Assessing Productivity and Performance of Seaports: The Importance for Gateways

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ABSTRACT

The advent of containerization has increased transshipment possibilities through some ports, while reducing the competitive advantages of others. The supply chain management concept implies that successful ports must add value to the movement of freight, such as by decreasing transit time or by providing value-added services. In light of these environmental developments, potential port strategies are analyzed using Porter’s (1980) three generic strategies and through the lens of the resource-based view of competitive advantage. Different resource characteristics are identified with distinct strategies. The major implication for port management is the need to closely assess a port’s operating position in order to properly arrive at a competitive strategy.

I. INTRODUCTION

Since the advent of the first intermodal container services in the 1950s, the ocean shipping industry has been radically transformed. Huge container vessels have been brought into service by the steamship lines, capable of carrying over 10,000 TEUs. The economics of operating these vessels has changed their routing patterns. Whereas the vessels used to stop at many ports on a coast, owners have reduced the number of port stops in order to maximize the revenue potential of the ships. (As the adage goes, ships only make money for their owners when they are at sea.) In order to compete for the container business, seaports have invested millions of dollars in infrastructure. In addition, railroads and trucking firms have developed the capabilities of transporting large numbers of containers to and from the seaports.

Over the past twenty years, we have also witnessed the development of the “supply chain management” concept; that is, the operational integration of suppliers, manufacturers, distributors, and retailers, in order to deliver products to consumers in a timely and efficient manner. Information systems have been developed to allow upstream suppliers and manufacturers to access downstream demand information, so that they can better plan their production and shipments to meet ever-changing demands. Distributors and retailers share information with

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1 TEUs stand for twenty-foot equivalent units, and are common units for measuring container port activity. A ship with a capacity of 10,000 TEUs has the capacity to carry 10,000 twenty-foot containers, 5,000 forty-foot containers, or some combination of the two container types adding to 10,000 TEUs.
their suppliers so that products can be delivered halfway around the world on a just-in-time basis. In turn, expectations from downstream firms have dramatically increased, with much shorter lead times and much smaller time windows allowed for deliveries. More capable rivals replace suppliers that fail to meet these expectations. Transportation routings are organized to avoid congested or inefficient seaports, in order to better ensure the timely delivery of products to customers.

In light of the changing economics of the shipping industry and the increased customers expectations resulting from supply chain management, ports have had to rethink their business operations. In this paper, we examine how ports can improve their performance and gain market share in a competitive marketplace. In order to accomplish this objective, we first present a more detailed analysis of the changing competitive environment for seaports. Next, we discuss a case example of the Port of Baltimore, illustrating how the Port has lost market share in the container trade to its rivals over the past twenty years given the changing competitive environment. Third, we present a general framework for achieving competitive advantage, drawing on the work of Harvard University economist Michael Porter and the researchers that have developed the ”resource-based view” theory of competitive advantage. Using this framework, we illustrate the various strategies ports can use to increase their productivity and performance. Finally, we draw conclusions and managerial implications from the analysis.

II. THE CHANGING ENVIRONMENT FOR SEAPORTS

Cullinane and Talley (2006, p. 1) define a port or seaport as “a place that provides for the vessel transfer of cargo and passengers to and from waterways and shores.” They note that a port is a “node” in a transportation system, connected to other ports and inland destinations by spokes or transportation routes or corridors. They further state that a port is not just a physical construct but an economic unit, competing on the basis of locational preference and value-added services.

Cullinane and Song (2006) describe how containerization has increased competition among ports. The intermodal movement of freight by containers through ports has reduced port-handling costs and increased the reach of markets served from a given port. If Port A operates efficiently and has good transportation connections, freight may be moved through Port A to destinations previously served exclusively through the less efficient Port B. Whereas a port used to be able to count on an exclusive “hinterland” for freight movements, these hinterlands may now be reached by freight movements through competing ports. As a result, ports have lost their monopolies over their hinterlands, with port hinterlands increasingly overlapping with one another.

