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Impact of privatization in ports : measuring efficiency through data envelopment analysis and key performance indicators

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IMPACT OF PRIVATIZATION IN PORTS:

MEASURING EFFICIENCY THROUGH DATA ENVELOPMENT ANALYSIS AND KEY PERFORMANCE INDICATORS

By

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DECLARATION

I certify that all material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the university.

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"At times our own light goes out and is rekindled by a spark from another person
Each of us has cause to think with deep gratitude of those who have
lighted the flame within us"
Albert Schweitzer

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I hope the study in addition to other existing ones; will make some contribution to future work in this field.

ABSTRACT

Title of Dissertation**: Impact of Privatization In Ports: Measuring Efficiency through Data Envelopment Analysis and Key Performance Indicators.**

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Does port privatization have a quantifiable effect on port performance?
Ports and terminals have been adopting different privatization strategies in a bid to increase their performance, and keep up with regional and global competitors. Though most privatization strategies affect port performance in terms of management and operations, this study is focusing on the impact of the strategies on core port operations which simultaneously influence port output and efficiency. This is important in order to identify the areas of, and reasons for success in different categories of ports, and also to identify the changes in efficiency over time. These changes are in many cases related to value added gained through movement from fully state owned public organizations to forms of private/public partnerships. Such partnerships are often characterized by expansion of infrastructure and superstructure and a more commercial approach to input combinations and output gains. Applied to real cases the DEA analysis and KPI assessment identifies and quantifies the exact effect of the capital and expertise that was gained through privatization. The approach taken has been able to isolate privatization effects on efficiency in ports, but still leaves questions as to the limit and extent to which the business areas should be privatized and how to spread the effects over the whole maritime logistic chain.

KEYWORDS: Privatization, Port Efficiency, DEA Analysis, KPI's

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
ECOWAS	Economic Community of West African States
GDP	Gross Domestic Product
GPHA	Ghana Ports and Harbours Authority
GPI	General Performance Indicators
HPH	Hutchinson Port Holdings
ICD	Inland Clearance Depot
ICTSI	International Container Terminal Services
KPI	Key Port Performance Indicators
LSC	Liner Shipping Connectivity
MDF	Maritime Dependency Factor
NATO	North Atlantic Treaty Organization
PMAESA	Port Management Association of Eastern and Southern Africa
PMAWCA	Port Management Association of West and Central Africa
PSA	Port of Singapore Authority
SPM	Single Point Mooring
TEU	Twenty Foot Equivalent Unit
UNCTAD	United Nations Convention on Trade and Development
VRS	Variable Returns to Scale

1. Introduction

Sea ports are the connections between the various routes that link up activities in the maritime sector. These maritime activities are generated as a result of trade and subsequently develop into related activities which induce the continuity of trade and business activities nationally and globally. The growth of sea trade and the evolution from subsistence production to production in terms of comparative advantage has gradually increased the need for transportation that gives the benefits of economies of scale and transportation links or nodes that facilitate the speedy and cost effective distribution of today's goods. (Alderton, 1995; Hoyle & Knowles, 2000).These needs of global trade have induced the following effects:

- Growth and evolution of shipping
- Growth and evolution of ports
- Related growth in the activities of linked industries in and around the ports
- Total growth of the economy

The business activities in ports are not regarded in isolation but rather as a chain of effects with interrelated performance that has a major effect on shipping and trade. The ineffectiveness of one of these nodes either in delays or unreliability defeats the purpose, advantages or economies of scale gained from sea transport by making it more costly. These factors have raised the need for innovation and expertise in port operations and management. How has this been gradually achieved? Mainly by the drive of private business entities willing to take the risk of investment and operation. Whether this occurred through mergers, takeovers or corporative ventures, the successes and perhaps failures of these ventures by mostly private entities now serve as benchmarks which have been applied to other areas just as successfully. This trend of private participation has facilitated the evolution of ports and shipping in some of the following ways:

- Harbours – reception of vessels and receipt and delivery of cargo
- Growth of ports with adjacent industries adding value to imported or exported cargo
- Multipurpose ports followed by subsequent specialized ports e.g. bulk ports, container terminals
- Purely national to multinational ports

- The evolution of governments

To keep up with the changes mentioned above and to promote and encourage sustenance of the multiplier effects of ports in economies, governments are gradually shifting towards policy and framework which make business easier to thrive (World Bank, 2007a). In effect there is a gradual shift from complete public ownership and management of institutions in countries to partnerships with the private sector. This trend may usually begin with subsidiary business entities and gradually shift towards national key installations. However, governments still have to instil some measures to safeguard the nations' interest even after the shift. The trend is also characterized by streamlining of public monopolies and the gradual removal of government subsidies to enable generation of authentic competition and general efficiency in activities induced by the possible aspect of failure through non performance. It is important to note that governments or public authorities are characterized by budget restrictions, wider interests and social responsibilities that may not necessarily make it possible to take the necessary strategies or decisions needed to keep up with the changing global nature of port operations and competition. Though they need not necessarily embrace it as a whole, they may to an extent implement those activities that may enhance economic activities in their geographical and socio cultural environment. In effect, the trend has influenced governments by prompting them to create enabling environments for these institutions to operate and thrive; eventually shaping their role towards a more regulatory and legal nature while reverting

commercial operational and some managerial issues partly or wholly to private enterprise (Independent Evaluation Group, 2008).

Private sector participation in ports is very broad and in theory most of these strategies are expected to have positive results. Various studies done on different aspects of this topic in the past have concluded with varying results (Song, Cullinane, & Roe, 2001a; Tongzon & Heng, 2005; Trujillo & Nombela, 2000). Some have broadly assessed the effects on management and operations while others have assessed actual effect on productivity using various methods. The results of these studies were very significant and have made it easier for subsequent studies to proceed. Most of the studies however focus on European or American ports and results are still mostly inconclusive as to whether improvement in efficiency may be attributed purely to privatization strategies.

1.1. Purpose

This study focuses mainly on aspects of port privatization; not so much on the variety of strategies but rather on the effect generated by these privatization strategies on port performance and efficiency. This study is aimed at finding out whether apart from the general theoretical and perhaps applied advantages or even disadvantages of privatization, what effect does it actually have on the efficiency of core port performance. Public and private involvement in ports is extremely broad and the extent of this involvement is not easily detached. This would indicate that to effectively analyse the relationship between private involvement and efficiency, which is the aim of this dissertation, an assessment on the reasons for both public and private participation in ports should be done, followed by an evaluation of performance within pre and post-privatisation periods. In order to do so, this study will seek to:

Assess the national, regional and global role and contribution of ports and the various reasons for previous government intervention and participation and related reasons for the subsequent shift away from that role. Then subsequently evaluate how the shift to increased co operation between both sectors has facilitated the evolution of ports and the effect this evolution has had on nations and their GDP.

The next chapter will subsequently consider the nature of privatization, the various privatization schemes, the extent to which it is applied in core and subsidiary port services and complete this by a review of the privatization strategy's relation to efficiency.

Successive chapters will firstly begin to attempt to assess the effect of privatization in ports by taking a look at the bigger picture and try to determine the efficiency of a number of ports with different structures sampled across Africa using Data Envelopment Analysis. Secondly review the role and importance of port performance indicators reviewing their ability to indicate port efficiency and evaluate the various means of measuring general port efficiency through port performance indicators. It will then focus on the use of these indicators in two case studies within areas directly affected by privatization. Through review, calculation and analysis of the trends in key port performance indicators in a selection of pre and post-privatization periods where applicable. and finally conclude with a summary of the results of the findings.

1.2. Methodology

The topic for this study is very broad and has interrelated areas which have been studied and analysed in the past. In view of this, the study will intermittently apply analysis and review of information and data from published books, journals, and articles from different sources including UNCTAD, World Bank, Port databases (Tema and Tanzania), Internet, World Maritime University library, and other

affiliated libraries. For the assessment of ports and calculation of performance indicators, information and literature retrieved from visits to Asian and European ports, shipping companies and maritime organizations (Japan, Singapore, France, Holland, Sweden) as well as from working visits to west African ports; (Benin-Cotonou, Togo-Lome) will be used where applicable. In order to ensure the use of figures that are published directly by respective port authorities, data bases from international maritime institutions, such as Containerization International, Institute of Shipping and Logistics, and subsequently port web pages and printed publications will be used.

1.3. Limitations

The subject is quite wide and this study is limited to the components stated in previous sections. Ports vary around the world in terms of structure and service provision i.e. multi purpose ports and exclusive container terminals which makes comparison difficult. The study does not broadly cover aspects of finance. Varying compilation of operational data by ports and sometimes unavailability of data in other port operational fields was a slight limitation. The study did not consider port areas that were not directly or even indirectly affected by direct private sector intervention, e.g. ferry traffic. Though it might be difficult to measure the total effect of port privatization or any other reform, it would be possible to confine this within the spectrum of port performance. Thus to begin the study, the next chapter will assess the contribution of ports to nations and the role they play which serve as a reasons for inducing and motivating governments to implement port reforms, such as privatization strategies to promote efficiency.

2. The Role of Seaports in Nations

2.1. Functions beyond receiving vessels

Sea ports have traditionally been defined as towns or harbours that can accommodate ocean going ships, or a safe place for ships to discharge or take cargo (Merriam-Webster, Encarta). Today the functions of seaports have evolved beyond these definitions. Ports now differ in terms of the kind of service provision, i.e. container terminals, multipurpose bulk ports among others.

Beyond the reception of vessels, ports perform the wider functions of:

- Encouraging local development, e.g. industrial, social and economic, through the integrated nature of port services and surrounding activities (Fujita & Mori, 1996). This generates sustainable development of the nation by facilitating infrastructural development, e.g. roads and railways and serving as a source of direct and indirect employment.
- Providing a security boundary; being a major entry and exit point of a nation, the port serves as one means to monitor the passage of cargo, agriculture commodities and human passage in order to ensure the safety of the nations and its people. In effect, ports serve as a gateway to minimize risk. Risk in this context is defined as "any potential condition which, if it were to become fact, would adversely affect efficiency" (Ellen, 1993). Security issues which may potentially affect port efficiency and ultimately national growth include theft, damage, drug trafficking and illegal transfer of biological matter. These evidently have economic and safety implications. This is perhaps illustrated by Britain's Port and Maritime Regiment or Logistic corps, who are stationed in ports, where they take part in operations but are trained and equipped to maintain security. This role is also performed by immigration, port health and customs.

- Generating trade in the hinterland and, by developing relationships with other transport and logistic providers, and sometimes participating in joint investment schemes, improving transportation networks, performing the function of fundamental part of the logistic intermodal process in global trade (De Langen & Van der Lugt, 2006). One good example of this is the port of Tauranga's Metro port initiative (Economic and Social Commision for Asia and the Pacific, 2003), which included collaboration between the port and the national rail company to create access to the local market, and quick and less costly transportation to other areas in the nation, while reducing congestion on national roads.

2.2. The Role of Ports in the National Economy

Globally and regionally nations thrive on trade. Over 95% of overseas trade to and from the US is by ship (Robinson, 2005). Sea borne trade grew from 3385 to 7817 million tonnes within 1986-2006 (Hiedeloff & Zachcial, 2007). Irrespective of the type of natural resource available to a nation; (oil, minerals e.g. gold bauxite, coal, iron ore, labour etc.) the means of sustaining reasonable development with these resources is through ports. The ports serve as primary access points, which have an economic multiplier effect (Alderton, 2005). This generates further logistics and industrial activity, which contributes to a nation's economic growth and development, (Banister & Berechman, 2001). Repeatedly, port operating countries are trying to establish niches for their port systems and services depending on the location, resource options, potential trade and vision of the nation, e.g. hub transshipment or feeder ports. If done effectively, this has an additional benefit for countries, such as employment, and a favourable position in the world maritime trade route. This need for successful innovation is one of the recurring reasons for privatization. For example Koreas bid to solve its economic problems in the 1990's through privatization deregulation and decentralization among other things (Song, Cullinane, & Roe, 2001b).

One factor which plays an important part in this is the Maritime Dependency Factor (MDF), i.e. seaborne trade as a percentage of GDP. Although 90% of world trade is currently carried by sea, that moment is more dominant in some areas than others because of dependence on maritime transport or the lack thereof. This is usually influenced by factors such as nature of the nations economy i.e. major dependence on agriculture, industry or services and technology, location, either landlocked or coastal (Ma, 2007).

The role ports play extends beyond the nation, and influences the neighbouring countries as well. Specifically ports have a very important effect on the activities of neighbouring landlocked countries. Efficient performances of ports, as well as their whole logistic supply chain, determine how expensive or reasonable their services are to landlocked countries. High transit costs, which may include monetary costs, or costs in time, may ultimately stifle trading activities of landlocked countries, something that will negatively affect their economic development. This is illustrated by the disparity in trade volumes (60% lower) and transportation costs (50% higher) in landlocked countries than in port hosting nations (UNCTAD, 2003b). Though it is possible that the port nations contribute to these high costs through general inefficiency or high cost of services, the current situation is gradually changing. Infusion of private participation in regional ports is generating competition which prompts port authorities and governments to work or strategize in order to keep their landlocked customers. For example in West Africa transit trade from Burkina Faso Mali and Niger are vied for by the ports of Ghana, Togo, Benin and Senegal. Ghanaian ports provide incentives, such as lower tariffs, longer storage periods and close customer service which invariably benefit the landlocked nations.

In keeping with the aim of generating more international trade, some governments and nations are trying to make their ports favourable by cultivating them as maritime gateways or hubs, something that is only possible through corporation with international private entities such as international stevedores and cargo handlers. This, if successful, would promote capital and technical investment infusion in the ports. But what factors may influence the willingness of these foreign, regional or even local private investors to corporate with other nations in these ventures? The answers to these include level of transport costs incurred in using port facilities on a particular route (Santanu, 2007; Wilmsmeier & Hoffmann, 2008) liner shipping connectivity, the level of logistic integration and most importantly port efficiency (Oum & Tongzon, 2007). All these factors are interrelated and would determine the extent of international shipping organizations' interest in the ports seeking private partnership. Not all ports have favourable geographical locations which make them imperative points of call, but the willingness to call at these ports may be gradually cultivated by implementing measures that would ensure efficiency, quick and effective customer service etc that would make it possible for shipping lines to reap some benefits through economies of scale (Cariou, 2008a) as well as savings in cost and time (Tongzon & Heng, 2005). These factors may be determined through assessment of the maritime connectivity index as illustrated in Table 1.

Table 1 Liner shipping connectivity index 2004 to 2007

Country		Rank		
	2004	2005	2006	2007
China	1	1	1	1
Malaysia	12	12	10	7
Egypt	16	16	16	17
Sri Lanka	20	21	20	19
India	21	19	18	20
Turkey	29	28	29	23
Colombia	39	41	40	30

Indonesia	27	26	32	34
Vietnam	55	52	54	50
Ghana	58	61	59	61
Ecuador	63	58	58	63
Kenya	84	82	76	73
Tanzania	90	86	81	76
Angola	76	73	74	78
Fiji	88	87	97	97
Lithuania	115	108	105	101
Bangladesh	116	119	109	105
Albania	162	162	162	156

Source: Cariou, 2008a

China apparently has the best liner connectivity in the years under review. This is probably due to the fact that China is currently the largest hub of maritime trade; Businesses around the world have relocated production and distribution bases to China to make use of the labour force and other interrelated beneficial factors: It has one of the largest populations.

Albania on the other hand has the least connectivity amongst the reviewed group for various factors including the following: Predominantly public port with public investment operation and management for an extensive period, e.g. achieved legal ability to operate as landlord port in 2003; Unstable political situations in the entire neighbouring region i.e. illustrated by occupancy of port areas, e.g. quays by exclusive compounds for NATO and Italian armed forces; and lack of an effective port plan or strategy.

These are perhaps some of the reasons why it maintained that position for three years without any improvement until 2007 as observed in Table 1. Ghana on the other hand relinquished its fully public management and operation of ports to an extent in 2000. The country however has an average liner connectivity index which also from Table 1 seems to be increasing in the rankings. The implication may be then that other

factors then influence the cooperation of international private entities with the nation in terms of ports. This could be attributed to the components of the local and hinterland demand or the business of the aggregated supply chain.

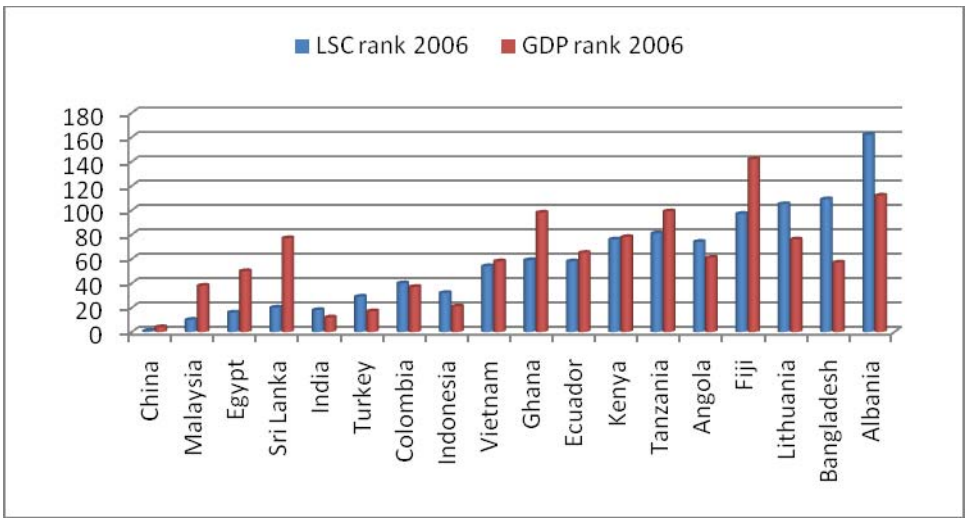

Figure 1 Comparison of LSC and GDP ranking in 2006
Source: Cariou, 2008a

In the next section focus is on evolution of ports and its possible effects on nations GDP. However, before that, one interesting observation to be made is the relation between the liner shipping connectivity and GDP ranking of countries in 2006. With a few exceptions, such as China who had top ranking in respect of GDP performance and liner shipping connectivity followed by India, there was a positive correlation between the two ranking trends. Outside those there were various anomalies, for instance Bangladesh, which was one of the countries with a middle level ranking of GDP actually had an inversely lower ranking for liner connectivity. Ghana on the other hand though somewhat poorly placed with respect to GDP had a middle level ranking for liner shipping connectivity. The rest of the countries had similar mixed results. This could imply that other factors such as those discussed above and not necessarily GDP performance of a country can determine its attractiveness to shipping lines and other maritime activities. Subsequently nations may develop these other factors to attract international maritime participation which would in turn

generate economic growth which may ultimately improve the GDP of the respective countries.

