ANALYSIS OF MAJOR PORTS CONTAINER TERMINALS WITHIN TAMIL NADU: A COMPARATIVE PERFORMANCE

A dissertation submitted to the School of Maritime Management, Indian Maritime University in partial fulfilment of the requirements for the award of degree in MBA- Port and Shipping Management

Submitted by

SAIYATHU YASIN. S

(Reg. No. 2203304024)

Under the supervision of,

Dr. B. SWAMINATHAN

Associate Professor & Head

INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

SCHOOL OF MARITIME MANAGEMENT

CHENNAI CAMPU

DECLARATION

I, **SAIYATHU YASIN. S (Reg. No. 2203304024)**, student of School of Maritime Management, Indian Maritime University – Chennai Campus, hereby declare that this project report titled **ANALYSIS OF MAJOR PORTS CONTAINER TERMINALS WITHIN TAMIL NADU: A COMPARATIVE PERFORMANCE** submitted in partial fulfilment of the requirement for the degree of **Master of Business Administration in Port and Shipping Management** is my original work carried under the guidance of my project guide. It has not formed the basis for the award of any Degree/Diploma of any University/Institution. The information submitted is true and original to the best of my knowledge.

NAME: SAIYATHU YASIN.S

(Reg No. 2003304024)

Place: CHENNAI

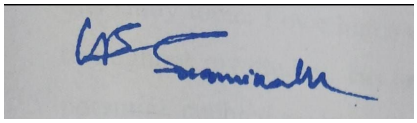
Chennai Date: 10.05.2024

CERTIFICATE

SCHOOL OF MARITIME MANAGEMENT

INDIAN MARITIME UNIVERSITY, CHENNAI

This is to certify that the project report entitled **"ANALYSIS OF MAJOR PORTS CONTAINER TERMINALS WITHIN TAMIL NADU: A COMPARATIVE PERFORMANCE"**, submitted to the School of Maritime Management, Indian Maritime University, Chennai Campus., in partial fulfilment for the award of the degree of Master of Business Administration in Port & Shipping Management/ International Transportation and Logistics Management, is a record of work carried out entirely by **SAIYATHU YASIN.S,** Reg. No. **2003304024**.



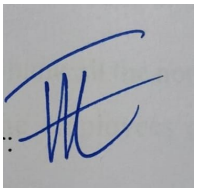
Dr. B. Swaminathan

Project Guide,
School Maritime Management,
Indian Maritime University,
Chennai campus.

External Examiner:

Place: Chennai

Date: 10.05.2024



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EXECUTIVE SUMMARY

The development of a nation's social and economic system depends significantly on maritime transportation. It affects the structure, pattern, and rate of growth. The Ministry of Ports, Shipping, and Waterways oversees shipbuilding and ship repair, major ports, national waterways, and inland water transport. The worldwide shipping sector transports around 90% of world trade. Without shipping, intercontinental trade, bulk raw material transportation, and the import and export of reasonably priced food and manufactured goods would all be impossible. Consumers everywhere benefit from decreasing freight costs as a result of the expansion of seaborne trade.

The sector is a crucial means of moving any significant cargo across international borders. The worldwide shipping industry is made up of liners, wet bulk (such as crude and petroleum products), and dry bulk (such as iron ore and coal) (like containers and others). Furthermore, different standards are used to determine freight charges for various divisions. The three that stand out the most are the Baltic Freight Index, Baltic Dry Index (for the dry bulk market), and Baltic Clean and Dirty Tanker Index (for tankers).

The supply and demand of the market largely dictates freight rates and industry profitability. Two elements that affect demand are trade expansion and the trade balance (which determines the length of haul required). On the other side, the supply drivers depend on both new shipbuilding orders and the scrapping of existing tonnage.

The rules and legislation of the flag state as well as those of the International Maritime Organization (IMO) govern this sector of the economy. In addition, the ship must abide by the laws and regulations of the several countries in which it travels.

In India, the ports and shipping sector are essential to maintaining the expansion of the nation's trade and commerce. Around 95% of India's trade is moved through sea transport, by volume, and 70%, by value, according to the Ministry of Shipping.

Ports and container terminals play an important role in today's economy. Since the mid-20th century, containerization has reduced international commercial transportation costs. Before

the invention of shipping boxes, the cost of shipping goods even half a country, let alone halfway around the world, was prohibitively high, but today American-branded cars can be built in Germany, products are manufactured in Japan, made in Taiwan and Singapore, cars are assembled in South Korea, and Advertising is done after delivery from one place to become a profitable activity for many firms due to the significantly reduced transportation costs brought on by containerization. Commodity handling has become highly automated and efficient across most kinds of transportation.

Previously isolated factories have joined a global network since they can select the least expensive location to produce in, and more multinational and international businesses are present in different marketplaces. As a result, offshoring, outsourcing, and widespread reliance on global supply chains have all had a positive impact on the economy today. These practices have all profited from container handling and transportation.

Efficiency in ports and terminals has therefore become more and more important. Container ports and terminals act as a connecting link between various modes of transportation, making them essential to the overall effectiveness of the global logistics chain. The efficiency of container ports and terminals has become a top priority for operators, in addition to their crucial role in the global commerce network, due to growing port and terminal competition worldwide.

Due to the rising volume of transhipment traffic, container port and terminal traffic will continue to outpace container commerce, which is growing quicker than goods trade and GDP growth in general. Demand growth does not result in lessening of rivalry; on the contrary, ports and terminals engage in fiercer competition for the business of shipping lines. The container shipping industry is dominated by a small number of liner companies, who have enormous negotiating power over the container handling sector, which includes ports and terminals. In order to compete for liner firms and handle the increasing container traffic, ports and terminals must be better prepared. The effectiveness of the container handling sector is nevertheless a major issue in this situation

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ABBREVIATIONS

IMO	International maritime organization
CHPA	Chennai port authority
KPL	Kamarajar port limited
VOCPA	V.O. Chidambaranar Port
PSA	Port of Singapore authority
GDP	Gross domestic product
LNG	Liquefied natural gas
ITF	International transport firm
BRI	Belt and road initiative
GMD	Government maritime board
LDT	Light displacement
CCTPL	Chennai Container Terminal Private Limited
CITPL	Chennai International Terminal PrivateLimited
AECT	Adani Ennore Container Terminal
TCT	Tuticorin Container Terminal
ICD	Inland container depot
CFS	Container freight station
FCL	Full container load
LCL	Low container load
FOB	Free on board
LDO	Light diesel oil
RTG	Rubber tired gantry crane
CSR	Corporate social responsibility
EXIM BANK	Export import bank
SEZ	Special economic zones
MTPA	Million tons per annum
SF	Stowage factor
GM	Metacentric height

CSWP	Code of Safe Working Practice
MSN	Merchant shipment notice
MGN	Maritime guidance notice
SWOT	Strength weakness opportunities and threatsanalysis
TEU	Twenty equivalent unit
VLCC	Very large crude carrier
POL	Port of loading
CHPA	Chennai port Authority
GT	Gross Tonnage
GOI	Government Of India
MMLP	Multi-Modal Logistics Park
RFID	Radio Frequency Identification
SBM	Single Buoy Mooring
BOT	Build-Operate-Transfer
BOOT	Build own operate transfer

CHAPTER I

INTRODUCTION

1.1 PORT INDUSTRY PROFILE

According to the Ministry of Shipping, maritime transport accounts for approximately 95% of India's trading by volume and 70% by value. Mr. Narendra Modi, Prime Minister of India, renamed the Ministry of Shipping, the Ministry of Ports, Shipping, and Waterways in November 2020.

India has 12 major ports and 205 notified minor and intermediate ports. Six new mega ports will be built in the country as part of the National Perspective Plan for Sagarmala. The Indian ports and shipping industry are critical to sustaining the country's trade and commerce growth. With a 7,517- kilometre coastline, India is the world's sixteenth-largest maritime country. The Indian government plays an important role in assisting the port sector The total cargo handling capacity of Indian ports is about 2400 MN tonnes per annum (MTPA). Ports in India handle approximately 95% (by volume) and 68% (by value) of India’s external trade. India is one of the world's top 5 ship recycling countries and holds a 30% share in the global ship recycling market.

