THE PORT OF SINGAPORE

'Singapore's raison d'être was its Port. Singapore must strive to remain a major hub port.'[1]

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[1] Minister Mentor Lee Kuan Yew, Inaugural Singapore Maritime Lecture in 2007, http://www.mpa.gov.sg/sites/pdf/singapore_nautilus_issue2.pdf, Accessed on 24 Aug 2015

1. Introduction

1.1. Historic Overview

Dating back to the 14th century, Singapore–then known as Temasek ("Sea Town")–was already flourishing as one of the major trading posts in the region. Many sea routes, like the Silk Road, crossed at the tip of the Malay Peninsula where Singapore was located. The country's strategic location attracted a variety of vessels that came to exchange goods and ideas from all over the world.[2]

In the 19th century, the British recognized the potential of the island as a trading station and established one of their main bases here due to its geographical location.[3] Under British governance, Singapore began to develop as an entrepôt. However, development during this period was hindered by piracy, which the British took tremendous effort to eliminate, as well as the need to reconstruct the main port infrastructure[4]. Through this and other continuing efforts by the authorities, Singapore grew and prospered as an Asian maritime trade hub.

The transition from the 19th century to 20th century was a key time in the history of the Port of Singapore. The demand for shipping lines was continuously evolving and, hence, the Port of Singapore had to make extensive changes and improvements to its services to meet the current demands as well as the predicted demands of the future.

1.2. Containerization

Source: Lewis Hine, https://commons.wikimedia.org/wiki/File:Stevedores_ny_1912.jpg

Source: Port of Singapore, William Cho, https://commons.wikimedia.org/wiki/File:The_port_of_Singapore.jpg

Figure 1: From Break Bulk Cargo to Containers[5]

The rapid surge in port demand was largely driven by the advent of containerization. Previously, goods were mainly packaged and transported as break bulk cargo. The handling of such cargo

[2] John N. Miksic. (2013). *Singapore and the Silk Road of the Sea, 1300-1800.*
[3] Singapore Tourism Board. (2013). *A Brief History of Singapore.*
[4] G. Pedrielli, E.P. Chew, L.H. Lee & K.C. Tan. (Upcoming). *Competitiveness of the Port of Singapore. An Historical Overview.*
[5] Photograph by Lewis Hine and William Cho

was highly labor-intensive, costly and inefficient. As technology advanced in the 20th century, the idea of containerization was mooted and eventually implemented. Shipping via containers can bring about numerous benefits such as increasing port efficiency and reliability and reducing transport costs.[6] Countries that realized the importance of containers began to heavily invest in the development of container ports, and Singapore was one such country. Thereafter, containerization brought about a boom in international trade and promoted globalization.

Investment in containerization was a strategic move by the Port of Singapore Authority (PSA) and made Singapore the most efficient container hub in the world. As demand for shipping lines increased, there was a need to enhance the port's capacity to handle more containers and offer faster services to reduce the waiting time and turnaround time for ships. New technologies and services had to be created to enable such advances. Hence, making relevant reforms to the regulatory bodies and the port itself were necessary to remain competitive in the global arena.

This article analyses and discusses changes made in government policy, the physical development of the port and the evolution of technology in tandem with port development from the 19th century to the present.

2. The Role of Government Policy and Management Structure

Central to the success of the Port of Singapore is continuous changes in government policies and management structure in relation to maritime development. Over the years, the port management has gone through numerous changes to meet the current demands of the port as well as to enhance future growth prospects.

In the early 19th century, dock and wharf services at New Harbour were privately managed by a monopoly, the Tanjong Pagar Dock Company. Due to its inability to continuously improve the dock facilities to meet growing demands, the British government eventually expropriated the company and replaced it with Tanjong Pagar Dock Board.[7] Under the management of the Tanjong Pagar Dock Board, the New Harbour was significantly improved through repairs and upgrades of the docks and machineries used. The Board then gave it the name that is still used today: Keppel Harbour.

On 1st July 1913, the Singapore Harbour Board (SHB) was established and took over the expansion projects for Keppel Harbour from the Tanjong Pagar Dock Board. The management behind SHB proved its capability and surpassed its predecessor's success by expanding the limits of the existing docks. All wooden structures were reconstructed with concrete and more storage services were provided.[8] Until 1964, SHB oversaw all operations at Keppel and Telok Ayer Harbour. During this period, break bulk general cargo and small volumes of bulk vegetable oil

[6] Rodrigue JP. (2015). Hofstra University: *The Geography of Transport System*.
[7] Lim, R. (1993). *Tough men, bold visions: The story of Keppel.* (pp. 24-25, 28).
[8] Liu, G. (2001). *Singapore: A Pictorial History, 1819-2000.* (pp.107).

and latex were handled.[9] However, neither dock was large enough to accommodate the influx of bigger and more vessels due to globalization and containerization.

