Performance of the Mombasa Port: An Empirical Analysis

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Abstract

Although the performance of the port of Mombasa has been an issue of public interest, there has not been any empirical study focusing on it over time. This study estimates the Total Factor Productivity (TFP) of the port as a measure of performance using annual time series data from 1978 to 2007 of cargo throughput as the output, and labour and capital as inputs from various statistical abstracts. Results show a general increase in productivity, an indication of increased port performance. However, this is accompanied by decreasing returns to scale. A PESTEL analysis and a correlation test indicated a relationship between the port's TFP and GDP per capital, exchange rate depreciation and politics; an indication of the impact of the macro-economy on port performance. The study recommends development of another port to deal with the decreasing returns to scale in the long run, incentives to encourage ship arrivals to improve the port performance, development of an economically active hinterland and other modes of transport such as road and railway and trade facilities in tandem, so as to ensure seamless movement of cargo to retain high frequency of ship and cargo arrivals.

Abbreviations and Acronyms

EAC	East African Community
KFS	Kenya Ferry Services
KMA	Kenya Maritime Authority
KNSL	Kenya National Shipping Line
KPA	Kenya Ports Authority
OECD	Organization of Economic Cooperation and Development
MSC	Mediterranean Shipping Company
PESTEL	Political, Economic, Social-cultural, Environmental, Legal analysis
PMAESA	Port Management Association of Eastern and Southern Africa
TEU	Twenty-foot Equivalent Units
TFPG	Total Factor Productivity Growth
UNCTAD	United Nations Conference for Trade and Development
VDS	Vessel Delay Surcharge

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1. Background

Globally, maritime transport remains the backbone supporting international trade, with over 80 per cent of the world's merchandise trade being carried by ships. This role has become more apparent and crucial in today's expanded and diversified world trade system. The advantage of maritime transport is the speed, comfort, safety and the ability to handle heavy traffic of goods and passengers at relatively low prices (Ahmed *et al.*, 2008). Maritime transport provides tremendous carrying capacity, while consuming far less energy compared to other modes of transport such as air, truck and rail (Kentucky Association of Riverports, 2008).

The port of Mombasa is important for Kenya for a number of reasons. First, due to its central geographic location in the East African region, it forms a gateway for trade in Kenya and the hinterland countries. Currently, maritime transport accounts for transport of over 80 per cent of the country's external trade (Helu, 2007). Secondly, the port plays a significant role in economic development through development of maritime related industries, creating employment and attracting foreign direct investments. Thirdly, the port creates the interface between maritime transport and the inland transport system, facilitating regional and international trade. The port is thus a crucial facilitator for the attainment of Kenya's Vision 2030 of a globally competitive[1] and prosperous nation.

Despite the importance of the port of Mombasa to the country and the region, the port's performance has been poor. The port of Mombasa has one of the longest ship waiting period with a turn around time of an average of 36 hours compared to Djibouti's 3 hours, Namibia (18 hours) and Durban (16 hours). This has greatly affected the competitiveness of the port, which is now placed at number 44 out of 62 developing countries' ports (United Nations Conference for Trade and Development, 2008) and number 4 in the Eastern and Southern Africa region (Port Management Association of Eastern and Southern Africa, 2008).

One of the most commonly used measures of assessing port performance is factor productivity, which can be measured by partial productivity, total factor productivity or port efficiency. Partial

[1] Determinants of competitiveness include: Supply side factors (TFP Level or growth, improved inputs and innovation) and demand side factors (consumer attitudes and changing needs)-OECD, 2004.

productivity only gives a partial picture of performance; therefore, Total Factor Productivity (TFP) and port efficiency are the preferred measures. However, efficiency is the relative measure and is mostly used on a sample of firms over time or at one point. This study applies total factor productivity approach in assessing the performance of the port between 1978 and 2007, using time series data.

The study focuses on the services offered by the port of Mombasa and does not attempt to assess the performance of other agencies that operate in the port, such as Kenya Revenue Authority and Kenya Bureau of Standards.

1.1 Statement of the Problem

During the past five years, the Government of Kenya has initiated reforms aimed at modernizing, replacing and refurbishing equipment at the port of Mombasa, all aimed at improving the port's performance. However, despite these investments, the port of Mombasa has continued to be characterized by delays in ship turn around, cargo congestion, and emerging stiff competition from other regional ports. It is not clear if the delays and cargo congestion are as a result of the factor inputs productivity or other external factors beyond the port management. The factor inputs productivity over time and the factors affecting the port productivity have remained unknown. Decisions concerning enhancing the port's performance have so far relied on conventional wisdom.

Increasing domestic and trans-shipment traffic and expected economic growth in Kenya as envisaged in Vision 2030 is expected to give rise to further increases in container traffic, hence increased demand for port services. This necessitates an analysis of the port's productivity growth as a measure of performance, with a view to answering the following questions:

a) What is the TFP growth of the port of Mombasa as an indicator of the port performance?

b) What are the returns to scale at the port?

c) What factors influence the port's performance?

1.2 Objectives

The main objective of this study is therefore to assess the total factor productivity growth (TFPG) as an indicator of Mombasa's port performance so as to provide policy recommendations and strategies to enhance maritime transport. The specific objectives of the study are:

- To determine the TFPG at the port of Mombasa over time
- To determine the returns to scale at the port of Mombasa
- To identify the various factors underlying the performance of the port of Mombasa

1.3 Justification

Policy makers in Kenya are laying emphasis on the competitiveness of the economy. It is a reality that the competitiveness of Kenya is inextricably linked to the productivity and competitiveness of its key sectors. This requires that industries are facilitated to become competitive internationally. Congestion and delays in ship turn around time undermines the competitiveness of these key sectors in the country by increasing shipping costs through direct costs such as vessel delay surcharge and indirect costs such as inventory, idle ships and trucks. This necessitates the need for the port of Mombasa to improve its performance to lower port and shipping charges and reduce transaction costs for businesses, as well as face increasing competition from neighbouring ports.

The port of Mombasa also forms a vital link in the overall trading chain and consequently their level of performances determines a nation's international competitiveness. Kenya needs an efficient transport system to maintain the momentum of the current economic recovery, especially in light of Vision 2030 where Kenya hopes to attain the status of a middle-level income economy.

2. An Overview of the Port of Mombasa

Kenya has several ports along the coast; Mombasa, Funzi, Kilifi, Kiunga, Lamu, Malindi, Mtwapa, Shimoni and Vanga. Kenya Ports Authority (KPA) presence is only at Mombasa and Lamu ports, while Kenya Revenue Authority administers the rest on behalf of the authority. Maritime transport system is managed by Kenya Ports Authority, Kenya Maritime Authority (KMA), Kenya National Shipping Lines (KNSL) and Kenya Ferry Service (KFS).

KPA manages the port of Mombasa, which includes Kilindini harbour, port Reitz, port Tudor and the whole of the tidal waters. The Port of Mombasa has 16 deep water berths with a quay length of 3,044 meters and maximum dredging of 10 meters. It has important infrastructure including bulk oil jetties, handling facilities for coal clinker and cement, three berth container terminal, and two inland container depots.

KMA is charged with formulating general guidelines and providing basic information for maritime transport, as well as undertaking functions necessary for the safety of Kenya's maritime transport. KMA has in the recent past developed a curriculum for training seafarers under the international convention on standards of training, certification and watch keeping for seafarers (STCW) 1978, and is in the process of developing a maritime policy.

The KNSL was the first and only shipping line in Kenya. So far, the shipping line does not have its own vessels but operates by buying charter space in other shipping lines serving Kenya and other countries. It is also a member of the East African Conference Line, whose membership includes P&O Nedlloyd, Wec Lines, H. Stinnes Linien GmbH, Mediterranean Shipping Company (MSC) and Ellerman Lines. The Kenya National Shipping Line operates MSC's vessels to Dar es Salaam and Mombasa.