India ranks 18th in the World’s Shipping Tonnage. India has 12 Major ports and about 200 non-major ports. Under Maritime India Summit 2021, 486 MO’s were signed for Maritime India Summit 2021 by 22 Maritime /Agencies/Authorities for USD 47.02 ban across different subsectors. India has become the fourth country in the world to have its independent Regional Navigation Satellite System (IRNSS). India has a merchant fleet of 1491 seagoing ships with total capacity of 13 MN GT.

The Ministry of Shipping strives to increase the overall port capacity to 3300+ MN tonnes per annum (MTPA) to cater to projected traffic of 2500 MTPA by 2025.[1] GOI aims to increase the Cargo capacity at the ports from 1282 MMTPA in 2020 to 1759 MMTPA by 2024-25 and cargo movement on all national waterways from 74 MN MT in 2020 to 95 MN MT by 2024-25. GOI aims to establish MMLPs and develop river ports in various

[1] Behera, S. K. 2016. Indian container market report. Drewry and gateway research. Chennai, India: Maritime Gateway. http://gatewayresearch.in/reports/INDIAN-CONTAINER-MARKET-REPORT-2016.pdf

part of Assam to leverage India's connectivity with Bangladesh and to reach markets of the world.

India has jumped to 63rd ranks in 2019 in the Trading Across Border (TAB) parameter of Ease of Doing business (Eid) from 80 in 2018 in World Bank's Ease of Doing Business Ranking 2020. This is due to parameters such as elimination of manual forms, direct port delivery, direct port entry, installation of container scanners, e-delivery orders and introduction of RFID. 58 projects involving a cost of USD 6.6 Ban have been identified as part of the National Infrastructure Pipeline (NIP) for infrastructure augmentation and development at major ports up to 2025.

Ministry has identified and added 25 new ports sector projects worth INR 7,738 cry as part of its continued efforts of effective implementation of NIP. The Sagarmala Programme aims to lead port industrialization by the development of Coastal Economic Zones (CEZs), Coastal Economic Units (CEUs), Port-Linked Industrial & Maritime Clusters and Smart Industrial Port Cities. Under Sagarmala Programme, port projects worth INR 3.55 lakh cry are under various stages of development. Under Project Unnasty 116 new initiatives to improve the efficiency and productivity of the major ports were identified of which 95 have been completed. India is strategically located on the world's shipping routes with a long coastline of about 7,517 km and over 200 minor ports, these ports play an important role in India's economy. JNPT has utilized modern technology to provide facilities for reducing turn-around time of loading and unloading to 26 hours. GOI aims to make JNPT a mega port in near future.

Ship Acquisition, Financing and Leasing (SAFAL) regime at India-IFSC is introduced that includes financial models to gauge the gap in costs, including capital and operating costs and tax costs of doing this business in IFSC and hubs. Model Concession Agreement (MCA) - 2021 for PPP projects at Major Ports is revised and is applicable to all the future PPP projects at major ports, as well as projects which are already approved by the Government but are still under bidding stage.

Ministry of Ports, Shipping and Waterways has awarded 31 projects of more than INR 14,600 crore on PPP till FY25 and look forward for an enthusiastic response from the stakeholders. Construction of Pandu Ship Repair Facility to start from May 2022 to be completed in two years. As part of Maritime India Vision 2030, a Total of 963 initiatives

have been identified for implementation across major ports with an estimated investment of INR 6,77,720.24 crores. The percentage of cargo handled at all Major Ports through PPP operators is targeted to be 85% by year 2030.

In August 2022, the Minister of State for Transport and Highways, Mr. Minister of Ports, Shipping and Waterways Nitin Gadara and Aryas Mr. Sarbananda Sonowal and Minister of State for Road Transport and Highways General VK Singh (retired) urgently set up a modern multi-modal logistics park (MMLP) inland to promote the Bharatmala Pariyojna across the country. In December 2021, India and Russia discussed cooperation in shipbuilding and maritime fields. Sonowal inaugurated new radar and ship control system at Cochin Port Trust. VTMS (Vessel Traffic Management System), commissioned at Cochin Port in 2009, has been upgraded to a state-of-the-art system with two new radars, one AIS station, three VHF radios and associated software and hardware at a cost of Rs. 58 Crore ($772,161.66). The same month, Union Minister for Culture and Tourism, Mr. G Kishan Reddy, announced that the Center had decided on Rs. 1 billion ($13.31 million) for Visakhapatnam Port Cruise Terminal. overcome The Inland Ships Bill 2021 was approved by Parliament in July 2021. The bill aims to create a single law for the country instead of separate laws for each state. According to the new law, registration documents will be valid nationwide and will not require state approval. The bill also creates a database to store ship and crew information in a web portal. development and India's international obligations in this field. The same month, the Gujarat government approved the construction of a new aircraft at an estimated cost of Rs. Navlakhi port cost 1.92 billion rupees ($25.77 million) and has been in operation since 1939. Gujarat.

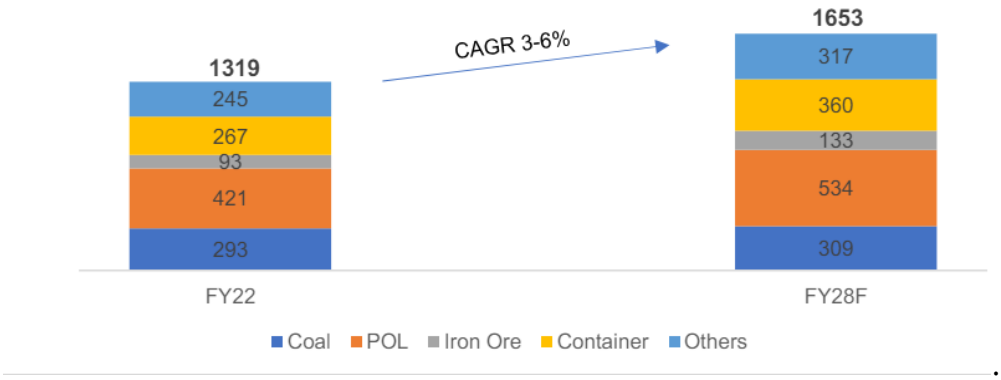
1.1.1 INDIAN PORT TRAFFIC

According to CRISIL MI&A estimates, port production is expected to increase by 8-9% in FY23 after increasing by 4.9% in FY22. Reason for the decline: Lockdown in India (and around the world) due to the spread of coronavirus and economic crisis.

In addition, with the recovery of commercial activities, demand and consumption of major goods increased, which supported the growth of the economy. Coal and POL (petroleum, petroleum and lubricants) segments are expected to drive transportation by FY23 as demand for domestic fuel increases. Coal shipments are expected to increase by

25-28% in FY23, while POL shipments are expected to increase by 4-7%. On the other hand, container transportation is expected to slow down due to macroeconomic fluctuations, while iron ore transportation will also grow slowly due to export loss. Both container volumes and iron ore shipment volumes are expected to grow steadily by 2-5% in 2023. After a decline in FY23, iron ore shipments are expected to rise 6-9% in FY24. In contrast, POL import growth will slow to 2-5%, but imports are likely to remain stable due to low demand.[2] The growth rate of Indian ports is expected to be 3-6% from the financial year 2024-2028. However, factors such as a slowdown in growth due to changes in supply, an increase in iron ore exports, and a decline in the POL market due to a slowdown in oil consumption are expected to limit shipments for a long time. This is shortened, which can deliver better performance and lower turnaround time (TAT) at a competitive price. Over the next five years, CRISIL MI&A expects non-major ports to grow at similar rates as major ports due to lower shipments and moderate growth in coastal shipping.