2.3. The evolution of ports and its effect on GDP

Table 2 briefly illustrates the evolution of ports and the various additional characteristics generated over time. These characteristics actually contribute to the level of development of countries and invariably influence their GDP.

Table 2 Evolution of Ports

FIRST GENERATION	SECOND GENERATION	THIRD GENERATION	FOURTH GENERATION
Connection between land and sea	Interface Plus industrial and commercial activities	Commercial orientation, integrated transport node and logistic centre	Sophisticated use of automation and non asset related logistic service provision
Operation as an independent nucleus	Closer relationship with transport and trade partners	Integrated relationships e.g. privatization	Globalization
Low value added i.e. traditional port services	Improved value added	Cargo and information flow and distribution High value added eg warehousing and distribution	Emphasis on quality of service and trained work force
Traditional management concepts	Broadening of management concepts	Proactive management Increased customer service awareness and practice	Same as 2nd and 3rd with additional input of global management concepts that match related evolution in business
Purely local , national or government based management	Same as first	Hybrid of local and foreign party management	Management of these ports and terminals located within a limited number of maritime global conglomerates

Investment made by state Labour/capital	capital	Technology	Information technology

Source: Alderton, 2005, Notteboom & Rodrigue, 2005

In the 1st and 2nd generation structures, as the state plays a leading role, gains and losses are enjoyed by the state. In the 3rd and 4th there is a mixture in the recipient of the benefit. The 4th generation ports are influenced by the trend of foreign direct investment, currently leaning towards human resource and capital intensive industries, e.g. ports and shipping. The trend has apparently been an investment in former state owned enterprises in the areas of petroleum, telecommunications and transportation among others. It is interesting to note that foreign assets of non financial transnational companies in developing countries rose from 195 – 400 billion from 2002 to 2005 with headquarters of these companies in the EU, US and Japan (UNCTAD, 2008a). This emphasizes the role of the top global terminal, stevedoring and port operators, e.g. PSA, Maersk, Hutchinson. But what is the implication for local national growth? The port benefits, invariably there are national benefits but the monetary benefits will be spread globally even though some sort of reflection would be made within the GDP, This has been referred to as "the spill over effect" (Notteboom & Rodrigue, 2005). What it means is the port's feed a larger international economy but unfortunately the downsides, notably pollution, marine and coastal degeneration from dredging, and other operations, remain locked within the port operating nation.

Wang has a similar approach to this when he states that:

- First generation cities do not really participate in value added.
- Second generation cities show some involvement in processes mostly for direct city, and inland consumption.
- Third generation cities show the use of scale economies for major transhipment and feeder traffic.

- Fourth generation cities activities are based on global economic trends, or they form regional hubs within import markets
- Fifth generation cities exhibit combination of the different modules, but are mainly located in coastal areas where global production occurs. (Wang & Olivier, 2006)

One may argue that the current generation of ports and the nature of privatization which often comprises foreign direct investment make it difficult to attest to the true nationality of ports or container terminals since most private international operators are conglomerates consisting of different nationalities and hence may probably affect the total benefit gained by the port's host nation (Asiedu, 2002). However to some extent the benefits derived are still quantifiable in monetary as well as value added terms, locally as well as internationally (Vanelslander, 2008). An illustration of this is the study of the contribution of the Flemish and Belgian ports to their regions economy where the collective contribution to GDP of the ports of Antwerp, Ghent, Zeebrügge and Ostend was 12.8 billion euro in 2004 which comprised significant contribution from both indirect and direct activities generated from maritime dependent businesses as well as businesses in the supply chain (Lagneaux, 2006).

2.4. GDP and Port Sector Contribution

Figure 2 compares the growth of world trade with GDP growth from 1995 to 2006 and shows the positive correlation between the two factors.

Figure 2 Comparison of world GDP and Growth Trend
Source: Muller, 2008

GDP has been defined as the total dollar value of goods and services over a period of time (Investopedia ULC, 2008) or a measure of the flow of goods and services produced within a country within a year (IC-Agency, 2007). It is the key economic indicator which is able to quantify growth in real terms (UNCTAD, 2008a).

While the GDP component of services has increased in developed countries, developing countries are also showing more trade liberalization reflected through larger contribution of imports and exports to their GDP results (UNCTAD, 2008a).

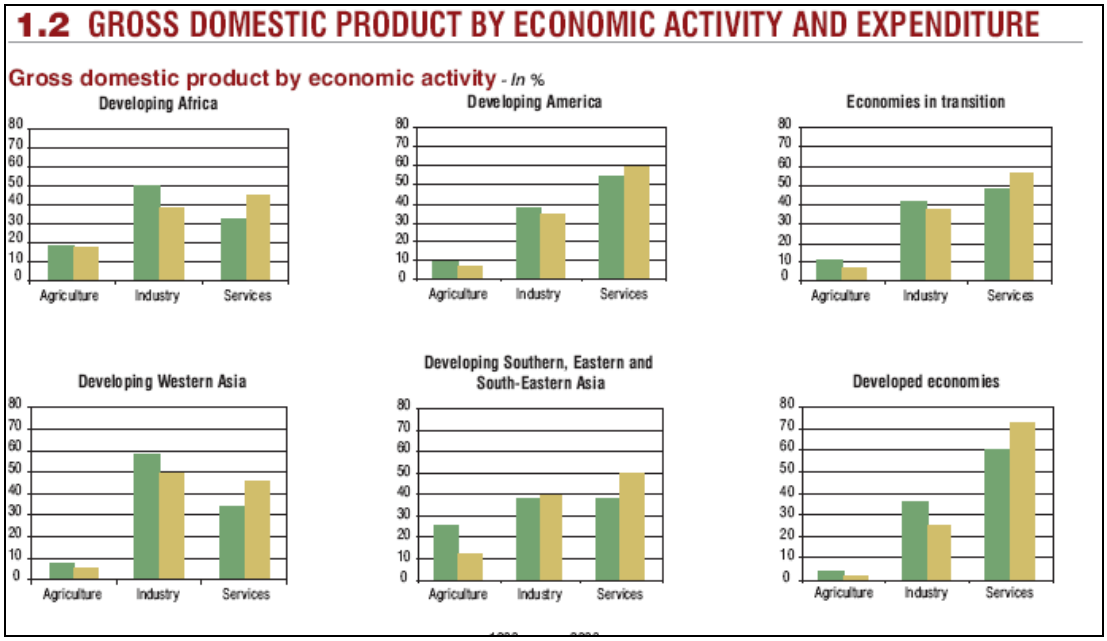

Figure 3 GDP Trend in Continents
Source: Muller, 2008

Currently the contribution of the port sector has become broader integrating the contribution of the whole maritime and logistic supply chain to the GDP of nations. Whether the role of the port is perceived to be a social source of employment and income to nationals or economic purely for business and profit; the truth is that both are probably not mutually exclusive. There would need to be productivity and efficiency and this is probably a reason why more states are leaning towards privatization as a means of generating better performance in their ports. This is illustrated by Dr Masahiko Furichi's reiteration of the important role of maritime shipping networks and ports in the Asia/Pacific region (Ports and harbours, 2008). This actually shows the nature of ports as key elements, not only in national, but in global transport chains as well.

In view of all the above, nations through their governments are pursuing strategies for port reforms that will improve the performance of their ports as well as fit in with the socio economic and probably cultural norms of the country. The most recurring strategy in recent times is privatization in its various forms.

3. Port Privatization

3.1.1. Public Port Operation and Governance

The important or key nature of the role of ports has probably been the reason why governments and public authorities have kept reign of the ports in the past. However, in a bid to keep up with the evolution of ports' public intervention has gradually had to decline while private participation in ports increases. Looking at the nature of activities listed in the 3rd and 4th generation port structures (Chapter 2), it is indicative that governments and their public governance structures may not be able to achieve this on their own. Though not applicable in all cases, more often than not, attempts to continue maintaining ports under full public authority management and operation have yielded the following problems:

- Over employment
- General inefficiency and persistent labour under productivity
- Divided interests', i.e. commercial interests as against the multiplicity of governments' interests such as employment, national social welfare, stakeholders, pressure groups and political interests.
- Nationalistic or local view to strategizing port improvement programmes rather than a global view which fits in with changing times (Baird, 2002).
- Monopoly and extreme bureaucracy which stifles competition (Song et al., 2001b).
- Debt
- Poor customer service
- Poor reputations in the international maritime environment
- Revenue and gradual business losses
- Loss of national income through recurrent subsidies to keep unprofitable institutions afloat.

Since the natural market forces which automatically generate efficiency by weeding out non performers are unable to operate, it is difficult to streamline or improve the performance of most public institutions (De Langen, & Van der Lugt, 2006). UNCTAD however indicates that problems in public enterprises may be addressed by the removal of government subsidies to create independence and encourage the entities to pursue strategies that would ensure revenue generation through cultivation of a commercial attitude, and the generation of competition to ultimately cultivate efficiency in operations (UNCTAD, 1995). More often than not, all the recommendations mentioned above are couched in, and may be achieved through different types of privatization strategies which will be discussed in the next section. Considering the evolution of global trade and the key role of ports within a maritime logistic system, the actions of various governments to streamline their port performance by applying different reform strategies is a matter of course. This chapter takes a look at the privatization strategies which seem to be the prevailing benchmark for port operations. It subsequently reviews first some types of privatization strategies, the extent of privatization in ports (3.3), the influential factors explaining the extent of privatization (3.4) and the perceived division of responsibilities between public and private entities on port services (3.5).

3.2. Port Privatization

Irrespective of broad missions and visions stated by ports, the objectives of most port entities are to establish efficiency, sustainability and equity. These values can be achieved through various means, privatization being one of them.

Privatization has been defined in many different ways, however, in general, it is any process aimed at shifting functions and responsibilities, in whole or in part, from the government to the private sector. This definition is generally acknowledged by many authors with some additional expansion (Song et al., 2001b; UNCTAD, 1998). According to the Michigan Education Society for instance, privatisation refers to

shifting the delivery of services performed by public employees to private business, a process that usually occurs in the form of contracting out or outsourcing. The definition is expanded further by several authors who have studied the privatisation process in ports. For instance port privatization can be defined as the transfer of ownership of assets from the public to the private sector, or as the use of private capital to fund investment in port facilities, equipment and systems (UNCTAD, 1998). Similar definitions are given by (Baird, 1999; Bucholtz, 2006). On the other hand other authors have not necessarily focused narrowly on the private and public role in defining privatization, but rather see it as all efforts made to improve the "commercial orientation of ports operations" (Ircha, 2001).

It therefore appears that the definition of port privatization is embedded in its mode or process of implementation which may vary and is therefore simplified or narrowed down by being defined either by the provision of services or by the ownership of assets. With regards to ownership and management of assets, distinction is made between the existing ranges of applications, from comprehensive – the sale of an entire port's shore and water side assets to a private or public entity, full – full ownership of a facility or service provision right by private parties, partial - transfer of a portion of assets and service provision to private enterprise and part privatization – joint ownership by both the public and private sector (UNCTAD, 1998). These distinctions indicate that there is no clear cut or regulated mode of application since some seem to be quite similar or may easily be re-structured to suit different systems. The implication is that subsequently more hybrids of privatization strategies can be formed in time with different levels of private participation based on existing institutional political or socio cultural factors in different parts of the world. In the same vein, this is illustrated by Baird with a port function matrix in which some functions are more suited to either private or public administration although these in practice may have differing benefits and threats.

Table 3 Port Function Matrix

	Port Functions		
	Regulator	Landowner	Operator
PUBLIC	Public	Public	Public
PUBLIC/Private	Public	Public	Private
PRIVATE/Public	Public	Private	Private
PRIVATE	Private	Private	Private

Source: Baird 1995, 1997

A similar comment applies to the (Internatioal Association of Ports and Harbours, 1999) that investigates private intervention in ports into three parts i.e. participation in port organization, port assets and port operations (Lee & Cullinane, 2005). These studies concede that privatization in ports may cover infrastructure, superstructure and management wholly or in part and in both cases division of responsibilities is not so clear cut and overlapping very often occurs.

Table 4 Summary of areas of private intervention in ports

Organization	Assets	Operations
Regulator	Landowner	Operator

Source: Baird 1995, 1997, Lee & Cullinane, 2005

Subsequent developments in these privatization trends indicate that most forms of port privatization may also be an integration of two or more of the categories above as indicated by the matrix above. However, this integration even seems to extend beyond the areas stated in the matrix and consequently will possibly result in the implementation of even more complicated hybrid strategies. This is currently illustrated by the movement from the existing majority of public ports in the past to the present proliferation of ports with public and private participation with the accompanying minority of totally private ports, for example ports in the United Kingdom and New Zealand.

3.3. The extent of privatization in ports

Ports are the modems which facilitate business and trade through the maritime sector. The services of ports previously focused on the entry and exit of cargo via sea transport, to and from countries or areas. As stated by Taylor, "Simplistically, ports are about ships and ships about ports."; however, that situation has changed today (Taylor, 1992). Business activities within ports have broadened and the survival of ports are linked not just to the ability of handling vessels but to port efficiency and the total efficiency of its surrounding logistics system. One strategy available to improve efficiency has been privatization in ports and this is broadly applied to different areas of port activities either directly or indirectly. Privatization has gradually developed through global players, i.e. shipping lines and port operators, who have fuelled the increase in private sector participation as a result of their need for: Quick and efficient operations in order to meet their timing in liner services; and Economies of scale through the use of relatively larger vessels which may previously not have been accommodated by these ports.

In view of these reasons, privatization strategies may be applied wholly to both replace public sector management and operation or partly to the range of port and even maritime activities. This participation in ports by private stakeholders and other parties comes in many forms, and plays mainly on the ownership and governance of ports. This trend is for instance stressed by Alderton (2005) who identifies the following port ownership structures:

- State ownership - ranging from total political supervision to state owned shares.
- Autonomous - a quasi governmental agency set up by an act of parliament
- Municipal ownership - local ownership by cities or municipalities
- Private ownership - totally private ownership and management

The groupings above are components of the four main port models under which most ports currently structure their ownership and organization:

- Service
- Tool
- Landlord ports and
- Private ports.

According to Brooks (2004) the service port is the primary model, where the port authority owns all land and available assets, and performs all regulatory and port functions. In effect, service ports are characterized by public entities offering services as well as providing infrastructure and superstructure. Possibly the port entities may also be private. The tool port category on the other hand and as explained for instance by Bichou & Gray (2005) owns and operates port infrastructure and superstructure, but may lease the latter out to private entities for operational purposes. Subsequently, the landlord port owns and develops infrastructure while private operators own and develop superstructure. Finally, in the private service port, all infrastructure, superstructure and operational and regulatory activities are owned and undertaken by the private operators with no public intervention.

Although there are examples of ports applying these models from top to bottom, more often than not the demarcation is not so clear, resulting in various kinds of hybrid models exhibiting one or more characteristics of the above categories. Grey areas already exist since in some fully public ports certain services e.g. ship chandeller services and waste reception, are provided by local private companies, not directly within the port hierarchy but probably within the community. Though this could be called outsourcing or other titles, it still is a form of private sector participation which is the core theme of privatization. One important question then

becomes: Does the service provision under the definitions above only relate to core port services, or does it relate to subsidiaries as well?

Another way to illustrate the extent of privatization programmes within the major port models is related to the scope of concessions. Concessions in this context are agreements between governments and private entities granting permission to operate; and the scope within which the operations may proceed. Out of 299 port privatization projects within 1990 to 2006 151 comprised direct concessions (Pallis, Noteboom, & De Langen, 2008). Table 5 summarizes some of the prevailing types of concession agreements.

Table 5 Examples of Concession Agreements

TYPE	**CHARACTERISTICS**
BOO- Build operate own	Land and infrastructure not returned to state or port authority
EOT- Equip operate transfer	Port infrastructure exists superstructure is provided by private operator
BTO – Build transfer operate	Entire facility is constructed then transferred to the operating entity.(public or private)
BOOT- Build own operate and transfer	Ownership of land and facilities are conveyed to the concessionaire but transferred back to the port authority at a given price at the end of the concession period
WBOT – wrap around BOT	Integration of BOT, management contract and a development agreement,
Lease or management contract	Normally no transfer of ownership or assets. Private sector management, technology and skills are provided for a period for a fee/ compensation
outright sale	

Source: World Bank, 2007b, Song et al., 2001a

However it is important to note once again that these categorizations are not necessarily cut and dried. Most schemes appear to be in reality a mixture of all or some of these methods, and may be applied to parts of, or the whole port structure,

irrespective of the prevailing type of organizational and administrational structure of the port.

