Information technology management: the case of the Port of Singapore Authority

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Abstract

The Port of Singapore Authority (PSA) used information technology (IT) extensively to create a high-tech port that has become the busiest port in the world. Now corporatised as a commercial port operator, PSA Corporation Ltd employs four key management success factors in managing IT to meet the demands and challenges facing port operators. They are: (1) having a business-driven IT investment; (2) aligning business and IT plans; (3) maintaining a flexible and extensible IT infrastructure; and (4) encouraging IT innovation and creativity. These management success factors are discussed and examples are given to illustrate how they help PSA more effectively leverage IT to streamline operations and sustain its competitive advantage. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

The Port of Singapore is a mega transhipment hub with unparalleled cargo base load and shipping connections. Every day, the port services some 60 container vessels and moves 45,000 containers across its quay. Despite the economic crisis experienced in the region, the port was able to maintain its growth in container traffic. Over these critical years, the

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container traffic grew from 12.94 million TEUs (twenty foot equivalent units) in 1996 to 14.12 million TEUs in 1997 to 15.1 million TEUs in 1998 and 15.9 million TEUs in 1999. With the regional economic recovery, the port has already seen an increase in cargo volume. The first quarter of 2000 saw the handling of 4.2 million TEUs, a 15.4% increase compared to the same period in 1999. The port also set a world record in handling 1.5 million TEUs in a single month in March 2000; no other container terminal operator has handled such a high volume in a single location within a single month anywhere in the world.

PSA has six terminals to accommodate all types of vessels — container ships, break bulk carriers, cargo freighters, coasters, lighters, and ocean liners — calling in its waters. The six terminals are Tanjong Pagar Terminal, Keppel Terminal, Brani Terminal, Pasir Panjang Terminal, Pasir Panjang Wharves and Sembawang Wharves. The terminals are purpose-built facilities for container vessels while the wharves are multi-purpose facilities for all kinds of vessels. The management of the terminals and wharves lies in the hands of PSA Corp’s Container Terminals Division and the Logistics Division, respectively. The Maritime and Port Authority (MPA), formed out of the old Port of Singapore Authority (PSA) and several departments of the then Ministry of Communications, is the landlord and port regulator.

Maritime trade is becoming an increasingly important part of Southeast Asia’s economic development. Countries in the region like Malaysia, Indonesia and Hong Kong are making efforts to improve their port services and to challenge Singapore’s position as a dominant shipping hub. Despite the competition, the Port of Singapore continues to outshine its neighbouring ports. In the Global Competitiveness Report 1999 published by the World Economic Forum, the Singapore port achieved a high score of 6.76 out of a possible 7 in terms of how well the port facilities met business requirements as compared to a 6.38 given to the Hong Kong SAR port (see Table 1 for a ranking of ports as provided by the report). In 1999, PSA Corp was awarded the “Best Container Terminal” by the Lloyd’s List Maritime Asia. In March 2000, at the 14th Asian
Freight Industry Awards organised by Cargonews Asia¹, the Port of Singapore won the Best Seaport (Asia) award for the twelfth time, and PSA Corp. won the Best Container Terminal Operator (Asia) award for the eleventh time. These awards give due recognition for the excellent services provided by the Singapore Port and PSA Corp.

Increasing competition from its neighbouring ports and the pressure to maintain a high standard of service for the shipping community are two important factors that motivated PSA to work hard at making the Singapore port the best port in Asia. Having an excellent infrastructure is key to the success of Singapore as a global shipping hub; information technology forms an important element of this infrastructure.

In showcasing its information technology capabilities on its web page (http://www.psa.com.sg), PSA points to the fact that “the battleground of the future will be the fast and accurate exchange of information between (itself) and its customers, suppliers, and other container terminal around the world.” Consequently, PSA has invested hundreds of million of dollars in IT over the last 5 years so as to keep pace with the intensity of port operations. The investments include a computer network that is purported to be the largest network in Singapore. Computer applications have been developed to support every facet of PSA’s administration, planning, and operation. Mr Eric Lui², the former Director of Information Technology (IT), noted that PSA “runs one of the most technologically advanced ports in the world.”