On 1st April 1964, the Port of Singapore Authority (PSA) was formed as a statutory board that took over SHB. During this period of time, containerization was introduced and PSA focused its efforts to establish and improve container operations. The first container berth was opened in Tanjong Pagar Harbour and Singapore was the first in Southeast Asia to accommodate a container vessel, the third generation containership M.V. Nihon in 1972.[10] Other milestone development projects included the opening of Jurong Port, Sembawang and Pasir Panjang Wharves. Besides developing new ports, PSA also aimed to increase efficiency by introducing the two-shift system that earned Singapore the title of "the port that never sleeps".

By 1982, Singapore had become the world's busiest port by shipping tonnage and achieved one million Twenty-foot Equivalent Units[11] (TEUs) in a year.[12] To continuously improve port management efficiency, state-of-the-art information technology and automation were adopted. These projects will be discussed in later sections.

The Maritime Port Authority of Singapore (MPA) was formed in 1996 to take over the regulatory functions of the PSA. The PSA was then corporatized, which was necessary so the organization could focus on international expansion and remain competitive in the maritime industry.

Today, both MPA and PSA work closely with Jurong Town Corporation (JTC) and Keppel Corporation Limited (KCL), two other important port players in Singapore, to improve maritime activities.

The table below summarizes the development of the various ports in Singapore, as well as the governing and managing bodies at different periods of time.

[9] Lee-Patridge, J.E. (2000). National University of Singapore. *Information Technology management: the case of the Port of Singapore Authority.* (pp 3).
[10] PSA. (2015). About Us: *Milestones.*
[11] TEU is a measurement to describe container capacity.
[12] Ibid.

Table 1: Singapore Terminal Development[13]

Port Name	1st operations	Governance	Management
Keppel Harbour	1850	1850 – 1905 : The Tanjong Pagar Dock Company 1968 – Current : KCL	SHB (Public) PSA (Public)
Telok Ayer	1879 (until 1932)	The Tanjong Pagar Dock Company	SHB (Public) PSA (Public) MPA (Public)
Tanjong Pagar Terminal	1972	1972 – 1977 : PSA 1977 – Current : PSA Corporation	SHB (Public) PSA (Private) MPA (Public)
Keppel Terminal	1991 (split from Tanjong Pagar Terminal)	PSA Corporation	MPA (Public)
Brani Terminal	1988	1988 – 1977 : PSA 1977 – Current : PSA Corporation	PSA (Private) MPA (Public)
Pasir Panjang Wharves	1976	1976 – 1977 : PSA 1977 – Current : PSA Corporation	PSA (Private) MPA (Public)
Pasir Panjang Terminal Phase 1	1998	PSA Corporation	MPA (Public)
Pasir Panjang Terminal Phase 2	2006	PSA Corporation	MPA (Public)
Sembawang Wharves	1971	1971 – 1977 : PSA 1977 – Current : PSA Corporation	PSA (Private) MPA (Public)
Jurong Port	1960	JTC	MPA (Public)

[13] G. Pedrielli, E.P. Chew, L.H. Lee & K.C. Tan. (Upcoming). *Competitiveness of the Port of Singapore. An Historical Overview.*