Ports benefit from these ranges of privatization schemes (if they are successful) by:

- acquiring efficient and professional expertise and operations
- transferring a part of risk related to operations and investments
- receiving long term revenue through royalties
- acquiring an increasingly favourable reputation based on performance.

At the same time, operators also benefit from their increasing participation in port activities as it gives them the opportunity to obtain license to generate business and make profit and a financial relief through investment sharing since in most cases infrastructure is already available.

As stated in a study by Napier University on the top 100 container ports, the aims of privatization is to increase efficiency/lower costs (50%), expand trade (27%), reduce cost to public sector (23%) and increase know-how (15%). Terminal concession and leasehold arrangements are the most common methods used (52%) followed by BOT (19%), the sharing of investment (50% of the cases) being the first advantage followed by the increase in productivity (44%) (Baird, 2005).

On the other hand, just like every other process, it has its demerits. Baird also mentions that the loss of control (31%) and the political/economical ambiguity (27%) are the main disadvantages of privatization. Arguments that can be stressed are related to the lack of transparency and to the creation of dominant position of the grantor, who may put pressure on private operators to employ staff previously employed by port authorities or state (Song et al., 2001b). Debatably, this may not altogether be a negative thing. Firstly, and if done properly, it may give the port authority some sort of control over private firms. Secondly, the transfer of

"qualified" personnel who are at least already familiar with operations, regulations etc can assist the new company while a certain social aspect of employment is satisfied without necessarily deviating from the commercial reasons for the strategy.

The opposite occurs in some other areas where the same lack of transparency may result in hasty and lax agreements which actually limit port authorities in some aspects of their regulatory role and give certain inexpedient concessions to the private operators which may ultimately make a farce of the landlord role, although, they may have a sort of implied regulatory component derived from the current existing legislation (Cowen & Cowen, 1998). However if these clauses are not stated explicitly, this may be inadequate for the fulfilment of the regulatory role by the landlord port authority. These issues lead to investigating what factors affect the extent of privatization in ports.

3.4. Key Factors influencing the extent of Privatization

The first obvious factor to affect the extent of privatization in ports is the general policy of a nation and its port. Nations have different aims and objectives related to their development. For example Ghana's "vision 2020", a policy document containing aspects of the country's economic development plan, has the following general provision among others (Meletiou, 2000):

> *"…promotion of higher investment by creating an enabling environment and a reduction in the cost of doing business, as well as private participation in the provision of infrastructure in the areas of roads, ports, railways, telecommunications power and urban water supply."*

This policy has been incorporated into the vision of the port authority of Ghana to ultimately convert Tema into a landlord port, and to introduce competition in port operations by increasing private sector participation.

South Africa follows a restructuring concept within their development policy, which covers privatization by enabling a framework for the privatization of State Owned Enterprises and enabling the participation of strategic partners in order to improve general performance in public enterprises.

South Korea employs a number of five year economic development plans, which include the objective of enhancing quality of life, and expanding social overhead capital through a policy of deregulation and liberalization of the economy. This invariably covers the port environment (Song et al., 2001b).

The changes in regional trade and customer requirements are a second factor explaining the extent of privatization. To keep up with these changes, port authorities aspire to enhance their service quality and update their facilities with the current innovation, which will increase their competitiveness and ability to participate beyond their regions, in a more global manner (Branch, 1986). Changing trade patterns and global market expansion influences the privatization trend through changes in cargo, in vessel size and capacity, and more importantly the subsequent change in customer requirements (e.g. demand for quicker and more efficient services). These factors motivate ports to take actions which will result in productive innovation. These changes can come from the needs of port stakeholders, e.g.:

- Shipping lines who need to keep up with the competition by offering speedy service and making use of scale economies, enhancing vessel sizes to cut cost and maximize profit. This may only be ensured if ports have the required infrastructural facilities to receive the ships and if they are capable of delivering efficient and quick throughput, berth output and gang output services.

- Governments who need to ensure that the ports are performing in line with their stated policies as well as maintaining their performance in order to increase contribution to national income rather than serving as a resource drainer.

- Importers and exporters who increasingly depend on the value of time and the undamaged state of their cargo to keep up with growing global competitive trends (Tongzon & Heng, 2005).

- Landlocked states who solely dependent on port operating states for handling their inbound and outbound cargo, providing sustenance to their economies, or serving as the basis for value added activity for those countries trade.

- Other stakeholders such as industries within the port operating state, dependent on the vibrant operation of the port, e.g. increased throughput, vessel calls that affect ship chandlers, bunkering services and waste disposal companies.

The "Business Culture" is the third element to play on the extent of privatization. Labour unions are for instance more dominant in certain areas, e.g. Europe (Paczynska, 2004). Smooth transition may depend on their willingness to accept the strategy which may be hindered by fears of redundancy and unemployment or just simply fear of change. Environmental issues are also a dominant factor in explaining the way the privatization process takes place in developed countries.

A fourth element is related to International Affiliation and Other Relationships such as regional agreement like the European Union and ECOWAS. Similar governance and policies regarding competition may exist for ports belonging to a specific area. Furthermore, across continents and oceans colonialism, neo colonialism may induce certain aspects of privatization, e.g. *Anglophone* and *Francophone* strategies

practiced in countries affiliated in some way to each other, especially if financing is also an issue (Saxton, 1997). (J. Wang, 2004) also states for instance that Shanghai's choice of joint venture Corporation is based on the port administration's formal guidelines for partner selection which states among three other clauses "the relationship with Shanghai".

3.5. Privatization in Port Services

The extent of privatization also depends on the port services considered. A survey on 188 ports shows for instance that private ports only represent 7% of the total sample (Internatioal Association of Ports and Harbours, 1999). A total of 71% are controlled through a public agency and 21% by a governmental department. The survey also shows that the port authority keeps control over:

- port navigation services in 56% of the cases (13% for private) and harbour master in 54% of the cases (6% for private).
- Dredging in 55% of the cases (26% for private)
- Pilotage in 42% of the cases (28% for private)
- Towage in 40% of the cases (31% for private)
- Container stevedoring services in 34% of the cases (36% for private)
- Bulk stevedoring services in 30% of the cases (37% for private)

It therefore appears that vessel handling operations are the area for which the extent of privatization is the highest, and depends on the type of port ownership and management structure and the size of the port among others. Developing countries and smaller ports tend to have provision of these services by the port authority, while, in developed countries, this service is often offered by private firms and operators.

Stevedoring, loading and unloading of vessels are therefore one of the key components of port operations that have increasingly been turned over to private sector participation for the major reason of generating efficiency in operations through quick and accident free activities.

In some authors' opinion any privatization strategy should maximize competition, and suggestions have been made to make ports handling 30,000-100,000 TEU's have several operators, e.g. stevedoring companies, to promote intra-terminal competition (Trujillo & Nombela, 2000). Shipping lines and major companies around the world have integrated themselves into this line of business to ensure that they at least have some form of control over a key area of the logistic chain that has the potential to determine the success of their services such as Hutchinson, APM terminals, PSA and Dubai Ports world among others.

Finally the extent of privatization in the area of storage transfer and delivery of cargo depends on the type of port management model used, e.g. in Ghana a proliferation of private container yards or off dock terminals are licensed by the port authority. The same applies for conservancy that includes provision of services such as bunkering, provision of waste disposal and reception facilities, ship chandler services among others, as illustrated in Table 6.

Table 6 Title Division of responsibilities between public and private sectors in different port structures

ox 27: Prevailing Service Providers under Different Port Management Models

Model	Port administration	Nautical management	Nautical infrastructure	Port infrastructure	Superstructure (equipment)	Superstructure (buildings)	Cargo handling activities	Pilotage	Towage	Mooring services	Dredging	Other functions
Public service port	pu	pu	pu	pu	pu	pu	pu	pu	pu	pu	pu	pu
								pr	pr	pr	pr	pr
Tool port	pu	pu	pu	pu	pu	pu	pr	pu	pu	pu	pu	pu
								pr	pr	pr	pr	pr
Landlord port	pu	pu	pu	pu	pr	pr	pr	pu	pu	pu	pu	pu
								pr	pr	pr	pr	pr
Private sector port	pr	pu	pr	pr	pr	pr	pr	pu	pr		pu	pu
								pr			pr	pr

ource: Author.

Source: World Bank, 2007b

3.6. General impact of Privatization on port efficiency

This chapter discussed some of the major types of privatization strategies and the reasons why nations apply them in their ports to different extents. The predominant reason is the search for efficiency in management and operations through reduction in operational costs, improvement and development of port services and facilities, and elimination of government subsidies; in effect issues of port efficiency (D. Song et al., 2001a). In a bid to achieve this, various privatization strategies usually result in an infusion of capital, technology and managerial resources and expertise. This may or may not cover several port components. For example those shown in Table 7:

Table 7 List of Port Facilities and Services and some Aspects of Private Sector Infusion

DESCRIPTION	COMMENTS
Infrastructure Approach Breakwater Locks Berths	Through capital infusion for construction of additional, maintenance of existing and dredging activities.
Superstructure Surfacing Storage Workshop Offices	Capital and technological infusion through construction of additional and improvement of existing facilities especially with regards to layout and space
Equipment Fixed – ship-to-shore gantry's, conveyor belts etc Mobile – straddle carriers, forklifts,	Through capital, technological and skills investment.
Services to ships Harbour masters office, navigational aids, pilotage, towage, berthing/unberthing, supplies, waste reception and disposal, security	Managerial and technological innovation and investment. Other alternative operating methods such as outsourcing. Operations based on global standards
Services to cargo Handling, storage, delivery/reception,	Managerial and technological innovation and investment. Other alternative

cargo processing, security	operating methods such as outsourcing. . Operations based on global standards

Source: UNCTAD, 1995, Song et al., 2001a

Indications are that the major aim of investment into these facilities and services, in most cases, is to generate and improve productivity and efficiency. The pertinent question however is: Do these ranges and effects of privatization strategies actually improve port efficiency and productivity? To assess this some authors attempted to make a comparison between performance in private and public sector management, and argued that efficiency is not only a matter of ownership, but is also related to social and commercial variables. These include, public sector participation, corporate policy and strategy, national regulation and focus, level and mode of privatization, political system and stability, economic development and GDP growth of the port host country, natural advantages e.g. key positioning or unique resource base e.g. first port of call, end port or superb geographical positioning (Letza, Smallman, & Sun, 2004). This indicates that though privatization may improve port performance and competitiveness a balance should always exist between public and private sectors (Tongzon & Heng, 2005). One might say that neither total privatization or public management and operation of ports will necessarily bring positive results. Total "publicisation" might result in complacency and decreased productivity/efficiency, whilst total privatization may result in monopoly drawbacks. In contrast to this Dick, (1987) states that privatization could be a factor that increases efficiency, whether a monopoly is involved or not, by possibly giving management and staff the drive to work towards purely commercial goals. No clear evidence has been found to show public enterprises were totally inefficient in certain respects as compared to private enterprises (UNCTAD, 1995). Efficiency was, in this report, separated into different compartments, e.g. technological efficiency, operational efficiency, or managerial efficiency. Taking ports in their current role as key installations in the maritime logistic supply chain, it would imply that their efficiency definitely affect the performance of businesses in the rest of the system

through reduction in total maritime transport cost (Oum & Tongzon, 2007). Middle ground between the private and public organizational structures is possible and brings different benefits that can satisfy the private sectors commercialism and the public sectors broader social economic drive, which is a positive thing and may help organisations realise full potential. Thus various institutions such as airlines, railways and ports are applying this through reforms. An example of this is illustrated in Table 8 which shows the effect of privatization on British Aviation services.

Table 8 Comparison of Public and Private sector intervention in British Aviation

.	CIVIL AVIATION 1970'S	PUBLIC SECTOR BRITISH AIRWAYS	PRIVATE SECTOR BRITISH CALEDONIAN
1	Flying hours per day	6.8	8.2
2	Capacity/ ton per employee	100 base index	115 (15% more productivity)
3	Competitive advantage/disadvantage	Better location at Heathrow	Inconvenient location at Gatwick
4	Short sea ship 1964-1980	Sea link	European ferries
5	Tourist vehicles	From 312000-301000	From 84,000-400000
6	Competitive advantage/disadvantage	With rail connections	Without rail connections

Source: Adopted from Pyke 1982

From a general perspective, Table 8 illustrates that the private sector airline was more productive even with less of a competitive advantage. In the same vein private sector participation can affect efficiency and productivity in ports.

Encarta defines productivity as

> "The rate at which a company produces goods or services in relation to the amount of materials and employees needed."

Looking at ports that definition needs to be changed somewhat. Port Performance Productivity has been defined as “Maximizing throughput in a port area by a mix of operational institutional and infrastructural improvements.” (Woodley, 2006)

This definition focuses on port throughput and the efficiency of other processes and activities which make the optimal amount of cargo flow through a port. Though a true illustration of productivity, the definition does not illustrate the true effect of the logistic supply chain on port performance. Some ports may record very high throughput by virtue of the type of cargo, i.e. bulk, break bulk, containers or by virtue of their location on the shipping route but may not be relatively productive as compared to similar ports with similar structures. Then again productivity is also related to efficiency or the efficient use of resources (Dowd & Leschine, 1989; Song et al., 2001a), This has been the core issue of the debates on whether private sector participation has raised the efficiency of ports or not. Private sector participation or any sort of port reforms for that matter may be quantified by the capital infusion or change in administrative structures. However, the measurement of port performance before or after any such reform has been done in different ways over the past years and two of these will be discussed in the following chapters.

4. Measuring Efficiency using Data Envelopment Analysis

4.1. Introduction

The previous chapter established that ports have various impacts on countries and regions; the principal impact which generates other effects is the economic impact. To harness this potential effect of ports, privatization as a port reform strategy has recurrently been applied by countries and ports around the world. The strategy is seen as a means of improving port performance and increasing productivity to keep up with growth and the changing trend of world trade. The question is: Does it really? and Is the effect the same for the implementing ports?

This chapter makes an analysis of twelve African ports. It is not really appropriate to compare ports in totality since each port has different locational, policy, service, operational and intermodal characteristics and variables which may influence the results of the comparison (Talley, 2006). Though each port is unique, assessment of technical or allocative efficiency with respect to the level of inputs used and output obtained, is still possible because factors such as draught limitations, berth availability and type of equipment used, influence the cargo or container output in various ports irrespective of size or location. This chapter takes a look at port efficiency and one method through which it can be assessed using Data Envelopment Analysis.

4.2. DEA Analysis

The Data Envelopment Analysis (DEA) is used to measure the performance of (inputs) decision making units in organizations, by assessing their relative efficiency, technical efficiency or scale efficiency with respect to specific output levels

(Cullinane & Wang, 2006). The system was initiated by Farrell in 1958 and developed by Charnes, Cooper and Rhodes in 1978. Development of the system did not end there but is still evolving and the system has currently been used to different extents to analyze activities in service organizations, such as banks, hospitals insurance companies and also in the measurement of different aspects of performance in ports and container terminals. Primarily, it has been used to assess the efficiency in terms of performance related to existing inputs and to compare port performance on the basis of benchmarks indicated by similarities in inputs or output of other ports. Examples of some previous applications include the study of 4 Canadian ports and 22 USA ports with different output capacities.(Turner, Windle, & Dresner, 2004), A study of Mexican ports (Estache, de la Fé, Tovar, & Trujillo, 2004; Sharma & Yu, 2008) ,.

Benefits of DEA analysis:

- Enables the evaluation of the impact of multiple inputs on output (either singular or multiple).
- Enables the application of existing actual data for informed and applicable results and eliminates the need for assumptions which invariably make analysis more theoretical than practical.
- Can be used to measure a wide range of port activities based on availability of data.

Some Constraint:

- Inability to asses allocative efficiency due to unavailability of financial data
- The system does not enable thorough assessment of actual performance of key decision making units e.g. crane productivity and berth output.
- The variable nature of data within the different categories. For example, transfer equipment comprises of gantries, mobile and floating cranes of different capacity and working loads. These are not taken in to consideration i.e. some ports may have a combination of 50 types of quay transfer

equipment which are mobile or quay cranes with lower weight capacity while others have 10 which may all be gantries of higher working loads. It is difficult to incorporate the effect of these differences into the analysis.