2. Background

Singapore is a small island state with a land area of approximately 620 km². Before 1964, the Singapore Harbour Board was responsible for overseeing the port facilities which were confined to some 5 km of wharves and 160,000 m² of transit sheds and warehouses at Telok Ayer and Keppel Harbour. Then, the main type of cargo handled was break-bulk general cargo, with small volumes of bulk vegetable oil and latex. In 1964, the Port of Singapore Authority was established to replace the Singapore Harbour Board. In 1971, the Stores Basin of the British Naval Base at Sembawang was handed over to PSA. This resulted in the establishment of the Sembawang Wharves. In 1972, the Tanjong Pagar Terminal was opened with three container berths. Later in 1974, the Pasir Panjang Wharves were set up.

The decision to construct the first container terminal in the late 1960s was a big gamble for PSA. This gamble paid off as evident from the increase in container volumes of over 100,000 TEUs in the 1970s to hitting the million mark in 1982. From this point, the growth in container throughput handled by Tanjong Pagar Terminal has been increasing substantially at a great momentum. Within a span of four years from 1982 to 1986, the throughput has increased a hundred-fold to 2 million TEUs. The next increase of a million TEUs was met in 1988 and then in 1989, it reached 4 million TEUs. The containers handled by the port continued to exhibit a steady increase over the last ten years (see Table 2). In fact, to

¹ Cargonews Asia is a trade journal based in Hong Kong.
² Mr Eric Lui has recently left the PSA.
maintain the rapid pace of expansion in container throughput handled, new container berths have been built almost every other year since 1980.

The sheer volume of container traffic and the overall increase in cargo handled began to stretch the capacity of PSA’s staff. Added to this is the growing complexity of running a global port. It was then that PSA decided to go high-tech with a commitment to harness information technology (IT) to run the Port more efficiently and more effectively. As stated by Miss Chung Suat Lay, Customer Systems Manager, “IT applications in PSA have come a long way to the present state. Our first planning back in the late 1970s was all carried out manually. Human errors during inputting and outdated information had caused much chaos and inconvenience … that is history now!”

### 3. Organisation structure

PSA was originally a statutory board under the purview of the Ministry of Communications. On 30th September 1997, PSA was corporatised and renamed PSA Corporation Ltd, a wholly owned subsidiary of Temasek Holdings. The mission of the new PSA Corporation is to excel as the world leader in providing seaport and logistics services of the best value to its customers. The organisation chart of PSA is shown in Fig. 1.

As noted from PSA’s organisation chart, the Information Technology Division (ITD) is a division under the Strategic Development Group. The ITD is responsible for the computerisation efforts in PSA. In other words, ITD supports the computerisation efforts of the other divisions. Currently, ITD has a staff strength of about 300 employees.

### 4. Harnessing IT at PSA

Port operations consume considerable resources and are time critical. Resources include berthing space for ships, tug boats for towing ships into the harbour as well as manpower to keep the port operational 24 hours a day, 7 days a week. The activities are time critical because if too much time is spent on unloading cargo, clearing customs, etc., ships will...
prefer to call at other regional ports. In fact, one of the key reasons why Singapore has continued to be the world’s busiest port is the ability of PSA to ensure that ships coming to Singapore are efficiently and promptly dealt with.

The various marine and terminal services provided by PSA are both complementary and inter-related. Directly or indirectly, the various activities at the port such as assignment of berths, bunkering, deployment of cranes and supporting equipment, shipside operations, yard management and gate systems, can all have an impact on one another. As speed is a critical factor in port operations, PSA has strived to co-ordinate the varied activities in the port through the use of IT.

The systems developed by the IS group are now well known among port users. Besides serving the needs of PSA’s users, these systems help the shipping community users to be more efficient and effective in the logistics and port operations. Mr. Tan Puay Hin, Senior Vice-President (Operations), mentioned that “To handle a throughput like PSA’s, usage of IT is a definite must.” Thus, PSA does not hesitate to invest heavily on IT.

