A resource-based view of competitive advantage at the Port of Singapore∗

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Abstract

The purpose of this paper is to discuss the resources, including operations and information technology that have contributed to the competitive position of the Port of Singapore. We present a detailed discussion of the Port and its resources, and analyze the case using the resource-based view of strategy. A firm with a competitive advantage excels in time, quality, or cost, or a combination of such over its competitors. We argue that a combination of resources including supportive government policies, ample investment, and well thought out operations and information technology along with location and a natural deep harbor to help create a sustainable advantage for the Port. We find that Singapore compensated for some of its natural disadvantages like small land area by successfully applying information technology in critical areas to increase the island’s capacity to handle shipping.

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The purpose of this paper is to describe the key resources, including operations and information technology (IT) that have contributed to the competitive position of the Port of Singapore. The Port of Singapore has achieved a sustainable competitive advantage relative to other locations by carefully building a set of resources that other Ports would find very difficult to match. Some of these resources are natural (a superb sheltered
harbor), some can be replicated at a significant cost (infrastructure, well-educated and hard working labor force), and some are particularly valuable in Singapore, but less useful in other Ports (scheduling systems for multiple cranes to handle the complexity of multi-tier stacking of containers).

There have been a number of studies of the Port of Singapore and the information technology that supports it, including a series of Harvard Business School teaching cases. One discusses Singapore TradeNet, an EDI system that dramatically reduced turnaround times for processing information about ship arrivals, loadings and unloadings and departures; see Konsynski and King (1990a) and Applegate et al. (1993). A subsequent case describes the efforts of Singapore to become an ‘intelligent island’ by developing a national network infrastructure (Applegate et al., 1995). A comprehensive description of the Port of Singapore may also be found in Applegate et al., 2001. Konsynski and King (1990b) describe Hong Kong’s TradeLink, which is interesting to compare with the EDI system in Singapore. The case in this paper extends this prior work by analyzing the Port’s strategy using a resource-based view, and by showing the importance of operations and information technology in creating an advantage.

We believe that RBV helps explain and interpret the contribution of technology to the Port of Singapore (PSA). This view of competitive advantage is based on the unique resources that a firm possesses. To the extent that a competitor cannot create or substitute for these resources, they provide an advantage to the firm that owns them. Two succinct presentations of the resource-based view (RBV) may be found in papers by Barney (1991) and Peteraf (1993). Jarvenpaa and Leidner (1998) have used this theory to analyze the case of a company in Mexico, a developing country, while Wade and Hulland (2004) review the RBV and information systems research. Section 1 of the paper presents a case study of the Port of Singapore, followed by an analysis of the case using the RBV of strategy. The paper concludes with the implications for management.

1. The Port of Singapore

1.1. Data

The data for this paper came from a number of sources. First, we interviewed Mr Eric Lui, Executive Vice-President (Information Technology)/Executive Vice-President, Container Terminals Division and several members of his staff at PSA. Second, one author visited Kent Ridge Digital Laboratory, the organization that assisted in developing expert systems at the Port. An author interviewed Mr Patrick T.C. Poon, the Director of RTW Shipping (S) Pte. Ltd, which is the shipping agent for the Evergreen and Uniglory Line and a major customer of the Port at the time of the interview. The purpose of the interviews was to learn about operations and specific IT initiatives employed by the Port.

The authors toured the Port to study its operations, and collected information from PSA publications, annual reports and various Singapore government Web sites. Finally, we drew on several prior studies of PSA including Teo et al., 1997, and several cases, described above, on the Port. We used the RBV of the firm to identify strategic resources at
the Port, and the results of interviews and information about different Port and Singapore
government initiatives to look for linkages among the resources.

1.2. Resources at the Port

Singapore’s most important natural resources include its large, protected harbor, its
location on major trade routes, and the skills of its well-educated work force. The location
advantage is clear in Fig. 1 from the Singapore Web site. Note that Singapore is located
where ship traffic between Europe and Southeast Asia and the US West Coast and
Southeast Asia must pass; it is a natural entry for products shipped to and from
neighboring countries.