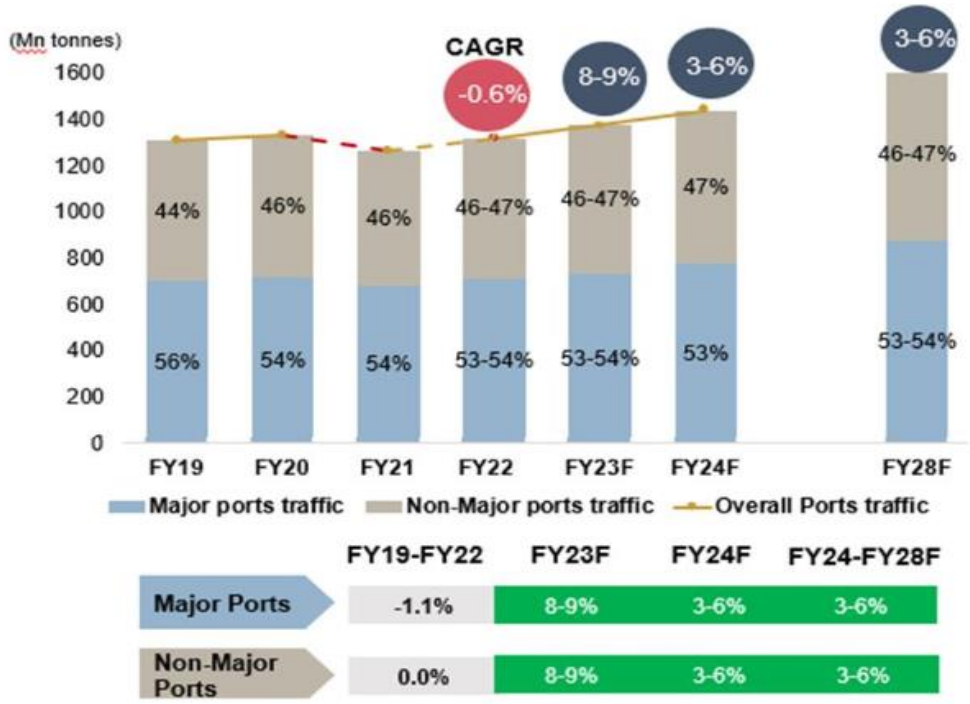
FIG 1.1 INDIA CARGO TRAFFIC PREDICTION



Source: study of port sector

[2] Behera, S. K. 2017. Indian container market report. Drewry and gateway research. Chennai, India: Maritime Gateway. http://www.containersindia.in/pdf/INDIAN CONTAINER MARKET REPORT-2016.pdf.

FIG: 1.2 MAJOR PORT AND NON – MAJOR PORTS TRAFFIC PREDICTION



Source: study of port sector

India's 5 Largest Ports

According to the Ministry of Shipping, India's foreign trade consists mainly of sea ports. These ports are responsible for connecting the Indian Ocean to European, Asian and Arctic trade routes in the International North-South Trade Corridor (INSTC). India has nine major ports in Maharashtra, Kerala, Goa, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu, Odisha and West Bengal. Here are the five largest container and shipping ports in India, which attract large amounts of goods and exports from all over the world.

1.Mumbai Port, Maharashtra

The second oldest port in India, Mumbai Port has been operating since 1873 (the oldest being Kolkata). In addition to its size, it is the largest port in India with an area of 46.3 hectares and a terminal length of more than 8,000 kilometres. It is also known as the largest port in India. This is an important place in the major port of India. It is located in the centre of the west coast of Mumbai. It also has a natural harbour of 800 square kilometres, bordered by the Konkan mainland to the east and Mumbai to the west. The water depth of the port is 10-12 meters, making it easier for large ships to enter and exit.

Additionally, Mumbai also has India's largest port. It can carry all kinds of items due to its many uses. There are refuelling stations in all docking areas. There are 32 beds in total. The railway connects to the Central Railway and Western Railway sectors of the national rail network. The port is also well connected. [3]

Total Cargo handled as per 2022-2023 report: 58.04 MT

2. Visakhapatnam Port

It is the largest port of Andhra Pradesh and an important port of India. It ranks third in terms of cargo, near the ports of Chennai and Kolkata. The port is operated by Visakhapatnam Port Trust (VPT) with 24 berths. Most of them work in the eastern and southern hinterlands of India. Various cargoes such as iron ore, manganese nodules, steel products, general cargo, coal, crude oil and different petroleum products are handled at the port. There are several mountains that protect it from the stormy season. Visage port shares cargo with nearby Gangavaram port. Vizag is now the headquarters of the Federation of Indian Steel Federation (RINL). The port added coal and steel rods to support this goal. Dredging efforts for larger ships are still ongoing. A satellite port for Bhimili has also been proposed.

Total Cargo handled as per 2022-2023 report: 55.74 MT

3. Mundra Port, Gujarat

Mundra is India's largest port with an annual throughput of 4.4 million TEU. It ranks 32nd among the 50 largest ports in the world. It is operated by Adani Ports and Special Economic Zone Limited (APSEZ), which started operations in 2000 and has become the largest port in India. It is well connected to important places in India. Mundra is located on the west coast of India, connecting the northern hinterland to the city by rail and road and providing good sea transport. Rail and road connectivity is provided by External Highway 8A and Mundra-Adipur Railway Line. Mundra Port in India specializes in bulk and bulk transportation including chemicals, fertilisers, food, agricultural products, metals and machinery. We reserved six of our ten berths for dry cargo and containers. In addition to modern infrastructure, this airport provides protection to all cargo during the

[3] Ports Annual Report 2022-23 English

monsoon season thanks to its large storage space. Gujarat is considering building a cargo plane at APSEZ as a way to improve connectivity.

4.Deendayal Port (Kandla), Gujarat

Deendayal Port, formerly known as Kandla Port, is the next largest port in the state of Gujarat and the second largest port in India. Kandla Creek flows through it, providing a natural harbour to the protected island. It is one of the four famous ports of India; others are Jawaharlal Nehru Port in Mumbai VO Chidambaranar Port in Tamil Nadu and Thailand's Kamala Jhar Port, Mir Nadu. The port in Gujarat is named after politician Deendayal Upadhyaya. Deendayal Port was built during the partition of India in the 1950s and its impact on the Karachi port on the Pakistan side of the border and the western coast of India, which lacked major ports. The oil refinery is its backbone. Oil, textiles, grain and salt are mainly exported. With an investment of Rs 9.757 billion, the port plans to expand and improve infrastructure, including the construction of new terminals, construction of new warehouses and upgrading of the railway. MT[4]

5. Chennai Port, Tamil Nadu

Located in the southern city of Chennai, it is the third oldest port in India with annual exports of 1.5 TEU. It was founded in 1881, but the history of maritime trade on its unexplored coast dates back to the 1600s. Known as the "Gateway to South India", it is the largest in the Bay of Bengal. Like Haldia, Chennai Port has helped boost the economy of the city as well as the state of Tamil Nadu. Cotton, textiles, automobiles, iron and leather are the major export items of Chennai Port. Raw cotton, grain, machinery, iron and steel were produced in many countries. The port has its own railway line. As a cruise ship, it has 3 terminals and 24 berths. The lighthouse at Chennai Port is also a popular tourist attraction, making it the best port in India.

[4] CRISIL-Report-Study-on-ports-sector-in-India-v2

TABLE 1.1 COMMODITY – WISE CARGO TRAFFIC AT MAJOR PORTS

YEAR	POL	IRON ORE	F & FRM	COLE	CONTAINER (IN MILLION TEU)	OTHER CARGO	TOTAL
2018 - 19	224.82	41.17	15.05	141.23	133.73 (9.14)	123.37	679.37
2019 - 20	233.70	38.81	15.41	163.67	145.52 (9.88)	101.99	699.10
2020 -21	234.86	55.68	16.15	149.04	146.86 (8.79)	102.34	704.93
2021 -22	206.77	64.82	17.67	126.75	143.77 (9.61)	113.44	672.68
2022 -23	221.27	51.71	15.93	146.80	166.77 (11.22)	117.44	720.05
APR - DEC 2023	175.08	29.70	12.31	140.72	125.76 (8.45)	93.06	576.63

SOURCE: PORT DATA MANAGEMENT PORTAL

1.2 INTRODUCTION OF CONTAINERIZATION

Container shipping began in 1956 when American businessman Malcolm McLean launched the first container ship. A decade later, in 1966, the Transatlantic Container Service marked the emergence of containers as a way to promote international trade. In the early days of container shipping, shipping lines, terminal owners, and freight forwarders refused to switch to new transportation systems. It requires significant investments in infrastructure and infrastructure such as ships, terminals and land transportation. As the advantages of containers as a means of transportation became more evident in the 1980s, containers spread across the seas and oceans.