Heaver (2006) states that competition among ports has changed from competition for hinterlands to competition among alternate logistics systems, among which ports form an important component. Shippers and their customers seek the best combination of logistics providers, including steamship carrier, third party logistics providers, customs house brokers, inland carriers, and port operators. To the extent that Port A can be a part of the most efficient, most
effective logistics chain, then it will be able to out-compete other ports for a shipper’s business. As Notteboom (2007, p. 46) states, “Port choice has become more a function of network costs and port selection criteria are related to the entire network, in which the port is just one node.”

Cullinane (2005) describes how steamship lines have responded to the changing economics of their industry by growing larger through mergers, acquisition, and internal growth. In addition, many steamship lines have formed alliances with other steamship lines. The growth in the size of the shipping companies, together with the formation of alliances, has allowed the steamship lines to extend the reach of their operations. This is important given the increasing internationalization of the operations for many firms. A steamship line that serves ports in Asia, Europe, the Americas, and elsewhere can provide “one-stop” service to a transnational corporation that has business in all of these regions. As well, the large steamship lines have the resources to raise the capital required to finance the huge container ships required for operations. As container ships increase in size, economies of scale reduce per-unit operating cost, thus increasing the productivity of the steamship lines.

The economics of the shipping industry also require that these huge capital investments (i.e., the container ships) minimize their port stays and maximize the time spent carrying cargo from one port to another. Thus, the steamship lines have concentrated their business at “load centers”, centralized ports for the transshipment of containers. Containerized freight from smaller feeder ports may be barged, railed, or trucked to the load center. Or, as is often the case, shippers may bypass the feeder ports entirely and transport their freight directly to the load center. This more direct routing may result in shorter and more reliable transit times for freight shipments.

The load center concept has intensified the competition among ports for the business generated by the steamship lines. Port operators compete by providing value-added services, such as refrigerated warehouses and breakbulk services, or by becoming evermore efficient by investing in the latest container crane technologies. However, as Notteboom and Winklemans (2001) state, the infrastructure investments may not be sufficient to maintain the loyalty of steamship lines, as shippers are constantly looking at alternate routings in order to reduce total logistics costs.

Carbone and De Martino (2003) place the changing environment faced by ports in the context of supply chain management. They note that supply chain management involves the coordination of multiple firms involved in manufacturing and delivering materials and products from their source location to their ultimate customers. Each member of the supply chain must add value to these processes; otherwise the firm may be eliminated or replaced. The contribution of a port to a supply chain depends on its infrastructure, connectivity, and ability to add value; for example by providing punctual and frequent service for shippers, by disseminating important information (e.g., product location) to other members of the supply chain, and by providing a secure environment for the cargo.

In summary, the competitive environment for ports has changed with the advent and growth of containerization, the increase in size of container ships and steamship lines, and the popularization of supply chain management. Ports must compete with other ports for business by being efficient or by providing value-
added services. Successful ports increase their container business at the expense of less successful competitors. In the next section of this paper, we provide a case example of the Port of Baltimore, and outline how changes in the competitive and regulatory environment have altered the competitive position of the Port.

III. CASE EXAMPLE – PORT OF BALTIMORE

The Port of Baltimore was founded in 1706 and recently celebrated its 300th anniversary. Many of the highlights of the Port’s history are described on the website devoted to the Port’s anniversary celebration (http://www.port-ofbaltimore300.org/history.htm). During its early history, the Port of Baltimore made use of its natural harbor to develop into one of the major ports on the East Coast of the United States. By the mid-19th century, Baltimore was the third largest city in the United States and its Port was a nexus for domestic and international trade. In the decades following the U.S. Civil War, freight traffic carried by the Baltimore and Ohio (B&O) railroad helped to transform the Port into the sixth largest in the world. By the early part of the 20th century, the Port was the second largest in the U.S. Baltimore’s unique position as the closest East Coast port city to the major markets and supply centers of the U.S. Midwest (most notably Chicago) increased the attractiveness of the Port (see Figure 1).

