742). However, there are a series of restrictions on the access of marine services markets (11.A 7214, 11.A 754) as well as port, shipping and freight agency (11.H 748) [See table 17].

Table 17: Applied port market access regime under 11.H: services auxiliary to maritime transport

	Sector title	Measure title	Measure text
Indonesia	Inland waterways , and auxiliary maritime transport services	Limits on foreign ownership	"Foreign investment in maritime transport services is limited to 60% in the ownership of vessels and cargo handling services. Foreign investment in maritime transport is limited to 49%: maritime passenger transport services, maritime freight transport services, harbour facilities harbour waste reception facilities salvage and underwater works maritime freight transport services, river and lake transportation services by ships of less than 30 gross tonnage. Foreign investment is limited to 49% in internal waterways shipping services.
	Maritime auxiliary services	Market entry is allowed (mode 3)	
Jordan	Maritime auxiliary services	Absence of restrictions on repatriation of earnings	
	Maritime auxiliary services	Establishment as branch allowed (greenfield)	
	Maritime auxiliary services	Establishment as subsidiary allowed (greenfield)	
	Maritime auxiliary services	Market entry is allowed (mode 3)	"Additional services other than those listed below are also permitted."
	Maritime auxiliary services	No other forms of discrimination on operations of established foreign suppliers	
	Shipping agents	Nationality requirement on managers	"Shipping agents must have a general manager of Jordanian nationality."
Malaysia	Maritime transport services	Forms of establishment	The following maritime transport services may only be conducted through a representative office, a regional office or a locally incorporated joint venture corporation with Malaysian individuals or Malaysian controlled corporations or both: • services for the maintenance and repair vessel services, • rental and leasing services of all types of self-propelled seagoing vessels with operator, • supporting services for maritime transport, such as vessel salvage and refloating services, • maritime cargo handling services for sea transport • storage and warehousing services • maritime freight forwarding services • maritime agency services (covering marketing and sales of maritime transport and related services and acting on behalf of the companies organising the call of the ship or taking over cargoes when required)
	Maritime auxiliary services	Establishment as branch allowed (greenfield)	
	Maritime auxiliary services	Establishment as subsidiary allowed (greenfield)	
Morocco	Maritime auxiliary services	Market entry is allowed (mode 3)	

Mozambique	Maritime auxiliary services	Absence of restrictions on repatriation of earnings	"To repatriate earnings, the projects must be approved by the Investment Promotion Centre and registered with the Central Bank."
	Maritime auxiliary services	Market entry is allowed (mode 3)	"'Other' auxiliary services are also permitted."
	Maritime auxiliary services	Nationality requirement for employees	"Employment of foreign staff is subject to authorization by the Minister of Labour and a labour markets test, i.e. equally qualified nationals should be given priority. Regarding the former, there is a de minimis threshold of 5-10% of total employment, depending on firm size, below which no authorization is required. It has also become practice to apply the de minimis threshold to the labour market test, however this practice might be challenged in the future."
Nigeria	Maritime auxiliary services	Market entry is allowed (mode 3)	"Shipping firms which win and own concessioning rights can supply auxiliary port services."
Oman	Maritime auxiliary services	Establishment as branch not allowed (Greenfield)	
	Maritime auxiliary services	Establishment as subsidiary not allowed (Greenfield)	
	Maritime auxiliary services	Market entry not allowed (mode 3)	"Each of Oman's three main ports is operated by a port management company, two of which are listed joint stock companies and one a joint venture, under a long-term concession granted by the government to operate the respective port facility."
Pakistan	Maritime auxiliary services	Authorities are required to inform applicants of reasons for license rejection (mode 3)	
	Maritime auxiliary services	Market entry is allowed (mode 3)	"This is open, except that foreign suppliers cannot provide these auxiliary services for ships of other firms."
Saudi Arabia	Maritime auxiliary services	Market entry is allowed (mode 3)	
	Maritime auxiliary services	Nationality requirement for board of directors	"Requirement applies to ship-owning companies only."
Turkey	Maritime auxiliary services	Absence of restrictions on repatriation of earnings	
	Maritime auxiliary services	Establishment as branch allowed (greenfield)	
	Maritime auxiliary services	Establishment as subsidiary allowed (greenfield)	
	Maritime auxiliary services	Market entry is allowed (mode 3)	"Some ports have been privatized, so there exist ports for which private sector entry is not allowed and some ports for which it is; the scope of permissible activities thus depending on the individual port."
	Maritime auxiliary services	No limit on the number of licenses available (mode 3)	
	Maritime auxiliary services	No other forms of discrimination on operations of established foreign suppliers	

Source: Consultant from WTO (as of 17/10/2014)

At the same time, the introduction of PPP and concession legislation have opened port markets in OIC countries to foreign and private sector investors which has widen the scope of private sector participation (PSP) in the sector.

Table 18: Public ownership share in the container terminals under study

Terminal /Company	Country	% public ownership
Dakar 1	Senegal	None
Tangier Med 1	Morocco	None
Tangier Med 2	Morocco	None
Casablanca 1	Morocco	100% (through public enterprise)
Casablanca2	Morocco	0%
Aqaba	Jordan	50% (through public enterprise)
Jakarta International	Indonesia	65%
Mersin International	Turkey	None
Ambarli Kumport		None
Ambarli Marport		None
Apapa	Nigeria	None
Maputo	Mozambique	45%
Salalah	Oman	70%
Qasim International	Pakistan	40%
Doraleh	Djibouti	35%
Jeddah Southern	Saudi Arabia	None
Jeddah Northern		None
Northport	Malaysia	20%
Westport Container Terminals (1,2,3 & 4)		5%
Tanjung Pelepas Container Terminal		None
Yantian International	China	None
Hong Kong Modern (1,2,5,8W & 9S)		None
Hong Kong Int. Terminals (4,6,7, 9N)		None
ECT Rotterdam	The Netherlands	None
Maersk Rotterdam		None
Singapore all terminals	Singapore	100% (through public enterprise)

Source: Consultant

5.1.2.3. Competition

Without adequate port competition, or market/economic regulation where such competition is not feasible, cost reductions and efficiency gains may not be fully achieved in the port and related transport and trade logistics sectors. The general competition policy in ports comprises, but is not exclusively limited to, the competition legislation in the sector, anti-trust and merger control, and state aid and subsidy rules.

Port competition can also take place through the unbundling of port services, the transparent management of the process and monitoring of the exclusive rights to provide services, and the promotion of through (intermodal) transport competition. Such practices are not always evident in OIC ports with only half of the ports under study (Malaysia, Morocco, Nigeria, Senegal, Saudi Arabia, and Turkey) showing full intra-port competition between terminals or through the unbundling of port services.

Port concession is another tool that can be used to regulate a market characterized by limited competition while in parallel attracting private investment to partly substitute public funds. This dual objective seems to be behind several concessions in OIC ports, especially those that have not been preceded by an institutional restructuring and policy reform.

Nevertheless, despite being relatively successful in attracting private sector funding and unbundling some of port services; the experience in many OIC countries shows that this had not been able to prevent public sector monopoly or eliminate instances of market failures. Indeed, none of the OIC countries under study has a separate and independent port regulator, although there are plans to create one in Nigeria and another one in Egypt (although the latter country is outside the sampled OIC ports for this study).

In most OIC countries, the greatest danger probably lies in the competition dynamics between state-owned enterprises and the private sector as well as in the difficulty to disentangle port policy, operations, and regulatory functions from public enterprises and government agencies (public port companies, port authorities). Often, this has led to monopolistic behaviour from state corporations and in some instances to poor or inexistent inter-port and intra-port competition between and within OIC ports.

5.1.2.4. Pricing

Pricing and tariff arrangements for port services and activities can also be indicative of market failure. Prices for port and maritime services are set either freely according to what the market can bear or publically through price regulation. In either case, the current pricing structure does not seem to capture marginal and external costs. Furthermore, pricing policies does not seem to be used as regulatory incentive to promote competition or disincentive against monopoly or collusion behaviour. Based on published port tariffs and annual port reports on operations of county port authorities, certain conclusions can be made.

For port charges, dues are set according to what the market can bear or taking other port charges as comparators; but a specific pricing regime could not be identified, e.g. strategic port pricing, marginal cost pricing, average cost pricing, congestion pricing, etc. being applied in any of the national ports. Indeed, port charges in OIC show discrepancy in methods and criteria for charging port fees and other revenues, which should serve to finance maintenance and improvement of ports' infrastructure. In some ports, there are no fees, while in others; fees are charged in advance at fixed rates. Most ports discriminate between foreign and domestic ships. However, some ports charge for each berth, in accordance with the ship’s length, and the amount per meter of the berthed vessel significantly differs between ports.

6. Operational Structure and Port Efficiency

For most OIC countries, the integration of their economies into global trade and supply chains depends critically on port efficiency. Thus, it is important to identify and assess the factors that most influence productivity and efficiency within the port sector with a view to formulating and implementing operational and policy measures for improving port performance and competitiveness. For ports, the benefits of performance benchmarking extend beyond operational and competitive objectives to include wider policy reform and global trade integration.

This section reports on the results of a study to measure and benchmark the efficiency and operational performance of the port sector in the OIC countries. The methods used to measure and benchmark ports' performance are Data Envelopment Analysis (DEA) and the Malmquist Index Productivity (MPI). Appendices 3 and 4 describe the DEA and MPI methodologies, respectively, and justify their use in the context of this study.

Inefficient port systems may also be the consequence of lengthy customs' and release procedures, cumbersome administrative arrangements, and a lack or absence of integration of the various processes (both physical and virtual) involved in trade logistics and cargo movements. The analysis of operational efficiency in this section also includes an assessment of port's trade and logistics efficiency in the OIC countries using global indicators such as the Logistics Performance Index (LPI) and the Liner Shipping Connectivity Index (LSCI).

6.1. Methodology and Data

6.1.1. Methodology

6.1.1.1. Data Envelopment Analysis (DEA)

The primary aim of port performance benchmarking is to measure and compare productive efficiency across time and/or between ports, or Decision Making Units (DMUs). Broadly, efficiency can be defined as the ability of a DMU to produce a given output in a manner that is economic and efficient. In other words, the productive efficiency is defined as the relative ability of a port to successfully use and allocate its resources (inputs) so as to maximize its production (output) and minimize its costs. In the multi-input and multi-output port environment, performance measurement and benchmarking entails a further dimension because of the potential for input substitution. Understanding the relationship between inputs and outputs is important for port owners, operators, regulators, and policy makers in order to assess port productivity, competitiveness, and quality of services.

In Appendix 4, benchmarking methods are reviewed for port operations and they demonstrate that a valid benchmarking analysis should be defined relative to an assessment of best practice, i.e. the level of efficiency should be measured relative to an efficiency frontier. It is also showed that several benchmarking techniques can be used to estimate the efficiency frontier. Such methodologies can be classified into two main categories: econometric (parametric) techniques such as the Stochastic Frontier Analysis (SFA) and programming (non-parametric) techniques such as Data Envelopment Analysis (DEA). The former require assumptions about the relationship between inputs and outputs to estimate the parameters of a cost or a production function; while the latter relates outputs to inputs by estimating efficiency directly from the data.

Further discussions on the advantages and disadvantages of each technique as well as on the features of container-port operating systems show that programming techniques are most suited to measuring and benchmarking port operational efficiency. In particular, the structure of container port production depicts different handling configurations and operating systems, which makes the estimation of a functional form under SFA very difficult to apply in the context of international port benchmarking. Programming techniques are less restricted to sample size than econometric models, and can estimate technical efficiency for both individual inputs and the overall production process. Moreover, both the multi-output nature of port production and the lack of detailed data are likely to limit the practicality and reliability of econometric methods. On such grounds, the use of programming techniques namely in the form of a series of DEA models are recommended.

6.1.1.2. Malmquist Productivity Index (MPI)

In addition to measuring and benchmarking port efficiency, total factor productivity (TFP) is tracked and decomposed using an index that can be derived and be compatible with the DEA methodology. To do so, the use of Malmquist DEA technique is advocated. The Malmquist Productivity Index (MPI), requires the estimation of a distance function but the latter can be directly specified under DEA. Appendix 5 describes in detail the MPI derived from DEA and its decomposition structure.

In applying the Malmquist Productivity Index, port data for both the assessment of port efficiency and for the analysis of total factor productivity growth can be exploited. On the one hand, this approach provides a sound basis for benchmarking terminal efficiency with a view to tracking the shifts in production over time. For instance, in the context of port ownership structure, the MPI can track changes in port productivity before and after the implementation of institutional reform. On the other hand, the approach also indicates whether any convergence in port productivity has taken place over time, especially for port groups with similar ownership and institutional structures. For instance, a clustering of ports by ownership and institutional arrangements, e.g. private v. public ports, landlord v. service ports; should shed further light on productivity differences across several groups of ports.

Another key advantage of the Malmquist Productivity Index is that it can be further decomposed into three various indices namely (i) the pure technical efficiency change (PEC) representing pure efficiency, (ii) the scale efficiency change (SEC) representing the effects of scale production, and (iii) the technological change (TC) representing the frontier shift effects. This feature makes the Malmquist Productivity Index a particularly attractive technique for measuring changes in, and decomposing the sources of, productivity. The decomposition of the Malmquist index helps to single out the impacts of certain port features, such as scale efficiency, from those of other port features.

6.1.2. Data and Variables

The Study start with a dataset for the selected 12 commercial ports in OIC countries and 4 other best in-class international ports as shown in Table 1. For each port, one or several container terminals, being defined as DMUs, resulting into a dataset of 26 terminals were selected. For the data used, the choice of variables is based on a high-level aggregation of container-terminal operations with a view to utilizing available and reliable data on operational performance and ensuring homogeneity between observation units.

In defining dataset variables, the variations in handling configurations and technology for instance by using indices that account for the variations of technological performance for sea-to-shore (STS) and yard-staking cranes are taken into account. Each generic port configuration usually incorporates a corresponding set of capital and labour mix, thus no cost or labour data is required for benchmarking operational efficiency.

The variables selected for this study consist of seven inputs and one output. The input variables are terminal area, maximum draft, length overall, STS-crane index, yard-stacking index, internal trucks and vehicles, and number of gates (or gate lanes). The output variable is terminal throughput in TEU. STS and yard crane indices are carefully defined to include the differences in handling technology and operating configuration among terminals in the sample.

Table 19: Input and output variables for container terminal operations

Variables	Descriptions	Units
Terminal area	Total terminal area in square meters	1000 m^2
Maximum draft	Maximum draft in the terminal	Meter
Length overall (LOA)	Total quay length in meter	Meter
Quay crane index	STS crane index = Lifting Capability * STS Cranes	TEU
Yard stacking index	Yard equipment stacking index = staking height *storage capacity *Yard Equipment	TEU /1000 m^2
Trucks & Vehicles	Internal trucks, tractors and other supporting vehicles	Number
Number of gates	Number of gates, gate lanes, and/or railway tracks at the gate	Number
Terminal Throughput	Annual total throughput	1000 TEU

Source: Consultant

Regarding the data collection methods, both primary and secondary data sources were used in this study. Primary data was sourced directly from the websites and annual reports of sampled ports and terminal operators through online and telephone queries (see Appendix 6) as well as during port visits. Secondary data was sourced from subscribed databases and trade journals such as Containerisation International, Cargo World, Fair-play, and World Port Focus. The information from all these sources are verified and crosschecked. The dataset consists of annual observations of sampled container terminals and spans the period from 2009 to 2013. This is because a recent time scale is selected that would allow to assess productivity changes over a reasonable period while avoiding the impacts of outside shocks such as the 2008 global recession. In a dynamic context, panel data prevail over times-series and cross-sectional data, and as such a DMU is defined as a container terminal-year, for instance ACT-2009 or PTP 2013. The combination of 26 terminals, 8 variables, and a 5-year timeframe has resulted into a panel dataset of 130 DMUs and 1040 data points.

Table 20: Descriptive statistics of OIC container terminals dataset

Variable	Minimum	Maximum	Mean	Standard Deviation
Terminal area (1000 m^2)	105	2650	730	505
Maximum Draft	10	18	14	2
LOA	305	4875	1515	993
STS-crane index	2	390	55	57
Yard stacking index	6	212	35	35
Internal trucks and vehicles	2	390	55	57
Gates	3	37	10	7
Terminal throughput (1000 TEU)	350	9600	1526	1465

Source: Consultant

6.2. Efficiency Results and Analysis

This section sets out to analyse and compare the efficiency estimates and results from both the benchmarking exercise and the productivity change analysis. The approach adopted in this section is to present and interpret the empirical results by type of analysis and terminal group. In so doing, the empirical results are analysed and validated in ways that allow understanding the nature of the container-port production and investigate the relationship between institutional and organisational structures and port efficiency. Software DEA-Frontier Zhu (2003) is used to derive solutions to both the benchmarking and productivity change analyses.

6.2.1. DEA Benchmarking Analysis

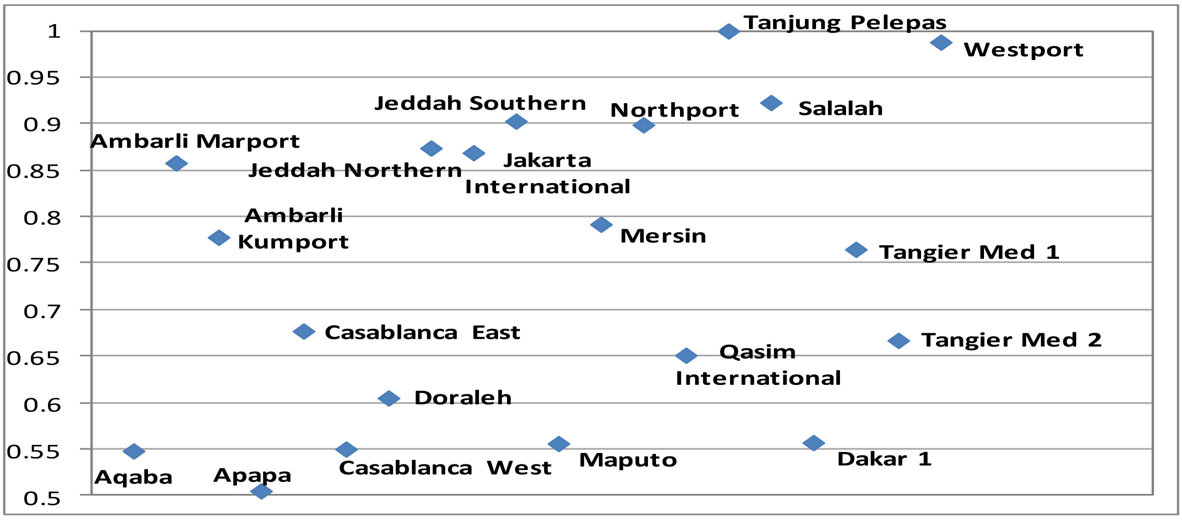
6.2.1.1. Efficiency estimates for OIC terminals

In this section, the results of the benchmarking analysis for OIC ports under two DEA approaches are presented: the contemporaneous DEA and the inter-temporal DEA. Both approaches assume constant technology over time, but each of them has its own advantage. Under contemporaneous (cross-sectional) DEA, the frontier is constructed at a single point in time (e.g. a year) from cross-sectional data. Consequently, a port or terminal is benchmarked against a small sample of observations and therefore has a greater chance to be classified as more efficient. Under inter-temporal (panel-data) DEA, a single frontier is constructed from panel data by pooling all port observations made throughout the time-periods under consideration so that each terminal-year is treated as a separate decision making unit (DMU). As a result, a terminal is benchmarked against a large sample of observations and therefore has a greater chance of being dominated or classified as less efficient.

Appendix 7 reports the results of the efficiency estimates of OIC terminals under cross-sectional analysis. Figures 5 to 9 show the performance rankings of OIC terminals in the years 2009-2013, respectively. Across the study period, the OIC terminals under study have performed differently with efficiency scores ranging from a maximum top of 1 (100%) to the low scores of 0.5 (50%). Tanjung Pelepas was the most consistent and highest performing terminal in all years with the maximum efficiency score of 1. Three other terminals, Northport, Salalah and Westport, have also scored consistently high in all the five years. At the other end of the scale, the two port terminals of Apapa and Maputo have constantly scored low efficiency ranking of 50%-60% in all years. Elsewhere, most terminals have not seen significant changes to their efficiency scores, with the exception of the Aqaba, Casablanca West, and Dakar terminals which have all experienced a noticeable efficiency jump from low score of 50-55% to the relatively high scores of 70-75%. Finally, worth noting Jeddah Southern Container Terminal which achieved the maximum efficiency score of 100% in 2012 and 2013 consecutively.

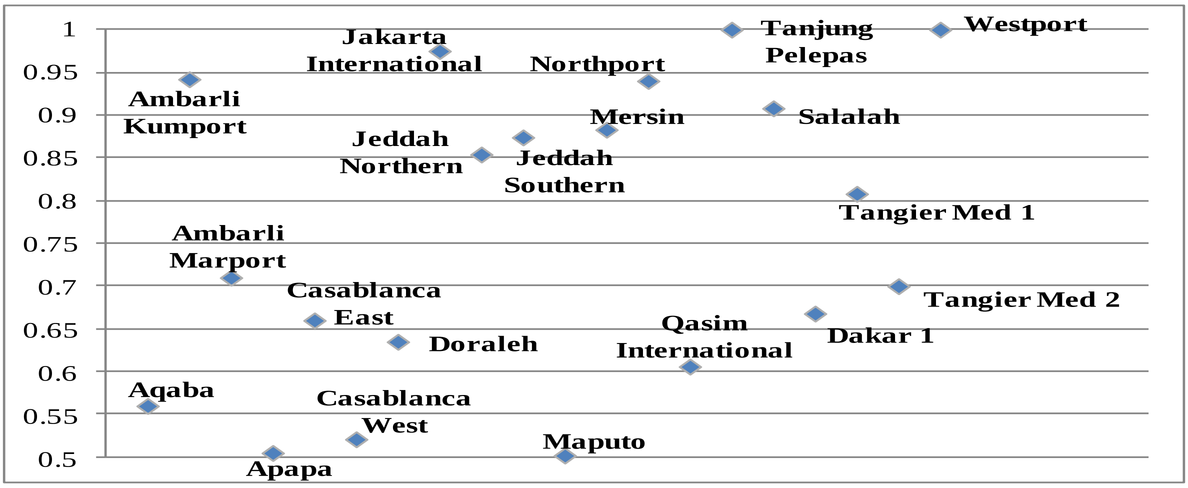
In terms of the average efficiency scores in cross-sectional analysis, there has been an upward trend of average terminal efficiency from 0.748 in 2009 to 0.836 in 2013, which translates into an 11.74% average efficiency rise over the five year study period or a 2.35% annual efficiency increase. The year 2013 has seen more efficient ports with 15 out of the 20 terminals under study showing an efficiency rating of over 75%. In contrast, 2009 has seen the lowest aggregation of efficiency scores with 5 terminals scoring less than 60% and only 4 terminals scoring more than 90%.