The international transportation system has reformed the supply chain, promoted the internationalization of production and consumption, and changed the world's economic geography and distribution. International port volume continues to rise, from 36 million TEU in 19801 to 237 million TEU in 2000, and has increased from 545 million TEU in 2010 to approximately 849 million TEU in 2021. This has led to huge pressure to introduce and expand support. structure and infrastructure. The result is massive investment in

container terminals in container ship expansion, ship modernization (ships of up to 24,000 TEU sent to the Europe-Far East trade route), geographical expansion, strengthening of container services and business strategy. The container terminal footprint is growing, with some of the newest facilities in major ports having annual production volumes of more than 5 million TEU. For a large-scale project, all resources related to infrastructure construction (walls, reclamation, dredging works, terminal ground preparation) and equipment (ship-to-shore cranes, construction materials) can reach millions of dollars. The emergence and expansion of the global container terminal network has led to significant changes in the management and operation of the container terminal industry, especially through the integration and cooperation of marine container terminal infrastructure. Corporatization, which refers to the reorganization of government institutions into commercial organizations, has been widely studied in economics and information management.[5]

Incorporation of the maritime sector, especially in the port terminal sector, continues. Although shipping companies were private entities, before 1990 port reforms were frequently announced and implemented. With the emergence of competitive hinterlands and more connected equipment, competition between ports is intensifying and ports are becoming business-oriented. Corporatization has brought greater participation in the private sector and is expected to make ports more competitive, increase efficiency and reduce costs. However, results vary between countries because ports are merely nodes in the international supply chain, and the real value of products increases and costs carried by ports provide lower benefits for producers and consumers as they enjoy the real benefits of increased production. reduction of costs. The international business challenge resulting from COVID-19 has exposed the limits of the network in the face of a major shock, with the company ensuring aircraft capacity is built to accommodate growth in the international market. At the beginning of the global pandemic, shipping shocks and demand shocks from the global lockdown began to slow trade and ports. However, the situation began to rapidly reverse in the summer of 2020, as consumer spending shifted from services to products, highways strengthened in the e-commerce sector, and the economy did not expect a major response from the government. Strong demand growth and massive restocking by importers and retailers are starting to put pressure on supply chains. At the same time, due

[5] Anwar, M., L. Henesey, and E. Casalicchio. 2019. "Digitalization in container terminal logistics: A literature review." In Proc., 27th Annual Conf., of Int. Association of Maritime Economists, 1–25. Greece: International Association of Maritime Economists.

to the shortage of ship capacity and equipment (empty containers, chassis, trains, etc.) and the problem of dock workers, truck drivers and logistics workers, the products cannot respond well. Labor shortages have become more serious due to temporary closures of factories, warehouses and terminals in China and elsewhere, as well as quarantines, lockdowns and stay-at-home orders. The combination of supply and demand led to the collapse of major ports and terminals around the world, primarily on the US West Coast, China and Northwest Europe. The growth of the commercial packaging industry, which started in the summer of 2020, increased in 2021 and 2022. We need to accept the history of high freight.

FIG – 1.3 TOP CONTAINER PORTS IN INDIA

SOURCE: CARGO PORT.COM

1.3 IMPORTANCE OF TAMIL NADU IN INDIA'S MARITIME SECTOR.

India's rise as a maritime power hinge on the strategic shoulders of Tamil Nadu. With a 1,000-kilometer coastline, peppered with natural harbour’s and cradled by a rich maritime heritage, this southernmost state plays a multifaceted role in shaping India's maritime destiny. Let's delve into the depths of its significance, navigating both economic currents and geopolitical tides.

As the gears of India's economy whir, Tamil Nadu acts as a powerful maritime engine. Its three major ports – Chennai, Ennore, and Tuticorin – hum with activity, handling a significant chunk of the nation's cargo traffic. These ports are arteries feeding India's

manufacturing boom, particularly the automotive industry, which flourishes in Tamil Nadu. The upcoming Kattupalli port promises to inject further power into this economic engine, attracting investments and propelling coastal trade. Beyond traditional ports, Tamil Nadu's shipbuilding prowess adds another dimension to its maritime might. Kattupalli Shipyard, India's largest, not only contributes to national shipbuilding goals but also acts as a magnet for foreign investments in this critical sector. Recognizing the ocean's immense potential, the state actively embraces the blue economy, promoting sustainable fishing, seaweed farming, and marine tourism, diversifying its maritime tapestry.

Standing tall like a lighthouse, Tamil Nadu's strategic location serves as an anchor for India's maritime ambitions. Bordering Sri Lanka and the Indian Ocean, it grants crucial access to vital sea lanes and the vast Indo-Pacific region. This positioning empowers India to project its maritime power, safeguard strategic interests, and contribute to regional stability.

Chennai, a bustling metropolis, houses the Integrated Headquarters of Southern Command, the nerve centre overseeing India's maritime security in the Indian Ocean Region. This facilitates collaboration with regional partners like Singapore and Indonesia, strengthening India's role in collective security initiatives. Moreover, Tamil Nadu stands at the forefront of countering challenges like piracy, illegal fishing, and maritime terrorism, actively safeguarding the region's maritime domain. The winds of technological innovation also swirl around Tamil Nadu's maritime sector. Renowned institutions like the National Institute of Ocean Technology and Anna University's Department of Ocean Engineering serve as beacons, guiding advancements in marine technology. Their research fuels India's ambitions in areas like underwater vehicles, ocean energy exploitation, and advanced lilted-based monitoring systems.[6]

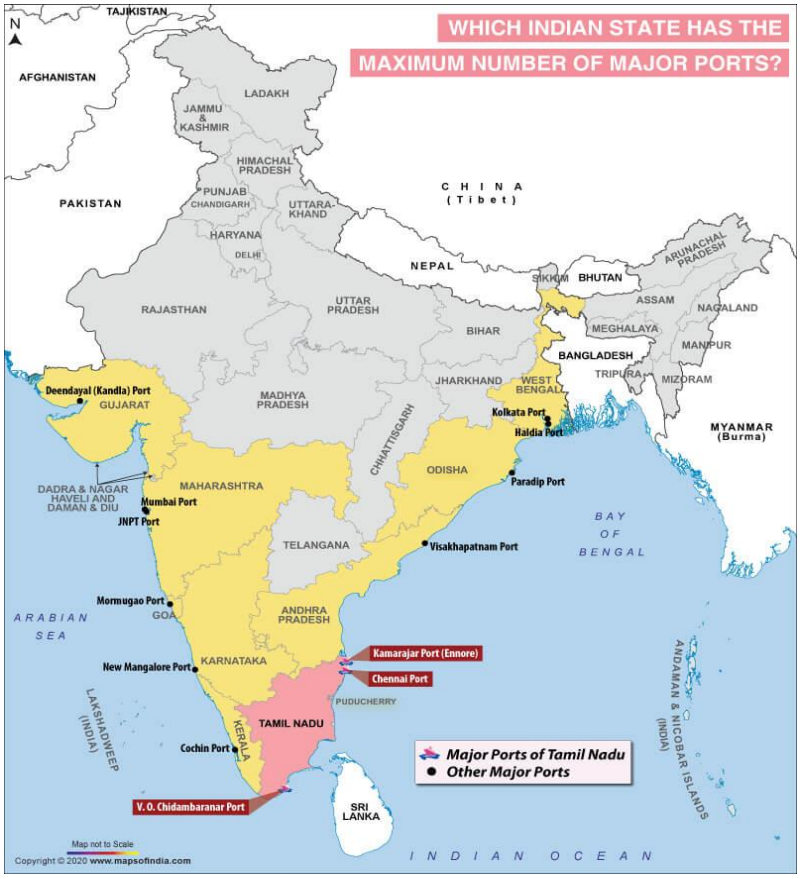
Furthermore, a vibrant start-up ecosystem in Chennai focuses on maritime technology, developing solutions for port efficiency, logistics management, and marine environment monitoring. This entrepreneurial spirit not only fosters innovation but also ensures that Tamil Nadu remains at the forefront of the technologically evolving maritime landscape. Like any voyage, there are challenges to overcome. Upgrading port infrastructure to meet

[6] Aqmarina, A., and N. Achjar. 2017. "Determinants of port performance – Case study of 4 main ports in Indonesia (2005–2015)." Econ. Finance Indonesia 63 (2): 176–185. https://doi.org/10.7454/efi.v63i2.574.

growing trade demands, bridging the skill gap in the maritime workforce, and balancing economic growth with environmental sustainability are pressing concerns. Recognizing these challenges and implementing effective solutions are crucial for harnessing Tamil Nadu's full potential.