A Port, particularly as shipping became containerized, requires massive infrastructure
development including berths, cranes, trucks, storage and warehousing, anchorages,
tugboats, pilot launches, etc. Early in its history, Singapore opened its economy to foreign
investment. As its economy grew, it allocated significant amounts of capital to developing
its Port. In 1972, Singapore opened its first container berth. In 1997, the Port of Singapore
Authority was privatized and its name changed to PSA Corporation, although the
government still holds 100% of the shares in the company. The primary difference since
privatization is that the company does not retain regulatory and statutory power to draft
and impose regulations and tariffs for Port operations. These duties are now handled by the Maritime Port Authority.

1.3. Operations at the Port

A brief discussion of Port Operations and Information Technology will demonstrate how PSA developed the Port’s attributes and enhanced the attraction of its location. See Fig. 2.

Key operations. Being sited in a strategic geographic location has its advantage but it is not the determining factor for PSA to become the number one transhipment Port in the world. The East–West sea lanes have many strategically located Ports, such as Port Klang (Malaysia) or Colombo (Sri Lankan). More recently, Malaysia has added another Port, the Port of Tanjung Pelepas (PTP), located at the southwest tip of the state of Johor, which is a stones-throw from Singapore. However, more than 200 shipping lines with connections to 600 Ports in 123 countries still choose to call at PSA. On an average day, there are two sailings to the United States, five to Japan, nine to China, Hong Kong, Taiwan, four to Europe and 70 to South Asia and South–East Asia Ports. This kind of high volume traffic requires efficient Port operations.

Key customer requirements in Port operations include freight rates, frequency of services, shipping options, turnaround time, Port charges (about 20% of freight charges), support services (ship maintenance, ship supplies), and feeder operations. The Port customers are essentially the shipping lines, however, it must be noted that shipping lines often take their cue from manufacturers, exporters, and the large buyers (MNCs) of goods and raw materials.
As Singapore is a transhipment hub for shippers, Port operations are very demanding. See Fig. 3. Arriving containers destined for other Port destinations have to be transferred to other ships or stacked (for later shipment), while containers destined for Singapore are placed on trailers for local delivery. These operations have to be well coordinated to minimize ship turnaround times. Before ships arrive in Singapore, the shipping companies send a message to PSA through the PortNet system. The company indicates when the ship will be arriving and applies for berthing spaces. Information sent to PortNet includes how many containers are on board, how they are arranged, their destination and their promised arrival date. Application for Port call can be made between 1 month and 24 h before the ship arrives.

Once PSA receives the application, operations planning will begin. Port personnel use the Computer Integrated Terminal Operations System (CITOS) to create plans for ship berthing and for unloading containers. Unloading plans have to specify whether the container will be picked up from the terminal, transferred to another ship immediately, or stacked for later shipment. The system also has to handle imports and exports for the domestic market. When the ship arrives, it docks at a specified time at its assigned berth.
A specific number of quay cranes are assigned to service the ship based on the number of containers to be unloaded and loaded. Prime movers (special trucks that carry two containers) in the Port move the containers from/to the ship and to/from the stacking yard.

At the stacking yard, cranes dismount and mount the containers. Containers in the yard are placed in an initial holding area. Internal yard operations re-stack the containers in appropriate places and ordered sequence to await eventual loading onto another ship or for pickup for domestic delivery by freight forwarders. Containers originating from Singapore exporters are handled by gate operations and routed to the stacking yard first, before eventual loading onto ships. CITOS determines the stack locations.

1.4. Enabling the Port operations

PSA anticipated global containerization in the late 1960s and built the first container Port in the region. It also made early preparations to harness IT on a major scale and used it strategically in its Port operations in the 1980s. PSA is expanding its terminal facilities in meeting the advent of globalization in the next millennium, and the anticipated cross-border trade growth that accompanies it. To attain the objective of becoming a major transshipment hub requires more than fast turnaround of containers.