Figure 5: OIC terminal efficiency under DEA cross-sectional analysis (2009)



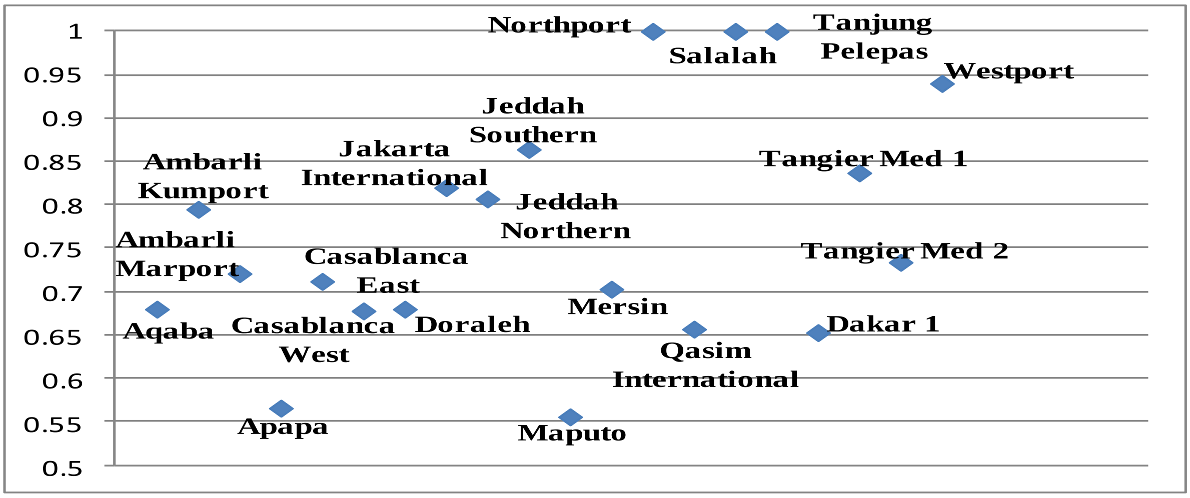
Source: Consultant

Figure 6: OIC terminal efficiency under DEA cross-sectional analysis (2010)



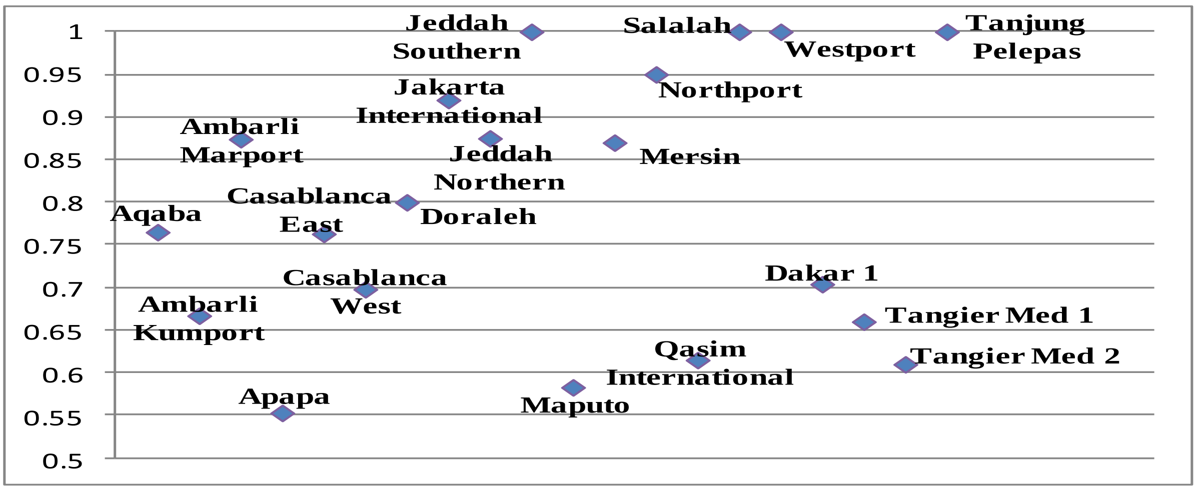
Source: Consultant

Figure 7: OIC terminal efficiency under DEA cross-sectional analysis (2011)



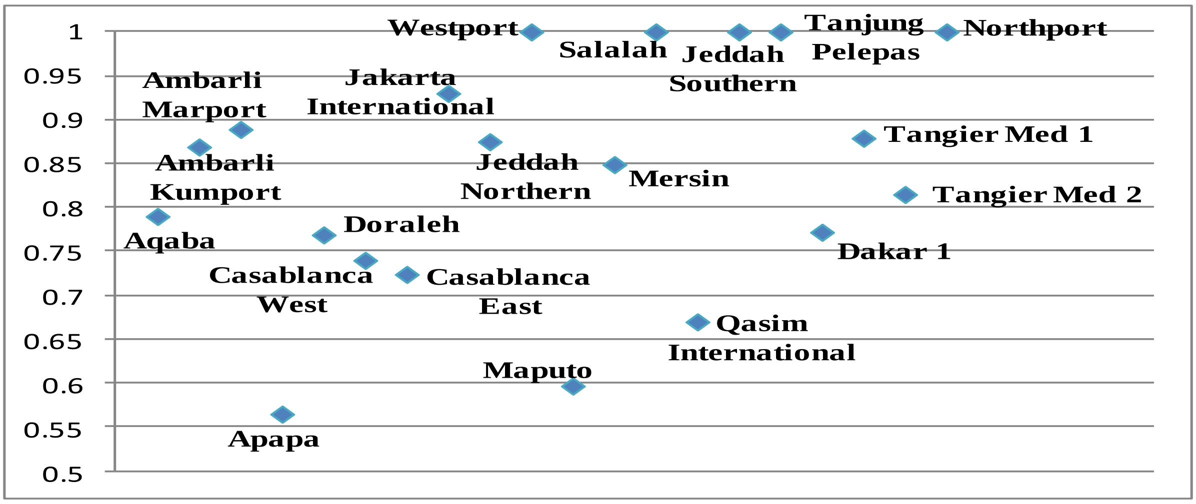
Source: Consultant

Figure 8: OIC terminal efficiency under DEA cross-sectional analysis (2012)



Source: Consultant

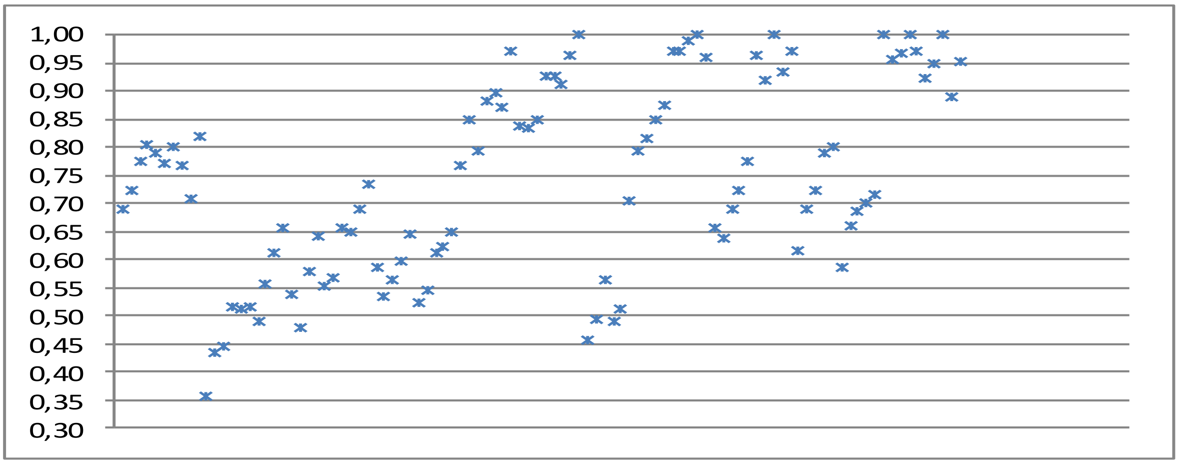
Figure 9: OIC terminal efficiency under DEA cross-sectional analysis (2013)



Source: Consultant

For the DEA panel analysis (inter-temporal DEA), Figure 10 shows the distribution of the 100 OIC terminal-years under study. It shows a general trend of relatively high operational efficiency with two-third of the terminals (75 terminal-years) scoring above 0.6 (60%) and almost half of the terminals (49 terminal-years) scoring a rating of over 0.75 or 75%. Among the performing terminals, six terminal-years out of 100 in the sample are identified as efficient (efficiency score of 1 or 100%). Those are Tanjung Pelepas-2009, Salalah-2011, Westport-2011, Northport-2012, Tanjung Pelepas-2012, and Jeddah South-2013. Conversely, nine terminal-years are identified as the least efficient with efficiency scores of less than 0.5 or 50%. Those are Dakar-2009, Maputo-2009, Aqaba-2009, Apapa-2009, Maputo-2010, Apapa-2010, Casablanca East-2010, Apapa-2011, and Maputo-2012. Appendix 8 shows the full results of the DEA panel data analysis.

Figure 10: OIC terminal efficiency under DEA panel-data analysis



Source: Consultant

6.2.1.2. Efficiency estimates for both OIC and reference ports

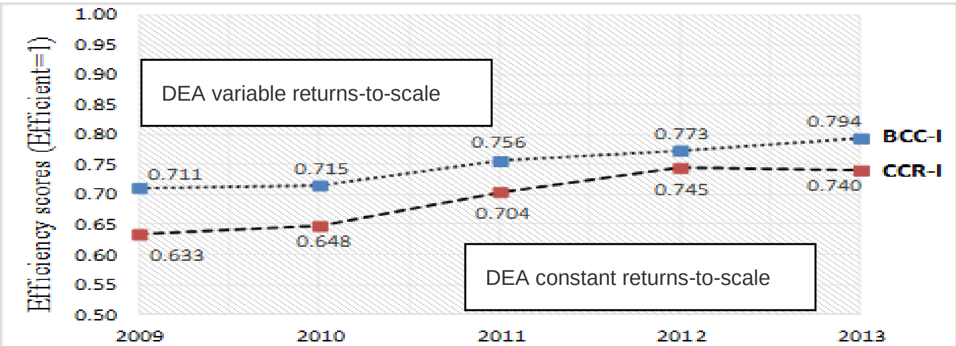
Here, six reference terminals (20 terminal-years) are added to check whether the results from the previous analysis still hold when adding international best-in class benchmarks but also to test how the performance of OIC ports in general compares with that of reference ports. The results, which are reported in Appendix 9, show that 20 out of the 130 terminal-years in the sample are efficient under the DEA variable returns-to-scale model compared with only 14 units identified as efficient under the DEA constant returns-to-scale model. These results confirm that while the same set of ports are identified as efficient under both models, the constant returns-to-scale model is more restrictive than the variable returns-to-scale models model, with average efficiency scores of 69.1% and 75% respectively.

Despite the general trend of relatively high operational efficiency across OIC ports, four terminals (14 terminal-*years*) depict particularly low average efficiency scores of less than 50%. Those are Apapa, Casablanca East, Maputo, and Dakar. At the other end of the scale, five terminals (41 terminal-*years*) depict high efficiency scores of over 90%. Those are Hong Kong International Terminals, Port of Singapore, Tanjung Pelepas, and Yantian International Terminals. The remaining terminals can be divided into 3 categories: those with an average score between 50% and 60% (Ambarli Marport, Casablanca West, Jakarta International); those with an average score between 60% and 70% (Aqaba, Ambarli Kumport, Doraleh, Mersin, Jeddah North, Port Qasim, and Tangier Med 1 and 2); those with an average score between 70% and 80% (Jeddah South, Westport); and those with an average score between 80% and 90% (Hong Kong Modern Terminals, Salalah, Northport, Maersk Delta and European Common terminals in Rotterdam).

Apapa-*2009* scored the lowest efficiency rating in the sample with a value of 0.351. Apapa also scored the lowest average efficiency score (0.452) for the 5-year study. In contrast, Yantian terminals in Shenzhen scored the highest overall score over the study period with a 100% efficiency rating. Yantian was closely followed by Singapore, Tanjung Pelepas, and Hong Kong International with average efficiency scores of 98.3%, 98.2%, and 97.6%, respectively. The above results are in line with the general efficiency distribution shown in the previous section. More importantly, they show that when adding reference ports to the terminal dataset, the general average efficiency of OIC ports drops between 10-15%. Yet, the results should be read with caution as several OIC ports notably Tanjung Pelepas, Northport, Westport and Salalah depict an equally high performance as the one set by reference international ports.

Turning to the comparison of overall efficiency scores, Figure 11 depicts the year-by-year evolution of average terminal efficiency. It shows a small upward trend for efficiency estimates throughout the study period. However, between 2009 and 2010 there was almost a flat trend with a rate of increase of 1.3%, while between 2012 and 2013 there is a slight decline of 0.7%. These results may be due to a flat or declining demand pattern as a result of the global financial crisis of 2008 and the fears of a global stagnating economy in 2013.

Figure 11: Year-by-year (2009-13) evolution of average terminal efficiency



Source: Consultant

6.2.1.3. Results by terminal group

In this section, the results of the DEA productivity analysis are used to compare OIC ports according to their institutional structure, traffic type, operating configurations, and scale features.

Impact of institutional structure and ownership type on terminal efficiency

To examine whether there is a relationship between port institutional structures and productive efficiency, terminals are classified into seven groups according to their institutional arrangements as previously outlined in Section 3, and analyse the variations of efficiency scores between and within groups. Because none of the OIC ports under study were classified as public service or tool ports, these groups have not been included.

Table 21: Port groups by institutional structure

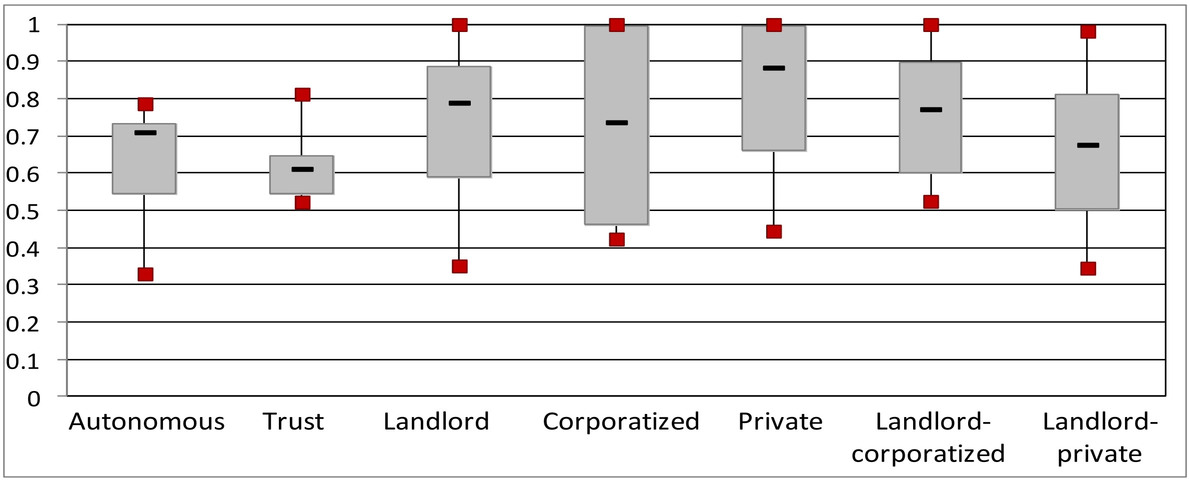
Institutional model	Terminals /Ports
Autonomous	Doraleh[4], Dakar
Trust port	Port Qasim
Landlord	Apapa, Casablanca West, Rotterdam ECT, Rotterdam Maersk Delta, Jeddah North, Jeddah South, Tangier Med 1, Tangier Med 2
Corporatized	Casablanca East, Singapore
Private service	Ambarli Marport, Ambarli Kumport, Mersin, Hong Kong Modern, Hong Kong International, Tanjung Pelepas, Westport, Yantian
Hybrid landlord-corporatized	Jakarta International, Northport
Hybrid landlord-private service	Aqaba, Maputo, Salalah

Source: Consultant

Figure 12 shows the variation of productive efficiency by type of institutional ownership across the 26 terminals under study. In Figure 12, the grey box represents the inter-quartile range of efficiency scores where the median is indicated by the black centre line and the lower and upper edges of the box are the first and third quartiles, respectively. The extreme values (minimum and maximum efficiency scores) are represented by the squares at both ends of the lines which extend beyond the grey box. Accordingly, the private service and landlord models depict on average the highest efficiency ratings, while the trust model shows the lowest average productive efficiency. The corporatized model is also performing well, largely because of the presence of Singapore, one of the most efficient ports in the world. On the other hand, neither the trust model nor the autonomous model has a maximum efficiency score of 85% or beyond, while all other models achieve the highest score of 100%. Those results suggest that port models with high private participation or corporatization levels tend to outperform other port structures particularly those with a high level of centralisation and public sector interference.

[4] Doraleh was autonomous until 2013-14

Figure 12: Variation of productive efficiency across port institutional structures



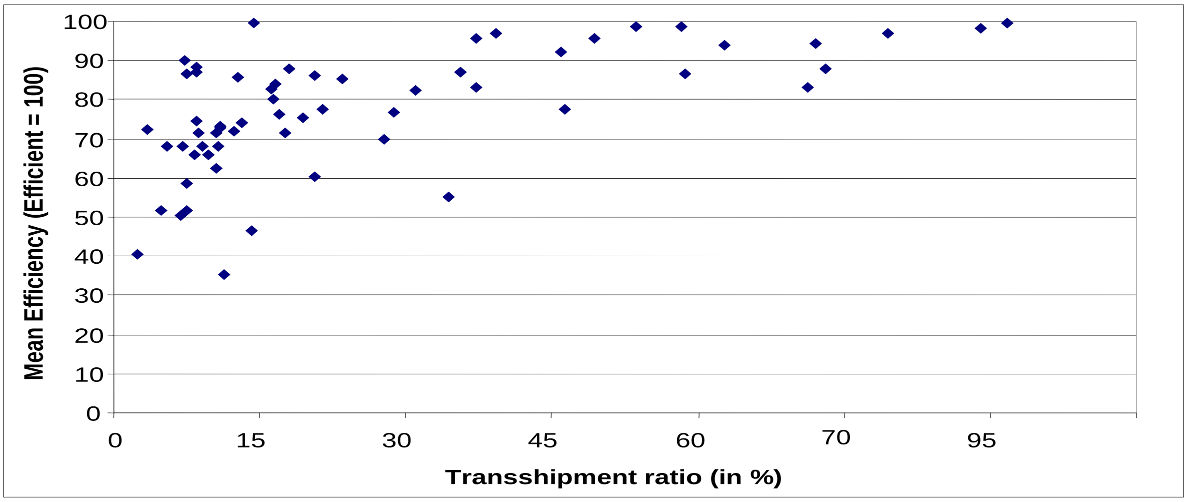
Source: Consultant

Impact of traffic type on terminal efficiency

Despite the observations made above, some terminals may appear efficient simply because of their trade and traffic mix associated with their operations. For instance, terminals with a significant ratio of transhipment traffic are likely to yield higher productive efficiency because transhipment containers are counted twice as they discharge from a mother vessel then load onto a feeder vessel, or vice versa. In addition, a transhipment container requires less input use because of the relatively simple rules for cargo handling and yard stacking. A higher proportion of transhipment traffic also implies additional calls from feeder vessels, which would increase berth utilisation and operational efficiency.

The relationship between terminals' efficiency and proportion of transhipment cargo is shown in Figure 13. The results show a strong association between transhipment concentration and terminal efficiency. Ports that have a significant transhipment incidence tend to yield higher productive efficiency than those with lower transhipment rations. This is the case of Singapore, Tanjung Pelepas, and Salalah, all operating with a transhipment ratio of over 85%. On the other hand, Tangier Med terminals 1 and 2, both with a transhipment ratio of over 94%, do not seem to perform as well as other transhipment centres.

Figure 13: Relationship between average efficiency and ratio of transhipment traffic



Source: Consultant

Impact of technology and operating configurations on terminal efficiency

One of the main shortcomings of the contemporary literature on container-port efficiency is that the variations in technology and handling configurations are hardly captured and incorporated in the benchmarking analysis. Even when various quay and yard equipment are included as input variables, their definition is often incompatible with the technology and operating systems. Bichou (2012) demonstrates empirically that the operating technology and conditions have a direct impact on port efficiency.

Out of the 26 terminals under study, thirteen terminals operate on a rubber-tired gantry (RTG) system (Apapa, Aqaba, Doraleh, Jakarta International, Jeddah North, Jeddah South, Salalah, Modern Terminals, Northport, Tangiers Med 1, Tangiers Med 2, Westport, Tanjung Pelepas), three terminals operate on a rail-mounted gantry (RMG) system (Hong Kong International, Singapore, Yantian), one terminal operate on a straddle carrier (SC) system (Casablanca West), six terminals on a hybrid system (Ambarli Kumport & Marport, Casablanca East, Maputo, Mersin, Dakar) and two terminals (Rotterdam Delta & ECT) on a fully or partially automated system. None of the terminals under study have operated on a wheeled system or have changed their operating configuration during the 5-year period of 2009-2013.

Table 22: Average efficiency by yard handling configuration

Handling configuration	2009	2010	2011	2012	2013	Average Efficiency[5]
RMG system	0.674	0.731	0.751	0.770	0.802	0.693
RTG system	0.650	0.731	0.772	0.754	0.799	0.674
Automated system	0.785	0.666	0.705	0.692	0.728	0.715
Straddle-Carrier system	0.619	0.728	0.738	0.757	0.763	0.660
Hybrid system	0.685	0.659	0.641	0.599	0.492	0.541

Source: Consultant

As shown in Table 22, terminals operating on automated systems depict the highest average efficiency score of 71.5%. Second in the ranking are terminals operating on yard gantry systems with 69.3% for RMGs and 67.4% for RTGs. Terminals operating on hybrid systems come next with an average rating of 66% while terminals operating on a straddle carrier system achieve the lowest average efficiency with a score of 54.1%.