Some of the systems developed by PSA’s IS group, that have been key in helping PSA to gain a favorable standing with its port users and against its competitors, include Computer Integrated Terminal Operations System (CITOS), BOXNET, PORTNET and FastConnect. With these systems, port users can look forward to faster handling speed and shorter ship turnaround times.

CITOS is used at the container terminals to plan and direct all container handling
operations in real-time. Using expert systems, CITOS plans the use of berth, yard, equipment, and manpower required. From the central Yard Control Computer, work instructions are transmitted to all the machine operators using a real-time wireless data transmission system (see Fig. 2). With CITOS, PSA is able to handle the highest vessel rates in the world despite the complexity, number and speed of box connections between vessels. As of April 30th 2000, CITOS has been made a permanent collection at the Smithsonian’s National Museum of American History and is one of the top five finalists for the ComputerWorld Smithsonian Award (Transportation Category). According to Daniel Morrow, the executive director of the Computerworld Smithsonian Program: “PSA Corporation Ltd’s CITOS is one of the outstanding showcases among the 444 laureates. CITOS comes out as among the very best in an extraordinary class of laureates in the 2000 collection.” (Business Times, 2000a).

BOXNET is an electronic data interchange (EDI) with hauliers to enable them to streamline their operations and to improve their fleet utilisation with easier tracking and allocation of jobs. Through BOXNET, hauliers receive the electronic delivery order directly into their system for processing and scheduling of delivery of containers from the port. At the same time, they can upload the shipping note for export containers from their system instead of re-keying into PORTNET. BOXNET also allows users to receive information regarding the arrival and exit of their trucks through PSA container gates. Important information such as container number,
vessel/voyage, and date/time of arrival/exit, can be received into the hauliers’ systems to record the job performed.

PORTNET is an EDI system that provides port users with a 24-hour a day electronic information and communication link with PSA. Currently, PORTNET has about 1500 subscribers. Through the system, port users have convenient access to information on PSA. In addition, they can also submit their work orders or process their bay-plans electronically. This basically eliminates the need to manually re-key and transcribe data, thereby preventing errors. Through PORTNET, users can also interact electronically with TRADENET, the government EDI system that facilitates rapid custom clearance, thereby providing one stop service to port users.

The system FastConnect aims to reduce the time-gap for approvable connections for transhipment of containers. The system accelerates the connection of containers as it enables shipping lines to select the earliest connecting carrier, and reduces the time taken for processing of transhipment containers. With FastConnect, the intra-terminal connections between the unberthing of a first carrier and berthing of a second carrier have been dramatically reduced from 8 to 2 h. For inter-terminal connections, the time has been reduced to 10 from 12 h. As transhipment is a very important business for the Singapore Port, FastConnect is a move towards the ideal of just-in-time connections.

5. IT management

Mr Eric Lui, the former Director of the Information Technology Division, highlighted that the objective of the IS department is to help PSA use IT to reengineer its business processes and to meet the demands of its customers. The efforts put in by the IS group in harnessing IT was given due recognition when PSA’s IS group won the first National IT award for the public sector in 1990. Quality products produced by the IS group have helped to push PSA into the forefront of a high-technology port. The quality of PSA’s IT development is evident not only from the awards it has received but also from the ISO9001 certification it obtained in 1994.

As part of PSA’s customer focused philosophy, it continually strives to improve its services. An example is the use of an innovative product, the remote-controlled bridge crane, at the new Pasir Panjang Terminal, to provide a faster and more efficient service. This new terminal uses the latest wireless technology for its navigation techniques. With more emphasis on remote control and automation, the reliance on IT will be even higher. In fact, the use of advanced container terminal technologies will enable the Pasir Panjang Terminal to handle some 750,000 TEUs per berth per annum, 25% more than existing terminals at Tanjong Pagar, Keppel and Brani (Business Times, 1999).