Although, loading and unloading containers is the key operation in shaping the success of PSA, there are a number of support features or enablers that make the Port operations highly effective and help sustain its competitive edge.

First, Singapore has a large merchant fleet, 3037 ships with 25.572 million gross tons at the end of 2003. Singapore had total trade amounting to an average of more than S$40 billion per month for the August–November 2003 time period, and the country is a major oil refinery center. Second, PSA is the largest owner of warehouse space in Singapore, managing over 500,000 m² of space. It manages the Tanjong Pagar, Alexandra and Pasir Panjang Distriparks, which cater to a host of distribution operators, manufacturers, traders, and freight forwarders. With the warehouse business, PSA attempts to provide value added services to its traditional Port operations, including the storage of goods and empty containers, labeling, repackaging, tagging, sampling and testing, quality control and billing. The aim is to establish an integrated global logistics hub that connects Singapore to major regions such as Asean, Western Europe, China, India, and the US. Such supporting attributes bring value-added services to shippers and carriers and sustain stable long-term revenues for PSA.

Third, PSA’s workforce is trained to focus on customers. A quality culture is prevalent in the organization. The Port has programs such as the ‘Key Customer Managers’ and ‘Chat Time’. The Key Customer Managers program provides regular dialog sessions with customers, helping PSA staff to understand better and to attend customer’s operational and contractual needs. Chat time allows the organization to build rapport with customers and keep abreast of the latest developments in the shipping industry. To promote a quality culture in the workforce, PSA has wide spread quality circles (QC) and encourages staff suggestions. Joint quality circles extend to customers and suppliers. Since 1990, through employee suggestions and as well as an average of 350 quality circle projects, PSA has been able to save about S$22 million in costs. In 1999, PSA won the Singapore Quality
Award (SQA), given annually to an organization that has shown consistent business excellence and achieving world class quality standards in its operations.

To maintain the productivity of its Port operations, PSA invests in employee training. Average training per year was 52.5 h per employee in 2002. PSA has its own in-house training school, called the PSA Institute, which conducted 1707 courses for staff in 1997 as well as for local and overseas maritime personnel. Singapore was named the best container Port in Asia for the 14th time and the best seaport for the 15th time in 2004 by the Asian freight industry.

Lastly, PSA has also actively integrated its own operations as well as customer operations through the Internet. Portnet.com, a subsidiary, has developed several web solutions to further enhance its own operations and also link customers’ operations to its own, thus creating a long-term strategic tie-in with customers. Proprietary web solutions; such as EZShip (for slot management and space booking), GEMS or Global Equipment Management System (links shipping lines to their depots, terminals, agents, container locations and logistics providers), EZBill (a common system for electronic billing of charges), CargoD2D (helps shippers manage cargo booking), TRAVIS or Throughput Analysis and Vessel Information System (report generator for throughput, vessel performance and transshipment handled) and COPLANS (allows shipping lines to pre-plan container stowage on board the vessel), makes PSA a leader in tying most Port and shipping operations to the Internet.

PSA has been able to harness these enablers and integrate them into its overall information and operations technology strategy to transform itself into a major regional transshipment hub for container shipping. More importantly, through a system of resources integrated by IT, PSA is able to reduce time, increase quality, cut costs, and create a high degree of flexibility that gives it a sustainable advantage.

PSA Corporation currently operates four container terminals in Singapore: Tanjong Pagar, Keppel, Pasir Panjang and Brani. Together, the four terminals yield a total of 37 container berths with a designed capacity of 20 million TEUs. Further development is ongoing and an additional five container berths will be added in the near future. Total designed capacity then will be 24 million TEUs. Together, these four terminals provide a global container shipment hub that connects Singapore to 600 Ports worldwide. In 2003, the four container terminals handled a total volume of 18.1 million TEUs. See Table 1.

