

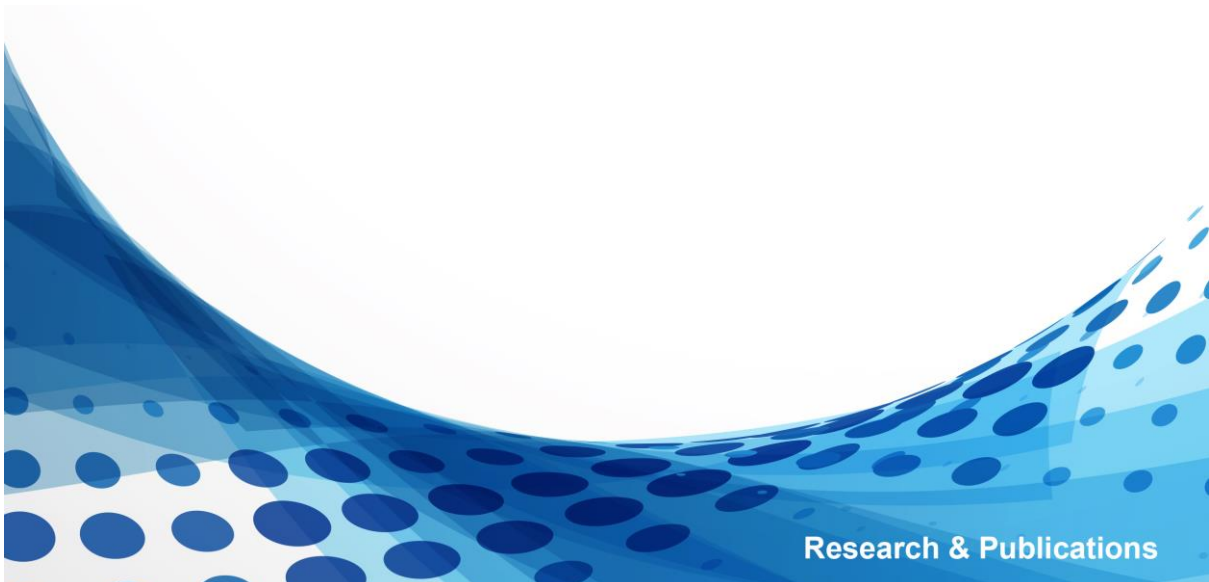


INDIAN INSTITUTE OF MANAGEMENT AHMEDABAD

IIMA
Working Paper

Enhancing Port Performance: A Case of Jawaharlal Nehru Port Trust

Aman Rathi
Ambesh Pratap Singh
Sundaravalli Narayanaswami



Research & Publications

Enhancing Port Performance: A Case of Jawaharlal Nehru Port Trust

Aman Rathi
Ambesh Pratap Singh
Sundaravalli Narayanaswami

December 2020

The main objective of the working paper series of the IIMA is to help faculty members, research staff and doctoral students to speedily share their research findings with professional colleagues and test their research findings at the pre-publication stage. IIMA is committed to maintain academic freedom. The opinion(s), view(s) and conclusion(s) expressed in the working paper are those of the authors and not that of IIMA.

Enhancing Port Performance: A Case of Jawaharlal Nehru Port Trust

ABSTRACT:

Ports are critical infrastructure and contribute significantly to international trade. They play a crucial role in connecting developing countries to the global market and boost the business and growth of the economy. This infrastructure is growing and becoming more complex. Hence, there is a demand for performance indicators to measure competitiveness and undertake strategic planning for improving them. Port performance tools can be an internal strategic management tool and benchmarking tool across the network of ports.

Through this study, we aim to identify the essential parameters of operational efficiency in any port, measure this parameter across time for Jawaharlal Nehru Port Trust (JNPT) and pinpoint avenues of improvement for enhancing overall port performance.

Executive Summary

Ports are of great significance to any country, but more so to India, where around 95% of the international trade is carried out through ports. Of the cargo transported through ports, containers have been occupying increasing importance due to standardization's benefits upon a trade cost. The primary government-owned Indian port for container movement in India is Jawaharlal Nehru Port Trust (JNPT), handling more than 50% of India's total container traffic. However, it now faces rapidly increasing competition from private ports, especially on the West Coast, where it has begun losing market share. Over the last decade, JNPT's share of west coast cargo has dipped by half in market share from 66% in 2010 to 35%. On the other hand, Mundra has increased its market share from 18% to 32% in the same period¹. As India pushes through with its aspirations to become a global export hub, all its public ports must increase their operational efficiency to reduce India's trade costs. This was our motivation to study JNPT in more detail and explore the port sector in India in general and JNPT in particular, and find areas of improving its operational efficiency.

For this study, we've referred to a multitude of data recorded and reports published on ports globally and in India. We've tried to map the journey of a ship from the time it enters the waters of JNPT, and to the time it loads/unloads cargo and the journey of a container from the time it is unloaded from the ship to the time it reaches an inland container depot or a container freight station. We've then benchmarked the time it takes for JNPT to other leading Indian and international ports and tried to identify the areas where JNPT is lagging. We've then explored the potential reasons for the lag and attempted to provide recommendations for the same.

The container's journey with a port begins a long way in advance with the freight forwarders and the bill of lading being prepared, determining the ship's destination port, etc. However, most of the port's area of operation begins when the ship enters the port's waters. After a vessel has been allocated a berth and the container has been loaded/unloaded through quay cranes, it is initially stored in the container yard. It then clears the government customs requirements and is provided a bill of entry. From there, it can be dispatched through multiple modes – road, rail, or inland waterways. JNPT has all three, but the significant chunk is still sent through road and rail. The container can either be transported through the Direct Port Delivery (DPD) route, which saves substantial time for the cargo owners or is transported to intermediate warehouses – container freight stations (CFS) or inland container depots (ICD).

Here we break the container's journey into two distinct steps to analyze it in more detail. The first is the journey of the ship to the point where it reaches the yard. The second is its movement to the warehouse (CFS/ICD). Both these steps are evaluated in more detail to find the drivers of inefficiencies.

The turnaround time for the ship after the containers have been loaded/unloaded can also be broken down into three distinct parts –

Turnaround time for ship = detention time + idle time at berth + waiting time at berth



The three components of turnaround time are then evaluated independently. The factors affecting each has been analyzed to find the root cause of the disparity of time between JNPT and the

¹ Source: (India Infra, 2019)

world's leading ports. The overall pre-berthing detention time for JNPT has been creeping downwards as new capacity is added, and berth utilization lowers, especially in BMCT. However, the average number here hides the disparities in two terminals – JNPT's own terminal JNPCT and the liquid terminal, both operating at close to 100% capacities. While at JNPCT, the available capacity isn't an issue since the demand has been going down in the past few years due to competition (the problem is due to low equipment productivity, which is addressed later), there is an urgent need for new capacity addition at the liquid terminal which can be achieved through either extension of the existing jetty or construction of a new coastal berth alongside BMCT. Given the rapid growth at BMCT, new container terminals can also be planned for which a potential location has been identified in the report. In addition to this, the northern anchorage area can enable lighterage operations for transferring cargo to the Mumbai port and provide space for waiting of the ships. The idle time at berth depends on the availability of labor and equipment at the berth. While there is sufficient availability of quay cranes and trucks in JNPT's terminals at the moment, the delay is caused by the low productivity of labor at the equipment, which can be addressed by improving the deployment planning of operators. The working time at berth depends on the productivity of equipment at the terminals. There is a significant disparity between productivity at the various terminals at JNPT. They severely lag behind private ports like Mundra and global best in class ports in crane productivity. This ratio can be improved by human resource changes like introducing an individual performance-based pay varying with crane efficiency or operational changes like increasing the share of twin-lift movements by better planning. Equipment productivity at JNPCT can also be increased by integrating the import & export yards at the terminal, which are currently separate, leading to long RTG movements.

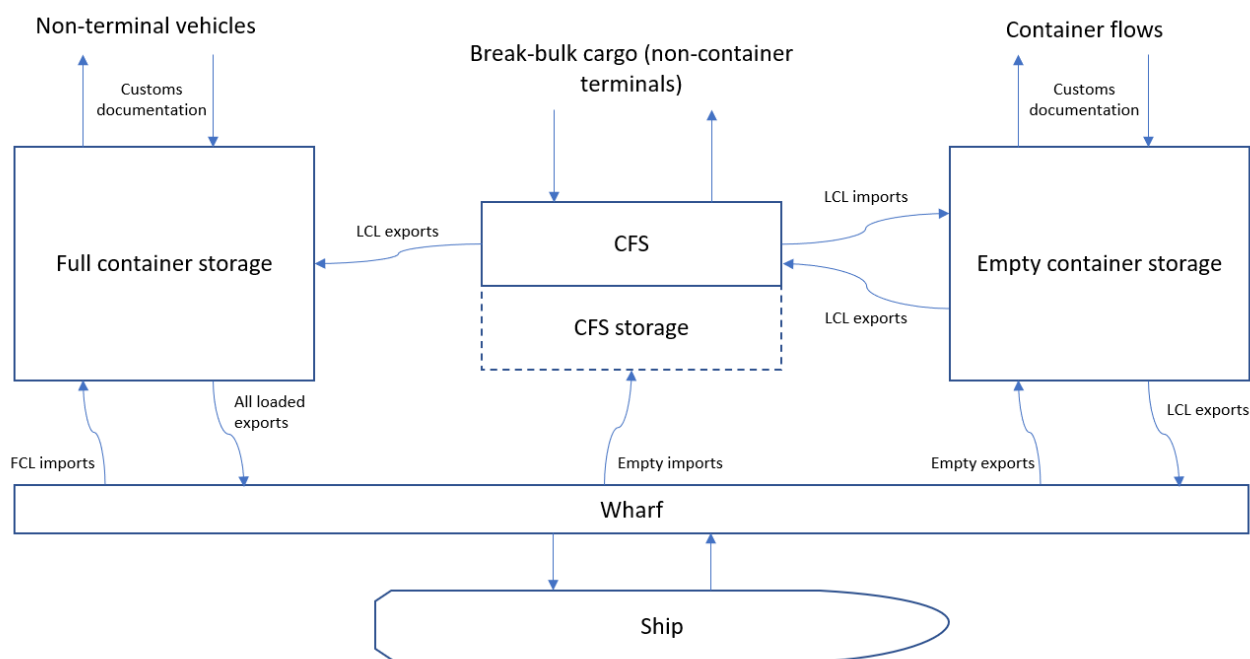


Figure 1: Container Import-Export Cycle

Container movement can be optimized through some infrastructure improvements at the bottlenecks in its movement throughout the journey. The truck congestion at terminal gates can be partly alleviated by constructing flyovers at the entrance route and allowing trucks inter-terminal access to pass through. A sizeable centralized parking plaza integrated with a customs house will remove stationary trucks from the roads and save time in documentation. There must also be more fixed scanners at the gates for the trucks entering and exiting the port instead of relying on manual inspection. Container stacking can be sped up by having the ICDs send the containers on a terminal basis color-coded with a small sticker. To reduce time and effort in the

documentation, JNPT's measures should be toward all-digital transactions and providing a one-stop website/app for all the documentation needs from berthing & pilot services to customs and port billing.

Another issue JNPT currently faces is the low evacuation of containers through the rail at about 20% of the volume, much lower than Mundra at ~40% and even lower than the national average at 22%. This ratio is lower in JNPT due to the practice of mixed-rail handling between terminals instead of individual trains, which leads to long waiting time for containers. There's a possibility to reduce transport time after the DFC is built drastically. Rail transport of cargo is much cheaper as compared to the road over large distances. One way to increase the port's rail coefficient would be to integrate the two different rail yards into one 1500m long rail yard with a large container storing facility nearby. This must be planned with the upcoming DFC in mind.

These recommendations mentioned can certainly improve the efficiency at JNPT but will only take them to the current level of private ports in India or the mid-ranked global ports. However, for JNPT to become a globally competitive port and enable India in its goal of becoming an export hub, it must also implement path-breaking port-wide changes at the level which the other leading ports are implementing. One critical strategic change JNPT can take up could be in the field of digital enablement. In the report, we've analyzed the current level of technologies being implemented at JNPT and tried to provide a roadmap to develop its digital strategy. The report identified the various areas the port can gather data from – infrastructure, equipment, intermodal traffic, customs & clearances, and environment. It also uses a BCG report to assess the type of digital strategy JNPT should go with, which varies with the aspirations of the port (emerging port, local trade hub, intermodal gateway, or city-based port). Further, it provides a roadmap for JNPT to develop its digital strategy, which will involve – linking the digital strategy to the overall port strategy, identifying the pain-points in the process which technology can fix, building a portfolio of possible solutions, deciding between off-the-shelf or custom solutions, and managing risks.

Introduction

Ports have been the centers of economic activity for millennia and continue to remain so. Both globally and in India, cities have come up as major hubs of commerce around a major port. London, Shanghai, Singapore, Los Angeles globally, and Mumbai, Chennai, Kolkata, Cochin, and Vishakhapatnam in India are prime examples of this.

Even today, more than 90% of international cargo flows through ships. (Rajya Sabha, 2018) This number is even higher in India at close to 95%. (IBEF, 2020) Since trade growth is an important indicator of a country's overall growth and its economic condition, ports are critical to the development of a nation. Ports are also important in fulfilling India's goal of increasing its exports to the world and crucial to the 'Make in India' agenda of the current government.

India is one of the largest maritime countries globally, with a coastline of more than 7,500 km. It is also blessed to be located in the Indian Ocean region and is host to one of the world's most important trade crossings – connecting East Asia to Africa & Europe. Close to 50% of the world's maritime & container trade and 70% of the energy trade goes through the Indian Ocean region. India's ports are strategically located to capitalize on this trade. (Niti Aayog, 2020)

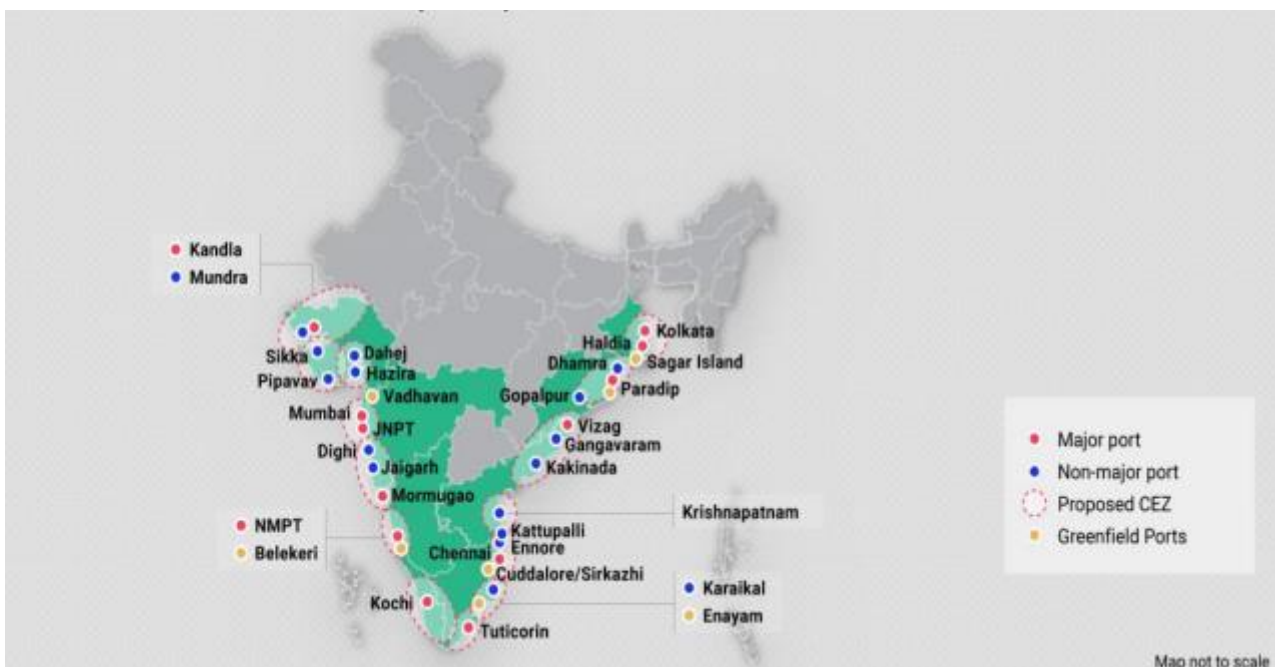


Figure 2: Major Ports in India²

It has 12 major ports and 205 minor and notified ports, and under the Sagarmala³ plan, six new mega ports will be developed in the country. The Government of India will play a crucial role in developing the ports sector. It has allowed FDI of up to 100 percent under the automatic route for port and harbor construction and maintenance projects. It has also introduced a 10-year long tax holiday for enterprises that develop, maintain and operate ports, inland waterways, and inland ports.

² Source: (CARE, July 2020)

³ The Sagarmala programme is the flagship programme of the Ministry of Shipping to promote port-led development in the country through harnessing India's 7,500 km long coastline, 14,500 km of potentially navigable waterways and strategic location on key international maritime trade routes.

Cargo profile

In FY20, major ports in India handled 704.82 million tonnes (MT) of cargo traffic, implying a CAGR of 3.83% percent during FY16-20. The major ports had a capacity of 1,514.09 MT per annum (MTPA) in FY19P. The Maritime Agenda 2010-20 has set a 2020 target of 3,130 MT of port capacity.

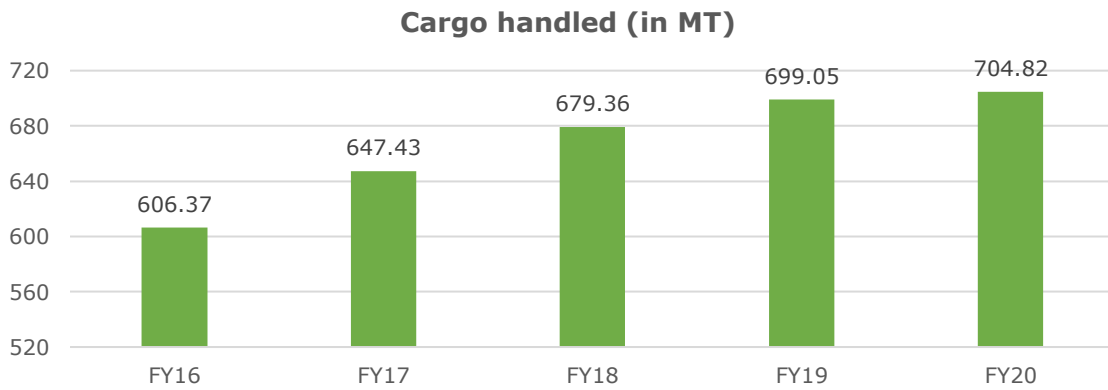


Figure 3: Cargo Handled (in MT) by major ports in India⁴

The cargo at major ports in India can be categorized into solid (coal, iron ore, fertilizer), liquid (petroleum, oil & lubricants), and container traffic. Out of these, solid cargo constitutes the largest segment at ~42% of the total traffic. Liquid cargo comes next at ~37%. Container traffic contributes to the remaining traffic share of around 21%⁵.

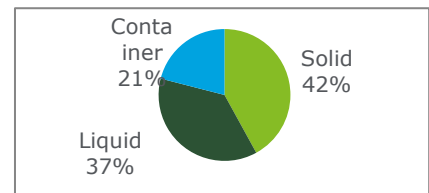


Figure 4: Categorization of Cargo

Amongst the ports in India, the non-major ports are slowly gaining share as the traffic shifts to them from the major ports. The volume of traffic at non-major ports has risen from 466 MT in 2016 to 583 MT in 2019 at a CAGR of around 7 percent. Correspondingly, the share of non-major port traffic to total traffic has risen from 43% in 2016 to 45% in 2019.

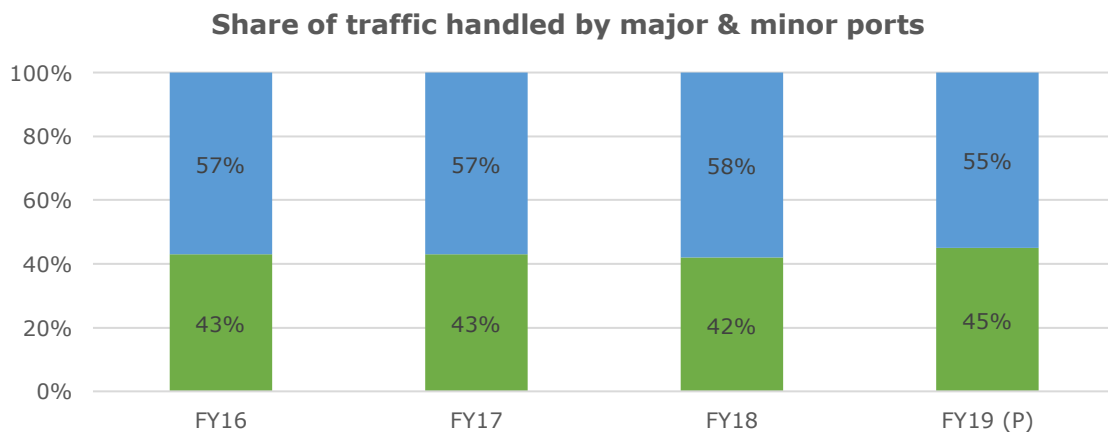


Figure 5: Share of Traffic handled by Major & Minor Ports in India⁶

⁴ Source: (India Brand Equity Foundation, 2020)

⁵ Source: (India Brand Equity Foundation, 2020)

⁶ Source: (India Brand Equity Foundation, 2020)

Challenges facing Indian ports

However, ports in India also continue to struggle with various natural, operational, and financial difficulties. For example, the Haldia Dock in West Bengal, being a riverine port, faces inherent challenges of heavy siltation and inadequate dredging capacities. Congestion at the approach roads is a common problem observed at quite a few Indian ports. For example, at the Jawaharlal Nehru Port, many studies report heavy congestion both enroute to and inside the port, leaving trucks stranded for days — with queues extending to as long as 12 km. This leads to excessive delays and increased transaction costs⁷.

Government initiatives

The government has taken some significant initiatives to promote the ports sector in India –

Port Upgradation

As of November 2019, projects worth Rs 13,308.41 crore (US\$ 1.90 billion) were awarded in the last three years on up-gradation of the major ports. Under the Sagarmala scheme, the government has envisioned a total of 189 projects for the modernization of ports involving an investment of \$22 billion by the year 2035.

MPA Bill

The Major Ports Authorities Bill, 2020, was introduced in the Lok Sabha, which seeks to provide for the regulation, operation, and planning of major ports in India and provide greater autonomy to these ports.

MCA

In March 2018, a revised Model Concession Agreement (MCA) was approved to make port projects more investor-friendly and make the investment climate in the sector more attractive.

Project Unnati

GoI started Project Unnati to identify areas of operational improvements for major ports. A total of 116 initiatives were identified under the project, out of which 93 had been implemented as of September 2019

SEZs

The government is also developing Special Economic Zones near several ports. This is underway around Mundra, Rewas, Krishnapatnam, and a few others. This will attract industries by providing strategic advantage to those setting up within these zones. Some plants being set up include –

- Coal-based power plants which can take advantage of imported coal
- Steel plants
- Edible oil refineries

Technological improvements

In the past few years, GoI and the port industry has also invested in multiple technology platforms to improve the efficiency of the ports. Some of these include –

- India introduced a Biometric Seafarer Identity Document (BSID) in August 2019, becoming the first country in the world to do so
- RFID based Port Access Control System (PACS) was implemented in the Kolkata Dock System (KDS)

⁷ Source: (The Hindu, 2016)

- Indian Ports Association (IPA) launched a cloud community system PCS1x, which intends to integrate the electronic flow of trade-related documents and information and function as a centralized hub for the ports & its various stakeholders

The Government of India is also investing in increasing connectivity of the ports in India through the development of road, rail, and multimodal logistic parks.

- Road connectivity projects worth close to \$30 billion are being implemented in coastal states
- GoI has undertaken 55 rail projects worth \$7 billion at various major and minor ports
- 15 multimodal logistics parks with a cost of ~\$700 million are under different stages of implementation

Due to these and other such policies, net profit at important ports increased from Rs 1,150 crore (US\$ 178.4 million) in FY13 to Rs 3,413 crore (US\$ 529.6 million) in FY18, while operating margin increased from 23 percent to 44 percent.

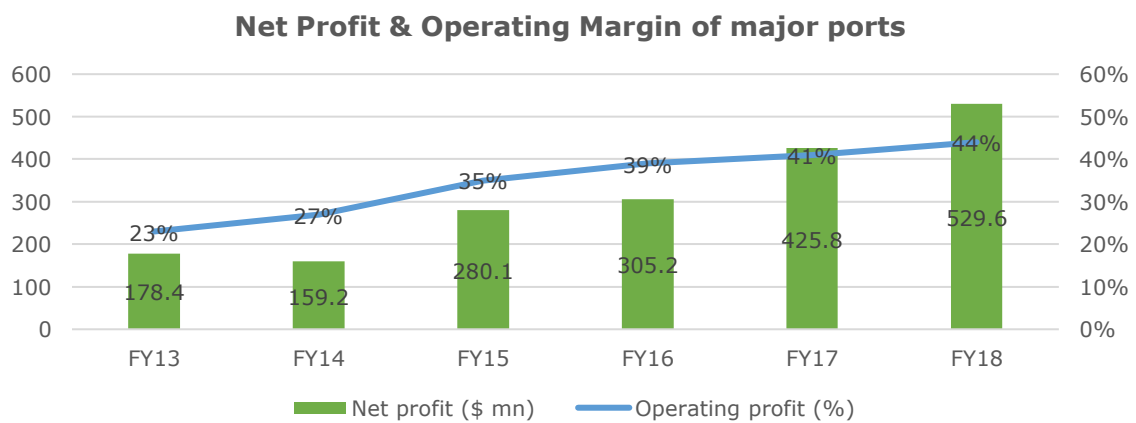


Figure 6: Net Profit & Operating Margin of Major Ports⁸

Sustainability initiatives at ports

The government of India is planning to make India the first country in the world to have all its major government ports run on renewable energy. It plans to install more than 200 MW of wind and solar power generation facilities at these ports. In the future, it plans to ramp this up further to 500 MW.

⁸ Source: (Ministry of Shipping, 2019)

Port Performance Indicators

Port performance can be done across four strategic dimensions: finance, operations, human resources, and market, to develop a balanced scorecard. Such a scorecard can be a helpful tool and serve as a heuristic measure to undertake strategic planning. Cargo operators usually focus on the operational aspect to reduce turnaround time and increase asset utilization. This can also be a useful device to disaggregate the complex nature of a port system and deliver the project in discrete phases or blocks. To produce measures that are of value to prospective policy, research, and industry users, it is also necessary to develop tools and standardize assumptions that allow for like-for-like comparisons. Hence, such standard performance measures can make multi-ports comparison feasible.

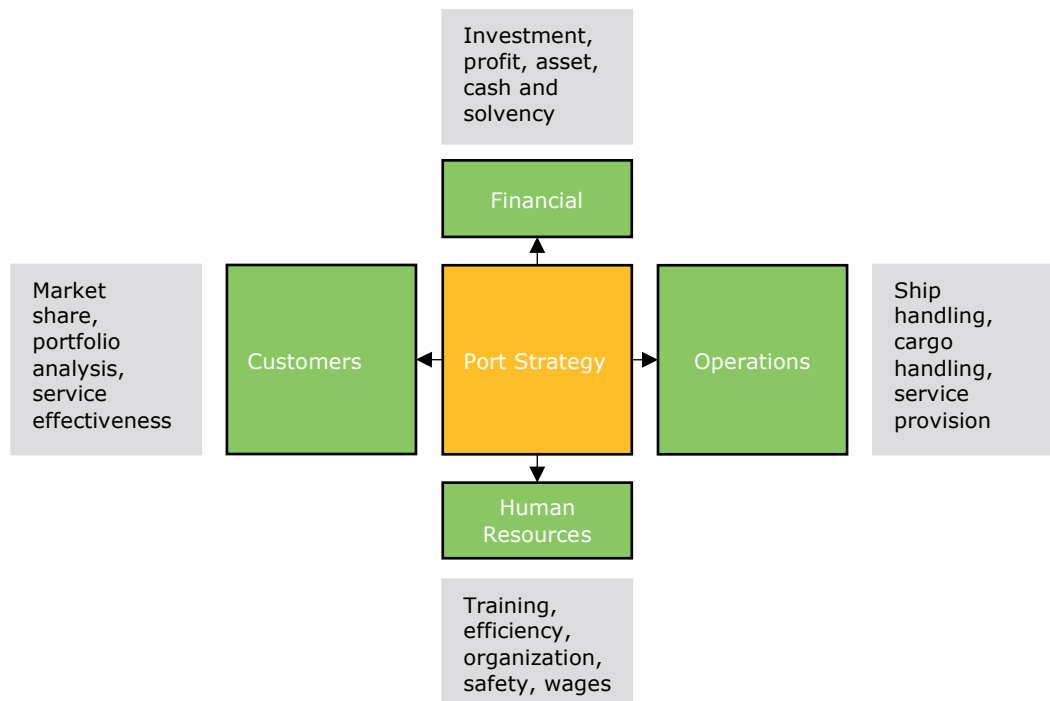


Figure 7: Dimensions of Port Performance Indicators⁹

Operational Indicators

Operational indicators are the most commonly used metrics in the assessment of a port. Every important stakeholder of the port uses them –

Customers: Shipping companies and vessel operators need to know the time duration for which their ships will be occupied on the route. They also decide which port to use in their route to minimize the amount of time their ships will be engaged. For example, a lower average pre-berthing delay will result in higher customer satisfaction

Investors: Operational indicators directly determine the financial performance of a port. For example, shorter turnaround time will result in higher revenue (given enough demand).