6. IT management success factors

The PSA’s IT division comprises a group of dedicated people who work hard at producing systems that will meet these demands. PSA has identified four key management success factors in creating an IT division that can meet the challenges and demands of a fast growing port:

(1) having a business-driven IT development;
(2) aligning business and IT plans;
(3) maintaining a flexible and extensible IT infrastructure; and
(4) encouraging IT innovation and creativity.

These factors are discussed in more detail in the following sections.

6.1. A business-driven IT development

PSA prides itself in using the latest computer technology in port planning and operations so that its customers can gain a competitive advantage in their businesses. Since PSA strongly believes that the users know their business best, development of information systems is always done jointly by users and the IT group. Here, users refer to both internal and external users. For systems with external users, the IT group makes an effort to obtain some input and feedback from them. For example, the FastConnect system was developed with inputs from shipping lines involved in transshipment containers.

Mr Lee Chee Yeng, former President (Warehousing and Logistics Division) and currently Managing Director (Changi International Airport Services, a subsidiary of PSA) commented that “computerisation should not be divorced from the users.” The IT group has the know-how on the feasibility of using technology to enhance the business. It is the marriage of these two groups of people that often results in systems that yield strategic value for the organisation. For example, Mr Lee was at one time concurrently the Director of IT and Operations. The technological know-how of the IT group is obtained through experience (since most systems are developed in-house) as well as by keeping track of latest developments through attendance at seminars and conferences world-wide.

For PSA to remain competitive, it is important for PSA to be able to facilitate ships entering and leaving the harbour. Since Singapore is a small island with limited coastline and land available for port activities, it is important for it to manage congestion at its harbours. The solution devised to deal with these problems was the development of a Computer Integrated Marine Operations Systems (CIMOS) that was fully implemented in mid-1995. CIMOS uses the Differential Global Positioning System technology to facilitate real time tracking of ships entering and leaving the harbour. In addition, it helps to ensure navigational safety by indicating which ships are on collision paths with each other, so that the port operator can contact the ships by radio to warn them to change course.

PSA also contends that attaching the IT personnel to the users helps the IT personnel to obtain a more in-depth understanding of the business of the organisation. This helps in giving IT personnel the scope required in creating systems that meet the demands of the organisation. For example, before a new group of IT staff is assigned to develop systems for port operations, they are attached to the Operations Division for about three months or more so that they have some knowledge about what is going on in that business. In addition to “job” attachment, IT personnel developing systems for users are located in the same building as the users. This helps the IT personnel to familiarise themselves with the user environment as well as to establish rapport between themselves and the users, thereby facilitating partnership essential for business-driven IT development.
6.2. Alignment of business and IS plans

In PSA, each domain in the IT division has to produce a rolling operational plan in consultation with the relevant business units. As both the IT division and the users are involved in developing the operational plans, this ensures that the demands of the business units are met in the operational plans. In other words, by involving users and obtaining their inputs during the development of the operational plans, the IT group is able to ensure that the plans are consistent with business needs and objectives.

Besides providing a task list of what is to be done over a defined period, the operational plans also serve as budgetary plans. When the operational plans are completed, they have to go through the head of the business unit for approval. The plans are evaluated based on several factors such as the impact on PSA’s services to customers, expected costs and benefits, and consistency with business objectives and strategies. They are then forwarded to the Management Committee for integration into PSA’s overall plan. As the Management Committee is directly involved in developing the strategic directions for the organisation, it is able to accordingly prioritise the operational plans to ensure that systems critical to the organisation’s strategic position receive the required attention.

6.3. A flexible and extensible IT infrastructure

Mr Eric Lui maintained that a key factor contributing to the success of the IT Division is its flexible and extensible IT infrastructure. Flexibility is defined in terms of its ability to meet the changing demands of users and to keep up with the rapid developments in IT. Extensibility is defined in terms of its ability to accommodate new technology developments without having to constantly restructure the organisation’s IT infrastructure.