Impact of port's size and incremental investments on terminal efficiency

The relationship between scale of production and operational efficiency can be inferred directly from Appendix 7. The results from applying input orientation show that of the total number of 130 terminal-*years* in the sample 30 exhibit constant returns to scale, while 100 exhibit increasing returns to scale, all years combined. These empirical results assert that container ports clearly depict a variable returns-to-scale production technology. Therefore, subsequent analysis will be mainly conducted, unless specified otherwise, under the assumption of variable returns-to-scale technology.

Among terminals found to be scale-inefficient, those depicting decreasing returns to scale have all an annual throughput of more than 2 million TEU in 2013 (Yantian, Hong Kong International & Modern, Singapore, Northport, Westport, Rotterdam Delta & ECT, Jakarta International, and Salalah), except for Tanjung Pelepas. Conversely, 85% of scale-inefficient terminals with an annual throughput of less than 500,000 TEU (Apapa, Dakar, Maputo, Casablanca East, and Casablanca East) are found to exhibit increasing-returns to scale. This suggests a strong association between large terminals and

[5] Based on input-oriented DEA-CCR as the effects of scale production is wanted to be excluded.

decreasing returns to scale and between small terminals and increasing returns to scale. Further analysis on the relationship between throughput and efficiency shows positive coefficients relative to both the Pearson correlation (for testing linear correlations) and the Spearman's rank order correlation (for measuring the strength of association). It indicates that the size of port production in terms of container throughput is positively correlated with efficiency ratings (Table 23). However, the small values of both coefficients seem to indicate that this positive correlation is not highly significant. Further tests reveal a weak correlation between the standard deviation of efficiency scores and the scale of production (Table 24).

Table 23: Relationship between throughput size and productive efficiency

DEA model	Type of data	Correlation between throughput and efficiency	
		Pearson correlation	*Spearman's rank order correlation*
Constant returns-to-scale	Panel data	0.557	0.193
	Cross-sectional data	0.569	0.228
Variable returns-to-scale	Panel data	0288	0.216
	Cross-sectional data	0.284	0.189

Source: Consultant

Table 24: Relationship between variations in efficiency scores and scale of production

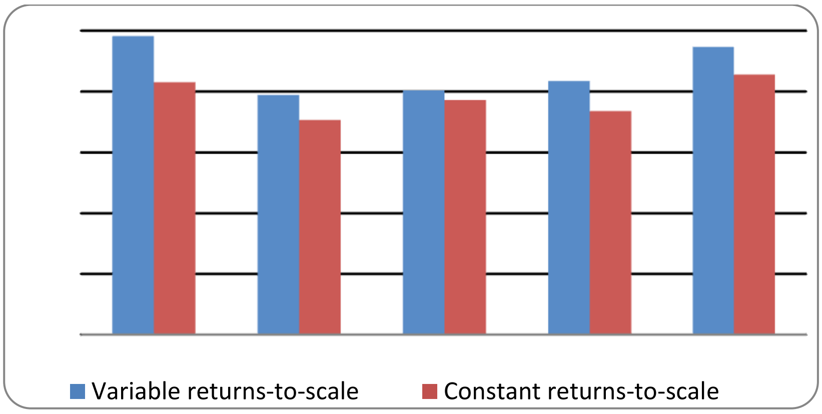
DEA model	Type of data	Correlation between throughput and efficiency fluctuation	
		Pearson correlation	*Spearman's rank order correlation*
Constant returns-to-scale	Panel data	-0.231	-0.198
Variable returns-to-scale	Panel data	-0.262	-0.177

Source: Consultant

The apparent inefficiency of large container terminals may be explained by the incremental nature of port investment, especially for large-scale capacity expansion projects. Because of the competitive dynamics of the port industry, and their quest to cater for future traffic while maintaining or increasing productivity levels, container ports incrementally expand their capacity ahead of anticipated increases in demand, which creates a short-term over-capacity and yields lower efficiency ratings during initial periods of stating up new expansions.

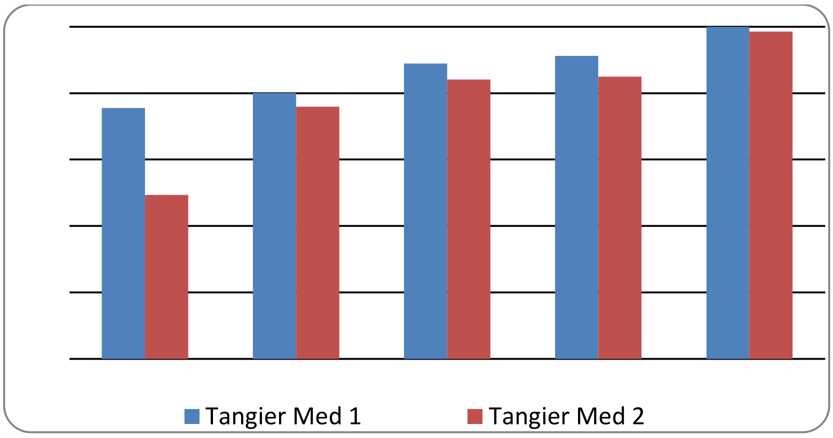
To illustrate the relationship between incremental investments in port capacity and subsequent reductions in productive efficiency, consider the case of in Salalah which has experienced a significant decrease in its relative efficiency following a significant expansion with two new berths opened in late 2009. The lagging-time or catching up effect between supply and demand of port services is depicted in Figure 14 by a sudden and significant decline in relative efficiency, indicative of short-term over-capacity, followed by a gradual return to normal productivity levels once anticipated increases in demand (traffic) start taking place. Newly built and operated terminals also depict a similar catching up effect, see for instance the evolution of the productive efficiency of Tangier Med terminals (1 & 2) which have started operations in mid-2007 and mid-2008, respectively.

Figure 14: Decline of productive efficiency of Salalah following terminal expansion



Source: Consultant

Figure 15: Gradual increase in efficiency of the newly opened Tangiers Med 1 & 2



Source: Consultant

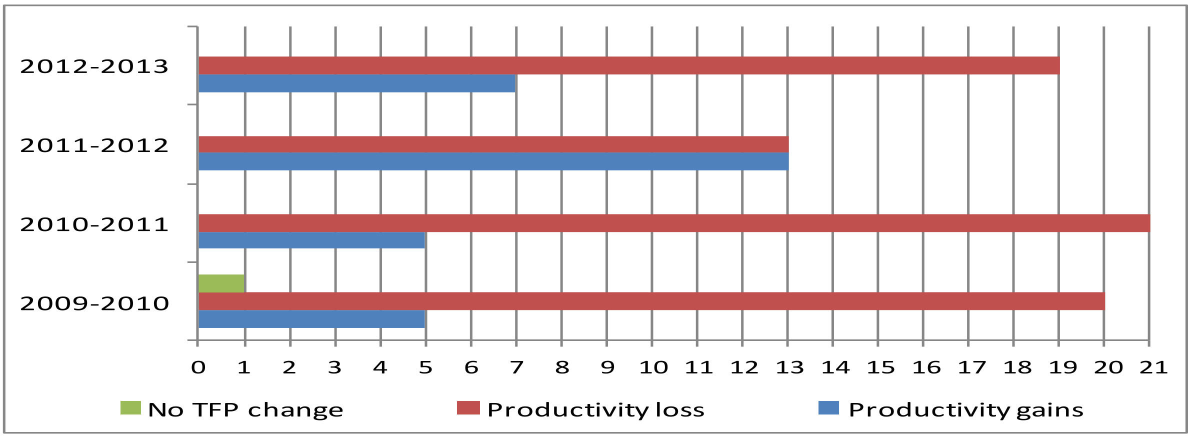
6.2.2. Productivity Change Analysis

As indicated earlier, the stepwise Malmquist DEA both on a year-by-year and on an institutional-regulatory basis is used. On the one hand, the Malmquist productivity index (MPI) on a *year-by-year* basis is estimated in order to benchmark the efficiency of OIC container-terminals between any two successive years, and track and decompose short-term changes in total factor productivity. On the other hand, the calculation of the MPI by *institutional-runs* can track productivity change before and after the introduction of institutional reform as well as between terminals that have implemented them and those that have not.

6.2.2.1. Multi-year TFP analysis

The full results of the multi-year total productivity analysis are reported in Appendix 10. They show that on a year-by-year basis during the study period, 30 terminals have achieved a productivity gain (MPI > 1), 73 terminals have experienced a productivity loss (MPI < 1), and one terminal recorded no change in total factor productivity (MPI = 1). Figure 16 shows the variations of productivity change across pairs of years. Overall, the average total factor productivity for terminals in the sample was regressing for all year-pairs but with varying degrees of productivity change both across pairs of years and between terminals. More specifically, it shows that much of the productivity decline took place between 2009 and 2011, reflecting the decrease in seaborne trade following the 2008 global recession. This downward trend was reversed in 2011-2012 only to return to back in 2013 due to general economic stagnation and the fears of another global recession.

Figure 16: Descriptive statistics of the year-by-year MPI and its sub-categories



Source: Consultant

Of the OIC ports that have registered the lowest average productivity change for throughout the considered period, worth mentioning Apapa and Salalah followed by Westport, Dakar, and Doraleh:

- For Salalah, Westport, and Doraleh, the decline in total factor productivity could be explained by the size of terminal expansions made during the study period, thus reflecting the impact of incremental investment and the resulting short-term over-capacity. For Apapa and Dakar, the decline in productivity change may be attributable to the generally low performance efficiency in those ports.

- For Apapa, productivity losses are persistent throughout the study period and are consistent with the particularly low efficiency scores observed in the DEA analysis. For Dakar, the loss in productivity change in 2009-2010 has been reversed in subsequent years due to productivity gains following the introduction of PSP and the change of port management from the historical operator to a global international operator (DP World).

On the other hand, three OIC ports have registered an overall average productivity gain throughout the study period: Ambarli Kumport, Casablanca East and West. Port Qasim had no productivity change throughout 2009-2013 followed by six ports (Jakarta International, Mersin, Aqaba, Ambarli, Jeddah South, and Maputo) with near-zero productivity change. Such results may be interpreted by those ports having reached their maximum operational capacity under existing conditions. This would require a major productivity boost through measures such as improving operational efficiency, enhancing terminal processes, redesigning terminal configuration, and/or expanding port capacity. Some of those OIC ports (e.g. Aqaba) have already embarked in large capacity expansion programmes.

Table 25 shows the descriptive statistics of the year-by-year changes in MPI and its sub-categories. The results from Table 25 show that, on average, container terminals in the sample have experienced minor changes in their pure technical efficiency (PEC), i.e. their operational efficiency excluding the impacts of changes in size or technology. On the other hand, there has been a steady improvement in scale efficiency (SEC), i.e. efficiency derived from economies of scale; from year to year throughout the study period. Finally, the technological change (TC) component, in other words efficiency gains or losses due to technological changes, shows varying productivity change levels between different pairs of years, with the period 2009-10 depicting a decline in productivity, the periods 2010-11 and 2011-2012 exhibiting a gain in productivity, and the period 2012-2013 showing almost no change in productivity.

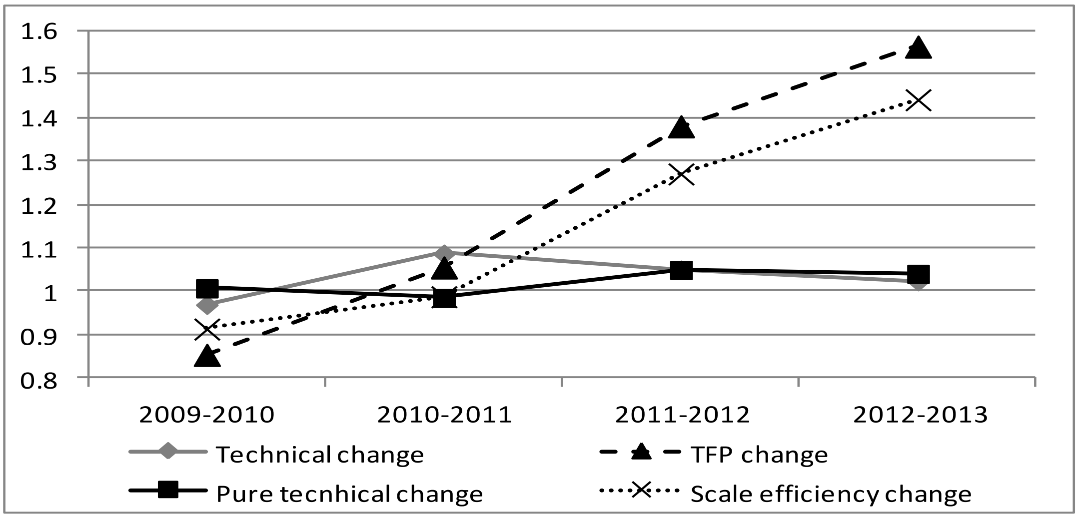
Table 25: Descriptive statistics of the year-by-year MPI and its sub-categories

			Index decomposition		
		Total Productivity change	*Pure efficiency change*	*Scale efficiency change*	*Technical change*
Period	N	26	26	26	26
2009-2010	Mean	0.887	0.933	0.988	0.961
	Median	0.903	0.968	1.000	0.960
	Minimum	0.320	0.368	0.860	0.872
	Maximum	1.305	1.384	1.181	1.084
	Std. Deviation	0.166	0.168	0.042	0.033
2010-2011	Mean	0.944	0.929	0.993	1.011
	Median	0.906	0.909	1.000	0.989
	Minimum	0.399	0.509	0.839	0.842
	Maximum	1.972	1.604	1.108	1.506
	Std. Deviation	0.297	0.222	0.041	0.121
2011-2012	Mean	1.035	1.011	1.007	1.000
	Median	0.937	0.946	1.000	0.983
	Minimum	0.615	0.644	0.903	0.845
	Maximum	2.935	2.482	1.288	1.373
	Std. Deviation	0.385	0.275	0.067	0.088
2012-2013	Mean	1.064	1.037	1.006	1.008
	Median	0.951	0.951	1.000	0.996
	Minimum	0.473	0.483	0.869	0.904
	Maximum	3.769	3.296	1.287	1.186
	Std. Deviation	0.462	0.368	0.058	0.066

Source: Consultant

Combining the productivity change results from all pairs of years, the variations in average productivity depicted in Figure 11 suggests that total productivity change and its sub-categories do not all follow similar productivity trends. The Figure shows that there has been an almost flat trend in average pure efficiency across all observation periods. On the other hand, both total factor productivity and scale efficiency changes seem to follow the same trend throughout the study period. Finally, technological change efficiency shows a different trend against other sources of efficiency. The results from both Table 25 and Figure 11 confirm the general trend of decreasing container-terminal efficiency as evidenced by multiple congestion problems and a persistent shortage of global port capacity in the two years prior to the financial crisis, but there is also a visible trend of average productivity gains after 2010, which was followed by an equally noticeable decline in 2013. This may provide some indication on short-term impacts of trade and capacity changes on port efficiency, but further analysis is required to understand the sources and variations of efficiency change.

Figure 17: Average values of MPI and its sources of efficiency on a year-by year basis



Source: Consultant

Looking at Table 26 below, the analysis of the relationship between the multi-year total productivity change and its sub-categories provides a statistical ground for explaining the changes in productivity through the various components of efficiency change. Starting with scale efficiency (SEC), productivity gains achieved from this component seems to have a stronger impact on the improvement of the overall efficiency of OIC and referenced container terminals despite, as previously outlined, many large terminals operating at the size of decreasing returns to scale. The stronger impact of scale efficiency rather than the non-scale (pure) technical efficiency indicates that the focus from the part of OIC and reference ports during the study period was on achieving operational efficiency through terminal expansion rather than through the rationalisation of input use. For the impact of technological change (TC), the results also show that the shifts in the frontier technology have a statistically meaningful impact on total factor productivity. However, the size of the impact from technological change is smaller than the one emanating from adjustments in port production scales (SEC) and even less than the one from the rationalisation of input factors (PEC). Note that in many OIC ports, the period following to the introduction of institutional reform has been marked by the highest impact of pure technical change and of technological change on TFP which may shed further light on the impact of privatisation and institutional change on port efficiency (see sections below).

Table 26: Correlation of the multi-year MPI and its sources of efficiency change

Period	MPI Decomposition		
	MPI-PEC	MPI-SEC	MPI-TC
2009-10	0.501	0.957	0.197
2010-11	0.312	0.965	0.123
2011-12	0.491	0.917	0.579
2012-13	0.698	0.972	0.404

Source: Consultant

6.2.2.1. Analysis of the impact of institutional runs

The previous section reports on total productivity change for the 26 container terminals in the sample. This approach is primarily undertaken to track productivity change on a year to year basis and identify the main sources of productivity change. However, as discussed in the previous sections and outlined in the section on the DEA analysis, terminals in the sample have different topologies according to their ownership and institutional structure, traffic type, and size features. To allow for the assessment of the impacts of a specific port-topology, the aggregate dataset has been divided into several datasets, each with a corresponding set of terminals. For each topology, the terminals for which the selected topology does not apply are excluded from the original dataset. By comparing the changes in terminal efficiency between terminals that are dominated by a particular topology and those that are not, it is possible to make inferences on the impacts of specific port features and topologies. Table 27 depicts the datasets utilised for each topology. Note that because some terminals do not depict a clear cut topology, the scope of analysis for some topologies is limited to few terminals in the sample.

Table 27: Regulatory-specific datasets for the analysis of productivity change

Datasets	Terminals
Private sector dominated	14 terminals: AKCT, AMCT, ECDT, HIT, MDCT, MTL, NCT, SCT, MIP, PTP, TMCT1, TMCT2, WPCT, YICT.
Public sector dominated	4 terminals: CTCE, JICT, MCLI, QICT.
Transhipment dominated	6 terminals: DCT, TMCT1, TMCT2, PTP, PSA, SPCT.
Gateway dominated	24 terminals: APCT, ACT, AKCT, AMCT, CTCE, CTCW, ECDT, MCDT, HIT, NCT, JICT, SCT, MCLI, MIP, MTL, NPCT, TCD1, WPCT, YICT.
Large scale	7 terminals: HIT, NPCT, PSA, PTP, SPCT, WPCT, YICT
Medium & Small size	9 terminals: ACT, AKCT, APCT, CTCE, CTCW, MLCI, MIP, QICT, TCD1.

Source: Consultant

Impact of ownership and institutional structure

One way to assess the impacts of port ownership on terminal efficiency is to track total productivity change of terminals that are private sector dominated against that of terminals that are public sector dominated. Table 28 reports the scores of MPI and its sub-categories for the two different institutional port groups.

Table 28: MPI and its sources of efficiency for terminals by ownership type

Index	Terminal Group	N	Mean	Std. Deviation	Minimum	Maximum
MPI	Private sector dominated	14	0.996	0.083	0.762	1.664
	Public sector dominated	4	0.844	0.244	0.525	0.986
	Total	18	0.817	0.237	0.525	1.664
PEC	Private sector dominated	14	0.985	0.107	0.719	1.386
	Public sector dominated	4	0.735	0.078	0.710	1.007
	Total	18	0.890	0.107	0.719	1.386
SEC	Private sector dominated	14	1.560	0.124	0.636	1.656
	Public sector dominated	4	0.894	0.204	0.394	1.048
	Total	18	1.113	0.203	0.394	1.656
TC	Private sector dominated	14	1.169	0.159	0.939	1.348
	Public sector dominated	4	0.657	0.122	0.438	0.797
	Total	18	1.002	0.130	0.438	1.348

Source: Consultant

Table 28 shows that for private-sector operated terminals, both the total productivity change (TFP/MPI) and the pure efficiency change (PEC) were almost constant during the study period, while scale efficiency change (SEC) and technical change (TC) have both experienced productivity gains. On the other hand, public sector ports recorded productivity losses in MPI and all its components, with the most losses being recorded in pure efficiency change (PEC) and technical change (TC). This suggests that private-sector ports generally outperform their public-sector ports. The latter suffered productivity losses in technological change most probably due to underinvestment in new technology. Public sector ports also recorded losses in their scale efficiency due to their relatively small size as well as their inability to capitalise on the sector's characteristics of scale economies.

Impact of traffic type

Table 29 presents the differences in aggregate terminal efficiency and its components between gateway ports (those with a high proportion of import and export traffic) and transhipment ports (those with a high proportion of transhipment cargo). During the study period, gateway terminals depict on average a lower total productivity change than the transhipment terminals. In a similar vein, both technical and scale efficiencies show lower productivity changes for gateway ports compared with transhipment ports, with pure technical efficiency (PEC) registering positive productivity gains for the latter group of terminals. For technical change, productivity gains have been recorded for both groups with a slightly larger gain for transhipment ports than the technical change (TC) gain achieved by gateway ports. Those results are fully compatible with the DEA results outlined in the previous section.

Furthermore, they show that transhipment terminals benefit the most from scale efficiencies given that transhipment centres require large scale port capacity and equipment superstructure to accommodate the very large and ultra large containerships. Note however that productivity change from technological progress (TC) are almost similar between the two groups of ports, which suggests that there is no particular association between a port's traffic type and its ability to benefit or not from technological progress.

Table 29: MPI and its sources of efficiency for OIC and reference ports by traffic type

Index	Terminal Group	N	Mean	Std. Deviation	Minimum	Maximum
MPI	Gateway	24	0.841	0.083	0.762	0.986
	Transhipment	6	0.996	0.244	0.525	1.664
	Total	30	0.974	0.237	0.525	1.664
PEC	Gateway	24	0.925	0.107	0.719	1.007
	Transhipment	6	1.010	0.078	0.890	1.386
	Total	30	0.990	0.107	0.512	1.386
SEC	Gateway	24	0.794	0.124	0.636	1.048
	Transhipment	6	0.941	0.204	0.394	1.656
	Total	30	0.928	0.203	0.394	1.656
TC	Gateway	24	1.054	0.159	0.939	1.330
	Transhipment	6	1.169	0.122	0.838	1.348
	Total	30	1.072	0.130	0.838	1.348

Source: Consultant

Impact of scale and size

Table 30 compares the changes in terminal efficiency (MPI) between large-scale and small-scale ports in the sample. As expected, the difference in scale efficiency change was most noticeable, with large ports showing almost 50% more productivity gains than small ports. On the other hand, the difference in productivity change in pure technical change (PEC) between the two groups of ports is negligible. Furthermore, productivity gains in technological change are actually slightly higher for small terminals than for large terminals. This clearly asserts that scale efficiency is the main driver behind TFP changes between the two port groups, where large terminals have during the observation period experienced an average productivity gain of 3.7% (MPI=1.037) against a 13.4% loss experienced by small terminals (MPI=0.866).