3. The Physical Development of the Singapore Port

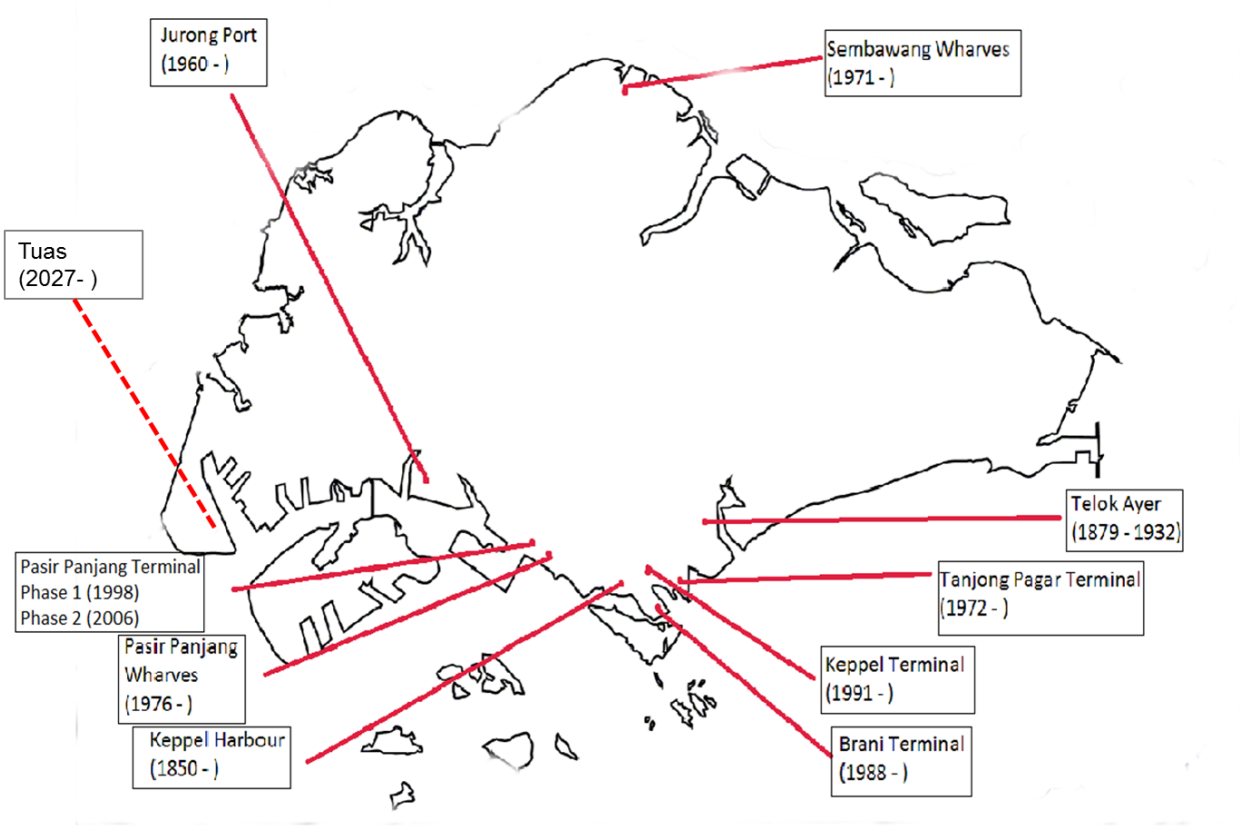

Figure 2: Port terminals of Singapore over the years

Figure 2 above shows the various terminals in Singapore. When Singapore achieved independence in 1965, Keppel Harbor was the only port in use. The Jurong, Pasir Panjang and Sembawang terminals were then built to keep up with the volume of cargo entering Singapore's waters.

Since the beginning of the containerization era in the 1970s, there has been a great increase in port traffic in Singapore and more land was required. Land reclamation was carried out by PSA and new land was reclaimed for port activities such as warehousing, re-packing and shipment services[14]. Port operations have been made more efficient by allocating specific wharves for selected services so that turnaround time and efficiency are increased: low-value cargo is directed to Sembawang Wharves where there are basic facilities and services, such as ship repair and refueling, while bulk cargo is directed to Jurong Port. Now, Sembawang Wharves has been

[14] G. Pedrielli, E.P. Chew, L.H. Lee & K.C. Tan. (Forthcoming). *Competitiveness of the Port of Singapore. An Historical Overview.*

developed so that it can handle heavy duty vessels and provide value-added services such as warehousing[15].

The newest terminal is located at Pasir Panjang. Pasir Panjang Terminal (PPT) phases 1 (1998) and 2 (2006) include a well-equipped port with berths and quay cranes that are able to support all types of containers. Phases 3 and 4 aim to automate yard operations to increase productivity[16]. In order to achieve this goal, these new phases will feature an automated container yard equipped with proprietary intelligent planning and operation systems as well as unmanned, rail mounted gantry cranes[17]. These cranes operate on electricity, and along with those installed at the berths, will reduce carbon emissions within the port area. This highlights how technology plays a significant role in the adoption of environmentally sustainable practices.

Work has already started for the Tuas Terminal, which will replace PPT and Jurong Port by 2027.