The flexibility and extensibility of the IT infrastructure is enhanced through standardisation of hardware and software, integration of systems to facilitate data access and sharing, adoption of structured development methodologies to facilitate rapid application development, support for open systems and the development of an overall master plan for systems development.

Further, emphasis is also placed on interoperability and scalability in the development of any new systems. Conscious and deliberate decisions that take into account flexibility and extensibility are made both during development and upgrading of systems as PSA believes that the IT infrastructure determines what a firm can or cannot do in response to changing environmental conditions and increased competitive threats.

Careful planning is therefore required to develop a flexible and extensible IT infrastructure. As the result of this planning, PSA has successfully migrated its mainframe system to a client server system in 1999. With the development of e-business, PSA is also actively looking at ways to incorporate these changes to its current systems. Recently, it went into a joint venture with iPlanet.com to “accelerate the creation of a digital infrastructure that will provide comprehensive port terminal and shipping solutions on the Internet to respond to (our) customers’ needs even faster, with more flexibility”.

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3 Quoted from Robert Yap, Managing Director of Portnet.com (Business Times, 2000c)
6.4. Encouraging IT innovation and creativity

In order to serve its customers well, PSA makes sure that it produces systems that would enhance the efficiency and effectiveness of its operations. It constantly benchmarks itself against its competitors in the shipping industry and organisations outside the industry by examining and adopting best practices in areas in which other firms excel. At times, necessity becomes the “mother of invention.” At other times, it is learning from other industries that results in innovative systems for the shipping industry.

In the first instance, an example is the container truck flow at the container gates. On an average day, some 6000 trucks enter or leave the port’s gate. However, the waiting space available at each gate is only for five trucks. This implies that there is a need to increase the service rate of each truck. This problem brought about the idea of container truck flow through with dynamic truck weighing. The solution to the problem was to introduce a system that includes the use of a transponder. The system that resulted from this innovation is the Gate Automation System (GAS).

GAS was implemented to shorten the gate processing time of trucks to ensure a more reliable and better service to port users. With GAS, when a container arrives at the gate, its arrival is registered, its weight is recorded, and a location is assigned or delivery is directed all within 25 s.

GAS makes use of a transponder system to identify the trucks arriving at the gate. To recognise the number on the containers, neural network technology is used. The numbers are transmitted to a PC which digitises and stores the characters. The recognised characters are then matched against a database of previously declared numbers. When there is a perfect match, the system allows the container to pass through. Such matching saves time and increases the quality of the service provided by the port.

Another instance where innovation and creativity have worked towards producing a system that greatly improves PSA’s service to port users is the Freight Auto Service Terminal (FAST). In the early 1990s, a perturbing problem facing PSA was how to introduce self-service terminals that allow hauliers to enter the required data and then print the necessary documentation. PSA’s IT team looked into a known technology widely used in the banking industry as a possible solution to its problem. The Automated Teller Machine (ATM) is a familiar technology. It allows users to key in their personal identification numbers and then issues their requested services. If a withdrawal is requested, both money and a receipt will be issued. This concept has been adapted by PSA for its cargo operations. The result is self-service terminals that provide round-the-clock service for hauliers bringing cargo in and out of the port. This system, the world’s first equivalent of an ATM for cargo operations, significantly reduces hauliers’ time spent in documentation and in queuing at the port.

In order to ensure continued innovation and creativity, PSA actively encourages its staff to participate in Quality Circles (QC). In 1999, PSA has a QC participation rate of 100% with more than 600 QCs. One unique feature of the QC movement at PSA is that some of these QC involve participation from its customers. These QC are called Joint Quality Circles as committees are made up of both staff members from PSA and their customers. Such partnerships help to foster closer ties as well as facilitate mutual understanding between PSA and its customers. In recognition for its efforts in improving quality, PSA
consistently remained as one of the top award winners at the annual National QC conventions.

In addition to encouraging staff participation in QC circles to solve operational problems, staff are also encouraged to make improvement suggestions in the Staff Suggestion Scheme. In 1999, PSA as a whole recorded a total savings of $6.23 million through its staff suggestion schemes and its quality circle programs (PSA Annual Report 1999).