Government: The operational efficiency of the ports of a country denotes the competitiveness of its economy since ports are the primary route of both inwards and outwards trade. More robust operational parameters will signify the higher competitiveness of a country's trade markets.

⁹ Source: (United Nations Conference on Trade & Development, 2016)

Operational indicators are usually divided into two broad categories – vessel indicators and cargo indicators.

Vessel indicators determine the operational parameters for the vessel from the time it enters the port to the time it exits. Cargo indicators indicate the operating parameters for either the cargo being imported or exported from the ship to the container depot or vice versa. Cargo indicators can be further divided into the type of freight and its product mix.

Vessel Indicators

Average turnaround time

Total time spent by a ship since its entry till its departure. i.e., the time taken by a vessel moving from anchorage to berth and returning to the anchorage after completing cargo handling operations.

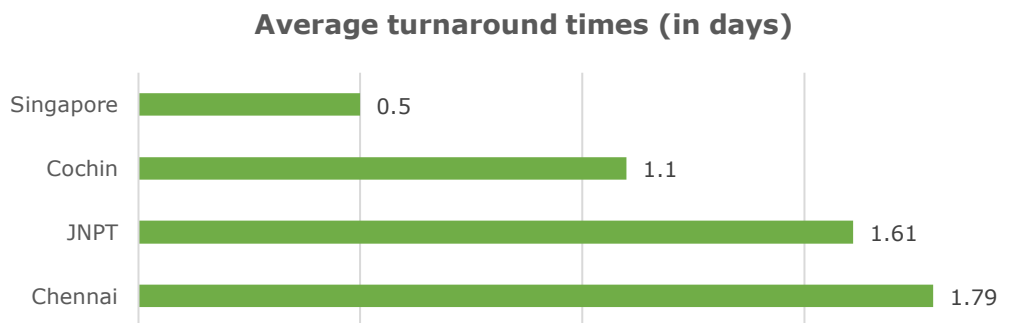


Figure 8: Average Turnaround time (in days), for illustrative purpose¹⁰

Average pre-berthing delay

The time the vessel needed to wait before it could enter in the berth. The delay could be because of various reasons – congestion (non-availability of a berth, non-availability of tug, non-availability of a pilot, navigation restriction, etc.)

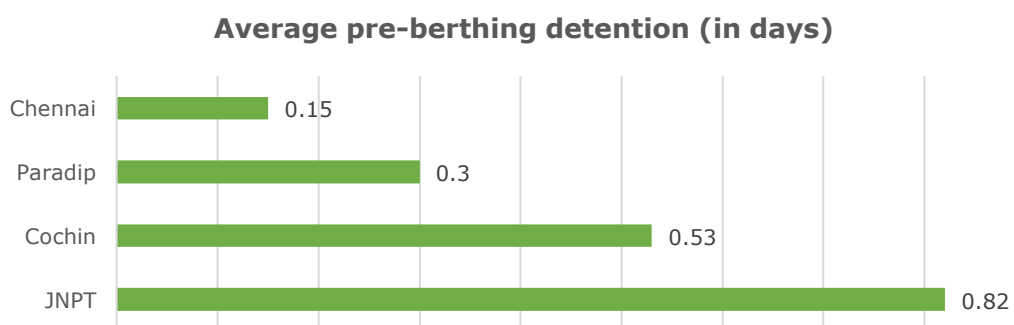


Figure 9: Average pre-berthing detention (in days), for illustrative purpose¹¹

¹⁰ Source: (Ministry of Shipping, 2019), (Port of Singapore, n.d.)

¹¹ Source: (Ministry of Shipping, 2019)

Percentage of idle time at berth to time at working berth

The ratio of the time spent idle at a berth to the time spent loading or unloading cargo. A lower ratio would indicate early completion of cargo handling and readiness for more vessels. Some reasons for this ratio being high could be the unavailability of cranes, unavailability of crane operators, etc.

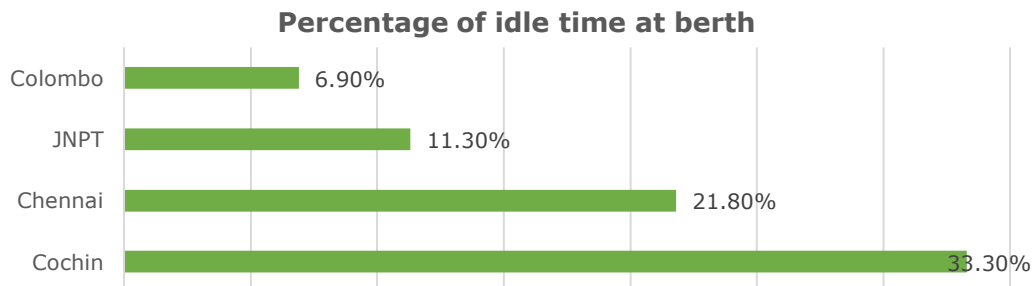


Figure 10: Percentage of idle time at berth, for illustrative purpose¹²

Average output per ship berth day

The average output of a ship at a berth per day is measured in tonnes of cargo.

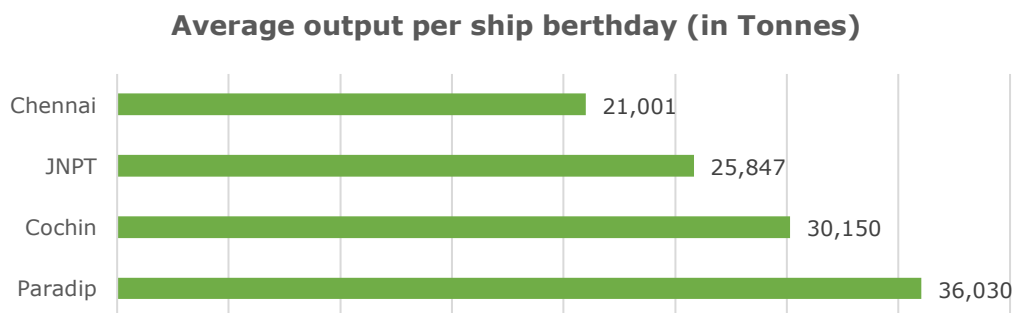


Figure 11: Average output per ship berth day (in Tonnes), for illustrative purpose¹³

Container Indicators

Container traffic has been gaining traction with a global increase in volumes due to its standard operations and equipment. The flexibility to handle a wide variety of goods at lower costs and universal acceptance leads to an increase in volumes and containerization of trades. It also serves as a direct measure of the volume of goods being handled at the port. The RFID based tagging to track each container has enabled authorities to track delays, improve operations, security, etc.

¹² Source: (LKI International Relations & Strategic Studies, 2019), (Ministry of Shipping, 2019)

¹³ Source: (Ministry of Shipping, 2019)

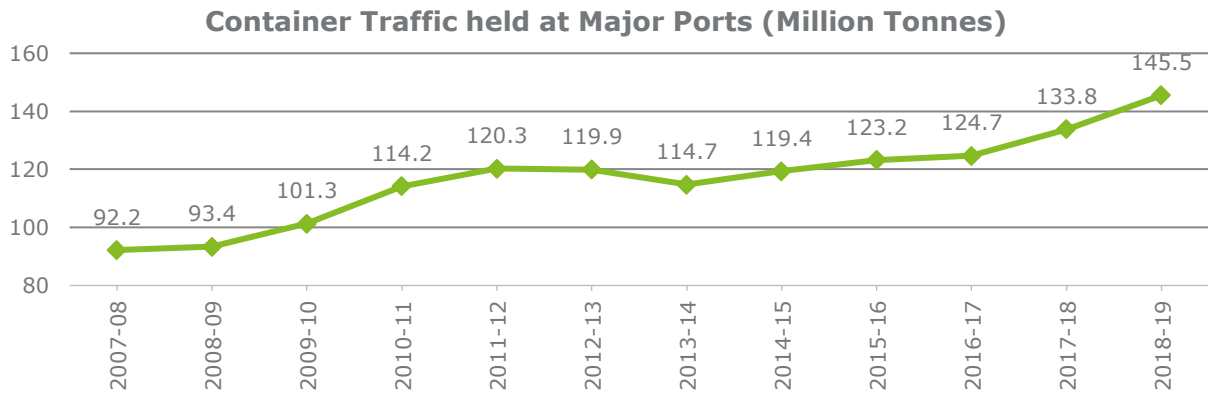


Figure 12: Container Traffic at Major Ports in India¹⁴

Container parameters in port operations are related to the time taken across different activities. Hence, we can divide the lifecycle of any container for import or export into different phases and measure each phase's parameter.

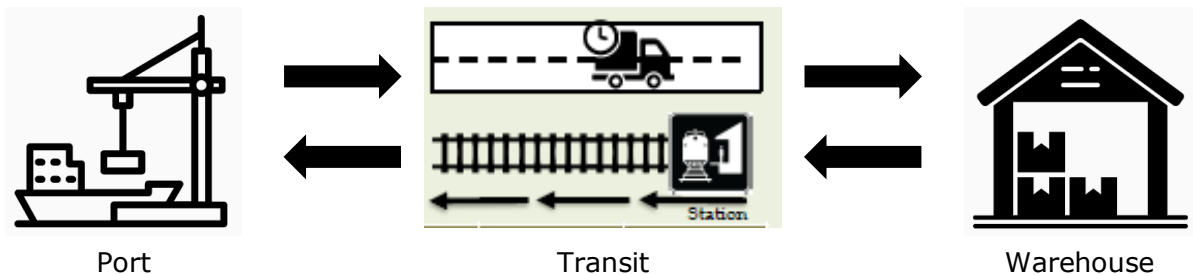


Figure 13: Container Value Chain

Port Dwell Time

In port parlance, dwell time is referred to as the time spent by export on the terminal before being loaded on the vessel or the time spent by an import on the terminal after being unloaded. This time varies based on the mode of transport: truck bound or rail-bound. While port operations affect dwell time, other factors such as an imbalance in load volume during the day/week, delay in arrival/departure, etc. also contribute to it.

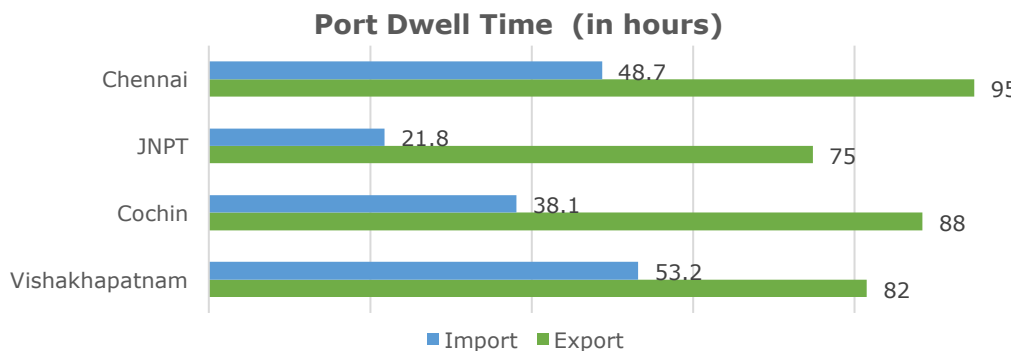


Figure 14: Port dwell time (in hours), for illustrative purpose¹⁵

¹⁴ Source: (Ministry of Shipping, 2019)

¹⁵ Source: (DMIDC Logistics Data Services Ltd., 2020)

Transit Time

The transit time is the time spent by the container during its movement to Container Freight Station (CFS) or Inland Container Depot (ICD). This type varies based on the location of the destination and mode of transport. Containers are transported via trucks to the nearby located CFS or by trains to distant ICD. The transit time between the two modes varies substantially due to the different speed and geographical location of the destination.

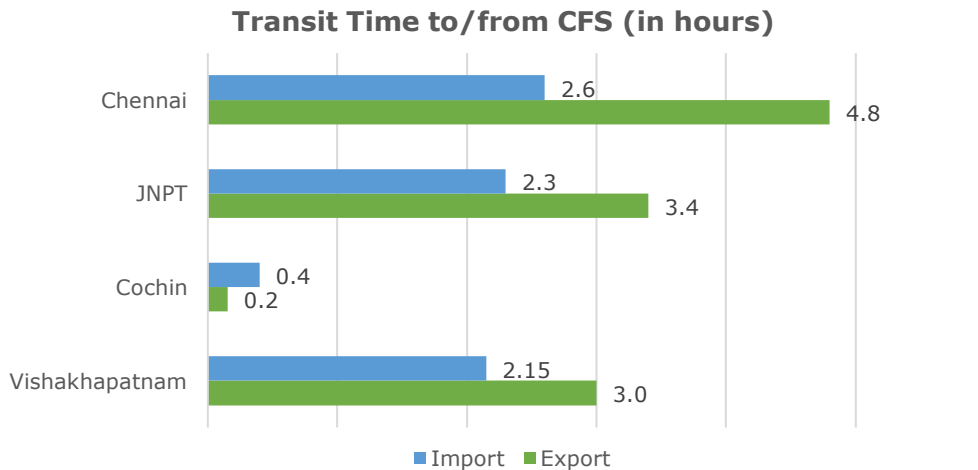


Figure 15: Transit time to/from CFS (in hours), for illustrative purpose¹⁶

Warehouse Dwell Time

Once the container reached the warehouse at CFS or ICD, it spends some time before getting picked up for the next operation. Export containers arrive ready for movement to the vessel, and import containers wait for their buyers. This dwell time varies based on whether it is an ICD or a CFS.

Based on the dwell time and amount of volume handled, a performance benchmarking exercise to identify the star performers and laggards among the CFS/ICD can be done over time and across ports.

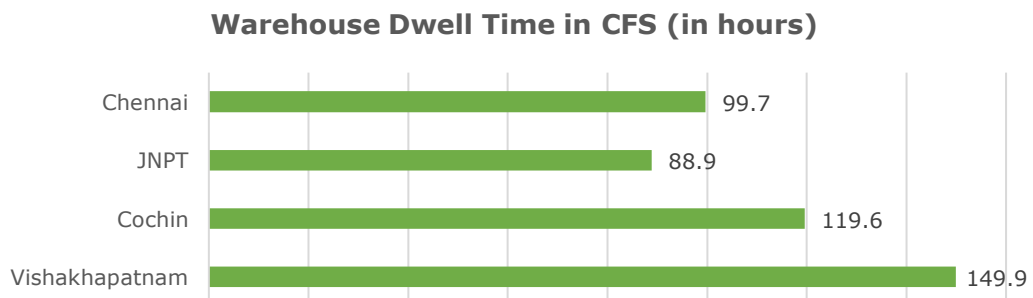


Figure 16: Warehouse Dwell Time in CFS (in hours), for illustrative purpose only¹⁷

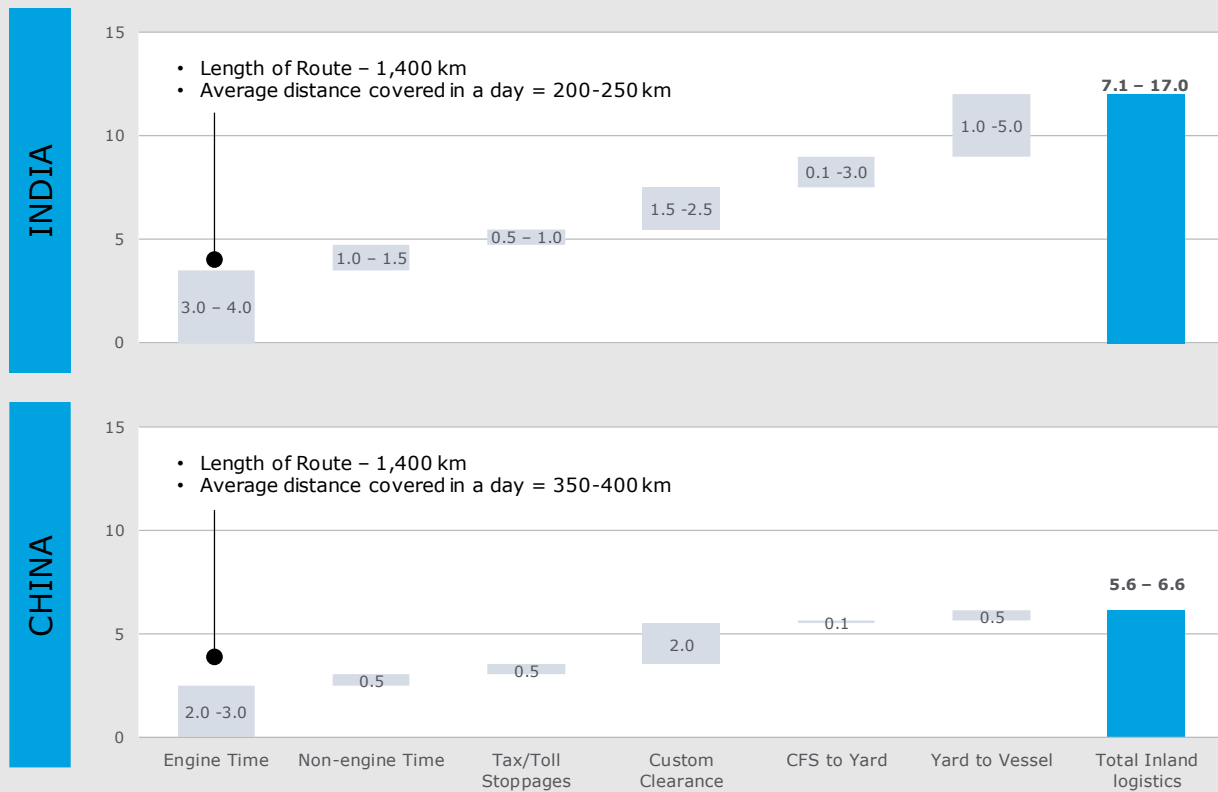
¹⁶ Source: (DMIDC Logistics Data Services Ltd., 2020)

¹⁷ Source: (DMIDC Logistics Data Services Ltd., 2020)

Comparison of end-to-end time of transporting a container in India and China by road on similar routes

Indian containers can take 1.5x more time than Chinese containers with the time being highly variable due to

- Lack of automation of customs process
- Lower speed of trucks
- Congestion and inefficiencies at ports



Source: (Ministry of Shipping, Government of India)

Other Operational Indicators

Apart from container and vessel operations, certain port-specific parameters can be assessed to benchmark operational efficiency. Some key metrics are given below:

Parking Plaza Dwell Time

Measuring the parking plaza and parking plaza to port transit time can help identify the better performing parking plazas and terminals based on the turnaround times. Furthermore, the distribution of the turnaround times can help us measure the variances, key metric in-service operation businesses. Ports have started deploying an automated entry/exit system to increase throughput and capacity of operations.

E.g., the submission of a form at the entry/exit gate at JNPT led to congestion of 6-8 hours at the gates.

Port Congestion

The architecture of port infrastructure in terms of road congestions, inter-terminal movements, amount of vehicle on roads, etc. can help us understand the dynamics of the flow of goods inside the port. Poor performance signifies that the current infrastructure needs a revamp to eliminate the existing bottlenecks and increase efficiency.

E.g., The presence of the Y junction at JNPT created congestion in the overall traffic.

Communication System and the use of technology

Breakdowns in the message exchange system can lead to long operational delays ranging from few hours to an entire day. Hence, it is essential to track the frequency of breakdowns of such systems facilitating communications and transactions at the port. Also, the use of technology to locate your inventory can help in reducing your operational delays.

The Case of Halifax Port Authorities

Located on the east coast of Canada, Halifax is the country's third largest container port with operations at two terminals. As a key gateway, the Port of Halifax moves a significant volume of cargo inland by rail. With over 550,000 TEU of container traffic moving through the port and its terminals each year, it was time-consuming to manually manage the status of their cargo.

HPA's management team decided to take an innovative approach to gathering the information they needed to track cargo from the port to final destination. Engaging an IT firm, HPA developed a container tracking system that uses EDI and communications technology to improve data collection. This CTS system has enabled port of Halifax to provide higher level of customer service and reduced average dwell time from 110 hours to 69 hours. The American Association of Port Authorities liked this technology and awarded Halifax with an award of innovation.

Source: (Halifax Port Authority)

Toll Plazas

While this may not be internal to the port infrastructure, it is important to measure the average time spent by a container between two consecutive toll plazas. This helps us in identifying the locations wherein the delays are occurring, leading to high transit time.

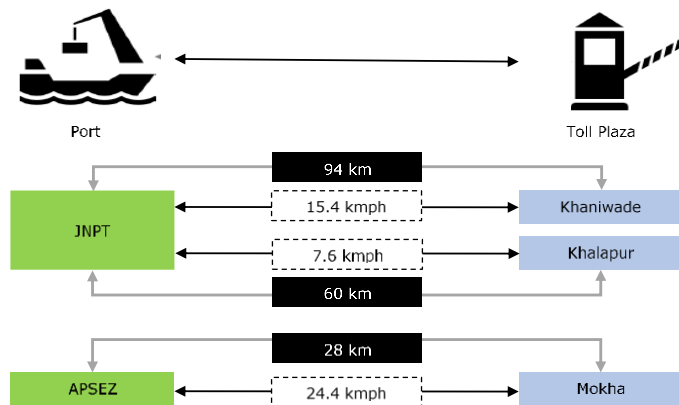


Figure 17: Average Speed taken by truck to cover the distance between Port terminals to nearest Toll Plaza¹⁸

¹⁸ Source: (DMIDC Logistics Data Services Ltd., 2020)

Other Indicators

Financial Indicators

Ports are an infrastructure-heavy business and usually involve high capital expenditure. Measuring a comprehensive financial performance is difficult for any port due to multiple business models through Public-Private Partnerships. However, attention can be focused on crucial parameters by viewing the ports as an entity. Hence, to undertake this exercise, there should be a clear picture of revenue streams and activity costs. Also, evaluation of asset and investment quality, utilization rate, cash flow, etc. are also crucial.

Revenue streams are easy to measure based on the operating model, such as lease, volume-based, etc. Revenues can be broadly segregated into two segments: terminal operations and allied activities. Terminal services mostly include vessel and container operations, stevedoring, etc. while allied activities include warehouses, land-based activities, etc. Costs are more challenging to analyze in a port because of a lack of proper accounting measures. Proper management accounting to allocate and apportion revenue and expenses for different segments is essential to identify the profit and loss-making segments.

One of the most straightforward and first points of comparison are the primary revenue heads and their variance over time. The primary revenue items are port dues and non-port dues. Port dues are revenue items related to cargo and vessel operations. Non-port dues constitute fees and licenses, rental income, and other sources. This simple accounting exercise can yield considerable fundamental values for comparison within the industry.

Financial performance indicators are mostly either ratios/percentages or based on unit economics to easily compare competitors and industry benchmarks. Some of the critical metrics are given below:

Operating Margin (EBITDA/Revenue)

This is the most common financial ratio used to compare across time and other players, especially in the heavy infrastructure business. This is a useful comparative measure as it excludes fixed cost items that can vary in across entities.

Vessel Dues/Revenue

These are the various charges related to asset utilization by vessels that enter or exit the port/harbor. The fees vary based on the gross tonnage as the sizes of vessels may vary. Over the years, the size of the vessels has been increasing, and the number has been reducing. Hence, revenue per ton also becomes an important indicator. Vessel dues are the fixed port dues and usually smaller.

Cargo dues/Revenue

This is the revenue earned by port authorities associated with the provision of cargo handling services. Charges may vary based on the classification of assets as per Standard International Trade Classification. This is the more significant part of port dues and is proportional to volume.

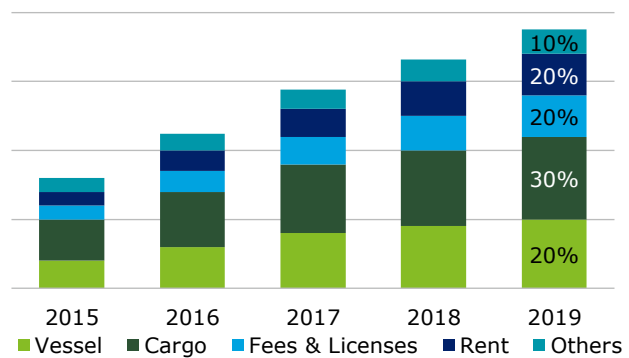


Figure 18: Revenue Mix for reported years (Illustrative)

Source: (United Nations Conference on Trade & Development, 2016)

Rent/Revenue

Typically in landlord ports, where ownership remains with public entity while the private sector manages services, the authority earns the rental income from leasing out port's areas or terminals. These can be significant income when ports have a land bank. Terminal operators form a considerable portion of the rental revenues.

Fees/Revenue

Licensing or concession arrangement of particular services in the ports is now a growing trend in the container handling industry. The recognition of this service as rent or income from licensing may vary across ports. However, the critical thing would be whether they remain consistent over the years.

Human Resource Indicators

This is the category of performance that is usually not focused much significantly impact the flow of operations in the industry. Even gathering the data for such a measure is challenging and brings in subjectivity. For example, a halt in services due to disputes or strikes usually does not reflect the performance. Also, indicators such as labor productivity across hierarchies and customer satisfaction are difficult to measure directly, and surveys are generally used as proxies.

The human resource indicators measuring performance are more standard and less related to port operations. From a performance perspective, tonnage measures and the amount of automation can be used to define the indicators. Apart from measuring the revenue and margins per employee, two key performance indicators are given below:

Training/wages

This is a crucial basis for port-to-port comparisons. Industries typically measure the amount of spending on training per unit of revenue. Hence, it is a non-standard measure but extremely relevant in port management studies as it can account for the differences in revenue profiles of ports based on the amount of cargo.

Wages/revenue

This metric of measuring the cost of labor per unit of revenue vary based on how port operations are managed. An increase in licensing to private players reduces the number of laborers in the space. Furthermore, labor costs are decreasing with an increase in automation and modernization of ports. However, it is an important metric to compare across similar seaports and with the national average to comply with the labor laws.

Other measures can be assessing the hiring policies of the port and how do other factors get affected due to the replacement of their laborers by private parties.

JAWAHARLAL NEHRU PORT TRUST



**जने ष न्यास
JNPT**

Jawaharlal Nehru Port Trust

Jawaharlal Nehru Port Trust, popularly known as JNPT, is the largest container port in India. JNPT was commissioned on 26th May 1989, located in the east of Mumbai. The port was originally planned to decongest the existing Mumbai Port and serve as a container cargo hub. Today, JNPT handles more than half of the container cargo across all major ports in the country and is ranked India's No. 1 container port. JNPT stands at 28th position in the world ranking of container ports.

History

In the earlier days, Mumbai Port experienced many issues like shallowness in the channel, road congestion, rail congestion, labor issues, etc. As a result, JNPT was commissioned as an autonomous body under the Major Ports Trusts Act, 1963. An investment of INR 1,109 Cr. was made over an area of 2,584 hectares. Today, JNPT has improved its operational capacity to transform itself into a port at par with global standards. The history and development of JNPT is depicted in the table below (Jawaharlal Nehru Port Trust, 2020).

Table 1: History & Development of JNPT¹⁹

Year	Development
1986	The construction work at JN Port commenced
1989	Inauguration
1997	Second Container Terminal led by a consortium of P&O Ports, Australia
1999	NSICT ²⁰ – India's first privatized container terminal commissioned
2001	JNPT becomes first Indian port to handle more than 1 million TEUs ²¹
2002	The bulk terminal rendered to be the container terminal
2002	Twin-berth Liquid Cargo Terminal, jointly developed by BPCL & IOC on BOT basis commissioned
2006	GTICT ²² – third container terminal led by Gateway Terminals of India Pvt. Ltd. commissioned
2007	JNPT crosses 3 million TEUs in container handling
2010	JNPT crosses 4 million TEUs in container handling
2012	Widening and deepening of channels by Boskalis International
2013	Concession agreement for 330-metre quay extension signed with DP World
2016	NSIGT ²³ – fourth container terminal commissioned
2018	BMCT ²⁴ – fifth container terminal commissioned
2019	Additional liquid berth for liquid cargo to be developed

Today, JNPT has a full-fledged custom house, 30 Container Freight Stations, and connectivity to 52 Inland Container Depots spread across the country. The connectivity is further extended and strengthened via Dedicated Freight Corridor (DFC) to expand the train capacity at the port. The proximity to the cities of Mumbai, Navi Mumbai, and Pune gives the Port a competitive advantage to address the shippers' needs efficiently.

¹⁹ Source: (Jawaharlal Nehru Port Trust, n.d.)

²⁰ Nhava Sheva International Container Terminal

²¹ Twenty foot equivalent unit, the measure used for container traffic

²² Gateway Terminal of India Container Terminal, developed by a consortium of AP Moller Maersk and CONCOR

²³ NhavaSheva International Gateway Terminal

²⁴ Bharat Mumbai Container Terminal

Location

JNPT is located at the eastern end of Mumbai on the Sheva Island at the coordinates 18°56'43" N and 72°56'24" E. The location and satellite image are depicted below.