4. The Role of Technology

Technology has played an important role in shaping the success of the Singapore port. Broadly, the technology used in the port has two purposes: (a) on-site port automation or (b) navigational services for the shipping lines at sea. Further analysis of the technology used for the two main purposes is discussed below.

(a) Automation of Port Operations

Increasingly, technology is used to increase the efficiency and productivity of the port. Equipment and machinery are commonly used to replace labour and manual work. For example, PSA developed Automated Guided Vehicles in hopes of enabling port operations to become more automated. They would enable containers to be transported through the yard without the need for human intervention. This would make transport more efficient and productive with fewer errors.

The Remote Crane Operations and Control (ROCC) is supplementary to the existing Remote Yard Operations in use at the Pasir Panjang Terminal. In the past, every yard crane was operated manually. ROCC includes the services of the Overhead Bridge Cranes (OHBC), which optimizes the job, which, together with ROCC, enables real-time monitoring of the remote crane operations. This technology enables more automation and higher productivity for the yard.

Since the advent of containerization, Singapore has had to find ways to become more efficient in its port operations to keep up with the increase in port traffic. Advancements in IT have made it possible to use computer programs to support container services.

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[15] Port of Singapore Authority. (2015). *Multi-purpose Terminals*.
[16] Port of Singapore Authority. (2012, October 1). *Unveiling the Future: PSA Launches S$3.5-Billion Pasir Panjang Terminal Phases 3 and 4 Development.*
[17] PSA International Pte Ltd. PSA SINGAPORE TERMINALS. UNVEILING THE FUTURE: PSA LAUNCHES S$3.5-BILLION PASIR PANJANG TERMINAL PHASES 3 AND 4 DEVELOPMENT. PSA Singapore. PSA Singapore, 1 Oct. 2012. Web.

In 1988, Computer Integrated Terminal Operations Systems (CITOS) were implemented to help control and co-ordinate various port facilities, such as cranes and drivers. CITOS is a fully automated system that helps to manage port operations such as berthing, ship planning, resource allocation and the flow-through gate. Another service provided by CITOS is the Gate Automation System, which uses CCTVs and assigns vessels to specific locations. In 1996, the flow-through gate was implemented, which enables vessels to pass through the gates without stopping because it is fully automated and controlled by CITOS. This technology reduces turnaround time and also increases vessel traffic through the gates[18]. This efficiency is reflected in the yard operations due to the sophisticated algorithms and strategy for container handling.

(b) Navigation Services

Similar to an air traffic control system in an airport, a Vessel Traffic Information Service (VTIS) is crucial for port operations as it provides information regarding vessels' location and traffic in the surrounding waters. This system enables MPA traffic controllers to operate more effectively and efficiently based on the data received, and also lowers errors in directing vessels. This state-of-the-art tracking and locating system is able to monitor any vessel of any size[19].

Box Story 1: Evolution of hydrography in maritime operations *(*Adapted from Wee Beng Geok, Chung Chee Kit and Yang Lishan's From Paper to Screen: Voyage Towards Real-Time in Maritime Navigation – Singapore's Hydrographic Services)

Hydrography is the science of charting bodies of water, like seas and coastal areas, for the main purpose of navigation (International Hydrographic Organisation). Over the years, hydrography has gradually evolved from using paper charts to the 21st century's electronic charts with the help of advanced IT. This transition was a major milestone in improving maritime operations and MPA's Hydrographic Department played a crucial role in pushing for this change.

Electronic Chart Display and Information System (ECDIS)

ECDIS is a major technological breakthrough in the history of hydrography and maritime operations. Developed in the 1990s, it involves the use of two types of charts, Electronic Navigational Charts (ENC) and Raster Navigational Charts (RNC), that evolved from the old paper charts.

The main feature of ECDIS is the ability to provide real-time navigational information with the use of Global Positioning System (GPS), radar or echo devices. If adopted, ECDIS would significantly improve the safety of navigation in all weather conditions. Another feature of ECDIS is an intelligent warning systems that automatically warns the captain of danger.

[18] G. Pedrielli, E.P. Chew, L.H. Lee & K.C. Tan. (Upcoming). *Competitiveness of the Port of Singapore. An Historical Overview.*
[19] Nair S. (2011, July 29). Singapore: New Operations Centre to Improve Maritime Safety and Security. *EnergyAsia*.