However, over the past twenty years, much of the container traffic growth in the Mid Atlantic region of the U.S. has gone to the Port of Norfolk, located to the south of Baltimore near the mouth of the Chesapeake Bay, rather than to Baltimore (see Figure 1). In terms of total tonnage, the Ports of Baltimore and Norfolk are about the same size, with Norfolk handling about 49 million tons of cargo in 2005 and Baltimore 44 million tons. However, in terms of container traffic, Norfolk has far surpassed Baltimore. As Figure 2 illustrates, until the late 1980s, container traffic at the Port of Baltimore exceeded the traffic at the Port of Norfolk. In 1990, traffic at both ports stood at about 500,000 TEUs. However, by 2005, container traffic at Norfolk had quadrupled to about 2 million TEUs while traffic at Baltimore remained at about 500,000 TEUs.

There has been a number of reasons advanced to this author as to the disparity in container traffic growth rates between Norfolk and Baltimore. These reasons, based on information gained from several visits to the Port over the past fifteen years, include the following:

- The impact of transportation deregulation. Prior to the deregulation of truck and rail transportation in the United States in the early 1980s, inland freight rates were tied closely to distance traveled. Thus, as the closest port to the Midwest, the Port of Baltimore had the lowest inland freight charges to the Midwest. Since the deregulation of freight transportation, freight rates have not been as closely tied to distance. Other factors, such as traffic density, are now important determinants of freight rates, so the Port of Baltimore no longer has a distinct price advantage for Midwest traffic.

2 Tonnage for Norfolk includes the throughput of neighboring Newport News. The Port of Norfolk ranked 15th in the United States in terms of tonnage in 2005, while the Port of Baltimore ranked 19th. If the Ports of Norfolk and Newport News are considered separately, the Port of Baltimore’s ranking moves up to 18th. (http://www.iwr.usace.army.mil/ndc/wscs/portname05.htm).
Figure 1: Location of the Port of Baltimore

- High labor costs. As the transportation of general cargo shifted from breakbulk to containerized moves, there was much less need for port labor. Containerized handling is more capital intensive but less labor intensive than the handling of breakbulk freight. As an old port, Baltimore had excess labor that was not easy to shed, contributing to high labor costs. As a much newer port, and as a growing port, Norfolk did not have nearly the same problem with excess labor. Nor, on average, was its labor as senior as the labor at Baltimore, resulting in lower average pay rates. Finally, the labor contract at Norfolk was in some ways more favorable than the contract at Baltimore, thus contributing to lower operating costs.³
- Railroad preference for Norfolk over Baltimore. It was claimed that the railroads prefer to concentrate their business at ports other than Baltimore for economic reasons. Norfolk Southern, one of the two Class 1 railroads serving Baltimore, prefers to concentrate its business at its homeport in Norfolk.

³ One example often cited was that for many years workers at the Port of Baltimore did not work but got paid on rainy days.
other Class 1 railroad, CSX, prefers to concentrate much of its business in New York.

- It is costly for steamship lines to transverse the Chesapeake Bay. The major problem faced by the Port of Baltimore is that it is 10-12 hours sailing time up the Chesapeake Bay. The steamship lines prefer to serve Norfolk, located at the mouth of Chesapeake Bay, thus saving a full day's travel time to and from Baltimore. Since most of the containerized traffic is not destined to local markets at either Norfolk or Baltimore, Norfolk provides a superior transshipment point, from the perspective of the steamship lines.

Figure 2: Container Traffic Comparison at the Ports of Baltimore and Norfolk

![Container Traffic - Baltimore and Norfolk](image)


Despite its lack of competitiveness in the containerized general cargo trade, the Port of Baltimore has done well in other trades, most notably the roll-on roll-off (ro/ro) business (e.g., tractors), the automotive trade, and the trade in forest products. With the latter two trades, the existence of a large local market makes Baltimore a superior destination to Norfolk. Many of the automobiles and much of the forest products (used for home construction) are destined for the Washington-Baltimore-Philadelphia corridor. In addition, the ro/ro and automobile trades require plenty of space for storage, and the Port of Baltimore is able to compete for this business because it has the available room. Finally, Baltimore does have
good highway connections, located only a couple of miles from Interstate 95, the major north-south highway on the East Coast.