Figure 19: Location of JNPT (retrieved from Google Maps)

Organizational Structure

JNPT is managed by a Board of Trustees comprising of multiple stakeholders. The Port Trusts is expected to maximize public interests and run operations in a commercially viable manner. The organizational structure of JNPT is described below:

- The Board of Trustees consists of a Chairman, a Deputy Chairman, and not more than 17 persons appointed by Central Government from time to time
- There are five departments with multiple sub-sections headed by an HoD, commonly known as Chief Manager

Table 2: Departments & Sub-sections at JNPT²⁵

Department	Sub-sections
Operations	<ul style="list-style-type: none"> • Bulk Terminal • Container Terminal • Engineering Services • Projects & CFS Section
Port Planning & Development	<ul style="list-style-type: none"> • Major Ports & Dredging Division • Port Area (Maintenance & Project) Division • Township (Maintenance & Project) & Environment Management Division • BOT Projects Section
Finance	<ul style="list-style-type: none"> • Revenue • Cash & Bank • Projects • Bills

²⁵ Source: (JNPT: A Study of Port Operations: Administrative Context, Structure & Processes)

Department	Sub-sections
	<ul style="list-style-type: none"> • Procurement & Stores • Establishment • Internal Audit • Financial Accounting • Costing & Budgeting • Loans
Marine	<ul style="list-style-type: none"> • Marine Conservancy & Pollution Control • Fire and safety • Marine Operations (including pilotage & port signal station) • Marine Engineering • Safety
Administration	<ul style="list-style-type: none"> • Personnel and IR • Legal and Estate • General and Administration • Hospital • Marketing

The organizational structure of JNPT resembles a blend of hierarchy, bureaucracy, and departmentalization aligned towards the common goal.

- Hierarchy: The organization is divided into a hierarchical structure with diversity in people and their credentials
- Bureaucracy: As an entity owned by the government, compliance and strict adherence to the set of guidelines laid by the government
- Departmentalization: Multiple departments performing a wide variety of functions

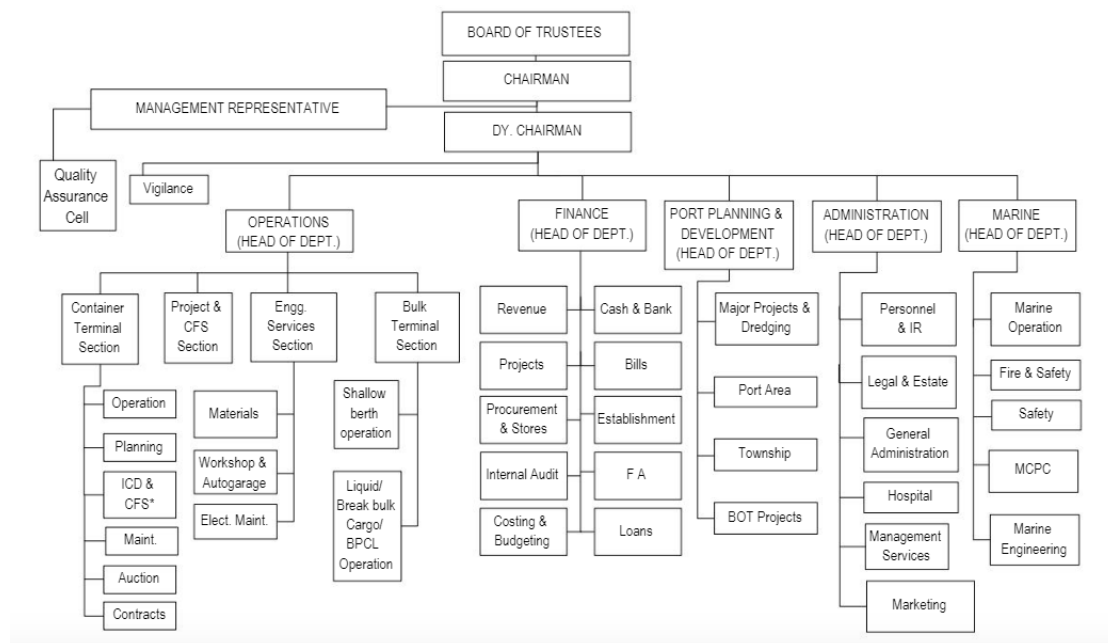


Figure 20: Organogram of JNPT²⁶

²⁶ Source: (JNPT: A Study of Port Operations: Administrative Context, Structure & Processes)

Terminals at JNPT

The Port has five terminals and one liquid terminal operated by different entities, making it the largest container port in the country.

Table 3: Terminals at JNPT²⁷

Terminal	Commissioning Date	Capacity (in TEUs)	Quay Length	Container Yard
JNPCT – Jawaharlal Nehru Port Container Terminal	26 th May 1989	1.5 MM	680 m	61.89 Ha
NSICT-DP World – Nhava Sheva International Container Terminal	April 1999	1.2 MM	600 m	25.84 Ha
BPCL and IOC Liquid Terminal	Oct 2002	7.2 MM tons	300	-
GTI-APM – Gateway Terminals India	March 2006	1.8 MM	712 m	54.57 Ha
NSIGT-DP World – Nhava Sheva (India) Gateway Terminal Pvt. Ltd.	July 2016	0.8 MM	330 m	27 Ha
BMCT – Bharat Mumbai Container Terminal	Feb 2018	4.8 MM	2000 m	200 Ha



Figure 21: Existing Facilities at JNPT (retrieved from Google Maps)

JNPCT – Jawaharlal Nehru Port Container Terminal

JNPCT is JNPT's own container terminal equipped with modern facilities of international standards. It has three berths with a total quay length of 680m that are capable of handling vessels of 14m draft. The terminal capacity is about 1.5 MM TEUs with a container yard of ~62 hectares. It also

²⁷ Source: (Jawaharlal Nehru Port Trust, n.d.)

has a shallow terminal of 445m quay length and a 10m draft with a total capacity of 0.15 MM TEUs and 4.5 MTPA of other cargo.



Figure 22: JNPCT Container Terminal (retrieved from Google Maps)

NSICT-DP World – Nhava Sheva International Container Terminal

NSICT-DP World was developed to cater to the increasing global demand container trade operations. Australian company P&O Ports developed the two-berth container terminal in a BOT model for 30 years. The project comprises construction of 600 m quay length, reclamation of 25.84 hectares of area backup for container yards, and requisite container handling equipment along with other related facilities. The current capacity of the terminal is about 1.2 MM TEUs per year.



Figure 23: NSICT Container Terminal (retrieved from Google Maps)

BPCL and IOC Liquid Terminal

A twin berth liquid cargo jetty built by BPCL and IOCL on a BOT model for 30 years lease period for handling liquid cargo, including POL. With a quay length of 300 m, the terminal can handle 7.2 MM tons per annum. The twin loading/unloading facility can accommodate two vessels simultaneously: 120,000 DWT in seaside berth & 45,000DWT on shore side berth.



Figure 24: BPC Liquid Terminal (retrieved from Google Maps)

GTI-APM – Gateway Terminals India

GTI, a joint venture between APM Terminals and CONCOR, operates the third terminal of JNPT on a BOT model since 2006 for 30 years lease period. With a quay length of 712 m and a container yard of 54.57 hectares, the terminal has a capacity of 1.8 MM TEUs. It is capable of handling vessels with a draft of 14 m.



Figure 25: GTIPL Container Terminal (retrieved from Google Maps)

NSIGT-DP World – Nhava Sheva (India) Gateway Terminal Pvt. Ltd.

NSIGT was commissioned in 2016 with a 330 m quay length, reclamation of 27 hectares of area backup for container yards, and capacity of 0.8 MM TEUs per year. The terminal has a maximum

vessel draft of 15 m. The terminal was developed in view of the growing demand and enhance private sector participation in ports.



Figure 26: NSIGT Container Terminal (retrieved from Google Maps)

BMCT – Bharat Mumbai Container Terminal

This is the most recent container terminal developed on a Design, Built, Fund, Operate, and Transfer (DBFOT) basis for the concession period of 30 years. With an estimated cost of INR 7,915 Cr., the work has been awarded to Bharat Mumbai Container Terminals Pvt. Ltd., a subsidiary of the Port of Singapore Authority. This terminal will approximately double the capacity of JNPT through a capacity addition of 4.8 MM TEUs (2.4 MM TEUs in two phases). JNPT crossed the annual 5 MM TEUs mark for the second consecutive financial year in FY19-20 after the commissioning of this terminal.



Figure 27: BMCT Container Terminal (retrieved from Google Maps)

Table 4: Comparison of Terminals at JNPT²⁸

Terminal	JNPCT	NSICT	GTI-APM	Liquid Cargo Terminal	BMCT		NSIGT
					Phase 1	Final	
Quay Length (m)	680	600	712	300-Sea 280-Shore	1000	2000	330
Maximum draft (m)	15	15	15	15-Out (Tidal) 10.5-Inner (Tidal)			15
Design capacity (MM TEUs Year)	1.5	1.2	1.8		2.4	4.8	0.8
Design capacity (MM Tonnes/Year)		20.5	23.7	7.2			
Reefer Points (Nos.)	576	772	840		1620	1620	336
RMQCs (Nos.)	9	8	10	10			4
RTGCs (Nos.)	27	29	36		36	72	16
RMGCs (Nos.)	5	3	3		4	8	
Tractor Trailers	80 (Hired) + 7(Owned)						
Yard Area (In Hectares)	61.49 (Including Shallow Berth area)	25.84	54.57	186 Tanks Capacity (15,34,686 KL)	90	200	27
Reach Stackers	03 (Hired)	2					
Maximum Permissible LOA of The Vessel (m)	370	370	370	330 - Outer Berth 185 - Inner Berth			370 Mtrs
Twin Lift Spreaders			61 Mt Rated Load				
Container Berths					3	6	
Depth at Berth					16.5 m	16.5 m	
Quay Cranes					12	24	
Ground Slots					9936	12500	
Railway Siding Tracks for ICD	4						

²⁸ Source: (Jawaharlal Nehru port Trust, n.d.)

Technological Upgradation at JNPT

JNPT is aiming to fast track its innovation quotient by implementing various technologies focusing on increasing the efficiency of port operations. It is targeting greater automation through digitization and data-based operations. Some of its notable projects include (Friedrich Ebert Stiftung, 2019) -

Gate automation systems

Started by DP World, one of the world's largest port terminal operators, began the process in 2005, when it set up a paperless gate module – Smart Gate. Now, the port boasts electronic, RFID gate operating procedures with reader and cameras at checkpoints in all the terminals. This automates entry and exit to a great extent, reducing workforce requirements from an average of 4 to 1.



Figure 28: Automated gates at the NSICT terminal in JNPT²⁹

Container traceability

Utilizing RFID chips for container traceability has now become commonplace in the port. This has made inventory management easier, faster, and less manually intensive. It has also enabled for the container owners and terminal operators to monitor the containers in real-time in the end-to-end logistics chain (from ship to the container freight station)

Monitoring activity & movement

Cameras have been installed at port and CFS to monitor the movement and activity of personnel and equipment. These have been installed everywhere in the port, terminals, and warehouse facilities.

Rubber tyred gantry (RTG) cranes

These are autonomous/semi-autonomous equipment that can lift and stack containers from vessels to the truck/rail and vice-versa. JNPT has procured a fleet of electrically powered RTG cranes used for cargo stacking in various terminals. These vehicles can handle a volume of 10-50 tons and can be operated by a single person compared to earlier when around ten operators would've been required for the same.

²⁹ Image Source: (JOC, 2015)



Figure 29: RTG cranes in BMCT, JN Port³⁰

Vehicle management system

Installation of Vehicle Miles Travelled (VMT) screens in the trucks allow for GPS enabled navigation in a terminal through a centralized system for a work assignment. This allows the system to allot assignments to truck drivers and provide a route and step-by-step instructions for picking up and dropping cargo in the terminal. This was earlier done through manual intervention at every stage and is now an automated process.

Ongoing Projects at JNPT

JNPT has been on an infrastructure development push in the last few years, aiming to build its capacity and surrounding facilities. Some of the major projects in development in and around the port are³¹ -

Development of the Bharat Mumbai Container Terminal in the port

BMCT's second phase of terminal development involves another 1 km of quay length, 16.5m depth at berth, 12 quay cranes, 46 RTG Yard cranes, and 4 RKGK cranes for its rail yard, generating a capacity of 2.4 Million TEU (total 4.8 MTEU). Construction of this terminal will expand the overall port handling capacity to 10 million TEUs and reinforce JNPT's position as the premier container port in India. The construction work is yet to commence and is expected to complete in Dec 2022.

Infrastructure development works of SEZ Phase 1

Under the port-led industrialization plan of the Government of India, JNPT has conceptualized a Special Economic Zone (SEZ) project. It is planned to be developed on 277.38 Ha of land area under-investment by JNPT of Rs. 500 Cr.

There are plans to set up Automobile, Electrical, Electronic, Engineering, Food Processing, and Pharma industries in the SEZ. More than 60% of the work has been completed as of July 2020.

³⁰ Image Source: (BMCTPL Press Release, 2018)

³¹ Source: (JNPT, 2020)

Construction of a dry port at Wardha, Nashik, Jalna, Sangli

A dry port is an intermodal terminal in a remote area servicing a region connected with one or more ports by rail or road transport. It offers specialized services between the dry port and overseas ports. It is generally for container cargo and provides logistics and value-added services for shipping and forwarding agents.

JNPT's dry ports are to be constructed in Wardha, Jalna, Nashik, and Sangli districts in Maharashtra. These ports will help reduce logistics costs and time for container movement to inland areas in India.

Additional Liquid Cargo Jetty

JNPT is funding the development of a liquid jetty of 4.5 MTPA at the cost of INR 309 crores. The jetty will have twin berths to handle two large vessels simultaneously - 35,000 DWT vessels on one side and 25,000 DWT vessels on the other side. The construction work on this started in Feb 2020.

Coastal berth construction

To accelerate coastal shipping in India, the Government of India is planning a coastal vessel berth at every major port which are going to be located in the shallow parts of the port. Large international ships will not be able to access these berths.

Regarding this requirement, JNPT is constructing a 250 m long coastal berth with two trestles of 94 m length each and a backup reclamation area of 11 hectares. The berth's capacity will be of 1.5 MTPA liquid cargo and general coastal cargo of 1 MTPA. The work on this berth is completed to a large extent as of July 2020.

Assessment of JNPT

Ports have evolved as the lifeline for international trade in the country. Also, with increased containerized movement and JNPT handling more than half of the volume, it is crucial to measure the ports' performance to identify issues and bottlenecks. Infrastructure heavy assets require higher turnaround time for increasing the available capacity and reduce utilization rate. JNPT is already at a higher utilization rate than the world's average, leaving less room for other activities.

Competitive Landscape: Comparing Port Performance (Global)

Despite the projects undertaken at JNPT, it lags on key performance indicators compared to other large ports globally. Factors such as the turnaround time of a ship are critical for shipping customers of a port. Shipping companies evaluate the service quality of a port on two categories – time and cost. Shipping companies evaluate the service efficiency of a port based on the port's time cost of the vessel. The most crucial parameter for assessing this metric is the *turnaround time* of the ship. This covers the total time taken for a ship between arrival and departure and includes – pre-berthing detention, unloading, inspection, documentation, etc. It can majorly be categorized into these few categories –

Turnaround time = pre-berthing detention + working time at berth + idle time at berth

JNPT has made marginal improvements in this regard over the past few years, and its turnaround time has oscillated as the port capacity changes and other facilities are improved –

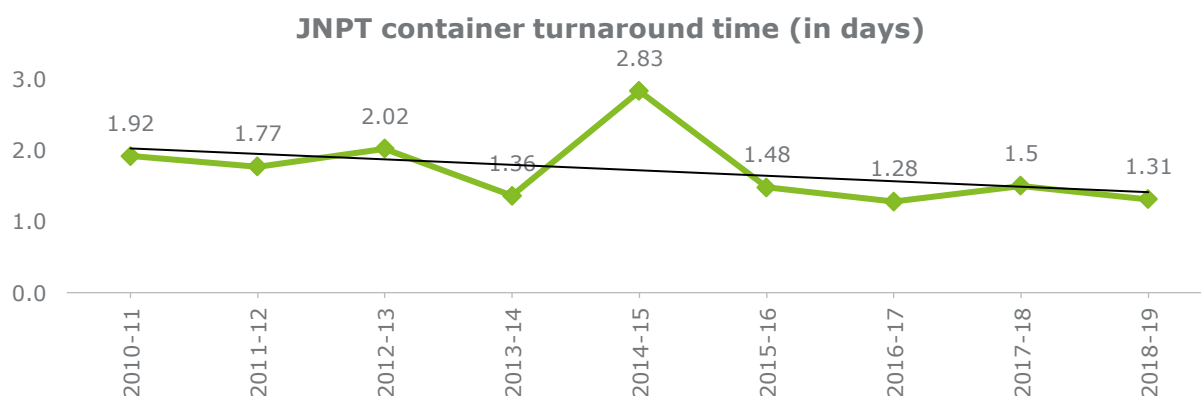


Figure 30: JNPT Turnaround Time Trend Analysis³²

However, JNPT's container turnaround time compared with the world's largest ports shows the difference it needs to cover when in terms of service efficiency –

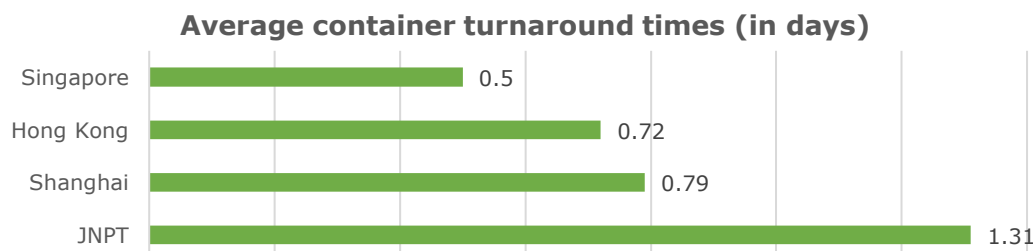


Figure 31: Global Benchmarking of Turnaround Time³³

³² Source: (Ministry of Shipping, various years)

³³ Source: (UNCTAD, 2018)

A major portion of the turnaround time is the pre-berthing detention when a vessel needs to wait before entering the berth. This time has also oscillated at close to 1 day in the past decade but is slowly inching downwards –

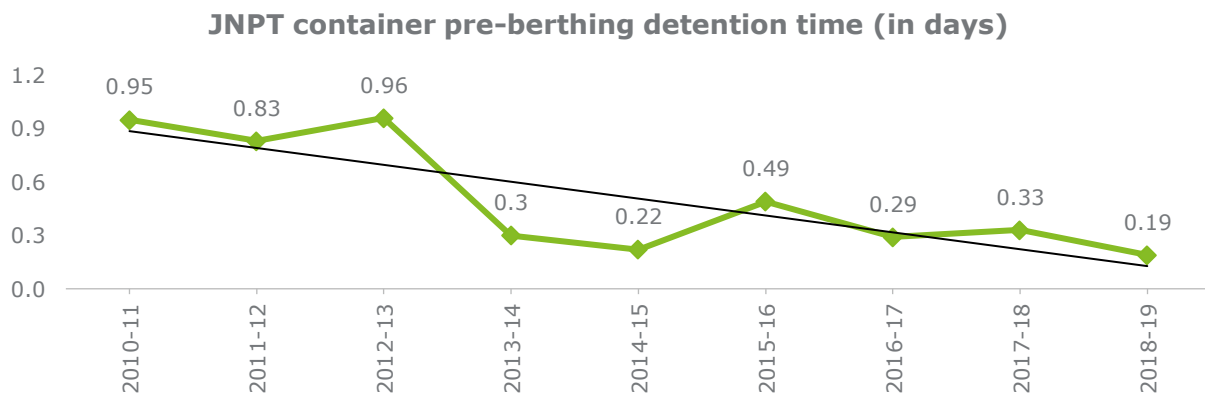


Figure 32: JNPT Pre-berthing Detention Time Trend Analysis³⁴

To look at the idle time at berth, we can look at the percentage of idle time at berth to time at working berth for container ships –

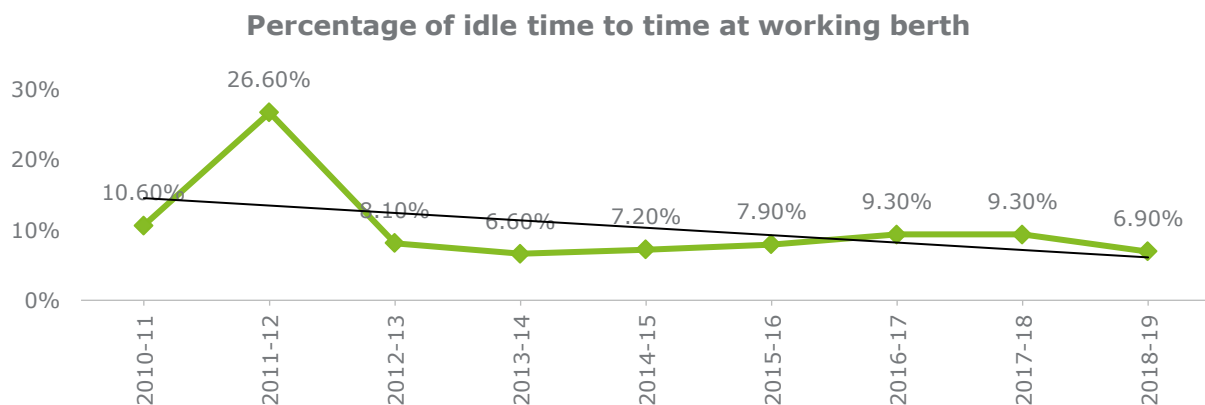


Figure 33: Percentage of idle time to time at working berth³⁵

This indicator has stayed more or less constant in the past decade. This means that vessels are still spending a considerable amount of time on the berth waiting for loading/unloading to begin. There could be various reasons for this – unavailability of cranes, unavailability of crane operators, unavailability of trucks, etc. These are also identified in our section on the capacity assessment of JNPT.

Thus, in this equation,

$$\text{Turnaround time} = \text{pre-berthing detention} + \text{working time at berth} + \text{idle time at berth}$$

We have seen that the pre-berthing detention time has decreased in the past decade, but the working time at berth and idle time at berth is still high. The reasons and solutions for these must be explored further.

³⁴ Source: (Ministry of Shipping, various years)

³⁵ Source: (Ministry of Shipping, various years)

Competitive Landscape: Comparing Port Performance (Local)

For competitive landscaping globally, the major ports in the three directions were taken and compared on different parameters related to available infrastructure and operations

Dwell Time

Comparing the pan India scenario for the month of Aug-20, JNPT has given the best performance in handling the overall import and export operations. JNPT's dwell time for exports is the lowest and second-lowest for import containers. A trend analysis of the dwell time performance across the three regions is also given below.

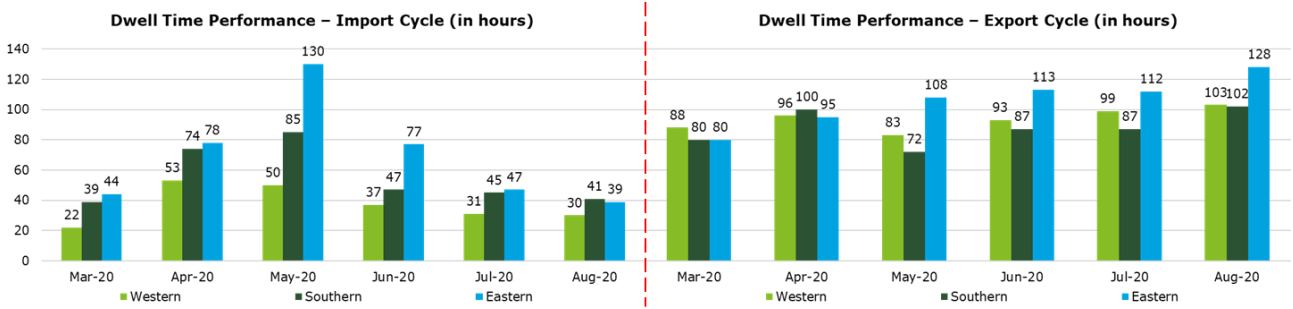


Figure 34: Dwell Time Performance of Ports: Trend Analysis³⁶

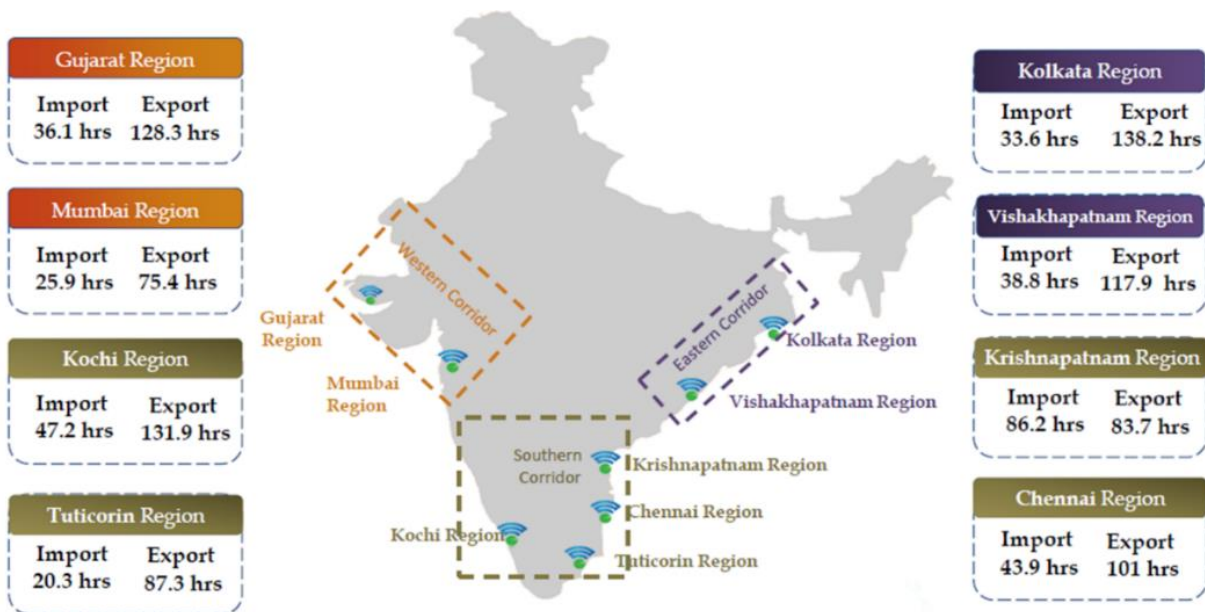


Figure 35: Pan India Performance Snapshot for Dwell Time (Aug-20)³⁷

³⁶ Source: (DMIDC Logistics Data Services Ltd., 2020)

³⁷ Source: (DMIDC Logistics Data Services Ltd., 2020)

Terminal Ranking³⁸

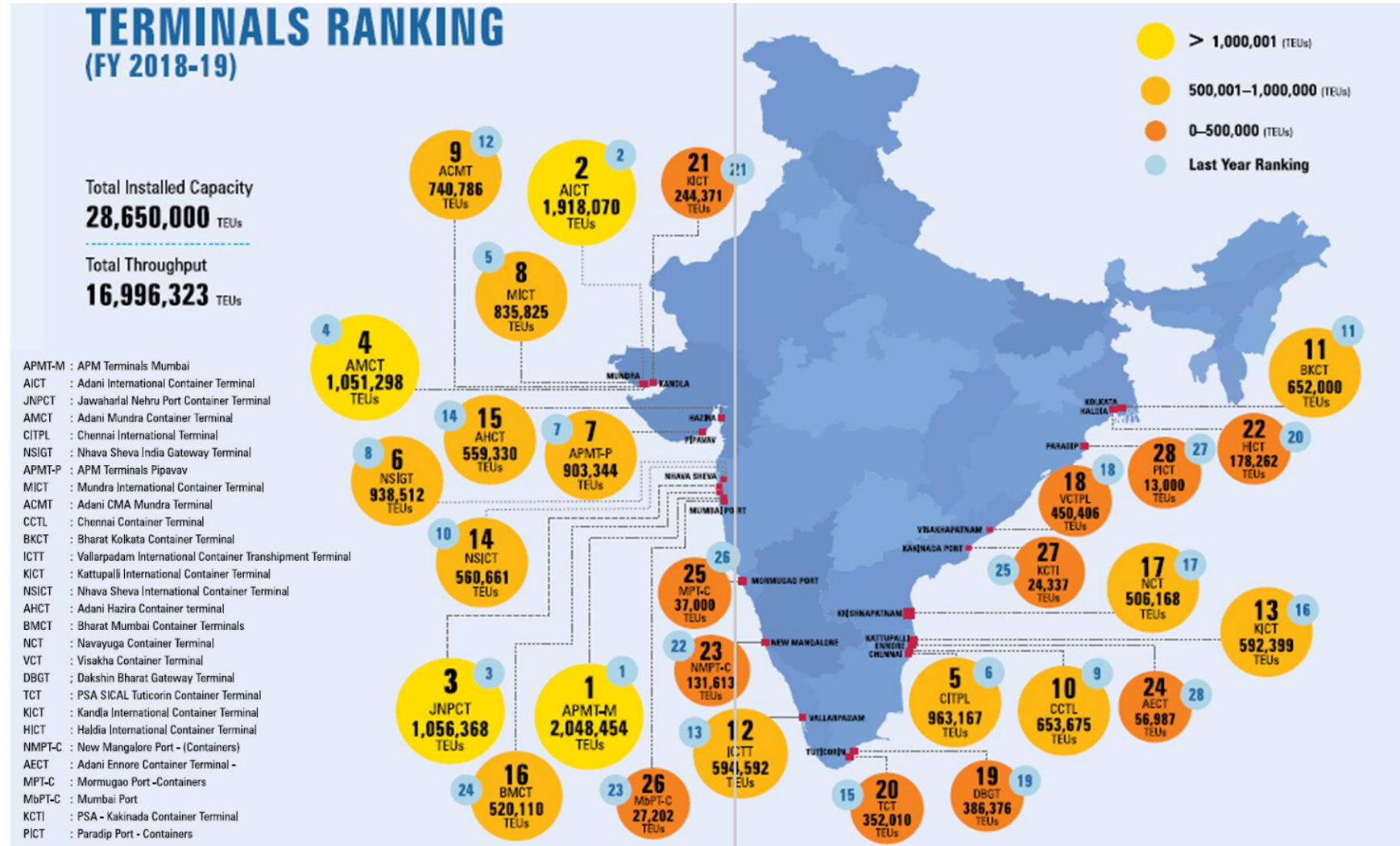


Figure 36: Terminals Ranking: FY 2018-19³⁹

³⁸ Refer to Appendix 2 for detailed terminal wise performance.