Singapore's Perspective

MPA considered ECDIS a game changer for maritime navigation in Singapore. Due to Singapore's highly congested waters and the need to speed up navigational operations, ECDIS could reduce the processing time for navigation and also mitigate the risk of collisions at sea. Hence, MPA took a major leap forward by launching and funding the use and enhancement of ECDIS.

However, in the early years, MPA faced challenges in adopting the ECDIS system.

Firstly, ENCs had limited coverage and many restrictions at that point in time. As a result, Singapore had to produce its own ENC, which had to meet many restrictions and standards set by the International Hydrographic Organisation (IHO). After two years of work, the first ENC for commercial use was released in 1998.

Secondly, many ship-owners were hesitant to give up their paper charts for ENCs, as the electronic charts were costly and had limited coverage. The ship-owners were not informed of the possible benefits of ENCs. Hence, ship-owners did not have a strong incentive to stop using paper charts. To address this issue, MPA collaborated with the United Kingdom Hydrographic Office (UKHO) and established the Singapore Hong Kong Admiralty Raster and ENC Demonstration (SHARED) Programme. This programme aimed to demonstrate the use of electronic charts and the potential benefits that could be reaped if they were adopted. Eventually, the major participating vessels saw how ECDIS could ease their navigational workload and, hence, became more likely to use the electronic charts available.

Future of ECDIS

MPA's Hydrographic Department will continue its approach to adopt ECDIS and push their vessels switch to this means of navigation. Similarly, MPA will further improve their ENC coverage and work with international partners to launch this initiative.

Interestingly, cutting-edge technology is not only used in PSA's Singapore terminals, but in many of PSA's overseas investments and port projects. For example, PSA's Bharat Mumbai Container Terminals Private Limited signed a 30-year concession with Jawaharlal Nehru Port Trust (JNPT) to develop the JN Port's fourth container terminal in Mumbai, India[20]. This terminal will be equipped with advanced port technologies and state-of-the-art equipment to "serve important industrial and manufacturing centres and cities in India's largest hinterland[21]". This underscores the emphasis PSA places on innovation and technology, and the important role technology plays in supporting PSA's business strategy of diversifying and expanding its operations overseas.

[20] PSA International Pte Ltd. *Annual Report 2014*. Web.
[21] PSA INTERNATIONAL. PSA LAYS FOUNDATION STONE FOR NEW CONTAINER TERMINAL IN MUMBAI, INDIA. PSA International - The World's Port of Call. PSA International, 11 Oct. 2015. Web.

5. The Business Portfolio Development

Over the years, two notable developments occurred in regards to the services offered by the Port of Singapore. These developments were partly in response to the fact that Singapore has limited space, which means its export and import capacity might be curtailed, and the need for the port to contribute more to the national economy, especially after the 1985 economic downturn.

5.1 Bunkering Centre

In tandem with the growth in the number and size of the ships calling at the Port of Singapore, the bunkering volume also grew. By 1990, Singapore had become a top bunkering centre in the world. In 1992, Singapore established the world's first Bunkering Procedure (CP:60) and the bunker quality certification standard ISO:8217. Singapore was able to dominate the bunker market as it had high trade volumes and a top-notch refining and cargo centre. Shell Eastern Petroleum set up the Pulau Bukom refinery and has been an important player in enabling Singapore to excel in bunkering services. Bunkering services were shaped by the SSCP60 bunkering standards applied by Singapore's government. The Special Bunkering Anchorage (SBA) scheme allows registered vessels to enjoy concession rates as an incentive to bunker in Singapore's port[22]. In addition, MPA developed BUNKERNET, which links all personnel in the bunker supply chain to allow them to exchange data and automate bunker purchases and delivery services. In fact, starting from Jan 2017, Singapore will be the first port in the world that mandates the compulsory use of mass flow meters[23] for marine fuel oil[24]. Although such a mass flow meter may cost between SGD100k – 250k (and a bunker vessel typically needs two meters), this new automated system minimizes the human intervention in the conventional manual approach. This "digital age" system will improve transparency (i.e. reducing opportunity for theft and disputes over quantity transferred) and improving operating efficiency (by reducing up to 3 hours in a possible 8-hour operation[25], translating into a possible USD5000 saving for each fueling) in bunkering operations. Underpinning this refueling using mass flow meter is the new technical standard for Bunker MFM, TR48. This new standard was jointly developed by SPRING Singapore, Maritime and Port Authority, A*Star and stakeholders from the marine and shipping and oil and gas industry. As highlighted by the assistant CEO of SPRING Singapore, Choy Sauw Kook:

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[22] G. Pedrielli, E.P. Chew, L.H. Lee & K.C. Tan. (Upcoming). *Competitiveness of the Port of Singapore. An Historical Overview.*

[23] According to http://www.platts.com/latest-news/shipping/singapore/singapore-likely-to-implement-mass-flow-meters-26425013, "Mass flow meters measure the flow rate in the pipe, gauging the quantity as well as the mass and density of the bunker fuel passing through. The more traditional method which was widely used earlier was the sounding tape method, which relies on a quantity reading from the barge fuel tank of the receiving vessel taken prior to transfer."