In summary, a number of factors have increased the competitiveness of the Port of Norfolk at the expense of Baltimore for container traffic. Notably, transportation deregulation reduced the link between inland distance and transportation charges, thus reducing Baltimore’s locational advantage. As well, the advent of containerization, the subsequent growth in size of container ships, and, concurrently, the increase in operating cost of the ships, rendered the Port of Norfolk a much lower cost port of call than Baltimore. On the other hand, Baltimore still has a competitive advantage in other trades, most notably for products destined to markets close to Baltimore, and for goods that require considerable open space for storage.

In the next section, we present general theoretical models that are then used to analyze port competitiveness.

IV. THEORIES OF COMPETITIVE ADVANTAGE

Perhaps the most prominent writer on how organizations obtain competitive advantage is Harvard economist Michael Porter. Porter (1980) outlines three generic competitive strategies. The first, he labels, “overall cost leadership”. According to Porter (1980, p. 35), a cost leadership strategy “... requires aggressive construction of efficient-scale facilities, vigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customer accounts, and cost minimization in areas like R&D, service, sales force, advertising, and so on.” Porter (1980) further states that an organization’s cost leadership gives it a “defense” against rival organizations, allowing it to earn profits even under highly competitive conditions.

The second strategy advanced by Porter (1980) is “differentiation”. With this strategy, an organization can earn above-average returns by creating a product or service for which consumers are willing to pay a premium. Differentiation may be accomplished by branding, through image enhancement, through technological improvements, by providing superior customer service, or through any other means, as long as consumers are willing to pay a premium (over cost) for this differentiation.

Finally, Porter (1980) defines “focus” as a third generic strategy. In this case, an organization focuses its efforts on a particular customer segment, product segment, or geographical market. In this narrow segment, the organization outperforms its competitors either by providing a good or service at a lower cost, or by differentiating its offerings so that buyers are willing to pay a premium to purchase from the organization. Therefore, the focus strategy may include either low prices or differentiation, but has a narrow product or segment focus.

A second framework often used to analyze competitive advantage is known as the “resource-based view”. It has been popularized by Wernerfelt (1984), Barney (1991), Peteraf (1993) and others writing in the Management field to explain competitive advantage. According to this theory, an organization uses its resources, consisting of both physical resources and human capabilities, to achieve competitive advantage. However, not all resources are equally capable of helping an organization achieve a competitive advantage; only those resources that are
generally rare and valuable, and difficult to imitate or substitute. A sustained competitive advantage can be achieved if both current and potential competitors are unable to imitate or substitute for an organization’s resources. In summary, there are at least four ways that an organization, such as a port, can attempt to achieve competitive advantage. They can use one of Porter’s (1980) three generic strategies - cost leadership, differentiation, or focus, or they can develop or obtain resources that are rare, valuable, and difficult to replace or imitate. In the next section, we apply these theories to seaport operations.

V. APPLICATION OF COMPETITIVE THEORIES TO PORTS

1. Cost Leadership Strategy

There have been many papers written on the productivity and efficiency of port operations. A good example is Turner, et al. (2004). Turner et al. (2004) collected fourteen years of data, from the 1984 to 1997, on twenty-six container ports in North America, and then used a linear programming technique, called data envelopment analysis (DEA), to compare the relative productivity of the ports. Finally, the authors regressed the relative productivity measures on a number of explanatory factors in an attempt to determine which factors differentiated the more productive container ports from the less productive ports. Their major findings include the following:

- Productivity, which was assessed by the output (TEUs) realized from the physical inputs (port size, quay length, number of container cranes) at each port increased significantly during the period of analysis. Productivity increases were highest among West Coast and Gulf Coast ports. East Coast ports significantly increased their productivity only in the last four years of the analysis. Productivity increases were attributed to a combination of improved capacity management (fewer unused inputs) and gains in operational efficiency (better use of inputs).