Kisumu port is managed by the Kenya Railways Corporation. However, despite its importance as a hub for cargo to the hinterland countries, very little activity has been taking place. The key port in the Kenyan maritime transport system is the port of Mombasa. Cargo from the port of Mombasa is transported by road, railway and pipeline to other parts of the country and the Great Lakes region through Tanzania and Uganda.

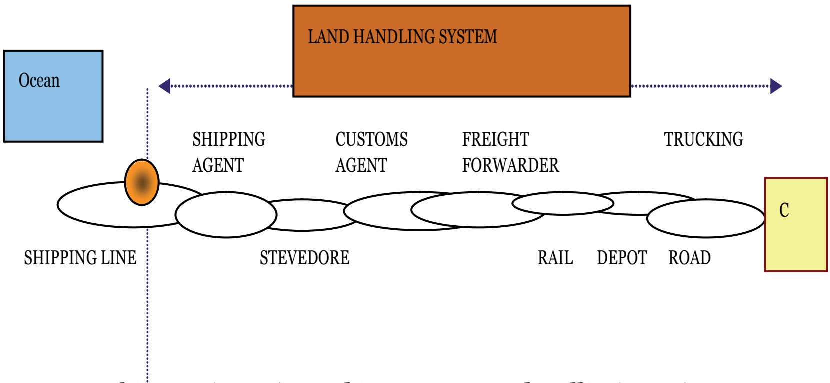
2.1 The Port of Mombasa

The history of Mombasa port dates back to the colonial period when the current old harbor catered for dhow trade and British merchant vessels. After independence, the port became part of the East African Harbors and Railways. However, after the collapse of the EAC in 1977, port management changed to Kenya Ports Authority through the adoption of the KPA Act of 1978. Later in 1986, the Kenya Cargo Handling Services Company was merged with KPA. Currently, it includes Kilindini harbor, port Reitz, the old port, port Tudor and the whole of the tidal works encircling the island (Port Master Plan, 2004).

The port of Mombasa is central to Kenya's maritime service industry, which comprises the shipping companies and their associated companies, sub-contractors, finance and insurance firms, logistics and transport firms, public sector agencies, interest groups and associations, among others. All these form part of the port's chain system, which are summarized in Figure 2.1. Cargo moves from the country of origin through ships, hence the shipping line. Shipping lines have their own shipping agents who look after the ship owners' interests and liaise on behalf of their clients and the various entities that service vessels in a port. Once the cargo is offloaded from the ship (stevedoring), the customs agents and the freight forwarders move it to the final consumer. The cargo is transported either by road, railway or pipeline.

The port of Mombasa's core services in the chain system fall under stevedoring and involve cargo handling services for containers, general cargo, dry bulk, oils and bulk liquids. This forms the main focus of this study.

Figure 2.1: Port chain system



Source: Robinson (2002) cited in Langen and Pallis (2006)

2.2 Port Performance

As indicated in Table 2.1, the port is a mixed cargo port handling mainly imports, due to the dependency of the regional economies on imports, particularly liquid petroleum oil products, which are about 48 per cent of the total imports through the port. Average waiting days per ship increased in the year 2007, which could have decreased the number of ships calling at the port to 1,811 from 1,857 in 2006. Of interest is the increase in cargo despite the decrease in ships, a good indication of the global increase in the size of ships. Transit in and out has remained at almost the same level, with about 30 per cent for transit in and 15 per cent for transit out. The cargo traffic at the Port of Mombasa has been on an increasing trend as indicated in Figure 2.2.

The increase in total cargo is mainly as a result of the increase in imports, not exports (Figure 2.2). The exports are in an almost straight line from 2000, while imports seem to move together with the total cargo, indicating that the increase in total cargo handled is as a result of increasing imports and not exports.

2.3 Port Development and Reforms

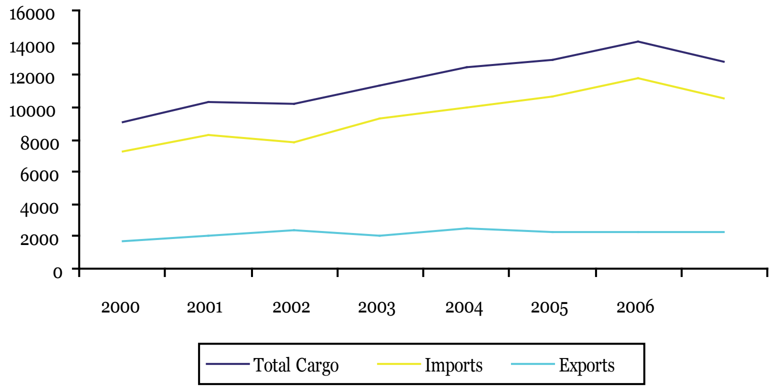
The world over has experienced changes in maritime transport. There have been remarkable institutional changes in the ownership of ports, with most ports being landlord ports and increased open registries. There

Table 2.1: Port traffic, 2003-2007

Nature of products	2003	2004	2005	2006	2007
Imports					
Containerized cargo (%)	24	26	25	25	29
Conventional cargo (%)	13	12	9	10	8
Dry bulk (%)	15	16	20	20	21
Bulk liquids (%)	48	46	46	46	42
Of which transit in (%)	23	26	30	29	31
Total imports in ‘000 Dead Weight Tonnes (DWT)	9,332	10,018	10,700	11,846	13,062
Exports					
Containerized cargo (%)	57	67	74	72	78
Conventional cargo (%)	10	8	6	8	7
Dry bulk (%)	19	15	13	14	8
Bulk liquids (%)	14	10	8	6	7
Of which transit out (%)	13	12	15	15	15
Total exports in ‘000 Dead Weight Tonnes (DWT)	1,994	2,494	2,278	2,255	2,474
Total vessel calls	1,705	1,779	1,731	1,857	1,811
Average waiting days per ship	1.77	1.34	1.61	1.49	1.74

Source: KPA

Figure 2.2: Port traffic, 2003-2007



Source: KPA

has also been a change in the technical progress that saw the introduction of containers and the scale effects from increased vessel size.

Increased containerization and shift to larger vessels has allowed for hub-spoke economies, where smaller vessels move cargo to a hub and shipments are thus aggregated into much larger and faster ships for longer hauls. Line haul ships of 4,000+ TEU are now common, 6,000+ ships have been introduced on major routes, 8,000+ TEU ships are being built and 10,000+ ships are under consideration. Shipping lines have taken advantage of this by consolidating their shipping lines, while terminal operators have also consolidated to enhance efficiency to serve expensive ships. This trend has necessitated the need for ports to invest in better cargo handling equipment and quality staff to avoid being relegated to feeder ports. So far, the port of Mombasa is not able to handle large vessels and, with time, the port has been turned into a feeder port. Of importance is the worldwide general trend in increasing private participation in port operations driven by the need for more resources to undertake development projects. Of the top 50 ports, 42 of them are landlord ports.

Currently, the largest container vessel that can call at the port of Mombasa is approximately 1,800TEU compared to South Africa's Durban port, port Elizabeth and Cape Town port which are in the order of 4,000 TEU. To effectively compete as a regional hub and handle bigger vessels in line with the global trend, the port needs to handle vessels of around 3,500 TEU and expand container handling capacity from the current 400,000 TEUs.