The ports used in this analysis are all multipurpose ports sampled from the African regions i.e. west, east, south and North Africa. All handle general cargo and containers in addition to other services. The ports are listed below:

Table 9 Current Port Status in Selected African Ports

NO.	PORT	PORT STATUS
1	Benin - Cotonou	Service Port
2	Egypt - Damietta	An international consortium was awarded a 40 year concession to build and operate a container terminal expected to be completed in 2009.(AME Info., 2007)
3	Djibouti	A public port with private participation from may 2000 in the form of a management contract (UNCTAD, 2003a)
4	Ghana- Tema	Private participation in stevedoring and cargo handling since 2002; container operations in 2007. with a landlord port authority structure
5	Ivory Coast - Abidjan	Landlord/ Service port authority structure with Private participation in container terminal operations
6	Kenya- Mombasa	Public service port with private sector participation in the form of a management and lease contract for the running of the Mombasa Container Terminal.(1996)
7	Nigeria -Apapa	Predominantly Public operation and management till 2005 when initiation of port reforms resulted in the adoption of the landlord model. Subsequent concession agreement (via a one million dollar bid) with APM terminals took effect in 2006 (Leigland & Palsson, 2007) (Harding & Palsson, 2007).
8	Mauritius- Port Louis	Public port authority with a container terminal run by a public corporation until 2001. A renewed role as a landlord port authority model with some private sector participation through the Greenfield projects for the Mauritius Freeport project and other concessions {{115 World Bank 2005; }}.
9	South Africa -	Pre dominantly public operation and management up to

	Capetown	2003
10	South Africa- Port Elizabeth	Same as above
11	Tanzania -Dar Es Salaam	Private participation in container terminal operations from 2000 (UNCTAD, 2003a)
12	Togo - Lome	Public

4.2.1. Input Selection

The selection of inputs was based on the fact that there is frequently a direct effect of investment capital infusion into these areas i.e. dredging of existing and construction of new berths or acquisition of innovative equipment. Furthermore, the selected variables directly influence container handling operations be they in multipurpose ports or pure container terminals. The input units used in the analysis over the review periods 2002, 2004 and 2006 comprised:

- Number of berths
- Maximum draught
- Storage space – in square metres
- Quay transfer equipment- Gantry cranes, mobile cranes and or floating cranes.
- Yard equipment – straddle carriers, rail mounted gantries, forklifts, reach stackers, trailers,
- Existence of rail infrastructure

(Check appendix for excel worksheets)

4.2.2. Output Selection

The output variable selected was container traffic changes over the review period 2002, 2004 and 2006. This selection was based on the fact that current global trade is geared towards movement of cargo in containers rather than in the traditional loose

packages transported by multipurpose vessels. Vessel building with respect to general cargo excluding liquid bulk and LNG vessels is geared towards different types of container vessels be they reefer, cellular or general container vessels. In view of this, port reforms are pre–dominantly aimed at handling this category of traffic more efficiently since it is becoming more and more the major form of maritime traffic. In addition to this, the traffic trend is measureable in terms of statistics compilation.

Though there has been privatization in other port activities over time. Implementation of the strategies with respect to containerization for most African ports e.g. West Africa was within 2000 to 2006.

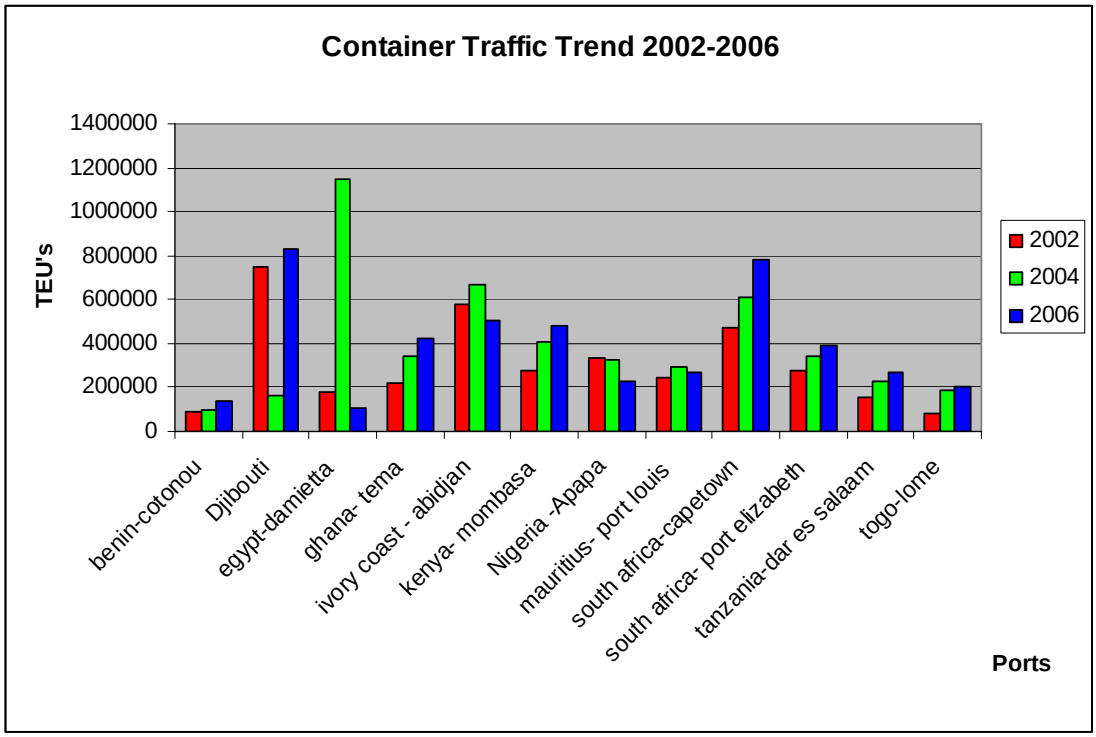

Figure 4 Container Traffic Trend in Selected African Ports
Source: Heideloff & Zachcial, 2007

The data used for analysis retrieved from containerization international yearbooks, ISL shipping statistics yearbook 2007 and respective port authority web pages.

4.3. Findings

4.3.1. Input-Oriented CRS Efficiency

Table 10 illustrates the constant returns to scale (CRS) efficiency of the various input units in the different ports over the review period.

Table 10 Input Oriented CRS Efficiency

COUNTRY	2002	2004	2006
Benin - Cotonou	0.60838	0.98847	1.00000
Djibouti	1.00000	0.44601	1.00000
Egypt - Damietta	1.00000	1.00000	0.53083
Ghana - Tema	1.00000	1.00000	1.00000
ivory coast - Abidjan	1.00000	1.00000	1.00000
Kenya - Mombasa	0.60083	0.73643	1.00000
Nigeria - Apapa	0.79504	0.49967	0.34419
Mauritius - port Louis	0.92133	0.74703	0.55153
South Africa - Capetown	1.00000	1.00000	1.00000
South Africa- port Elizabeth	1.00000	1.00000	1.00000
Tanzania - dar es salaam	0.33423	0.44240	0.65388
Togo - Lome	0.53154	0.96193	1.00000

CRS shows the ability of the organization to produce specified output levels without decreasing or even increasing their level of efficiency; the production of a unit of output is proportional to the allocation of the input. In other words, the port may be relatively efficient with regards to the output level being achieved with available inputs. This may not be a bad thing, but it sends signals that there may be room for expansion in size of the terminal, storage space berths or either of the following inputs in order to achieve increase in output levels.

It also implies that if the output levels increase significantly at the existing level of input or infrastructure. There may possibly be the effects like port congestion, extended periods of queuing and so on. In this view, ports can be considered as purely technically efficient if their CRS is equal to one (1); on the other hand, it does

not actually imply inefficiency if the CRS is not equal to one but rather suggests the existence of some limitations discussed earlier e.g. size and infrastructure.

It is important to note that the result drawn for the category in Table 10 is not totally conclusive but rests heavily on the result of the VRS in Table 11 to determine full technical efficiency i.e. if CRS = VRS =1 the ports are fully technically efficient however if CRS≤ 1 and VRS = 1 is still equal to one. The ports are still technically efficient but have capacity limitations.

4.3.2. Input Oriented VRS Efficiency

Table 11 illustrates the variable returns to scale (VRS) efficiency in the respective ports during the review periods. VRS efficiency indicates the exploitation of economies of scale with respect to available inputs and achievable output. i.e. ports may achieve either increasing or decreasing returns to scale with the available level of inputs. This illustrates that efficiency is not just related to factor or input combinations but other influential variables such as management; which are not quantified within the model.

Table 11 Input Oriented VRS efficiency

COUNTRY	2002	2004	2006
Benin - Cotonou	1.00000	1.00000	1.00000
Djibouti	1.00000	0.95322	1.00000
Egypt - Damietta	1.00000	1.00000	1.00000
Ghana - Tema	1.00000	1.00000	1.00000
Ivory Coast - Abidjan	1.00000	1.00000	1.00000
Kenya - Mombasa	1.00000	1.00000	1.00000
Nigeria - Apapa	1.00000	1.00000	0.95041
Mauritius - Port Louis	0.97781	0.95833	0.94262
South Africa - Capetown	1.00000	1.00000	1.00000
South Africa- Port Elizabeth	1.00000	1.00000	1.00000
Tanzania - Dar Es Salaam	0.85500	0.86498	0.91098
Togo - Lome	1.00000	1.00000	1.00000

4.3.3. Assessment of Technical Efficiency

From the results shown in table 12, it appears that in 2002 and 2004 the ports of Cotonou, Mombasa, Apapa and Lome were not necessarily or purely technically efficient since their CRS‹ 1; however, by 2006 Mombasa , Cotonou and Lome had achieved relative efficiency shown by CRS = VRS = 1. These groups of ports are significantly public ports, ports with some sort of private sector participation through management contracts or ports which have only just recently i.e. 2006 onwards started to apply reforms to enable privatization with respect to container handling,

Table 12 Comparison of CRS/VRS results

	2002		2004		2006	
	CRS	**VRS**	**CRS**	**VRS**	**CRS**	**VRS**
Benin - Cotonou	0.608	1.000	0.988	1.000	1.000	1.000
Djibouti	1.000	1.000	0.446	0.953	1.000	1.000
Egypt - Damietta	1.000	1.000	1.000	1.000	0.531	1.000
Ghana - Tema	1.000	1.000	1.000	1.000	1.000	1.000
Ivory Coast - Abidjan	1.000	1.000	1.000	1.000	1.000	1.000
Kenya - Mombasa	0.601	1.000	0.736	1.000	1.000	1.000
Nigeria - Apapa	0.795	1.000	0.500	1.000	0.344	0.950
Mauritius - Port Louis	0.921	0.978	0.747	0.958	0.552	0.943
South Africa - Capetown	1.000	1.000	1.000	1.000	1.000	1.000
South Africa - Port Elizabeth	1.000	1.000	1.000	1.000	1.000	1.000
Tanzania - Dar Es Salaam	0.334	0.855	0.442	0.865	0.654	0.911
Togo – Lome	0.532	1.000	0.962	1.000	1.000	1.000

For example Togo and Ecomarine's future plans for construction of a container terminal (UNCTAD, 2003a). The exception in this case was the port of Apapa whose results indicated inefficiency in productivity or operations. Prior to 2006 Nigerian

ports were managed and operated by the state under a pre dominantly centralized system characterized by bureaucracy, overstaffing, congestion, long turn around times and other negative factors, which contributed to levels of general efficiency (Kruk, 2008). One interesting thing is the trend of container traffic through Apapa from 2002-2006 as indicated by the respective containerization international yearbooks, traffic volumes actually declined within the review period which certainly affected the results; in contrast to the others in this first group, Nigeria has had investment in container handling through APM terminals; however, indications are that though general performance linked directly to private investment and technical expertise could be improving technical efficiency, other broader factors such as traffic declines through poor location and logistic chain accessibility could be hampering the results. Probably future assessment would determine any changes private sector participation will have on this port.

Damietta, Tema., Ivory Coast, Capetown and Port Elizabeth all exhibited pure technical efficiency in all the review periods. These ports all had forms of private sector participation in their management and operations

The results for Damietta Port in this instance was interesting because 2006 results indicated capacity constraints to efficiency in terms of capacity e.g. size although container traffic declined. This anomaly may possibly be explained by activities geared towards the construction or expansion of the private container terminal (AME Info., 2007).

Results for Dar es Salaam and Port Louis showed lack of technical efficiency in the review period 2002-2006. Container handling in Dar es Salaam has been fully privatized since 2000 as shown in Table 9 with management and operations being handled by capable global operators. However, other factors within the whole logistic chain influence these results eg dissatisfied lines pulling out traffic volumes to neighboring ports because of delays due to congestion having been a negative

influential factor. This has been caused by long dwell time for containers, poor feeder and access roads (University of Dar es Salaam, Ministry for Infrastructure & Development, & WBCSD, 2007). In the case of Port Louis, reforms were instituted to increase port competition as well as efficiency in operations. The port had been characterized by delays for ship and cargo which resulted in the loss of a major transshipment client (World Bank, 2005). This accounts for the decline in container traffic in 2006. Port Louis results for the review period were not only due to capacity and size limitations but some level of technical inefficiency as well illustrated by the loss of a major crane through damage in 2003 (World Bank, 2005). The World Bank document in 2005 indicated that unlike the public container handling company, private sector institutions would be more adept at adapting to and keeping up with the changing nature of port competition.

4.3.4. Assessment of Scale efficiency

The results in this category represent the performance of scale efficiency in the various ports. i.e. when CRS/ VRS =1 the ports have achieved scale efficiency within the review period. When CRS/VRS is less than one it shows inefficiency of scale albeit to varying degrees. The results for the three years are presented in tables 12, 13 and 14.

Table 13 Assessment of Scale Efficiency - 2002

COUNTRY	**CRS**	**VRS**	**SCALE CRS/VRS**
Benin-Cotonou	0.60838	1.00000	0.608
Djibouti	1.00000	1.00000	1.000
Egypt-Damietta	1.00000	1.00000	1.000
Ghana- Tema	1.00000	1.00000	1.000
Ivory Coast - Abidjan	1.00000	1.00000	1.000
Kenya- Mombasa	0.60083	1.00000	0.601
Nigeria -Apapa	0.79504	1.00000	0.795
Mauritius- Port Louis	0.92133	0.97781	0.942
South Africa-Capetown	1.00000	1.00000	1.000
South Africa- Port Elizabeth	1.00000	1.00000	1.000

Tanzania-Dar Es Salaam	0.33423	0.85500	0.391
Togo - Lome	0.53154	1.00000	0.532

In 2002, six out of 12 ports operated with scale efficiency; these were Djibouti, Damietta, Tema, Abidjan, Elizabeth and Cape Town. The rest showed signs of less than scale efficiency to varying degrees. The number reduced to five ports with optimal scale efficiency in 2004 and increased to six in 2006.

Table 14 Assessment of Scale Efficiency - 2004

COUNTRY	**CRS**	**VRS**	**SCALE CRS/VRS**
Benin-Cotonou	0.98847	1.00000	0.988
Djibouti	0.44601	0.95322	0.468
Egypt-Damietta	1.00000	1.00000	1.000
Ghana- Tema	1.00000	1.00000	1.000
Ivory Coast - Abidjan	1.00000	1.00000	1.000
Kenya- Mombasa	0.73643	1.00000	0.736
Nigeria -Apapa	0.49967	1.00000	0.500
Mauritius- Port Louis	0.74703	0.95833	0.780
South Africa-Capetown	1.00000	1.00000	1.000
South Africa- Port Elizabeth	1.00000	1.00000	1.000
Tanzania-Dar Es Salaam	0.44240	0.86498	0.511
Togo-Lome	0.96193	1.00000	0.962

Table 15 Assessment of Scale Efficiency - 2006

Country	**CRS**	**VRS**	**Scale CRS/VRS**
Benin-Cotonou	1.00000	1.00000	1.000
Djibouti	1.00000	1.00000	1.000
Egypt-Damietta	0.53083	1.00000	0.531
Ghana- Tema	1.00000	1.00000	1.000
Ivory Coast - Abidjan	1.00000	1.00000	1.000
Kenya- Mombasa	1.00000	1.00000	1.000
Nigeria -Apapa	0.34419	0.95041	0.362
Mauritius- Port Louis	0.55153	0.94262	0.585
South Africa-Capetown	1.00000	1.00000	1.000
South Africa- Port Elizabeth	1.00000	1.00000	1.000
Tanzania-Dar Es Salaam	0.65388	0.91098	0.718
Togo-Lome	1.00000	1.00000	1.000

Table 16 Comparison of Scale Efficiency from 2002-2006

Country	2002	2004	2006
Benin-Cotonou	0.608	0.988	1.000
Djibouti	1.000	0.468	1.000
Egypt-Damietta	1.000	1.000	0.531
Ghana- Tema	1.000	1.000	1.000
Ivory Coast - Abidjan	1.000	1.000	1.000
Kenya- Mombasa	0.601	0.736	1.000
Nigeria -Apapa	0.795	0.500	0.362
Mauritius- Port Louis	0.942	0.780	0.585
South Africa-Capetown	1.000	1.000	1.000
South Africa- Port Elizabeth	1.000	1.000	1.000
Tanzania-Dar Es Salaam	0.391	0.511	0.718
Togo-Lome	0.532	0.962	1.000

The interesting thing about these results was the fact that some of the ports attained and lost optimal scale intermittently. It was not necessarily continuous during the review period even if the ports were privatized. Ports which maintained scale efficiency throughout all the review periods were Tema, Abidjan, Capetown and Port Elizabeth. The Ports of Cotonou and Lome operated below scale efficiency but at an increasing rate and finally achieved scale efficiency in 2006. The ports with the poorest results were Port Louis and Dar es salaam. Port Louis continuously showed decreasing returns to scale indicating capacity or size constraints.

In spite of the results above, it is important to make allowances for various other influential factors that affect the performance of ports. In Kenya for example, political instability initiated the shutting down of container handling operations for a period. In Ghana during the national power crises through the drying up of the Akosombo dam the major power source for the country resulted in power rationing all over the nation, which also affected port operations.

Though there may be different types of efficiency e.g. allocative, technical etc. There is interrelation between them all. And the final effect will eventually influence the general performance of a port, which is related invariably to its economic performance and its general existence irrespective of other broad objectives.

Furthermore, efficiency levels vary or fluctuate with time. The significant thing over the three review periods is not necessarily increase in size or amount of equipment but some times types and combinations of equipment used by the ports. For instance, in 2002 some ports had a very high number of yard equipment which sometimes comprised lots of forklifts and some reach stackers; however, in 2006 there was a slight increase in the use of larger capacity equipment eg straddle carriers or rail mounted gantries depicting an advantage in the use of stronger quicker and perhaps bigger equipment with more capacity than the prior use of minor ones which would take a lot of space. This could be an indication of the purposes of privatization for the various ports i.e. not necessarily a matter of expansion for its sake but rather to increase efficiency which is subsequently expected to produce a multiplier effect by generating more traffic . Finally, more ergonomic combinations of quay transfer and yard equipment can be made.