1.5. Innovations in information and operations technology

PSA has invested heavily in information and operations technology, both to solve immediate operating problems and to remove constraints on the growth of container traffic.

Tradenet. One of the first trade-related technological innovations in Singapore was TradeNet. The Trade Development Board (TDB) sponsored the design of this EDI system to facilitate the processing of trade documents. Prior to the development of the system, 1 TEU is a 20-ft equivalent unit used to measure Port activities. A 40-ft container would be counted as two TEUs.
a large number of clerks processed batches of forms to clear shipments in and out of Singapore. The EDI system links the TDB, Customs, shipping agents, the Ports, freight forwarders, traders and others together. After the introduction of the system, turnaround time for documents that took 2 days under manual processing dropped to 15 min while documents that used to require 4 days now normally take 4 h (Teo et al., 1997).

TradeNet has greatly facilitated document processing, and it has removed time considerations for most of the parties who use it. Port operations, on the other hand, impose severe, real-time requirements on information processing. The objective of customer service, which is measured by minimum ship turnaround time and error free container handling, imposes significant constraints on information processing and Port operations.

PSA, in combination with various partners, developed an integrated set of traditional and expert systems to provide customer service to shipping lines. There are two major systems and many subsystems, which allow the Port to provide superb service despite its handicap in land area for storing and moving containers.

CITOS. The Computer Integrated Terminal Operations System, or CITOS, supports planning for and managing all operations of the Port. The subsystems in CITOS process information for allocating berths to ships, planning the stowage of containers,
the allocation of resources in general, and reading container numbers and operating trucking gates.

Prior to the arrival of a ship, shippers notify the Port Authority of the containers that will be loaded through PortNet, which is an online system with about 1500 subscribers. PSA replies with a window of time for the shipper’s trucks to appear at an entry gate to the Port. Its objective is to have trucks go to the right stack of containers and to have a yard crane available to offload the container onto the truck. Such scheduling minimizes the time to handle containers.

The Container Number Recognition System uses a video camera for each letter and number of the 11-character container ID. A neural net recognizes each character and the system checks it against its record of the container that was expected. The gate automation subsystem also records the weight and directs the driver to the container’s location within 45 s. This system reduced the number of individuals manually checking IDs from 16, one per lane, to 3.

The Ship Planning Subsystem deals with the loading and unloading of containers, positioning the containers inside a vessel, the allocation of quay cranes alongside the vessel, and the sequence in which the cranes will operate. This problem is complex because ships typically carry cargo for several destinations; it is important to minimize handling by loading containers in the right sequence. As an example, one of the new large container ships, the Antares, made her voyage to Singapore in 2000. In the process of handling the ship’s containers, PSA achieved a rate of 234 container moves per hour for this vessel, exceeding its 1997 average of 88 moves per hour (the fastest in the world). The Port handled 1375 boxes and turned the ship around in less than 6 h.

The Yard Planning expert subsystem sorts containers to support fast turnaround. One of its objectives is to use space efficiently and keep yard activities orderly. It makes sure that containers are accessible to avoid unnecessary handling and movements.

The Resource Allocation Subsystem assigns all operations staff and container handling equipment with the exception of the quay cranes.

CIMOS. The Computer-Integrated Marine Operations System helps to manage shipping traffic and the activities of the Port. It includes a Vessel Traffic Information Subsystem, which watches the Singapore Straits and approaches to the Port using five remote radars. Another set of four radars monitors Port waters; this subsystem sends information to expert systems that plan the deployment of tugboats, pilots and launches. All of this information is available in a database that shippers access via PortNet to learn about the status of vessels in the Port.

There are five expert systems used for planning including applications to assign ships to anchorages, schedule the movement of vessels through channels to terminals, deploy pilots to tugs and launches, route launches, and deploy tugboats.