The government and the port of Mombasa have initiated several reforms aimed at increasing the port's performance and raising its status from that of a feeder port to a hub port. For example, under Vision 2030's medium term plan, reforms include:

- Dredging the port of Mombasa for the purpose of deepening the channel to 14.5 meters to enable larger post-panamax vessels to access the port,
- Develop other minor satellite ports (Funzi, Vanga, Shimoni, Kilifi, Malindi, Lamu, Kiunga and Mtwapa) through strategic partnerships,
- Expand and modernize the port of Mombasa to increase efficiency and cargo handling capacity,
- Develop an ultra modern cruise ship terminal at the coast, and
- Establish and operationalize a free trade port in Mombasa.

Under ERS, the government;

- Modernized and replaced obsolete equipment at the port of Mombasa, including development of cruise ship facilities, and
- Replaced and refurbished several sea to shore cranes, gantries and tug masters.

Port Master Plan of 2004 included most of the above and,

- Conversion of some conventional berths 7-10 into container handling facilities to serve the Kilindini container terminal, and
- Gradually transforming the port from the current service port organizational structure into a landlord port (This is still under consideration and is yet to be done).

Currently, the competition for regional hub status is mainly from Durban, Djibouti and Dar es Salaam ports.

2.4 Origin-Destination Structure of Maritime Traffic

Maritime traffic is mainly concentrated on the northern hemisphere due to flourishing intra-industry trade. As indicated in Figure 2.3, ships sail between America, Asia and Europe. There is very little traffic in Africa; trade is mostly concentrated in the North and South Africa, the countries that have natural resources, an active hinterland and also fall on the main route structure.

The sequence of cargo flows is as follows: Far East to Indian sub continent to Eastern Africa to West Africa to South Africa to Eastern Africa to Indian sub-continent to Far East (Port Master Plan, 2004). Ships originating from the Far East pass through South Africa on the return trip after having passed through East Africa and West Africa. This indicates that the major destination and origin of cargo from the East African coast is Far East, Middle East, other African countries and Europe. It is also apparent that a large number of containers through Eastern Africa coast are transhipment containers.

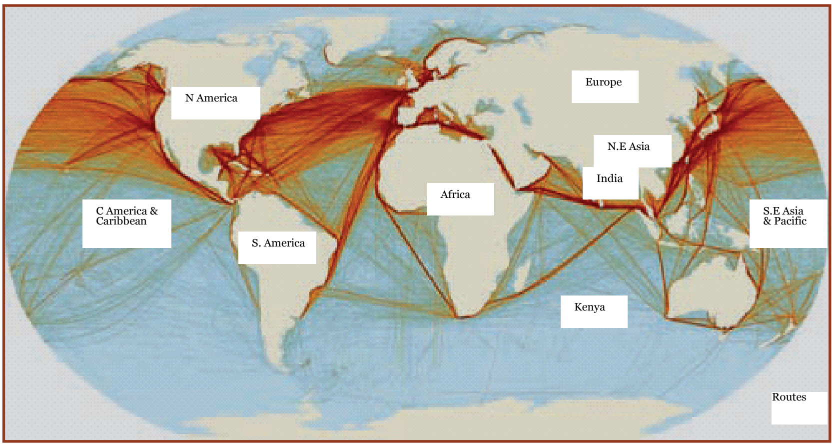
As indicated in Figure 2.3 by the thin line, the port of Mombasa accounts for only about 0.2 per cent of the world's international seaborne trade mainly because of its location, higher costs and low trade levels. Durban has the most traffic in sub-Saharan Africa, with about 1.21 per cent of the world's international seaborne trade (Review of Maritime Transport, 2008).

The Port Master Plan of 2004 came up with an origin and destination matrix assigning cargo flows to regions using route structure and employment sequence of the 66 identified individual shipping lines.

The Origin-Destination matrix showing overall container trade flows between the various maritime regions transported by shipping lines also calling at Eastern and Southern Africa are indicated in Table 2.2.

Table 2.2 is in line with Figure 2.3, where the major cargo flows from East Africa are mainly to Middle East, South Africa, Far East, Indian sub-continent, Europe and West Africa. The major destinations for cargo from East Africa is Far East, Middle East, South Africa, Indian sub-

Figure 2.3: Maritime traffic in 2004



Source: World Development Report (2009) continent and Europe in descending order. Cargo to East Africa mainly originates from Middle East, South Africa, Far East, Europe and Indian sub-continent, in descending order. However, the Middle East cargo is likely to pass through the port of Djibouti and Somalia, hence the port of Mombasa can act as a hub for East Africa region on trade cargo to and from Europe, South Africa and Far East.

Becoming a hub port means the port needs to be prepared to compete with other world and regional ports. This means ensuring the port has capacity to handle large vessels in line with the current world shipping developments, adequately sized and fitted terminals, an economically active hinterland besides efficient container handling and terminal operations, and network of infrastructure assets.

Table 2.2: Estimated container flows between world maritime regions

From/To	North America	Caribbean	South America	Europe	Middle East	Ind. Sub	East Africa	South. Africa	West. Africa	Far East	Australia New Zealand	Total
North America	0	24,496	0	0	3,219	3,219	3,219	132,783	3,647	0	0	170,582
Caribbean	0	0	0	0	0	0	0	23,740	756	0	0	24,496
South America	0	0	0	0	59,686	0	34,902	251,259	0	221,241	0	567,088
Europe	0	0	0	0	82,478	3,240	128,434	459,626	32,066	0	100,173	806,016
Middle East	0	0	50,570	144,583	0	14,808	338,281	95,190	9,116	182,445	0	834,991
Indian Sub-continents	0	0	1,248	0	76,852	0	106,463	31,695	24,017	121,124	0	361,398
East Africa	0	0	19,242	97,414	295,712	99,399		266,973	60,348	303,393	32,380	1,174,861
South Africa	139,057	0	254,590	440,811	120,988	64,927	236,989	0	327,356	260,200	29,349	1,874,267
West Africa	311	0	33,638	60,601	0	59,336	102,652	239,926	0	137,113	0	633,577
Far East	0	0	207,801	20,869	153,329	133,553	209,246	532,877	176,272	0	36,686	1,470,633
Australia, New Zealand	0	0	0	41,739	41,739	0	14,674	29,349	0	71,087	0	198,588
Total	139,368	24,496	567,088	806,016	834,001	378,482	1,174,861	2,063,417	633,577	1,296,603	198,588	8,116,499

Source: Port Master Plan (2004)

3. Literature Review

3.1 Measuring Performance of Ports

Ports are complex organizations where multiple services are provided by a large variety of agents, hence their complexity in production, market structure and demand. According to Tovar, Trujillo and Diaz (2007), cargo handling requires special attention as it accounts for more than 80 per cent of the bill of a vessel that arrives at a port for loading and/or unloading. This has made shipping lines to evaluate the attractiveness of the ports on the time taken to offload/load their ships, as this affects their costs, revenue base and marketing efforts. It has hence become very important for ports to invest in better equipment and employ sophisticated management to improve performance. These translate to capital and labour, hence the use of productivity as a performance measurement.

Ports provide different service activities particularly to vessels, cargo and inland transport; hence the performance of a port cannot be assessed on a single value or measure. However, most studies like Cullinane *et al.* (2004), Tovar *et al.* (2007), Herrara and Pang (2008) among others, analyze the activities carried out by the port authority or container ports and not by other associated agents.

Bichou and Gray (Jaffar and Ridley, 2005) argue that port performance can be measured in physical, factor and financial productivity. Physical productivity measures time related to ship operations. Factor productivity indicators measure assets needed in the port in terms of capital, labour and economic, while financial productivity measures the total income and expenditure related to TEU. Several methods have been suggested for evaluating port productivity that is partial productivity (Tongozon, 1995), total factor productivity (Kim and Sachish, 1986), and port efficiency (Estache *et al.*, 2002). Since these methods only give one measure of performance, it is better to consider other business environment factors affecting the port's performance by doing a political, economic, social-cultural, environmental and legal (PESTEL) analysis.