Though this sample size meets the recommended size of being at least twice the number of inputs or outputs, it is still not the best number to ensure the best results for a regional or continental analysis. However, the results indicate that depending on existing and potential container throughput levels, private intervention through provision of facilities and facilitation of expansion of port capacity may make the difference between the kind of benefits and operational levels a port achieves in terms of decreasing, constant or increasing returns to scale.

The next chapter narrows down the study to the assessment of the performance of individual decision making units through a review of key port performance indicators.

5. Measuring Efficiency Using Port Performance Indicators

5.1. Importance of Port Performance Indicators

Port performance indicators serve as a means of recording port activities within periods, i.e. days, weeks, quarters etc. Indicators can be defined as being "measures of various aspects of port operations" (UNCTAD, 1995). Indicators enable ports to assess the performance of their various activities, on ship at berth and even within the port, in order to monitor and ensure that the correct mix of labour, capital and technology is being used to achieve targeted or actual output. This is actually the heart of every economic decision, i.e. determining the proportion of available resources necessary to produce the required level of output which has been described as allocative efficiency (Song et al., 2001a).

Effective planning and controlling of port activities is facilitated by the use of port performance indicators (UNCTAD, 2007). It serves as a means of thoroughly assessing performance of different areas within the same framework of port activities which enables quick identification of problem areas or areas of potential. This enables planning related to core services, such as vessel handling, stevedoring and shore handling, which depend greatly on indicators, such as crane output, gang output, waiting and idle time indicators. Control, responsibility and accountability in operations are also enhanced when management is able to use the indicators to set benchmarks for labour performance or measure actual against targeted performance (UNCTAD, 2006). More importantly the indicators illustrate actual and not perceived port performance which remains a significant interest to stakeholders.

Potential investments in port infrastructure, superstructure and terminals, are based on information analyzed from key port performance indicators. Present and

forecasted operational capacity assessed from collected indicators determines the level and type of financial or capital investments required in different ports (Cariou, 2008b).

Performance indicators serve as a basis of intra institutional comparison, e.g. between different ports or container terminals. There are various difficulties related to intra port comparison, e.g. geographical and institutional differences (Bichou & Gray, 2004). However, some common parameters which enable comparison can be found in the use of port performance indicators. This also benefits nations as a whole by enabling them to assess and take decisions on what strategies to employ to improve or maintain the position of their ports in relation to changing global trends based on the results derived from port performance indicators.

The use of indicators is not limited to the maritime or port industry but to every industry which aims to improve efficient and effective performance in diverse ways. The airline industry applies both singular and multiple indicator approaches to measure its performance (Oum & Yu, 2004).

5.2. Types of indicators

Micro performance indicators compare port performance based on inputs and output combinations. Under this category one can place the various indicators under four broad headings; operational, financial, commercial and social indicators (UNCTAD, 2007). These methods of port comparison are more concise and fall within the criteria indicating that selection of indicators in any field of activity should be based on the following factors: “Comparability, Relevance and Materiality, Verifiability Reliability and Understandability” (UNCTAD, 2008c). The simple indicators which measure specific areas of port operation fall within these parameters since they are easy to understand, calculate and analyze. The debated disadvantages are the perceived narrowness of the indicators since they focus on the performance of a

single operational activity within a period of time. This in itself may not quite be a disadvantage since the efficient or inefficient performance of one activity in the port operations chain will determine the performance of activities within the system which still makes it a significant method of analysis.

Table 17 below summarizes some of the broad categories under which KPI's have been placed by different authors:

Table 17 KPI Broad Categories

UNCTAD 2007	Bichou and gray 2004	Comments
operational	Physical	time measures for ship or land transport
commercial	Factor and productivity	maritime focus
Financial	Economic and financial	sea access, impacts on national and hinterland
Social		

Source: UNCTAD, 2007, Bichou & Grey, 2004

Though the various headings may have slightly different terminology, they basically cover the same theme. Another point to note is that the categories do not necessarily remain exclusive. Factor productivity indicators may serve as operational indicators to different ports or groups. Alternatively port performance may be assessed or compared on the basis of its throughput, or cargo traffic, in relation to its actual operational capacity (Talley, 2006). However, it is clear that this approach would still incorporate the use of other productivity indicators since throughput optimization or capacity is not mutually exclusive from the number of berths, cargo handling equipment, storage area and other related port infra and supra structure.

5.3. Introduction to case studies

Discussions in previous chapters established that the major drive for implementing privatization as a strategy of port reforms is the drive to generate efficiency in port operations, not only to keep up with the competition, but also to ensure continuous business by keeping customers satisfied (Tongzon & Heng, 2005). The question is whether these strategies have actually succeeded in generating this effect and whether this can be effectively determined given the availability of data and other influential factors. This chapter focuses on two African case studies which have applied varying degrees of privatization and attempts to review probable effects in areas which are directly influenced by these strategies.

In a survey of African ports the following major reasons for opting for privatization were stated (UNCTAD, 2003a):

- Improvement of productivity and efficiency - 45%
- Cultivate an environment for future private investment - 25%
- Reduction in costs in the port and ultimately the maritime logistic chain - 20%
- Infuse modernization into port infrastructure and superstructure - 17%

The significant thing which cuts through all these reasons for encouraging private sector participation is the implication of an aim to improve by either increasing positive features or decreasing the negative which in effect is the creation of "efficiency". The statements above in effect indicate that the ports expect the privatization strategies to ultimately attain efficiency by increasing output and simultaneously maximizing the use of inputs (Estache, González, & Trujillo, 2002).

Ports' perception of efficiency may vary with the role they play in their region, the type of services provided, and the over all mission or vision of the port. In all cases

however, the common aspect is efficiency in operations as this will in turn ensure quicker service, making the port more attractive to callers and subsequently increasing throughput, i.e. cost- and technical efficiency (Talley, 2006). This chapter comprises an assessment of selected ports, using Key Performance Indicators in a singular port approach (Talley, 2006). The analysis focuses on port performance within a specified period and determines productivity based on the increase or decrease of trends in the various categories, e.g. throughput and berth productivity. One would expect notable improvement in these indicators, i.e. an increase in positive indicator figures or a corresponding decrease in negative indicator figures etc. Is this really the case, or are there other influential factors that may affect the results due to the differing nature of each specific ports situation? Ports studied in this chapter, i.e. ports of Tema and Dar es Salaam are multipurpose ports, and though indicators are very broad, and may cover virtually every aspect within the port system, the assessment here is done in areas in which the investment infusion from privatization possibly has a direct impact. For example, technical innovation through additional equipment, plus the infusion of technical know how and operating skills and managerial innovation.

5.4. Ghana case study on key port performance indicators

5.4.1. Background

Tema Port is a multipurpose port located on the coast of Ghana West Africa. The port is made up of 12 berths and two quays with draughts ranging from 9-11.5 metres. Tema Port, which handles 70% of Ghana's seaborne trade, is one of the ports under the administration of the Ghana Ports and Harbours Authority, and was a service port with purely public albeit autonomous administration prior to year 2000. Even within that period there was some form of private sector participation since certain subsidiary services such as cleaning and ship chandler services were outsourced to local private entrepreneurs. Privatization of core port services through

port reforms started taking place in 2000 under the gateway project which has the vision of making Ghana the gateway to West Africa under the nation's vision 2020 policy project. Projects to transform the port into a more productive institution included among others an infusion of investment into information technology through the execution of the Ghana community net, which is a web interface connecting the port and various stakeholders, such as customs, to facilitate quicker shipping and clearance services. There was further public investment in an off dock devanning yard, which is being run by the port authority as a small business unit for; devanning, i.e. stuffing and unstuffing of less than full container loads, empty container storage, uncleared cargo or state warehouse facilities, and storage of imported vehicles. In addition, several licenses have been given to various private off dock container yards called Inland Clearance Depots, (ICDs) to decrease port congestion. Currently the following companies are running the ICD services: Maersk Container Terminal, Tema Bonded Terminal, African Coastal Services, Safebonnd Company Limited and Atlas Ghana (GPHA, 2006).

When it comes to core port services, 75% of stevedoring and 100% of shore handling are being run by private enterprises paying royalties of 25% and 10% respectively to the port authority (Josiah, 2003). Presently one shore and cargo handling company and 10 stevedoring companies are currently operating within the port of Tema. The cargo handling company Safebond Ghana is part of the Safebond Africa group, as well as a subsidiary of Carl Tiedemann Ltd. With regards to container handling, the privatization strategy primarily consists of BOT concession agreements between APM Terminals, Bollore/Sdv Ghana, Bouygues Traveaux and the Ghana Ports and Harbours Authority. In 2007 the container terminal was fully transferred to private management and operation of the group above under the name Meridian Port services in a 20 year concession agreement. On a broader level, the transfer was expected to provide expertise in port operations, some level of employment and additional training and investment in equipment and information technology (Ghana Ports and Harbours Authority, 2007). The capital and technical infusion from the

investment would gradually consist of an amount of 89 million dollar investment in infra and superstructure comprising among others the following (Gyebi-Donkor, 2007)

:

- 25.5 hectares terminal back-up area leased from GPHA
- 4 ZPMC Panamax gantry cranes (STS) (3 commissioned May 2005, 1 delivery 2009)
- 8 ZPMC Rubber Tyred Gantry cranes (RTG) (4 commissioned May 2005, 4 delivery 2009)
- 12 Reach-Stackers, 45 tonnes
- 4 Empty-handlers, 15 tonnes
- 40 terminal tractors (30 delivery mid-2007, 10 delivery 2009)
- 45 terminal chassis (33 delivery mid-2007, 12 delivery 2009)
- 24 Utility vehicles and fork-lift trucks
- 8-lane gate complex
- Office and ancillary buildings
- Workshops
- 336 reefer plugs (expandable to 496)

The port's major markets consist of the local Ghanaian market, the hinterland, comprising mainly Burkina Faso, Niger and Mali, and a transhipment market.

Table 18 Tema Port Ranking within African ports

YEAR	RANK
2001	12
2002	10
2003	9
2004	9
2005	7
2006	7

Source: Degerlund, 2001; Degerlund, 2002; Degerlund, 2003; Degerlund, 2004; Degerlund, 2005; Degerlund, 2006; Degerlund, 2008

Figure 5 Tema Port, Ghana
Source: Meridian Port Services, 2008

With regards to the nature of privatization applied from the year 2000, the indicator analysis will focus on operational and productivity indicators which are directly related to the change in management and administration of stevedoring and shore handling as well as assessing its impact on total general port indicators. The pre and teething stages for privatization related to stevedoring activities will be considered with data from 1998 to 2002 with post privatization based on available data from 2003 to 2007. The data used in the analysis was provided by the ports from the data base. Tema Port General Performance Indicators (GPI) prior to, and after the application of privatization strategies, were the following, summarized below in table 19.

5.4.2. Tema Port GPI 1998 to 2007

An overview of GPIs from 1998 to 2002 indicated general yearly increases while from 2002 to 2007 vessel traffic and container traffic did rise significantly. However, there were fluctuations with general cargo traffic. The transshipment and transit sectors picked up steam in 2000 and, excluding 2005 when the building of a new container terminal affected figures, showed significant increases. Certain important

and influential factors that also affected results within the sample privatization years were the following:

- Actual private dredging activities were simultaneously being done on quay 1 in 2000 and 2003
- Construction of the terminal, pavements rails for gantry's etc were being done
- The use of the Gantry cranes
- The initiations of the offshore SPM in 2007 – due to new partnerships, some vessels were handled at the offshore SPM accounting for the reduction of calls within the main port..

Table 19 General Port Indicators

Description	Vessel calls	Cargo traffic	Container traffic	Transit	transhipment
1998	1095	5,417,112	169,687		--
1999	1190	6,368,539	197,900		--
2000	1163	6,219,517	166,963	144,973	17,715
2001	1169	6,314,968	178,342	261,251	38,165
2002	1272	6,841,481	223,377	627,773	151,233
2003	1172	7,391,268	305,868	855,093	138,520
2004	1381	8,447,655	342,882	763,993	43,587
2005	1642	9,249,977	392,669	875,325	155,815
2006	1994	8,046,838	425,408	887,589	339,841
2007	1672	8,378,682	495,427	843,656	119,728

Source: Tema Port Data Base

5.4.3. Key Performance Indicators

Though general performance was relatively positive, a closer look at various key performance indicators shows the actual performance in various areas, e.g. vessels, output, labour and crane performance.

5.4.4. Conventional Vessels

This category comprises all general cargo vessels stevedored at the common user and multipurpose berths. Performance in terms of time indicators prior to 2000 showed a continuous decrease in vessel calls with unexpected increases in turn around and waiting time. Figure 6 shows that there was a noticeable reduction in turn around time from 2004 to 2006, while the decrease in waiting time was even more significant since it corresponded with increases in conventional vessel calls especially from 2005 to 2006. This was probably because conventional berths were becoming more available for quick service when pure container vessels could start moving towards the new container terminal. Regarding output productivity there were fluctuations all through the periods under review, both pre and post privatization. However, average output per ton/workday was 61/2259 tons in the first 5 years and reduced to 57/2123 in the latter 5 years. One could attribute this performance from 2002 to 2005 to the reduction in conventional vessel calls or the ongoing construction activities, but there was a reduction in tonnage output. This however improved greatly from 2006 to 2007.

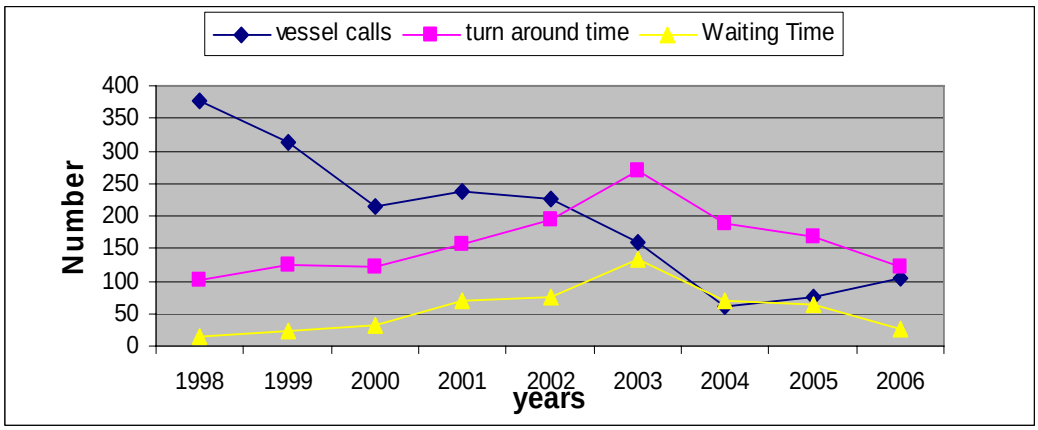

Figure 6 Conventional Vessel handling trends
Source: Tema Port Data Base

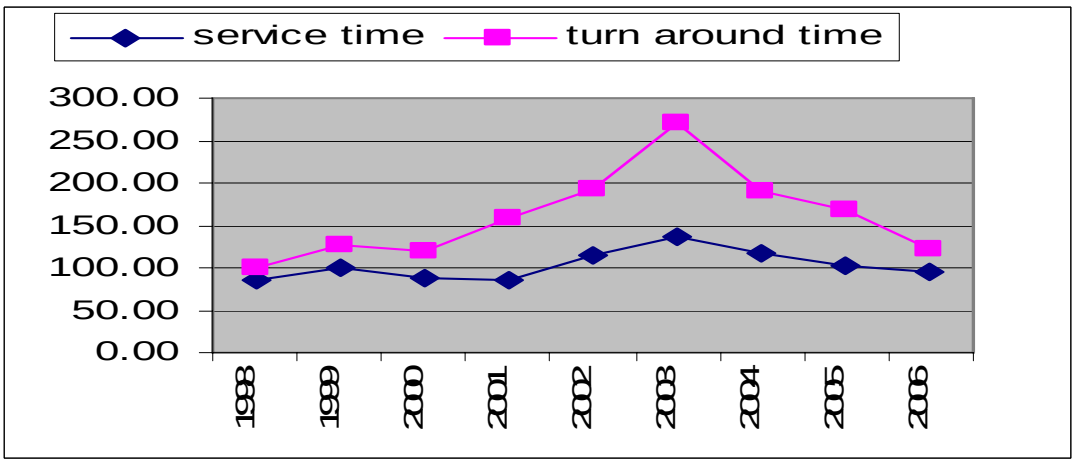

Figure 7 conventional vessels: comparison of service time and turn around time
Source: Tema Port Data Base

Table 20 Conventional Vessel Output Productivity

YEARS	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Tonnes per ship hour at berth	65	64	63	54	61	58	50	60	49	67
Tonnes per ship work day	2262	2259	2260	2258	2257	2253	2016	2200	1638	2509

Source: Tema Port Data Base

5.4.5. Container Vessels

The new privatized container terminal consists of two dedicated berths with draughts of 11.5-12 meters and two common user berths with draughts of 10 and 8.5 meters respectively. As at 2007 actual equipment capacity on the container terminal comprised:

- 3 ship to shore gantry's
- 4 rubber tire gantry's
- 12 reach stackers
- 4 empty container handlers
- Ancillary lifting equipment and utility vehicles (Ghana Ports and Harbours Authority, 2007).