³⁹ Source: (Drewry, 2019)

Comparing Terminal Operations

Jawaharlal Nehru Port Container Terminal



Figure 37: Jawaharlal Nehru Port Container Terminal⁴⁰

JNPCT is owned and operated by JNPT. Despite being the largest port in container volume and crossing an annual volume of five million TEUs, JNPCT has registered negative growth. The CAGR for during the last five years from FY14-15 to FY18-19 is -4.3%. The terminal handled a volume of 1,056,368 TEUs for FY18-19, with a current handling capacity of 1,350,000 TEUs per annum. At the 78% rate of capacity utilization, there is a requirement for capacity expansion and operations efficiency.

The key challenger of reduction in throughput is a lack of digitization at the gate operations and longer lead time for Equipment Interchange Receipts. The gate time is longer than peers. Moreover, yard utilization rates and low quay crane productivity are also some key issues.

To address the concerns, JNPCT has upgraded the gate entry procedures for the entrance of trucks and trailers. RFID techniques have now been implemented at the gates. The major improvement areas of the terminal are dual cycling, efficient yard planning, twin lifts quay cranes, quay crane operator skills, and productivity enhancement through monetary incentives.

Nhava Sheva India Gateway Terminal

NSIGT is one of the two terminals managed by DP World. This terminal is known for its advanced technology investments. It has shown an exponential growth rate with more than 100% capacity utilization, meaning the requirement of capacity addition. This terminal had a throughput of 9.38

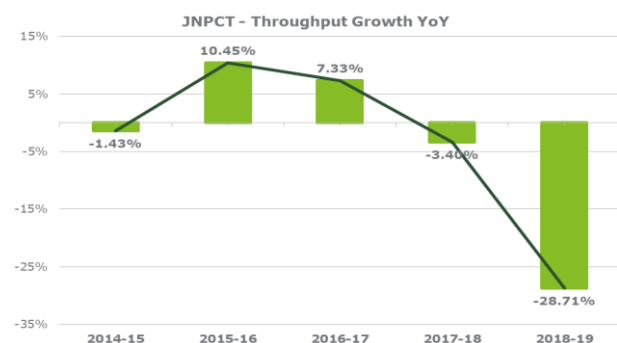


Figure 38: JNPCT - Throughput Growth YoY

Source: (Drewry, 2019)

⁴⁰ Image Source: (Drewry, 2019)

lakh TEU's in FY18-19 at an installed capacity of 8 lakh TEUs. The throughput grew by 44% compared to the previous year.



Figure 39: Nhava Sheva India Gateway Terminal⁴¹

The terminal is equipped with the largest and advanced remote operated quay cranes, OCR technology, an advanced Reefer Monitoring System, and revolutionary Electrical Rubber-Tyred Gantry cranes (E-RTGs). The terminal is the first in India to use 'Remote Quay Cranes Operations Capability.' Automated gates through OCR and RFID help in a smooth flow and keep accuracy in data. The terminal has a separate smart video room for real-time operations monitoring and governance. NSIGT has overtaken NSICT in terms of volumes in 3 years. DP World is diverting its business to NSICT as the terminal is more commercially beneficial than NSICT.

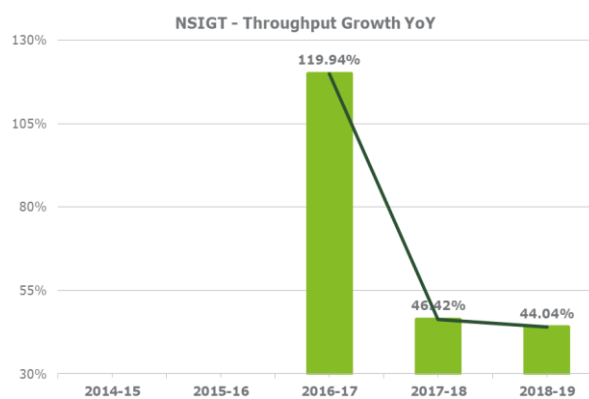


Figure 40: NSIGT - Throughput Rate YoY

Source: (Drewry, 2019)

Nhava Sheva International Container Terminal Pvt Ltd

An old terminal established in JNPT operated by DP World. With an installed capacity of 12 lakh TEUs, the terminal is only running at a capacity utilization of 47% with 5.6 lakh TEUs. The negative growth rate is consistent in the last few years, with a CAGR of -10.4% from FY14-15 to FY18-19. The decline in volume has been due to the tariff by the Tariff Authority of Major Ports (TAMP) that has made the operations unprofitable for them.



Figure 41: NSICT - Through Rate YoY

Source: (Drewry, 2019)

⁴¹ Image Source: (Drewry, 2019)

The terminal is investing in cargo handling by adding 15 RTGs to cut down fuel costs and enjoy easy maintenance to improve operations. These RTGs will be fitted with a variable speed generator (VSG) to optimize RPM as per the power demand automatically. This offers a high fuel economy and cuts emissions.



Figure 42: Nhava Sheva International Container Terminal⁴²

Bharat Mumbai Container Terminal



Figure 43: Bharat Mumbai Container Terminal⁴³

BMCT is the new terminal developed and operated by the Singapore entity PSA International. The installed capacity is about 24 lakh TEUs enhancing JNPT's much-required flexibility and operational capacity. The terminal is equipped with new technology for a faster turnaround time

⁴² Image Source: (Drewry, 2019)

⁴³ Image Source: (Drewry, 2019)

of vessels. BMCT has shown the potential of catering to significant volume incoming at JNPT. After integration with the Dedicated Freight Corridor, the terminal is expected to outperform with an added advantage of handling 1.5 km double stack DFC trains. With an increase in traffic share towards trains, the terminal shall further reduce the logistics cost operations.

As the largest standalone container terminal in India, BMCT is set to revolutionize the container trade for the hinterland supporting it. The terminal continues to deliver consistent high productivity, a major consideration for the customers to select a terminal of call, especially with the upcoming maritime regulations.

Performance Benchmarking of Port

To evaluate the performance of JNPT terminals against other ports on the western coast of India, we're using a framework developed by DLDS - DMICDC Logistics Data Services, a joint venture between the Government of India represented by the National Industrial Corridor Development and Implementation Trust (NICDIT) and Japanese IT company NEC Corp which is entrusted with collating data across operational parameters on many ports in India. Their flagship product *Logistics Databank System* provides container visibility across the western corridor of India along with comparable performance metrics. (DLDC, 2020)

Their benchmarking plots terminals on a graph measuring container volume handled and dwell time of the containers. Basis these metrics, the terminals are categorized on one of four quadrants representing – Slow bulk movers, star performers, high potential, and laggards. These are defined as –

Slow bulk performers

Terminals which have catered to relatively high container volumes but at a relatively higher dwell time. These terminals usually have high volumes due to locational or legacy advantages and wouldn't have sustained their high volumes in a more competitive environment.

Star performers

Terminals which have catered to relatively high container volumes at a relatively lower dwell time. These are the ideally placed terminals on the grid with both high volumes and high efficiency. However, given the lower benchmarks in Indian ports, these ports still lag when compared to global peers. Hence, they must still find ways to become more operationally efficient while increasing their container volumes.

High potential

Terminals which have catered to relatively low container volumes at lower dwell times. These have the potential to move to the *Star performers* quadrant as the terminal demand increases. However, operational efficiency also increases with low container volumes and high capacity. Ideally, efficiency must derive from factors like technological advantages and productivity instead of idle capacity. Therefore, the reason for high potential must also be ascertained.

Laggards

Terminals which have catered to relatively lower container volumes at higher dwell times. These have to improve on both dwell times and work on increasing their demand. While one of the reasons for low demand could also be the higher dwell times, it must be analyzed if there are other locational disadvantages, which can't be solved. For example, without a natural draught or the possibility to dredge, the ports can't attract larger ships and hence, increase their throughput per ship.

The categorization as of July'20 is –

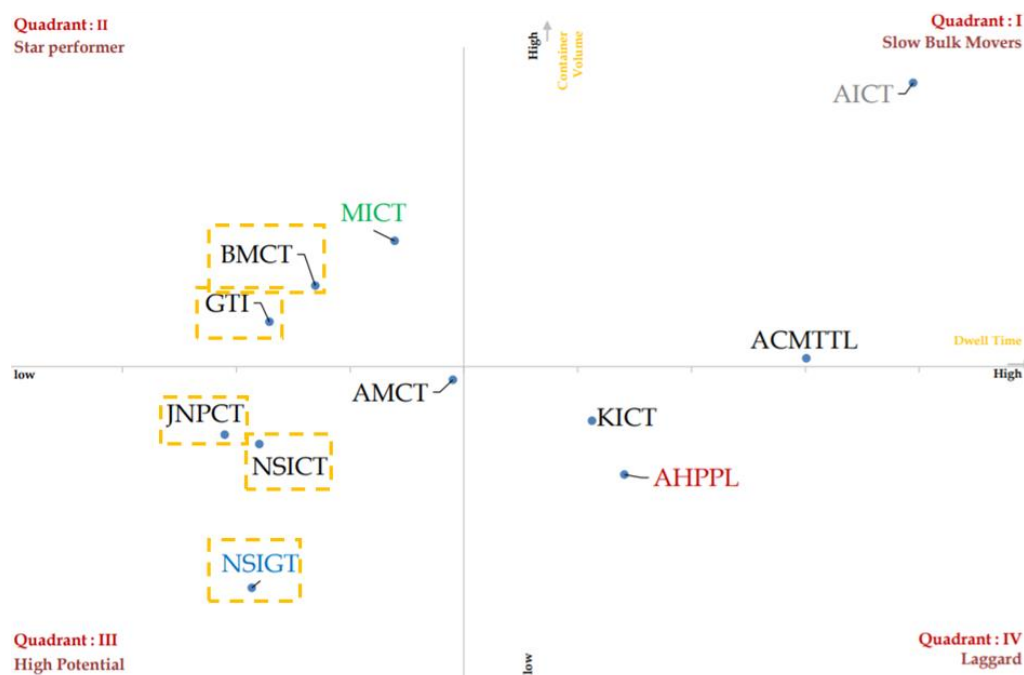


Figure 44: Port Terminal Performance Index - July'20⁴⁴

As shown on the chart, the five JNPT terminals – JNPCT, NSICT, NSIGT, GTI, and BMCT (boxed in yellow) are either in the *high potential* or *star performer* quadrants. The high potential terminals can move into the star performer quadrants as and if their demand increases. But their dwell times are already lower than the other ports on the western coast. However, to become a world-class port, it needs to further reduce its dwell time in line with world-leading ports. Moreover, it's important to analyze the reason for the low dwell time. It could be because of either high efficiency or low utilization. JNPT's own terminal JNPCT, for example, has seen falling throughput over the past couple of years. Hence, it's capacity utilization has gone down. This is a big reason why its dwell time has fallen and not because of operational improvements.

We evaluate the demand and dwell time of JNPT terminals in more detail in the coming sections.

The top-performing terminal in India is the Mundra International Container Terminal (MICT) in the Mundra port owned & operated by the global port terminal operator DP World. MICT leads in both a high container volume and a relatively low dwell time. Because of its operational efficiency and being on the same coast as that of JNPT, it has been able to steal the market share of JNPT. However, the dwell times of the JNPT terminals are lower than MICT and have a lower container volume.

Capacity Assessment of Existing Berths

The container and cargo handling capacity of a terminal and port depends on various factors such as the capacity utilization of berths, the capacity of stackyard, equipment provided, handling rates, etc.

⁴⁴ Source: (DMICDC Logistics Data Services Ltd., 2020)

An important metric in deciding the berth capacity of a port or terminal is the berth occupancy factor. This is the ratio between the total number of days a berth is occupied and the number of the port operational days in a year. For either lower number of berths or random arrival of ships, this ratio has to be kept low to reduce bunching of vessels and berthing delay. The recommended berth occupancy factors are –

Number of berths	Recommended berth occupancy factor
1	60%
2	65%
3 or more	70%

JNPT’s berth occupancy over the past few years has been as follows (Ministry of Shipping, 2019)

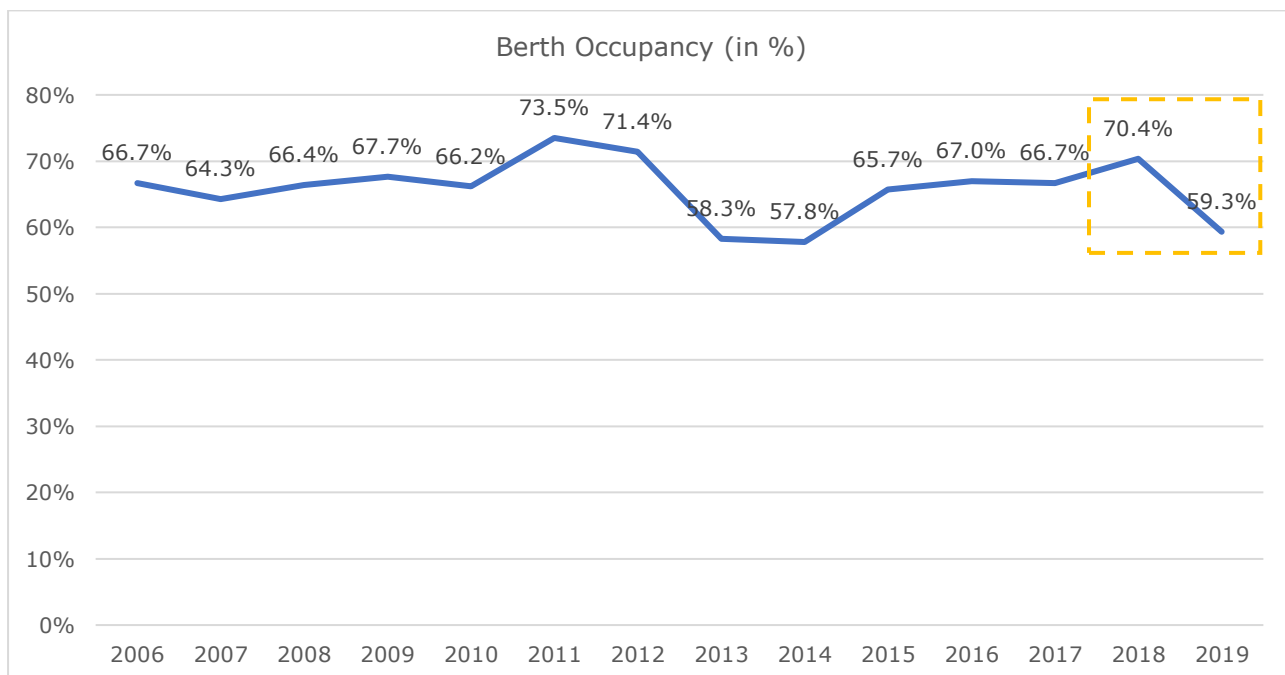


Figure 45: Birth Occupancy at JNPT⁴⁵

As we can see, JNPT’s overall berth occupancy was very close to the benchmark of 70% by 2018. If the demand kept on increasing, the port would’ve exceeded the benchmark occupancy ratio. However, after adding the BMCT terminal’s 2.4 MTPA capacity, the overall occupancy factor has gone down. However, the new terminal is already facing high demand and ramping up quickly. It hits its one-millionth container milestone in Oct 2019 after launching in the month of February the same year. As the terminal's demand increases further, the overall berth occupancy % of the port will go up again⁴⁶.

However, the occupancy of individual terminals is still very high. The GTI terminal is operating at an occupancy factor of close to 100%. The NSIGT port is operating at a more than 100% capacity utilization. Its other port is being operated at ~44.2% utilization due to strategic reasons by its operator DP World. DP World has a commissioning deal for NSICT with the Government of India, where it must pay a very high concessional rate for throughput higher than 0.6 TEU and must maintain the demand of at least 0.6 TEU according to the agreement. Hence, it is intentionally limiting the throughput of the NSICT terminal to 44% utilization and redirecting the remaining demand to its other terminal NSIGT where the concessional agreement is much more favorable. This is even though its quay length at the NSICT terminal is close to double that of the NSIGT

⁴⁵ Source: (Ministry of Shipping, various years)

⁴⁶ Source: (The Hindu, 2019)

and hence has more berths and more quay cranes. JNPCT’s utilization rate is close to 53% due to falling demand. As an average of all the terminals, the overall utilization of JNPT is low, but many terminals are close to 100%.

Liquid cargo handling facility

In the liquid cargo handling facility, the berth occupancy is over 80%. The waiting time vessels sometimes go up to 5-6 days, out of which waiting time attributed to the port is 2-3 days and due to other factors is 3-5 days. While the JN Port has plans to develop a second liquid terminal, there is time before that plan comes to fruition. Hence, it is imperative for the port to assess the possible schemes on how the waiting time of the port can be decreased.

It can also be seen under the reasons for pre-berthing detention of liquid bulk at JNPT. The below chart shows the average number of hours of delay for each type of ship at JNPT –

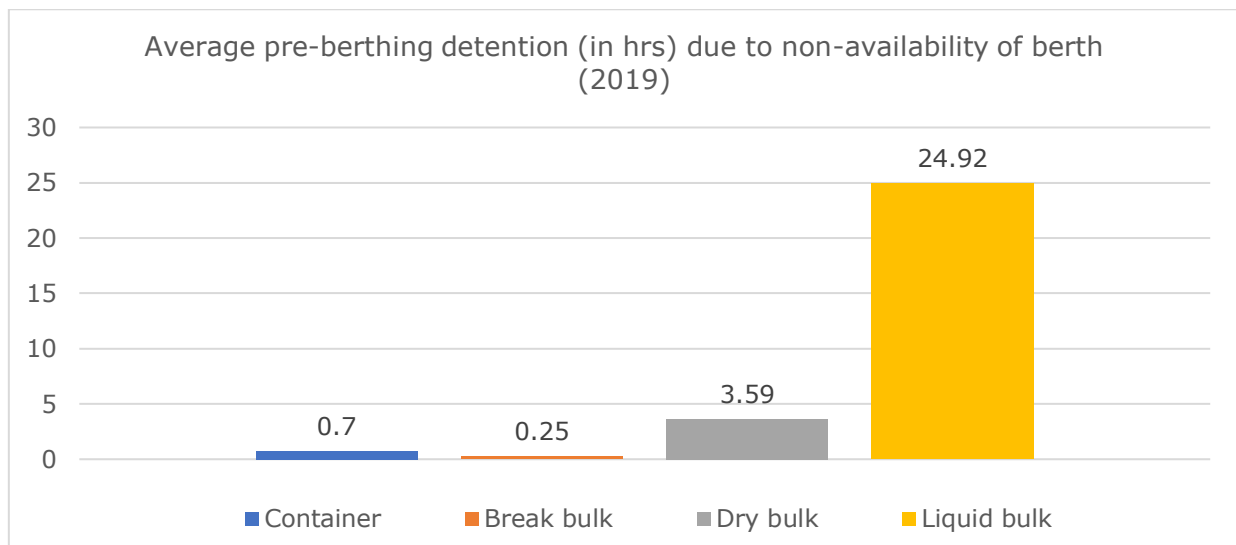


Figure 46: Average pre-berthing detention due to non-availability of berth⁴⁷

Moreover, when an LPG vessel has berthed on the front side in this facility, then a Crude or Petroleum Oil Lubricant (POL) ship cannot be berthed on the other side. Chemicals or edible oil tankers can only use it.

Container Transportation

In container transportation, the container cargos are transhipped from/to the vessel to/from ICDs/CFS. The transshipment can happen via rail or road. JNPT has both the facilities of rail transportation and road transportation. Usually, trucks are used to ship the container from vessel to CFS in the import cycle and vice-versa. Trains are used for long-distance transport to ICDs located across the country. The movement cycle is given in Appendix 2.

Container Cycle

The cycle can be broken down into port dwell time, transit time, and time spent at the warehouse (CFS/ICD). The timings have remained variable across the months (currently due to Covid-19). The data in Fig 32 breaks down the container lifecycle details at the port terminals for the month of Aug-20. One critical bottleneck is that the export container port dwell time is significantly higher than the import container. A further breaking down of port dwell time is given in Table 4

⁴⁷ Source: (Ministry of Shipping, 2019)

for the month of August. At JNPT, 80% of the volume is transported via train while the remaining 20% happens via rail. The majority of the rail volume is routed towards Delhi-Tughlakabad ICD in the northern region.

An import cycle's total cycle time is about 118.9 hours via truck while 216 hours via train. On the other hand, the export cycle time is 171.1 hours in the truck and 255.2 hours on the train. This higher dwell time at JNPT exists across all the terminals predominantly. Also, the trend analysis across all months depicts that seasonality is not the case. The dwell time is higher significantly higher compared to global ports (<24 hours of dwell time).

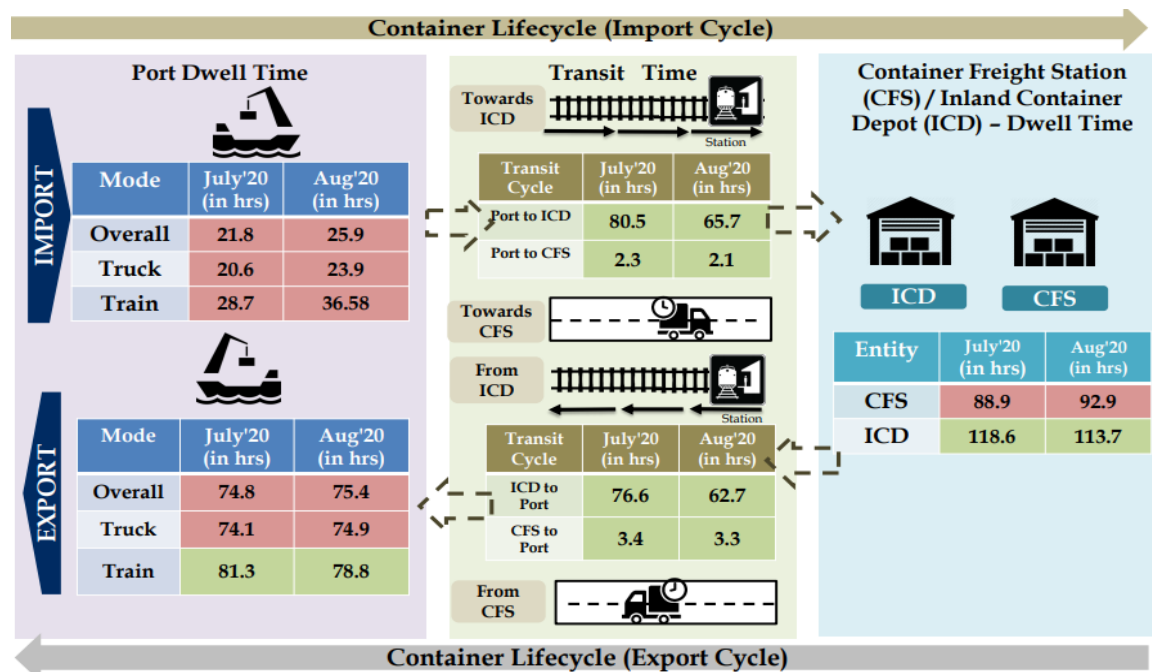


Figure 47: Container Transportation: JNPT Port Terminals⁴⁸

Port Dwell Time

Overall

The table below details dwell time variability for different container routes – truck or train, direct delivery or CFS, and empty vs. laden for export and import cycle. The export dwell time at the ports is significantly higher than the import dwell time across all the metrics. It is clear that export containers spend more time at the port waiting for getting transported to the vessel as compared to the import container being lifted for the destination.

Table 5: Import and Export Cycle Dwell Time⁴⁹

Parameter	Import	Export
Overall Dwell Time of Truck and Train Bound Containers	25.9	75.4
Port Dwell Time for Truck Bound Containers	23.9	75
Port Dwell time for Train Bound Containers	36.6	78.8
Port Dwell time Direct Port Delivery/Entry (DPD/DPE) containers	42.8	79.8
Port Dwell time Containers bound for/from CFS	19.5	76.8
Port Dwell for Empty Containers	39.7	68
Port Dwell for Laden Containers	22.2	76.4
Port to CFS / CFS to Port	2.1	3.3

⁴⁸ Source: (DMIDC Logistics Data Services Ltd., 2020)

⁴⁹ Source: (DMIDC Logistics Data Services Ltd., 2020)

Trend Analysis

The variability in import and export port dwell time across a time horizon is given below. Exports have shown lower variability but a higher dwell time as compared to imports that have high variability but a comparably lower dwell time. Except for one month due to Covid-19, across all the months' imports have been better and reduced their dwell time compared to exports. Further, the export volume has been slightly lower than the overall imports with higher dwell time.

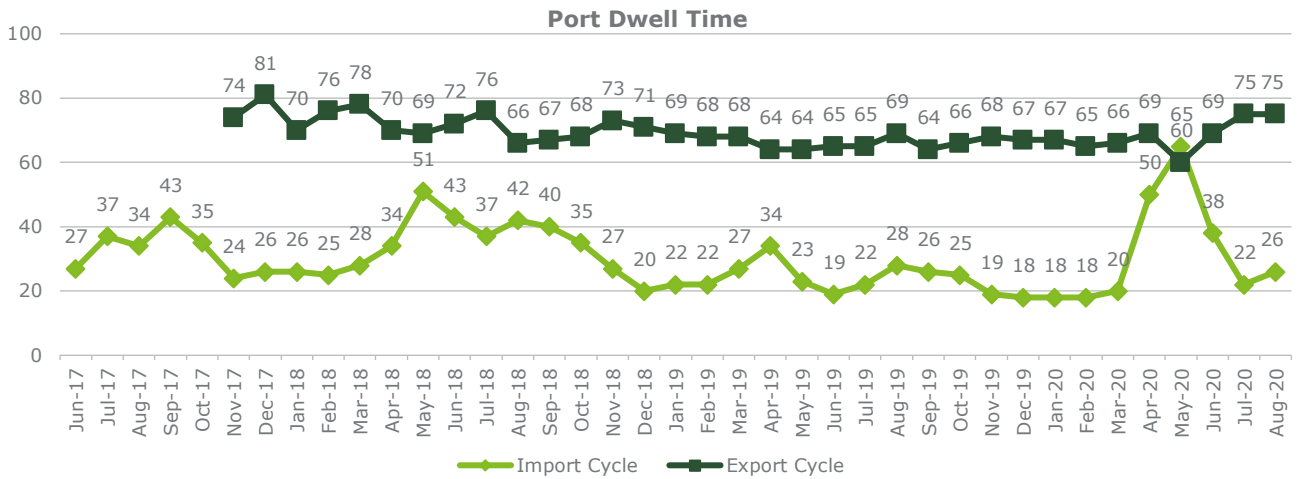


Figure 48: Port Dwell time Trend Analysis - Import & Export Cycle⁵⁰

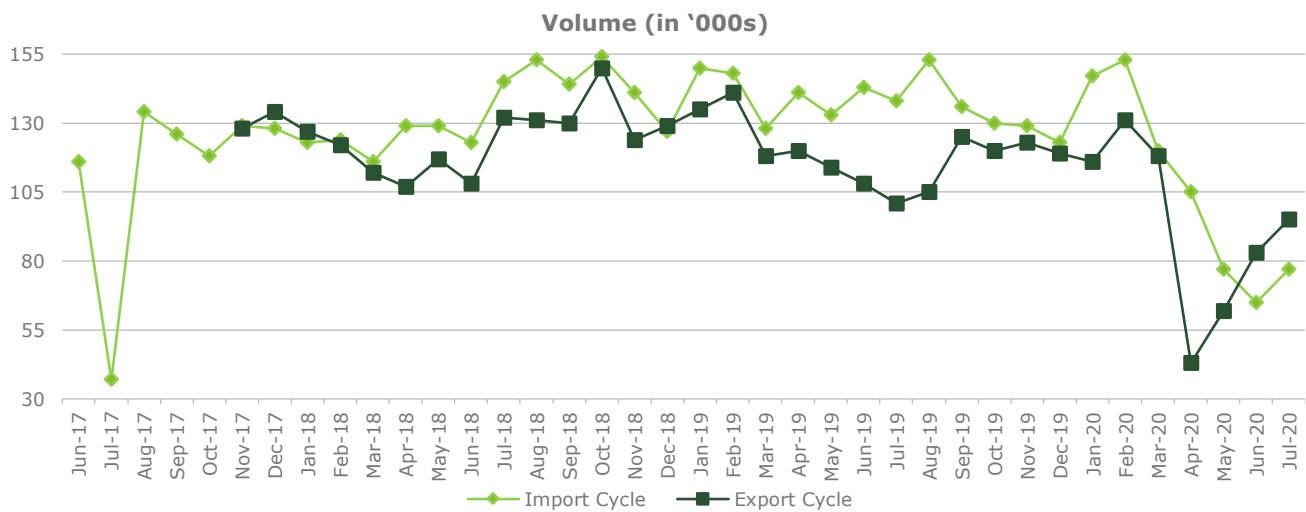


Figure 49: Port Volume Trend Analysis - Import and Exports⁵¹

Terminal Operations

Based on the terminal operations data in Figures 35 & 36 for the month of Aug-20, it is clear that exports lag as compared to the imports, and it is high in trains as compared to the trucks. Also, the higher dwell time in terminal operations is observed across all terminals. The truck operations are expected to perform better than train operations, and it is getting reflected in the time. The variability across terminals in the truck is lower as compared to the trains, both in the export and import cycle.