7. Discussion

The four management success factors in this case study serve as important lessons to other companies who desire to leverage IT strategically. For example, “a business driven IT development” is often viewed as an essential ingredient in the effective deployment of IT to serve business needs (Henderson and Sifonis, 1988). At PSA, a key effort towards this direction was the appointment of the Director of IT as part of the senior management team. As a member of the senior management team, he knew the strategic directions set for PSA and had ideas on what systems would be essential for PSA. As Director of IT he then set the strategic directions for the IT division and was responsible for transforming these ideas into systems that met the needs of the organisation. As the senior management team was directly involved in developing the strategic directions for the organisation, it was able to prioritise the operational plans to ensure that systems critical to the organisation’s strategic position received the required attention. Such a strong partnership between IT and business management was found to be a key element in the success of IT management practices in the two-year study conducted by Ross et al. (1996).

Further, as the Director of IT was at one point concurrently the Director of Operations, he had excellent knowledge about the business operations of PSA. Teo and King (1997) have shown that the business knowledge of the IT executive is a key factor in facilitating greater alignment between business and information systems plans. In a similar vein, IT management knowledge about business was found to be even more important than top management knowledge about IT (Teo and Ang, 1999). Such knowledge of PSA’s business operations was instrumental in ensuring that IT applications served business needs and that IT plans were consistent with business plans.

Based on their studies of information systems leaders in sixty organisations, Earl and Feeny (1994) proposed six areas in which a CIO can add value to the organisation (summarised in Table 3).

As iterated by Earl and Feeny, the CIO (in this case, the Director of IT) can play a significant role in the organisation’s perception on whether IT is considered an asset or a liability. At PSA, the Director of IT was well versed with business problems and areas where IT could be potentially deployed to add value as he was once in charge of operations. Given his background, his focus was on the business imperative (#1) and he was able to establish and maintain IT executive relationships (#3) to make sure that IT is aligned with business strategies. Furthermore, he actively examined success stories of IT use (#2) in similar or different industries and adapted such ideas for PSA as in the case of the self-service terminals (an idea extracted from ATMs used by banks).

The Director of IT also set development efforts (#5) on integrated systems (e.g. CITOS
and CIMOS) that form the core of PSA’s operations. These systems were developed with quality in mind and were known to meet users’ needs. As such, the IT department has built a credible reputation for itself (#4). Through the successful and effective deployment of IT, the Director of IT has achieved a shared and challenging vision for the role of IT (#6) as a key enabler to achieving business strategies.

Related to the first success factor is the second factor which emphasises alignment of business and IT plans. The need for aligning IT plans with business plans has been emphasized in both prescriptive (e.g. Baets, 1992; King, 1978) and empirical studies (e.g. Teo and King, 1996, 1997). Basically, these studies show that alignment between IT plans and business plans is necessary to ensure that the IT function supports organizational goals and activities at every level (Lederer and Mendelow, 1989a) in order to achieve business value from IT (Lederer and Salmela, 1996; Teo and King, 1996) and better exploitation of IT for strategic advantage (Goldsmith, 1991). Such alignment also helps to identify critical applications for development (Lederer and Sethi, 1991) and ensures that adequate resources are allocated to such applications (Lederer and Mendelow, 1989a,b).

At PSA, the alignment was facilitated through the development of IT plans in consultation with business units, and the involvement of the IT Director in both business and IT planning. By working closely with business units, rapport is developed between the IT department and business units, thereby facilitating partnership that is crucial for business-IT alignment and for IT to deliver value to the firm (Ross et al., 1996; Luftman et al., 1999; Teo and Ang, 1999). This is also in line with Earl and Feeny’s (1994) suggestion that the key roles of the CIO (and hence the IT department) include establishing and maintaining executive relationships as well as facilitating the achievement of a shared vision for the role of IT.