However, it is important to note that operations were still being handled by the port authority prior to 2007, although other stevedoring companies handled containers at the common user berths. Tables and figures below show berth output indicators and productivity indicators related to container handling within the whole Tema Port.
The first part in Table 21 shows output productivity indicators for container handling within the whole port. There does not seem to be much difference between the two periods at a first glance; however, average output in the first five years was 11/290 per ton per work day and 12/298 per ton per workday in the five years under ongoing port reforms. There is again in this category as a whole some minor improvements which may not be as much as expected because of factors like time needed for technical and innovation transfer to crane operators as well as the national power crises which affected the whole country between 2006 and 2007. In view of these factors, it is important to note that it would not be possible to get a completely fair indication of performance within that period.

With respect to time efficiency an indicator assessment will be done according to some of the different categories of container vessels handled within the port. These include Reefers and Cellular container vessels.

Table 21 General overview ship output per hour and day

DESCRIPTION	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Boxes per ship hour at berth	12	10	11	12	12	13	12	12	11	11
Boxes per ship work day	292	290	290	289	289	279	329	315	285	284

Source: Tema Port Data Base

5.4.6. Cellular Container Vessels

The number of vessel calls rose consistently within the two review periods at an average rate and within the first and second five year period respectively. Service time/ time at berth fluctuated while the time in port increased sharply from 2005 due in part to the construction of the container terminal and closure of its berth 1 and 2 which invariably caused a level of queuing. This is illustrated in Figure 9 which shows the service time curve levelling off and beginning to fall in 2007 while the waiting time curve uncharacteristically rises.

Table 22 Summary of Cellular Container Time Indicators in Hours

YEARS	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
vessel calls	276	325	275	316	421	468	438	440	551	560
time at berth	29.02	24.70	21.90	26.75	25.30	31.05	35.74	44.60	46.92	43.00
time in port	33.69	31.66	30.77	41.51	42.73	59.63	59.61	70.28	78.65	82.44

Source: Tema Port Data Base

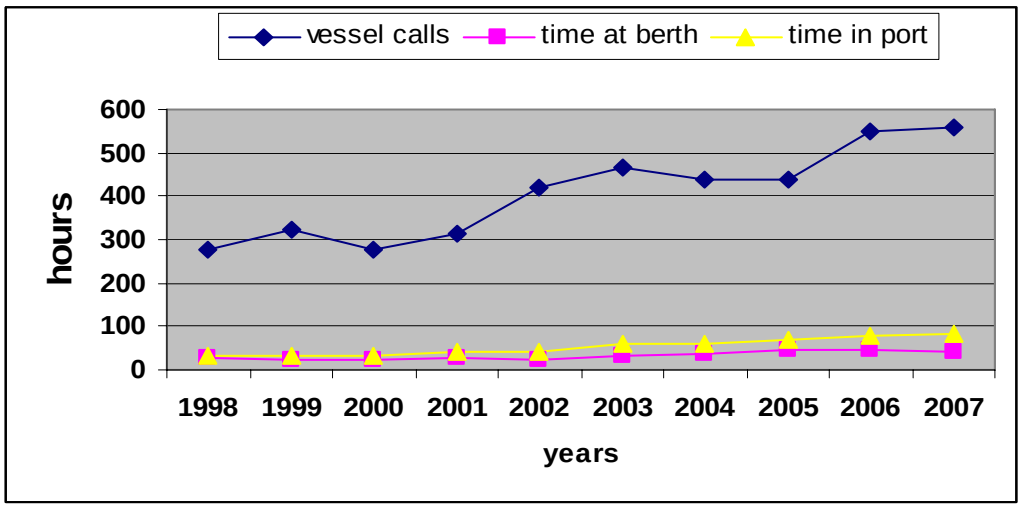

Figure 8 cellular vessel time indicators
Source: Tema Port Data Base

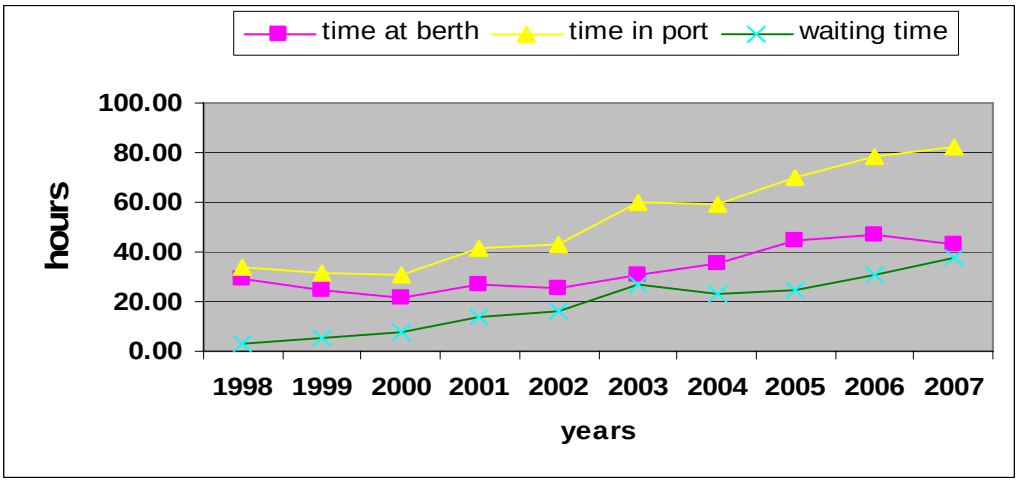

Figure 9 cellular vessel time indicators B
Source: Tema Port Data Base

5.4.7. Reefer Container Vessels

This category of vessel traffic had one of the most efficient service and turn around times in port, always less than a day. In the first period, 1998-2002, and the beginning of the second period 2003, average service time and turn around time decreased simultaneously with increases in vessel numbers. The decrease in

productivity in 2004 and 2005 may be attributed to the construction of the container terminal at the berths with deepest draught which explains the slight fall in vessel traffic and the increase in turn around time as these vessels had to be serviced at multipurpose berths. During that period, i.e. 2004 and 2005 the reefer vessels had an average grade of waiting of 21% to 48% this however began to improve immediately after 2005 as shown in table 23 and figure 10 below.

Table 23 Summary of Reefer Container Time Indicators in Hours

Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
vessel calls	0	0	74	76	98	105	99	95	111	123
time at berth	0	0	12.31	11.06	11.07	13.67	17.18	38.76	33.93	18
time in port	0	0	9.76	8.90	8.57	8.14	13.37	25.53	23.48	21.49

Source: Tema Port Data Base

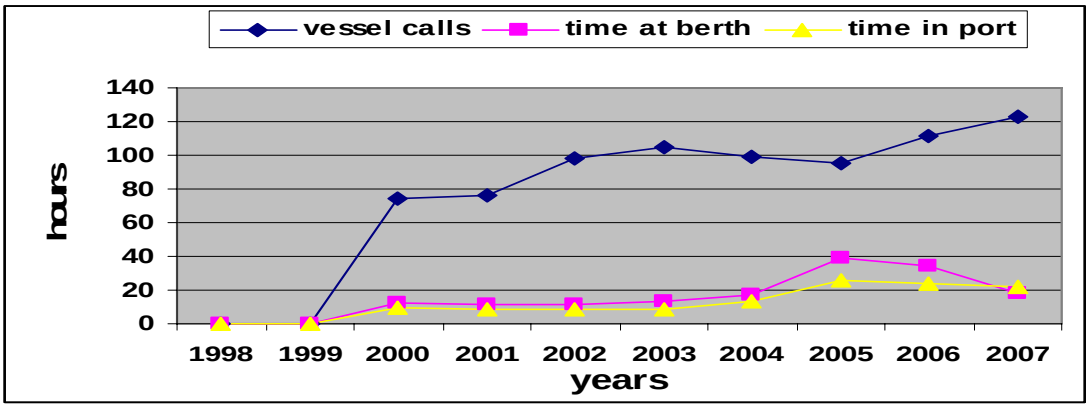

Figure 10 Reefer Vessels Service and Turn Around Time Indicators
Source: Tema Port Data Base

5.4.8. Bulkers

The bulk products which come through Tema Port are the direct result of the business activities of a limited number of companies. The vessel trends, i.e. growth or decline, in this category therefore depend on the activities of the contracting companies. Commodities in the major bulk group are comprised of clinker,

limestone, gypsum and alumina. Performance of the service time in this category both in the pre and post period was mainly influenced by load levels. After the construction of the container terminal in 2005, the port has subsequently been able to dedicate berths for bulk activities.

Table 24 Summary of Bulk Vessel Time Indicators in Hours

Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
vessel calls	78	74	68	74	76	88	92	130	98	106
time at berth	101.08	139.61	91.85	98.59	87.09	122.98	104.91	125.25	119.37	135
time in port	114.67	166.08	116.54	128.85	122.20	207.05	142.89	179.71	155.84	173.36

Source: Tema Port Data Base

Figure 11 illustrates the performance of the different bulk product categories.
These comprise agricultural bulk products, mainly cocoa and shea nuts, which are usually exported. That product trend is more or less constant. Dry bulk grains consist of wheat and other similar produce which are mainly imports, and finally dry bulk ghacem are those mentioned earlier, e.g. clinker. These cargoes are discharged mainly by hoppers but agri and dry bulk grains are handled at separate berths, and dry bulk Ghacem at its dedicated berth.

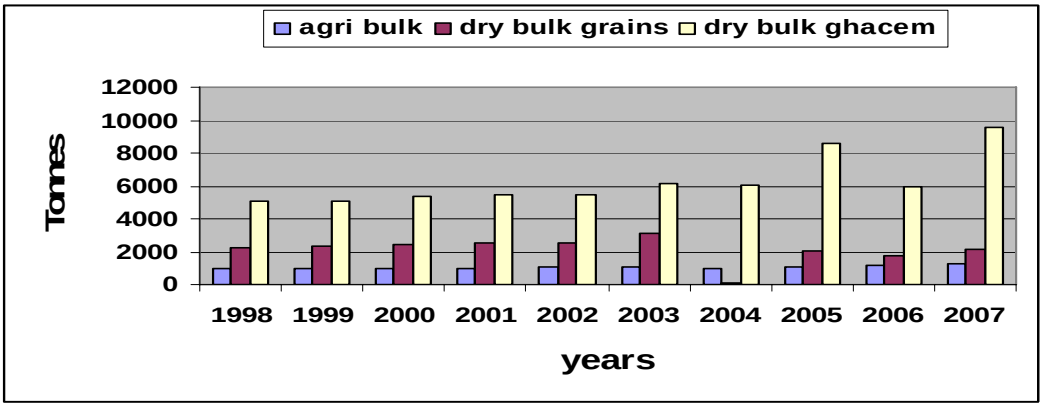

Figure 11 Performance of Dry Bulk Categories
Source: Tema Port Data Base

5.4.9. Idle time

Total turn around time and all other time performance indicators discussed are mainly influenced and determined by the level of idle time. With respect to Tema Port, idle time is computed on the basis of causative units at each period of time. An assessment of these components indicate that though the port's service time improved in most of the cases, there still remains a significant difference between service time (productive time at berth) and total turn around time in port due to the levels of idle time.. The major causes of idle time levels comprise the following:

Category A are those directly or partly under port control:

- Waiting for and break down of cranes or equipment
- Labour shift changes
- Stevedoring preparation of trucks and equipment
- Unavailability of berths
- Waiting for lorries, barges or storage facilities (CARGO)

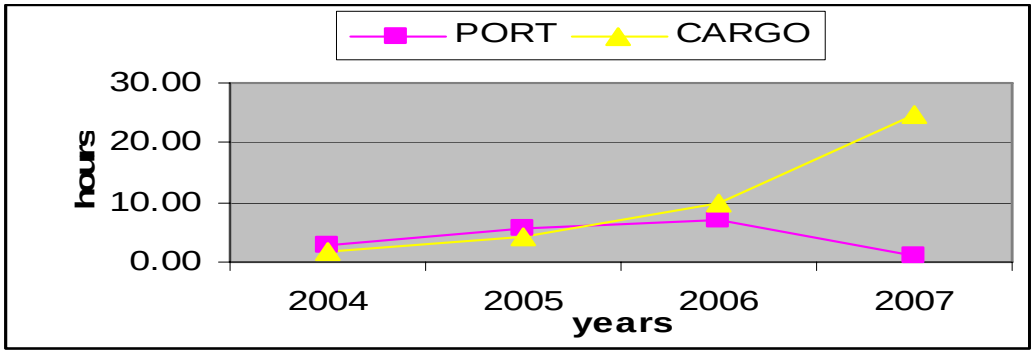

Figure 12 Port related idle time
Source: Tema Port Data Base

Table 25 Ports and Cargo Related Idle Time

YEARS/HOURS	2004	2005	2006	2007
PORT	2.99	5.58	6.93	1.15
CARGO	1.71	4.27	9.74	24.55

Source: Tema Port Data Base

These factors are directly related to stevedoring and shore or cargo handling. There was significant reduction in idle time related to core port activities especially from 2005 to 2006. The remaining problem in this category is however attributed to waiting for lorries, which suggests some problems with direct delivery operations and insufficient storage facilities. It is however necessary to note the related increase in cargo levels as well.

Category B are other interrelated institutions involved in port operations where the port has only negotiating influence:

1. Ship delays related directly to the vessel, captain and owners decisions.

- Delays pending instructions from cargo interest
- Laying or lifting of dunnage

- Ship gear break down
- Bunkering, ballasting / de-ballasting
- Trimming, warping, shifting and cleaning

2. Customs -delays from waiting for customs
3. Port health -delays from waiting for health clearance
4. Others -delays from acts of God e.g. weather.

Figure 13 shows a summary of other components affecting idle time:

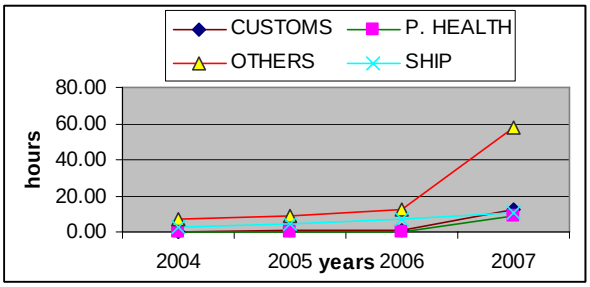

Figure 13 other idle time components
Source: Tema Port Data Base

Table 26 summary of other idle time components

YEARS/HOURS	2004	2005	2006	2007
SHIP	2.74	4.62	6.93	10.51
CUSTOMS	0.43	0.55	0.72	12.65
P. HEALTH	0.01	0.00	0.07	8.60
OTHERS	6.72	9.20	12.47	57.94

Source: Tema Port Data Base

The latter category of idle time illustrates the importance of all parties within the maritime service supply chain. Improvement in the ports operational activities is actually negated by these other groups, which ultimately increases the total idle time and affects the port's efficiency, after subtraction of the navigational and waiting time components idle time.

5.4.10. Hinterland Business Effects

The last section of the assessment of Tema Port's KPI's takes a look at the transit business to assess whether there have been any notable effects since the onset of the privatization schemes. Tema Port's hinterland market is mainly comprised of Burkina Faso, Mali and Niger. The business visibly picked up in 2000 during a period of political instability in the Ivory Coast. Most of the transit clients subsequently moved business to Tema Port and the port has successively been working to keep them. Some of these measures include:

- Construction of a transit truck park
- Provision of office spaces for shipping representatives from the respective countries
- Concessionary tarrifs for transit cargo storage
- The ongoing construction of an inland port at Boankra within the Ashanti region of Ghana.

One significant difference here is that the port authority is the forerunner of all these projects; however, with some level of liaison with private enterprise. Figure 14 indicates continuous growth till 2003 after which some fluctuation occurs. This may to a large extent be influenced by regional competition for the transit trade between Tema , Togo, Benin and Ivory Coast.

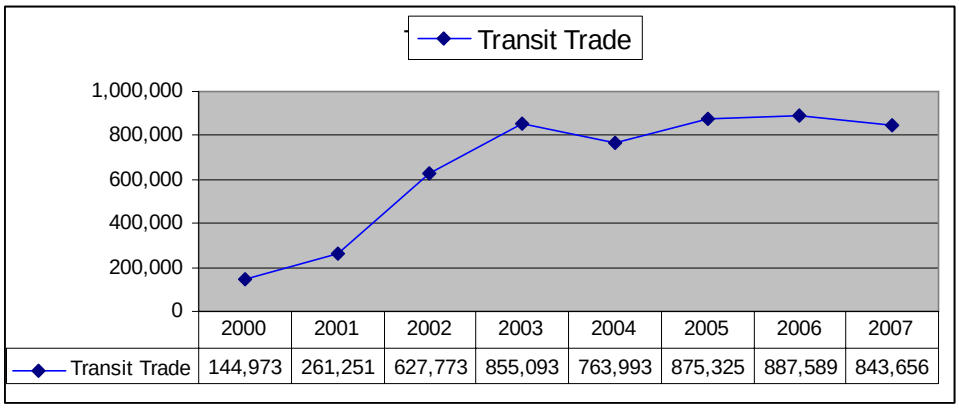

Figure 14 Transit Trade Trend
Source: Tema Port Data Base

It is important to note that the major aim of the Ghanaian port privatization strategy was to separate the operational and regulatory functions of the port. This was done successfully; however the assessment of efficiency is not very conclusive given the time range as well as other influential factors such as the national power crises which affected all industry intermittently within 2004 to 2007. This may account for the fluctuating nature of the results.

5.5. Tanzania – Port of Dar Es Salaam

This section will assess a second case study with slightly different characteristics. For this case study the analysis will be limited to container handling, which was the major area of port operation with private sector infusion within the period under review.