As India sets sail on its maritime journey, Tamil Nadu stands as a strategic captain, steering the course with its economic might, geopolitical significance, and innovative spirit. By addressing existing challenges and capitalizing on emerging opportunities, Tamil Nadu can contribute significantly to India's maritime ambitions, ensuring a smooth and prosperous voyage towards securing its strategic interests in the region and beyond

FIGHER:1.4 TAMIL NADU MAJOR PORTS



SOURCE: MAPS OF INDIA

1.4 IMPORTANCE OF CONTAINER TERMINALS

There are several advantages to having container ports, which are important for facilitating international trade and the global economy. Here are some of the key advantages:

Efficient Transport

Container ports are designed to handle large volumes of cargo efficiently, making it easier to transport goods from one location to another. By using standardized containers, cargo can be easily loaded and unloaded from ships, trains, and trucks, reducing the time and cost of transportation.

Improved Supply Chain Management

Container ports enable efficient handling of goods throughout the supply chain, reducing the risk of delays and bottlenecks. This allows businesses to more effectively manage their inventory and plan their operations.

Increased Trade

Container ports facilitate international trade by providing a hub for the movement of goods between countries. This helps to boost economic growth by increasing exports, imports, and foreign investment.

Job Creation

Container ports create jobs for a range of professions, including stevedores, truck drivers, customs officials, and logistics professionals. This can help to stimulate economic development in the surrounding areas.

Reduced Environmental Impact

Containerization has been shown to reduce the environmental impact of transportation by reducing the number of individual cargo movements and reducing the need for packing materials. Container ports can also incorporate sustainable practices such as energy-efficient equipment and waste management systems.

Containerization has had a significant impact on India's economy and transportation infrastructure. It has enabled faster and more efficient movement of goods within the country and across international borders, leading to increased trade and economic growth.

Containerization has also created new job opportunities in India. The growth of containerization has led to the development of new industries, such as logistics,

warehousing, and transportation. These industries have generated employment opportunities for people across different skill levels, from truck drivers to logistics managers.

Containerization has also facilitated the growth of the manufacturing sector in India. Manufacturers can now transport their goods across the country and across international borders with ease, which has led to increased competition and improved efficiency in the manufacturing sector.

1.4.1 ADVANTAGES OF CONTAINER TERMINALS

Standardization

The container is a standard transport product that can be handled anywhere in the world (ISO standard) through specialized modes (ships, trucks, barges, and wagons), equipment, and terminals. Each container has a unique identification number and a size type code, allowing to be a unique transport unit that can be managed as such.

Economies of Scale

The cost of transporting goods by containers is said to be 20 to 25 times less than the cost of transporting the same goods as loose bulk or LCL. Containerization has drastically brought down the transport cost element in the pricing of goods.

Economies of scale are a major factor here. In general, economies of scale are the advantage companies get as a result of producing or dealing in bulk.

Safety and Security

Intermodal containers are safe and secure. These heavy-duty boxes are walled on all five sides except one end where the double doors are located. These double doors have double lock-rods each, that are used to lock and seal the container making it safe and tamper-proof.

1.4.2 DRAWBACKS

Re-Positioning of Empty Containers

Containers that come in with cargo are unloaded and eventually moved to the designated stack for empty containers at their destination. Shipping companies need their empty containers to be available where there is demand. Hence, are moved out of empty container yards to destinations where they can be put to use, it would result in demand-supply

imbalance leading to a shortage of containers for shipments. Large sums of money are spent by shipping companies to reposition their empty containers.

Smuggling

Smuggling of contraband such as arms, drugs, and even human trafficking happens through containers. Typically, customs authorities the world over inspect containers at random. It is possible that contraband can sometimes slip through. Other reasons that prompt the authorities to inspect certain containers are tip-offs, irregular documentation, suspicious patterns of shipping goods, etc.

1.6 OBJECTIVES OF THE STUDY

Compare the performance of major ports' container terminals within Tamil Nadu.

Define specific performance metrics indicators that will be used to assess the efficiency and effectiveness of container terminals.

Compare analysing and the operational performance of container terminals in terms of cargo handling and terminal capacity.

Explore and identify any trend patterns in the performance of these container terminals.

Provide recommendations based on the analysis to improve the overall performance of the container terminals**.**

1.7 SCOPE OF THE STUDY

Overall, the scope of the study can encompass a wide range of factors that can affect the performance of container terminals. If any organisation wants to grow further it has to analyse the past performance of it. A comprehensive study can provide insights into how to improve the efficiency and productivity of container terminals, which can have significant economic and social benefit to the economy. It helps to know the Container Terminal. The scope of the study is to compare the past performance with the present performance**.**

Specify the major ports and container terminals within Tamil Nadu that will be included in the analysis.

Indicate the time period covered by the study. For example, whether it focuses on recent years or has a historical perspective.

Identify the key parameters or factors that will be considered in evaluating the performance of the container terminals.

CHAPTER-II

REVIEW LITERATURE

2.1 THEORETICAL FRAMEWORK

Port and terminal operations are crucial components of global trade and transportation, involving complex logistical processes. Various theories and models have been developed to understand and optimize these operations, ensuring efficiency, safety, and profitability. Here, we discuss some of the prominent theories and models relevant to port and terminal operations:

Berth Allocation Models:

Berth allocation models aim to efficiently assign berths to incoming vessels, considering various constraints such as vessel characteristics, berth availability, cargo types, and operational priorities. These models employ optimization techniques, including mathematical programming and simulation, to maximize berth utilization, minimize turnaround time, and reduce idle time for vessels.

Container Terminal Operations Models:

Container terminals are key nodes in global supply chains, handling large volumes of containers with diverse origins and destinations. Various operational models, such as yard management models, quay crane scheduling models, and container stacking models, are employed to optimize container handling processes. These models consider factors like container types, vessel schedules, yard layout, and equipment capacity to enhance productivity and reduce dwell time.

Port Performance Measurement Models:

Port performance measurement models provide quantitative frameworks to evaluate the efficiency, productivity, and competitiveness of ports. Key performance indicators (KPIs) such as vessel turnaround time, berth occupancy, container throughput, and cargo dwell time are analysed to assess port performance and identify areas for improvement. These models facilitate benchmarking among ports and help stakeholders make informed decisions regarding investments and operational strategies.

Queuing Theory:

Queuing theory is widely applied in port operations to analyse and optimize the flow of ships, vehicles, and cargo. It focuses on studying waiting lines and aims to minimize queuing time, congestion, and delays. By analysing factors such as arrival rates, service rates, and queue lengths, port authorities can design better layouts, allocate resources effectively, and improve overall throughput.

Simulation Models:

Simulation models simulate real-world port operations to analyse system behaviour, test scenarios, and evaluate the impact of operational changes. Discrete event simulation (DES) and agent-based modelling (ABM) are commonly used techniques to model various port processes, including vessel arrivals, container handling, equipment utilization, and terminal logistics. Simulation enables port operators to assess the effectiveness of different strategies, optimize resource allocation, and improve overall performance.

Supply Chain Integration Models:

Port operations are integral parts of broader supply chain networks, connecting producers, suppliers, and consumers across different regions. Supply chain integration models emphasize collaboration and coordination among stakeholders to enhance the efficiency and resilience of port operations. Concepts such as port-centric logistics, intermodal transportation, and information sharing platforms are utilized to streamline supply chain processes, reduce lead times, and improve overall competitiveness.