Table 30: MPI and its sources of efficiency for OIC and reference ports by scale & size

Index	Terminals	N	Mean	St. Deviation	Minimum	Maximum
MPI	Large scale	7	1.037	0.232	0.698	1.664
	Small scale	9	0.866	0.220	0.525	1.515
	Total	16	0.980	0.241	0.525	1.664
PEC	Large scale	7	1.013	0.090	0.890	1.386
	Small scale	9	0.986	0.121	0.512	1.046
	Total	16	0.994	0.104	0.512	1.386
SEC	Large scale	7	1.255	0.178	0.687	1.656
	Small scale	9	0.654	0.223	0.394	0.866
	Total	16	0.939	0.201	0.394	1.656
TC	Large scale	7	1.014	0.116	0.838	1.307
	Small scale	9	1.084	0.117	0.938	1.330
	Total	16	1.057	0.117	0.838	1.330

Source: Consultant

To examine further the differences between various port groups, a non-parametric test (Mann-Whitney-U-test) is used. The method is based on the ranking of data to test whether two samples of observations come from the same identical distributions. An advantage with this test is that the two samples under consideration may not necessarily have the same number of observations. In our case, the objective is to test a null hypothesis that two types of ports are the same against an alternative hypothesis, especially that a particular port population tends to have larger values than the other. Three groups used in this study are refered to test three (null) hypotheses:

1. Private-sector ports exhibit a similar TFP change to that of public sector ports.
2. Gateway ports exhibit a similar TFP change to that of transhipment ports.
3. Large scale ports exhibit a similar TFP change to that of transhipment ports.

Table 31 presents the results on the statistical differences between TFP indices of various regulatory groups. The null hypothesis at a 5% significance level was accepted for both Hypothesis 3 and rejected for hypotheses 1 and 2. The results confirm the findings from previous DEA results where large scale ports have been to exhibit a similar productivity change to that experienced by transhipment ports.

Table 31: Results of the Mann-Whitney U test on regulatory groups

	Mean Value		Non-parametric statistical index		
Institutional structure	Private-dominated terminals	Public-dominated terminals	Mann-Whitney U	Z	Asymptotic significance (2-tailed)
MPI	0.820	0.986	138	-0.703	0.424
PEC	0.969	0.995	192	-1.68	0.10*
SEC	0.891	0.935	165	-3.219	0.129*
TC	0.948	1.072	129.5	-1.662	0.096*
Traffic type	Gateway terminals	Transhipment terminals	Mann-Whitney U	Z	Asymptotic significance (2-tailed)
MPI	0.841	0.996	213	-0.812	0.493
PEC	0.925	1.010	113.5	-1.65	0.92*
SEC	0.794	0.941	150	-2.30	0.039*
TC	1.169	1.054	183	-1.612	0.103*
Size and scale	Large terminals	Small /medium terminals	Mann-Whitney U	Z	Asymptotic significance (2-tailed)
MPI	1.037	0.866	206	-1.95	0.560
PEC	1.013	0.957	155	-2.15	0.010**
SEC	0.982	0.854	125	-2.44	0.219**
TC	1.044	1.084	213.5	-1.626	0.016**

Source: Consultant

6.3. Analysis of Logistical Inefficiency

Because they are controllable aspects of global supply chains, ports deserve particular attention in a country's trade and logistics efficiency. The relative costs imposed at ports are influenced by a number of factors, such as quality of infrastructure, shipping connectivity, distance to markets, logistics competency, and other trade, logistics and procedural issues. Ports can account for 8% to 12% of transport costs between product origin and destination. The impact of port inefficiency on trade and welfare has been studied by extensively by the World Bank that found that, based on a worldwide comparison, improving the efficiency of a port from the 25th percentile to the 75th percentile reduces shipping costs by 12%. In other words, bad ports impose a penalty equivalent to being 60% farther away from market.

Tables 32, 33, and 34 show the score and ranking of OIC countries in UNCTAD's liner shipping connectivity index (LSCI), the World bank's logistics performance index (LPI), and the World Bank's doing business report indicators; respectively:

- Starting with liner connectivity, the latest 2014 tables show that OIC countries that are well connected to the global shipping network are Malaysia (104), Egypt (61.7) Morocco (64.8), Saudi Arabia (61.8), and Turkey (54.6). The countries least connected, excluding landlocked countries, are Qatar (3.86), Guinea Bissau (4%), Guyana (4.13), Brunei (4.3), Iran (5.17), Iraq (5.5), Guinea (5.8), Mauritania (6.1), Comoros (6.8), Libya (6.82), Algeria (6.9), Tunisia (7.52), Maldives (7.8), Kuwait (8.22), Bangladesh (8.4), and Mozambique (9).

- A common trend among most performing countries in liner connectivity is the presence of large transhipment ports (Malaysia, Morocco, Egypt) and gateway ports (Malaysia, Saudi Arabia, Turkey). For the least performing countries, they are marked by small or medium sized ports which are not located on the main liner shipping services or lack the physical and operational capacity to serve large container ships. The Maldives and Guyana both have low connectivity scores due to the disadvantages of being small-island and remote locations.

- Regarding the logistics performance index (LPI), the latest 2014 tables show that of the OIC countries under study, Malaysia, Turkey, Saudi Arabia, Indonesia, Morocco, and Oman come on top of the rankings; while Djibouti and Mozambique come at the bottom. This suggests there is a general correlation between LSCI and LPI rankings. In terms of the LPI components that are directly linked to port performance, the quality of infrastructure, ease of shipments, and logistics services; those seem to be highly representative of the overall logistics productivity score for both high-ranked and low-ranked OIC countries. Nevertheless, the LPI components of customs and timeliness show varying levels of performance even across top performing OIC countries. For instance, Oman does not score well for both indicators while Saudi Arabia scores badly in Timeliness. Such factors, although outside the control of ports and terminal operators, have a significant port on the trade and logistical efficiency of ports and terminals.

- As for the World Bank's doing business indicators, the latest tables show the time and dollar costs of import and export in OIC countries. Table 34 also compares average costs and times across main regions, although significant variations exit within regions. Of noticeable importance are the time lag and trade costs for landlocked countries (see for instance Afghanistan, Niger, and Burkina Faso) which can be 5 to 6 times more than the average cost in OIC countries and take twice longer to complete. For the OIC country ports under study, Mozambique, Nigeria, Saudi Arabia and Senegal are the most expensive countries for exports and imports costing on average twice than Malaysia, Morocco, Oman, and Pakistan. In a similar vein, the times it takes for container export and import are particularly high in Nigeria and Pakistan compared with a relatively low average for Malaysia, Morocco, and Turkey.

Table 32: Multi-year LSCI scores for OIC member states, excluding landlocked countries

Country	2009	2010	2011	2012	2013	2014
Albania	2.30	4.34	4.54	0.53	4.43	4.11
Algeria	8.37	31.45	31.06	7.80	6.91	6.94
Bahamas	19.26	25.71	25.18	27.06	26.41	26.70
Bahrain	8.04	7.83	9.77	17.86	17.90	27.01
Bangladesh	7.91	7.55	8.15	8.02	7.96	8.39
Benin	13.52	11.51	12.69	15.04	14.28	17.21
Brunei	3.94	5.12	4.68	4.44	4.61	4.30
Cameroon	11.60	11.34	11.40	13.44	10.85	12.74
Comoros	5.00	5.74	7.14	5.17	5.21	6.83
Côte d'Ivoire	19.39	17.48	17.38	16.45	17.55	21.87
Djibouti	17.98	19.55	21.02	16.56	20.29	20.22
Egypt	51.99	47.55	51.15	57.39	57.48	61.76
Guinea	8.32	6.28	6.21	7.42	8.06	5.78
Guinea-Bissau	3.54	3.50	4.07	4.31	4.00	3.97
Guyana	4.34	3.95	3.96	4.06	4.31	4.13
Indonesia	25.68	25.60	25.91	26.28	27.41	28.06
Iran	28.90	30.73	30.27	22.62	21.30	5.85
Iraq	5.11	4.19	4.19	7.10	5.69	5.17
Jordan	23.71	17.79	16.65	22.75	22.68	22.63
Kuwait	6.54	8.31	5.60	6.60	7.12	8.22
Libya	9.43	5.38	6.59	7.51	7.29	6.82
Malaysia	81.21	88.14	90.96	99.69	98.18	104.02
Maldives	5.43	1.65	1.62	1.60	8.12	7.79
Mauritania	7.50	5.61	5.62	8.20	6.53	6.00
Morocco	38.40	49.36	55.13	55.09	55.53	64.28
Mozambique	9.38	8.16	10.12	9.82	10.23	8.96
Nigeria	19.89	18.28	19.85	21.81	21.35	22.91
Oman	45.32	48.52	49.33	47.25	48.46	49.88
Pakistan	26.58	29.48	30.54	28.12	27.71	27.50
Qatar	2.10	7.67	3.60	6.53	3.35	3.86
Saudi Arabia	47.30	50.43	59.97	60.40	59.67	61.25
Senegal	14.96	12.98	12.27	13.59	11.08	12.90
Somalia	2.82	4.20	4.20	4.34	4.20	5.45
Sudan	N/A	N/A	N/A	12.75	8.42	13.14
Syria	11.03	15.17	16.77	15.64	16.53	17.46
Togo	14.42	14.24	14.08	14.07	14.76	19.09
Tunisia	6.52	6.46	6.33	6.35	5.59	7.52
Turkey	31.98	36.10	39.40	53.15	52.13	52.37
UAE	60.45	63.37	62.50	61.09	66.97	66.48
Yemen	14.61	12.49	11.89	13.19	19.00	18.45

Source: Consultant from UNCTAD (2015a)

Table 33: 2014 cross-sectional analysis of LPI scores & components of OIC and reference countries

	Overall LPI		Customs		Infra-structure		Ease of Shipment		Logistics Services		Ease of Tracking		Timeliness	
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**Rank**	**score**	**rank**	**score**	**rank**	**score**	**Rank**
Netherlands	*4.05*	*2*	*3.96*	*4*	*4.23*	*3*	*3.64*	*11*	*4.13*	*2*	*4.07*	*6*	*4.34*	*6*
Singapore	*4.00*	*5*	*4.01*	*3*	*4.28*	*2*	*3.70*	*6*	*3.97*	*8*	*3.90*	*11*	*4.25*	*9*
HK, China	*3.83*	*15*	*3.72*	*17*	*3.97*	*14*	*3.58*	*14*	*3.81*	*13*	*3.87*	*13*	*4.06*	*18*
Malaysia	3.59	25	3.37	27	3.56	26	3.64	10	3.47	32	3.58	23	3.92	31
UAE	3.54	27	3.42	25	3.70	21	3.20	43	3.50	31	3.57	24	3.92	32
Qatar	3.52	29	3.21	37	3.44	29	3.55	16	3.55	28	3.47	32	3.68	41
Turkey	3.50	30	3.23	34	3.53	27	3.18	48	3.64	22	3.77	19	3.55	47
Saudi Arabia	3.15	49	2.86	56	3.34	34	2.93	70	3.11	48	3.15	54	2.80	119
Bahrain	3.08	52	3.29	30	3.04	49	3.04	58	3.04	51	3.29	42	3.53	50
Indonesia	3.08	53	2.87	55	2.92	56	2.87	74	3.21	41	3.11	58	3.39	60
Morocco[6]	3.03	50	2.64	65	3.14	39	3.01	46	2.89	59	3.01	58	3.51	53
Kuwait	3.01	56	2.69	68	3.16	43	2.76	89	2.96	59	3.16	50	3.29	67
Oman	3.00	59	2.63	74	2.88	57	3.41	31	2.84	73	2.84	80	2.99	99
Egypt	2.97	62	2.85	57	2.86	60	2.87	77	2.99	58	3.23	43	3.46	58
Jordan	2.87	68	2.60	78	2.59	76	2.96	65	2.94	60	2.67	96	2.79	123
Pakistan	2.83	72	2.84	58	2.67	69	3.08	56	2.79	75	2.73	86	3.46	57
Nigeria	2.81	75	2.35	117	2.56	83	2.63	107	2.70	85	3.16	51	3.31	64
Côte d'Ivoire	2.76	79	2.33	120	2.41	101	2.87	75	2.62	95	2.97	67	3.44	59
B&H	2.75	81	2.41	105	2.55	84	2.78	87	2.73	81	2.55	107	2.51	148
Maldives	2.75	82	2.95	49	2.56	82	2.92	72	2.79	74	2.70	92	2.89	108
Lebanon	2.73	85	2.29	124	2.53	89	2.53	118	2.89	67	3.22	44	3.24	69
Kazakhstan	2.70	88	2.33	121	2.38	106	2.68	100	2.72	83	2.83	81	3.04	94
Algeria	2.65	96	2.71	66	2.54	87	2.54	117	2.54	102	2.54	109	3.21	71
Burkina Faso	2.64	98	2.50	88	2.35	111	2.63	105	2.63	94	2.49	115	2.53	146
Senegal	2.62	101	2.61	76	2.30	116	3.03	59	2.53	103	2.65	98	3.18	75
Bangladesh	2.56	108	2.09	138	2.11	138	2.82	80	2.64	93	2.45	122	2.85	115
Benin	2.56	109	2.64	73	2.35	109	2.69	99	2.35	123	2.45	123	3.16	80
Tunisia	2.55	110	2.02	146	2.30	118	2.91	73	2.42	120	2.42	124	3.02	97
Chad	2.53	113	2.46	97	2.33	112	2.33	136	2.34	125	2.71	90	2.74	133
Tajikistan	2.53	114	2.35	115	2.36	108	2.73	92	2.47	113	2.47	119	2.85	114
Libya	2.50	118	2.41	104	2.29	119	2.29	140	2.29	131	2.85	78	2.90	106
Mali	2.50	119	2.08	141	2.20	129	2.80	82	2.20	142	2.70	91	3.10	86
Guinea	2.46	122	2.34	119	2.10	141	2.47	125	2.35	124	2.41	126	2.74	131
Guyana	2.46	124	2.46	99	2.40	105	2.43	128	2.27	133	2.47	117	2.57	143
Azerbaijan	2.45	125	2.57	82	2.71	68	2.57	113	2.14	149	2.14	148	2.73	135
Guinea-Bissau	2.43	127	2.43	101	2.29	121	2.29	141	2.57	101	2.29	139	2.71	136
Comoros	2.40	128	2.58	81	2.30	117	2.51	119	2.26	134	2.37	128	2.37	154
Uzbekistan	2.39	129	1.80	157	2.01	148	2.23	145	2.37	122	2.87	77	3.08	88
Niger	2.39	130	2.49	93	2.08	143	2.38	130	2.28	132	2.36	129	2.76	127
Togo	2.32	139	2.09	139	2.07	145	2.47	124	2.14	150	2.49	116	2.60	140
Turkmenistan	2.30	140	2.31	122	2.06	146	2.56	116	2.07	155	2.32	134	2.45	153
Iraq	2.30	141	1.98	149	2.18	131	2.31	139	2.15	147	2.31	136	2.85	116
Cameroon	2.30	142	1.86	156	1.85	154	2.20	147	2.52	104	2.52	111	2.80	120
Gambia	2.25	146	2.06	143	2.00	149	2.67	101	2.22	138	2.00	154	2.46	151
Mozambique	2.23	147	2.26	126	2.15	135	2.08	154	2.10	153	2.08	152	2.74	134
Mauritania	2.23	148	1.93	152	2.40	103	2.07	155	2.06	157	2.23	142	2.75	130
Kyrgyzstan	2.21	149	2.03	145	2.05	147	2.43	127	2.13	151	2.20	145	2.36	155
Gabon	2.20	150	2.00	148	2.08	142	2.58	112	2.25	135	1.92	157	2.31	157
Yemen	2.18	151	1.63	159	1.87	153	2.35	134	2.21	141	2.21	144	2.78	124

[6] Morocco LPI scores are for 2012

	Overall LPI		Customs		Infra-structure		Ease of Shipment		Logistics Services		Ease of Tracking		Timeliness	
Sudan	2.16	153	1.87	155	1.90	152	2.23	144	2.18	144	2.42	125	2.33	156
Djibouti	2.15	154	2.20	134	2.00	150	1.80	158	2.21	140	2.00	155	2.74	132
Syria	2.09	155	2.07	142	2.08	144	2.15	150	1.82	159	1.90	158	2.53	145
Afghanistan	2.07	158	2.16	137	1.82	158	1.99	156	2.12	152	1.85	159	2.48	149
Somalia	1.77	160	2.00	147	1.50	160	1.75	159	1.75	160	1.75	160	1.88	160

Source: Consultant from World Bank

Table 34: Relevant logistics efficiency indicators for selected OIC countries

	World Rank	Documents to export (number)	Time to export (days)	Cost to export (US$ per container)	Documents to import (number)	Time to import (days)	Cost to import (US$ per container)
Afghanistan	184	10	86	5 045,00	10	91	5 680,00
Bahrain	64	6	11	810	8	15	870
Benin	121	7	25	1 052,00	7	25	1 487,00
Burkina Faso	174	10	41	2 305,00	12	49	4 330,00
Cameroon	160	11	23	1 379,00	12	25	2 267,00
Djibouti	56	5	20	885	5	18	910
Egypt	99	8	12	625	10	15	790
Gambia	77	6	19	1 040,00	6	19	745
Indonesia	62	4	17	571,8	8	26	646,8
Iran	148	7	25	1 350,00	11	37	1 555,00
Iraq	178	10	80	3 550,00	10	82	3 650,00
Jordan	54	5	12	825	7	15	1 235,00
Kazakhstan	185	10	79	5 285,00	12	67	5 265,00
Kuwait	117	7	15	1 085,00	10	20	1 250,00
Malaysia	11	4	11	525	4	8	560
Mauritania	151	8	31	1 640,00	8	38	1 523,00
Morocco	31	4	10	595	6	14	970
Mozambique	129	7	21	1 100,00	9	25	1 600,00
Niger	179	8	56	4 475,00	10	61	4 500,00
Nigeria	159	9	22,9	1 564,00	13	33,9	1 959,50
Oman	60	7	10	765	8	9	700
Pakistan	108	8	20,7	765	8	18,4	1 005,00
Qatar	61	5	15	927	7	16	1 050,00
Saudi Arabia	92	6	13	1 285,00	8	17	1 309,00
Senegal	79	6	12	1 225,00	6	14	1 940,00
Suriname	106	8	22	1 050,00	6	19	1 190,00
Turkey	90	7	13	990	8	14	1 235,00
East Asia & Pacific		6,1	20,2	864	6,7	21,6	895,6
Europe & Central Asia		6,9	23,6	2 154,50	8	25,9	2 435,90
Latin America & Caribbean		5,7	16,8	1 299,10	6,8	18,7	1 691,10
Middle East & North Africa		6	19,4	1 166,30	7,8	23,8	1 307,00
South Asia		8,1	33,4	1 922,90	9,4	34,4	2 117,80
Sub-Saharan Africa		7,6	30,5	2 200,70	8,9	37,6	2 930,90

Source: Consultant

7. Conclusions and Recommendations

7.1 Study Results and Conclusions

In view of the above diagnostic, several conclusions can be made at the level of individual and combined OIC ports. Following the analysis of ownership, institutional, regulatory, and operational structures and performances of OIC and reference ports, the main research findings for this study are summarised below.

7.1.1. Port Organisation and Institutional Structuring

Most ports in the 25 OIC countries that have commercial ports follow a landlord, a public service, and/or an autonomous port model therefore reflecting the importance and level of involvement of the public sector in port ownership and management. However, when analysing the institutional structure of the 20 OIC ports under study, one could observe several variations both between and within ports. Many countries under study have adopted either a private service model or a hybrid landlord-private service model, thus showing that private sector participation (PSP) has been adopted in many of the OIC ports in some form or another.

Our analysis of the port organisation on OIC countries also show that few ports still adopt distinctive port models notably the trust port model in Port Qasim (Pakistan) and the autonomous port model in Dakar (Senegal). Some OIC ports under study depict uncommon models not found elsewhere, for instance in case of Salalah (Oman) and Jakarta (Indonesia); while in other countries such as Turkey the concept of a port authority does not even exist. Finally, large variations of institutional structures were founded within countries and sometimes within the same port, for instance in Casablanca and Port Klang.

Regarding the type and level of private sector participation, there are also variations across and within OIC ports. Some OIC countries such as Malaysia, Mozambique, Pakistan, and Turkey have taken the lead in implementing PSP in the port sector and have implemented the first PPPs (public-private partnership) in the sector. Those have been followed by other countries such as Egypt, Jordan, and Morocco, and more recently by a third group of OIC countries such as Djibouti and Senegal.

In terms of the forms of PSP in OIC ports, two models seem to dominate the scene: the management model of existing facilities and the development model of new facilities. This mirrors the type of port investment model in OIC countries which has so far been dominated by Brownfield port developments. It also shows that only few OIC countries have been successful or willing to develop joint venture models with the private sector for port development and operation. On the other hand, Malaysia leads the way as the first OIC country launching a proper port divestiture programme back in the 1980s with the privatisation of Port Klang. This has later on followed up recently by Turkey, but no other OIC country seems to have embarked on a port divestiture programme.

As for the involvement of international terminal operators (ITOs), most OIC ports under study show the presence of ITOs either as single port operators or as partners with other local firms. Much of the ITO involvement in OIC ports seem to be equally split between terminal operating shipping lines (TOSL) namely the subsidiaries of the three largest shipping lines (Maersk, MSC, CMA-CGM), and international terminal port authorities (TOPA), most notably DPW. In countries such as Malaysia, Morocco, Turkey, and Saudi Arabia, local port companies have been successful in operating domestic ports often in partnership with large ITOs.

7.1.2. Institutional Port Performance

The results from the analysis of institutional performance in the OIC ports under study show the dominance of industrial and spatial (geographical) fragmentation at the expense of service and functional fragmentation. Most OIC port systems, except in Malaysia, Indonesia and Turkey, depict an industrial fragmentation where ports are organised by cargo and traffic type coupled with a spatially-centred fragmentation where port management is centralised at the level of either a Governmental department or a national port authority. Such forms of fragmentation, while reflecting historical developments of the port sector in OIC countries, are not always desirable because they entangle the port sector into public sector management and may act as a barrier against inter-port competition.