Figure 15 Tanzania Container Terminal

The port of Dar Es Salaam is also a multipurpose port located on the coast of East Africa. The port has 11 berths, a jetty and single point mooring (SPM) with draughts ranging from 9 to 12 meters. In addition to the country's locality, it also serves other countries such as Malawi, Zimbabwe, Uganda, Rwanda, Zaire and Burundi (Lloyds Register, 2007). The port comprises 158,200 square meters of open and closed storage and 120,000 square meters container storage, as well as two off dock inland depots. One significant infrastructural installation is the railway linking the port to its major transit destinations i.e. some of the countries mentioned above. The port established major port privatization reforms in 2000 through a concession agreement with ICSI/HPH expected to provide an investment of 65,000,000 dollars (UNCTAD, 2003a). The consortium which initially included a Philippine group in collaboration with a Tanzanian entity (Vertex Financial Services), and subsequently Hutchinson port holdings, operates the container terminal, while the port authority still handled general cargo operations as of 2007 (Mbuli, 2007). The reforms are gradual and ongoing and not limited specifically to the port but also include related institutions, e.g. inland transport, since these have problems which invariably affect the whole supply chain. The proposal for port reforms actually started in the late 1970s when the government had identified the need to expand and improve operational efficiency (Meilink, 1992). Public service reforms and private sector participation is the proposed catalyst for Tanzania's vision 2025. In most cases, private sector participation is limited to the operation of services and infrastructure through leases or concession agreements, with government retention of ownership rights (World Trade Organization, 2006). Meilink further indicates that currently there is greater private sector in Tanzanian maritime transport with the exception of the port authority which is state owned and is working towards assuming a landlord port authority role, while gradually privatizing other commercial port services. Data used in this analysis was derived from annually published statistics. For this analysis pre privatization period will be period A (1992-1999) and the post privatization is Period B (2000-2006) from the beginning of the concession agreement.

5.5.1. General performance indicators

This section reviews the general performance of the various categories in table 27. The performance of general cargo traffic before the onset of the reform period was quite erratic. For example cargo traffic growth ranged from -9% in 1994 to 12% in 1995 and -19% in 1996. After 2000 however, there was a yearly average growth of 9% i.e. from (2000-2006) this ranged from a growth of 10% in 2001 to 14% in 2003 and 5% in 2006. Container traffic, on the other hand, had an average growth rate of 3,5% within 1992-1999 and 13% within 2000-2006. The vessel call category is quite interesting. Numbers did not necessarily increase much in the post privatization period. This may be as a result of either positive reasons such as dredging at the new container terminal generated slightly larger vessel calls thereby reducing the number of smaller ones or secondly port congestion may be affecting clients who perhaps may have withdrawn or diverted to neighbouring competitive ports (Port News Agency, 2008; The Citizen: Tanzania, 2008).

The performance of transhipment traffic trade may have been influenced by competition from neighbouring ports and the problem of congestion which apparently caused some shipping lines to issue ultimatums of withdrawal due to costs incurred from delays (Port News Agency, 2008).

Table 27 Summary of General Port Performance Indicators

Year	cargo traffic	(TEU's) Container traffic	Vessel Calls	(TEU's) Transhipment
1992	4,702,375	86,961	2,610	234
1993	4,632,697	97,755	2,734	260
1994	4,198,148	90,448	4,915	824
1995	4,686,287	98,559	5,538	265
1996	3,794,209	98,906	6,175	22
1997	4,525,517	103,486	6,156	25
1998	4,042,437	109,546	6,152	8,916

1999	4,075,730	108,158	5,893	2,194
2000	3,836,168	124,648	5,240	1,980
2001	4,271,574	141,720	3,746	6,280
2002	4,524,508	153,796	3,881	12,409
2003	5,168,964	186,117	3,912	18,319
2004	6,054,030	227,114	4,494	27,790
2005	6,371,974	258,389	4,486	29,661
2006	6,689,175	272,700	4,198	30,453

Source: Tanzania Port Authority, 2007

5.5.2. Key Port Performance Indicators

This section assesses the performance of operations in conventional and container cargo handling by reviewing the time and output indicators.

5.5.2.1. Conventional Cargo

Table 28 Conventional cargo time indicators

Year/days	Waiting time	Service time	Turn-round time
1992	1.1	6.9	8
1993	1.1	5.7	6.8
1994	1.1	6	7.1
1995	0.8	6.3	7.1
1996	0.6	4.8	5.4
1997	1	5.7	6.7
1998	1.1	5.1	6.2
1999	0.8	5	5.8
2000	0.9	4	4.9
2001	0.3	3.4	3.7
2002	0.4	4.3	4.7
2003	0.3	3.2	3.5
2004	0.5	3.7	4

Source: Tanzania Port Authority, 2007

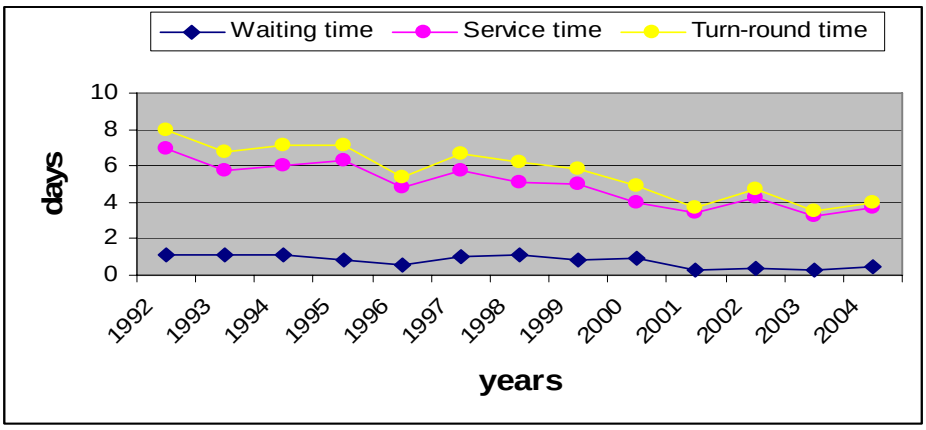

Figure 16 Comparison of time indicators for conventional cargo handling
Source**:** Tanzania Port Authority, 2007

5.5.2.2. Containers

The major privatization infusion from year 2000 was the transfer of the container terminal into private entity operations and management with additional dredging activities.

Table 29 summary of container handling time indicators in days

	Waiting time	Service time	Turn-round time
1992	0.2	1.1	1.3
1993	0.2	1.04	1.24
1994	0.31	1.05	1.36
1995	0.2	1.05	1.25
1996	0.14	1.07	1.21
1997	0.1	1.02	1.12
1998	0.77	1.09	1.86
1999	1.23	1.1	2.33
2000	0.16	1.1	1.26
2001	0.2	0.7	0.9
2002	0.2	0.8	1
2003	0.2	0.9	1.1
2004	0.4	1.1	1.5

Source: Tanzania Port Authority, 2007

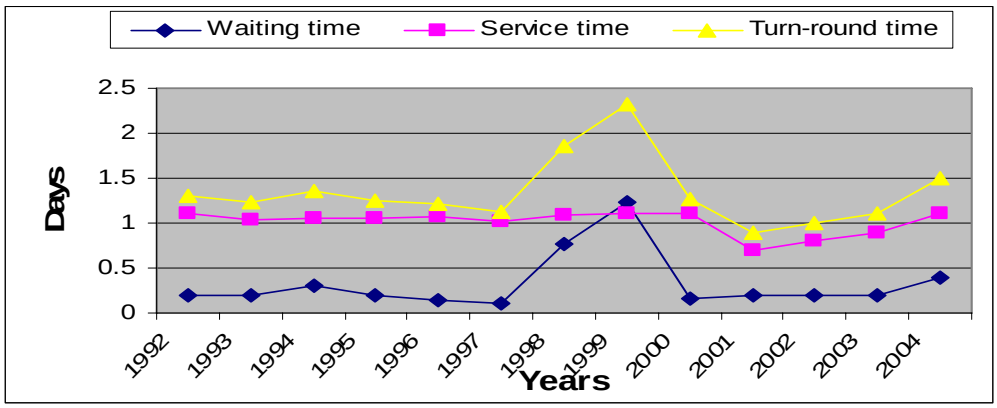

Figure 17 Comparison of container handling time indicators
Source**:** Tanzania Port Authority, 2007

The effects in the case of container handling are evident. Productivity in container handling from 1992 to 1999 was characterized by periodically declining crane output. The average productivity for the eight years prior to the change in ownership was 14 moves per hour. This increased significantly to 21 moves per hour in 2000 to 2004.

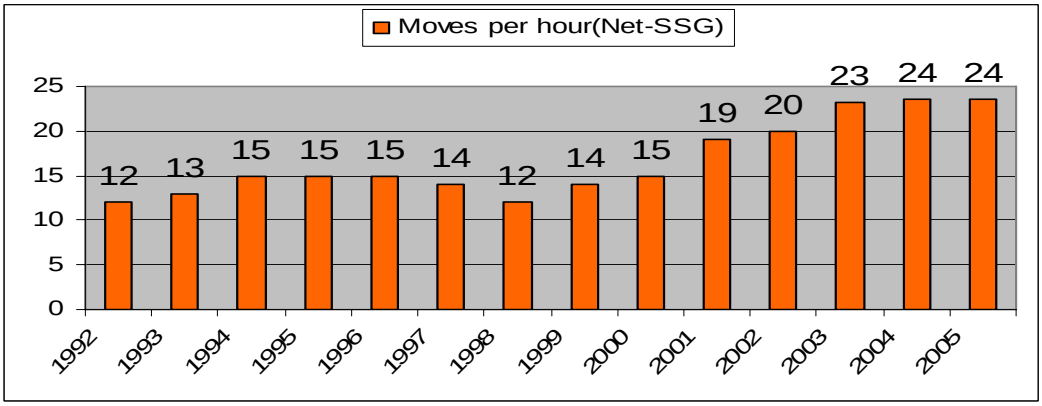

Figure 18 Overview of crane productivity
Source: Tanzania Port Authority

5.5.3. Hinterland Business Effects

The port of Dar Es Salaam serves the landlocked countries: Uganda, Malawi, Burundi and Congo. Various measures were and are still being taken to improve this business segment in the form of trade liberalization through:

- Privatization of transport service provision
- Movement from national transit transport licence to COMESA (common market for Eastern and Southern Africa) transit carrier transport license scheme.
- Foreign investment for the east African road network project. Integrated road program paving from Isaka to Burundi and onwards

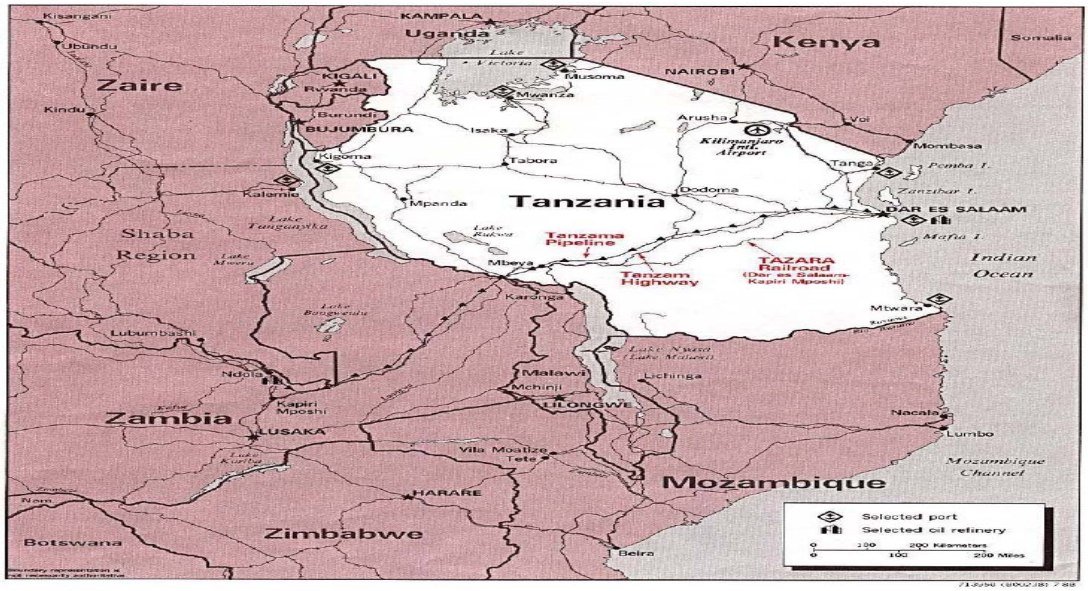

Figure 19 Dar es Salaam Major Transport Routes

Source: Heideloff & Zachcial

It is however difficult to determine if the performance of this segment is influenced directly by the reform strategies or by the simultaneous influence of activities by competitors for this business segment, which includes Kenya. Furthermore, one

major problem faced by Dar Es Salaam in the transit business is the poor performance of railways operated by the Tanzania railway company, connecting hinterland transit destinations. Although there have been alleged attempts to employ the operation of private enterprises it is still unclear as to whether the rail company has been successfully leased out or is still being run by the government. This is in direct contrast to its transit business competitors Uganda and Kenya who have leased their rail service to a single operator (Mbuli, 2007). A summary of the transit traffic performance is illustrated in figure 19.

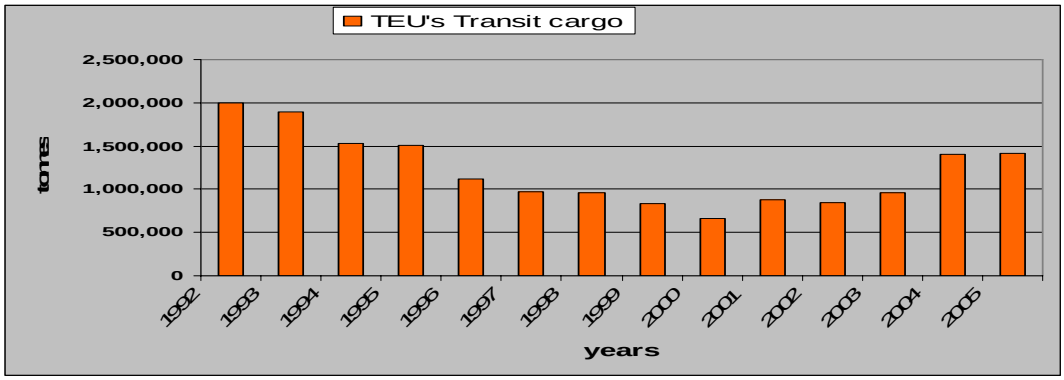

Figure 20 Transit Container Traffic Trend
Source: Tanzania Port Authority

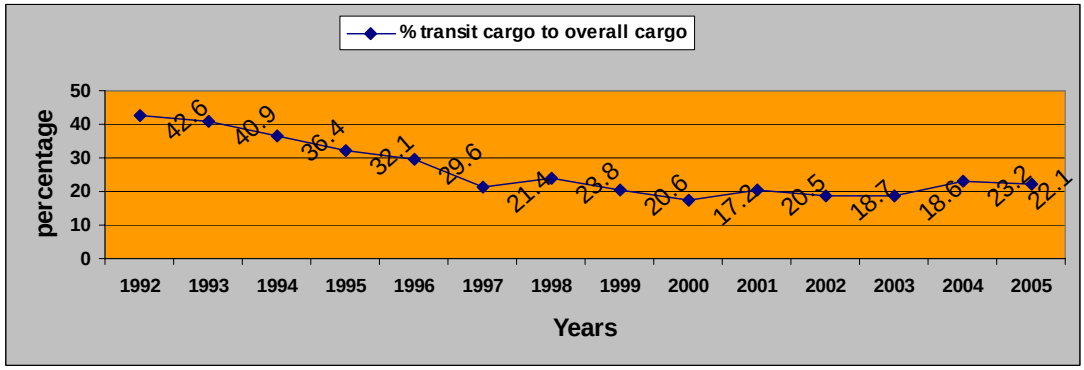

Figure 21 Comparison of transit cargo as a proportion of total cargo
Source: Tanzania Port Authority

There were general improvements after 2000 in this case, however problems existed that were beyond the reach of the private sector. It appears to be problems such as

congestion and unforeseen cargo and container traffic increases caused by political problems within neighbouring competitive nations e.g. Kenya's closure of transhipment traffic operations in the wake of political unrest. These and other problems such as customs clearance problems within the whole maritime supply chain invariably affect the activities of the terminal operators who are characterized by global expertise in this field.

5.6. General Observations

Basically the performance of both ports varied for various reasons within the privatization period. There were some marked improvements and some inconclusive results as well given the time frame especially for container handling in the Ghanaian port which was formally handed over to private management and operation in 2007. However, the aim of this chapter was not to compare ports but to assess the effect on vessel and cargo handling operations within each port's unique nature which was done in the case study analysis.