According to Kotler (1998), PESTEL analysis is a useful strategic tool for understanding market growth or decline, business position potential and direction of operations. It ensures that the company's performance is aligned with the forces of change that are affecting the business environment.

3.2 Productivity and Efficiency

Productivity and efficiency measures are often used interchangeably, but they are not precisely the same (Coelli *et al,* 2005). Productivity measured through TFP estimation is the ratio which accounts for the effects in total output not caused by accumulation of inputs. Efficiency rests on the comparison of observed values of outputs and inputs, with optimum relative values arising from the evidence provided by other firms (Gonzalez and Trujillo, 2007). TFP is mostly applied to time series data and assumes the firm is technically efficient. Efficiency tests are mostly applied on sample firms over time (panel) or at one point in time (cross sectional) and provide measures of relative efficiency among those firms.

Dowd *et al.* (1989), and Kim and Sachish (1986) found a comparison of productivity of a port on a time series more appropriate than on a cross sectional analysis or a panel analysis. This is because ports are of different sizes, face different traffic and traffic mix and lack uniformity in the definition of data.

3.3 Theoretical Literature

Studies on port productivity can be classified into three main groups: studies that employ partial productivity indicators, engineering approaches that use simulations and queuing theory (Gonzalez and Trujillo, 2007), and the TFP approach which uses both mathematical programming and econometric approaches. Analysis of productivity from an engineering point of view takes into account the potential result that the firm has not exploited which could serve as a source for increasing its productivity.

Partial productivity approaches attempt to relate one output to one production input. Many studies use partial productivity when analyzing productivity of certain activities. Although commonly used, the partial productivity measure does not control the level of other inputs employed (Odhiambo and Nyangito, 2003).

Total Factor Productivity has been analyzed in the neoclassical framework of growth theory in which growth is determined by two sources; factor accumulation and productivity growth. Growth accounting is as a result of one of the methodologies used in TFP analysis. Using the Solow residual, the method determines how much growth is due to accumulation of inputs and how much can be attributed to technical progress. The method assumes the existence of a well behaved neoclassical production function which is used as an organization device in order to isolate the contribution of various factors of output growth assuming a neoclassical world. TFP is treated as the residual. Critics of this model point out lack of a stochastic term and restriction of the parameters which have to add up to one.

Port TFP analysis has been done following conventional Cobb Douglas production function expressed as $Y_t = A_o e^{\gamma(t/l)} K_t^{\alpha} L_t^{\beta}$ (Dasanayaka, 2006; and Chang, 1978 cited in Cullinane *et al.,* 2006). Where Y, the output, is measured in either total tonnage handled at the port or the port gross earnings and the inputs are labour and capital which comprise about 95 per cent of the total cost structure of a port (Cullinane *et al.*, 2006). The $A_o e^{\gamma(t/l)}$ gives the residual or the TFP.

Econometric estimation of TFP forms the better alternative to the growth accounting approach. This is because econometric estimation provides for potentially omitted factors that prohibit the achievement of the production frontier to be captured by the stochastic dominance term (Fuentes and Morales, 2006) under the stochastic frontier analysis. However, this requires either a panel or a cross sectional data set.

3.4 Empirical Evidence

There are very few empirical studies on port productivity that use time series data and the production functions on a single port. Based on data from the port of Ashdod in Israel, Kim and Sachish (1986) found the technical change to have been saving labour and using capital and TFP to have been growing at an annual average rate of 0.11. The analyses were done using a translog cost function, total cargo loaded and unloaded as output, labour and capital as the factors of production. They also found TFP to have declined negatively when the port experienced severe labour strikes.

Dasanayaka (2006) analyzed the scale of operation of the port of Colombo using a Cobb Douglas production function, capital employed in book value and wages in salaries as the inputs and gross port revenue as the output and found increasing returns to scale in the Colombo seaport when the technological proxy was dropped, decreasing returns to scale with the technology proxy. The returns to scale were largely dependent on the change in demand and the development to cope with this demand.

Most of the studies by Estache *et al.* (2002) on efficiency of Mexican ports, Trujillo and Trovar (2007) on European ports efficiency, Ahmed *et al.* (2008) on efficiency of Middle East and East African seaports and Cullinane *et al.* (2004) on efficiency of several container ports, used panel data sets to measure productivity and efficiency of ports. However, critics of this technique argue that because ports are of different sizes and face different traffic and traffic mix, the use of cross-sectional or even panel data may produce misleading results and fail to capture basic differences among various ports (Mundlak, 1961). It is thus important to estimate econometrically the productivity of a port at the single port level, using time series data (Kim and Sachish, 1986).

Ahmed *et al.* (2008) evaluated the efficiency and scale of operation of 22 seaports in the Middle East and East Africa, using berth length, storage and handling equipment as the inputs and ship calls and throughput in tonnes as the output. They found the port of Mombasa to be below average on scale efficiency and to be experiencing decrease in returns to scale.

Others have used different methods of assessing port performance. Tongzon (1995), based on a sample of 23 international ports, developed a model of assessing the factors influencing port performance and efficiency as well as providing an empirical basis for the crucial role of terminal efficiency relative to other factors. However, this method only used cranes efficiency, a partial productivity analysis. Clark, Dollar and Micco (2002) measured efficiency relating it to maritime transport costs. Their result indicated seaport efficiency as an important determinant of maritime transport costs. They found port efficiency to be positively influenced by infrastructure and regulations and negatively influenced by organized crime. However, they used an aggregated measure of port efficiency consisting of one to seven indices from the Global Competitiveness report.

3.5 Overview of Literature

Cargo handling requires special attention as it accounts for most of the bills of a vessel that arrives at a port for loading and/or off loading, hence the need to assess the port's performance. There are three ways of measuring port performance; physical productivity, factor productivity and financial productivity. Factor productivity can be measured in three ways; partial productivity, TFP, and port efficiency. Total Factor Productivity and port efficiency are the preferred estimates of factor productivity, but only TFP is applicable to a study that is assessing the performance of one unit over time.

Most of the studies have analyzed the performance of a port by assessing the relative efficiency such as Ahmed *et al.* (2008). However, efficiency measure only gives the performance of the port relative to other ports in the analysis and does not tell how the port has performed over time. This means that the level of efficiency determined is greatly affected by the other ports in the study and may not necessary reflect the actual performance of the port.

Total Factor Productivity Growth using the conventional Cobb Douglas production function as expressed by Dasanayaka (2006) and Chang (1978) cited in Cullinane *et al.* (2006) is chosen for this study as it allows an estimation of the port's TFPG, a good indicator of the port performance which is the focus of this study. Total cargo loaded and unloaded is used as output, and labour and capital as the factors of production.

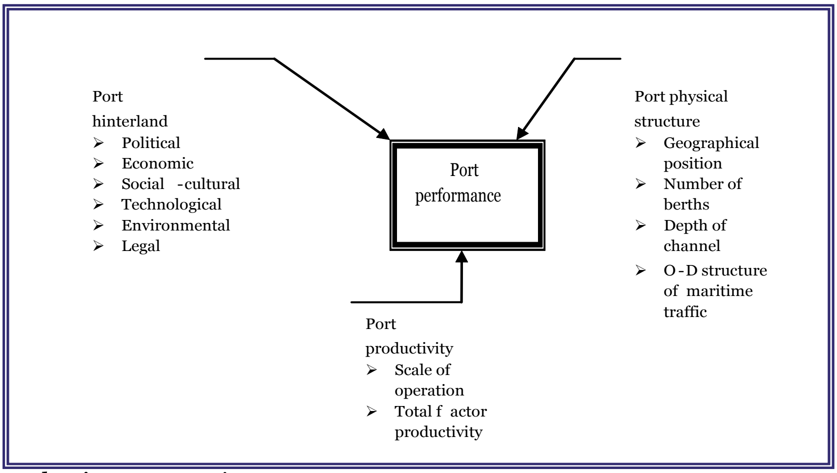
4. Study Methodology

4.1 Conceptual Framework

The performance of a port can be influenced by the port's physical infrastructure, the factor productivity which is classified as the port's productivity, and the environment in which the port is operating called the port hinterland (Figure 4.1). The physical factors include the geographical position, number of depths, depth of the channel and the origin and destination structure. The factors of productivity include total factor productivity and the scale of operation. The port's hinterland includes the political, economic, social-cultural, technological, environmental and legal environment where the port operates in.