Nevertheless, it is in the areas of service and functional port fragmentation where most OIC countries seem to fail. On the one hand, service fragmentation where port activities are separated and port services are unbundled in order to promote competition is not widely used in OIC countries across their port sectors. On the other hand, while functional fragmentation, where port policy, operations, and regulation are undertaken by separate entities, has been found to be common and desirable across OIC countries; the effectiveness and outcome of such form of fragmentation have been far less successful.

There are indeed many gaps and overlaps in the functional organisation of the port sector in several OIC countries particularly in the countries of Indonesia, Jordan, Morocco, Nigeria, Oman, Senegal, and Turkey. Several factors contribute to this predicament including the prevalence of cross-ownership and cross-subsidisation, weak or absent coordination between Government agencies, and the lack of institutional and human capacity within national port and governmental authorities.

7.1.3. Regulatory Port Performance

The analysis of regulatory performance has covered both technical regulation and market (economic) regulation of the port sector in the OIC countries:

- Technical regulation has looked at the areas of port safety, labour organisation, security, and environmental sustainability, with a major focus on benchmarking the performance of OIC and OIC countries against those of international safety regulations and standards in the industry.

- Economic regulation has looked at the aspects of liberalisation, market access, competition, tariff and pricing arrangements within and across OIC ports with a view to unravel major discrepancies and shortcomings.

For the analysis of regulatory performance under technical regulations, the results have shown that in general most OIC countries are up to-date with the main international regulations in place, but further improvements are needed in the areas of container safety and environmental management. The OIC countries Guinea Bissau, Iraq and Djibouti have been found to be lagging behind other member states and should step-up their efforts in regulatory compliance. In the area of port state control, the OIC countries of Albania, Côte d'Ivoire, and Lebanon have been found to be behind industry benchmarks such as the Paris Memorandum of Understanding (MoU), the United States Coast Guards (USCG) port state control standards, and the ICC/ISF (International Shipping Council / International Shipping Federation) performance table.

For the analysis of economic (market) regulation, the results show that despite the ongoing process of liberalisation induced by market deregulation and sector privatisation, many of the OIC countries under study (Indonesia, Jordan, Morocco, Mozambique, Oman, Senegal, and Turkey) still retain a significant stake in port ownership and management. Further analysis has shown that this is mostly caused by policies of corporatization and partial privatisation implemented in those countries.

Second, on market access, the results from analysing WTO (World Trade Organisation) data on the status and commitments of market liberalisation in port services have shown that most OIC countries have limited or no conditions on market access in the provision of cargo handling services. However, most OIC countries have placed constraints on accessing the markets for marine services (navigational aid, pilotage, salvage, ship repair, ship supply, bunkering, port and shipping agency, etc.) by limiting access to those markets to only local and domestically registered companies.

Third, on port competition, the analysis has shown that there is an acceptable level of inter-port competition in OIC ports, except obviously for countries with only one port (Djibouti, Jordan) or port facilities (e.g. Mozambique).On the other hand, intra-port competition between terminal operators is only observed in half of the OIC countries under study. In particular, the study found that the process of PSP and service unbundling in several OIC ports has not prevented public sector monopoly or eliminated the risk of market failure. Therefore, there is still a high risk of collusion with or interference from public-owned port enterprises in some countries.

Fourth, on pricing and tariff charging, the study has found significant variations between the charging regimes and pricing structures in the OIC ports under study. There are obviously historical grounds for port pricing structure in each of the OIC countries, however with private funding of ports being widely used and port pricing schemes becoming globally standardised, many OIC ports must review their pricing models and structures including for those ports operating based on regulated tariffs.

Last, but not least, the study has found that none of the OIC ports under study has an independent economic port regulator, although in some countries (e.g. Malaysia and Turkey) there are structures dealing with transport regulations while in others (e.g. Egypt and Nigeria) there are plans to establish independent port regulators.

7.1.4. Operational Port Performance

The number of container terminals identified as efficient under various DEA models and port samples oscillates between 10% and 20%. This suggests that the sample of OIC ports under study is dominated by inefficient terminals. However, the analysis in terms of comparative efficiency scores of OIC terminals reveals that on average there is an upward trend for efficiency estimates throughout the study period. Yet, there is still considerable room of improvements with average scores about 25% below the efficiency frontier, and in some OIC countries up to 50% below the efficiency frontier.

The analysis also shows that there is a wide variation in average efficiency scores between (i) the OIC ports and the reference ports and (ii) the OIC ports themselves. Further analysis shows that the more OIC efficient terminals tend to have less relative variability over time than the less efficient OIC terminals. These findings are at variance with those of the mainstream port benchmarking literature. This is due to the sampling procedure used in most port benchmarking studies where DMUs are usually selected from top-ranked ports in terms of throughput or from ports located within the same country or region.

The analysis of the relationship between the ownership and institutional structure and port efficiency shows that the private service and landlord models depict on average the highest efficiency ratings, while the trust model shows the lowest average productive efficiency. The results also suggest that that port models with high PSP or corporatization levels tend to outperform other port structures particularly those with a high level of centralisation and public sector interference.

The relationship between productive efficiency and traffic type shows that cargo type differences have a direct effect on terminal efficiency. Terminals with high proportion of transhipment containers tend to yield higher efficiency scores than their other counterparts. This suggests that both exogenous factors and the nature of the port market served can have a significant effect on terminal's efficiency ranking, even for terminals with similar levels of operational efficiency.

Port technology and operating configurations also have a direct impact on terminal efficiency. The results show that terminals operating on automated systems tend to depict the highest efficiency ratings, while those operating on a straddle carrier system achieve the lowest average efficiency. Further investigation revealed that few OIC ports operate automated or semi-automated terminal systems, thus suggesting that further improvement in operational efficiency in OIC ports can still be achieved through capacity management measures such as upgrading port technology, improving terminal configuration, and streamlining operating processes, without prior recourse on capacity expansion.

The analysis of the relationship between scale of production and operational efficiency reveals that a large proportion of terminals exhibit increasing returns to scale properties, which asserts that the container terminal industry clearly depicts a variable returns to scale (VRS) production technology. The analysis also shows that the larger terminals and those investing in new facilities tend to depict decreasing returns to scale, whereas scale-inefficient small terminals tend to exhibit increasing-returns to scale.

The above results suggests a strong association between large terminals and decreasing returns to scale and between small terminals and increasing returns to scale. Further statistical analysis has confirmed the high correlation between incremental increases in port investment and the variations in productive efficiency, and concludes that a full utilisation of port capacity is detrimental to port efficiency in the medium and long runs.

For the productivity change analysis, the stepwise multi-year Malmquist DEA confirms the general trend of decreasing container-terminal efficiency but with varying degrees of productivity change both across pairs of years and between terminals. More specifically, it shows that much of the TFP decline took place between 2009 and 2011, reflecting the decrease in seaborne trade following the 2008 global recession. This downward trend was reversed in

2011-2012 only to return to back in 2013 due to general economic stagnation and the fears of another global recession. The overall results of the MPI analysis are compatible with those of the DEA analysis in particular by inferring the relationship between productivity change and incremental investment as well as between a terminal's efficiency and its maximum operational capacity.

The analysis of the efficiency changes in MPI sub-categories has revealed an almost flat trend in average pure efficiency change (PEC) throughout the observation periods, against an increasing trend in average scale efficiency change (SEC). Further analysis of the relationship between MPI and its sub-categories shows a stronger impact of scale efficiency compared with the non-scale (pure) technical efficiency, which suggests that the focus from the part of many OIC ports was on achieving operational efficiency through terminal expansion rather than through the rationalisation of input use. The analysis of the impact of technical change (TC) provided first insights on the shifts in the frontier technology and on the impact of the technological progress following the introduction of PSP and institutional reform in OIC ports.

When analysing the correlation between the institutional-run productivity changes, the results show that unlike private-sector ports, public sector ports recorded productivity losses in total factor productivity and all its components, with the most losses being recorded in pure economic (PEC) and technological change (TC) efficiencies. This suggests that private-sector ports generally outperform their public-sector ports. The latter suffered productivity losses in technological change most probably due to underinvestment in new technology. Public sector ports also recorded losses in their scale efficiency due to their relatively small size as well as their inability to capitalise on the sector's characteristics of scale economies.

In a similar vein, the comparative analysis of productivity change between gateway and transhipment ports shows that the former tend to depict on average lower productivity change than the latter. The results show that transhipment terminals benefit the most from productivity change induced by scale efficiencies, which confirms previous results from the DEA analysis.

Finally, the analysis of the relationship between productivity change and terminal size has shown that the difference in scale efficiency (SEC) was most noticeable in large ports which exhibited 50% more productivity gains than small ports. At the same time, the difference in productivity change in both the pure technical change (PEC) and the technical change (TC) was almost negligible between large and small ports. This confirms previous inferences from the DEA analysis that scale efficiency has been the main driver of productive efficiency in the OIC countries during the observation period of this study.

7.1.5. Logistical Port Performance

The analysis of the trade logistics performance in the OIC countries focused on a comparative analysis of three international key logistics benchmarks, namely UNCTAD's liner shipping connectivity index (LSCI), the World Bank's Logistics Performance Index (LPI), and the World Bank's doing business report indicators. The purpose of this analysis was to assess and highlight the impact of trade logistics and other factors in OIC countries on port efficiency.

The results from the comparative analysis has shown that several OIC countries, particularly small island countries and those with small sized ports, have poor connectivity to international shipping routes and services, thus placing them at a disadvantage vis-à-vis other countries with large scale transhipment and gateway centres. As for the analysis of logistics performance, the results from the LPI rankings and cross-sectional analyses show that while several OIC countries are placed in the 2nd quartile in the global ranking, some OIC countries rank at the bottom of the global LPI. However, when looking at LPI components, indicators such as customs efficiency and timeliness score quite low even for OIC countries registering a relatively high overall LPI score.

Finally, a review of the latest World Bank's doing business indicators show the significantly high nominal and time-related trade logistics costs incurred by landlocked OIC countries such as Afghanistan, Niger, and Burkina Faso compared with the highly performing OIC countries of Malaysia, Morocco, and Turkey. Closer analysis found that even for maritime OIC countries, e.g. Mozambique, Nigeria, Saudi Arabia and Senegal, the cost of container export and import can be as twice that of performing countries and may take 3 times longer to complete.

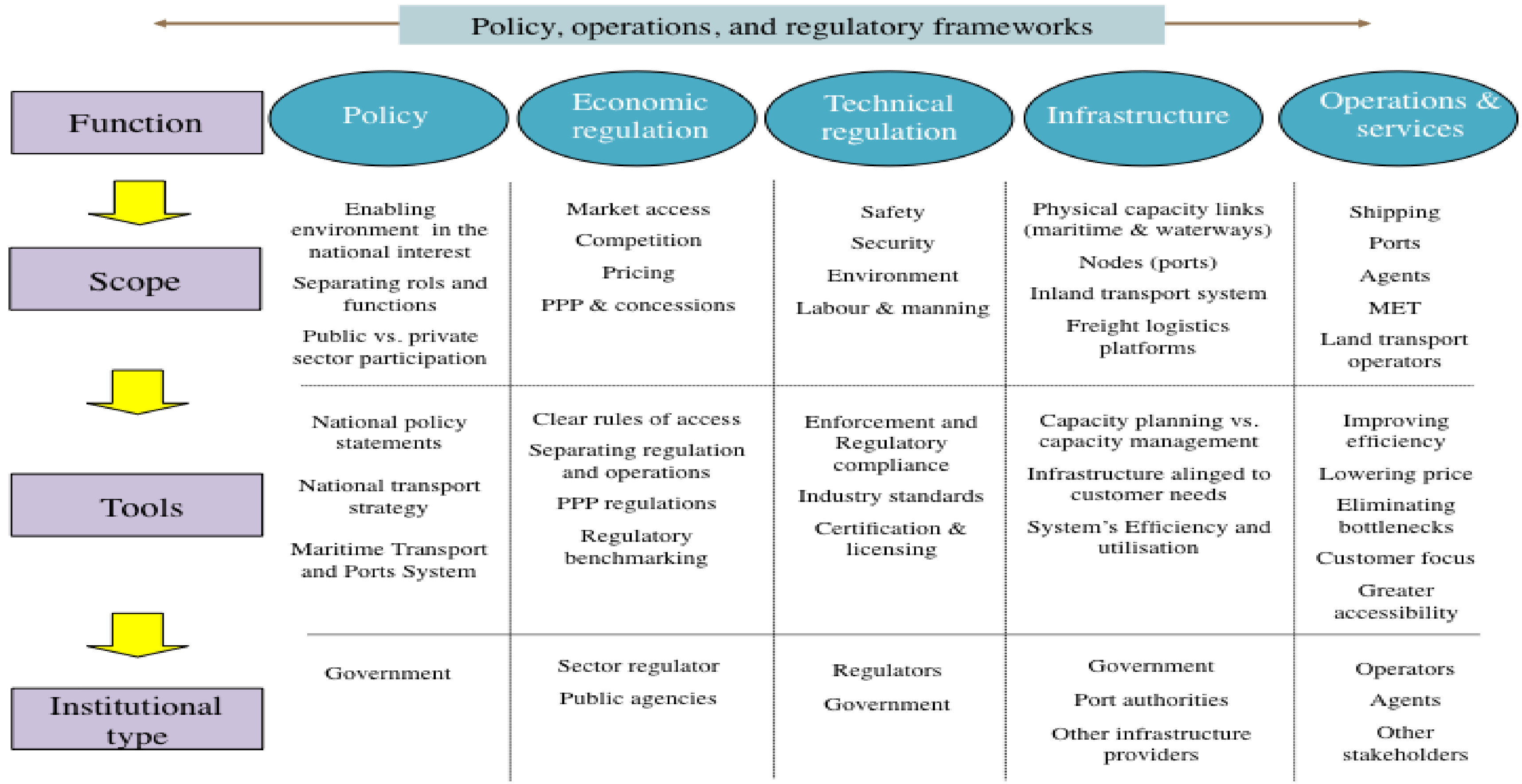
7.2 Institutional, Operational, and Policy Recommendations

In the previous sections, the Study has reviewed the institutional and regulatory framework of the OIC port sector, examined its capacity and services, and analysed its performance and competitiveness. In view of the above diagnostics and analyses, this report recommends a nine operational, institutional, and policy recommendations targeted at the port sector in OIC countries. The pillars of institutional and policy recommendations are around six main areas as outlined below, the other three recommendations are for wider port policy reform.

7.2.1. Identify Responsibilities and Reduce Institutional Fragmentation

Clarifying the responsibilities of various institutions and the manner in which they operate and interact could reduce fragmentation and should be a priority for OIC ports. However, simply clarifying roles will not solve the problem for two reasons. First, bright line boundaries should be drawn among operations, policy and regulation. Second, any division of responsibilities should aim at the successful pursuit of a strategy to make the sector more competitive and efficient. To this end, the current port institutional structure in many OIC countries is in need of reform to fill institutional gaps, avoid overlapping responsibilities and eliminate the implicit conflict among public entities. Figure 18 provides a framework on how port policy, operations and regulation should be structured in OIC countries.

Figure 18: A proposed framework on the interplay between policy, operations, and regulation in OIC countries



Source: Consultant

7.2.2. Encourage Private Sector Participation and Devolve Landlord Port Structures

In many OIC ports, the landlord port model is either absent, e.g. Turkey, or not properly developed, e.g. Morocco, Jordan, Senegal, and Indonesia. As shown in both the institutional and operational performance analyses, the landlord model, where properly developed and implemented, tends to generate efficiency gains and promote competition.

Furthermore, the countries where ports are most successful are those where port operations and management are devolved at the regional or local port level. Devolving the port landlord function to the region(s) served by each OIC port will not necessarily require changing the institutional structure of existing ports and could be achieved by the inclusion of regional representatives in port governance and policy making so that the ports can become economic catalysts for their hinterlands, which in turn will boost efficiency and promote inter-port competition.

In parallel, private sector participation (PSP) should be allowed and promoted in the port sector across OIC countries. PSP in container terminal operations and management can take different forms, but regardless of the option selected, this take place at the terminal/port level rather than at the national or centralised level.

7.2.3. Promote Inter and Intra-Port Competition

Sustaining productivity improvements following private sector participation depends on the extent to which competitive pressures can be brought to bear, either between or within ports. As shown in this study, most of the benefits of private participation in port activity results from competition. In particular, dominance by single port operators, global or national, needs to be avoided, supporting the view that joint ventures should be pursued at the port/terminal level.

In injecting more competition into terminal operation, due consideration needs to be given to the market characteristics of the terminals, private sector willingness to get involved, the impact on the Governments' finances and public interest issues. Structuring the market to achieve greater competition is not a straightforward process and must be given proper due diligence and consideration. For instance, while for small terminals local private participation may be more suitable, large-scale container ports require exposure to international practices and the injection of new technology.

At the same time, the Study recommends phasing out cross-subsidies and public sector monopolies, either directly or indirectly, in the OIC ports as this generates inefficiencies. Moreover, and in line with our proposals to encourage private sector participation in ports, it is envisaged that port authorities and public agencies to play more a role of port facilitator and promoter. This should be accompanied by the phasing in of inter-port competition through the relaxation of the requirement for unified and rigid national tariffs.

7.2.4. Set-up Port Stakeholder Groups and User Councils

In many countries, port councils have been established as consultative entities with the aim of deliberating on port development, tariff revision, and changes in legislation. For some OIC countries, shippers' councils, shipping and freight forwarding associations, and other NGOs deliver good advocacy services and stakeholder activities. Such groups would only maintain credibility if they are seen to act appropriately and a useful model is to have a ports' users' and stakeholders' platforms that would represent the perspectives of operators, carriers, traders, public agencies, and other port interests.

However, in most OIC countries there are no port users' and stakeholders' councils and especially it seems that the current decision planning process does not involve key stakeholders. Indeed, several port operators and users which the Consultant have met in the country visits in Malaysia, Morocco, and Senegal, have openly expressed their desire to be consulted during the preparation of ports' long-term strategies, development and master plans.

To this end, the Study suggests the establishment of 'Port Stakeholders Groups' which could consist of public and private sector stakeholders. Such groups can have significant benefit if (i) they meet regularly, (ii), actions are followed up / responded to adequately, and (ii) membership of the group is appropriate.

7.2.5. Conduct Port Performance and Price Review

Yard stick benchmarking and performance review is one of the main tasks of a port regulator, the establishment of which is recommended in Sections 1 and 2 of this study. The establishment of a performance benchmarking and price review mechanism in OIC countries is recommended where either the port sector show instances of market failures or where tariffs are calculated and imposed on an arbitrary basis. To address the shortcomings outlined in both sections on port performance and concession arrangements:

- Performance benchmarking using established models similar to the one used in this report will allow both regulators and policy makers to compare the efficiency of OIC port operations against regional and international benchmarks.

- Performance benchmarks shall be used as targets for terminal operators in concession agreements, thus driving port operations towards efficiency targets.

- In a monopolistic situation, such as that of several OIC ports, performance benchmarks should be used as part of a contract programme or other similar arrangements between the concessioning (e.g. port authority) and conceding party (e.g. terminal operator) under the oversight of an independent port regulator, where applicable. Such an approach should also guide OIC countries future port policies in deciding how pricing can be used as a tool to introduce and promote port competition.

- Performance benchmarks are also used for price regulation for both terminal services (under concessions) and marine services (still under port authorities in many OIC countries). For activities under concession, performance (yardstick) benchmarking is used to establish price caps and/or efficient firms according to which port tariffs are decided. In case of non concessioned activities, performance benchmarks are used to establish comparables, including marginal costs and prices, against which port dues and conservancy charges should be set.

At the same time, one of the main issues in port operations is the determination of port capacity. Port capacity is dynamic (rather than static) and changes according to the equipment and technology used but also according to the types of ships serviced and cargo handled. Establishing performance targets in concession and contract agreements between public sector landlord authorities and private sector terminal operators, e.g. minimum throughput guarantees and/or congestion and dwell time indicators, depend very much on the approximate estimation of port capacity because otherwise such targets may be too easy or too difficult to achieve. In many OIC ports, the study did not come across any sophisticated estimation of terminal capacity and utilisation that is linked to performance targets, and it seems that the calculation of port capacity was either simplistic or reporting theoretical design estimations. The Study recommends that such calculations be part of any mid-term review or auditing of port concessions.

7.2.6. Compile and Publish Detailed KPIs for Port Performance

In most ports, detailed key performance indicators are measured and compiled regularly (daily, weekly and monthly) and serve as a tool for detecting inefficiencies and improving port performance. In many OIC ports, including the ones visited in Morocco and Senegal, such KPIs were neither made available nor are they published in official port websites or in its regular reports.

A case in point is ship turn-around time which denotes the duration of the vessel's stay in port and is calculated from the time of arrival to the time of departure. Commonly expressed in hours, the port authority and terminal operator should normally compile statistics that would provide monthly and annually average turn-round times. The average turn-round time per ship is determined by dividing the total hours by the total number of ships calling at the port. In its basic form, ship turn-round time does not mean much, as the length of stay of a vessel is influenced by (a) the volume of cargo, (b) the facilities made available and (c) the composition of the cargo itself. Thus it becomes necessary for the port to break the basic ship turn-round time down for different types and sizes of vessels and even sub-dividing these into domestic trade, regional trade and deep sea trade.

In compiling data that would enable the port to determine ship turn-round time or the tonnage handled per ship day (or ship hour), a port would normally split total time in port into time at berth and time off the berth and within each, the opportunity would be taken to record for each service activity the amount of delay (idle time) as well as the reasons for the delay (e.g., waiting for cargo, opening/closing hatches, waiting for gears, rain, waiting for berth, etc). In particular, the ratio between the waiting time for berth and the time spent at berth, known as the waiting rate, is a significant indicator of congestion and inefficiency in ports.

7.2.7. Establish a Ports Regulator

In most OIC ports, the dominant approach is to use contract law to enforce the terms of concession and joint venture agreements, with responsibility for enforcement vested in the local landlord port authority other governmental agencies. However, there are some risks of this approach in terms of impartiality and political interference. There is also a risk in assigning too strong a regulatory role to the landlord port authority and other governmental agencies resulting in them micro managing privatised businesses. There is also the risk for conflicts of interest and regulatory capture (development of common interests by the regulator and the organisation being regulated). Furthermore, it is difficult to find the necessary skills and experience within a landlord port authority or particular sector agency. It may also be difficult to develop a standardised and intellectually consistent approach.