[24] http://www.spring.gov.sg/NewsEvents/ITN/Pages/Singapore-leads-the-world-in-making-bunker-mass-flow-meters-mandatory-20160217.aspx

[25] http://www.platts.com/latest-news/shipping/singapore/singapore-likely-to-implement-mass-flow-meters-26425013

"Singapore's bunkering industry competes not only on price and efficiency but also being a trusted hub for quality, quantity and dispute resolutions"[26]

5.2 Off-Shore Centre

The Offshore Marine Centre (OMC), managed by Jurong Port, was established in 2011 to offer offshore services such as wharf side services, and equipment management by assembling modules from different workshops. It also serves as a common platform for companies to load and unload heavy modules safely, as OMC requires all staff and contractors to undergo a Safety and Security Induction Course (SSIC). This enables companies to enjoy a fully integrated yard operation system that significantly decreases turnaround time.

Ship repair services have been offered in Singapore since 1859. Through various government policies, Singapore has established itself as a major international ship repair centre[27]. Ship repair services offered by Singaporean companies cater to various types of vessels such as mid-sized tankers, navy vessels, container vessels and bulk carriers, which gives them a competitive advantage.

This section demonstrates how technological innovations have complemented business and strategy developments, helping the Singapore Port become the success that it is today.

6. Future Challenges

This paper has examined the evolution of the Port of Singapore through the decades and emphasized how these changes were brought about by the changing demands of the port. These changes can be seen in the key areas of port management, technology development and services provided. By looking at the trends in the past and the possible challenges in the future, we can predict new policies that MPA and PSA will undertake to continue to improve our port.

The most prominent and urgent problem that the Port of Singapore has to address is dwindling land space. Singapore has already reclaimed a significant amount of land that its ports are constructed on; in the future, this solution may no longer be effective as land reclamation is costly and time consuming. An alternative way to address the land shortage is to optimize the usage of every square meter of land. Recently, MPA announced the start of the Tuas Port project, which aims to consolidate all container activities there. The aim of consolidation is to reap bigger economies of scale and higher efficiencies for every square meter of land used.[28] New automation technologies will also be used to accommodate larger and more complex vessels in the near future.

[26] http://www.spring.gov.sg/NewsEvents/ITN/Pages/Singapore-leads-the-world-in-making-bunker-mass-flow-meters-mandatory-20160217.aspx
[27] Association of Singapore Marine Industries. (2015). *A Closer Look at the Marine Industry*.
[28] Ee, J. (2012). Singapore Nautilus: *Port of Possibilities*.p.15

Box Story 2: Next Generation Container Port: SINGA Port

Figure 5: SINGA Port's double-storey design[29]

In 2013, the Next Generation Container Port (NGCP) Challenge organized by MPA and Singapore Maritime Institute (SMI) announced a winning design entitled "SINGA Port" (Sustainable Integrated Next Generation Advanced Port) designed by NUS, Shanghai Maritime University and Shanghai Zhenhua Heavy Industries Company. The design includes an iconic double-storey container terminal that enables additional space for storage and transportation. This design successfully addresses Singapore's lack of land space and ensures that land usage is optimized per square meter.

Another future challenge lies in the security of the port. In light of the September 11 attacks, it has been seen how devastating terrorist attacks could affect and impact the economy. The Port of Singapore plays a crucial role in the global economic arena and, hence, Singapore must practice vigilance to ensure the safety of its port, port users and citizens. Port technologies have tremendously helped to reduce the risk of a breach in security. Cargo x-rays, Automatic Identification Systems (AIS), covert alarms, electronic cargo seals, crane-mounted radiation detectors and supply chain software are a few of the technologies used to ensure the security of the port.[30]