In a recent survey among IT practitioners in the United States, building a responsive IT infrastructure to support existing applications while remaining responsive to change is

### Table 3

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<tr>
<th>The value add of the CIO (Earl and Feeny, 1994)</th>
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<tr>
<td>1. Obsessive and continuous focus on business imperatives</td>
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<tr>
<td>Successful CIOs consistently invest their personal time in discussions with business executives in order to better understand and focus on business goals and strategies</td>
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<td>2. Interpretation of external IT success stories</td>
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<tr>
<td>Successful CIOs are skilled analysts who are able to extract key elements of IT success stories and communicate its potential relevance to the business</td>
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<td>3. Establishment and maintenance of IS executive relationships</td>
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<td>Successful CIOs are able to build alliances or partnerships with business executives in the deployment of IT</td>
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<td>4. Establishment and communication of IS performance record</td>
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<tr>
<td>Successful CIO are able to enhance and communicate IS reputation and track record to business executives</td>
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<td>5. Concentration of the IS development effort</td>
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<td>Successful CIOs focus on IS development projects that are integral to business strategy</td>
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<tr>
<td>6. Achievement of a shared and challenging vision of the role of IT</td>
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<tr>
<td>Successful CIOs are able to effectively sell and share their vision of IT as an enabler of business transformation</td>
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rated as the number one key issue (Brancheau et al., 1996). Hence, it is not surprising that PSA placed emphasis on building a flexible and extensible IT infrastructure as its third success factor. A good IT infrastructure underpins the competitive positioning of business initiatives for an organisation (Broadbent and Weill, 1997). Furthermore, a flexible IT infrastructure is needed to provide long-term support for a business strategy that can quickly respond to changing environmental conditions (Eardley et al., 1997). PSA has built its infrastructure such that it can comfortably include current IT trends like downsizing and the development of the Internet and Intranet in its system development. An example is how PSA is able to extend its current infrastructure to include e-commerce capabilities. PSA set up PORTNET.com to tap on e-commerce opportunities and to move its users from using its existing Electronic Data Interchange (EDI) to new Internet offerings (Business Times, 2000b).

Innovation and creativity are often essential characteristics of leaders in any industry. PSA realises that it is difficult to sustain any competitive advantage by IT alone. Consequently, PSA emphasises the importance of continued innovation and creativity as its fourth success factor, in order to stay ahead of its competition. PSA managed its human asset by providing proper training and encouraging creativity and innovation among staff. The approach taken by PSA to encourage creativity and innovation is consistent with “inside-out innovation” advocated by Earl (1989) to identify IT applications that may yield competitive advantage or create new strategic options. Earl emphasises that innovation is facilitated through the use of idea generation techniques (e.g. brainstorming during QC meetings), organisational processes that involve external people (e.g. involving users, external parties in QC or committees) and construction of a facilitative technological environment (e.g. support for staff in exploring new technologies).

8. Conclusion

The Port of Singapore has a long-standing reputation of being the best seaport in Asia and one of the best in the world. In its relentless pursuit to maintain its position amidst keen competition from neighbouring ports, PSA has harnessed IT strategically to improve the efficiency and effectiveness of port operations not only for its own staff but also for other port users.

The key message in this case is that PSA has been able to leverage on IT to remain competitive through having a business-driven IT development, aligning business and IS plans, maintaining a flexible and extensible IT infrastructure and encouraging creativity and innovation among its IT personnel. Although these four success factors have been emphasised in past research, this paper contributes to a better understanding of how they are actually implemented in an organisation, in this instance, PSA. Furthermore, since past research has also advocated a wide range of factors for effective IT management, it makes it difficult for firms to decide which factors are most important. In this paper, we have highlighted four key success factors which have been found to play a crucial role in PSA’s success. The four success factors can also be viewed as best practices in IT management.
By paying attention to these best practices, practitioners can enhance the effectiveness of their IT management.

In addition, firms should choose a CIO (or Director of IT) that is able to add value in key business areas. While the case highlighted practices that may be context specific, they can nevertheless provide other organisations with insights that are pertinent for achieving excellence in IT management.

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