An independent regulator is therefore essential to control entry (entry regulation), to determine tariff (rate regulation), to set the performance standards (performance regulation and yardstick benchmarking), and (sometimes) to set technical standards (health and safety, security, environmental, and labour regulation); both of which have been found to be lacking in several OIC countries. Additionally, the regulator may be required to act as an arbitrator (to handle disputes), as well to manage any universal or social service obligations imposed by the authorities. At the same time, it might be better to put in place a multi-sector regulator for the ports and transport logistics sector as a whole to cover the dry ports and freight logistics sectors as well. There are four main arguments in favour of a multi-sector regulator:

a. It makes more cost effective use of resources, which is important in a country where regulatory skills and experience are still poorly developed.
b. It ensures that the same principles are applied to all transport infrastructures, eliminating unfair competition at the margin where different modes compete.
c. It supports the development of specialist knowledge and expertise, including the transfer of best practice between modes.
d. It encourages the development of a single set of policy guidelines, which recognise the inter-relationships between different modes and their common policy objectives.

7.2.8. Establish Integrated Port Maritime Systems and Clusters

In attempt to structure and organise the ports and maritime transport sectors, several countries in the world have developed formalised ports and maritime systems that reflect their strategic priorities and policy orientations, as discussed in the previous recommendation, and can sometimes be targeted at specific segments of the port industry or extended to sectors and industries outside the port and maritime spectrum.

An integrated port/maritime system is a set of organisations, firms and/or industries that operate within or across the maritime and port sectors and are systematically linked, both among themselves and with the outside environment, through vertical and horizontal relationships. In many OIC countries, there is no formalised maritime system that defines, categorises, organises, and integrates maritime activities according to economic, trade, social, strategic, or any other relevant attributes. The lack of a formalised and integrated port system constitutes a major obstacle against a systematic organisational and institutional structure of the port sector, and there is a need for identifying and prioritising those components in line with port, and wider maritime and transport, policy goals and strategic objectives.

In line with integrated port systems, some countries have established spatial (regional) port clusters to bring several components of the ports and maritime industry into one spatial platform within or close to port boundaries. Since the last two decades or so, several countries have successfully developed port geographical clusters such as Rotterdam’s port cluster, London’s Gateway ports and logistics cluster, and Singapore’s port trade and distribution cluster. Some OIC countries have started recently to develop port clusters, e.g. Klang’s port cluster, Tangier’s port and logistics hub, Jeddah’s port and industrial city; but such attempts have not yet developed into a fully integrated cluster, as many industrial and service components of the port’s sector are either inexistent or not sufficiently developed in those clusters (e.g. port design and engineering, port’s finance, port training and education, and port legal and insurance services). Indeed, this is the picture across all ports in the OIC countries under study.

7.2.9. Formulate Port Policy Statements and Long-Term Strategies

Generally, a port strategy is formulated based on two understandings: (i) the role of port sector 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. The aim of strategy formulation under any port and maritime organisation is to provide a justification and overview of a set of strategic measures and develop an indicative and an action plan for their implementation.

The main observation with regard the structure of the port sector in many OIC countries is the confusion between strategy and policy. Port policy is an integral part of the overall economic policy yet in many OIC countries often, there are few (and sometimes no) policy statements at either port's or Governmental levels as regards long-term objectives and priority segments in the and port sector. Therefore, the mission and objectives of a country's port system must be well defined and understood before the efficiency and adequacy of the institutional, organisational, regulatory, and operational frameworks can be properly assessed and analysed.

In this regard, the decisive factor framework proposed by Bichou and Gray (2005) may be taken as a reference framework for systemising a port policy and related strategy. The framework proposes a categorisation and/or prioritisation of the factors determining the approaches used to define a maritime system. Some of these factors are summarised in Table 35. For example, the early recognition of ports as intermodal platforms in the USA has led over the years to the active involvement of multimodal operators in port operations and management. Rail transport operators such as CSX became port institutions through terminal ownership and management (CSX World Terminals, now part of DP World). In a similar vein, the adoption of the 1998 Ocean Shipping Reform Act redefined the role and functions of many traditional market players such as non-vessel operating common carriers. In Singapore and Dubai, a major review of port roles and objectives prompted a shift from local to international operations, which has led to the creation of relevant institutional and international structures: PSA International and DP World, respectively. In many other cases, the prior definition of port missions also has led to different models of institutional and operational port systems.

Table 35: Factors determining the port approach

Decisive factors/ Examples of approaches to maritime systems		Missions	Assets & facilities	Functions	Institutions
Macro-economic approaches	Economic catalyst	Major			
	Job generator	Major			
	Trade facilitator	Major			
Institutional / organisational models	Private/public	Minor			Major
	Landlord/tool/service		Major		Minor
Geographic and spatial approaches	Port-city	Major			
	Waterfront estate	Minor	Major		
	Sea/shore interface	Minor		Major	
	Logistics centre	Minor		Major	
	Clusters				Major
	Maritime industrial development areas; trade, distribution and marketing centres	Major		Minor	
	Free zones and trading hubs	Minor		Major	
Hybrid approaches	UNCTAD generations (1st to 4th)	Major		Major	Minor
	World Bank port authority model	Major			Major
Alternative new approaches	Combinative strategies (cargo/sea led, supply/demand led)	Major		Major	
	Logistics/ systems (tele-port, trade port etc.)	Major		Major	
	Business units (production, marketing, pricing etc.)	Minor		Major	

Source: Bichou and Gray, (2005)

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APPENDIX 1: SELECTED OIC AND INTERNATIONAL CONTAINER TERMINALS FOR THE ANALYSIS OF PERFORMANCE BENCHMARKING

Terminal	Abr.	Operator	Port	Country
Aqaba Container Terminal	**ACT**	ADC/APMT	Aqaba	Jordan
Ambarli Kumport Container Terminal	**AKCT**	Kumport	Ambarli	Turkey
Ambarli Marport Main & West Terminals	**AMCT**	Kumport	Ambarli	Turkey
Apapa Container Terminal	**APCT**	APMT	Lagos	Nigeria
Casablanca Terminal Conteneurs Est	**CTCE**	Marsa Maroc	Casablanca	Morocco
Casablanca Terminal Conteneurs West	**CTCW**	Somaport	Casablanca	Morocco
Doraleh Container Terminal	**DCT**	DPW	Doraleh	Djibouti
ECT Delta Container Terminals	**ECTD**	ECT (HPH)	Rotterdam	Holland
Hong Kong Int. Terminals (4,6,7, 9N)	**HIT**	HPH	Hong Kong	China
Jakarta International Container Terminal	**JICT**	HPH	Tanjung Priok	Indonesia
Jeddah Northern Container Terminal	**NCT**	Gulftainer (GSCC)	Jeddah	Saudi Arabia
Jeddah Southern Container Terminal	**SCT**	DPW/ Siyanco	Jeddah	Saudi Arabia
Maputo Container Terminal	**MCLI**	DPW/CFM	Maputo	Mozambique
Maersk Delta Container Terminal	**MDCT**	APMT	Rotterdam	Holland
Mersin International Port	**MIP**	PSA/ Akfen	Mersin	Turkey
Modern Terminals (1,2,5,8W, 9S)	**MTL**	Modern Terminals	Hong Kong	China
Northport Container Terminals (1, 2)	**NPCT**	Northport (NCB)	Port Klang	Malaysia
Qasim International Container Terminal	**QICT**	DPW	Port Qasim	Pakistan
Tanjung Pelepas Container Terminal	**PTP**	APMT	Tanjung Pelepas	Malaysia
PSA all terminals	**PSA**	PSA	Singapore	Singapore
Salalah Port Container Terminal	**SPCT**	SAOC/ APMT	Salalah	Oman
Terminal Conteneurs Dakar 1	**TCD1**	DPW	Dakar	Senegal
Terminal Conteneurs 1	**TMCT1**	APMT /Akwa	Tanger Med	Morocco
Terminal Conteneurs 2	**TMCT2**	Eurogate/ CMA	Tanger Med	Morocco
Westport Container Terminals (1,2,3,4)	**WPCT**	Kelang/HPH	Port Klang	Malaysia
Yantian International Container Terminal	**YICT**	HPH	Shenzhen	China

APPENDIX 2: INFORMATION FICHE OF SELECTED OIC TERMINALS

A2.1 Ambarli Kumport and Marport Container Terminals (AKCT, AMCT), Turkey

The port of Ambarli near Istanbul contains the largest container terminal facilities in Turkey in the country and handles about 40% of the country's annual container traffic. The total container handling capacity in Ambarli is about 6.5 million TEU per year. Marport and Kumport are the main container terminals in Ambarli, and both terminals are being operated by private enterprises.

Infrastructure

	AMCT	AKCT
Berths	03	03
Length overall	1560 m	2180 m
Draft	14.5-16.5 m	9-16.5 m
Terminal area	34 hectares	40 hectares

Superstructure

	AMCT	AKCT
STS cranes	17, of which 10 post-panamax	16 of which 12 post-panamax
Yard gantries	35 RTGs	14 RTG, 17 SC
Other equipment	Several stackers, trucks & chassis	Several stackers, trucks & chassis

Throughput

- AMCT: 1.7 million in 2013, AKCT: 1.3 million in 2013.
- Annual capacity: AMCT: 1.9 million; AKCT: 1.7 million TEU.

A2.2 Apapa Container Terminal (APCT), Nigeria

Apapa port is located in the Lagos port complex serving Nigeria's main economic and trade hub with an estimated share of 90% of the country's container's imports. The port was concessioned to APMT in 2006 for 25 years, and as part of the institutional reform of the port sector that has seen the change of the role of Nigerian Ports Authority (NPA) from a service model to a landlord model. An expansion programme was launched in 2011 to increase the terminal's capacity to 1.5 million by 2014.

Infrastructure
- Number of berths: 04.
- Length overall: 1,000 m.
- Draft: 10.514.5 m.
- Terminal area: 55 hectares.

Superstructure
- STS: 10, of which 4 are post-panamax.
- Yard gantries: 12 RTGs, 23 reach stackers.
- Other terminal equipment: 590 reefer plugs

Throughput
- 650,000 TEU in 2013.

A2.3 Aqaba Container Terminal (ACT), Jordan

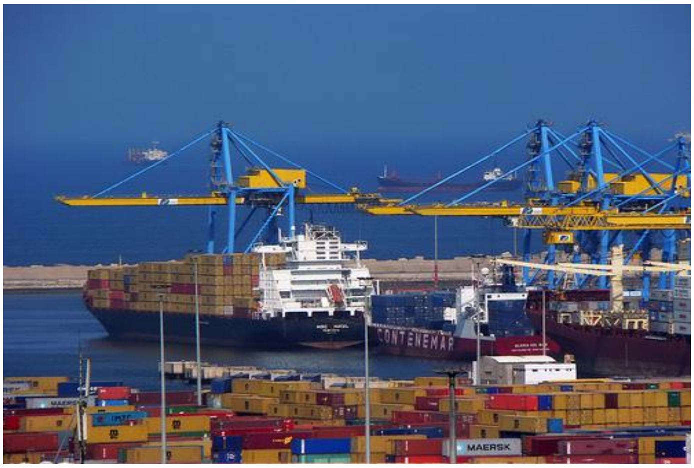
Jordan has a limited coastline extending just 27 kilometres (km) and comprising only 3 nautical miles of territorial water. The Port of Aqaba, the country's only seaport, handles over 80% of foreign trade and holds an economically and politically strategic position. ACT is a joint venture between APM Terminals and Aqaba Development Corporation (ADC) for the development and operations of the container terminal on a common user basis. The 25-year joint development agreement was signed in 2006, following a 2-year successful management contract with the same operator. ACT has currently an annual capacity of 1.5 million TEU following a 426 million quay expansion opened in 2013.

Infrastructure
- Berths: 04 of which 03 are container berths and one is a RoRo berth.
- Length overall: 1,000 m.
- Draft: 14.5 m.
- Terminal area: 50 hectares.

Superstructure
- STS: 06, of which 5 are post-panamax.
- Yard gantries: 18 RTGs, 14 reach stackers.
- Other terminal equipment: 700 reefer plugs

Throughput
- 873,000 TEU in 2013; of which 35% transit.

A2.4 Casablanca East and West Container Terminals (CTCE and CTCW), Morocco



The port of Casablanca is the largest port of Morocco. Located on the Atlantic coast and comprising a number of container, car and Ro-Ro, break bulk, and dry bulk facilities. The port is the main gateway for the most active economic region in Morocco and is well connected to other regions. For container traffic, the port has two main container terminals (East: TCE and West: TCW). TCE, of an annual capacity of 500,000 TEU, is operated by Marsa Maroc which won the terminal concession in 2006. TCW, an annual capacity of 300,000 TEU, is operated by Somaport (a consortium of COMANAV and CMA-CGM) which won the terminal concession in 2008. A third container terminal (CT3) has been developed by Marsa Maroc which won its concession in 2013. CT3 is scheduled to start operations in 2015-2016 with an annual capacity 600,000 TEU.

Infrastructure

	TCE	TCW
Berths	04	01
Length overall	600	700
Draft	12 m	9.6 m
Terminal area	60 hectares	30 hectares

Superstructure

	TCE	TCW
STS cranes	08, of which 02 pos-panamax	03 post-panamax
Yard gantries	43 SC	10 RTG
Other equipment	Several stackers, trucks & chassis	Several stackers, trucks & chassis

Throughput

- Combined TCE and TCW: 1 million in 2013.
- TCE: 650,000 TEU in 2013; TCW: 350,000 TEU in 2013.

A2.5 Dakar Container Terminal (TCD1), Senegal

Dakar, the capital and port city of Senegal is a strategic gateway to West Africa and offers transit access to several landlocked countries in the region. In 2007, DP World (DPW) won a competitive tender for a 25-year, renewable concession awarded by the Dakar autonomous port authority, to operate the Terminal Conteneurs Dakar 1 (TCD1). The reported total transaction size of the first phase was US$294m.Phase I of the project was completed and became fully operational in 2013 with a 600,000 TEU annual capacity. With expected increases in cargo traffic, a phase II option is planned and would involve developing an entirely new container terminal (Port du Futur) with a potential capacity of 1.2 million TEU.

On 13 February 2014, the Terminal Conteneurs Dakar 2 TCD2 was launched to enhance existing operations at TDC1 and respond to increasing traffic demand. This second platform managed and operated by CMA CGM, the 3rd largest global container shipping company.

Infrastructure
- Number of berths: 02
- Length overall: 700m.
- Draft: 12-13 m.
- Terminal area: 12,000 m^2.

Superstructure
- STS: 04, of which 2 are post-panamax.
- Yard gantries: 10 RTGs, 14 reach stackers.
- Other terminal equipment: 400 reefer plugs

Throughput
- 360,000 TEU in 2013; of which 8% transhipment and 15% transit.

A2.6 Doraleh Container Terminal (DCT), Djibouti

In 2000, the Djibouti government established a joint venture with DPW and awarded the company a 20-year concession to operate the Doraleh Container terminal (DCT). The terminal was inaugurated in 2009 with an initial capacity of 1.5 million TEU per year. As part of Phase II development, DCT's capacity will be extended to 3 million TEUs after the completion in 2024. In July 2014, the Government of Djibouti said it had filed for international arbitration seeking to rescind on the DPW concession to operate Doraleh Container Terminal, and hoped to have the annulment confirmed and receive damages for losses incurred from alleged corruption practices and bribes to the former chairman of the Djibouti's former ports and free zones authority. DPW will continue to operate the terminal throughout the tribunal proceedings which are expected to commence in 2015.

Infrastructure
- Number of berths: 02.
- Length overall: 1,050 m.
- Draft: 18 m.
- Terminal area: 50 hectares.

Superstructure
- STS: 08 post-panamax
- Yard gantries: 22 RTGs, 9 reach stackers.
- Other terminal equipment: 480 reefer plugs

Throughput
- 744,000 TEU in 2013; of which 25% transit to Ethiopia.

A2.7 Jakarta International Container Terminal (JICT), Indonesia

JICT was opened in 199 as part of an agreement signed by HPH and its joint venture partner PT Pelabuhan Indonesia (Pelindo) II for a 20 year concession period. JICT has two terminals. In 2012, JICT announced it was planning to invest around $ 100 million to boost annual capacity at JICT to 2.8 million TEU.

Infrastructure
- Number of total berths: 09.
- Length overall: 2150 m.
- Draft: 18 m.
- Terminal area: 54.7 hectares.

Superstructure
- STS: 19 post-panamax
- Yard gantries: 74 RTGs, 10 reach stackers and side loaders.
- Other terminal equipment: 624 reefer plugs

Throughput
- 2.4 million TEU in 2013.

A2.8 Jeddah North and South Container Terminals (NCT & SCT), Saudi Arabia

Jeddah is the port gateway of Saudi Arabia on the Red sea and also acts as a transhipment facility for north and south routes through the Suez Canal. The two main container terminals, SCT and NCT, were commissioned in 1999 and 2001, respectively. The two terminals are currently operated by DPW and Gulftainer (the latter has in 2013 bought the majority share of Gulf Stevedoring, the historical operator of NCT). A third terminal operator, the Red Sea Gateway Terminal (RSGT), opened in 2009 under a 33-year BOT concession and is currently undergoing major expansion. RSGT was not included in the OIC port performance analysis because of its recent history.

Infrastructure

	NCT	SCT
Berths	07	06
Length overall	1750	1500
Draft	16 m	16.5 m
Terminal area	170 hectares	141 hectares

Superstructure

	NCT	SCT
STS cranes	11 pos-panamax	18, of which 10 are post-panamax
Yard gantries	35 RTG, 11 RS and handlers	32 RTG, 15 SC, 16 RS & handlers
Other equipment	2148 reefer points	2148 reefer plugs

Capacity

- NCT: 3 million TEU; SCT: 2 million TEU.

A2.9 Port Klang North and West Container Terminals (NPCT and WPCT), Malaysia

Port Klang is situated 40 km from Kuala Lumpur, the capital city of Malaysia. It serves the main commercial and industrial hub of the country (the Greater Klang Valley). Since 1993, the port has been developed as the main national load centre and a hub for the South East Asia region. The port assets have been divested to the private sector resulting into two main container port facilities: Northport (NPCT) and Westport (WPCT).

	Northport CT1	**Northport CT2**	**Northport CT3**	**Westport**
Total Area (hectares)	93.4			28.54
Ship Berths	4	2	3	2
Ship Berth Length (m)	1,100	1,100	520	1800
Depth (m)	10.5-13.2	13	15	15
Quay Cranes	32			47
SCs	26			-
RTGs	84			152
Annual capacity (TEU)	5.6 million			11 million
Combined throughput (TEU)	17.04 million			

A2.10 Maputo Container International Terminal (MCLI), Mozambique

Maputo Container International Terminal (MCLI) was privatised in 2003 where DPW holds 60% shares while CFM (Mozambique Ports and Railways) holds 40% shares. When opened, MCLI had an initial capacity of 120,000 TEU which was expanded to 250,000. Its throughput has risen dramatically from a mere 40,000 TEU in 2003 to more than 180,000 TEU in 2013. The port of Maputo is the main gateway for Mozambique's exports and imports, but is also used as an import transit point for South African bound-cargo along the Johannesburg corridor.

Infrastructure
- Number of total berths: 01 (berth 14).
- Length overall: 300 m.
- Draft: 11 m.
- Terminal area: 8 hectares.

Superstructure
- STS: 2 and 3 mobile cranes
- Yard gantries: 74 RTGs, 10 reach stackers and side loaders.
- Other terminal equipment: 100 reefer plugs

Throughput
- 2.4 million TEU in 2013.

A2.11 Mersin International Port (MIP), Turkey

Mersin International Port (MIP) is the 2nd largest container facility in Turkey and serves the Ankara hinterland and associated industrial area. It also operates as a private port through a joint venture between PSA and Akfen holding, which took over the TCDD Mersin Port Management for a period of 36 years on May 11 2007. Additional yard capacity was added in 2012 to meet increasing demand.

Infrastructure
- Number of total berths: 4 container berths (21 berths in total for MIP).
- Length overall: 1470 m (for 3 container berths and one general cargo berth).
- Draft: 10-14 m.
- Terminal area: 110 hectares.

Superstructure
- STS: 7 post-panamax, 3 mobile.
- Yard gantries: 25 RTGs, 18 reach stackers.
- Other terminal equipment: 624 reefer plugs

Throughput
- 2.5 Million TEU annual capacity
- 1.38 million TEU in 2013.

A2.12 Port Qasim International Container Terminal (QICT), Pakistan

Qasim International Container Terminal (QICT) is Pakistan's first dedicated international container terminal established by the private sector on BOO basis. QICT started operations in 1995 through a 30-year concession originally awarded to P&O Ports. The latter group was sold to DPW in 2006 took over the operations and management of the port until today. QICT had an initial capacity of 850,000 TEUs, but was expanded in 2011. The 2nd container terminal (QICT 2) has started operations in 2011 adding another 700 meters of quay length and a combined annual handling capacity of 2 million TEUs.

Infrastructure
- Number of total berths: 04.
- Length overall: 1327 m.
- Draft: 13-16 m.
- Terminal area: 26.2 hectares.

Superstructure
- STS: 9 post-panamax
- Yard gantries: 27 RTGs, 11 reach stackers.
- Other terminal equipment: 1000-2000 reefer plugs

Throughput
- 722,000 TEU in 2013.

A2.13 Salalah Port Container Terminal (SPCT), Oman

Salalah is a major transhipment centre located at the crossroads of international shipping services plying the Middle East and Indian Ocean. SPCT has gone through a series of expansion programmes. Berths 5 and 6 were opened in 2007 and 2008, respectively, boosting the terminal's annual capacity to 4.5 million TEUs (from 2.5 million TEUs). The port is planning to add another 4 million TEU by 2017 to boost capacity and meet forecast demand.

Infrastructure
- Number of total berths: 06.
- Length overall: 2205 m.
- Draft: 16.5-18.5 m.
- Terminal area: 26.2 hectares.

Superstructure
- STS: 17 super post-panamax
- Yard gantries: 45 RTGs, 11 reach stackers.
- Other terminal equipment: 1000-4000 reefer plugs

Throughput
3.34 million TEU in 2013.