2.2 REVIEW OF PREVIOUS STUDIES

Estimates suggest that Indian container terminals will handle 25 million twenty-foot equivalent units (TEUs) by 2025. Although there are many initiatives taken by the Indian government, many important things affect the operations of container terminals in India. This study identifies the factors affecting the performance of container terminals in India and the impact of these factors. A conceptual model was developed using fuzzy qualitative comparative analysis (QCA) with a qualitative approach. The conceptual

model developed by QCA includes physical properties, factors, and problems. This study demonstrates the combination and individuality of the cases identified. The results showed that most of the aircraft equipment, real estate, infrastructure, construction, commissioning, refrigeration and logistics equipment were good. This study contributes to the existing literature on container terminal operations in India and supports policy makers in improving container terminal operations.[7]

The important role played by ports in the movement of goods from one country to another is well known. International trade of most goods cannot be separated from ports[8]. As the global economy continues to expand in the era of globalization, their important role in the transportation of goods by sea around the world is becoming increasingly important. In India, major ports are under the Ministry of Shipping. There are 12 major ports and 172 small ports in the country. Located at the southern tip of India, Cochin Port is the only major port in Kerala and one of the largest ports in India. International Container Transshipment Terminal (ICTT) is India's only container transshipment terminal and is affiliated with Cochin Port Trust. It has Special Economic Zone (SEZ) status and was established through public-private partnership (PPP). Despite its special status as India's only transshipment terminal and other special features, there are concerns about the performance of its major infrastructure. In this article, as a continuation of their previous research, the authors examine the ICTT on exports and exported products for four years from 2012 to 2015 and offer recommendations to improve its performance.

Container terminals are important intermodal transportation interfaces in the global transportation network. Efficient operation of container loading and unloading at the terminal is very important in reducing transportation costs and managing loading times. This analysis explains these issues in the context of the terminal box model. Methods/Statistical Analysis: The basic process of the problem is formulated as a two-machine flow shop problem. The famous Maximum TSP (Max TSP) problem is used in

[7] Operational performance model for Indian container terminals using qualitative comparative analysis, VPS Nihau Nany am, December 2022

[8] : International Container Transhipments Terminal (Ictt), Kerala: A Comparative Study of Exports and Imports, Dr. Manoj P. K, Joseph P. S, June 2016

this study.[9] The maximum TSP can be solved according to the TSP by replacing each edge value with its own additional equipment, since there is a difference between the load factor I when loading group j and the load factor I when loading group, I when removing group j; Problem (ATSP). Results of the research: All aspects of the shipping container were found to need improvement and optimization. This problem is solved optimally for this type of real-world system. This study reveals a significant potential for time savings. In the case of reloading two ships located side by side in real life (8 groups in bays, 11 bays, 4 volumes in groups), the time saved as a function of the berth length is shown in relation. Time savings associated with container lines are demonstrated. Simulation models of container cranes show that significant time savings can be achieved if two cycles are used. The results show that depending on the parameters, applying two cycles can save time between 12% and 27%. This evaluation is based on a random simulation scenario and an analytical optimization method. Implementation/Development: Good planning of work at the terminal box can reduce long waiting times. Reducing wait times increases customer satisfaction and increases energy efficiency, giving box terminals an edge over competitors.

The aim of this study is to select containers in major ports in South Korea and China as a comparison site, evaluate their relative performance and determine their changes in terms of change, and provide the necessary motivation to improve performance and management levels. Because, unlike previous studies, the scope of comparison is narrow as far as the terminal box, detailed comparisons and analyses can be made and the importance of the results becomes evident.[10] To achieve this goal, 30 large containers from two countries were selected, the strategies and different equipment of each terminal were taken into account, and the DEA (data analysis data) model was used for analysis. The results show that the efficiency of South Korea's major terminals (CCR: 0.815, BCC: 0.886) is similar to China's terminals (CCR: 0.817, BCC: 0.887). Previous studies have concluded that South Korean ports are less efficient than Chinese ports.

[9] An Analysis on the Modelling of Container Terminal Operations, S. Aravindan and K. Thiruvenkatasamy, October 2016

[10] A Study on the Efficiency of Container Terminals in Korea and China, Nam Kya Park, December 2016,

The steady growth of the maritime sector over the last two decades has led to an increase in the number of cargo ships, ports and terminals. In addition, the structure of the maritime industry continues to develop. By integrating shipping lines between carriers, integration of ports, international drivers and special containers was achieved. The aim of this study is to determine the performance of ports and harbours and to examine how the performance of the port/terminal can be increased. In particular, we examine how certain factors affect the performance of ports and terminals. Regional port and international container volumes are analysed according to the Stochastic Frontier Analysis (SFA) model. Two datasets were used: a panel dataset of 32 container ports in the Northern Mediterranean over a nine-year period and a cross-sectional dataset of 165 container terminals worldwide. Net effect and total effect SFA models were applied to both data sets. Evaluation of the technology, size and overall performance of each port/terminal. Analysis of operational and investment strategies for ports and port options. Most container ports and terminals in the Northern Mediterranean model have low efficiency: 90% of containers have an efficiency below 0.80; This study concluded that volume change plays an important role in the performance of containers. The annual growth of port production is lower than technology allows. Container terminals have proven to be more convenient than many other destinations. It turned out that the international terminal staff was not fully staffed at the terminal as expected. He also found that the scale of the terminal box business was too large. The findings here may influence decisions made by carriers, terminal operators, and policymakers, as both dossiers provide an overview of the effectiveness of each port/terminal and provide detailed information on the ineffectiveness of individual ports.[11]

This paper proposes a different microscopic discrete event simulation model for box terminals. The aim is to best model the time it takes to get the job done and the level of detail that needs to be followed, according to the different plans that decision makers need to make at the meeting. These models share the same design concept but differ in the way they estimate uptime. The operation of the terminal is decomposed into activities according to a level of parsing not found in the text; -Analysis, analysis Different plans

[11] Efficiency analysis of container ports and terminals, Q. Liu, Jan 2010

(current/short term, long term) are recognized. Strategic planning and modelling issues related to strategic planning are discussed and practical advice is given.[12]

Hong Kong, Guangzhou and Shenzhen, the three major cities in the Pearl River Delta region, play an important role in the development of the region. However, these ports face many problems such as port overcapacity, environmental problems, and it becomes difficult to expand traffic due to the large cargo volume. Therefore, this study uses relaxation-based measurement-data analysis (SBM-DEA) and DEA-bad models to evaluate the performance of large containers in our province from 2018 to 2019. See, Yantai and Container Terminal 9 (South) are the most used. It was successful and was followed by Container Terminals 6 and 7. The research results provided useful information for future port investments and regional development in the Pearl River Delta region.

Purpose - The port is a symbol of world trade and international trade. Despite the important role that Chinese ports play in international trade, few studies have examined the performance of Chinese container terminals. Moreover, research on China's port efficiency mostly focuses on port-level analysis rather than terminal-level analysis. Therefore, this study focuses on analysing the performance of container terminals in China. SE-DEA is superior to simple DEA models and can sort and classify terminal boxes more efficiently and effectively. If more than one decision unit (DMU) is active in the simple model, their effectiveness is -1.[13] The top 20 packaging companies in China were selected according to packaging level. While many production quotas are set as inputs, the container is considered as output. Findings - The findings show that Terminal Shanghai Dingdong Container Terminal Co., Ltd. was ranked 1, followed by Shanghai Shandong International Container Terminal Co., Ltd., Shanghai International Port (Group) Co., Ltd. and Yidong Container Terminal Branch

During COVID-19, major ports around the world faced insufficient workforce, port congestion, international supply chain disruptions and many other problems. In such

[12] Tactical and strategic planning for a container terminal: Modelling issues within a discrete event simulation approach, Stefano de Luca, February 2012
[13] The efficiency of major container terminals in China: super-efficiency data envelopment analysis approach, Liu-Liu Li, May 2021

cases, using a fully electric generator is an option to ensure stable operation of the port. This study aims to evaluate the performance of fully electronic terminals compared to non-automated terminals during the transportation period affected by coronavirus. Four operating ports, both fully automatic and non-fully automatic, have been selected. Target terminal performance; It is measured according to values such as throughput, number of ship arrivals and berthing times. The results showed that fully automated containers were more efficient than fully automated containers. The first one resulted in an increase in exports, a slight decrease in ship docking time and an increase in the number of ships arriving at the port. There are also economic results showing that the total revenue of the terminal increases for all automatic generators, while the total revenue from the terminal to the automatic user decreases as the number of calls increases[14]. Therefore, all automated terminals can be considered as an alternative for a flexible and stable response to a crisis such as COVID-19.