The focus of this study is the port's productivity. In this case, the empirical analysis focuses on the activities carried out by the port using labour and capital in the port as the main factors of production. Since we are assessing the performance of the port of Mombasa over a period of time (time series), TFP will be the most appropriate method of analysis. The main output or product of the port production activities is cargo handled. Increase in the cargo handled is expected to be as a result of an increase in labour and capital (factor accumulation), however growth in the cargo handled could also be occasioned by advance in techniques at the port (productivity).

Figure 4.1: Conceptual framework



Author's computation

The other two factors, port hinterland and the port infrastructure, are empirically analyzed. However, a comprehensive literature review will be undertaken to inform policy recommendations. This study is informed by both qualitative and quantitative analysis. While port productivity is analyzed quantitatively, port environment/hinterland is analyzed qualitatively through literature review and PESTEL analysis.

4.2 Empirical Model

The production function estimated was designed to get the best possible assessment of the port productivity. In this study, Cobb Douglas production function is used to capture the key ingredients of the port's operations. This enabled the establishment of a relationship between inputs and outputs at the port of Mombasa. Our output was measured as total cargo in tonnes loaded and unloaded during the period of the analysis. Factors of production specified were labour and capital.

$$Q_t = A_o e^{bt} K_t^{\alpha} L_t^{\beta} \quad \text{.......} 1$$

Where Q_t [2] is the total cargo handled by the port in period t

K_t [3] is the capital employed book value in time t

L_t is the number of people employed in time t

$A_o e^b$ is the TFP, where the fixed component of TFP A_o is assumed to grow at a rate *b*.

To undertake an econometric estimation of equation (1), we get the natural logs so that our equation takes the form

$$\ln Q_t = \ln A + \alpha \ln K_t + \beta \ln L_t + bt + d + \mu_t \quad \text{.......} 2$$

We included a dummy (d) variable in equation 2 to capture the effects of liberalization on the port.

Since ln A in equation 2 is not observable, the estimated factor shares from equation 2 are used to construct the annual TFP growth so that the TFP growth rate is measured by reorganizing equation 3 to get

[2] A port is an economic unit that provides a service as opposed to producing a physical product. The amount of this transfer service is referred to as the port throughput (Cullinane *et al.,* 2006). The port throughput hence gives us the output of the port production function. Port throughput is total cargo handled by the port.

[3] Labour and capital costs of a port comprise 95 per cent of total cost structure of a port. It therefore seems a reasonable assumption that this is sufficiently high proportion to describe virtually the whole cost account (Cullinane *et al.,* 2006)

$$\Delta Q / Q = \alpha \Delta K / K + \beta \Delta L / L + \Delta A / A \ldots\ldots 3$$

$$\Delta A / A = \Delta Q / Q - \alpha \Delta K / K - \beta \Delta L / L \ldots\ldots 4$$

Hence, TFP growth is the residual after subtracting from output growth, the weighted rate of growth of factor inputs, where the weights are the corresponding input shares. The study moved further to correlate the TFP growth generated with key macroeconomic variables identified through the PESTEL analysis. This helped us identify the magnitude of the relationship between TFP and the identified variables.

4.2.1 Data requirements

Secondary data on port of Mombasa between 1978 and 2007 sourced from KPA, various statistical abstracts and economic surveys among other sources is used for the analyses. The GDP per capital and exchange rate data for the correlation test is sourced from various statistical abstracts. The period of analyses is from 1978 when KPA was established after the collapse of the East African Community in 1977. From political independence in 1963 to 1977, the port of Mombasa was part of the East African Harbors and railways corporation with headquarters in Dar-es-Salaam.

The study uses net book value of cargo handling equipment as capital. The net book value of cargo handling equipment is adjusted for price effects by deflating using the commercial loans interest rates to get the capital inputs. Earnings to the public sector in the supporting services to water transport are used as a proxy for labour input. The labour earnings are also deflated using consumer price index to remove the price effects in the data. We use cargo throughput in tonnes as the output.

4.2.2 Estimation issues

All the three series cargo, capital and labour, were tested for stationarity using the Augmented Dick Fuller (ADF) test and Philip Peron test. The long run production function was estimated using the Johansen methodology of cointegration (1988 and 1991), interpreted as representing a long run equilibrium relationship. The methodology is based on the following vector error correction model (VECM).

$$\Delta x_t = \sum_{i=1}^{p} \Gamma \Delta x_{t-i} + \Pi x_{t-1} + \mu + \varepsilon_t \ldots\ldots 5$$

Where $\prod = -\left[1 - \sum_{t=1}^{p} A_i\right]$ and $\Gamma_i = -\sum_{j=t+1}^{p} A_j$

Γ is a matrix that represents short term adjustments among variables, $\Pi = \alpha\beta'$ therefore $\alpha \ \beta' x_{t-1}$ gives the long-run information, β' gives the normalized cointegrating vector which gives the long run coefficients, is the vector of adjustment coefficient and gives the adjustment of the short run disturbances to the long run path. Two tests were used to determine the number of cointegrating vectors, the trace test and the maximum-eigenvalue test.

The Johansen methodology estimation followed these steps (Enders, 2004):

1. Testing for the order of integration using ADF and Phillip Peron units root tests.
2. Determining the lag length to be used by using different information criterion. This is done because the results of the tests can be quite sensitive to the lag length.
3. Performed diagnostic tests on the estimated VAR model to test that the errors are white noise.
4. Estimated and determined the number of cointegrating equations using the maximum eigen value and the trace statistics.
5. Imposed cross equation restrictions and analyzed the normalized cointegrating equations.

4.3 PESTEL Analysis

The constructed annual TFPG was linked to a PESTEL analysis. This analysis captured factors that have affected the port performance as well as those that are likely to affect the port in the future. In this analysis, political, economic, social, technical environment and legislative factors were looked at.

The main aspects of PESTEL analysis involve looking at external factors, influences or pressures that have identified implications and impacts now or in the future for each of the PESTEL components:

- Political-Global, national, regional and local political trends.
- Economic-Economic growth trends and economic reforms in the world, region and in the nation.
- Social-Developments in the society such as cultural, behaviour expectations and composition.

- Technological-Developments in information technology, inventions and other new discoveries.
- Environmental-Global, regional and national environmental pressures and developments.
- Legal-World, regional or national legislation and regulatory changes.

The identified factors through the PESTEL analysis were correlated with the TFP growth to identify the strength of the relationship between them.

5. Estimation Results and Analysis

5.1 Descriptive Statistics

Table 5.1 gives a summary of the port statistics. The average cargo handled by the port per year is 8,531 thousand tonnes. Capital required to handle this cargo is Ksh 2,439 million, while the labour required is Ksh 1,422 million almost half that of capital. The minimum and maximum cargo handled by the port is 5,931 thousand tonnes (1979) and 14,101 tonnes (2006).