Note that these systems are unique; they have almost no applicability outside of a Port, and the size of Singapore’s Port makes them inappropriate for many smaller Port locations. As an example, PSA is willing to market the CITOS system, but few Ports are complex enough to use it. TRADENET reduces the cycle time for processing trade documents, which encourages shippers to use the Port. CITOS reduces the cycle time for loading and unloading ships, adding a further benefit for customers. Abundant capital to
invest in the Port made extensive use of technology possible and provided physical equipment (docks, quay cranes, prime movers, etc.) to handle cargo in a seamless process.

1.6. Key performance data

Singapore is the busiest Port in the world in terms of shipping tonnage, and compares quite favorably on metrics of Port operations. At any one time, there are more than 800 ships in Port. In 2001, Singapore received 146,265 vessels with a shipping tonnage of 960 million gross tons. Singapore is Asia’s main transhipment hub and is one of the world’s largest container terminal operators, handling a throughput of 18.1 million TEUs in its four container terminals in 2003.

PSA facilities can provide on average 100 container moves per hour. It recorded 280.4 containers moves per hour in 2001 with the ship ‘APL Sardonyx’. PSA Marine, a wholly-owned subsidiary, performed 108,048 pilotage jobs and 94,904 tug jobs in 1997. The company provides high standards of service as 99% of pilotage jobs were serviced within 30 min and 96% of tug jobs were serviced within 15 min.

![Fig. 4. PSA operating statistics. Data for the figures came from PSA reports and archives.](image)
Fig. 4 presents some annual operating statistics for PSA: note that measures of volume have been steadily increasing, while the work force has peaked and is declining. The data in Fig. 5 show that Operations and Information Technology help substitute for labor. It is also clear that OIT helps to compensate for the relative lack of physical space at the Port. Efficient operations and support from information technology allow Singapore to increase the number of containers handled without a proportionate increase in space. Until the world economic downturn in 2000, income per employee had shown steady increases, as had the number of TEU container moves per hectare of Port space.

2. Analyzing PSA’s strategy

2.1. The resource based view

The RBV theory defines firm resources as “all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm.” (Barney, 1991, p. 101), and proposes that a firm has a competitive advantage when it creates a successful
strategy based on firm resources that cannot be duplicated by a current or potential competitor. The theory goes on to state that a resource must be rare, valuable, inimitable and nonsubstitutable to confer an advantage in the first place. Over time, a competitor may be able to duplicate an organization’s strategic resources, or develop a set of different resources that allow it to attain an advantage. There is no guarantee that a set of resources that once provided a competitive advantage will continue to do so indefinitely. Even if a competitor fails to duplicate your resources or develop new ones, there still may be ‘revolutions’ in an industry so that resources that once sustained an advantage for a firm are no longer valuable. “…What were resources in a previous industry setting maybe weaknesses, or simply irrelevant in a new industry setting (Barney, 1991, p. 103).”

Teece et al. (1997) have suggested a view of advantage based on ‘dynamic capabilities’, which are ‘the firm’s ability to integrate, build, and reconfigure internal and external competences (sic) to address rapidly changing environments.’ They argue that competitive advantage lies with a firm’s managerial and organizational processes, which are shaped by the firm’s asset position (resources) and the paths available to it. The basic idea of capabilities has been examined by Winter (2003), while Helfat and Peteraf (2003) present the idea of capability lifecycles, which helps explain the evolution of capabilities over time. Dynamic capabilities are particularly important in settings, which feature rapid technological change. Instead of just matching current firm resources to opportunities in the market place, the firm needs to develop the ability to identify new opportunities and respond quickly to them (Jarvenpaa and Leidner, 1998). The richness of the RBV of the firm provides a framework for our analysis of the development of Singapore’s Port.

2.2. The analysis

There are many ways to interpret the events in a single case. We have chosen to report on resources, which, in our opinion, contribute positively to PSA’s efforts to build and sustain a competitive advantage. Table 2 presents two natural and three additional manmade resources which have contributed to the success of the Port and PSA Corporation. The table also shows how these five resources combined to form an integrated resource that allows PSA’s to sustain a resource-based competitive advantage (Lucas, 2002). We chose these resources because of a belief that they make a significant contribution to the competitive position of the Port. There are numerous other resources that contribute to PSA, but our research suggests these are the most important.