⁵⁰ Source: (DMICDC Logistics Data Services Ltd., 2020)

⁵¹ Source: (DMICDC Logistics Data Services Ltd., 2020)

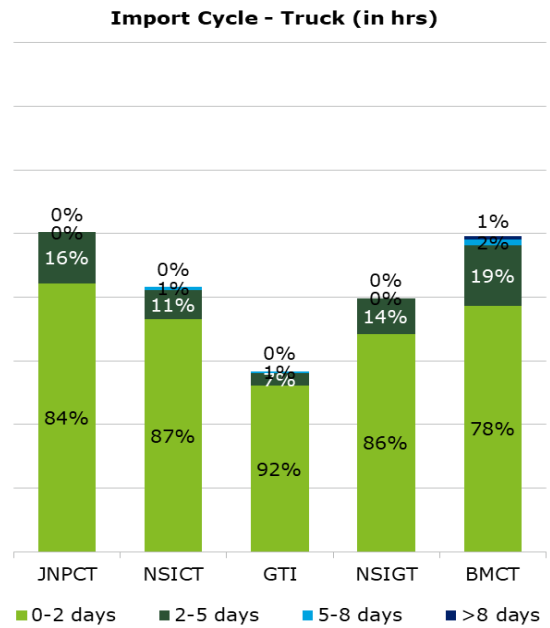
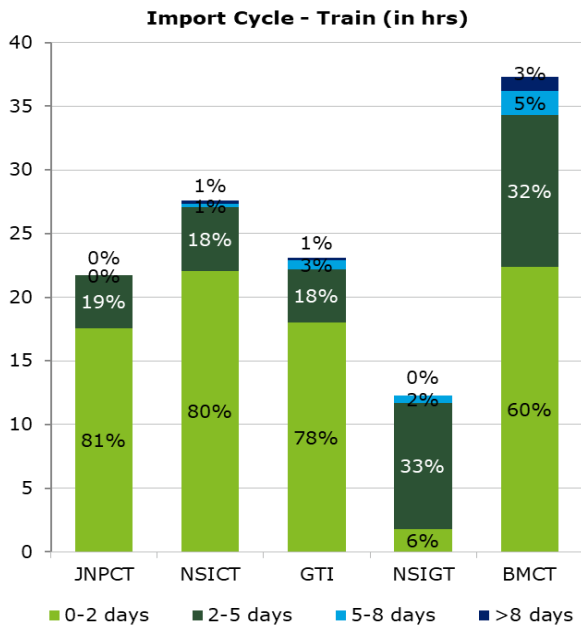


Figure 50: Terminal wise Import Cycle Performance⁵²

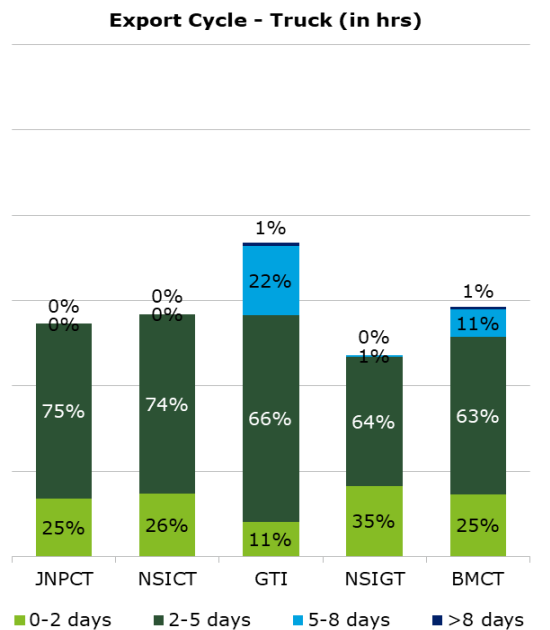
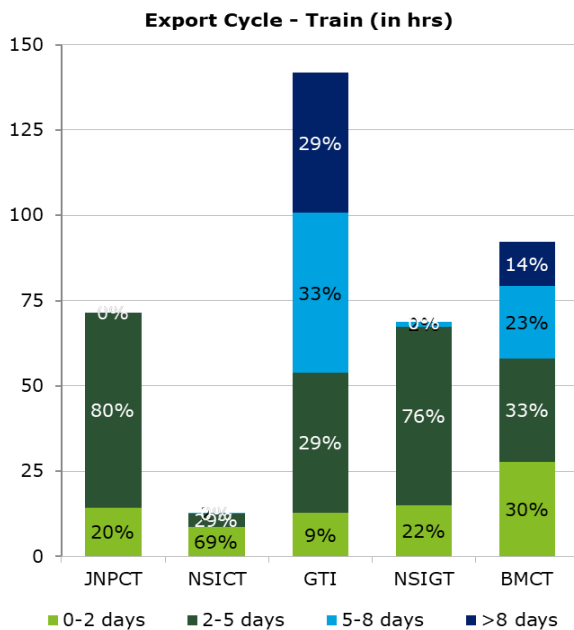


Figure 51: Terminal wise Export Cycle Performance⁵³

Performance based on transit and container type

Direct port delivery containers take higher time as compared to the container bound for CFS in case of imports. However, in the case of exports, both are comparable but higher than import operations.

⁵² Source: (DMIDC Logistics Data Services Ltd., 2020)

⁵³ Source: (DMICDC Logistics Data Services Ltd., 2020)

The laden containers, which require better handling, have lower dwell time in imports than the exports. Further, their time is significantly lower than empty containers. In this scenario as well, the export time is higher than import time.

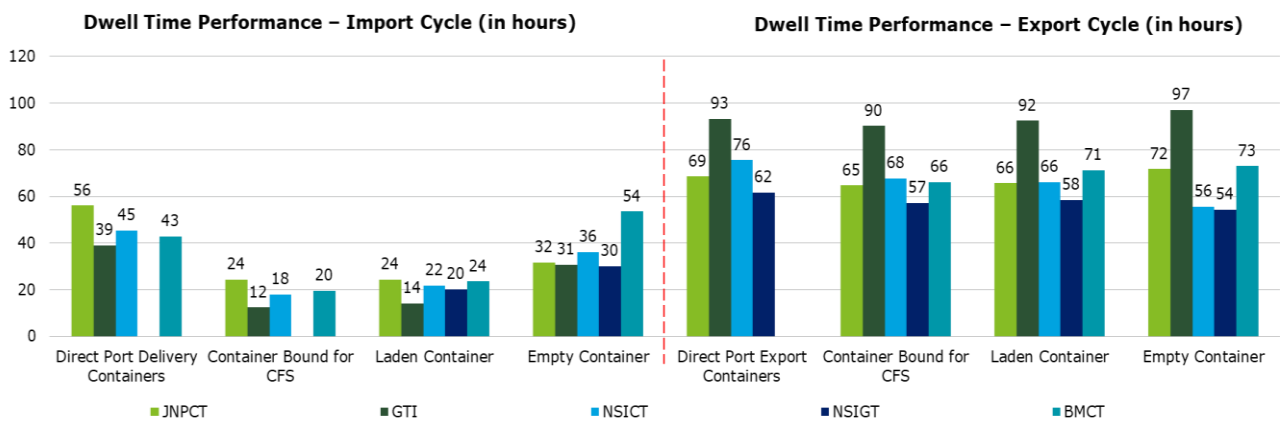


Figure 52: Terminal wise Import & Export Dwell Time Performance based on transit type & container type⁵⁴

Parking Plaza Dwell Time

The below table depicts the Parking Plaza & Parking Plaza to Port Transit Performance at JNPT Port Terminals and their volume bifurcation in the export cycle. Half of the container volume is moved out within six hours, while the other half spends 6-24 hours. This means that there is a bottleneck in moving out of the gate as well. On the other hand, the entrance of containers from gate to terminal happens within six hours for about 80% of the volume but still has some reduction potential.

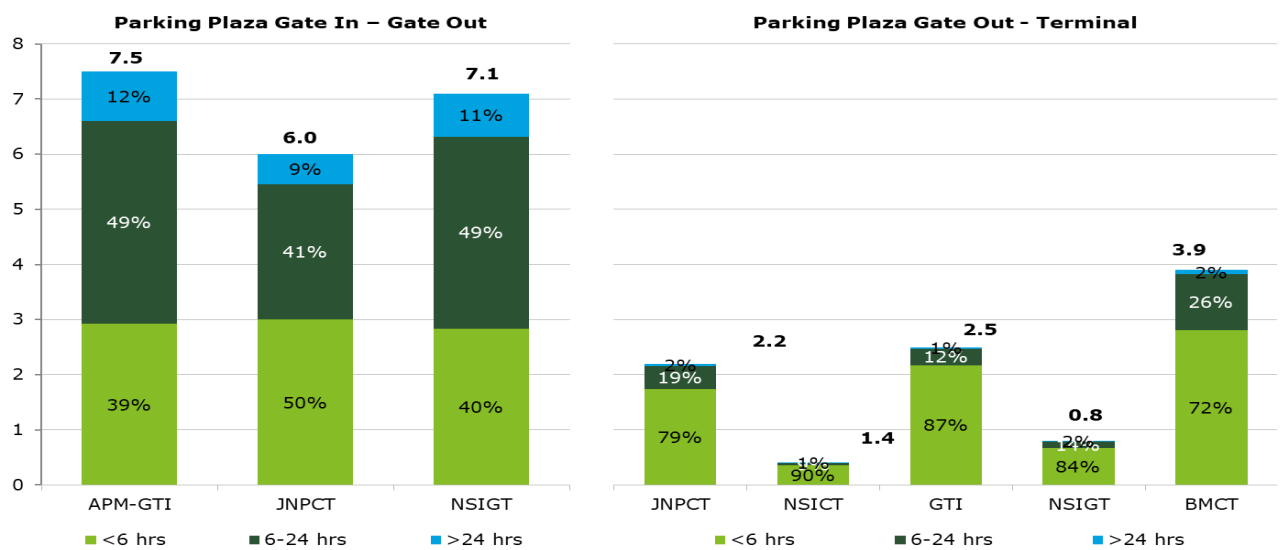


Figure 53: Parking Plaza Dwell Time Analysis (Aug-20, in hrs)⁵⁵

Yard Operations

JN Port’s yard area is discontinuous, and its import and export areas are separated. This leads to delay in operations and restricts the movement of equipment – particularly RTGs.

⁵⁴ Source: (DMIDC Logistics Data Services Ltd., 2020)

⁵⁵ Source: (DMIDC Logistics Data Services Ltd., 2020)



Figure 54: Discontinuous Yard for Import and Exports (retrieved from Google Maps)

Rail Operations

The current rail coefficient of JNPT is very low as compared to the other private ports in India. This is problematic because rail transport is both faster and cheaper than road transport over greater distances. Although most major container ports in India have a low share of rail evacuation, the percentage of JNPT is very low compared to the all India average as well.

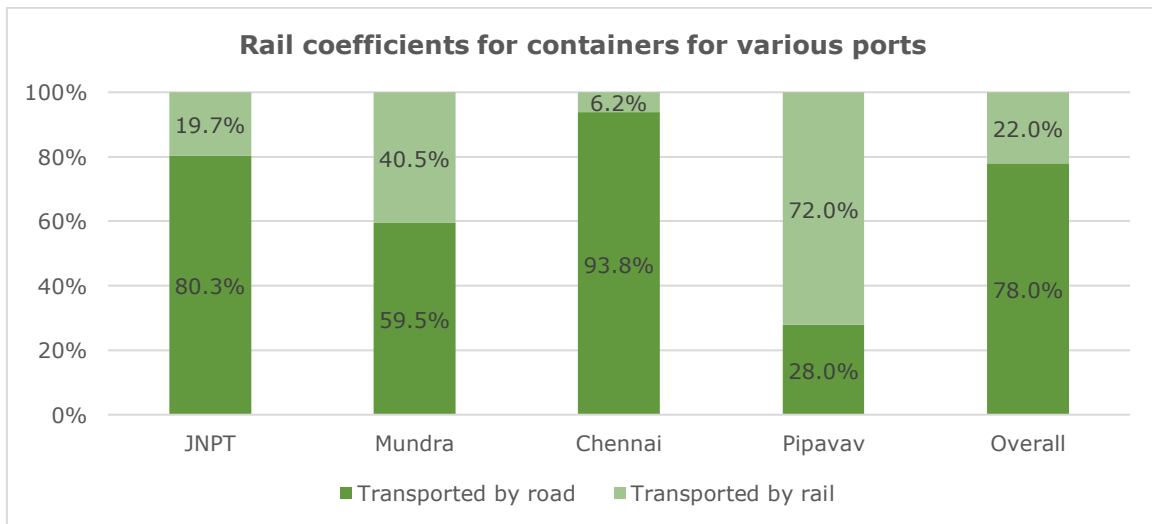


Figure 55: Rail coefficients of ports in India⁵⁶

A major reason for the lower share of rail evacuation at JNPT is the “mixed-rail handling” practice instead of dedicated trains for each terminal. Another reason is the longer dwell time of the containers sent through rail due to the low speed of freight rail movement in India, especially for shorter distances. Since many of the JNPT containers are also sent to the nearby hinterland

⁵⁶ Source: (Ministry of Shipping, 2017)

(including Maharashtra), this leads to a low share of rail for JNPT, thus increasing its costs. Mundra has started its rail line to evacuate containers, thus reducing its dwell time as well.

Currently, JNPT has two separate rail yards and a total of 9 operating rail lines. Both yards are 750 m long and can handle 4-45 wagons with a maximum capacity of 90 TEUs.



Figure 56: Rail Yard at JNPT (retrieved from Google Maps)

However, given the limited number of rail operators, it is possible to lower the turnaround time for rakes with a single line rail line. Containers from different terminals can be aggregated here. Moreover, a longer yard length will allow for longer rakes possible with the DFC, where the rakes could be 1.5 km long. (Financial Express, 2010)

Equipment utilization & productivity at JNPCT

There are significant differences between equipment utilization levels at JNPCT and GTI. JNPCT’s RTGC (RT Gantry Crane) and quay crane utilization level is very low even as its availability is high. This level has fallen more in the past couple of years, even as the overall terminal utilization remains high. This creates a high occupancy gap between the berth and the yard & its equipment. (Ministry of Shipping, 2019)

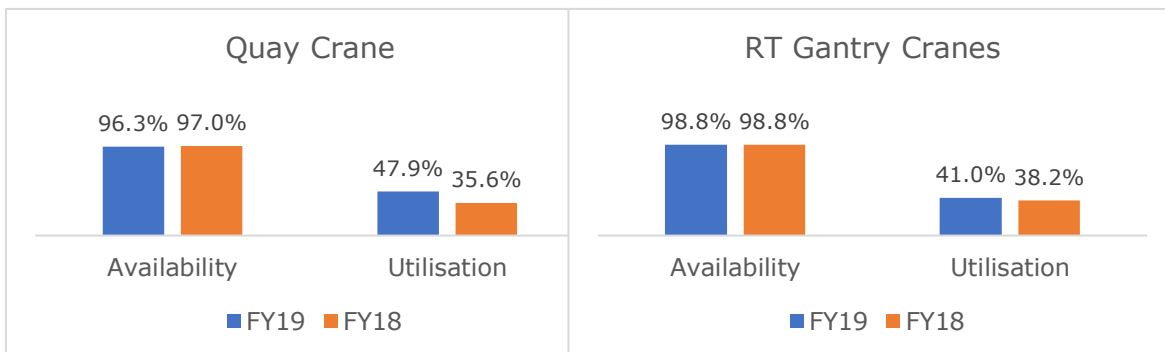


Figure 57: Equipment Utilization & Productivity⁵⁷

The productivity of the equipment at JNPCT is also very low. For example, the average RTGC productivity at JNPCT is six gross moves per hour (GMPH), whereas, in the nearby GTI terminal, it is at 12 GMPH. Increasing the number of moves per hour can result in unlocking more efficient container stacking and movement operations. One of the primary reasons for the low utilization

⁵⁷ Source: (Ministry of Shipping, Indian Ports Association, 2016)

is the separation of import and export yards at JNPCT. This results in longer travel times for RTGCs. The utilization rate also varies across the import and export yards.

The quay crane productivity at JNPT is also very low when looking at the moves per hour. There are stark differences within the port as well. JNPCT operates at 17 crane moves per hour, whereas other private terminals are much more productive at GTI at 26 moves/hour and the DP World terminals at 22 moves/hour. Compared to other private and public ports in India and globally, the difference is even more glaring. JNPT lags behind other government ports in Cochin, Chennai, and Vizag, and far behind the private ports in Mundra and Krishnapatnam. The best in class ports globally like Yokohama or the Port of Jebel Ali in UAE are multiple times more productive than JNPT.

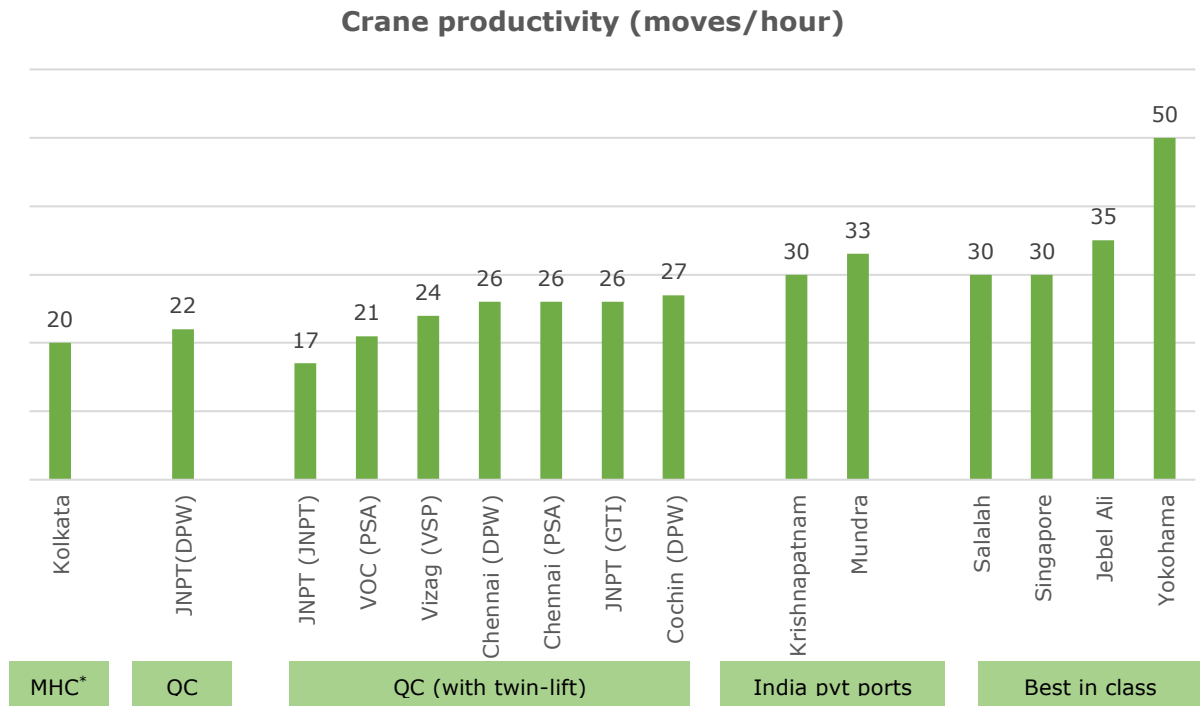


Figure 58: Crane productivity in various Indian & global ports⁵⁸

*MHC = Mobile harbor cranes

Another primary reason is a large amount of non-working time during the day, which arises from work stoppages at shift changes. The three working shifts at JNPCT are 7 am to 3 pm, 3 pm to 11 pm, and 11 pm to 7 am. However, it has been reported that for the shift ending at 3 pm, the shift wrap-up starts at 2.30 pm, with work stopping at 2.40 pm. Work begins again at 3.20 pm, with full productivity only beginning at 3.30 pm. Thus, 60 minutes between 2.30 pm and 3.30 pm are wasted, which repeats for two more shift changes during the day. (Sagarmala)

There are problems with the work assignment and incentive scheme of the crane operators as well. There are no specialized operators for the different types of cranes – quay cranes, RT gantry cranes, etc. Quay cranes are more specialized and complicated and require a higher level of specialization to operate. Currently, no such distinction exists. The crane operator incentives are also linked to the overall terminal productivity and not their own productivity. This creates no incentive for them to improve their skills and target a higher productivity rate.

⁵⁸ Source: (Ministry of Shipping, Indian Ports Association, 2016)

Technological challenges at JNPT

Despite the technological improvements undertaken, JNPT lags behind its Indian peers and global counterparts when it comes to technological innovation. Ports like Singapore and Rotterdam have long employed advanced technologies in the terminals to increase their automation and utilization level.

For example, the Port of Rotterdam has recently increased its productivity by increasing automation. It became the first port globally to utilize remotely-controlled ship-to-shore gantry cranes and supplemented those with 54 Automated Rail-Mounted Gantry Cranes (ARMGs). Wind turbines also power the terminal instead of fossil fuels. These produce no CO₂ and are also considerably quieter than diesel generators used in ports⁵⁹.

The Port of Singapore is planning to become both the world's largest and most innovative port. Expected to handle a volume of 65 million TEUs in 2021, it will feature automated cranes, innovative planning systems, and driverless vehicles. It has entered into collaborations with the National University of Singapore to come up with new port innovations⁶⁰.

⁵⁹ Source: (Shipping & Freight Resource, 2019)

⁶⁰ Source: (Forbes, 2018)

Issues at JNPT

Slow growth in traffic handled by JNPT can be attributed to several challenges in the port. With the increasing containerization of port traffic globally, it is essential to identify and address the issues at one of the country's biggest container ports. Based on the benchmarking and the capacity assessment of JNPT over the past few sections, some key issues have been identified and listed below.

Physical Infrastructure

Terminal Draft

Port operations are predominantly driven by the volume of container/cargo being handled. This is dependent on the size of the vessel that the port can accommodate. This is determined by the draft available at the terminals. The maximum available draft at the port of JNPT is 14m that is less as compared to international ports like Rotterdam (24m), Shanghai (20m), Singapore (16m), etc. This brings in a natural limitation at the volume of operations JNPT can handle. Even in India, the draft is lower as compared to terminals of Mundra and Pipavav, who are competitors in the container segment.

Gangavaram Port in the eastern corridor has built its capacity ahead of demand. Low utilization, increased mechanization, and extensive port infrastructure has allowed it to be more efficient than the neighboring ports. The available draft at the port is 19.5m sufficient, even for Ultra Large Crude Carriers (ULCC) and Very Large Ore Carriers (VLOC).

Quay Length

The port of Singapore has a quay length of 15,500m while it is only 680m for JNPT. As a result, the port has a limited capacity to handle several vessels at a time. If JNPT can handle ten ships simultaneously, the Port of Singapore can accommodate significantly more and bigger container vessels.

Yard Area

The available yard area at JNPT is about 350 hectares (post full commencement of BMCT) while that of Port of Singapore is 600 hectares. Furthermore, land acquisition issues in India imposes a problem of expanding the yard area. JNPT depends on the acquisition of land behind the terminal and is fraught with land acquisition issues and resettlement/rehabilitation.

Operations

Capacity Utilization

Although the overall berth occupancy of JNPT is low, the capacity utilization of multiple terminals in the port is close to 100%⁶¹. In the only private terminal such as BMCT, the utilization is quickly creeping up. A forecasting of the port container demand must be done and future capacity planned as demand grows.

Berthing Time

The working time at berth and idle time of JNPT is very high due to either equipment or personnel unavailability when the ship is berthed.

⁶¹ The capacity utilization of NSICT is lower because of regulatory issues between TAMP and DP World making operations unviable.

Liquid Container Terminal

The pre-berthing delay at the liquid container terminal is too high. Although there are plans for new liquid terminals, there is time for that to become operational. In the meantime, there should be an assessment of how to increase the efficiency of the existing terminal.

Crane Utilization

The current crane utilization and productivity at JNPT (especially at JNPCT) are very low compared to other private and government ports in India, even with high availability. This results in high working time at berth and idle time of JNPT because of the high unavailability of either equipment or personnel when the ship is berthed. The reasons for this must be explored further, and HR interventions to increase productivity must be explored.

Technological Advancement

The current technological level of JNPT and the number of digital interventions are low compared to global peers. Suppose JNPT has to lower its time of operations to as low as other international ports and gain in customer satisfaction. In that case, it must explore a large overhaul of its operations with state-of-the-art port technologies. There are multiple examples of both Asian and European ports that have achieved this.

The manual and human interaction is high, contributing to the high turnaround time of vessels and containers' high dwelling time. Singapore Port is fully automated, showing the significant difference between the turnaround time and making it incomparable. The stevedoring charges are higher due to manual operations at JNPT.

Message Exchange System

There have been numerous breakdowns of the Indian Customs EDI System (ICES) and the Port Community System (PCS). Consequently, this results in time delays hampering overall operations and adding congestion.

There is a need for these systems to be made more efficient to facilitate communication and transactions at the port. These platforms act as single window systems that enable paperless transactions and seamless information flow between various stakeholders.

Scanning Operations

The existing system can scan up to a thickness of 180mm, which is not sufficient for all containers. The process is time-consuming by using existing mobile scanners, leading to delays and generating scanning lists with a lead time of two days.

By these two days, the containers have already moved out to the CFS. When the scanning list is generated, the containers are brought back to the port, entailing a cumbersome process and adding to the congestion.

Container Freight Stations

The monopoly of the shipping line in choosing the private CFS removes the flexibility and transparency of operations. More than 30 CFS are located near JNPT. In practice, the importer has no say in choosing the CFS bringing in arbitrariness and more leverage to the shipping line. This practice requires an urgent check as it adds to the cost for the end-user.

Entry & Exit

Containers arriving at JNPT and other Ports in India have to wait at the gate for a considerable time for the transaction of formalities & congestion. At JNPT, the three terminals do not operate as one seamless terminal. PSA Singapore Port follows a fully automated and paperless process as one seamless terminal with complete horizontal integration.

Customs

Customs formalities have to be completed in the Indian Ports, and duties are collected before receipt/despatch of cargo. In Singapore, the cargo is handled mostly through transshipment, not requiring any custom formalities. The status of Free Trade Zone at Singapore Port further relieves the customs formalities and payment of duty.

Operational Metrics

Port Dwell Time

Port Dwell time is higher for Train bound Export/ Import containers compared to truck containers. This trend exists across all the months, and addressing the same would reduce the overall dwell time at the ports and bring in the efficiency. (Globally best ports have Dwell time of fewer than 24 hrs (Port of Singapore))

CFS Dwell Time

The CFS dwell time is on a higher side, and reducing the same will positively impact the overall trade. The difference between best performing CFS and low performing CFS is higher, indicating that the laggards can catch up with the best performers by streamlining the operations.

ICD Dwell Time

The ICD's provide for minimal demurrage charges at its facility, which is currently enabling the manufacturing companies to prefer to stock their goods at ICDs. However, this is leading to an increase in the dwell time of ICD's. The ICD's dwell time is on a higher side, and reducing the same will positively impact the overall trade.

Promotion of Direct Port Delivery/ Direct Port Export may reduce the overall dwell time across the ports. An attempt has been made for the same, but the operations are not streamlined, leading to high dwell time for DPD containers.

Toll Plaza Travel Time

The average speed between different Toll Plazas is used to identify the locations wherein delays occur, leading to overall high lead time.

Port Area

Discontinuity in Yard at JNPCT

The available yard at JNPCT is discontinuous, separating imports and exports. This results in lower overall efficiency and restricts the movement of equipment.

Road Congestion

There exists a Y-junction at JNPCT near the port gate. The high congestions at the junction limit the inter-terminal movement. Further addition of a new terminal, the expected traffic is further going to increase. Traffic jams of a km have also been observed at the port, affect the turnaround time. This impacts the overall costs of the traders.