5.2 Time Series Properties

5.2.1 Unit root tests

Time series properties of the data used in the estimations were examined using the Augmented Dickey Fuller test and the Philip Peron test. The unit root tests were conducted by including an intercept, and intercept and trend. The unit roots tests were done to determine the order of integration of the three variables by determining whether the variables are stationary or not, at levels. The order of integration is important in determining if the variables are co-integrated, that is, if there exists a long run relationship. For cointegration to exist, the variables have to be integrated, and of the same order unless they are multicointegrated.

As indicated in Table 5.2, cargo and labour became stationary after differencing once. This means that they are difference stationary, and are therefore integrated of order 1. Capital became stationary after detrending meaning that it is trend stationary and is integrated of order zero.

5.2.2 Diagnostic tests and lag length selection for the VAR

The appropriate lag length for the VAR and cointegration analysis was determined using VAR order selection criteria. Lag 3 was the one selected by most of the criteria (final prediction error, akaike information criteria, and Hannan-Quinn information) as indicated in Appendix 1.

Table 5.1: Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cargo	30	5931.00	14101.00	8531.0000	2227.41618
Capital	30	181.78	10802.04	2439.5867	2160.60148
Labour	30	209.72	5236.50	1422.3133	1593.97253

Table 5.2: Unit root tests

Variable	Test	Test at levels		Test at difference		Results
		Intercept only	Intercept and trend	Intercept only	Intercept and trend	
Cargo	ADF	0.520007	-1.01594	-5.672269	5.821291	Variable is 1(1) No trend in the series Stationary at first difference (Difference stationary)
	PP	0.979666	-1.329756	-5.672269	-6.401500	
Labour	ADF	-2.307703	-2.077561	-1.882216	-2.054167	No trend in series Variable 1(1) stationary at first difference as indicated by the PP (Difference stationary)
	PP	-1.377946	-1.019682	-4.532262	-4.782532	
Capital	ADF	-2.336486	-3.967601			Trend in series Variable is 1(0) (Trend stationary)
	PP	-2.336486	-3.967601			

Critical values at 1%, 5%, 10% significance levels are as follows; intercept ADF (-3.689194, -2.971853, -2.625121), PP (-3.679322, -2.967767, -2.622989), Intercept and trend ADF (-4.323979, -3.580623, -3.225334), PP (-4.309824, -3.574244, -3.221728)

The diagnostic tests consisted of test of normality using the Jarque Bera normality test, serial correlation LM test and white heteroscedasticity test. The results as indicated in Appendix 2, show that our VAR(3) is well specified with the residuals appearing normal, homoskedastic and serially uncorrelated.

5.2.3 Cointegration test

Having established the non-stationarity of the variables and the lag length, a cointegration test was done using the Johansen cointegration test. This test was done to check for the existence of a long run equilibrium relationship among the variables. If cointegration is established, then there exists a long run relationship among the variables, if not, the long run paths of the variables are divergent and therefore there exists no long run relationship. The results in Table 5.3 indicate two cointegrating equations at 5 per cent significance level.

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level. The study assumed a linear deterministic trend due to the existence of a trend stationarity in capital.

The existence of two cointegrating equations indicates that despite the variables being individually non-stationary, a linear combination of them is stationary, an indication of long-run relationship between variables.

Table 5.3: Test for cointegration

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.801147	83.26502	42.91525	0.0000
At most 1 *	0.774386	41.27011	25.87211	0.0003
At most 2	0.093699	2.557977	12.51798	0.9244
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level.				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.801147	41.99490	25.82321	0.0002
At most 1 *	0.774386	38.71213	19.38704	0.0000
At most 2	0.093699	2.557977	12.51798	0.9244

Tests for long-run relationship

We test for long-run relationship by imposing restrictions. From the theory of production, output is determined by the amount of inputs, while cargo handled is determined by the amount of labour and capital. We impose the restriction of B(1,1)=1, B(1,2)=0, and B(1,3)=0 to test that no long-run relationship governs cargo, labour and capital or that cargo is exogenous to capital and labour. The result gives us an LR of 16.05 and a p value of 0.000327. This leads to the rejection of the null hypothesis indicating that we have a long run relationship between cargo, capital and labour. We do the same test on capital so that our restriction is B(2,1)=0, B(2,2)=1, and B(2,3)=0; the results give us an LR statistic of 17.94 and a p value of 0.000023 indicating that we have a long run relationship in our second row which can be normalized on capital.

These results indicate that at least one of our cointegrating equations can be normalized on cargo. These results are expected. From the theory of production, output is determined by the amount of inputs, in this case cargo handled is determined by the amount of labour and capital, hence normalizing on cargo.

Weak exogeneity test

We have so far assumed that all the variables in the model are endogenous. We expect that there will be feedback effects from one variable to the next. The variables may not be endogenous, meaning a single equation framework can be used for estimation.

To test for these, we use weakly exogeinity tests which tell us if a variable responds to deviations from the long run. If the speed of adjustment in the α_i matrix are zero, then the variable is weakly exogenous. If all the model variables are weakly exogenous, then we can use single equation formulation, if not, then we can use system of equations (Odour J., 2008). In this study, the first hypothesis is that labour is weakly exogenous in the port production model (α_3 =0 restricted by A(3,1)=0), and the second hypothesis is that capital is weakly exogenous in the port production model (α_{21} = 0 restricted by A(2,1)=0).

The weakly exogeneity tests results show that capital has a p value of 0.602840. We accept the null hypothesis that capital is exogenous to the long run port production model. The exogeneity test for the labour variable gives us a p value of 0.288073, indicating that labour is exogenous to the port production model. This means that a single equation specification framework can be used to model cargo on capital and labour (Enders, 2003).

Using the above restrictions, we can get the restricted cointegrating coefficients for the port of Mombasa long run production model as indicated in Table 5.4.

The sample values of χ^2 for the exclusion of labour or capital are 18.6 and 3.81 respectively, comparing these values to 3.8 the critical value at 5 per cent significance level, they all are above 3.81 indicating that labour and capital are significantly different from zero in the port long-run production function.

Table 5.4: Cointegrating coefficients-long run equilibrium relationship

Restricted cointegrating coefficients (not all coefficients are identified)			
LN_CARGO01	LNCAPITAL	LNLABOR	@TREND(79)
1.000000	-0.033909	-0.204838	-0.024080
-0.494438	1.000000	0.000000	-0.158903

5.3 Total Factor Productivity Growth and Returns to Scale

Using the above restricted cointegrating coefficients, we can write our long run port production function as

$$\ln Q_t = 0.034 \ln K_t + 0.20 \ln L_t + 0.024 trend ....7$$

which is consistent with a traditional Cobb Douglas production function. The signs of the estimated coefficients are also consistent with the traditional Cobb Douglas production function. An econometric interpretation of these results is as follows, the coefficient of capital 0.034 measures the partial elasticity of output with respect to the capital. It indicates holding labour input constant. If capital input at the port of Mombasa increases by 1 per cent on the average, the seaport output goes up by 0.03 per cent. The same applies to labour; if it is increased by 1 per cent, then the port output will increase by 0.2 per cent. This interpretation gives an important policy message that labour has more responsiveness to output than capital. The trend coefficient can be interpreted as indicative of a positive TFP growth of about 2 per cent.

If we add the two coefficients, we obtain the returns to scale parameter, which gives the response of output to proportional change in inputs. The sum of the two coefficients of capital and labour is 0.234 suggesting that the port of Mombasa is experiencing decreasing returns to scale, doubling the input may less than double the output. This finding is consistent with Ahmed *et al.* (2008).