No single resource is totally responsible for the Port’s success. Rather, a combination of resources works to produce a competitive advantage. As an example, Singapore’s location alone could not produce a successful Port; there are other possible Ports around the area which have not developed. Information technology alone could not confer an advantage without an investment in physical infrastructure at the Port like docks and cranes.

The initial (natural) resources are Singapore’s location and its harbor. Singapore’s location positions it well for shipments between Asia and Europe and between Asia and the West Coast of the United States. The natural harbor is well protected and provides an extremely large anchorage for over 800 ships. In addition, Singapore is one degree North of the Equator, which means that it is not subject to typhoons and major storms. While rare
and valuable, Singapore’s location fails to be inimitable or nonsubstitutable; there are other competing Ports in the area, especially Malaysia. A natural harbor is rare and valuable, but there are other, possibly smaller harbors that can compete with Singapore.

To develop and exploit these natural resources, Singapore has developed man-made resources of capital, information and operations technologies, and has developed IT management skills, as evidenced by the successful completion of the IT projects described earlier. The government built an infrastructure of housing, roads and quasi-governmental organizations to promote trade. It has encouraged foreign investment in order to provide jobs and capital. A policy that encourages trade as a way to build the economy means that the country has to provide a world-class Port. Through its emphasis on education and encouragement of the IT profession, public and private organizations have developed significant IT management skills (Matta et al., 1995). However, capital, IT and operations

<table>
<thead>
<tr>
<th>Resource attribute</th>
<th>Rare</th>
<th>Valuable</th>
<th>Inimitable</th>
<th>Nonsubstitutable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore’s location</td>
<td>Yes-few other sites as convenient for transhipping</td>
<td>Yes-high volume shipping route Asia–Europe</td>
<td>No-other locations in SE Asia can expand their Ports</td>
<td>No, there are nearby Ports capable of development esp. Malaysia</td>
</tr>
<tr>
<td>The natural harbor</td>
<td>Yes</td>
<td>Yes</td>
<td>No-possible to create at high cost</td>
<td></td>
</tr>
<tr>
<td><strong>Additional resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital for infrastructure-foreign investment</td>
<td>Yes, relatively so for Asia</td>
<td>Yes</td>
<td>No, funding might be possible from taxes, world agencies</td>
<td>No, capital may be available from other sources</td>
</tr>
<tr>
<td>IT and operations capabilities for a Port</td>
<td>Yes due to size and scale of Port operations</td>
<td>Yes</td>
<td>No, in principle, but few Ports have this scale</td>
<td>No if another Port is to provide acceptable service</td>
</tr>
<tr>
<td>IT management skills</td>
<td>Yes</td>
<td>Yes</td>
<td>No in general, yes for running a large Port</td>
<td>Yes-outsourcers do not have experience with this scale</td>
</tr>
<tr>
<td><strong>Combined resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location, harbor, capital for infra-structure, foreign investment</td>
<td>Yes</td>
<td>Yes</td>
<td>No, but difficult to catch up</td>
<td>No</td>
</tr>
<tr>
<td>Infrastructure, IT, operations and Port equipment</td>
<td>Yes</td>
<td>Yes</td>
<td>Difficult</td>
<td>Difficult</td>
</tr>
<tr>
<td>IT management skills, Port technology and operations</td>
<td>Yes</td>
<td>Yes</td>
<td>No in general, yes for running a large Port</td>
<td>Yes-outsourcers do not have experience with this scale</td>
</tr>
</tbody>
</table>
capabilities and IT management skills are all imitable. A smaller Port can steal business from Singapore without needing, for example, the same investment in IT because its operations will be simpler. While difficult, it is not impossible for another Port to find capital, and to develop or outsource IT management.