South Africa's shipping industry faces many risks, the most significant of which is traffic congestion at ports. The Port of Cape Town is one of the important ports of South Africa. Two risks related to port congestion facing the Cape Town Container Terminal (CTCT) are severe weather conditions and physical problems. This study investigates the frequency and timing effects of weather- and system-related interactions currently encountered by ocean carriers in the CTCT. This research was carried out in two stages: secondary research and primary research[15]. Secondary research provides background information and historical data on the Port of Cape Town, CTCT, South African port congestion and international port congestion. Additionally, primary data collected, including personal interviews and email communications, were used to identify the current nexus in CTCT and create a risk profile. The main results of this study show that both air- and port-related systems were assessed as main risk factors in the CTCT of 2011 and 2018, and further risk mitigation strategies are needed. If mitigation strategies are not developed, the risk of the risk will increase in the future. This study classifies air and port related systems in the CTCT by risk level and helps identify areas where management should focus to reduce risk in the future.

[14] Study on Comparing the Performance of Fully Automated Container Terminals during the COVID-19 Pandemic, Bokyung Kim, August 2022
[15] Risk Profile of Weather and System-Related Port Congestion for the Cape Town Container Terminal, Lilian Potgieter, August 2020

India's container terminals have grown 46% in the last five years and 9% annually since 2015. The country's container terminal usage. This study uses box volume ratio, Herfindahl-Hirschman Index (HHI) and Shared Performance Analysis (SSA) for analysis from 2015 to 2019 to examine the concentration and distribution trends of container terminals in India. Additionally, this study also examines the development of container terminals in India during the same period. Draw a growth matrix and classify terminals according to their business and growth rate. The results show that containers have shown a different explosion trend over the past five years. The HHI index has fallen by more than 33% in five years; This shows that the market has moved to full competition, thus creating room for the growth of new terminals. Adani International Container Terminals (AICT) emerged as the star player in terms of growth distribution matrix during the said period. This study is the first of its kind on container terminals in India. The findings will enable port authorities, private companies and ports to understand the business they operate in and their strategies to improve their terminals.[16]

This study presents a study on the performance of container terminals in Indian ports. The aim of this study is to evaluate the performance of terminals by evaluating their relative performance using data analysis and evaluation results. Our analysis can identify weak and ineffective energy sources and measure their performance over time. We found that operators operating terminals in large ports on the West Coast outperformed private terminals operating in smaller ports on the East Coast. But East Coast ports proved to be the most profitable for two office holders. Our research informs the development of non-renewable products and provides ocean stewardship information to people.[17]

This article examines the main features of port development in VOC ports, whether modern inland port or outer port construction. Two options can be considered to increase the current cargo from 64 million tons to 125 million tons: Option I - Increasing the inner port depth (Ø) to 16.50 m CD and strengthening the existing berths to have a capacity of 8000-12,500 TEU 6th generation container ships as well as Panamax 95,000 dwt carriers and oil tankers with a maximum height of 15.20 m. Option 2 - Deepening and building

[16] Concentration analysis of container terminals in India, V.P.S. Nihar Nanyam, August 2021
[17] Performance assessment of seaport container terminals of India using data envelopment analysis, Binay Kumar Rajak, July 2022

outer harbours, connecting the northern and southern breakwaters and building new harbours in the breakwater. The first and second options will take 5 and 10 years to implement. Option I was considered the most suitable for rapid growth. The total investment cost of using Option I was found to be 20% cheaper than Option II[18]. Option 1 involves more dredging, but all of the dredged material is used for reclamation. Options for deep renovation/upgrading of existing stations without affecting freight traffic are also being discussed.

In the coming years, India's container terminals can achieve many goals by tapping into their untapped potential. Many factors will affect an existing terminal's ability to operate at maximum capacity. Despite the importance of capacity shortage, little research exists to identify these factors and their impact on container terminal operations in India. The aim of this study is to develop a conceptual model to identify enablers and guardians and demonstrate how their relationships affect the performance of container terminals in India. This study identified 21 operators, 15 defenders and 7 performance indicators through extensive literature review and expert consultation. Additionally, surveys of 81 participants from different contexts in India were analysed and exploratory results were used to identify characteristics identified in 5 enablers, 3 inhibitors and 2 performance indicators. A hypothesized model containing all these attributes and features was developed and tested using Partial Least Squares Statistical Modelling (PLS SEM). The results showed that auditors and their responses had a significant impact on the performance of terminal boxes. Infrastructure development and initiatives, parking and policies, refrigerated containers and transport efficiency, processes and procedures, contracts and start-up costs are the core of the business. In addition, issues related to management and resources, infrastructure and business issues, and issues related to policy and procedure may also be viewed as material. This research can help port professionals and port partners deal with these situations and improve the efficiency of the container terminal.[19]

This article examines the key factors affecting the changing operations of port container terminals. The aim is to use queuing techniques to determine service improvement

[18] Development of Port Infrastructure at VOC Port, Tuticorin, R. Sundaravadivelu, November 2020
[19] Conceptual Model for the Operational Performance of the Container Terminals in India, V.P.S. Nihar Nanyam, May 2022

strategies for container terminals by analysing queues. The model developed here is called mass arrival multi-server queuing system and is defined as a stochastic model. The model is then compared to other analytical models and simulation methods. A comparison of these models has been made and the results show that the experimental model can replace the simulation model.

Maritime transport is an important part of India's trade and economic growth, accounting for 90% and 77% of India's trade volume and value. The current trend is towards outsourcing to India and China; China is further developing its ports to meet its outsourcing potential. In the case of India, the box vehicle has grown at over 15% annually in the last five years, which is impressive and more when compared to world trends. Although the turnaround time and additional pre-berthing time decreased from 3.7 days on 3 March 2002 to 3.5 days in April 2003 and from 6.9 hours in March 2002 to approximately 5 hours in 2003. World standards are still a long way off. India plays an important role in the maritime field, accounting for less than one percent of the world market. When capacity is increased, the infrastructure to support it cannot be provided. For example, JNPCT and NSICT face capacity constraints commensurate with their increasing numbers. Throughput growth exceeds capacity growth, resulting in congestion and low productivity. Low productivity levels and poor processes and procedures make the Indian maritime sector unattractive in the eyes of international players. There are many deficiencies in Indian ports such as inadequate infrastructure, backward logistics, backward technology, administrative problems, operational problems. India is one of the world's five largest exporters and its economic growth is inevitable. If the infrastructure, facilities and processes of Indian ports are not updated to world standards, there will be a huge loss in the business of Indian ports. Seeing this and acting faster is the need of the age. The public and private sectors should be encouraged to participate in the modernization of India's infrastructure. Single window clearance, multi-modal transport and efficient customs procedures will enhance the competitiveness of Indian ports in the global shipping market.

Although there are many studies on the performance of containers, most of them are in developing countries and there are very few studies on developing countries such as India. Indian ports have become very important due to their location and ability to provide transportation. Their performance should be understood at the micro level,

especially at the terminal level, rather than the performance of the entire port. This article uses data analysis techniques to focus on analysing the performance of 26 container terminals in India from 2015 to 2018 and interprets it from the perspective of facility quality, regulatory and private management of terminal operations. This study examines the Malmquist Index, which measures changes in productivity over time and breaks it down into two factors: changes in performance (called catch-up) and front-line staff turnover. This study lists the performance of terminals. While the relative number of container terminals on the west coast of India is better than on the east coast, the efficiency of container terminals built by major ports shows a declining trend compared to other ports. The private sector has not seen similar efficiencies across all containers. Among the seven high-performing terminals identified by the analysis, Tuticorin Terminal is the best in terms of relative performance and overall growth rate. The study revealed that the main factor affecting the performance of the terminal is the size of the terminal, which has the advantage of economies of scale.

In the era of globalization, ports play an important role in connecting national products to international markets. Improving port operations has become a priority for many countries. One way to achieve this is to check current performance against performance not specified by the port industry. This paper uses data analysis of selected strategies and outcomes to evaluate the performance of major ports in India. Different strategies include warehouses, number of beds and cargo handling equipment. The two output quantities included are the average total shift duration and the average daily output per ship berth. Six of the 12 ports are considered high-performance ports. Additionally, the researchers sought to identify various areas for port development by interviewing port managers of selected ports in India, where the researchers had the opportunity to conduct research projects. The interviews were followed by qualitative discussions with port managers about port operations. This study can form the basis on which further changes can be made to meet their specific needs.[20]

[20] Improving port efficiency: a comparative study of selected ports in India, Sachin S. Kamble, Arun D. Raoot, Oct 2001

2.3 PERFORMANCE METRICS IN PORT OPERATIONS

Key Performance Indicators (KPIs) are essential tools for evaluating the efficiency and effectiveness of port operations. They provide quantitative measures to assess various aspects of port performance, enabling stakeholders to monitor progress, identify areas for improvement, and make informed decisions. Here, we identify and elaborate on key performance indicators commonly used in evaluating port efficiency:

Vessel Turnaround Time:

Vessel turnaround time measures the time taken for a vessel to complete its port call, including arrival, berthing, cargo operations (loading/unloading), and departure. It is a critical indicator of port efficiency, reflecting the terminal's ability to handle vessels promptly and minimize turnaround delays. Delays in vessel turnaround time can lead to increased operating costs for shipping lines and congestion at the port.