Last but not least, environmental sustainability is a pressing issue for the port. MPA has played a major role in incorporating green solutions into port operations. One example is the establishment of the Maritime Singapore Green Initiative in 2011. This initiative includes three programmes: the Green Ship Programme, the Green Port Programme and the Green Technology Programme. Under the Green Ship Programme, ship-owners with ship designs that exceed

[29] NUS ISE. News: *NUS-ShMU-ZPMC team wins US$1 million in the NGCP Challenge*.
[30] G. Pedrielli, E.P. Chew, L.H. Lee & K.C. Tan. (Upcoming). *Competitiveness of the Port of Singapore. An Historical Overview.*

IMO's energy efficiency design index enjoy a variety of benefits including a 50% reduction in initial registration fees and a 20% rebate on their annual tonnage tax. The Green Port Programme pushes for a reduction in pollutants by ocean-going ships calling at the Port of Singapore with an attractive 15% reduction on port dues if ships use clean fuel or approved scrubber technology. Lastly, the Green Technology Programme pushes for local maritime companies to adopt green technologies by co-funding up to 50% of their total qualifying costs.[31] This high percentage suggests that many implementations of green practices are innovation-driven and that the role of technology in developing green practices is too vital to ignore.

Box Story 3: Jurong Port (Adapted from Singapore Nautilus 2015 Issue 1[32])

One of MPA's commendable green initiatives is the launch of the Jurong Port as the first eco-friendly port in the world. Since 2010, sustainable practices and features have been implemented in aim of achieving maximum reduction of the port's carbon footprint and air pollution. These efforts were thoroughly planned by MPA and required collaborative efforts with other organisations like Surbana and PUB.

Key Sustainability Efforts

The expansion of berths and storage areas was performed using recycled and green concrete from demolished berths in aim of reducing the carbon footprint of the construction process. The use of environmentally friendly saw cutting technology during demolition also helped reduce noise and air pollution in the vicinity.

Jurong Port also collaborated with PUB to create a water source and 100% irrigation using harvested rainwater. Specially built drains collect rainwater from the sloped surfaces of the storage areas and unwanted particles are filtered out. This water can then be collected and used for watering plants and trees.

Other green technological initiatives include the installation of air quality monitors to monitor air pollution and berth lights powered by a solar energy roof that "supports 20% of the annual energy consumption".

Outcome

The success of the Jurong Port as an eco-friendly berth can be measured by its numerous awards in recent years. It was presented with the Building and Construction Authority's (BCA) Green Mark (Gold) Award and was certified as an Active Beautiful Clean (ABC) Waters Project by PUB. Jurong Port and MPA are continuing their collaboration to implement more green initiatives and will continue to heavily invest in green technologies to promote environmental sustainability in their port operations.

There are many other examples of policies and actions taken by MPA and private companies, such as PSA, KCL and JTC, to address the future challenges. They constantly predict future

[31] MPA. (2009). Maritime Singapore Green Initiative.
[32] Gan, A. (2015). Singapore Nautilus: *Building the world's first green berths*. p. 28