The resources described thus far, in and of themselves, are incapable of creating a competitive advantage. While these individual resources alone cannot sustain a competitive advantage, the unique combination of resources interacting with each other has proven to be a key to PSA’s long-standing competitive edge.

Because of its location, harbor, capital for infrastructure and foreign investment, PSA has been in the desirable position of continually upgrading Port operations. Singapore built an infrastructure to attract foreign capital, and this capital in turn generated economic activity that paid for further infrastructure development. Moreover, a strong norm against corruption has given Singapore a reputation as one of the least corrupt places in the world to do business, making it more attractive for companies. The government has consciously tried to raise living standards with government housing and a pension plan, which benefits citizens and makes the country more attractive for investment. Singapore places great importance on education, and an educated workforce attracts investments. These external resources also serve to the advantage of PSA. Combined with PSAs internal resources, the excellent reputation of business in Singapore reinforces PSAs competitive position and helps produce the funds to invest in maintaining a world-class Port.

The combination of Singapore’s infrastructure, IT, operations and specialized Port equipment also contributes to the Port’s competitive position. Singapore’s infrastructure; including the International Enterprise Singapore (IE Singapore, formerly called the Trade Development Board), the national IT initiatives that spawned Tradenet (Mahizhnan and Yap, 2000), distriparks (warehouses), and the highway system, together make the Port attractive to shippers. It is easy to transship goods in Singapore, and there is a great deal of truck traffic moving shipments down the Malay Peninsula to Singapore’s Port. The efficiency of the Port is enhanced by IT and operational systems, and by the infrastructure Singapore provides in general. While one could develop parts of this system easily, it is their combination that makes it difficult for another Port to compete. It would be difficult to imitate this group of resources, though a smaller Port would not need their full extent.

IT management skills and Port operations and information technology combine to make it difficult for other Ports to replicate its facilities. One example is PSA’s successful implementation of a number of expert systems. IT professionals from Kent Ridge Digital Laboratories worked closely with PSA staff members to develop these applications, and both groups developed skills in technology and Port operations. CITOS is another example of PSA’s ability to successfully design and implement a major technology initiative. PSA has the IT management skills to undertake a variety of development projects for a major Port, and these skills have contributed a series of key systems.

Fig. 6 is one possible causal interpretation of the role of different resources and government policies in the success of the Port. It would be difficult or impossible to delineate all the causal relationship in such a complex system; it is our belief that there is much mutual causality and interaction among the resources and policies. In the figure, the location and harbor provided the Port with the physical resources needed to be successful. Government development policies attracted foreign investment, which in turn provided
capital for trade. Government educational and industrial policies developed IT technical and managerial skills; these skills contributed to the successful design and implementation of the various operations and IT systems at the Port. Operations and information technology, in turn, contributed to highly efficient Port operations, which attracted shipping lines. The technology also helped expand the capacity of the Port to handle cargo without a concomitant increase in scarce physical space.

2.3. The impact of operations and information technology

The Singapore experience shows how IT can reduce the consequences of disadvantages; Singapore cannot dramatically increase its land area, but it can and has used IT to increase the capacity of its constrained physical resources to run a large Port.\(^2\) Singapore’s strategy of supplementing its location and harbor with manmade resources has overcome the limitations of the natural resources to create a Port whose location, harbor, infrastructure, and operations and information technology combined are rare, valuable, inimitable and nonsubstitutable. While OIT has helped reduce labor in some instances, reduce time and increase quality, its major contribution has been to create flexibility. This flexibility allows PSA to enlarge the capacity of the Port to handle more ships and cargo. In this way, operations and information technology take on a role comparable to physical infrastructure; one can expand a Port physically to provide more capacity, or one can employ technology to increase the volume of cargo handled by an existing physical infrastructure. For Singapore, given limitations on land, technology was a natural choice for maximizing the throughput of the Port. The combination of space restraints and OIT innovations increased productivity as well. Because the Port’s land area is small, yard cranes and prime movers have shorter distances to travel than in physically larger Ports, while OIT applications help make efficient use of stacked containers.