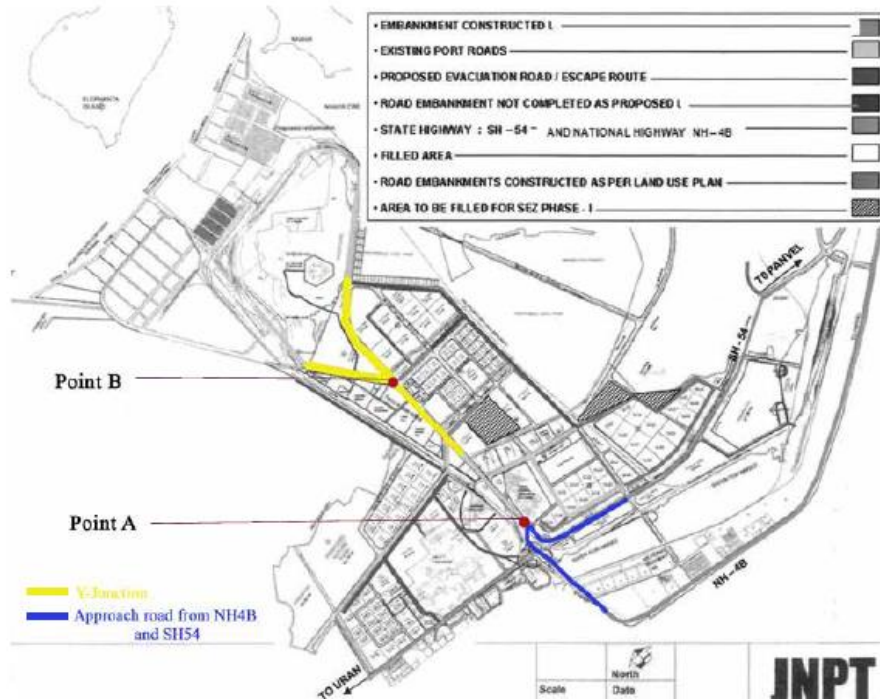


Figure 59: Congestion at the Approach Road (Y-junction)⁶²

Rail Yard Operations

The current rail yard operations of JNPT are inefficient due to the separated yards and mixed-rail handling practice. Although things should improve with the advent of the Western DFC, JNPT must explore other methods of enhancing the efficiency of rail operations at the port as well. It is important to note that JNPT has a significantly low rail coefficient. As a result, the traffic of northern hinterland is lost due to competition from Gujarat Port. The coverage area of JNPT is getting restricted to the central and western regions.

Increased time consumption in stacking and de-stacking containers as per terminals at the rail yard due to paucity of equipment leads to increased train turnaround time.

The root of this issue lies in the contract between the port and the contractor pertaining to revenue share. For instance, the contractor's revenue share from two cranes would be much lower than if he used four cranes. This reduces the efficiency of container evacuation from the rakes, increasing the train TAT. With more number of cranes, train TAT can be reduced to 4 hours.

Handling Bulk-Break Cargo

The port doesn't have a full facility for handling multi-purpose break-bulk cargo. At JNPT, only transit sheds are available, and warehouses are not permitted. This increases handling and storage costs. At Singapore (PSA, Jurong), Multipurpose terminals with ample storage and warehouses exist in continuation to the berth for stacking of cargo on a short and long term basis.

Regulatory

NSICT & NSIGT – DP World

The major port in India are governed through Port Trusts, and tariff charges are decided by a common authority Tariff Authority of Major Ports (TAMP). NSICT is bound to pay a fixed amount

⁶² Source: (Bureau of Research on Industry and Economic Fundamentals (BRIEF), 2016)

for every TEU handled due to the concession agreement. TAMP slashed the rate in 2012 that made the operations unviable at NSICT. As a result, NSICT has been deliberately diverting the volume to NSIGT after meeting the minimum requirement of 6 lakh TEUs. Hence, there is a need to provide an incentive to NSICT to revive operations.

Dual Role

In India, ports play both commercial and regulator roles. On the other hand, Singapore Ports and Terminals operate purely on a commercial basis as corporate entities, and the Port Terminal operator does no regulatory function.

Competition

Competition from Gujarat Port & Private Players

Apart from JNPT, the other big container ports are the Mundra and Kandla Port, known for their efficient operations. As a result, the market is getting competitive, and the volume attracted by JNPT is at stake.

The Adani International Container Terminal at the Mundra Port has an installed capacity of 30 lakh TEUs. At capacity utilization of ~64%, the terminal has shown a CAGR of 23.4% from FY14-15 to FY18-19. AICT has achieved VMT Driven terminal operations entirely. It also Implemented Remote Terminal In-gate, upgraded its Terminal Operating System from ACTOS to IPOS, and initiated E-ITV for terminal operations. It is a transshipment hub for the Middle East, South Asia, and India. Due to its deep draft of 17 meters, it is capable of handling Ultra-large container vessels.

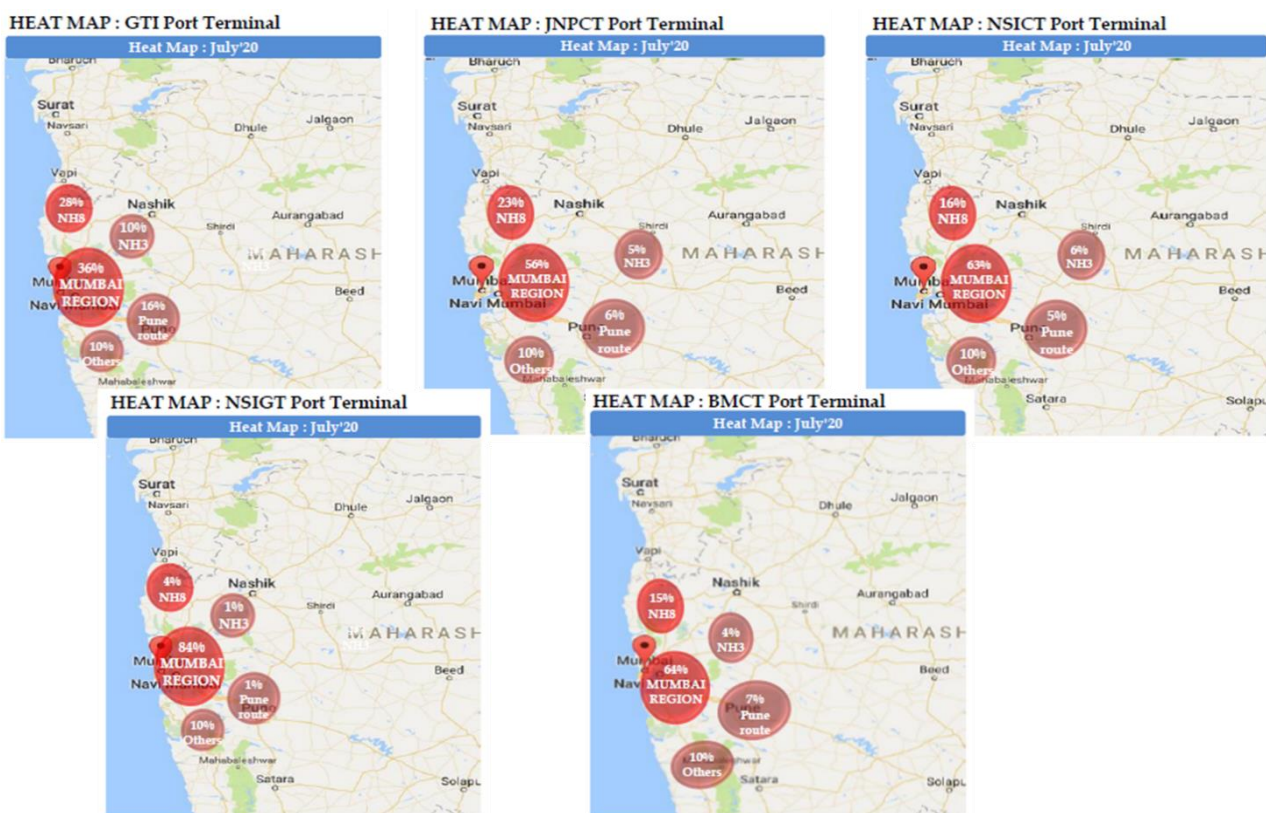


Figure 60: Container Movement around the JNPT Port Terminals region via Truck⁶³

⁶³ Source: (DMIDC Logistics Data Services Ltd., 2020)

Kandla International Container Terminal is a new terminal recently commissioned in 2016. While the volume handled is low, the growth rate is high. This terminal remains the first choice for most EXIM cargo that gets stored at Gandhidham due to its proximity. This terminal also performed positively in terms of efficiency parameters as it has recorded an average turnaround time of 1 day with a growth of 2.73 percent, average output per ship berth day is 932 TEU's with a gain of 28 percent, and average crane productivity is 30.66 moves per hour with a growth of 4.96 percent.

JNPT is already losing its volume from the northern hinterland against these Gujarat ports. Additionally, the most awaited infrastructure project, the Dedicated Freight Corridor is expected to reach the Gujarat terminals a year before it reaches JNPT. Moreover, the rail coefficient for Mundra Port is 25.8%, and Pipavav is 67%. Hence, the DFC is going to give a major boost to their operations and put JNPT in a difficult position.

Improving Operations at JNPT

The global movement towards containerization of trade and high-volume flow of containers through JNPT, it is necessary to address the issues and improve operations. While the port is already in the phase of increasing its handling capacity, it also needs the current facilities to operate efficiently and avoid operational bottlenecks, which would result in users drifting away from the port. The present section provides possible remedial measures that can be implemented by JNPT or already under implementation.

Infrastructure Interventions

Given the location-specific issues at JNPT, as addressed in the section above, the port authorities need to undertake some capex heavy investments to augment capacity and benefit in the long term in managing operations and attracting volume.

JNPT Yard Restructuring

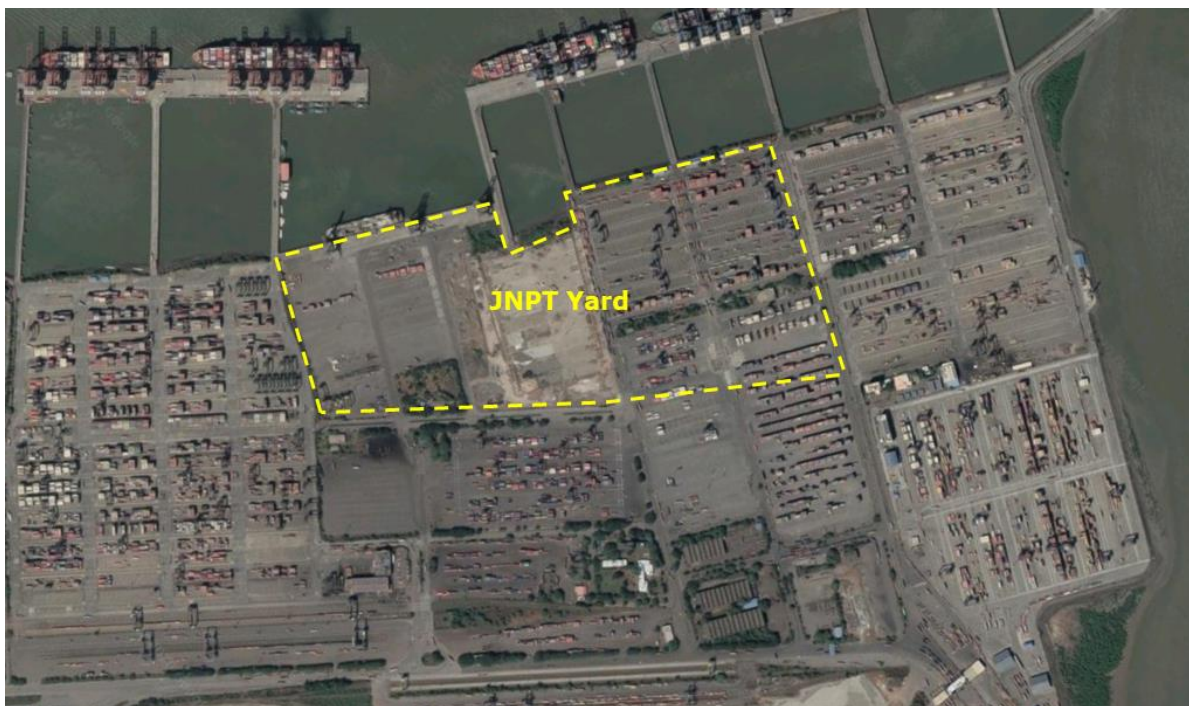


Figure 61: An integrated yard for JNPT⁶⁴

The JNPT import & export yards must be integrated for a continuous area and ensure the equipment's free movement. The RTG cranes, which earlier took hours for transportation between the yards can now move freely. Subsequently, their operations can also now be planned more efficiently, and hence, productivity will increase. The restructuring will also allow for optimum utilization of the yard space. Currently, there are about 6,500 ground slots in the JNPT yard. To account for future demand and growth, around 9,500 ground slots are required. This must be kept in mind while planning for the yard space. However, this problem will be partly solved with optimum utilization of space as the yards are combined. Space must also be accounted for widening the internal roads and facilitating the trucks and RTGs' movement in the yard. To achieve the integration, there must be a negotiation between adjoining yards GTI and NSICT. However, given that this creates a continuous yard for all the terminals and opens up more space for common roads to the rail yard, this would be beneficial to all the terminals and would be easier to drive the bargain. More common space for movement will improve circulation for all the terminals in the yard and improve access to the rail yards.

⁶⁴ Source: (AECOM India Private Limited, 2016), Google Maps

Common rail yard

The four older container terminals in JNPT – JNPCT, GTI, NSICT, and NSIGT should have a combined rail yard instead of two separate ones. This will enable the aggregation of all the containers from various terminals into one location that can then be processed together and allow for the longer Western DFC rakes that will come up soon. The combined rail yard could be structured as follows -

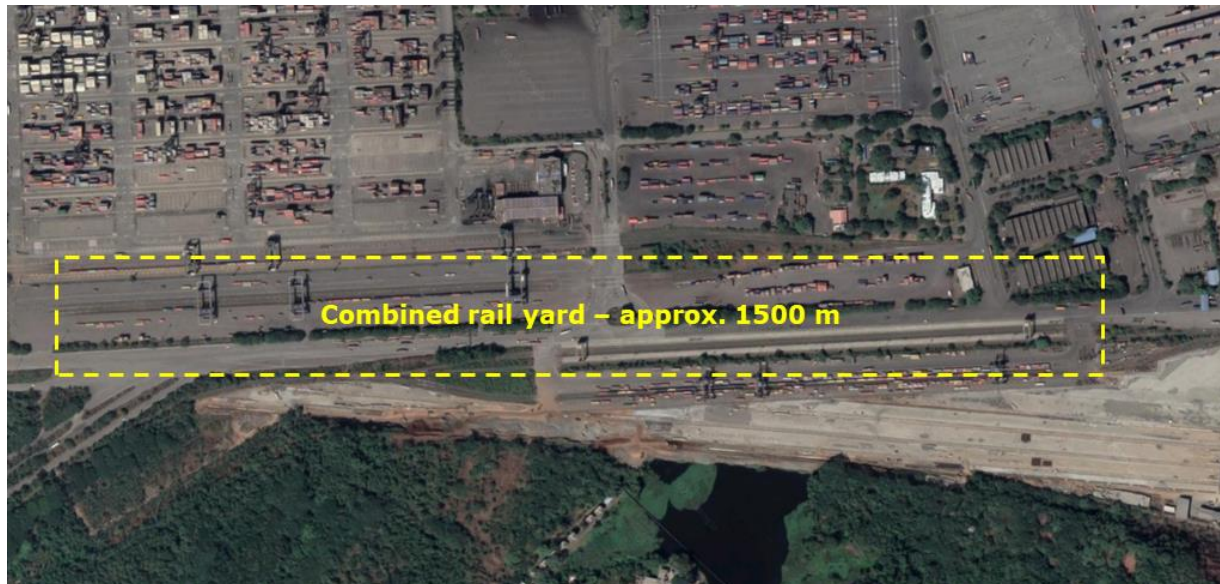


Figure 62: Potential combined rail yard for terminals⁶⁵

The new combined rail yard should have these capabilities –

- i. A large number of stacking space and ground slots for storage of containers from the four terminals
- ii. Facilities for loading and unloading on the DFC rakes which will be around 1400 m in length
- iii. Roads alongside for the movement of trucks and internal transfer vehicles (ITVs)
- iv. Rail-mounted gantry cranes (RMGCs) and RTGs for quick loading and unloading of containers and reduce the turnaround time
- v. Changeover points in the track for handling to smaller non-DFC rakes at the same time

The number of ground slots required at the combined yard will increase with both the total capacity handled by the four terminals and the port's rail coefficient. It can be safely assumed that the rail coefficient of the port will rise as the DFC is connected for operations; it becomes both cheaper and more efficient to transport through rail. The total number of ground slots required then depends on a few factors – namely, the total container capacity handled by the ports, the rail coefficient, the height of stacking containers (number of containers stacked in one slot), the dwell time of the containers, and the operational factor (share of ground slots not to be stacked to full height). The allocation of ground slots will vary with how long the port aims for the dwelling time of containers. Dwell time in the rail yard can be reduced if the containers are stored in the shipyard till the rakes are scheduled to be loaded. However, this will also require more operational efficiency of labor and other equipment – trucks, RTGs, etc. to ensure the containers are reached on time for loading. Otherwise, it'll cause a delay in the container movement of all other terminals. Longer dwell times in the rail yard will require a larger number of ground slots.

⁶⁵ (AECOM India Private Limited, 2016), Google Maps

Table 6: Ground slots required at combined rail yard for increasing rail coefficient⁶⁶

	Rail coefficient 20%	Rail coefficient 30%	Rail coefficient 40%
Capacity of existing terminals (TEUs/annum)	5,000,000	5,000,000	5,000,000
Rail coefficient of terminals	20%	30%	40%
TEUs moved through rail	1,000,000	1,500,000	2,000,000
Height of container stacking	5	5	5
Number of ground slots	200,000	300,000	400,000
Number of working days	350	350	350
Number of days of storage (dwell time in rail yard)	2	2	2
Number of containers moved every day	1,142.9	1,714.3	2,285.7
Operational factor	75%	75%	75%
Total number of ground slots required	1523.8	2285.7	3047.6

Expansion of the Liquid Terminal

Given the increasing demand at the liquid terminal of JNPT, it is essential to expand the capacity of the terminal. There are two independent ways of doing this – either increasing the existing liquid jetty or developing a new jetty on reclaimed land at the terminal. Both have their advantages and disadvantages, but any developments planned will have to cooperate with the new PSA terminal since any movement will be through the shallow waters also used by their terminal. The two available options are –

Extension of the existing jetty

The first method would be to extend the current jetty at the liquid terminal. This will allow for the berthing of either one or two more tankers on the side opposite the PSA terminal. There'll be the need of either 150m or 300m of the jetty depending on if they're planning to berth one or two tankers. In either case, JNPT will have to consult with PSA to ensure that this will not disrupt their operations since they'll be encroaching on the waters used by BMCT. This will also be the most cost-optimal solution since the capex investment apart from the jetty extension will be relatively low. The only other infrastructure investment would be to lay new pipelines and connect them to the existing infrastructure.

⁶⁶ Self-calculation, formulae referenced from (UCTAD, 2012)



Figure 63: Option to extend the liquid terminal jetty

Construction of a new coastal berth

The second option is to construct a new coastal berth on reclaimed land right opposite the existing liquid terminal. According to calculations by a consulting firm (AECOM India Private Limited, 2016), the new coastal berth can provide an additional capacity of around 1.3 MTPA for edible oil and chemicals.



Figure 64: Option to build a new coastal berth

Easing Road Congestion

To handle the current and the potential increase in traffic, projects for easing congestion comprising infrastructural and operational measures may be the way forward. It has already been recommended to JNPT in BRIEF, and Sagarmala reports to construct flyovers at the Y-junction to ease separate entry to terminals and inter-terminal movements. Furthermore, widening of roads and creating larger parking spaces to shift traffic from road to terminal-specific parking. The trucks can wait at the parking lots for document completion and vessels to arrive. However, careful planning and controlling need to be done during construction as it will be an irreversible and inflexible project, with high capital investment.

Increase draft

As depicted in earlier sections, the 14m draft of JNPT is not suitable for mother vessels, requiring an 18m draft. The demand for dredging is important at JNPT to drive the EXIM capacity, draft maintenance, and compete against rival ports with a high draft. A limited draft is a perennial issue at all major ports. The government may also explore allowing more private players to undertake operations instead of burdening Dredging Corporation of India.

Inter-Terminal Movements

Presently, the inter-terminal truck movement for exports is not encouraged. There are three separate gates for entrance to the three terminals at JNPT. There are instances when the entrance to a particular terminal is congested, while the other two are free. In such situations, the entry of trucks can be allowed through either of the remaining two gates. This would significantly ease congestion at the port gate.

Construction of flyovers should reduce not only congestion but also allow easy inter-terminal movements. It is essential to manage inter-terminal traffic to avoid congestion. In the absence of the same, direct inter-terminal transfers can be temporarily banned until the yard re-design is completed. Traffic management is required across yards. Proper road signs and monetary fines for traffic violations shall be implemented across all terminals to streamline truck movement.

Centralized Parking Plaza

As discussed earlier, a large centralized parking plaza is required to transfer the traffic from roads to the parking area. The integration of customs in the parking area can help in utilizing the time for documentation. JNPT is already taking up the measure to some extent.

North Anchorage

The northern anchorage area can enable lighterage operations for transferring cargo to the Mumbai port and provide space for waiting of the ships. This would reduce sailing time and increase overall occupancy and throughput.

New Terminal in future

Given the exponential increase in the BMCT terminal immediately after commissioning, JNPT, in the future, can also look for an additional terminal for capacity expansion. A potential location for the terminal is depicted below.



Figure 65: New Terminal Location

The location does provide an opportunity for a continuous quay. However, the cost of dredging, access to the area, hydrodynamic conditions, and planning for rail and road connectivity also needs to be planned beforehand.

Another way is to create new small terminals in Nhava creek. The existing terminals can be dredged for greater depth and only handle large vessels.

The presence of Elephanta caves (UNESCO Heritage) and large forest areas also poses issues from the Ministry of Environment & Forests.

Operational Efficiency

JNPT also needs to look at some of the operational parameters to fasten the current process in place and augment effective port capacity. Adopting the state-of-the-art facilities used by the best ports in the world, there are several ways for JNPT to improve its scale of operations.

Improving crane productivity

As discussed in the previous sections, JNPCT cranes currently operate at a very low-efficiency level, resulting in long ship berthing times and overall low productivity of assets. Analysis by a consulting firm on the productivity of cranes has shown that increasing the crane productivity at JNPCT from the current 17 moves per hour to 25 moves per hour will increase profits by around 80 crores per annum. A survey by the same consulting firm also shows that the availability of berths and turnaround time/productivity are the two key areas where JNPT currently lags behind Mundra.

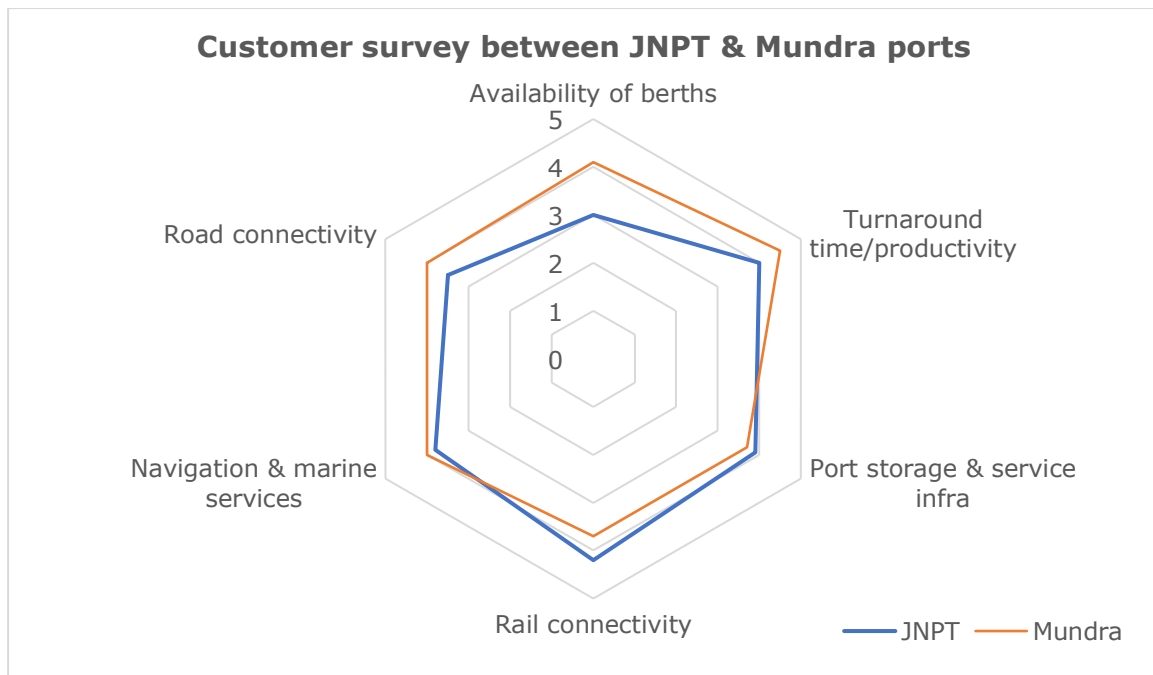


Figure 66: Customer survey comparison between JNPT and Mundra ports⁶⁷

The possible solutions to increase the productivity of cranes could be –

Minimizing shift change losses

JNPT currently faces huge productivity losses during shift changes of operators. Given the ~30 minutes shift operators take to wrap up at the end of their shift, and the ~30 minutes the new operator takes before ramping up, around one hour is lost for every shift change and a total of around three hours in a working day⁶⁸. This needs to be reduced with better work planning and shift change allocations. Some possible solutions could be –

- **Advance operator deployment**
Any leaves taken by the operators (except medical emergencies) should be communicated to the shift in charge at least two days in advance to make alternative arrangements. Moreover, the operator taking over after shift change must report at least 10-15 minutes before his/her shift starts.
- **The flexibility of hours to handle delays**
In case the next operator is delayed, there must be enough flexibility in the system for the current operator to continue for up to a half-hour
- **Enforce strict rules for shift changes**
The log-in/log-out times must be strictly supervised, and the exact reason for time loss must be figured out and plugged. The monetary impact of the time loss must also be evaluated.

Increase ratio of twin-lift crane moves

Twin-lifts are crane moves that lift or place two containers at the same time. They can be carried out at terminals where the share of 20 feet containers is high. The percentage of such containers at JNPT is around 50%. All nine quay cranes at JNPT are equipped with twin-lift capabilities with a maximum capacity of approximately 50 tonnes⁶⁹. Hence, there

⁶⁷ Source: (AECOM India Private Limited, 2016)

⁶⁸ Source: (AECOM India Private Limited, 2016)

⁶⁹ Source: (AECOM India Private Limited, 2016)

is sufficient potential at JNPCT to move to twin-crane movements, and its potential must be explored. Some recommendations would be –

- **Identify and segregate potential twin-lift containers**
Given the total lifting capacity of the quay cranes at JNPCT limited at around 50T, there is a need to identify the 20 feet containers with a weight of less than 25T. The share of such containers in JNPCT is about 70% after accounting for the ones with weight very close to 25T, which shouldn't be operated this way due to operational risks.
- **Yard planning**
There is a need to store the containers appropriately to be lifted onto trucks when needed for the picking up and dropping off of the identified & segregated containers.
- **Crane stowage planning & monitoring**
Proper instructions must be given to the operators to ensure twin-lifts. Moreover, the number of twin-lifts actually performed vs. the potential must be tracked regularly and ensured that the targets are being met. The analysis must also be conducted to determine where the leakages are happening so that the planning process can be improved.

Improve operator incentive scheme

There is an insufficient focus on individual operator productivity at JNPCT. Variable pays are linked to the overall terminal profitability but not individual operator productivity. This does not induce enough incentives for the operator to work at their full potential. There is also a high variance of the level of skills between operators and a lack of specialization between the types of cranes operated⁷⁰. Consequently, no specialized quay crane operators require a higher level of skill than other cranes. Some recommendations would be –

- **Regular assessment**
There must be a regular assessment of the crane operators at least at an annual or bi-annual level to determine their competency level based on the average crane movements. The new operators must be tested to determine their level of skills before they're assigned to operations, and a minimum skill level of 27-30 moves per hour must be required for them to start operations.
- **Focus on low performers**
The clear focus of the management must be to improve the performance of low performing crane operators. They must be removed from the deployment roster for fixed periods (2-3 weeks) and retrained to increase efficiency and reduce cycle times.
- **Performance linked pay**
After a certain duration of this new scheme has been introduced, the terminal must link the crane operators' variable remuneration to their efficiency. Benchmarks must be set up for each type of crane (and not just quay cranes), and a steeper % of base pay must be applicable at the target rate (eg., 50% of the variable pay only stepping in after 27 crane moves per hour and rising rapidly after that)

⁷⁰ Source: (AECOM India Private Limited, 2016)

Port Entry & Exit

Fixed scanners for trucks entering the gates for easy pass-through and speedy clearance of cargo. There are instances where the container is called back from the CFS, which increases the dwell time and incur extra costs. Per hour output of a fixed scanner is comparatively much higher and therefore is expected to be an important alternative, given the growth in traffic at the port. Mobile scanners scan at 20 trucks per hour while fixed scanners have a throughput of 30-180 trucks per hour.

At Port of Singapore, a unique "Flow through gate system" introduced in 1997 permits the trucks to enter the Port terminal within 25 seconds. By this method, about 8000 trailers are handled per day at an average of 700 trailers per peak hour. It is a fully automated and paperless process and is linked electronically to the Port's computerized system⁷¹.

Color Coding of Containers

Random stacking of containers at the yard leads to delays in container movement while evacuating. The ICDs should send containers based on terminals, preferably with color-coded stickers on containers, to enable quick stacking of containers at the respective terminals⁷². The color coding can also help in having a large common entry and exit gate instead of terminal wise. This will aggregate the overall traffic and reduce congestion. Situations where one gate is idle while the other gate is congested, would not occur.

RFID Gates

Today, containers are tracked via radio frequency identification (RFID). Similarly, the installation of RFID tracking at the terminal gates can help in easy tracking, quick entry-exit, and reduce congestion. This is also a security measure and monitoring system for check-in and check-out time of containers.

