Chinedum Onyemechi, Ph. D.
Department of Maritime Management Technology
Federal University of Technology Owerri
Owerri
Nigeria

Review article

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PORT EFFICIENCY MODELLING IN THE POST CONCESSIONING ERA: THE ROLE OF LOGISTICS DRIVERS, AGILE PORTS AND OTHER PERSPECTIVES

SUMMARY

The work described the use of efficiency measures and other logistics metrics and drivers in improving port performance for the port concessionaires. Both the logistical drivers of transportation, facilities and inventory and the cross functional drivers of information, pricing and sourcing have been analyzed to ascertain their contribution to the port supply chain. The role of the regulator in applying the rate of return regulation and price cap regulation to induce concessionaire cost reduction and their technological inputs into the port system have been compared. Static efficiency as well as dynamic efficiency and their benefits to the port concessionaires have been analyzed. A situation has been developed where agile ports will develop healthy partnership cultures through dynamic partnerships with other agile ports and dry ports with integrated transportation chains.

Key words: port efficiency modelling, port regulation, concessioning, logistics, West Africa

1 INTRODUCTION

In the post concessioning era of the port industry in Africa, most African nations have been dormant in implementing a virile regulatory framework for the management of their concessioned ports. Some have chosen to see the port authority as the regulator without any legislative power to execute the act of regulation. This has created a situation where the port authority exists as a docile partner in the committee of port operators. One explanation to this is the lack of knowledge in modern day port management principles.

The objectives of this work are as follows: first, to develop a port regulatory framework for African ports as well as to develop an agile efficiency model of the port system in a total port supply chain using both logistics and functional drivers.

2 LITERATURE REVIEW

Modelling tools applied in measuring port efficiency in recent years have been inconsistent. Wang, Song and Cullinane (2004), according to Cullinane (2002) there exists no standard methods that are accepted as applicable to every port for the measurement of its performance. One reason given for this is the plethora of organizations to which the port system owes a duty of efficiency; namely, the shipping lines, the cargo owners and the land transport operators. Attempts to standardize efficiency and productivity measures of ports have resulted in the use of some of the following port performance measures:

1. Short term port productivity measures: namely, measurement of the stevedoring process, gate intermodal cycles and yard operations.
2. Long term port productivity measures: namely, overall throughput, terminal throughput density and container storage dwell time.
3. Measure of port productivity based on six indicators: namely, productivity, net berth productivity, gross gang productivity, net gang productivity and net/net gang productivity, Robinson(1999).
4. Fourthly, the use of single performance indicators the shadow price of variable port throughput per profit dollar was advocated by Talley (1994).

At the general level, more sophisticated analytical tools have been applied in port efficiency evaluation. Some of them include: the analytical hierarchy process AHP, data envelopment analysis DEA, fuzzy logic, statistical multivariate analysis such as cluster analysis, principal component analysis, factor analysis stochastic frontier analysis regression methods, production function techniques, etc.

The shipper's choice of a port in the modern world is based on the existence of a perfect supply chain attached to the port. Magala and Sammons (2008) opine that the shipper's choice of a port depends on the existence of a supply chain. In this parameter, studies focused on the shipper's choice of a port in isolation of the supply chains remains suboptimal or inefficient, Robinson (2002), Magala (2004).

3 METHODOLOGY

The method adopted in this work is basically exploratory as it intends to meet its objective of developing a port regulatory framework for African ports in the post port concessioning era. The other objective of developing an agile efficiency model of the port system is also complied by using the logistics drivers and cross-functional drivers of the port supply chain.

4 REPORT OF FINDINGS

The work received the constituents of the port supply chain by using the logistics drivers of transport, inventory and facility as well as the cross functional drivers of information, pricing and sourcing.

Analytical instruments applied in determining port efficiency in modern times include, but is not limited to, the following: Analytical Hierarchy process, principal component analysis, factor analysis, discriminant analysis, and fuzzy logic etc. These tools reveal different levels of port efficiency models applying input and output data.

In a total port system supply chain of the present day, that takes into cognizance of the six different aspects of the total logistics and functional drivers in the port supply chain, this model will reveal more about the science of managing an efficient port system.