Table 30 General Observations of Post Privatization Effects in Both Ports

‘ TANZANIA	TEMA
Multipurpose port part of the PMAESA group	Multipurpose port part of the PMWCA group
Application of concession agreements with pre dominantly international operational and management participation	Application of concession agreements international participation pre dominantly international operational and management participation
Decrease in employment levels as perceived by an analysis of the ports in eastern African group which are participating in port reforms through privatization. (UNCTAD, 2003a)	Increase in employment levels determined through analysis of the ports applying privatization reforms in western and central Africa (UNCTAD, 2003a)
Significant increases in cargo and	Significant increases in cargo and

container traffic volumes (GPI Tables)	container traffic volumes (GPI Tables)
Fluctuating but impressive service time indicators	Fluctuating service time indicators
Improvement in operations as determined by African port ranking	Improvement in operations as determined by African port ranking
Other multiplier logistic effects from overall national reforms include: • Reduction in customs clearance times i.e. 51- 39 days for imports, 30- 24 days for exports. • Reduction in new business costs • Reduction in transfer of property rights costs (World Bank, 2007a)	Other multiplier logistic effects from overall national reforms include • Reduction in customs clearance times i.e. imports 7-3 days, exports 4-2 days. • Reduction in corporate tax • Reduction in transfer of property rights costs fees (World Bank, 2007a)

Though it has been argued that inadequate benefits are derived from technology and innovation transfer from foreign direct investment due to extremely wide socio cultural and infrastructural gaps (Goedhuys, 2007). It is quite clear that there are benefits which are shown by some of the positive improvements in the two different case studies. Ultimately, some of the problems linked to the strategies are not even as a result of the type or nature of the strategy but other institutional and even intermodal frameworks as was illustrated by the case of Dar es Salaam.

6. Conclusion

The core aims of this study were to firstly assess the importance of ports in different nations, review privatization as a strategy and review the reasons for prevalent applications in ports focusing on the primary reason given by most institutions i.e. generation of efficiency and productivity. Secondly, another aim was to evaluate KPI's to determine whether there were any significant differences in pre and post privatization periods. In pursuit of these aims the following observations were made:

Private sector participation in ports extends far beyond privatization or any of its related strategies, such as commercialization and devolution, which indeed have varying effects on port performance. For instance, ports developing themselves as hub or feeder ports require very good hinterland transport networks, in terms of road and rail. In African countries, especially, efficient operation and management of rail transport services usually occur through private sector participation in whatever form. In relation to this, many of the ports sampled in the study had different degrees of private sector infusion. They were not limited to container handling alone, but extended to information technology, training, land side transport infrastructure, and so on.

The multiplier effect of the reforms in policy, frameworks and infrastructure, necessary to enable the implementation of the port privatization programmes, extend far beyond port operations. This has actually contributed to the current global ease of doing business by removing various barriers which hinder trade and make it more costly. For example, the World Bank report on the ease of doing business in Africa (World Bank, 2007a) indicated among other things that 22 countries, both coastal and landlocked, had streamlined some policies to facilitate easier or less bureaucratic and costly ways of doing business. This is a plus for global trade. However, a balance should be maintained. It would also be prudent for nations to still be careful so as not to relax certain key policies too much and to ensure that the prospective

business ventures are beneficial to both the nation as well as the private entrant. It is also important to note that though input variables may be improved through expansion, international private partnerships are necessary to generate greater economic activity and levels of output capacity, as illustrated in Figure 22, since most African ports have poor connectivity (UNCTAD, 2008b).

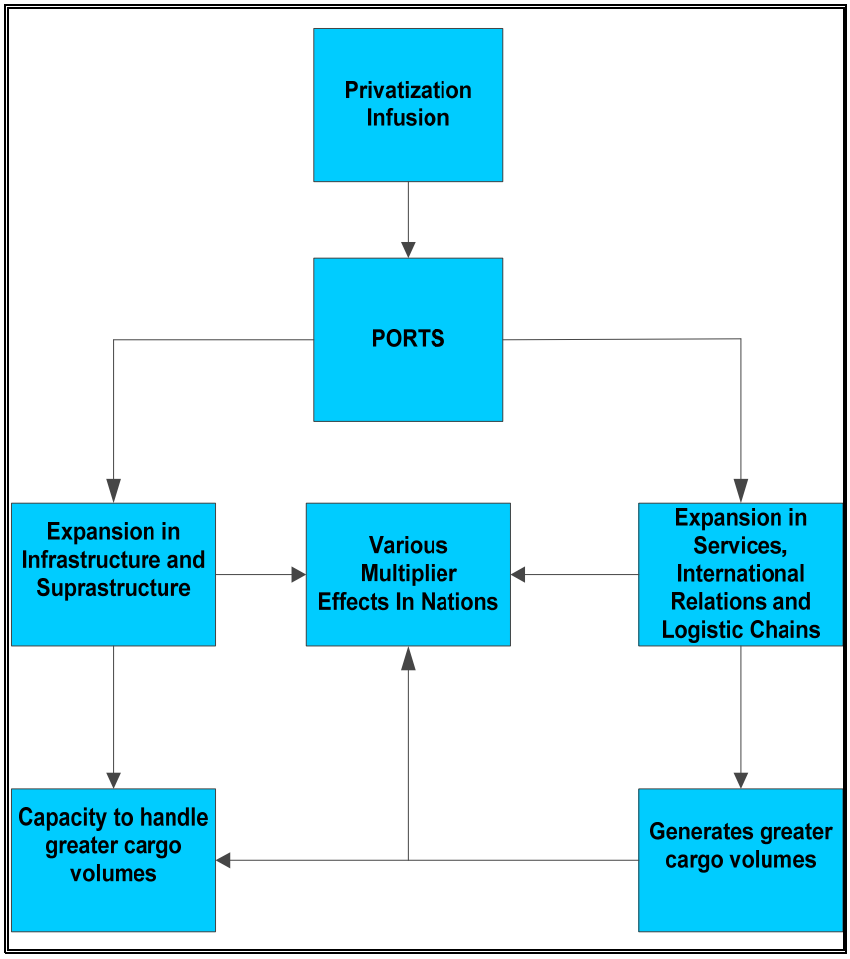

Figure 22 Impact of Private Sector Investment
Source: Flow Chart Showing Summary of Study

In addition to this, it is apparent that private sector participation extends beyond the locality of nations and is currently a trend in international co-operation. An illustration of this is evident in a large section of the sample of African ports used for

the DEA analysis, for example APM terminals in Apapa, Ecomarine in Togo, and Kuwaiti participation in Damietta.

Findings from the DEA analysis indicated that private investment in port infrastructure and superstructure was capable of influencing a port's performance albeit only in relation to output. The DEA analysis showed scale returns in relation to the available port capacity/container throughput and through this enabled assessment of relative technical efficiency. In relation to this capital investments from privatization or private/public partnerships are directly related to expansion or acquisition of infrastructural or superstructure installations and hence these investments do play a part in increasing port efficiency and productivity.

However, when narrowed down to assessment of KPI's in both port case studies, there were various anomalies. Though some results e.g. increase in container throughput in both ports and increase in crane productivity in Dar es Salaam were positive, the results were still quite inconclusive because external influential factors were very strong on port performance, but could not really be quantified. For example, the Tanzania Container Terminal is run by global container terminal operators who are experts in that field. Though handling operations at the quay improved, port efficiency did not due to congestion and other related factors. This is not necessarily a result of the strategy, but rather perhaps the existing policy and framework within that supply chain. Thus, even though private partnerships provide an infusion of capital and technical and managerial expertise, these do not completely ensure the efficiency of the whole port, but rather improve efficiency in the limited areas to which their operations extend.

For Tema Port there were general improvements. However, results for core container handling were inconclusive because the terminal had been in private operation for one year. Results with respect to cargo handling were also mixed, i.e. favourable in certain periods and unfavourable in others.

The implications of these results are mainly the following:

The type of privatization strategy, for example international private participation, will be simultaneously linked with increases in traffic, while local private participation may be linked with other benefits. There is an impact on port efficiency and performance linked specifically to core port services which are linked to private sector infusion, e.g. vessel and cargo handling. However, the overall port efficiency cannot simply be attributed to the strategies since they are very strongly linked to variables within the supply chain. In view of this, it would probably be more appropriate to privatize the other sectors of the ports supply chain to the same or related private sector operators in order to enable more control, accountability and cohesion of activities. This would prevent a situation where a port has good quay performance, but, because of congestion and related issues, inefficient yard and gate performance. In addition, customs, transporters and other key contributors to port operations should be integrated under a wing of port authorities, in order to coordinate their activities with the objectives of the ports. Though in reality this may not be easily achieved, gradual planning and cooperation can make it a possibility.

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Appendices

Appendix A – 2002 DEA Results

DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks			
1	benin-cotonou	0.60838	0.313	Increasing	0.017	ivory coast - abidjan	0.296	south africa- port elizabeth
2	egypt-damietta	1.00000	1.000	Constant	1.000	egypt-damietta		
3	Djibouti	1.00000	1.000	Constant	1.000	Djibouti		
4	ghana- tema	1.00000	1.000	Constant	1.000	ghana- tema		
5	ivory coast - abidjan	1.00000	1.000	Constant	1.000	ivory coast - abidjan		
6	kenya- mombasa	0.60083	0.466	Increasing	0.048	egypt-damietta	0.418	ivory coast - abidjan
7	Nigeria -Apapa	0.79504	0.450	Increasing	0.450	egypt-damietta		
8	mauritius- port louis	0.92133	0.839	Increasing	0.603	ghana- tema	0.236	south africa-capetown
9	south africa-capetown	1.00000	1.000	Constant	1.000	south africa-capetown		
10	south africa- port elizabeth	1.00000	1.000	Constant	1.000	south africa- port elizabeth		
11	tanzania-dar es salaam	0.33423	0.300	Increasing	0.235	ivory coast - abidjan	0.065	south africa- port elizabeth
12	togo-lome	0.53154	0.175	Increasing	0.041	Djibouti	0.134	ivory coast - abidjan

DMU No.	DMU Name	Input-Oriented VRS Efficiency	Optimal Lambdas with Benchmarks							
1	benin-cotonou	1.00000	1.000	benin-cotonou						
2	egypt-damietta	1.00000	1.000	egypt-damietta						
3	Djibouti	1.00000	1.000	Djibouti						
4	ghana- tema	1.00000	1.000	ghana- tema						
5	ivory coast - abidjan	1.00000	1.000	ivory coast - abidjan						
6	kenya- mombasa	1.00000	1.000	kenya- mombasa						
7	Nigeria -Apapa	1.00000	1.000	Nigeria -Apapa						
8	mauritius- port louis	0.97781	0.906	ghana- tema	0.094	south africa-capetown				
9	south africa-capetown	1.00000	1.000	south africa-capetown						
10	south africa- port elizabeth	1.00000	1.000	south africa- port elizabeth						
11	tanzania-dar es salaam	0.85500	0.696	benin-cotonou	0.027	egypt-damietta	0.145	ghana- tema	0.122	kenya- mombasa	0.010	Nigeria -Apapa
12	togo-lome	1.00000	1.000	togo-lome						

	max draught	no. of berths	container sto	transfer equipment	yard equipme	rail	container traf
benin-cotonou	10	8	70000	2	2	1	92000
egypt-damietta	14.5	16	575000	19	154	1	748000
Djibouti	12	3	220000	7	49	1	178405
ghana- tema	11.5	12	150000	0	63	0	223377
ivory coast - abidjan	14	11	250000	2	37	1	579000
kenya- mombasa	10.9	19	220000	4	204	1	278000
Nigeria -Apapa	8.2	20	1708000	101	287	1	336308
mauritius- port louis	12	14	347000	10	100	0	247000
south africa-capetown	14	24	972000	6	110	0	476000
south africa- port elizabeth	12.2	13	22000	4	2	1	278000
tanzania-dar es salaam	12.2	12	180000	4	177	1	154,000
togo-lome	12	3	80000	3	58	1	84783

Appendix B – 2004 DEA Results

DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks							
1	benin-cotonou	0.98847	0.247	Increasing	0.042	ivory coast - abidjan	0.205	south africa- port elizabeth				
2	Djibouti	0.44601	0.139	Increasing	0.139	egypt-damietta						
3	egypt-damietta	1.00000	1.000	Constant	1.000	egypt-damietta						
4	ghana- tema	1.00000	1.000	Constant	1.000	ghana- tema						
5	ivory coast - abidjan	1.00000	1.000	Constant	1.000	ivory coast - abidjan						
6	kenya- mombasa	0.73643	0.572	Increasing	0.044	egypt-damietta	0.528	ivory coast - abidjan				
7	Nigeria -Apapa	0.49967	0.283	Increasing	0.283	egypt-damietta						
8	mauritius- port louis	0.74703	0.754	Increasing	0.636	ghana- tema	0.118	south africa-capetown				
9	south africa-capetown	1.00000	1.000	Constant	1.000	south africa-capetown						
10	south africa- port elizabeth	1.00000	1.000	Constant	1.000	south africa- port elizabeth						
11	tanzania-dar es salaam	0.44240	0.407	Increasing	0.075	ghana- tema	0.268	ivory coast - abidjan	0.064	south africa- port elizabeth		
12	togo-lome	0.96193	0.238	Increasing	0.054	egypt-damietta	0.184	ivory coast - abidjan				

DMU No.	DMU Name	VRS Efficiency	Optimal Lambdas with Benchmarks								
1	benin-cotonou	1.00000	1.000	benin-cotonou							
2	Djibouti	0.95322	0.269	benin-cotonou	0.047	ghana- tema	0.684	togo-lome			
3	egypt-damietta	1.00000	1.000	egypt-damietta							
4	ghana- tema	1.00000	1.000	ghana- tema							
5	ivory coast - abidjan	1.00000	1.000	ivory coast - abidjan							
6	kenya- mombasa	1.00000	1.000	kenya- mombasa							
7	Nigeria -Apapa	1.00000	1.000	Nigeria -Apapa							
8	mauritius- port louis	0.95833	1.000	ghana- tema							
9	south africa-capetown	1.00000	1.000	south africa-capetown							
10	south africa- port elizabeth	1.00000	1.000	south africa- port elizabeth							
11	tanzania-dar es salaam	0.86498	0.683	benin-cotonou	0.055	egypt-damietta	0.135	ghana- tema	0.123	kenya- mombasa	0.004	Nigeria -Apapa
12	togo-lome	1.00000	1.000	togo-lome								

	max draught	Total no. of b	container storage s	transfer equip	yard equipme	rail	container traf
benin-cotonou	10	8	65000	1	2	1	98000
Djibouti	12	5	220000	8	83	1	159727
egypt-damietta	14.5	16	575000	19	154	1	1146000
ghana- tema	11.5	12	150000	0	63	0	343000
ivory coast - abidjan	14	11	250000	4	37	1	670000
kenya- mombasa	10.9	19	220000	4	89	1	404000
Nigeria -Apapa	8.2	20	1708000	99	287	1	323825
mauritius- port louis	12	14	347000	10	100	0	290000
south africa-capetown	14	24	972000	6	146	0	610000
south africa- port elizabeth	12.2	13	22000	4	2	1	340000
tanzania-dar es salaam	12.2	12	180000	3	48	1	227,000
togo-lome	12	3	80000	3	58	1	184993

Appendix C – 2006 DEA Results

DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks					
1	benin-cotonou	1.00000	1.000	Constant	1.000	benin-cotonou				
2	egypt-damietta	1.00000	1.000	Constant	1.000	egypt-damietta				
3	Djibouti	0.53083	0.531	Increasing	0.531	togo-lome				
4	ghana- tema	1.00000	1.000	Constant	1.000	ghana- tema				
5	ivory coast - abidjan	1.00000	1.000	Constant	1.000	ivory coast - abidjan				
6	kenya- mombasa	1.00000	1.000	Constant	1.000	kenya- mombasa				
7	Nigeria -Apapa	0.34419	0.273	Increasing	0.273	egypt-damietta				
8	mauritius- port louis	0.55153	0.569	Increasing	0.494	ghana- tema	0.075	south africa-capetown		
9	south africa-capetown	1.00000	1.000	Constant	1.000	south africa-capetown				
10	south africa- port elizabeth	1.00000	1.000	Constant	1.000	south africa- port elizabeth				
11	tanzania-dar es salaam	0.65388	0.679	Increasing	0.063	benin-cotonou	0.565	ghana- tema	0.051	ivory coast - abidjan
12	togo-lome	1.00000	1.000	Constant	1.000	togo-lome				

DMU No.	DMU Name	Input-Oriented VRS Efficiency	Optimal Lambdas with Benchmarks					
1	benin-cotonou	1.00000	1.000	benin-cotonou				
2	egypt-damietta	1.00000	1.000	egypt-damietta				
3	Djibouti	1.00000	1.000	togo-lome				
4	ghana- tema	1.00000	1.000	ghana- tema				
5	ivory coast - abidjan	1.00000	1.000	ivory coast - abidjan				
6	kenya- mombasa	1.00000	1.000	kenya- mombasa				
7	Nigeria -Apapa	0.95041	0.050	ghana- tema	0.950	kenya- mombasa		
8	mauritius- port louis	0.94262	1.000	ghana- tema				
9	south africa-capetown	1.00000	1.000	south africa-capetown				
10	south africa- port elizabeth	1.00000	1.000	south africa- port elizabeth				
11	tanzania-dar es salaam	0.91098	0.567	benin-cotonou	0.262	ghana- tema	0.171	kenya- mombasa
12	togo-lome	1.00000	1.000	togo-lome				

	max draught	no. of berths	container storage sqm	transfer equipment	yard equipment	rail		container traffi
benin-cotonou	11	8	65000	1	2		1	141000
egypt-damietta	14.5	16	600000	16	169		1	830000
Djibouti	12	3	220000	4	100		1	107955
ghana- tema	11.5	12	150000	3	52		0	420000
ivory coast - abidjan	12.5	11	250000	4	37		1	507000
kenya- mombasa	10.9	19	220000	4	89		1	479000
Nigeria -Apapa	11.5	26	1640000	101	277		1	226571
mauritius- port louis	12.2	14	347000	10	100		0	266000
south africa-capetown	14	24	972000	6	146		0	783000
south africa- port elizabeth	12.2	13	22000	4	2		1	393000
tanzania-dar es salaam	12.2	12	180000	3	48		1	272,000
togo-lome	12	3	80000	3	58		1	203372