Documentation

A container involved in export and import goes through various charges and involved documentation at every stage. Hence, digitization of activities and obtaining all approvals such as e-invoice, e-payment, e-delivery, etc. beforehand in electronic form can help in the early clearance of cargo and reduce processing costs. JNPT is already under the process of digitization by establishing a logistics data bank to facilitate seamless communication without the need for hard copies. The idea should be to make JNPT a hassle-free one-stop shop for all shipping requirements (Appendix 7).

Direct Port Entry and Exit have now been implemented to JNPT so that containers move directly to/from the consignee warehouse without routing through CFS to get customs approval. The dwell is currently high for DPD/DPE containers but is expected to reduce and free space at the CFSs.

At Port of Singapore, the EDI platform ensures there is no paper transaction. The EDI platform enables ordering of berth and pilot services, documentation, inquiry and tracking, linkage to Govt. and Port authorities' systems, and Port Users existing system, billing, etc. Typically, planning begins 72 hours before a vessel arrives when a shipping line applies for a berth and files the stowage plan and connection instructions.

Free Trade Areas

Bigger ports like Port of Singapore and Port of Shanghai have free trade area for trans-shipment and free of customs. The creation of such facilities can help make JNPT (and India), increase trade, and attract more container volume.

⁷¹ Source: (Planning Commission, July 2007)

⁷² Source: (Bureau of Research on Industry and Economic Fundamentals (BRIEF), 2016)

Electronic Data Interchange & Port Community System

As ports are gateways to international trade, they face new challenges in meeting the demands for sophisticated data communication solutions. Customers and trading partners expect ports to have the most sophisticated data technology available for moving data around the terminal / berth. An integrated Port Community System is intended to integrate the electronic flow of information across all trading partners involved in the maritime transport chain through a common interface. This internal automation will function as the centralized hub for all Major Ports of India and other stakeholders like Shipping Lines / Agents, Surveyors, Stevedores, Banks, Container Freight Stations, Government Regulatory Agencies, Customs House Agents, Importers, Exporters, Transporters etc. for exchanging messages electronically in a secure manner using the latest technologies⁷³.

Digitization at JNPT

JNPT is trying to improve its operational efficiency by digitizing its operations and moving to equipment-based efforts wherever it was earlier, relying on manual labor. There have been some improvements in its operational metrics through these efforts. Primarily, its turnaround time is reducing due to reduction berthing time, and its second-order effect is the reduction of the pre-berthing detention time of ships. It has driven these efforts with the more prevalent use of widely used equipment like electric RTGs, container traceability, vehicle management systems, etc. However, using these technology efforts, JNPT can only reach the middle-order of advanced ports globally. If it needs to increase its efficiency to the extent of the most advanced ports globally – Rotterdam, Shanghai, Singapore, etc., it needs to get on the next stage of port digitization that these ports are targeting. It'll lead to a quantum jump in the efficiency metrics of the port. A case in point is the Port of Hamburg, which aims to double its capacity without doubling the amount of land area it has through modern transport & communications systems⁷⁴. This section explores the digitization strategy that JNPT can adopt and the technologies it can use.

Need for a smart stakeholder-based port technology

Today, ports have become intricate partner-based systems that involve stakeholders from across the value chain – from shipping lines, port authorities, terminals, logistics companies, and labor providers. To make any port technology successful, there needs to be a careful integration of the technologies used by each of these players and that being adopted by the port. These technologies must enable the increase in efficiency of the port through seamless information sharing. Moreover, the stakeholders must use the technology without significant changes in their current software or any port equipment. Therefore, the port needs to have a platform-based system where other port technologies can be integrated.



Figure 67: Port technology platform needs to integrate stakeholders across the value chain

⁷³ Source: (Planning Commission, July 2007)

⁷⁴ Source: (Port Strategy, 2015)

The technology also needs to integrate information from a range of port equipment and machinery. It must utilize industrial internet-of-things (I-IoT) based systems to gather data from across the port and seamlessly transfer it to the platform for the use of the stakeholders. The data will be collected from –

Infrastructure

Smart I-IoT sensors will help the port & terminals track, seamlessly operate and maintain the infrastructure used. Embedded sensors in quay walls, railway tracks, roadways, etc., will transmit real-time information on the port's condition and avoid the need to shut the port down for inspection or regular maintenance. Instead, preventive maintenance can be done where and when required.

Cargo handling

Sensor-based monitoring systems can ensure that the cargo handling equipment (cranes, RTGs, forklifts, etc.) operate at peak efficiency and can be monitored remotely. The data gathered will also help benchmark the operations in more detail and provide information on where the bottleneck in the operations is. It will also help in the preventive maintenance of the cranes, thus ensuring that the cranes do not break down during operations and waste the critical time of ships. The Port of Valencia experimented with a sensor-based technology and installed “black-boxes” (akin to flight records) in their cargo handling equipment – cranes, forklifts, trucks, etc. This system records data from the equipment, undertake processing, and reports the bottlenecks in the system to the central control room. The prototype developers estimate that they can reduce equipment idle time by ~10% using these technologies⁷⁵.

Intermodal traffic

Ports & terminals need to implement solutions to reduce the lag time between dropping off and picking up cargo by coordinating with logistics providers (trucking & rail services). The Port of Singapore is experimenting with an automated traffic monitoring system that employs sensors at key areas to track truck & container movement and notify logistics operators where and how to reach to drop off or pick off cargo. As a future initiative, they're also working on an autonomous driving technology for trucks⁷⁶.

Customs & clearances

Customs is a crucial area where containers flow is broken, and the dwell time increased. Customs clearances have come a long way in Indian ports. JNPT itself is moving to a paperless method of customs clearance and has brought down the customs times in the past. However, more advanced ports, for example, in Europe, Singapore, and China, are experimenting with block chain technologies to lower the customs clearance times. This will ensure that the record maintenance is efficient, inexpensive, and transparent throughout the value chain⁷⁷.

Environment

Digitisation can also help ports save energy consumption and reduce waste. Ports globally utilize smart illumination tech to ensure that energy isn't wasted in lighting up areas that aren't in use. The Port of Valencia reduced its energy consumption by 73% in a pilot using a dynamic lighting system combined with LED technology. This installation paid for itself in under two years through the energy savings⁷⁸.

⁷⁵ Source: (ShipTechnology, 2019)

⁷⁶ Source: (JOC, 2017)

⁷⁷ Source: (WCO News, 2017)

⁷⁸ Source: (Valencia Port, 2015)

Developing a digital strategy for JNPT

The technological needs of every port are different. They depend on the size, type, level of maturity, competition, and focus of the port. The tech strategy of the port must also be in sync with the needs and overall strategy of the port. A study by Boston Consulting Group (BCG) in 2018 categorizes four different kinds of ports according to their needs and the corresponding applicable solutions for them⁷⁹. These are –

Table 7: Categorization of Ports

Type	Focus	Applicable solutions
Emerging port	Ease of doing business	<ul style="list-style-type: none"> • Port community systems • Single-window solutions • X-ray scanning • Biometric access control systems
Local trade hub	High productivity	<ul style="list-style-type: none"> • Smart cargo-handling systems • Equipment management & control • Gate automation • Safety management solutions
Intermodal gateway	Optimized traffic across transport modes	<ul style="list-style-type: none"> • Truck appointment systems • Traffic-monitoring systems • Integrated rail and barge platforms
City-based port	Minimized impact on surroundings	<ul style="list-style-type: none"> • Asset health monitoring • Environment and energy • Management systems • Port-wide platforms

Their needs are defined as –

Emerging ports

These are in rapidly developing economies, which are building new ports to cater to the increasing amount of cargo being traded. These ports aim to keep up with the growing demand and, at the same time, overcome the limits of a legacy port. By adopting new technologies, these ports can integrate with and come into the league of more global ports and become easier to work with.

Local trade hubs

These are the established ports in the developing economies, which are the hub for the movement of goods to and from the country. These ports target being competitive enough to increase the competitiveness of local exports. They also have to deal with the increasing amount of trade from and to the region. It is also essential for the ports to maintain an efficient link with the hinterlands to keep the time and costs low.

Large intermodal gateway ports

These are large ports in developed markets (eg., North America, Europe & China) that transport large cargo from and into hinterlands. Most of these are located on high-volume trade routes and handle ultra-large vessels combined with the complexity of intermodal goods movement, leading to high trade costs if not managed efficiently.

City-based ports

These ports deal with the dual challenge of both handling large volumes of cargo and being conscientious towards the environment. They must combine operational efficiency with environmental and ensure that the level of pollution and traffic is kept to the minimal

⁷⁹ Source: (Boston Consulting Group, 2018)

possible level. In the end, they must ensure that the port and the cities can co-exist in a sustainable manner.

To categorize JNPT into just one of these is tricky. JNPT has the distinct advantage of not being a city-based port but still operates in the greater Mumbai region. Still, the other categories for JNPT are hazy since it's such a rapidly evolving port. It is a large port in a rapidly developing economy competing with the up and coming private ports in the country. Therefore, it is undoubtedly an emerging port for the Indian subcontinent and South Asian region. Its share of cargo is increasing rapidly but is already integrated with the global cargo ecosystem. However, in recent years, it has been trying to implement the technologies mentioned by BCG –

Port community system

After initial hiccups, JNPT has implemented a pilot port community system PC1x, which is aimed to improve the fluidity of cargo movement. This system will connect the various stakeholders from shipping lines to transportation providers and longshore workers and attempt to reduce the dwell time of containers⁸⁰.

Single window solutions

In the last few years, India has also tried to implement single window systems for customs clearances at various ports. This was conceptualized in 2016, and Jawaharlal Nehru Customs House has been working with the Central Board of Indirect Taxes and Customs (CBIC) to implement these systems. Multiple programs are being run in other Indian ports as well⁸¹.

X-ray scanning

JNPT has now begun installing x-ray scanners at four JNPT terminals to reduce the scanning time of containers. These drive-through scanners have the capacity of close to 100 containers per hour and will prevent the time wasted in manually checking containers.

Biometric access control systems

JNPT has begun mandating Biometric Seafarer Identity Document (BSID) in August 2019, becoming the first country in the world to do so⁸².

JNPT needs to move forward with the technological improvements to become more competitive. It is a local trade hub for India. A huge share of India's container movement passes through JNPT, and the competitiveness of Indian exports rests partly upon the operational efficiency of JNPT as well. Thus, it has to maintain an efficient link with the Indian hinterlands to ensure that the trade cost of imports and exports is as low as possible. It is also a large intermodal gateway port at the same time. Being the primary container port of India, it has been integrated with multiple modes of freight transportation – road, rail, and now inland waterways. As it aspires to be a competitive global port in the South Asian region, it must ensure that it aims to be as technologically advanced as the large ports in the developed markets. Thus, JNPT has to look across the technological needs of each of these stages of progress and correspondingly formulate a digital strategy for itself.

To recommend a digitization strategy for JNPT, we have conducted a comprehensive literature review. We come across a report which recommends a five-step process for

⁸⁰ Source: (JOC, 2019)

⁸¹ Source: (CBIC, 2020)

⁸² Source: (PIB, 2019)

developing a smart-port technology strategy. This BCG report outlines these five steps below. Some JNPT specific solutions could be –

Link the smart port strategy to the overall port strategy

A port's digital strategy doesn't exist in a bubble. Instead, it has to coexist with the overall port strategy to improve the bottom line, increase market share, use data-based tools to provide additional services, etc. The port must analyze its overall strategy and then find a tech strategy to be the perfect fit. Accordingly, JNPT must define what its current strategy looks like. It is India's primary container port but is facing intense competition from private ports like Mundra, which have recently come up. Moreover, given its location advantages in the Indian Ocean, it has the potential to become a global port as well and compete with the likes of Shanghai and Singapore ports.

It must benchmark itself with its competitors regarding both commercial and operational metrics at a container level. Since our benchmarking has shown that the container handling time in the port for JNPT is much higher as compared to other Indian and international ports, one key component the strategy must be to become the leader in operational efficiency in container movement.

Identify the pain-points in the process that smart port technologies can fix

Once the broader strategy is understood, JNPT must pinpoint the exact source of the problems and the potential fixes. The problems could either be structural – relating to the equipment and infrastructure employed, behavioral – pertaining to the port users or workers, or policy-related – either specific to JNPT or India's broader port policies. The tech solutions must then be specific to the problems identified.

Most structural policies originate from either the lack of equipment at the terminals or its inefficient use. For example, JNPT suffers from high dwell times due to inefficient allocation of trucks to container movement. This can be fixed with GPS based solutions and central tracking software which allocates truck movements properly.

Behavioral problems are slightly more challenging to fix as they result from how the port workers behave. For example, in the JNPT terminal, there are sufficient quay cranes with enough uptime. Still, they are being used inefficiently because there aren't enough incentives for the crane operators to improve their performance. One solution could be to link the variable pay of the operators with their crane moves per hour. This can be enabled by installing I-IoT-based solutions and connecting the data collected to a central database.

Generate a portfolio of possible solutions

After identifying the causal problems in the port, the next step would be to construct a portfolio of possible tech solutions for the same. A possible solution of reducing traffic congestion at key bottlenecks could be through digital solutions. The range of solutions could vary from road sensors that track utilization of the infrastructure & report back the data to the port authorities to GPS systems installed in trucks. Both could be clubbed with an algorithm to allocate movement of trucks and reduce traffic.

An essential step in building this portfolio of solutions would be to research what other ports have done worldwide and the type of technologies they've employed. JNPT can study the technologies adopted by both Indian ports performing well, like Mundra and the world's leading technologically superior ports like Rotterdam, Shanghai, and Singapore. However, this must be clubbed with the unique position that JNPT is in, including its opportunities and challenges.

Decide whether to use an off-the-shelf or custom solution

After deciding what the port strategy, the issues to tackle, how to approach them with digital solutions, and the range of technologies that could help, the port must decide how to procure the technology. The possible solutions are to purchase an off-the-shelf platform or developing a custom solution for itself. There are pros and cons to each approach.

In most cases, an off the shelf is both faster and cheaper, especially for a less technologically advanced port like JNPT. It is also possible to customize them to your specific needs. However, one significant trade-off is that these are quite generic and hence limited to how well they can do. There could also be problems in integrating it with the technology in use. Developing a custom solution can provide the port with a competitive edge and ensure that it is the best fit for the port's needs. It can also be developed to be integrated with the technology platforms already being used.

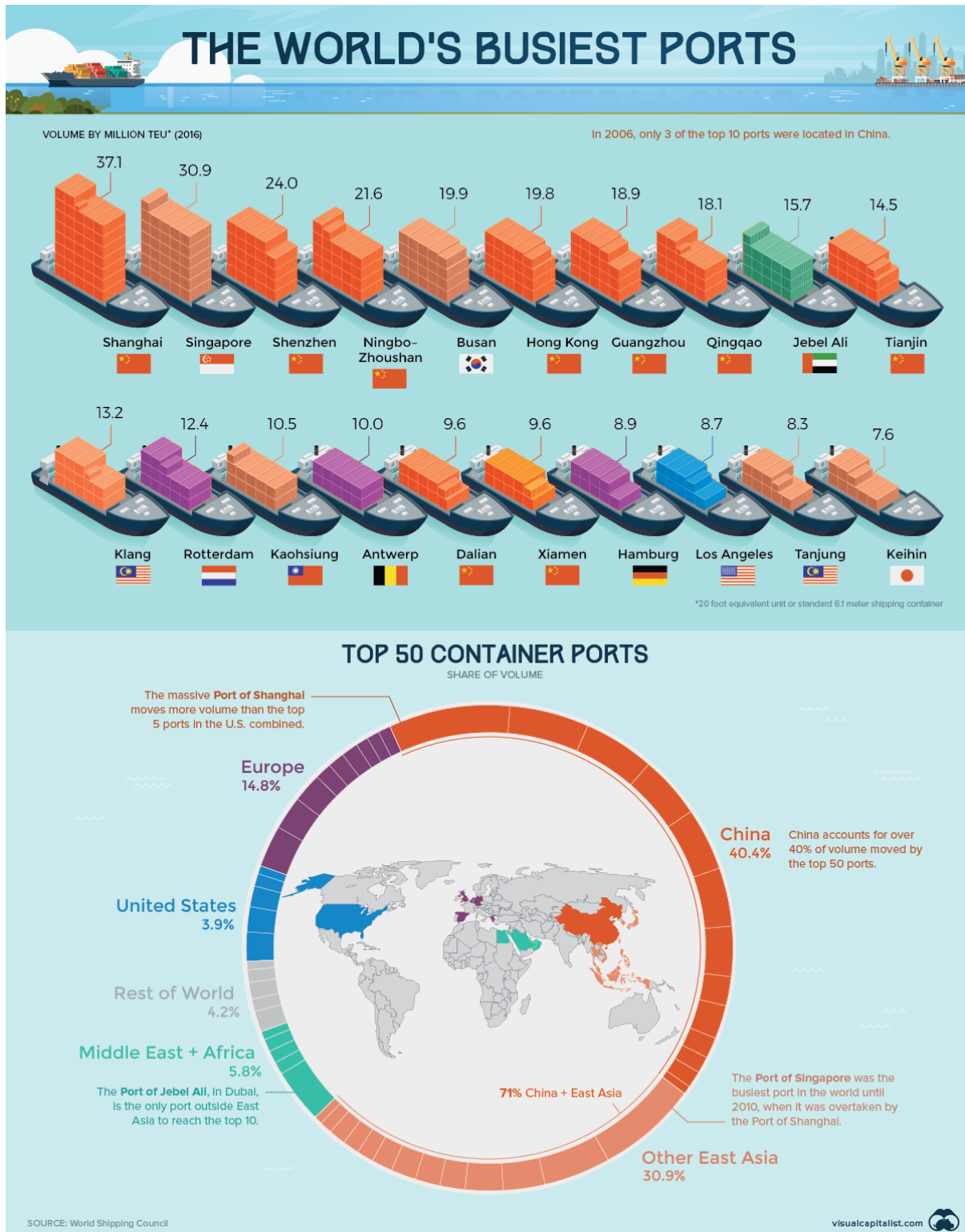
In the end, the optimal solution is often a mix of the two. Various low-level generic requirements can be fulfilled using off-the-shelf solutions. For the more complicated solutions (like a port community system or an IoT platform), either a customized available solution or a solution built from the ground up is required.

Manage risks

Adopting any new technology can be risky. The platform could turn out to be buggy, not integrate well with the hardware, and the other digital solutions could take a long time for the workers to get used to or could just not have the same return, which the management expected. One way to minimize the various risks is to implement the technologies in stages. The first one is a pilot project if the tech implementation is too wide in its application. This can also be applied by first building a minimum viable product first and then test the improvement and acceptance of the solution. Another way is to implement the riskiest part of the solution first and test the results. If the results are as expected, the risk of the remaining aspects goes down.

Appendix

Appendix 1: The World's Busiest Ports (World Economic Forum, 2016)⁸³



⁸³ Source: (World Economic Forum, 2019)

Appendix 2: Indian Container Terminals⁸⁴

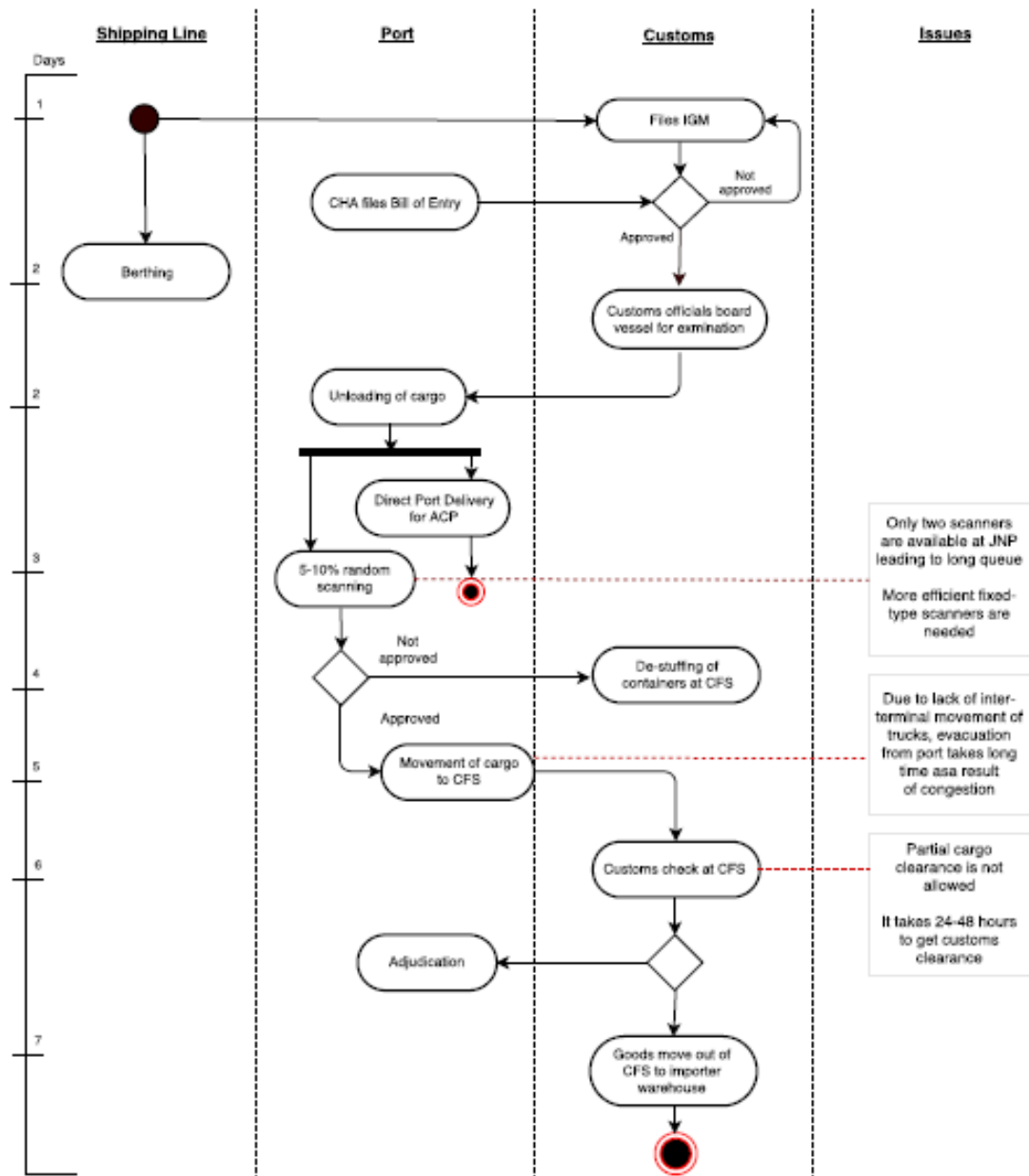
Container Terminal Name	Abbreviation	Operated By	Year of Commission	Draft (m)	Berths	Quay Length (m)	Installed Capacity ('000s TEUs)	Throughput	Import Share	Export Share	Yard Area (Hectares)	Total Ground Slots (TGS)	Reefer Plugs	Quay Cranes	Rubber Tyre Gantry Cranes (RTGC)	Rail Mounted Gantry Cranes (RMGC)	Reach Stackers	Fork Lifts	Utilization Capacity (%)	Volume Handled	Annual Growth
APM Terminals Pipavav	APMT-P	APM Terminals Pipavav	2002	15.5	2	735	1350	903344	NA	NA	36	3409	525	3 Panamax and 5 Post Panamax	20	4	9	2	67%	Medium	High
Mundra International Container Terminal	MICT	DP World	2003	14.5	2	631	1500	835825	NA	NA	25	5400	366	4 Super post panamax and 2 Post panamax	18	2	2	4	56%	Medium	Low
Adani Mundra Container Terminal	AMCT	Adani Ports & SEZ Ltd	2007	15.5	2	631	1200	1051298	46%	54%	24	4014	366	6 Super Post Panamax	20	NA	2	NA	88%	High	Medium
Adani International Container Terminal	AICT	JV of Adani Ports & SEZ Ltd. and MSC	2012	16.5	4	1460	3000	1918070	49%	51%	65	13903	405	14 Super Post Panamax	45	3	3	NA	64%	High	High
Adani CMA Mundra Terminal	ACMT	JV of APSEZ & CMA CGM SA	2017	16.5	2	650	800	740786	48%	52%	28	6500	400	4 Super Post Panamax	12	NA	3	NA	93%	Medium	High
Adani Hazira Container Terminal	AHCT	Adani Ports & SEZ Ltd	2012	13	2	637	1200	559330	49%	51%	20	3500	120	4 Post Panamax and 2 Super Post Panamax	12	NA	2	NA	47%	Medium	High
Kandla International Container Terminal	KICTL	ICTIPL & JM Baxi Group	2016	13	2	545	600	244371	50%	50%	14	NA	48	4 Super Post Panamax	8	NA	4	NA	41%	Low	High
Jawaharlal Nehru Port Container Terminal	JNPCT	JNPT	1989	14	3	680	1350	1056368	NA	NA	62	10482	576	9 Super Post Panamax	27	5	11	3	78%	High	Low
Nhava Sheva International Container Terminal	NSICT	DP World	1999	14	2	600	1200	560661	NA	NA	26	6222	778	6 Post Panamax and 2 Super Post Panamax	29	3	11	2	47%	Medium	Low
Nhava Sheva India Gateway Terminal	NSIGT	DP World	2015	14	1	330	800	938512	51%	49%	25	NA	336	4	16	3	1	NA	117%	Medium	High
APM Terminals Mumbai	APMT-M	APM Terminals & CONCOR	2006	14	2	712	2000	2048454	53%	47%	30	9723	880	10 Post Panamax	40	3	2	6	102%	High	Low
Bharat Mumbai Container Terminals	BMCT	PSA International	2018	16.5	3	1000	2400	520110	51%	49%	45	9366	1620	12	4	36	2	3	22%	Medium	High
New Mangalore Port Containers	NMPT-C	New Mangalore Port Trust	NA	NA	NA	NA	NA	131613	49%	51%	NA	NA	150	Mobile Harbour Cranes	NA	NA	3	NA	NA	Low	High
Mormugao Port Containers	MPT-C	Mormugao Port Trust	NA	13.1	1	250	NA	37000	NA	NA	2	489	84	2 Mobile Harbour Cranes	NA	NA	2	NA	NA	Low	High
Vallarpadam International Container Transshipment Terminal	VICTT	DP World	2011	14.5	2	600	1000	594592	51%	49%	61	2500	450	4 Super Post Panamax	15	NA	3	NA	59%	Medium	High
Paradip International Container Terminal	PICT	ICTIPL & JM Baxi Group	NA	17.1	1	450	NA	13000	NA	NA	5	NA	15	3 Mobile Harbour Crane	2	NA	1	6	NA	Low	High
Chennai Container Terminal	CCTL	DP World	2001	15	4	885	1200	653675	55%	45%	18	3960	355	8 Super Post Panamax	23	3	2	1	54%	Medium	Low

⁸⁴ Source: (Drewry, 2019)

Container Terminal Name	Abbreviation	Operated By	Year of Commission	Draft (m)	Berths	Quay Length (m)	Installed Capacity ('000s TEUs)	Throughput	Import Share	Export Share	Yard Area (Hectares)	Total Ground Slots (TGS)	Reefer Plugs	Quay Cranes	Rubber Tyre Gantry Cranes (RTGC)	Rail Mounted Gantry Cranes (RMGC)	Reach Stackers	Fork Lifts	Utilization Capacity (%)	Volume Handled	Annual Growth
Chennai International Terminal	CITPL	PSA Chennai	2009	15.5	3	832	1200	963167	58%	42%	28	5424	306	3 Post Panamax and 4 Super Post Panamax	18	NA	6	NA	80%	Medium	Medium
Adani Ennore Container Terminal	AECT	Adani Ports & SEZ Ltd	2017	18	1	400	1400	56987	74%	26%	NA	4000	NA	4 Super Post Panamax Cranes	12	NA	1	NA	4%	Low	High
Visakha Container Terminal	VCTPL	ICTIPL & DP World	2003	16.5	2	450	600	450406	51%	49%	8	2500	204	2 Panamax and 2 Post Panamax	10	0	5	3	75%	Low	High
Navayuga Container Terminal	NCT	NCT	2012	16.5	3	650	2000	506168	45%	55%	36	5000	400	5 Super Post Panamax	9	0	16	2	25%	Medium	Medium
Kattupalli International Container Terminal	KICT	Adani Ports & SEZ Ltd	2013	14	2	710	1200	592399	34%	66%	18	5120	360	6 Super Post Panamax	15	NA	2	4	49%	Medium	High
Bharat Kolkata Container Terminal	BKCT	PSA International provides O&M Services	1979	8.5	5	812	850	652000	NA	NA	13	3000	NA	Mobile Harbour Cranes	NA	NA	9	NA	77%	Medium	Low
Halda International Container Terminal	HICT	ICTIPL & JM Baxi Group	1977	8.5	2	432	250	178262	46%	54%	5	3000	NA	2 Panamax	4	NA	3	NA	71%	Low	High
PSA SICAL Tuticorin Container Terminal	TCT	Sical & PSA International	1999	11.9	1	370	450	352010	50%	50%	10	1000	84	3 Post Panamax	8	0	2	1	78%	Low	Low
Dakshin Bharat Gateway Terminal	DBGT	Dakshin Bharat Gateway Terminal Pvt Ltd	2014	14.2	1	345	600	386376	50%	50%	10	1725	112	3 (Twin)	9	0	2	1	64%	Low	High
PSA - Kakinada Container Terminal	KCTPL	Bothra Shipping, Kakinada Infrastructure Holdings and PSA Chennai Investments	2016	14.5	2	300	100	24337	52%	48%	5	400	90	2 Post Panamax	0	0	2	NA	24%	Low	High
Mumbai Port - Containers	MbPT-C	Mumbai Port	NA	NA	NA	NA	NA	27202	95%	5%	NA	NA	NA	NA	NA	NA	NA	NA	NA	Low	Low