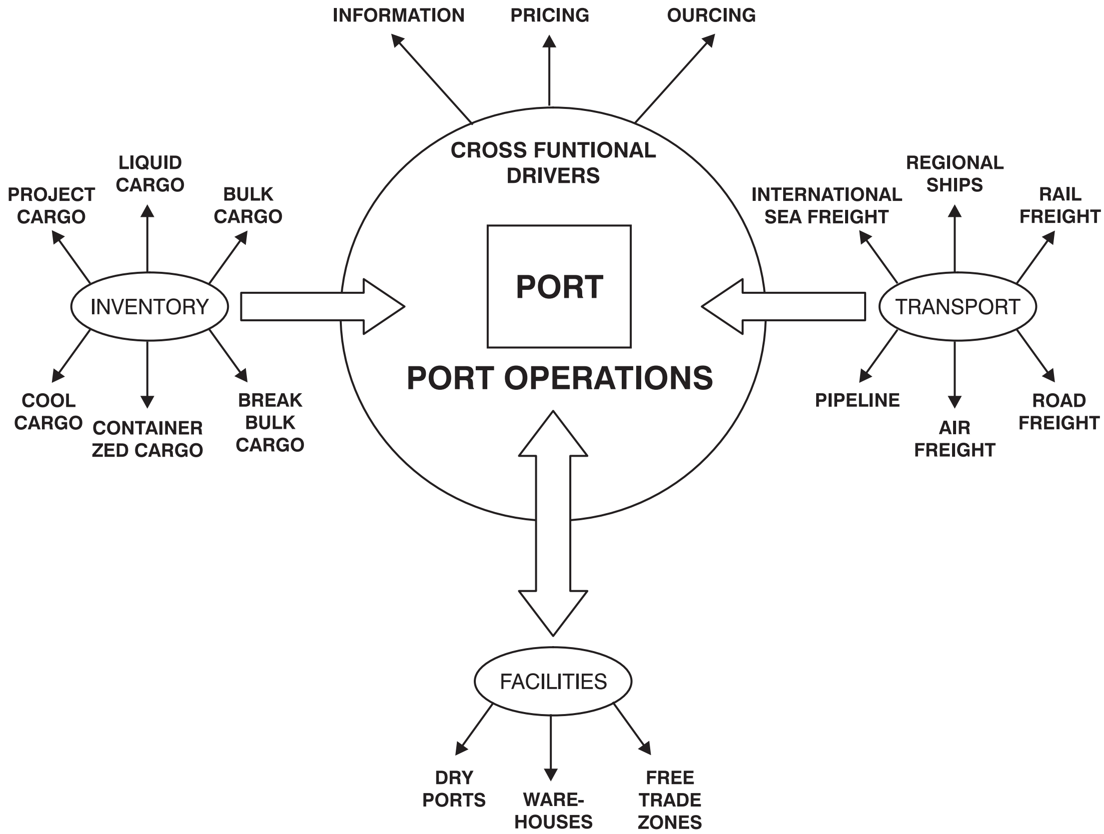

Fig. 1 Total port supply chain efficiency model

Most importantly, in addressing the efficiency problem in a modern port system, one must identify the logistics and cross functional drivers operating in the port system supply chain. Diagrammatically represented in fig.1 is the total port supply chain efficiency model proposed in this work.

The supply chain efficiency in the port system is efficiency achieved across the total port supply chain. An activity in each arm of the supply chain obviously affects the efficiency of other constituents of the supply chain. The port at the center of the supply chain diagram acts as a recipient and agile distributors of inventories. Different types of inventories are available from the global market. Restrictively, they may be classified under the following subheadings: liquid cargo, bulk cargo, project cargo, cool cargo, containerized cargo and break bulk cargo. These inventories are received and stored in the ports warehousing and stacking facilities for onward transfer, like facilities situated in the port hinterland via agile transport logistics systems. The speed of transfer will be limited to the level of agility available in the transport logistics constituents of waterway transport, rail transport, pipeline and road transport. These transportation networks will be channeled to connect dry ports, and warehousing facilities located in the hinterlands.

Apart from the basic logistical drivers discussed above, certain other constituents of the total port systems supply chain presently classified as cross functional drivers also affect the efficiency of the port system. These drivers are namely: information, pricing and sourcing.

The need for port regulations in the post concessioning era have been established in Trujillo and Nombella (2000). This is because once a port or parts thereof has been bidden for and awarded to concessionaires, the tendency for a new monopoly returning to the port system is high. To avert this situation, a regulatory regime, based on either the rate of return regulation or price cap regulation, is necessary. The regulation thus offers a new way of inducing competition among the concessionaires.

The regulation may not be necessary if there is substantive evidence that competition exists among the ports. There are intraterminal, interterminal and interport competitions. Kent and Houston (1998) have established a threshold value to limit competition among ports.

Table 1

Type of competition	Level of traffic (TEUs)
Intraterminal	30,000
Interterminal	100,000
Interport	300,000

Source: Kent and Houston, 1998

4.1 The regulatory process

The regulator tries to achieve two things in the process of port regulation: the first is a static efficiency. Here, the regulator tries to get the operator to minimize cost and allocate resources to the area where they yield the most to the society. The second is a dynamic efficiency. Here, the regulator tries to stimulate the right amount of innovation and investment to ensure that the operator can meet future demands. The regulator in the process of regulating must ensure the operator breaks even, or recover cost plus minimum profit.