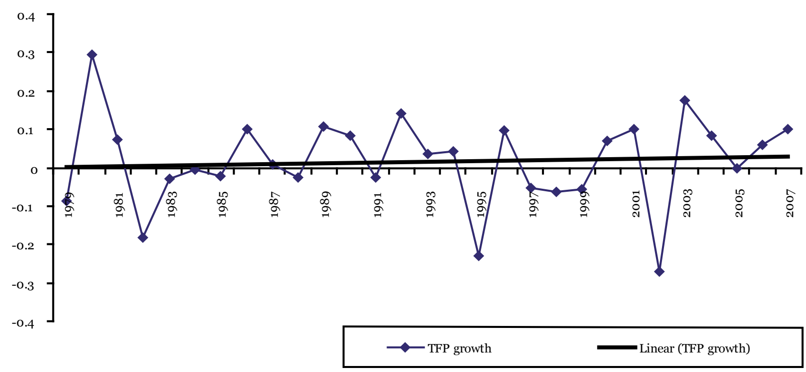
To estimate the TFP growth from year to year, we use the estimated parameters such that we can get the TFP growth to be

$$\Delta A / A = \Delta Y / Y - 0.034 \Delta K / K - 0.2 \Delta L / L$$

The results are indicated in Figure 5.1.

However, these parameters estimates are likely to be super consistent as indicated in Stock's 1987 study (cited in Enders, 2003) that estimates cointegrating non stationary variables converge faster than estimates using stationary variables giving super consistent estimator.

Figure 5.1: Total factor productivity growth

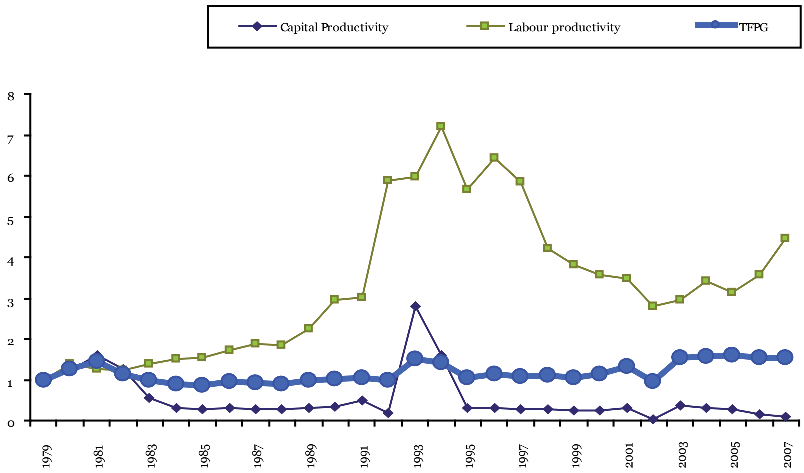


As indicated in Figure 5.2, the TFP growth for the port of Mombasa has been on the increase. This confirms the positive coefficient of trend (+0.024) established. It is important to note that the TFP growth in this case captures the effects of technical change and scale effects and assumes the port is efficient. Notably also, the TFP is changing more in some years than others, a clear indication of the effects of the business environment in the country on shipping.

For instance, the port experienced a low TFP growth in a number of years especially in the mid 80s and 90s. This was mainly due to slow economic growth and political instability in the neighbouring countries of Sudan and DR Congo, among others. Since 2000, the port has experienced increasing TFP growth. This can be attributed to increased economic growth which averaged 6 per cent between 2004 and 2007, and peace in the country as well as in the hinterland countries.

To establish which of the factors of production are contributing to the increase in TFP growth, we estimated the partial productivities of capital and labour, by getting the ratio of cargo handled in tonnes to capital inputs and wages in shillings. Figure 5.2 indicates that capital productivity has been on the decline, while labour productivity has been on the rise. The increase in port productivity can be attributed to increased labour productivity.

Figure 5.2: Partial productivities and TFPG



5.4 PESTEL Analysis and the TFP Growth

As indicated in Figure 5.2, the productivity of the port has been changing from one year to another. Some of these changes can be attributed to changes happening in the country's political and economic environment. For instance, there is an increase in the TFPG in major economic reform years such as 2003 and a decline in TFPG in years with political instability such as the 1982 coup, and 1997 and 2002 election years. This necessitates the need to link the TFPG results with the environment in which the port operates. Table 5.4 provides a link of the TFPG with the political and legal reforms, economic reforms and growth, technological advancements, environmental and social and cultural factors that influence the performance of the port.

From the PESTEL analysis, the port is affected by several macroeconomic issues mainly economic growth, exchange rates and politics. To confirm the findings of this analysis, a correlation test between TFP, GDP per capital, exchange rates[4] and a dummy for years with political instability (1982 and all election years 1992, 1997, 2002, 2007 and the constitution review referendum was done). The correlation matrix in Table 5.5 indicates that GDP per capital has a positive relationship with the port TFP growth. The exchange rate has a negative relationship with the port TFP growth. The relationship of the political years to TFP growth is negative as expected.

The positive relationship between economic growth and TFP growth is expected. Economic growth increases imports and exports, hence increasing the cargo handled by the port meaning that a 10 per cent increase in the GDP per capital is associated with a 4.03 per cent increase in TFPG. Similarly, a 10 per cent increase in TFP growth is associated with a 4.03 per cent increase in GDP per capital. The depreciation of Kenya shilling discourages imports, hence the negative relationships of 0.0583. This means that a 10 per cent increase in the exchange rate is associated with a 5.83 per cent decrease in TFP growth. Similarly, a 10 per cent increase in TFP is associated with a 5.83 per cent decrease in exchange rate. The dummy for political years also indicates that politics has a negative relationship with the TFP growth of Mombasa port.

[4] Using data from various Economic surveys and statistical bulletins

Table 5.4: PESTEL analysis

Dimension	Issues	
	Link with TFP	A futuristic perspective
Political/ legal (political reforms, stability and legal reforms).	Decline in 1982 due to attempted coup. Notable declines in 1997 and 2002 election years due to political instability. Increased performance from 2002 due to political stability and peace in Kenya and hinterland countries. 2005 decline due to the constitution review referendum. Performance in the period beginning 2003 also attributable to the various governance and civil service reforms. 1995 decline attributable to gulf crisis which raised oil prices.	Recent post election violence likely to affect performance. Peace at the hinterland shaky with the recent DR Congo war and upcoming referendum in Sudan. Somalia pirates could affect the routing of cargo ships. The transformation of the port into a landlord port. The proposals to have an open register system in Kenya is likely to increase ships calling at the port.
Economic (economic and market reforms, growth, exchange rates and interest rates among others).	Decline in TFP in 1979 due to impact of oil shocks of 1977-1979 on imports. Increased TFP growth in 1980 due to removal of import banso. Reduced economic growth in 1983 and after due to relaxing of high tariff protection in the 1960s and 1970s. High productivity change of the port observed in 2003 due to increased economic growth accompanied by economic reform. The 1986 performance due to impact of preferential trade area for Eastern and Southern Africa (now COMESA). 2001 increase due to the signing of the EAC treaty. 1995 decline can be attributed to the impacts of the 1994 drought.	Introduction of a 24 hour system at the port likely to improve performance. Continued economic growth in the sub-Saharan African countries is likely to increase cargo at the port. The development of oil facilities in Angola and Nigeria and new liquefied petroleum gas in Equatorial is likely to increase ports activities.
Social-cultural	The high population growth rates in the 1980s and the first incidence of HIV/AIDS in the country could have contributed to the low TFP.	Efforts to manage HIV/AIDS and population is likely to have a positive on TFP.
Technological	Increased performance from 2003 due to the modernization of cargo handling equipments. The automation of cargo clearing systems also contributes to increased performance in 2003.	Increasing larger vessels versus the low depth of the port could lead to the port being relegated to a feeder port. There is need to accelerate the dredging plans.
Environmental issues	The establishment of the Kenya Maritime Authority in 2004 enabled international ships to call at the port of Mombasa due to port compliance with SOLAS 1974 (safety of life at sea convention).	The periodic and constant dredging of ports is sometimes very expensive for ports to manage due to the pollution controls that come with it.