\(^2\) The authors are indebted to the Senior Editor for her insights on this point.
3. Conclusions

3.1. PSA’s strategy in summary

Singapore began with two natural resources: its location and a large, protected, deep-water Port. These resources, while rare and valuable, were imitable and substitutable. Fig. 7 illustrates the Port’s set of resources. Singapore combined capital with its location and natural harbor to invest in Port operations. Foreign investment helped generate the needed capital; in addition the government built ancillary infrastructure like roads, housing, sanitation, water and electrical systems. The management of PSA saw operations
and information technologies as a way to solve problems and expand the capacity of the Port.

3.2. Competitive response

An organization can never assume that an advantage will last; competitors do not give up easily. In 2002, Singapore lost Maersk Sealand and Evergreen Marine left PSA and moved to the Port of Tanjung Pelepas in Johor Bahru, Malaysia. The fundamental reason for the move was that the Malaysian government offered the two a say in managing the Port along with dedicated berths. Cost-wise, Johor may have an edge over Singapore, but this advantage may well be negated by PSA’s higher efficiency and shorter turn-around times. For example, Mr Poon, Director of Evergreen, stated in 1998 that PSA was the most competitive and efficient Port in the region, with the fastest turnaround time and the most efficient operations times.

In response to the loss of these carriers, PSA dropped the handling rate for empty containers by 50% and is considering giving operators a stake in PSA’s operations. The Port cut fees by a total of S$300 million for 1 year, and began a new policy to promote greater customer focus and flexibility. PSA worked with China Ocean Shipping Group Company (COSCO) to establish the COSCO–PSA terminal in December 2003, a dedicated berthing arrangement for COSCO ships. The government has established an Economic Review Committee with nearly 100 members who are looking at ways to ‘transform the economy (New York Times 4/30/02)’. In 2003, PSA recovered the loss of the roughly 3 million TEUs from Maersk and Evergreen the year before.3

4. Implications for management

Is it possible to generalize these findings for managers who work in other domains and deal with different resources? While this paper has focused on the Port of Singapore, which is quite unique, there are implications for management that extend well beyond PSA. PSA supplemented limited natural resources with man-made resources, including operations and information technology, to build one of the leading Ports in the world. These man-made resources compensated for some of the country’s natural limitations. Managers should look at resources provided by nature and build resources to supplement them. Not all important resources are under the control of an organization, so one must (1) identify external resources that can be used to one’s advantage and (2) build internal resources capable of enhancing those external resources).

The case points out an important characteristic of operations and information technology; it can be used to expand capacity without adding investment in plant and equipment or physical space. Technology helps the firm utilize assets more effectively. This same principle applies in other settings as well; a railroad can reduce the need for new locomotives through systems that monitor their mechanical condition, and systems that

3 Speech on 1/30/04 by Senior Minister Lee Kuan Yew, Queenstown Community Centre.
provide more efficient scheduling of trains. A manufacturing company can increase the capacity of its plants through better production control and scheduling systems. Operations and information technology offer the manager the ability to increase capacity without adding physical assets.

Singapore consciously developed all of its resources; the country has a clear industrial policy, and it encouraged the development of specific industries and built a transportation infrastructure to support trade. Its entire set of dynamic resources provides a competitive advantage, but PSA must continue to add to its resources to sustain this advantage. We believe that other organizations can learn from PSA’s experiences, especially their effort to develop a relatively large number of resources simultaneously that complement each other. Managers should recognize that they are unlikely to be able to gain a competitive advantage from one resource, or a random set of resources. Success is much more likely to come from a group of resources that interact with each other.

In summary, the Port of Singapore developed a series of man-made resources to supplement and enhance its natural resources of a protected Port and location. We believe that such a group of dynamic resources can help sustain an organization’s competitive advantage.

References