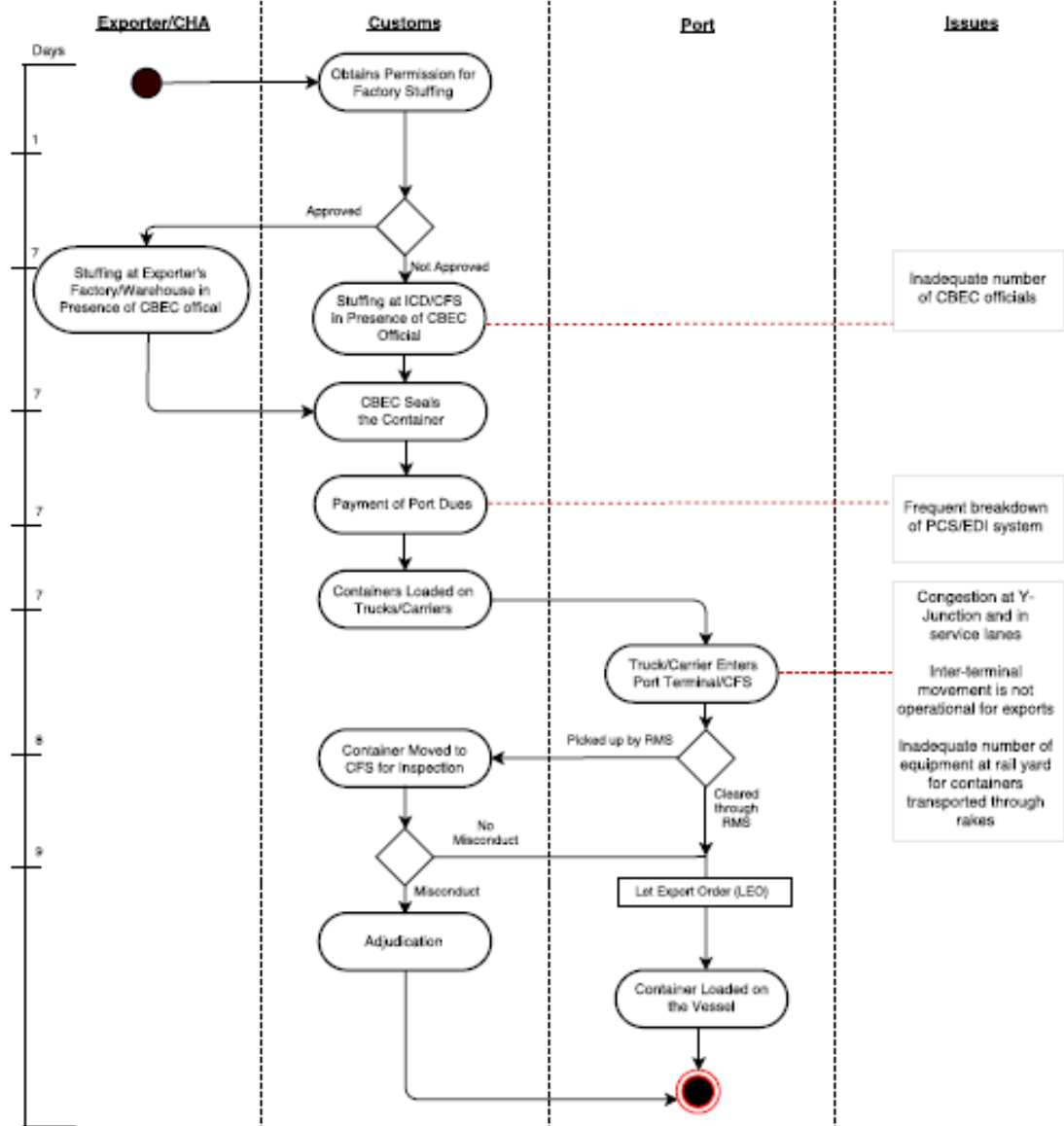
Appendix 3: Movement of Container at JNPT

Import⁸⁵



⁸⁵ Source: (Bureau of Research on Industry and Economic Fundamentals (BRIEF), 2016)

Export⁸⁶



⁸⁶ Source: (Bureau of Research on Industry and Economic Fundamentals (BRIEF), 2016)

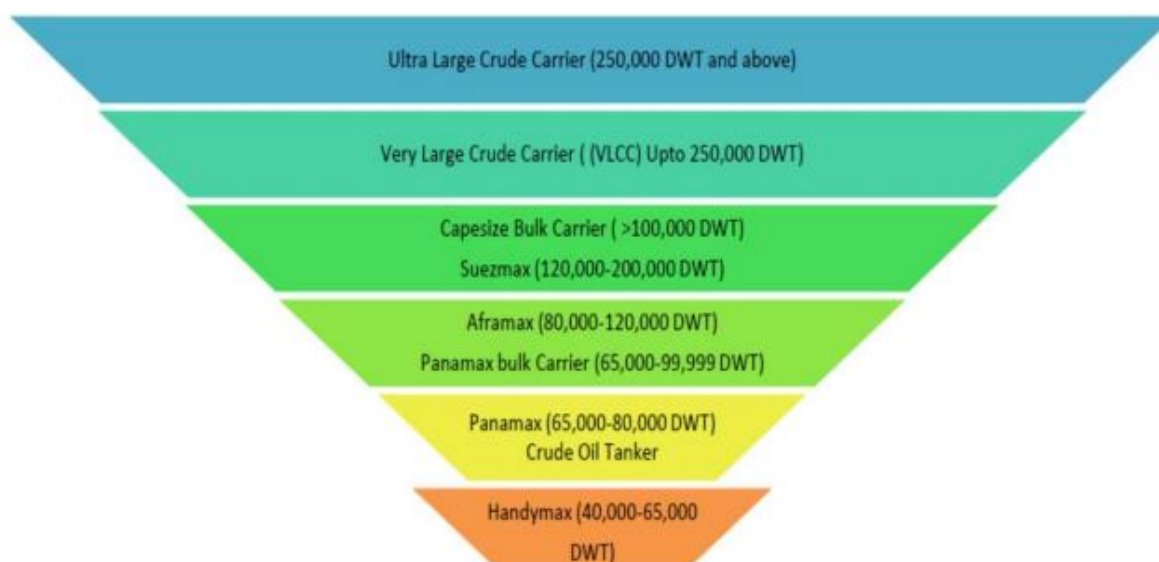
Appendix 4: Glossary

Term	Definition
Berth	A specified length of quay wall where a vessel can tie-up
Berth Hire	Charges for the hiring of berths by a shipping line for loading/unloading operations. The amount depends on the number of berths and duration of hire
Breakwaters	Physical structure that protects port infrastructure from the sea
CFS	Container Freight Stations - the location where shipments are consolidated/de-consolidated for future movement
Dead Weight Tonnage	The total weight ship can carry including cargo, fuel, freshwater, passengers, crew, etc.
Demurrage	The penalty imposed by the port authority on the receivers of cargo for not clearing cargo from the port premises within the stipulated time
Draft	The vertical distance between the waterline and bottom of the hull. It determines the maximum depth to which ship can travel safely. Higher draft implies higher volumes ships can be accommodated the port
Dredged channels	A section of the entrance to a port for vessels that are kept to a specified depth
FCL	Full Container Load
Gantry	A bridge-like overhead structure that is used to straddle an object or a workspace
Ground Slots	Measurement of an area immediately near to the berth. One ground slot is the area a single container rests on. Containers are stacked on top of each other
ICD	Inland Container Depots - dry ports equipped for handling and temporary storage of containerized cargo and empties. This means that hinterland customers can receive port services more conveniently closer to their premises
Landlord port	The private sector manages a form of port model where ownership of infrastructure is maintained by the port authority (public) and port services
LCL	Less than Container Load
LOA	Length overall of Vessel
Mobile Harbour Crane	Cranes suitable for handling container, cargo, and bulk cargo
Panamax	The maximum size of the ship that can cross the Panama Canal
Pilotage	Service of assisting the master of a ship by a pilot assigned by the port in navigation when entering or leaving the port. It is the fees payable for the services of the pilot
Quay	The necessary physical infrastructure provided to berth ships
Reefer	Intermodal container for temperature-sensitive cargo
Reefer Plug	Power connection in a container yard of the port/berth to the reefers
Rubber Tyred Gantry Crane	A crane built on the top of a gantry with rubber tyres to provide mobility
Stevedore	The person who provides cargo handling service
Stevedoring	Charges levied by the port operator in employing labor for loading and unloading of cargo
TEU	Twenty Foot Equivalent - size of container with dimensions 20ft x 8 ft x 8 ft
Towage	Towage charges relate to the tugging service provided by the port authority, which owns and operated the tugs
ULCC	Ultra Large Crude Carriers
VLCC	Very Large Crude Carriers
VLOC	Very Large Ore Carriers
Wharfage	Dues recoverable on all cargo landed or shipped within the port limits or passing through the declared landing stage

Appendix 5: Port Metrics Definition

Parameter	Definition
Dwell Time	The duration for which an entity stays in the port for service is called the dwell time of the entity. In the port parlance, the entities are mainly the vessel and cargo/containers. Import Dwell Time = Loading of last ton of cargo - unloading of last ton of cargo from ship Export dwell Time = Loading of first ton of cargo on the ship - Reception time of first ton of cargo
Turnaround Time	Total time spent by the vessel in the port from arrival to departure TAT = Pre-berthing waiting time + Navigation Time + Stay at berth
Pre-berthing Waiting Time	Time taken by a ship from the time of arrival at reporting station till arrival at berth, excluding the time taken for any inward navigation Pre-berthing waiting time = Time of arrival at berth - Time of reporting - Inward Navigation Time
Average Output Per ship berth day	The average output of a ship at a berth per day in tonnes of cargo. It refers to the total cargo handled and unloaded and loaded cargo treated separately Average Output per ship berth day = Total Cargo handled in tonnes / Total working days
Idle Time at Berth	It is the %age of the time that vessel is idle at its designated berth Idle Time at Berth % = Total Idle Time at berth / Total time at berth
Berth Occupancy	It is the %age that any vessel occupies a berth as compared to the total time available at a berth during the period Berth Occupancy % = Time Berth is occupied by any vessel / Total available time
Port Capacity	#Working Days x Berth Occupancy x Output per ship Berth day

Appendix 6: Vessel Classification by Cargo Type & Size⁸⁷



⁸⁷ Source: (CARE, July 2020)

Appendix 7: Documents Involved⁸⁸

Documents involved in each stage of the voyage

Pre-Arrival Documents				
S. No.	Activity	Document	Document Flow	
			From	To
1	Cargo Arrival Notice	Letter	Steamer Agent	Importer
2	Transfer of BL	BL	Owner / Charterer (Principals)	Steamer Agent
3	Bank Guarantee or Corporate Letter of Indemnity	Form	Consignee	Owner
4	Delivery Order Instructions	Form	Owner	Steamer Agent
5	Issue Of Delivery Order	Delivery Order	Agents	Consignee
6	Filing of IGM	Prior IGM	Steamer Agent	Customs
7	Arrival Intimation	Vessel Arrival Intimation	Steamer Agent	Port
8	General Information	Form I	Master / Steamer Agent	Port / Customs / MMD / PHO / Police
9	Arrival Report	Form III	Master / Steamer Agent	Port / Customs / MMD / PHO / Police
10	Grant entry Inwards	Grant entry Inwards for Vessel	PO Customs	Customs
11	General Declaration	Form II	Master / Steamer Agent	Port / Customs
12	Import Clearance	Permission to grant entry inwards	Customs	Steamer Agent
13	Rummaging	Shipping Journal	Master	Preventive Officer Customs
14	Declaration	Gold / Bullion / Silver	Master	Customs
15	Declaration	Agency for vessel	Master	Customs
16	Declaration	Same bottom cargo	Master	Customs
17	Declaration	No opium certificate	Master	Customs
18	Declaration	No Arms & Ammunition	Master	Customs
19	Declaration	Deck Cargo	Master	Customs
20	Declaration	No Passenger on Board	Master	Customs
21	Declaration	Store list	Master	Customs
22	Draft survey	Survey Certificate	Surveyor	Steamer Agent
23	Receipt	Store list	Customs	Master
24	Report on the arrival of a vessel in port	Emigration Journal	Master	Immigration Officer

The arrival of the Vessel to Sailing of Vessel				
S. No.	Activity	Document	Document Flow	
			From	To
1	Immigration Officer Boards the vessel verifies the list of crew and passengers, if any, Issues Immigration Clearance, and Issues Shores Passes	Crew, Passenger List, Clearance Certificate, and Shore Pass	Immigration Officer	Steamer Agent / Passenger / Crew
2	Delivery Oversight	Overside Delivery Order	Steamer Agent	Master
3	Ships Certificates	Receipt	Steamer Agent	Master
4	Vessel Planning	Vessel Planning Form	Steamer Agent	Port
5	Tally	Tally Sheet	Port	Stevedore Agent
6	Intimation of Cargo Arrival	Cargo Arrival Notice	Steamer Agent	Importer

⁸⁸ Source: (Planning Commission, July 2007)

7	Draft Survey	Surveyor Certificate	Surveyor	Steamer Agent
8	Completion of Discharge	Discharge Completion Certificate	Steamer Agent	Customs
9	Export Cargo loading / no discharge	Export Cargo loading / no discharge certificate	Steamer Agent	Customs
10	Consignee appoints C&F Agent			
11	Tank Inspection by Chief Officer / Surveyor Draft Survey for dry bulk, no survey for general cargo	Inspection Report Draft Survey Report		Steamer Agent / Consignee
12	Statement of facts for calculation of laytime		Agents	Signed by master & receiver
13	Pilot Called		Master	Port
14	Delivery Order	Issue of Delivery order	Steamer Agent	CHA
15	Filing of BE	Bill of entry with Invoice, Packing list, Country of Origin Certificate, Analysis Certificate	CHA	Customs Service Centre
16	Filing of Import Application	Import Application		CHA
17	Print checklist	Checklist for the verification of the BE	Service Centre - Customs	CHA
18	Issue of Challan TR6	Challan TR6	Customs	CHA
19	Duty value assessed	Duty advice	Customs	CHA
20	Examination	Examination order	AO Appraisal	AO Docks
21	Testing for edible items for human consumption	CFTRI Mysore Certificate	PHO	CHA / SA
22	Plant Quarantine	Phyto / Fumigation certificate, Plant Quarantine clearance certificate	Plant Quarantine Officer	Steamer Agent
23	Cargo Verification	Out of charge	Customs	CHA
24	Request for gate opening	Gate Opening Application	CHA / SA	Port
25	Grant Permission	Permission letter	Port	CHA / SA
26	Carting Order	Carting chit	CHA / SA	Transporter
27	Filing of Export Application	Export Application	CHA	Port
28	Filing of SB	Shipping bill with packing list, Invoice, Exchange Control Declaration (GR) form no. BA	CHA	Customs
29	Permission for direct	Permission letter	CHA	Port
30	Passing cargo for exports	Let Export Order	Customs	CHA
31	Loading Export Cargo	Allowed for Shipment	Customs PO	CHA
32	Filing Labour Indent	Gang Indent	Stevedore	Port
33	Filing Equipment Indent	Equipment Indent	Stevedore	Port
34	Filing Labour Indent	Gang Indent	CHA	Port
35	Filing Equipment Indent	Equipment Indent	CHA	Port
36	Delivery of Imported Cargo	Vehicle Ticket	Port	CHA
37	Transport Instructions	Form-20A	CHA	Transporter
38	Receipt of goods on board	Mate Receipt	Master	Port / CHA
39	Port Clearance	Port Clearance Certificate	Port	Steamer Agent
40	Port Clearance	Port Clearance Certificate	Steamer Agent	Customs
41	Grant entry outwards	Grant entry outwards	Customs	PO Customs
Sailing of the vessel to the closure of the voyage				
1	IT Returns for the Vessel	Authorization letter	Master	Steamer Agent
2	Bill	Final Marine Bill	Port	Steamer Agent
3	Export Cargo in Vessel	Export General Manifest	Steamer Agent	Customs
4	Import Cargo lying	Out Turn Statement	Port	Steamer Agent / Customs

Documentation – Import Cargo

S. No.	Agency	No. of documents	Name of document
1	Customs	6	Bill of Entry (B/E), Customs out of charge, Customs permission on Trans-shipment permit TP, Customs NOC for restricted commodities.
2	Port	4	Tally Sheet, Shed Delivery Order, payment receipt for wharfage & demurrage, Gate pass
3	Shipping Agent	17	Application for Rotation with vessel details, Application for Registration, Import General Manifest (IGM), Berthing application, docking application, Advance list, payment receipt for berth hire charges and stevedoring charges, Certified Hazardous cargo list, ISPS declaration, Copy of P&I cover, Stowage plan, Bay plan, Hatch Summary, Application to PHO, Agents delivery order, Railway indent, Trans-shipment permit (TP), Load list.
4	CHA / Importer	4	Bill of Lading (B/L), Packing list, Invoice, Cargo inspection certificate
5	PHO / PQ	2	PHO / PQ report (for perishable cargo), PHO NOC of the ship (yellow fever zone)
6	MCGM	2	A, B / N form (for octroi charges)
	Total	35	
1	Customs	8	IGM, Inward entry, Customs permission (for CY to CFS), Bill of Entry (B/E), Customs out of charge (OOC), Customs permission on SMTP, Customs NOC for restricted commodities. Open Chit
2	Port	6	Tally Sheet, Container Movement challan, Shed Delivery Order, payment receipt for wharfage & demurrage, Gate Pass, EIR
3	VOA / COA	24	Application for Rotation with vessel details, Application for Registration, Import General Manifest (IGM), Berthing application, docking application, Advance list, payment receipt for berth hire charges and stevedoring charges, Certified Hazardous cargo list, ISPS declaration, Copy of P&I cover, Stowage plan, Bay plan, Hatch Summary, Application to PHO, Container load plan, Agents delivery order, Agents CMC permission, Agents gang delivery order, SMTP, Railway indent, Trans-shipment permit (TP), Load list, Form – 13, D.O
4	CHA / Importer	5	Bill of Lading (B/L), Packing list, Invoice, Cargo inspection certificate, country of Origin
5	CONCOR	2	Train summary, Inland waybill (For ICD)
6	PHO / PQ	2	PHO / PQ report (for perishable cargo), PHO NOC of the ship (yellow fever zone)
7	State Govt.	2	A, B / N form (for octroi charges)
	Total	49	

Documentation – Export Cargo

S. No.	Agency	No. of documents	Name of document
1	Customs	4	Shipping Bill, Let Export Order, Customs NOC for restricted commodities outward entry
2	Port	2	Tally Sheet, Payment Receipt for Port Charges for wharfage/demurrage charges on Export Cargo.
3	Shipping Agent	11	Application with vessel details, Application for registration, Application for carting, Berthing application. Advanced payment receipt for berth hire and stevedoring charges, Certified Hazardous cargo list, ISPS declaration, Copy of P&I cover, Mate Receipts, Application for Port clearance, Bill of lading.
4	CHA / Exporter	3	Checklist, Invoice/purchase order, Cart chit
5	PHO / PQ	1	PHO's Clearance (for Foodgrains)
	Total	21	

S. No.	Agency	No. of documents	Name of document
1	Customs	8	EGM, Outward entry, Shipping Bill (S/B), Let Export Order (LEO), Allowed For Shipment, Customs NOC for restricted commodities. Open Chit, Port Clearance
2	Port	6	Tally Sheet, Pre Advice Slip, Container Movement Challan, payment receipt for wharfage & demurrage, Gate Pass, EIR
3	VOA / COA	24	Application for Rotation with vessel details, Application for Registration, Export General Manifest (EGM), Berthing application, docking application, Advance list, payment receipt for berth hire charges and stevedoring charges, Certified Hazardous cargo list, ISPS declaration, Copy of P&I cover, Stowage plan, Bay plan, Hatch Summary, Application to PHO, Container load plan, Agents delivery order, Agents CMC permission, Agents gang delivery order, SMTP, Railway indent, Trans-shipment permit (TP), Load list, Form -13, D.O
4	CHA / Importer	5	Packing list, Invoice, Cargo inspection certificate, Carting Order
5	CONCOR	2	Train summary, Inland waybill (For ICD)
6	State Govt.	2	A, B / N form (for octroi charges)
	Total	47	

References

- AECOM India Private Limited. (2016, August). *Sagarmala: Master Plan for JNPT*. Retrieved from Sagarmala: http://sagarmala.gov.in/sites/default/files/4.Final_Master_Plan_JNPT.pdf
- Allied Market Research. (April 2020). *Shipping Containers Market: Global Opportunity Analysis and Industry Forecast (2020-2027)*. AMR.
- BMCTPL Press Release. (2018). Retrieved from <https://bmctpl.com/wp-content/themes/twentyten/PDF/BMCTMediaRelease051218.pdf>
- Boston Consulting Group. (2018). *To Get Smart, Ports Go Digital*. Retrieved from https://image-src.bcg.com/Images/BCG-To-Get-Smart-Ports-Go-Digital-Apr-2018_tcm9-188400.pdf
- Bureau of Research on Industry and Economic Fundamentals (BRIEF). (2016, March). *Bridging Infrastructural Deficits at Select Trade Ports in India*. Retrieved from BRIEF INDIA: <http://briefindia.com/wp-content/uploads/2017/05/Bridging-Infrastructural-Deficits.pdf>
- CARE. (July 2020). *Research Report on Shipping Industry in India*. CARE.
- CBIC. (2020). *A Successful Symphony: Coordinated border movement at JNPT Customs House*. Retrieved from http://www.jawaharcustoms.gov.in/pdf/Paper_on_TRS.pdf
- Crisil. (2020). *Ports*. Crisil.
- DLDC. (2020, August). Retrieved from <https://www.dldsl.in/about.aspx?mpgid=2&pgidtrail=3>
- DMICDC Logistics Data Services Ltd. (2020). *Logistics Databank Analytics Report - JNPT - July'20*.
- DMIDC Logistics Data Services Ltd. (2020, Aug). *Logistics Databank Analytics Report- Aug 2020*. Retrieved from DMICDC Logistics Data Services (DLDS): https://www.dldsl.in/Uploads/image/140imguf_LDBAnalytics-Ministryreport-August2020.pdf
- Drewry. (2019). *Indian Container Market Report 2019*. Retrieved from Containers India: <http://containersindia.in/pdf/INDIAN%20CONTAINER%20MARKET%20REPORT-2019.pdf>
- Financial Express. (2010). Retrieved from <https://www.financialexpress.com/archive/dedicated-freight-corridors-tracks-apart-for-industry/690303/>
- Forbes. (2018). *Technologically Supercharged Ports Are Defining The New Silk Road*. Retrieved from <https://www.forbes.com/sites/wadeshepard/2018/01/25/technologically-supercharged-ports-are-defining-the-new-silk-road/#43f3437b70d2>
- Friedrich Ebert Stiftung. (2019). *Impact of Digitalization in the Ports Sector*.
- Halifax Port Authority. (n.d.). *My Ship's Come In. Where Is My Container? How a well-designed container tracking system can help a Port Authority avoid this question*.
- IBEF. (2020). *Shipping Industry & Ports in India*.
- IDFC Securities. (Dec 2019). *Logistics: Exim container volume see traction, while port volumes muted*. IDFC.

- India Brand Equity Foundation. (2020, Sep 4). *Shipping Industry & Ports in India*. Retrieved from IBEF: <https://www.ibef.org/industry/ports-india-shipping.aspx>
- India Infra. (2019, November). *Boxing up*. Retrieved from <https://indianinfrastructure.com/2019/11/05/boxing-up/#:~:text=The%20Jawaharlal%20Nehru%20Port%20Trust,cent%20during%20the%20same%20period.>
- Jawaharlal Nehru Port Trust. (n.d.). *Terminals*. Retrieved from JNPT: <http://jnport.gov.in/terminals>
- Jawaharlal Nehru Port Trust. (2018). *Annual Report 2017-18*.
- Jawaharlal Nehru Port Trust. (2020). *History*. Retrieved from JNPT: <http://www.jnport.gov.in/hstory>
- Jawaharlal Nehru Port Trust. (n.d.). *History of JNPT*. Retrieved from JNPT: <http://jnport.gov.in/hstory>
- JNPT. (2020). Retrieved from http://www.jnport.gov.in/projects_ongoing
- JNPT: A Study of Port Operations: Administrative Context, Structure & Processes*. (n.d.). Retrieved from https://issuu.com/inniray/docs/jnpt_administrative_structure_context_port_operati
- JOC. (2015). *DP World opens automated gates at JNPT terminal*. Retrieved from https://www.joc.com/port-news/asian-ports/port-jawaharlal-nehru/dp-world-opens-automated-gates-jnpt-terminal_20151203.html
- JOC. (2017). *Singapore port pushes automated trucking*. Retrieved from https://www.joc.com/port-news/asian-ports/port-singapore/singapore-port-pushes-automated-trucking_20170109.html
- JOC. (2019, May). *India progresses on port portal after rocky rollout*. Retrieved from https://www.joc.com/port-news/asian-ports/india-making-progress-new-port-portal-after-rocky-rollout_20190514.html
- LKI International Relations & Strategic Studies. (2019, Feb). Retrieved from <https://lki.lk/publication/sagarmala-indias-new-port-development-strategy-and-its-implications-for-sri-lanka/>
- Ministry of Shipping. (2017). *Draft Policy on Multi-modal transport*.
- Ministry of Shipping. (2019). *Annual Statistics*. Retrieved from <http://shipmin.gov.in/sites/default/files/bps%20corrected.pdf>
- Ministry of Shipping. (various years).
- Ministry of Shipping, Government of India. (n.d.). *National Perspective Plan Executive Summary*. Retrieved from Sagarmala: <http://sagarmala.gov.in/sites/default/files/NPP%20executive%20summary.pdf>
- Ministry of Shipping, Indian Ports Association. (2016, November). *Final Report for Sagarmala*. Retrieved from Sagarmala: http://sagarmala.gov.in/sites/default/files/20161222_Sagarmala_final%20report_volume%2001_0.pdf
- Niti Aayog. (2020, June). Retrieved from <https://niti.gov.in/post-covid-economic-growth-will-come-through-indias-ports>
- PIB. (2019, August). *BSID*. Retrieved from <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1583253#:~:text=India>

%20has%20become%20the%20first,bio%2Dmetric%20data%20of%20seafarers.
&text=The%20new%20facial%20biometric%20technology,data%2C%20with%20
modern%20security%20features.

Planning Commission. (July 2007). *Report of the Inter Ministerial Group: Reducing Dwell Time of Cargo at Ports*. The Secretariat for the Committee on Infrastructure.

Port of Singapore. (n.d.). Retrieved from
<https://www.mpa.gov.sg/web/portal/home/maritime-singapore/what-maritime-singapore-offers/global-connectivity/global-hub-port#:~:text=The%20comprehensive%20port%20facilities%20and,of%20less%20than%2012%20hours>.

Port Strategy. (2015). *Double Port Capacity Without Doubling Land*. Retrieved from
<https://www.portstrategy.com/news101/port-operations/port-performance/double-port-capacity-without-doubling-land>

Raghuram, G. (April 2006). *A Diagnostic Study of Jawaharlal Nehru Port Trust*. Indian Institute of Management Ahmedabad.

Rajya Sabha. (2018). *Rajya Sabha Standing Committee Report*.

Shipping & Freight Resource. (2019). *Rotterdam Tech*. Retrieved from
<https://www.shippingandfreightresource.com/most-advanced-container-terminal-in-the-world/>

ShipTechnology. (2019). *Smart ports: increasing efficiency and cutting costs*. Retrieved from <https://www.ship-technology.com/features/smart-ports-increasing-efficiency-cutting-costs/>

Swaminathan, B. (March-2019). The Relative Efficiency between the Container Terminals Operated in Jawaharlal Nehru Port Trust–Navi Mumbai. *International Journal of Multidisciplinary*, 85-89.

The Hindu. (2016, May). Retrieved from
<https://www.thehindu.com/opinion/columns/facilitating-trade-in-indian-ports/article8552323.ece>

The Hindu. (2019, Oct). Retrieved from
<https://www.thehindubusinessline.com/economy/logistics/bharat-mumbai-container-terminals-becomes-fastest-to-reach-one-million-container-handling-milestone/article29756067.ece>

UNCTAD. (2012). *Capacity Calculation at Ports*.

UNCTAD. (2018). *Review of Maritime Transport*. Retrieved from
https://unctad.org/en/PublicationChapters/rmt2017ch4_en.pdf

United Nations Conference on Trade & Development. (2016). *Port Management Series, Volume 4: Port Performance*. Retrieved from UNCTAD:
https://unctad.org/en/PublicationsLibrary/dtlkdb2016d1_en.pdf

Valencia Port. (2015). *NOATUM RUNS REAL-TIME DYNAMIC LIGHTING SYSTEM TESTS IN ITS VALENCIA TERMINAL*. Retrieved from
<https://www.valenciaport.com/en/noatum-runs-real-time-dynamic-lighting-system-tests-in-its-valencia-terminal/>

WCO News. (2017). *Blockchain: unveiling its potential for Customs and trade*. Retrieved from <https://mag.wcoomd.org/magazine/wco-news-87/blockchain-intro/>

World Economic Forum. (2019, Feb 5). *Here are the 20 busiest ports on the planet.*

Retrieved from World Economic Forum:

<https://www.weforum.org/agenda/2019/02/visualizing-the-world-s-busiest-ports>