The regulator balances the return on the investment of the operator to enable him to invest into the port as well as to reduce the power of the operator with monopoly power. To achieve this, two methods are available to him (rate of return regulation and price cap regulation).

4.1.1 Rate of return regulation

Under the rate of return regulation, the regulator controls the maximum rate of return allowed from the investment thus controlling the profit of the firm. It works with the formula:

$$\text{Allowed rate of return} \times \text{assets value} = \\ = \text{price} \times \text{quantities-operational costs} \quad (1)$$

Stated in another form, the concessionaire or operator will not be interested in the port concession unless:

$$\text{Price} \times \text{quantities} \geq \text{operational cost} + \\ + \text{allowed rate of return} \times \text{asset value} \quad (2)$$

Thus, the in rate of return regulation information on cost is very important. In this sense a risk adjusted rate of return which passes risks to the users is often used. The major problem with the rate of return regulation proceeds from the fact that excess incentives can be built into the rate of return equation, Estache and Rus (2000).

4.1.2 Price cap regulation

This regulatory method was introduced by United Kingdom in the 1970's. Under the price cap regulation cost incentives are increased while the incentive to over invest is decreased. The price cap allows an operator to increase his prices with inflation, less a discount factor *x*, which reflects part of the average increases in productivity. The factor is intended to transfer benefits to the users.

Expressed as an equation, the price cap regulation technique is shown in equation (3):

$$\text{Price in year } 1 \leq \text{price in year } 0 \times \\ \times (\text{inflation} - \text{factor } x) \quad (3)$$

By adjusting the factor *x* between positive, negative and 0, the regulator can achieve various levels of efficiency in the system. The regulator in setting $x = 0$ adjusts only the price for inflation, leaving the real price as a constant. This means that the initial price set at year 0 is maintained. Again, where the regulator wants to improve efficiency in the regulated industry (the concessioned ports) he sets *x* to be positive, thus lowering real prices. Prices charged in this case are lower than price in year 0. This will cause the concessionaires to cut costs and achieve efficiency gains higher than the industry average. Where the regulator wants to promote additional investment in capacity or quality, he sets *x* to be negative. The implication here is that real prices are increased. Prices will be higher than in year 0.

Once *x* has been set, it is important that it be left constant for four to six years in order to stimulate improvements in the regulated industry for that period. After this period, the regulator resets *x* based on the cost reductions and passes on all or parts of these gain to the user.

4.2 Parameters for full supply chain port efficiency modelling in Africa's post port concessioning era

In line with Magala and Sammons (2008), the need for new modeling tools for the total supply chain in which the port serves as an important contributor is necessary. To evolve such a model the following attributes of the port supply chain should be put into consideration:

1. **Port Administration.** This considers the regulatory frameworks existing in the port. To what extent are the concessionaires regulated? How does the port avail itself of modern regulatory concepts in line with the fourth generation port principles? How agile is the port?
2. **Port logistics.** The question to be answered includes, but is not limited to, the following: How are the logistics drivers of transport, inventory and facilities provided for in the port investment master plan? What levels of connectivity exist between the port and its most efficient neighbours like the inland container deposits (ICD) or dry ports. What facilities exist for warehousing and storage in the port and its hinterland? What level of analysis is done to ascertain the expectation of cargo inventories in the ports?
3. **Cross functional drivers in the port system.** This consists of the information system, port pricing and level of outsourcing in the port system. A system that emphasizes information sharing between ports will be more efficient than other ones. Information sharing between ships and ports and between ports and ports is very important. A port pricing regime under a regulated port system will be more efficient than where no regulation exists. With respect to sourcing, the need of outsourcing port functions to operators other than the concessionaire should be properly documented in the concessioning agreement to ensure full participation of local operators (Local content should be accomodated in the perspective of including international investors).
4. **Quality management.** This involves the analysis of the quality of services delivered by a port. Included are here port benchmarking procedures which compare various levels of port parameters with each other. Non parametric analytic tools as well as performance indicators are in use. These measurements, however, should be extended to cover activities along the port supply chain hinterland.

5 CONCLUSION AND RECOMMENDATIONS

The post concessioned African ports should imbibe the concepts of regulation to improve the efficiency of service delivery at its ports. The port Authority should liaise with the tertiary institutions knowledgeable in port research in the bid to evolve and apply logistics research methodologies that will improve efficiency in its concessioned ports. Models that will capture the local content requirement in the ports section should be encouraged. Lastly, the work has established the need for improved port efficiency models for the regulation of post port concessioned African ports.

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