Table 5.5: Correlation between TFP, exchange rates and politics

Per TFP	1.000000			
Capital GDP	0.0403	1.0000		
Exchage rates	-0.0583	0.8978*	1.000000	
Election years	-0.2805	0.1828	0.1140	1.000000

** All coefficients significant at the 5% level or better.*

5.5 Interpretation of Results

Tests for stationarity of the series were done and capital and labour were found to be in difference stationary, while capital was trend stationary. The cointegration tests found evidence of two cointegrating relationship of which one was interpreted as the long-run port production function. Exogenous tests indicated lack of feedback effects from one variable to the next, meaning one single equation could be used in the study.

The results indicate a general increase in the TFPG, an indication of increased performance of the port for the period under review. The results also indicated decreasing returns to scale, which show that increased labour and capital might not necessarily increase cargo handled.

The responsiveness/elasticity of labour to cargo is 0.2, while that of capital to cargo is 0.034 indicating that cargo is more responsive to labour than to capital in the long run. Thus, holding labour and other factors constant, if the capital input is increased by 1 per cent, then the cargo handled would increase by 0.03 per cent. Holding the capital input and other factors constant, 1 per cent increase in labour would increase cargo handled by 0.2 per cent. This could be as a result of the recent modernization of cargo handling equipment.

The year to year TFP varied, an indication of the changes in the performance of the port. These variations could be linked to the political, economical, technological, social-cultural and environmental factors in the country at the time.

There was notable decline in TFPG in the years the country experienced political instability (1982, during the coup and all election years) and an increase in the TFPG in the years the country had positive economic growth (period after 2002). The gulf crisis could also be attributed to the decline in 1995 TFPG. This gives a good indication of the impact of politics and economic growth to port performance.

The increased performance in the port could be attributed to increased labour productivity. However, the capital productivity was on the decline indicating that the port performance problems are more on the capital productivity than labour.

A correlation test indicated that economic growth had a positive relationship with the port's TFPG. Exchange rate depreciation and dummy variable for political years indicated a negative relationship with the port's TFPG.

6. Conclusion and Policy Recommendations

6.1 Conclusion

This study sought to assess the performance of the port of Mombasa from 1978 to 2007 by estimating the yearly TFP growth, analyzing factors affecting the port performance and assessing the returns to scale. The results indicate a general increase in the TFPG, hence the performance of the port for the period of the study. The performance of the port could be linked to the political, economical, technological, social-cultural and environmental factors in the country at the time as indicated in Table 6.1. Economic growth and the political environment were identified as key factors affecting the port performance among others in the PESTEL.

The results indicate decreasing returns to scale which shows that increasing labour and capital in the same proportion would increase cargo by a smaller proportion. Labour productivity has been on the increase while capital productivity has been on the decline, an indication that the port performance concerns are mainly from the capital than labour.

6.2 Policy Recommendations

Invest in another port

The port is experiencing decreasing returns to scale meaning that in the long run, it might not be attractive to invest more in the port of Mombasa in its current state. There is need to invest in another port such as the port of Lamu as proposed in the Vision 2030 to deal with the decreasing returns to scale. This could be done through public private partnerships or through engaging development partners.

Another port would bring in competition in port services enhancing efficiency in service delivery, and help the government deal with decreasing returns to scale. The new port would also take development to another coastal town by creating new maritime associated industries.

Increase the port's attractiveness

The government needs to put up measures and incentives that specifically encourage the number of ships calling at the port of Mombasa. This would be through offering incentives for ship ownership by revising the Merchant Marine Act to facilitate an open registry system which will encourage many ships to be registered under the Kenyan Flag as well as for locals to own ships.

The government should also fast track the proposed dredging that would encourage large ship arrivals. Currently, the largest container vessel that can call at the port of Mombasa is approximately 1,800TEU compared to South African ports which receive up to 4,000TEU. Dredging to increase large ships will greatly increase the port attractiveness as a regional hub as all ships will be able to call at the port increasing the cargo handled and the ship calls, hence increasing the port's productivity.

Ensuring a conducive business environment

The port performance is greatly affected by the business environment in the country and globally. At the country level, the country needs to continue with macroeconomic reforms aimed at increasing economic growth, and promoting investor confidence by ensuring there is political stability even in election years.

Invest in cargo handling equipment

The government also needs to increase investment in cargo handling equipment, while ensuring that increasing labour productivity is maintained. The increase in containerized traffic worldwide also necessitates the need for the port to invest more in cargo handling equipment.

Develop other modes of transport in tandem

The total factor productivity growth indicated a slight increase in the port performance meaning that the current delays and cargo congestion are not purely as a result of the port management. The government needs to develop other modes of transport such as road and railway and trade facilities such as customs in tandem to ensure seamless movement of cargo.

6.3 Suggestions for Further Research

The study concentrated on assessing the performance based on services offered by the port, however there are other services offered by other government agencies that can also affect the performance of the port. This includes customs services by Kenya Revenues Authority, standards and quality check by the Kenya Bureau of Standards and road and rail transport. Though important, these issues were not considered in this study and provide opportunities for further research.

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Appendix

Appendix 1: VAR lag order selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: LN_CARGO01 LNCAP LNLABOR
Exogenous variables: C DUMMY

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-29.61161	NA	0.003109	2.739355	3.029685	2.822960
1	28.54644	93.94762*	7.18e-05	-1.042034	-0.316209*	-0.833022
2	37.82143	12.84230	7.37e-05	-1.063187	0.098133	-0.728769
3	51.91861	16.26597	5.55e-05*	-1.455278*	0.141537	-0.995453*
4	60.43285	7.859300	7.12e-05	-1.417911	0.614398	-0.832680

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2: Summary diagnostic tests

Test	Statistic	p-value	Conclusion
Normality test	JB(9.1447)	0.1656	Residual are multivariate normal
Residual serial correlation	LM(10.5395)	0.3086	There is no serial correlation at lag order 3
Heteroscedasticity	Ch-sp(116.1196)	0.4272	VAR residual are not heteroscedastic

If the P values are greater than 0.05 then we reject the null hypothesis that: residuals are not multivariate normal, the residuals are serially correlated and that the VAR residuals are heteroscedastic.

Appendix 3: Exogeneity tests

Restrictions:				
b(1,1)=1, b(1,2)=0,b(1,3)=0				
Tests of cointegration restrictions:				
Hypothesized No. of CE (s)	Restricted Log-likehood	LR Statistic	Degrees of freedom	Probability
1	46.19903	16.11491	2	0.000317
2	64.60213	18.02084	1	0.000022
Restrictions:				
b(2,1)=0, b(2,2)=1,b(2,3)=0				
Tests of cointegration restrictions:				
Hypothesized No. of CE (s)	Restricted Log-likehood	LR Statistic	Degrees of freedom	
2	64.61996	17.98519	1	0.000022

Appendix 4: Weak exogeneity tests

Restrictions:				
b(1,1)=1, a(3,1)=0,				
Tests of cointegration restrictions:				
Hypothesized No. of CE (s)	Restricted Log-like-hood	LR Statistic	Degrees of freedom	Probability
1	53.69183	1.129304	1	0.287924
2	73.50317	NA	NA	NA
Restrictions:				
b(1,1)=1, a(2,1)=0,				
Tests of cointegration restrictions:				
Hypothesized No. of CE (s)	Restricted Log-like-hood	LR Statistic	Degrees of freedom	Probability
1	54.10848	0.295996	1	0.586404
2	73.03781	NA	NA	NA