- Larger seaports were found, on average, to be more productive than their smaller counterparts, leading the authors to conclude that there are economies of scale in container port operations. Concurrently, the authors found that the larger the average-sized vessel served at a container port, the more productive the port. This latter result may stem from higher berth occupancy rates as vessel size increases (holding total output constant).

- Higher measures of port productivity were associated with greater numbers of Class 1 railroads serving the port. According to the authors (Turner, et al. 2004, p. 353): “This is clear support for the importance of rail service quality, perhaps including frequency of service, and rail service competition, to the

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4 An excellent list of these papers is contained in the references of Cullinane and Song (2006).
5 The authors assumed that labor costs did not vary much among North American container ports, since port operations were all covered under similar union agreements. Therefore, they concentrated on determining the productivity of capital and land at ports.
6 According to the authors, this result supported previous work. See, De Neufville and Tsunokawa (1981) and Kim and Sachish (1986).
7 For example, there may be less downtime at a port serving ten 6,000 TEU vessels, than at a competing port serving twenty 3,000 TEU vessels, given the same available berth and container yard space, and the same number of operating container cranes.
success of container ports.” Surprisingly, the authors found that the presence of on-dock rail at a port was negatively associated with port productivity. The authors attributed this finding to the opportunity cost of on-dock rail; that is, the land devoted to on-dock rail might be better utilized in other capacities.

- Other factors that were hypothesized to affect container port productivity were not found to be significant. These included, the percentage of dedicated terminal capacity (i.e., terminal capacity leased to specific carriers rather than generally available to all potential users), and the draft into a port.\(^8\)

In summary, it would seem that the best way to become a low-cost port operation is to grow larger, serve bigger vessels, and to maximize rail service into the port. Clearly, this is not a strategy that can be used by all ports. However, to the extent that ports are able to increase in size, they can expect per unit costs to decrease.

2. Differentiation Strategy

Ports serve a number of customer groups, including steamship lines, shippers, consignees, railroads, trucking companies, third party logistics operators, and freight forwarders. The supply chain management concept implies that all members of the supply chain, including the port, must add value to the shipment of goods, or face elimination or replacement. The greater the value that a port can add to supply chains, the more likely steamship lines, shippers, freight forwarders, and other customers will choose to use that port.

Nir, et al. (2003) summarized a number of papers related to port choice. Murphy and Daley (1994) examined port selection factors from the perspective of purchasing managers. They found that purchasing managers are most concerned with accessing shipment information and with the loss and damage performance of the port. Engle, et al. (1978) examined port selection from the perspective of both carriers and shippers. They concluded that carriers are most concerned with factors such as freight charges, terminal facilities, cargo loss and damage, transit time, the satisfaction of shippers, and shipment information. Shippers are concerned with many of the same factors, although the level of concern between the two groups varied. Likewise, Murphy, et al. (1992) found some differences among user groups in the factors considered most important in port selection. Nir et al. (2003) used a multinomial logit model based on the revealed choices of shippers to examine shipper choice among competing ports in Taiwan. They found that inland travel time and cost were significant factors that affected the choice of ports. Travel time to the port, although in this case, the travel time of the steamship line, was also an important factor cited for the growth in container traffic at the Port of Norfolk relative to the Port of Baltimore.

In summary, it appears that ports may be able to differentiate their services from their competitors by offering reduced travel time and costs (both inland and seaside) and through other factors such as providing timely shipment information and convenient terminal facilities.

