Port Efficiency and Effectiveness

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A port is a node in a transportation network – a spatial system of nodes and links over which the movement of cargo (passengers) occurs. A port is also an economic unit that provides a (transfer) service as opposed to producing a physical product. ***The amount of this transfer service is referred to as the port's 'throughput'***. In a competitive environment, ports not only compete on the basis of location and operational efficiency, but also on the basis of the fact that they are embedded in the supply chains of shippers. Users of port services are those that utilize the port as part of the transportation process of moving cargo (passengers) to and from origin and destination locations. Users include transportation carriers such as shipping lines, railroads and trucking firms that perform these movements and shippers and individuals that provide the cargo and themselves as passengers to be transported. Port users demand port services, whereas port service providers supply port services to port users. The primary port-service provider is the port's terminal operator that operates the port or one (or more) of its marine terminals. Other port-service providers include, for ex-ample, stevedores, ship agents, customs brokers, freight forwarders, ship pilots and towage, dredging and government customs-service providers.

A study is made which disaggregates the demand for port services between bulk and container throughput by assuming that a port handles only both these two types of cargo and has the economic objective of maximizing annual throughput (of bulk and container cargoes) subject to a minimum profit constraint. The annual demand for the port's bulk and container throughputs are functions of the generalized cost (money and time) associated with their handling in port. Thus, port charges and time costs incurred by ocean carriers, inland carriers and shippers are accounted for. Production functions for the provision of bulk and container throughputs

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are specified as well as the resource functions representing the relationship between the minimum amount of a given resource employed by a Terminal output is measured by annual throughput in TEUs. The three input variables include:(1) terminal quay length in meters, (2) terminal area in hectares and (3) the number of pieces of cargo handling equipment employed.

A primary finding by 'Cullinane and Song' is that ***larger container ports or terminals tend to be more efficient than their smaller counterparts***. The analysis finds clear evidence that port efficiency, port infrastructures, the degree of private sector participation in ports and inter-port connectivity all have a statistically significant and strong impact on international maritime transport costs. Indeed, the estimated elasticity for port efficiency is found to be the highest of all port-related variables.

With the exception of customs delays, port improvements appear to have a stronger impact on the maritime freight charged on a country's exports than on imports. It is estimated about 40–50% of the variation in maritime transport costs; a figure that can be significantly improved by segmenting the regressions by individual commodity groups. Yet further improvement could be secured by taking into account the specific time of the transaction within the year.

The final conclusion is that improvements in ports are the most effective mechanism by which cost savings and increased trade competitiveness can be achieved and that it is important to recognize that this will have a beneficial impact beyond the direct effect on international maritime transport costs; on inter alia the cost of using other modes, the price of traded goods, a port's scale of operation and its consequent unit cost.

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An Empirical Model

A port's economic production function represents the relationship between the port's maximum throughput and given level of resources.

Maximum Port Throughput = Function of (Port Productive Resources) (Eq-1)

Where

- *Throughput*: Tons of cargo handled or Numbers of TEUs
- *Port productive resources*: Labor, infrastructures, mobile capital (Cranes, vehicle..), energy, port roadways / Railways.

If the port achieves maximum throughput for given level of resources it is call technically efficient else it is technically inefficient.

A port's economic cost function represents the relationship between the port's minimum costs to be incurred in handling a given level of throughput:

Minimum Port Cost = Function of (Port Throughput) (Eq-2)

If the port provides throughput at a minimum cost then it is cost efficient else cost inefficient.

From the above equations it can be summarized that:

In order to be cost efficient, the port needs to be technically efficient.

A port not only concerned to be efficient alone, but also with whether it **effective** in providing throughput. Effectiveness is concerned with how well the port provides throughput services to its users i.e. shipper, ship-owners, carriers (land transportation).

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Effectiveness may be measured by its adherence to its operating objective e.g. ***Maximizing Profits.***

In order to port to be effective, it must be cost effective which in turn demands it should be technically efficient.

A critical component of a port's effectiveness operating objective is the demand for its throughput services. A port's throughput demand function shows the relationship between the demand for port's throughput services by its user and the generalized port price incurred by these users i.e.

Port Throughput = function of (Generalized Port Price) (Eq-3)

Where

Generalized Port Price = Port Price Charged + Ocean Carrier Port Time Price **(OCPTP)** + Inland Carrier Port Time Price **(ICPTP)** + Shipper Port Time Price **(SPTP)** (Eq-4)

Port Price – Cost of services by port (wharfage, berthing, cargo handling and so on)

OCPTP – This per unit of throughput represents the time related cost incurred while the ships are in port (ship depreciation, fuel, labour cost and so on)

ICPTP - This per unit of throughput represents the time related cost incurred by inland (rail, truck) carriers while vehicles are in port (depreciation, fuel, labour cost and so on)

SPTP – it represents the time related cost incurred by shippers while shipments are in port (depreciation, obsolescence, insurance costs and so on)

Hence we could say, profit i.e. effectiveness operating objective can be written as:

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Profit = Port Price Charged X Port Throughput – Minimum Costs (Eq-5)

Substituting equation 3 and 2 in above equation 5 can be written as:

Profit = Port Price Charged x function (Generalized Port price) – function (Port Throughput) (Eq-6)

Substituting equation1 in equation 6:

Profit = Port Price Charged x function (Generalized Port price) – function [function (Port Resources)] (Eq-7)

Resources in above profit function may be expressed as functions of port's operating options and the amounts of cargo to be handled by port. Port's operating options are the means by which it can vary the quality of its throughputs service.

Profit = Port Price Charged x function (Generalized Port price) – function [port operating options] (Eq-8)

For Maximizing profit (as in Eq-8) one needs to minimize the operating options without compromising the quality of service. A port can differentiate the quality of its service with respect to such operating options as:

- Ships loading / unloading time incurred in port
- Berthing / un-berthing time incurred in port
- Inland carrier time in port
- Inland carrier entrance and departure time (queuing time for clearance)
- Minimizing cargo inside quay
- Minimizing cargo clearance time by custom and govt agency
- Minimizing labour strikes
- Efficient container stacking / movement / reshufflings / area allocation
- Pre information exchange for booking of containers / railway rake booking and so on.

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Example for estimating land required for container stacking area:

- Annual throughput (Ty)
- Daily requirement (Dr) = Ty/365
- Dwell time (Dt) expressed in days or fractions of days
- Peaking factor (Pf) normally taken as 0.75
- TEU ground areas = 15.25 m2
- Stacking area as Twenty feet ground slots (TGS)
- Stacking Height (Sh)

TGS = (15.25 x Dr x Dt) / Pf / Sh

Global Yard Area / Total TGS area =e

Total Container Stacking Area in m2 = Total TGS area X e

'e' varies from 1.8 to 2.3 depending on container movement vehicle deployed in port

Conclusion:

From above discussion, it is evident to become and maintain status of competitive port; it has to be technically efficient and effective throughput. The efficiency of port depends on three basic parameters namely:

1. Cost
2. Quality
3. Throughput

Also it is evident, the parameters where port management can exercise their authority, are more optimal than the state controlled parameters e.g. customs. Lastly is evident to have a great port, one requires to have good infrastructure and great hinterland.