A2.14 Tangier Med Container Terminals 1 & 2 (TMC1 and TMC2), Morocco

The port of Tangier Med in the North of Morocco is strategically located in the strait of Gibraltar. It was developed to become one of the major transhipment port hubs in the Mediterranean serving both East-West and North-South routes. The port has been developed in two phases: Tangier Med I which comprises 2 container terminals (CT1 and CT2) with a combined capacity of 3 million TEU. The development port of Tangier Med II was launched in mid-2010 and comprises two other container terminals (CT3 and CT4) with a combined capacity of 5.2 million TEU.

CT1 was launched in July 2007 and is operated through a 30-year concession by a consortium made of APM Terminals and Akwa Group. CT2 was launched in July 2008 and is operated through a 30-year concession by a consortium made of Eurogate, MSC, CMA-CGM and COMANAV. As part of Tangier Med 2, a new container terminal (CT4) is currently under development and would have an overall quay length of 1200 m, a terminal area of 60 hectares, and a nominal capacity of 2.8 million TEU. CT4 is planned to start operations in mid-2015 by Marsa Maroc (the largest Moroccan port operator) under a 30-year concession agreement.

Infrastructure

	TC1	**TC2**
Berths	01	01
Length overall	800	812
Draft	18 m	18 m
Terminal area	40 hectares	40 hectares

Superstructure

	TC1	**TC2**
STS cranes	08 post-panamax	08 post-panamax
Yard gantries	23 RTG	21 RTG
Other equipment	Several stackers, trucks & chassis	Several stackers, trucks & chassis

Throughput
- Combined TC1 and TC2: 2.6 million in 2013of which 92% transhipment.
- TC1: 1.5 million TEU in 2013; TC2: 1.1 million TEU in 2013.

A2.15 Tanjung Pelepas (PTP), Malaysia

The port of Tanjung Pelepas was developed by Maersk (APMT) in 2000 following the refusal of PSA to provide the company with dedicated terminal facilities in Singapore. The port is a major transhipment facility in direct competition with Singapore, and has since its opening seen tremendous growth and 3 phases of expansion. The latest phase was launched in 2012 to expand its quay by the addition of two berths increasing the quay length by 0.7 km to the existing 4.32 km. The two berths became fully operational in mid-2014. The expansion has boosted the handling capacity to 10.4 million TEUs.

Infrastructure
- Number of total berths: 14.
- Length overall: 5 km.
- Draft: 16.5-18.5 m.
- Terminal area: 180 hectares.

Superstructure
- STS: 52 super post-panamax
- Yard gantries: 174 RTGs.
- Other terminal equipment: 5800 reefer plugs

Throughput
Annual capacity 10.5 million
7.6 million TEU in 2013.

APPENDIX 3: PORTS VISITS AND MEETINGS

A3.1 Schedule

- 17-23 August 2014: Port Klang (North & West Ports) and Tanjung Pelepas (PTP).
- 28 September - 04 October 2014: Casablanca (CTCE) & Tangiers-Med (TMCT1/TMCT2).
- 02-07 November 2014: Dakar Port (DTC1 and Dakar RoRo Terminal).

A3.2 Meetings

17/08/2014: Arrival to Kuala Lumpur, Malaysia.
18/08/2014: Meeting with the Malaysia Maritime Institute and with the Malaysia Institute of Supply Chain Innovation (MIT Scale Network)
19/08/2014: Meeting with Klang Port Authority.
19/08/2014: Meeting with West Port Company.
20/08/2014: Meeting with North Port Company
21/08/2014: Travel to Tanjung Pelepas.
22/08/2014: Meeting with APMT / PTP
23/08/2014: Meeting with Johor Port Authority
24/08/2012: Return to Kuala Lumpur, Travel back home (London)
28/09/2014: Arrival to Rabat, Morocco.
29/09/2014: Travel to Casablanca. Meeting with the Directorate of Merchant Marine
30/09/2014: Meeting with Marsa Maroc and with the National Agency of Ports (ANP)
01/10/2014: Meeting with the editor of maritimenews.ma.
02/10/2014: Meeting with TMSA in Casablanca. Travel to Tangiers
03/10/2014: Meeting with TMPA. Travel to Rabat
12/10/2014: Travel back home (London)
02/11/2014: Arrival to Dakar, Senegal.
03/11/2014: Meeting of Senegalese Shippers' Council
04/11/2014: Meeting of Dakar Autonomous Port
05/11/2014: Meeting of Group Bolloré
06/11/2014: Meeting with former Minister of Transport
07/11/2014: Travel back home (London)

A3.3 Site Visits

20/08/2014: West Port Container Visit.
22/08/2014: PTP Port Visit
01/10/2014: Casablanca Port Visit (CTCE)
02/10/2014: Tangier Port Visit
05/11/2014: Dakar Port Visit (DCT1)

APPENDIX 4: DATA ENVELOPMENT ANALYSIS (DEA)

A4.1 Introduction to DEA

An important aspect to consider when using productivity index methods is the fundamental difference between productivity and efficiency. Although the two measures seem to be closely related, each denotes a different performance measurement concept. Productivity is a descriptive measure whereby a productivity index provides a comparison between firms but uses no reference technology for a benchmark. Efficiency, on the other hand, is a normative measure in that the benchmarking of firms is undertaken with reference to an underlying technology.

The frontier concept in this context denotes the lower or upper limit to efficiency with respect to the inputs consumed and outputs produced by a decision-making unit (DMU). Under this approach, a DMU is defined as efficient when it operates on the frontier and inefficient when it operates away from it (below it for a production frontier and above it for a cost frontier). Early attempts to construct a frontier used ordinary least squares regression techniques to fit a function (often a cost or production function), which is then shifted to become a frontier. Stochastic Frontier Analysis (SFA) is a more sophisticated version of this approach. The objective is to construct a non-observable frontier from a set of best obtainable positions. The method used to identify the frontier may be parametric (econometric) or non-parametric (linear programming). Unlike econometric (parametric) models, non-parametric approaches do not require a pre-defined function but use linear programming techniques to determine a frontier. Techniques belonging to the non-parametric approach include DEA and FDH (Free Disposal Hull). These techniques can handle multiple outputs and multiple inputs.

The rationale behind DEA is that in seeking to solve the issue of DMUs (for example ports) assigning different weights to their respective inputs and outputs, each DMU is allowed to set a combination of weights that puts it in the most favourable position vis-à-vis others. The method works by solving a series of linear programming problems and selecting the optimal solution that maximises the efficiency ratio of weighted output to weighted input for each DMU. The efficiency frontier is constructed from the envelope of these linear combinations.

Assuming a set of *K* DMUs (*k*=1,…,*K*) in the sample, each with *M* inputs (*j*=1,…,*M*) and *N* outputs inputs (*i*=1,…,*N*). the efficiency ratio of the DMU k can be defined as the ratio of its weighted sum of outputs over its weighted sum of inputs:

$$E_k = \frac{u_1 y_{1k} + u_2 y_{2k} + \dots}{v_1 x_{1k} + v_2 x_{2k} + ..} = \frac{\sum_{i=1}^{N} u_i y_{ik}}{\sum_{j=1}^{M} v_j x_{jk}} \quad (1)$$

where x_{jk} and y_{ik} are the amounts of j^{th} input and i^{th} output consumed and produced by DMU k, respectively. u and v correspond to (*M* x 1) and (*N* x 1) vectors of input and output weights, respectively. The DEA formulation starts with specifying a mathematical problem that maximises the efficiency of DMU *k* subject to the efficiency of all other DMUs being less than or equal to 1. The weights are the variables of this problem and the solution gives the most favourable weights and an efficiency score for each DMU.

$$\begin{aligned} & Max_{u,v}\left(u'y_k / v'x_k\right) \\ & st \quad u'y_k / v'x_k \leq 1, \quad k = 1,2,\dots,K \qquad (2) \\ & \quad u,v \geq 0 \end{aligned}$$

The problem with the fractional formulation in (2) is that it has an infinite number of solutions. To avoid this, the constraint $v'x_k = 1$ is imposed, which provides (3) which is a linear programming problem.

$$\begin{aligned} & Max_{\mu,\upsilon}\left(\mu' y_k\right) \\ & st \quad v' x_k = 1 \\ & st \quad \mu' y_k - v' x_k \leq 0 \quad k = 1,2,\dots,K \qquad (3) \\ & \quad \mu, v \geq 0 \end{aligned}$$

Each DMU selects input and output weights that maximise its efficiency score and the problem is run *K* times to identify the relative efficiency scores of all DMUs. The formulation in (3) is known as DEA-CCR (after Charnes, Cooper, Rhodes) for constant returns to scale (CRS). The dual of (3) is (4) where is a dual variable referring to the unity constraint in (3) while λ is a *K*x1 vector of dual variables relating to the second set of constraints in (3).

$$\begin{aligned} & Min_{\theta,\lambda}\theta \\ & st \quad - y_i + Y\lambda \geq 0 \\ & \quad \theta x_j - X\lambda \geq 0 \qquad (4) \\ & \quad \lambda_1 \dots, \lambda_k \geq 0 \end{aligned}$$

An additional constraint, shown in (5), leads to the DEA-BCC (after Banker, Charnes, Cooper) model, which allows for variable returns to scale (VRS).

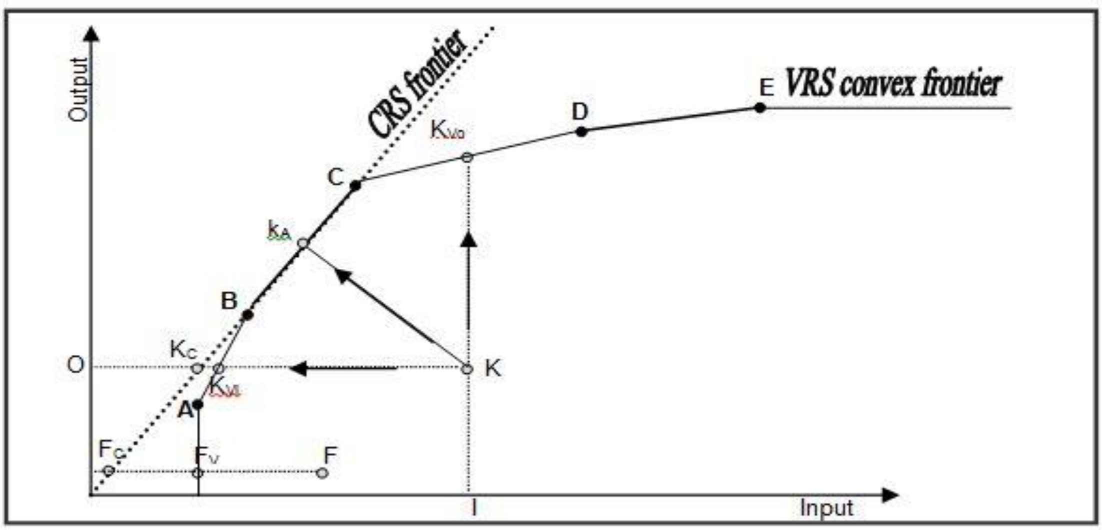
$$\begin{aligned} & Min_{\theta,\lambda}\theta \\ & st \quad - y_i + Y\lambda \geq 0 \\ & \quad \theta x_j - X\lambda \geq 0 \qquad (5) \\ & \quad \lambda_1 \dots, \lambda_k \geq 0 \\ & \quad N1'\lambda \leq 1 \end{aligned}$$

where *N*1 is a *N*x1 vector of 1.

The models in equations (4) and (5) are output-oriented. Input-oriented models can be formulated in the same way using duality in linear programming. The choice of orientation depends on the objective of the benchmarking exercise (input conservation versus output augmentation), and on the extent to which inputs and outputs are controllable. Both models should estimate exactly the same frontier, with the same set of DMUs being identified as efficient under either model. However, efficiency scores of inefficient DMUs may differ under VRS.

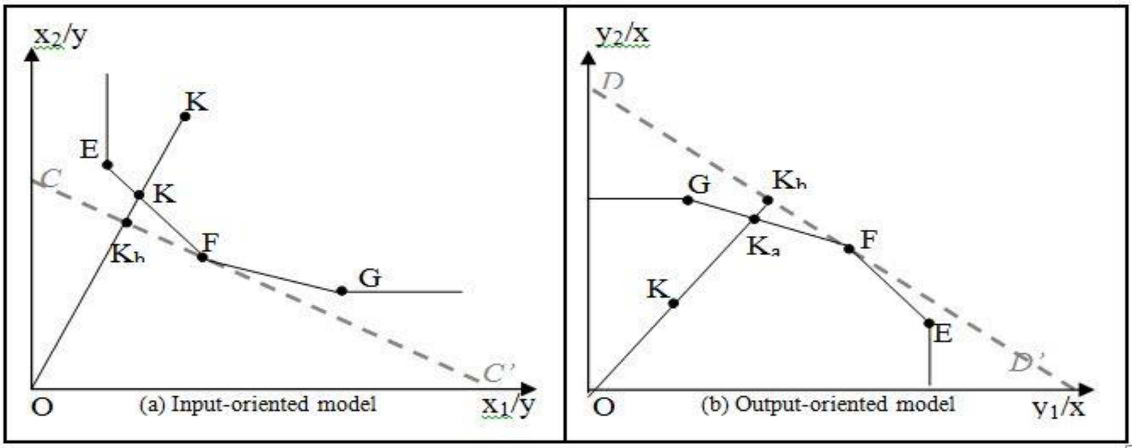
In the simple scenario of a single-input and a single-output, Figure A illustrates DEA models and efficiencies under different orientations and scale technologies. The DEA frontier consists of a convex hull of intersecting planes which envelops the efficient data points A, B, C, D and E. Note that only units B and C are efficient under both CRS and VRS, which confirms that DEA-CRS is more restrictive than DEA-VRS. For the inefficient DMU K, the projection towards the CRS frontier (the straight line) makes point K_C the new target, while points K_{Vi}, $K_{Vo,}$ and K_A are the VRS targets for the input, output and additive orientations respectively. Unlike the CCR or BCC model the additive model is un-oriented, i.e. it does not differentiate between input or output orientation which means that a reduction of input with a synchronous enhancement of outputs is possible.

Figure 19: DEA production frontier under a single-input/single-output scenario



Another way of illustrating DEA input and output orientations is by analysing production sets of either two inputs (x_1, x_2) and one output (y) for the input-oriented model, or one input (x) and two outputs (y_1, y_2) for the output-oriented model. Figure B depicts TE (technical efficiency) and AE (allocative efficiency) measures in both orientations.

Figure 20: Illustration of DEA models, excluding the effect of technological change.



When cost and price information are available, one can draw the iso-cost line CC' (combination of x_1 and x_2 giving rise to the same level of cost expenditure) for the input-oriented model and the iso-revenue line DD' (combination of y_1 and y_2 giving rise to the same level of revenue) for the output-oriented model. Allocative efficiencies for input (AE_i) and output (AE_o) orientations can therefore be calculated, corresponding in our example to the ratios OK_b/OK and OK/OK_b, respectively. The overall economic efficiency (EE) can be measured as the product of TE and AE in each model. Finally, note that the reference set or peers for the inefficient DMU K are E and F in the input-oriented model, and F and G in the output-oriented model.

On the other hand, DEA also has a number of drawbacks. In particular, DEA does not allow for stochastic factors and measurement errors, although a second-stage analysis or a stochastic parameterisation "can" solve this. Most economists, however, still stress the need of a stochastic-based distance function, namely SFA, to complete DEA and vice versa. Other issues regarding DEA are, in our view, more related to the definition and interpretation of the parameters, variables and models selected rather than to the analytical attributes of the technique.

A4.2 DEA Models Used in this Study

In order to estimate and compare efficiency scores under a stationary frontier over time, contemporaneous and inter-temporal DEA analyses is conducted using cross-sectional and panel data, respectively. In the context of cross-sectional data, the contemporaneous approach compares observation units within the same time-period, e.g. one year. In the context of panel data, the inter-temporal approach pools all data over the total time observed, e.g. total number of years. By using both approaches, the selected port DMU is benchmarked against varying sample sizes while still assuming constant technology over time.

Although contemporaneous and inter-temporal analyses are useful for estimating and comparing technical efficiency, they can be misleading in a dynamic context because neither approach accounts for possible shifts of the frontier over time. Furthermore, there is no means of checking whether the frontier is moving or stationary over time. To ensure a DMU's efficiency is tracked over time while allowing for shifts in the efficiency frontier, several time-dependent versions of DEA have been developed, notably DEA window analysis. Under DEA window analysis, also referred to as window DEA, DMUs in selected time-periods are included simultaneously in the benchmarking analysis. Depending on the width of the window, the technique may be conducted in terms of contemporaneous, inter-temporal and locally inter-temporal analyses. Contemporaneous and inter-temporal analyses correspond to the basic DEA approaches described above where the window width is equal to *1* (one) and *T* (total time or number of years observed), respectively. The locally inter-temporal analysis compares subset DMU observations at different but successive time windows where each DMU-observation is only compared with the alternative subset in the single window, assuming a constant frontier during each window. Under this approach, the window width is larger than one and less than all periods combined, but it is usually set for a three-year period.

Although the locally inter-temporal window analysis seems an attractive technique for tracking changes in efficiency over time, it has many limitations. First, the technique is akin to a moving average procedure where the technology remains constant in each window. Second, a DMU under window DEA is only compared with a subset of data and not with the whole data set. Indeed, the width of the window is usually defined arbitrarily given that no underlying theory or analytical evidence that validates the choice of a particular window size exists. In the context of benchmarking container-port efficiency, the overlapping subsets derived from successive windows wrongly imply that the container port production is somehow discontinuous over the study period. Last, but not least, because the efficiency of a DMU observation in a particular window is calculated more than once and hence included in several windows, it is not obvious how to define the frontier in the same window-period. This issue hinders the application of total factor productivity (TFP) analysis such as through the Malmquist productivity index (MPI). For instance, Asmild et al. (2004) recommended that it is not appropriate to decompose Malmquist indices based on window DEA into standard frontier shift and catching up effects (See Appendix 3).

In this study DEA is used to measure and benchmark container-port efficiency. Primarily, DEA seeks to measure technical efficiency without using price and cost data or specifying a functional formulation. A common feature of port benchmarking studies is the use of operational data due to the difficulty to obtain port costs and prices. When formulating DEA, an input orientation is used given the emphasis of this section on operational structure and port efficiency (equation 1). DEA-CCR and DEA-BCC models are used to express constant returns to scale (CRS) and variable returns to scale (VRS), respectively.

$$
\begin{aligned}
& Min\,\theta_k \qquad w.r.t \qquad \lambda_1,\ldots,\lambda_n \\
& \text{s.t. } \theta x_{ik} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0 \qquad i = 1,2,\ldots,m \\
& \quad -y_{rk} + \sum_{j=1}^{n} \lambda_j y_{rj} \geq 0 \qquad r = 1,2,\ldots,s \qquad\qquad (1) \\
& \quad \lambda_j \geq 0 \qquad j = 1,\ldots,n \qquad (\text{CCR}) \\
& \quad \sum_{j=1}^{n} \lambda_j = 1 \qquad\qquad (\text{BCC})
\end{aligned}
$$

Where:

x_{ij} and y_{rj} are the respective amounts of i^{th} input and r^{th} output consumed and produced by DMU j

λ_j ($j = 1,2,\ldots,n$) are non-negative scalars representing input and output weights such

APPENDIX 5: MALMQUIST PRODUCTIVITY INDEX

A5.1 Introduction to TFP and MPI

The basic definition of total factor productivity (TFP) is the rate of transformation of total input into total output. In this thesis, total factor productivity change is focused on, hereafter abbreviated to TFP, rather total factor productivity growth (TFPG), the latter being an established branch of economic growth and statistical accounting.

The TFP concept incorporates multiple inputs (M) and outputs (S) to measure (and sometimes decompose) productivity change over time or between firms. So often, the TFP concept is reduced to multi-factor productivity (MFP) measures relating one measure of output to a bundle of inputs. A TFP index is determined by calculating the ratio of the weighted sum of outputs with respect to the weighted sum of inputs, with its general formula being expressed as follows:

$$TFP = \sum_{s=1}^{S} \omega_s Y_s \Big/ \sum_{m=1}^{M} \omega_m X_m \qquad (1)$$

Where ω_m are input weights and ω_s are output weights, each must sum to 1

In general, the weights are the cost shares for the inputs and the revenue shares for the outputs under the assumption that input and output markets achieve productive efficiency. This is the case of the Törnqvist index (Törnqvist, 1936), a widely used TFP index in productivity studies. Equations (2) and (3) show Törnqvist input and output indices from the base period t to the period $t+1$, respectively. Because they attempt to construct a measure of total output over total input, TFP indices such as the Törnqvist index are widely used in benchmarking studies.

$$T_i = \prod_{m=1}^{M} \left[x_{mt} / x_{m(t+1)} \right]^{\frac{\omega_{m(t+1)} + \omega_{mt}}{2}} \qquad \text{Input index (2)}$$

$$T_o = \prod_{s=1}^{S} \left[y_{st} / y_{s(t+1)} \right]^{\frac{\omega_{s(t+1)} + \omega_{st}}{2}} \qquad \text{Output index (3)}$$

Where

$x_{m(t+1)}$ and x_{mt} are quantity of m^{th} input in periods $t+1$ and t, respectively

$y_{s(t+1)}$ and y_{st} are quantity of s^{th} output in periods $t+1$ and t, respectively

ω_{mt} and $\omega_{m(t+1)}$ are the m^{th} input cost shares in periods t and $t+1$, respectively

ω_{st} and $\omega_{s(t+1)}$ are the s^{th} output revenue shares in periods t and $t+1$, respectively

The above TFP measures are based on quantity data and market prices but the latter may not be available or may not be appropriate for weight aggregation. Port data are often not available at terminal or cargo-type level. Sometimes, prices may have little economic meaning for productivity measurement of non-market activities such as port operations in certain countries or under specific institutional and management systems. In addition, the non-frontier approach to TFP measurement relies on a number of assumptions, for instance the competitive characteristic of markets and the efficient behaviour of firms, but such conditions rarely hold in practice.