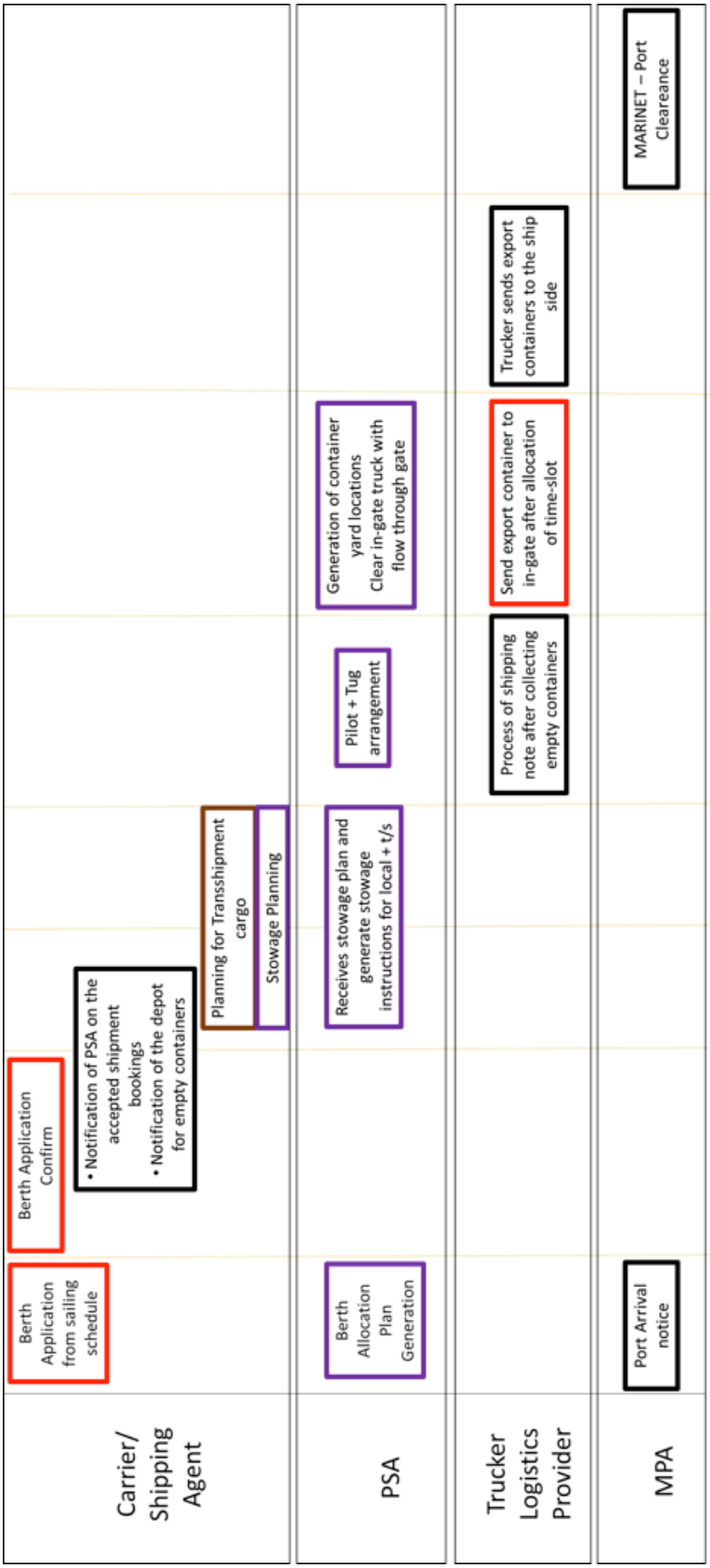
trends and seek new and innovative ways to improve port operations so Singapore will remain competitive in the global arena. However, as history has shown, many ports have come and gone: ports in Italy surrendered to the Atlantic Ocean becoming the main seaway; Europe developed land transportation over sea transport; the port of New York was hard hit by containerization; and, recently, the Port of Hong Kong changed her business model to become a port for the hinterlands due to the growth of huge export ports in the rest of China. What does Singapore need to do to ensure that the port remains, in the words of Mr. Lee Kuan Yew, "*Singapore's raison d'être"?*

Appendix

The following figure describes the main port operations involving interactions between the shipping lines and the port authorities as well as the shipping agents. With a horizon of 30 days, it shows all the main operations as well as the technologies supporting them in a normal port operation day.

In the figure, the colours of the boxes are associated with different software packages developed within PSA to facilitate port operations:

- Red – PortNet
- Purple – CITOS
- Orange – Ship Planner (part of CITOS)
- Brown – Ezship (part of PortNet)


Carrier/ Shipping Agent
PSA
Trucker Logistics Provider
MPA
Berth Application from sailing schedule
Berth Application Confirm
• Notification of PSA on the accepted shipment bookings
• Notification of the depot for empty containers
Planning for Transshipment cargo
Stowage Planning
Berth Allocation Plan Generation
Receives stowage plan and generate stowage instructions for local + t/s
Pilot + Tug arrangement
Generation of container yard locations
Clear in-gate truck with flow through gate
Process of shipping note after collecting empty containers
Send export container to in-gate after allocation of time-slot
Trucker sends export containers to the ship side
Port Arrival notice
MARINET – Port Clearance
30 days before ETA
3 days before ETA
24 hours before ETA
12 hours before ETA
8 hours before ETA
4 hours before ETA
Ship in Port
Ship Sails

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Discussion Questions

1. What were the challenges in the past and the success factors that led to the rise of the Port of Singapore?

2. What is the role of engineering and technology in the Port of Singapore? How has it changed over the years?

3. How has the services offered by Port of Singapore change over the years?

4. How did the government policy influence the development of the Singapore port over the years?

5. Which is the role of the Singapore Port in the urban development of Singapore?

6. What are the main challenges for the Port of Singapore in the future? What can engineers do to overcome these challenges?