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\(^8\) In the first case, it had been assumed that dedicated terminal space might be used less efficiently than non-dedicated space. In the second instance, it was thought that deeper drafts on channels into ports would be associated with larger ships and higher productivity levels. As noted, neither of these variables was found to significantly influence port productivity.
3. Focus Strategy

It is important that an organization assess its key strengths and weaknesses before arriving at a focus strategy. The Port of Baltimore provides a good example. The Port’s location up the Chesapeake Bay increases travel time for container ships, reducing the attractiveness of the Port to these lines. The Port’s container operations are also relatively small, implying that the Port has not been able to achieve the economies of scale of its larger competitors. On the other hand, as indicated above, the Port’s access to the Washington-Baltimore-Philadelphia region makes it an excellent destination for automobiles and forest products destined for this populated region. As well, the Port’s available space allows it to serve, competitively, the ro/ro and automobile trades, both of which require considerable operating area.9

4. Resource-based View

Most capital resources at ports, such as container cranes, can also be readily obtained by competitors with sufficient resources.10 Therefore, it is unlikely that a port can obtain a sustainable competitive advantage based on capital equipment. All major ports in the U.S. draw workers from unionized labor pools. In general, one would expect no major differences in quality levels between these pools. Therefore, it is unlikely that a port can obtain a competitive resource advantage on the basis of port labor. On the other hand, a port may be able to obtain a distinct, sustainable, competitive advantage on the basis of its location. It is difficult for other ports on the East Coast of the United States to “imitate” or “substitute” for the ports operated by the Port Authority of New York and New Jersey. Most steamship lines serving the North Atlantic schedule stops at New York/New Jersey because there is considerable freight destined for this huge local market. The same is true for the Ports of Los Angeles and Long Beach on the U.S. West Coast.11

Furthermore, a port may also be able to achieve a competitive advantage based on a location close to open water combined with excellent rail connections. This is true for the Port of Norfolk. It is close to the open ocean, thus reducing transit times for steamship lines. Its rail connections, especially through the Norfolk Southern, make the Port of Norfolk an ideal transshipment point.

Finally, the availability of land around a port may be another resource that is difficult to imitate. Many ports are situated in “built-up”, populated areas, and have little room to expand. Therefore, if a port possesses available land, it can, like the Port of Baltimore, compete for trades, such as ro/ro traffic, that require the availability of large open areas.

In summary, many resources possessed by ports are relatively easy to obtain, and therefore cannot be considered to be especially rare or difficult to imitate. On the other hand, a port’s location, either close to a densely populated area, close to the open ocean with good rail connections, or in an area with

9 Containers can be stacked. Ro/ro and automobiles are not stacked at ports.
10 Ports often look to public subsidies for the purchase of capital equipment.
11 However, in this case, the two ports are operated by different authorities and compete with each other for container traffic.
available space for operations, may be a resource that can create competitive advantage.

VI. CONCLUSIONS AND IMPLICATIONS

The purpose of this paper is to assess strategies for port performance in light of changes in the international shipping industry. The advent of containerization has increased transshipment possibilities through some ports, while reducing the competitive advantages of others. The supply chain management concept implies that successful ports must add value to the movement of freight, such as through decreases in transit time or by providing value-added services.

Potential port strategies were analyzed using Porter’s (1980) three generic strategies and through the lens of the resource-based view of competitive advantage. It was found that becoming the low-cost port operator (one of Porter’s generic strategies) may be facilitated through operational size; in other words, that there are economies of scale in port operations. A second generic strategy, differentiation, may be best achieved by operating within a supply chain that offers lower transit times and costs than do supply chains through rival ports. The focus strategy is best achieved by narrowly focusing on a geographical region (e.g., local market) or on a distinct cargo trade that makes best use of the port’s strengths.

Finally, a port’s locational resources may be most critical for providing sustained, competitive advantage.

The major implication for port management is that a port needs to closely assess its operating position in order to properly arrive at a sensible strategy. For the Port of Baltimore, for example, this has meant concentrating on the ro/ro, automotive, and forest products markets, rather than on the container trade.

REFERENCES


WEB PAGES


http://www.portofbaltimore300.org/history.htm, accessed April 24, 2007