To incorporate all such sources of efficiency while recognising the limitations of the non-frontier TFP approach, researchers use the Malmquist TFP index constructed by estimating a distance frontier. The Malmquist productivity index (MPI) is defined as the measure of TFP change of two data points by calculating the ratio of the distances of each point relative to a common technology. To avoid deciding on which period to define as the reference technology, Färe et al. (1994) proposes a geometric mean of two TFP indices evaluated between periods t and $t+1$ as the base and the reference technology periods, respectively (see Equations 4 and 5 below). This allows input and output weights to be calculated directly, which eliminates the need for price data. In addition, no assumption is required on the firm's efficient behaviour (i.e. profit maximisation or cost minimisation).

$$M_o(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{d_o^t(y_{t+1}, x_{t+1})}{d_o^t(y_t, x_t)} \frac{d_o^{t+1}(y_{t+1}, x_{t+1})}{d_o^{t+1}(y_t, x_t)} \right]^{1/2} \quad \text{(Output orientation)} \quad (4)$$

$$M_i(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{d_i^{t+1}(y_t, x_t)}{d_i^{t+1}(y_{t+1}, x_{t+1})} \frac{d_i^t(y_t, x_t)}{d_i^t(y_{t+1}, x_{t+1})} \right]^{1/2} \quad \text{(Input orientation)} \quad (5)$$

Few studies have estimated or used a TFP index for ports. Early attempts were made by Kim and Sachish (1986) who propose an aggregate TFP index consisting of labour and capital expenditure as the inputs and throughput in metric tonnes as the output. The index was also decomposed to account for scale economies and technical change. Later, Sachish (1996) proposes a weighting mechanism of partial productivity measures while Talley (1994) suggests a TFP index using a shadow price variable. More recently, Lawrence and Richards (2004) decomposed a Törnqvist index to investigate the distribution of benefits from productivity improvements of an Australian container terminal, while De (2006) used a TFP index to assess the total productivity growth in Indian ports over the period 1981-2003. As for the application of the Malmquist index to port efficiency, fewer studies exist in the literature. Among these, Lui et al. (2006) applied the MPI to measure productivity change of several container terminals in China during the period 2003-2004. Their MPI was decomposed into two sources of efficiency: technical efficiency change and technical change. Estache et al. (2004) decomposed further the MPI by adding a scale efficiency measure to assess Mexico's port productivity changes following the country's recent port reform.

The main advantage of TFP indices is that they reflect the joint impacts of the changes in combined inputs on total output. This feature is not accounted for when single or partial factor productivity indicators are used. However, the TFP methodology is a non-statistical approach and does not allow for the evaluation of uncertainty associated with the results. Furthermore, TFP results depend largely on the technique used and the definition of weights, which implies that different TFP indices may yield different efficiency results. In many cases, the choice of the appropriate TFP approach is reduced to a trade-off between the requirement of large datasets in the econometric approach and the simplifying assumptions in the index approach.

A5.2 MPI Model Used in this Study

Recall the formulation of the Malmquist input-oriented index as shown in equation (6):

$$M_i(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{d_i^{t+1}(y_t, x_t)}{d_i^{t+1}(y_{t+1}, x_{t+1})} \frac{d_i^{t}(y_t, x_t)}{d_i^{t}(y_{t+1}, x_{t+1})} \right]^{1/2}$$

The Malmquist productivity index (MPI) is the geometric mean between two indices, the first evaluated against period $t+1$ technology and the second evaluated against period t technology. Two of the four distance functions, $d_i^t(y_t, x_t)$ and $d_i^{t+1}(y_{t+1}, x_{t+1})$, are technical efficiency measures while the other two, $d_i^t(y_{t+1}, x_{t+1})$ and $d_i^{t+1}(y_t, x_t)$, depict cross-period distance functions showing efficiencies which use observations at periods t + 1 and t relative to the frontier technology at periods t and t + 1, respectively. A value of MPI greater than 1 indicates an improvement in TFP while a value lower than 1 indicates a deterioration in TFP.

Equation (6) can also be expressed as (7) whereby the left-hand part measures the change in technical efficiency (TEC), representing the catching up effect, while the right-hand part measures technological change (TC), representing the frontier shift effects*1*. Färe et al. (1992) use DEA distance functions to calculate the CRS Malmquist index in Equation (7).

$$M_i(y_t, x_t, y_{t+1}, x_{t+1}) = \frac{d_i^{t}(y_t, x_t)}{d_i^{t+1}(y_{t+1}, x_{t+1})} \left[\frac{d_i^{t+1}(y_t, x_t)}{d_i^{t}(y_t, x_t)} \frac{d_i^{t+1}(y_{t+1}, x_{t+1})}{d_i^{t}(y_{t+1}, x_{t+1})} \right]^{1/2} \qquad (7)$$

In order to measure TFP using the above MPI expression, CRS distance functions are required. This is because the technical efficiency change (TEC) entails changes in both scale efficiency (SE) and non-scale technical efficiency (pure technical efficiency: PEC). Since the DEA VRS model does not capture the impact of production scale on efficiency, the MPI under VRS distance functions is not able to measure changes in scale efficiency. Hence, it may be misleading as to the extent of frontier shift effects.

Färe and Lovell (1994) and Färe et al. (1994) suggest an enhanced TFP decomposition that relaxes the CRS assumption while allowing for the measurement of scale efficiency change. By introducing some VRS distance functions, technical efficiency change (TEC) can be decomposed into a pure technical efficiency change (PEC) component and a scale-efficiency change (SEC) component. Equation (7) can therefore write as (8) where superscripts V and C refer to VRS and CRS technology, respectively. Equation (8) decomposes the TFP change (TFPC) into various sources of efficiency change, and is expressed as follows:

$$M_i = \frac{d_i^{t(V)}(y_t, x_t)}{d_i^{t+1(V)}(y_{t+1}, x_{t+1})} \left[\frac{d_i^{t+1(V)}(y_{t+1}, x_{t+1})}{d_i^{t(V)}(y_t, x_t)} \frac{d_i^{t(C)}(y_t, x_t)}{d_i^{t+1(C)}(y_{t+1}, x_{t+1})} \right] \left[\frac{d_i^{t+1(C)}(y_t, x_t)}{d_i^{t(C)}(y_t, x_t)} \frac{d_i^{t+1(C)}(y_{t+1}, x_{t+1})}{d_i^{t(C)}(y_{t+1}, x_{t+1})} \right]^{1/2} \qquad (8)$$

$$TFPC = PEC \times SEC\ X\ TC$$

APPENDIX 6: DATA ONLINE QUESTIONNAIRE

Dear xxx,

We are undertaking a global study on the efficiency and competitiveness of a selected sample of ports in the OIC countries. We have gathered some data on different aspects of terminal operations from trade journals such as Containerisation International, but we still need to fill in some data gaps as well as cross-check the validity of the secondary data collected. We would be very grateful if you can complete the attached table **(for your terminal)** and return the same to me via e-mail at your earliest convenience. Obviously we will treat the information provided as strictly confidential, but we will be happy to share with you the result of our study once completed. Your assistance is very much appreciated.

Thank you in advance
Best regards,

Dr Khalid Bichou

Indicators	Your terminal data	Observations
Terminal throughput in TEU		
Total terminal area in m^2		
Maximum draft in meter		
Total quay length in meter		
Number of sea-to-shore cranes (STS)		
Lifting capacity in tons		
Average STS crane move per hour		
Number & type of yard stacking equipment		
Average staking height of yard equipment		
Number of internal trucks and vehicles		
Average dwell time in the yard		
Number of gates or gate lanes		

APPENDIX 7: EFFICIENCY ESTIMATES OF OIC TERMINALS UNDER CROSS-SECTIONAL DEA

Terminal	2009	2010	2011	2012	2013
Aqaba	0.548	0.56	0.68	0.765	0.79
Ambarli Kumport	0.858	0.942	0.295	0.667	0.869
Ambarli Marport	0.903	0.71	0.721	0.874	0.889
Apapa	0.505	0.505	0.665	0.553	0.565
Casablanca East	0.677	0.66	0.712	0.763	0.769
Casablanca West	0.55	0.521	0.678	0.698	0.74
Doraleh	0.605	0.635	0.68	0.778	0.724
Jakarta International	0.874	0.975	0.82	0.92	0.97
Jeddah Northern	0.869	0.854	0.807	0.875	1
Jeddah Southern	0.778	0.874	0.864	1	0.896
Maputo	0.556	0.502	0.556	0.583	0.997
Mersin	0.792	0.883	0.703	1	0.849
Northport	0.899	0.94	1	0.89	1
Qasim International	0.651	0.606	0.657	0.615	1
Tanjung Pelepas	1	1	1	1	1
Salalah	0.923	0.908	1	1	1
Dakar 1	0.557	0.668	0.653	0.704	0.772
Tangier Med 1	0.765	0.808	0.837	0.66	0.879
Tangier Med 2	0.667	0.7	0.734	0.61	0.715
Westport	0.988	1	0.94	1	1

APPENDIX 8: EFFICIENCY ESTIMATES OF OIC TERMINALS UNDER PANEL DATA ANALYSIS

Terminal-*year*	Efficiency scores	Terminal-*year*	Efficiency scores	Terminal-*year*	Efficienc y scores
Ambarli Kumport-*2009*	0.689	Doraleh-*2012*	0.622	Salalah-*2010*	0.920
Ambarli Kumport-*2010*	0.724	Doraleh-*2013*	0.647	Salalah-*2011*	1.000
Ambarli Kumport-*2011*	0.775	Jakarta Intl-*2009*	0.766	Salalah-*2012*	0.934
Ambarli Kumport-*2012*	0.805	Jakarta Intl-*2010*	0.850	Salalah-*2013*	0.970
Ambarli Kumport-*2013*	0.789	Jakarta Intl-*2011*	0.795	Tangier Med1-*2009*	0.615
Ambarli Marport-*2009*	0.770	Jakarta Intl-*2012*	0.883	Tangier Med1-*2010*	0.689
Ambarli Marport-*2010*	0.800	Jakarta Intl-*2013*	0.897	Tangier Med1-*2011*	0.724
Ambarli Marport-*2011*	0.767	Jeddah North-*2009*	0.871	Tangier Med1-*2012*	0.788
Ambarli Marport-*2012*	0.707	Jeddah North-*2010*	0.972	Tangier Med1-*2013*	0.801
Ambarli Marport-*2013*	0.819	Jeddah North-*2011*	0.836	Tangier Med2-*2009*	0.585
Apapa-*2009*	0.355	Jeddah North-*2012*	0.835	Tangier Med2-*2010*	0.659
Apapa-*2010*	0.432	Jeddah North-*2013*	0.848	Tangier Med2-*2011*	0.685
Apapa-*2011*	0.445	Jeddah South-*2009*	0.925	Tangier Med2-*2012*	0.700
Apapa-*2012*	0.516	Jeddah South-*2010*	0.926	Tangier Med2-*2013*	0.717
Apapa-*2013*	0.512	Jeddah South-*2011*	0.911	Tanjung Pelepas-*2009*	1.000
Aqaba-*2009*	0.515	Jeddah South-*2012*	0.965	Tanjung Pelepas-*2010*	0.955
Aqaba-*2010*	0.528	Jeddah South-*2013*	1.000	Tanjung Pelepas-*2011*	0.969
Aqaba-*2011*	0.555	Maputo-*2009*	0.455	Tanjung Pelepas-*2012*	1.000
Aqaba-*2012*	0.612	Maputo-*2010*	0.494	Tanjung Pelepas-*2013*	0.970
Aqaba-*2013*	0.655	Maputo-*2011*	0.564	Westport-*2009*	0.924
Casablanca East-*2009*	0.587	Maputo-*2012*	0.489	Westport-*2010*	0.949
Casablanca East-*2010*	0.597	Maputo-*2013*	0.511	Westport-*2011*	1.000
Casablanca East-*2011*	0.579	Mersin-*2009*	0.703	Westport-*2012*	0.891
Casablanca East-*2012*	0.643	Mersin-*2010*	0.793	Westport-*2013*	0.952
Casablanca East-*2013*	0.722	Mersin-*2011*	0.817		
Casablanca West-*2009*	0.569	Mersin-*2012*	0.850		
Casablanca West-*2010*	0.554	Mersin-*2013*	0.873		
Casablanca West-*2011*	0.650	Northport-*2009*	0.971		
Casablanca West-*2012*	0.690	Northport-*2010*	0.970		
Casablanca West-*2013*	0.734	Northport-*2011*	0.988		
Dakar-*2009*	0.526	Northport-*2012*	1.000		
Dakar-*2010*	0.534	Northport-*2013*	0.960		
Dakar-*2011*	0.562	Qasin Intl-*2009*	0.655		
Dakar-*2012*	0.597	Qasin Intl-*2010*	0.636		
Dakar-*2013*	0.644	Qasin Intl-*2011*	0.689		
Doraleh-*2009*	0.523	Qasin Intl-*2012*	0.724		
Doraleh-*2010*	0.545	Qasin Intl-*2013*	0.775		
Doraleh-*2011*	0.612	Salalah-*2009*	0.965		

APPENDIX 9: EFFICIENCY ESTIMATES OF BOTH OIC AND REFERENCE TERMINALS

DMU	BCC-I	CCR-I	DMU	BCC-I	CCR-I	DMU	BCC-I	CCR-I
ACT-2009	0.727	0.723	JICT-2009	0.525	0.349	PSA-2009	0.987	0.782
ACT-2010	0.687	0.684	JICT-2010	0.557	0.371	PSA-2010	0.928	0.928
ACT-2011	0.683	0.680	JICT-2011	0.599	0.598	PSA-2011	1.000	1.000
ACT-2012	0.711	0.705	JICT-2012	0.613	0.612	PSA-2012	1.000	1.000
ACT-2013	0.822	0.817	JICT-2013	0.756	0.712	PSA-2013	1.000	1.000
AKCT-2009	0.636	0.532	NCT-2009	0.698	0.698	PTP-2009	1.000	1.000
AKCT-2010	0.564	0.472	NCT-2010	0.620	0.618	PTP-2010	0.950	0.950
AKCT-2011	0.681	0.569	NCT-2011	0.743	0.741	PTP-2011	0.962	0.962
AKCT-2012	0.703	0.588	NCT-2012	0.543	0.483	PTP-2012	1.000	1.000
AKCT-2013	0.793	0.613	NCT-2013	0.779	0.692	PTP-2013	0.995	0.995
AMCT-2009	0.445	0.441	SCT-2009	0.655	0.648	SPCT-2009	0.982	0.831
AMCT-2010	0.512	0.512	SCT-2010	0.735	0.727	SPCT-2010	0.947	0.856
AMCT-2011	0.546	0.545	SCT-2011	0.817	0.808	SPCT-2011	0.789	0.707
AMCT-2012	0.599	0.598	SCT-2012	0.817	0.817	SPCT-2012	0.804	0.773
AMCT-2013	0.613	0.612	SCT-2013	1.000	0.779	SPCT-2013	0.835	0.736
APCT-2009	0.351	0.350	MCLI-2009	0.345	0.343	TCD1-2009	0.330	0.254
APCT-2010	0.386	0.385	MCLI-2010	0.401	0.398	TCD1-2010	0.383	0.296
APCT-2011	0.426	0.425	MCLI-2011	0.429	0.426	TCD1-2011	0.511	0.394
APCT-2012	0.534	0.532	MCLI-2012	0.407	0.404	TCD1-2012	0.696	0.537
APCT-2013	0.562	0.560	MCLI-2013	0.581	0.575	TCD1-2013	0.787	0.607
CTCE-*2009*	0.423	0.269	MDCT-2009	0.856	0.596	TMCT1-2009	0.756	0.756
CTCE-*2010*	0.440	0.280	MDCT-2010	0.954	0.629	TMCT1-2010	0.801	0.801
CTCE-*2011*	0.445	0.441	MDCT-2011	0.861	0.629	TMCT1-2011	0.889	0.889
CTCE-*2012*	0.512	0.512	MDCT-2012	0.888	0.894	TMCT1-2012	0.913	0.913
CTCE-*2013*	0.546	0.545	MDCT-2013	1.000	0.731	TMCT1-2013	1.000	1.000
CTCW-*2009*	0.525	0.349	MIP-2009	0.568	0.566	TMCT2-2009	0.494	0.505
CTCW-*2010*	0.557	0.371	MIP-2010	0.623	0.620	TMCT2-2010	0.759	0.522
CTCW-*2011*	0.599	0.598	MIP-2011	0.657	0.655	TMCT2-2011	0.841	0.389
CTCW-*2012*	0.613	0.612	MIP-2012	0.662	0.660	TMCT2-2012	0.850	0.598
CTCW-*2013*	0.556	0.548	MIP-2013	0.655	0.652	TMCT2-2013	0.985	0.662
DCT-2009	0.725	0.585	MTL-2009	0.869	0.851	WPCT-2009	0.958	0.755
DCT-2010	0.731	0.590	MTL-2010	0.884	0.883	WPCT-2010	0.800	0.800
DCT-2011	0.733	0.591	MTL-2011	0.905	0.905	WPCT-2011	0.896	0.850
DCT-2012	0.645	0.508	MTL-2012	1.000	1.000	WPCT-2012	1.000	1.000
DCT-2013	0.774	0.610	MTL-2013	0.814	0.814	WPCT-2013	0.960	0.960
ECTD-2009	1.000	0.956	NPCT-2009	0.789	0.747	YICT-2009	1.000	1.000
ECTD-2010	1.000	0.956	NPCT-2010	0.819	0.775	YICT-2010	1.000	0.998
ECTD-2011	0.970	0.638	NPCT-2011	0.924	0.875	YICT-2011	1.000	1.000
ECTD-2012	0.882	0.824	NPCT-2012	0.945	0.895	YICT-2012	1.000	1.000
ECTD-2013	0.801	0.759	NPCT-2013	1.000	0.947	YICT-2013	1.000	1.000
HIT-2009	1.000	1.000	QICT-2009	0.523	0.465			
HIT-2010	0.939	0.939	QICT-2010	0.545	0.485			
HIT-2011	1.000	1.000	QICT-2011	0.612	0.561			
HIT-2012	0.970	0.959	QICT-2012	0.813	0.777			
HIT-2013	0.969	0.968	QICT-2013	0.647	0.642			

APPENDIX 10: MPI YEAR-BY-YEAR TFP CHANGE

Terminal	2009-10				2010-11				2011-12				2012-13			
	MPI	PEC	SEC	TC	MPI	PEC	SEC	TC	MPI	PEC	SEC	TC	MPI	PEC	SEC	TC
MTL	0.988	1.000	1.000	0.988	0.807	1.000	0.905	0.892	1.266	1.075	1.167	1.009	0.767	0.955	0.858	0.936
HIT	0.939	1.000	1.000	0.939	1.290	1.000	1.136	1.136	0.859	1.000	0.897	0.958	0.930	1.000	0.965	0.964
YICT	0.922	1.000	1.000	0.922	0.816	1.000	0.911	0.896	1.184	1.000	1.107	1.070	1.364	1.000	1.257	1.085
TMCT1	0.850	1.000	0.975	0.872	0.858	1.000	0.907	0.945	1.002	1.026	0.960	1.018	0.898	0.974	0.940	0.981
AKCT	1.000	1.035	1.006	0.960	1.235	1.103	1.136	0.986	1.048	1.008	1.078	0.965	1.105	1.031	1.159	0.925
TCD1	0.320	0.860	0.388	0.959	0.835	0.955	0.861	1.015	1.181	1.019	1.218	0.951	0.937	0.992	0.980	0.964
AMCT	0.886	0.971	0.953	0.957	0.952	1.002	0.980	0.970	0.773	0.935	0.884	0.935	1.050	1.005	1.026	1.018
WPCT	0.711	0.912	0.813	0.959	0.976	0.966	0.861	1.174	0.754	0.945	0.850	0.939	0.814	1.005	0.865	0.936
ECTD	1.063	1.001	1.110	0.956	0.961	0.971	0.935	1.059	0.853	0.971	0.901	0.975	0.955	0.999	0.953	1.003
PSA	1.059	1.000	1.116	0.949	1.017	1.000	1.012	1.005	1.062	1.000	0.926	1.147	0.879	1.000	0.932	0.943
MDCT	1.225	0.995	1.264	0.974	0.629	0.936	0.702	0.957	1.363	1.092	1.072	1.164	0.774	0.989	0.834	0.938
AMCT	0.963	1.000	1.000	0.963	0.789	1.000	0.888	0.888	1.241	1.000	1.053	1.178	0.856	1.000	0.927	0.924
NPCT	0.886	0.971	0.953	0.957	0.952	1.002	0.980	0.970	0.773	0.935	0.884	0.935	1.050	1.005	1.026	1.018
NCT	0.892	0.975	1.007	0.909	0.837	0.965	0.893	0.971	0.902	0.985	0.933	0.981	0.976	1.003	0.995	0.979
SCT	1.068	1.006	1.119	0.949	0.955	1.035	0.961	0.961	0.817	0.983	0.847	0.981	0.982	1.033	0.966	0.985
APCT	0.338	0.987	0.368	0.931	0.583	1.000	0.598	0.975	0.651	0.969	0.674	0.998	0.870	0.985	0.882	1.001
TMCT2	0.779	0.970	0.845	0.950	0.971	1.000	0.933	1.041	1.025	1.003	1.017	1.005	0.914	0.997	0.923	0.993
CTCE	0.747	1.181	0.641	0.986	1.879	1.009	1.560	1.193	1.099	1.011	1.069	1.017	1.032	0.990	0.954	1.093
CTCW	0.799	0.947	0.855	0.988	0.861	0.980	0.768	1.144	1.425	1.016	1.339	1.048	1.075	0.992	0.913	1.186
DCT	0.941	1.000	1.000	0.941	0.702	1.000	0.834	0.842	0.861	1.000	0.928	0.928	0.904	1.000	0.888	1.018
SPCT	0.980	1.021	1.038	0.925	0.399	0.839	0.509	0.935	0.792	0.924	0.840	1.021	0.791	0.982	0.864	0.932
LMCI	0.532	1.000	0.534	0.996	0.900	1.000	0.859	1.047	1.182	1.000	1.138	1.039	0.987	1.000	0.925	1.067
JICT	0.700	1.000	0.716	0.977	0.875	1.000	0.873	1.002	1.913	1.219	1.554	1.010	0.473	0.918	0.483	1.066
MIP	1.005	0.952	1.052	1.004	0.956	0.988	0.884	1.094	0.798	0.966	0.830	0.995	0.906	0.957	0.884	1.070
QCIT	0.896	1.000	0.915	0.979	0.683	1.000	0.698	0.979	0.618	1.000	0.674	0.917	1.807	1.000	1.681	1.075
ACT	0.987	1.000	1.015	0.972	1.084	1.000	0.943	1.150	0.909	1.000	0.901	1.009	0.952	1.000	0.974	0.977

Source: Consultant