Berth Occupancy Rate:

Berth occupancy rate represents the percentage of time that berths are occupied by vessels during a specified period. It indicates how effectively berths are utilized and provides insights into terminal congestion and capacity constraints. High berth occupancy rates may indicate the need for additional berth infrastructure or improved berth allocation strategies to enhance port efficiency.

Container Throughput:

Container throughput measures the volume of containers handled by the port within a given timeframe, typically expressed in TEUs (twenty-foot equivalent units). It is a fundamental indicator of port activity and capacity utilization, reflecting the terminal's ability to handle cargo efficiently. Increasing container throughput indicates growing trade volumes and may require corresponding investments in terminal infrastructure and equipment to maintain operational efficiency.

Cargo Dwell Time:

Cargo dwell time measures the duration that cargo remains within the port area, including storage, handling, and transit times. Long dwell times can indicate inefficiencies in cargo handling processes, such as congestion, inadequate storage capacity, or inefficient

logistics operations. Minimizing cargo dwell time is essential for optimizing port efficiency and reducing supply chain costs for cargo owners.

Port Productivity:

Port productivity measures the efficiency of cargo handling operations, typically expressed as the number of containers or tonnage handled per unit of time or per unit of resource (e.g., labour, equipment). It reflects the terminal's ability to process cargo quickly and cost-effectively, considering factors such as equipment utilization, workforce productivity, and operational practices. Improving port productivity requires optimizing workflows, deploying advanced technologies, and enhancing operational efficiency.

Safety Performance:

Safety performance indicators assess the port's compliance with safety regulations and its efforts to prevent accidents, injuries, and environmental incidents. Metrics such as lost-time injury frequency rate, near-miss incidents, and environmental compliance violations provide insights into the effectiveness of safety management systems and risk mitigation measures. Maintaining high safety standards is essential for safeguarding personnel, assets, and the surrounding environment while ensuring uninterrupted port operations.

Customer Satisfaction:

Customer satisfaction measures the satisfaction levels of port users, including shipping lines, cargo owners, and logistics providers. Surveys, feedback mechanisms, and service level agreements (SLAs) are commonly used to assess customer perceptions regarding service quality, reliability, responsiveness, and overall experience. Positive customer feedback indicates a well-performing port that meets stakeholders' needs and expectations, fostering long-term relationships and competitive advantage.

2.4 CONTEXTUALIZING TAMIL NADU PORTS

Tamil Nadu, a state situated in the southern part of India, has a rich maritime history dating back thousands of years. The state's coastal geography, with a vast stretch along the Bay of Bengal and the Indian Ocean, has contributed significantly to its maritime heritage and economic development. Here's an overview of Tamil Nadu's maritime history and its current status in the global maritime industry:

Ports and Infrastructure:

Tamil Nadu is home to several major ports, including Chennai Port, Kamarajar Port (formerly known as Ennore Port) and V.O Chidambaranar port. These ports serve as vital gateways for international trade, handling diverse cargo types such as containers, bulk commodities, petroleum products, and automobiles. The state government and port authorities have invested in modernizing port infrastructure, expanding capacity, and implementing technology-driven solutions to enhance efficiency and competitiveness.[21]

Industrial and Economic Hub:

Tamil Nadu's maritime industry contributes significantly to the state's economy and industrial development. The presence of industrial clusters, including automotive, textiles, pharmaceuticals, and electronics, along the coastline has fuelled demand for maritime transportation and logistics services. The integration of ports with industrial zones and Special Economic Zones (SEZs) has facilitated seamless movement of goods and raw materials, attracted investments and fostered economic growth.

Shipping and Logistics:

Tamil Nadu has a strong presence in the shipping and logistics sectors, with numerous shipping companies, freight forwarders, logistics providers, and maritime service firms operating in the region. Chennai, the state capital, serves as a major hub for maritime services, including ship management, marine insurance, maritime education, and research. The Chennai Port Trust and other stakeholders collaborate to promote skill development, innovation, and sustainability in the maritime domain.

Emerging Opportunities:

Tamil Nadu's strategic location and growing economy offer various opportunities for further expansion and diversification in the maritime industry. Initiatives such as the Sagarmala Program, aimed at enhancing port connectivity, hinterland infrastructure, and coastal economic development, present avenues for unlocking the state's maritime potential. Additionally, investments in renewable energy, coastal tourism, and marine biotechnology offer prospects for sustainable development and innovation in the maritime sector.

[21] INDIAN CONTAINER MARKET REPORT-2021

CHAPTER III

METHODOLOGY

3.1 RESEARCH DESIGN

3.3.1 QUANTITATIVE ASPECT:

The quantitative aspect of the research would involve gathering numerical data on various performance metrics of the container terminals. This could include data on container throughput, turnaround times, vessel waiting times, handling efficiency, infrastructure capacity, and utilization rates.

Quantitative methods would allow for the systematic comparison of these metrics across different ports, providing numerical insights into their relative performance.

Statistical analysis could be used to identify trends, patterns, and correlations within the data, helping to draw meaningful conclusions about the efficiency and effectiveness of each terminal.

3.3.2 QUALITATIVE ASPECT:

The qualitative aspect of the research would involve gathering insights from stakeholders such as port authorities, shipping companies, customs officials, and logistics providers.

Qualitative methods such as interviews, focus groups, and open-ended surveys could be used to gather rich, descriptive data on factors influencing terminal performance. This could include aspects such as regulatory environments, infrastructure investments, operational practices, labour dynamics, and customer satisfaction.

Qualitative data would provide context and depth to the quantitative findings, helping to explain variations in performance across different terminals and uncovering potential areas for improvement.

3.3.3 MIXED-METHODS APPROACH:

By combining quantitative and qualitative methods, researchers can triangulate their findings, enhancing the overall validity and reliability of the study.

The quantitative data would provide numerical benchmarks for performance, while the qualitative data would offer insights into the underlying reasons and dynamics driving these performance differences.

Integrating both approaches would enable a comprehensive understanding of the comparative performance of major ports container terminals within Tamil Nadu, allowing for more informed policy recommendations and managerial decisions.

3.2 DATA COLLECTION

3.2.1 PRIMARY DATA SOURCES:

Surveys and Interviews: Conducting surveys and interviews with port authorities, terminal operators, shipping companies, and relevant government officials to gather first-hand information about operations, performance metrics, challenges, and future plans.

Field Visits: Visiting the major ports and container terminals in Tamil Nadu to observe operations, infrastructure, efficiency, and any bottlenecks first-hand.

Questionnaires: Distributing questionnaires to stakeholders to gather specific data on throughput, handling capacity, turnaround time, infrastructure utilization, and customer satisfaction.

Financial Reports: Obtaining financial reports directly from the port authorities and terminal operators to analyse revenue, expenditure, investment, and profitability.

3.2.2 SECONDARY DATA SOURCES:

Government Publications: Utilizing reports, publications, and statistical data released by government bodies such as the Ministry of Shipping, Port Trusts, and Tamil Nadu Maritime Board.

Industry Reports: Accessing reports and analyses published by research firms, industry associations, and consulting agencies focusing on the maritime sector in Tamil Nadu.

Academic Journals and Research Papers: Reviewing scholarly articles, research papers, and case studies related to port performance, container terminal operations, and maritime logistics within Tamil Nadu.

Online Databases: Extracting data from online databases such as port statistics databases, trade databases, and shipping databases to gather quantitative information on cargo volumes, vessel traffic, and trade patterns.

News Articles and Press Releases: Analysing news articles, press releases, and media coverage related to developments, expansions, and challenges faced by major ports and container terminals in Tamil Nadu.

3.2.3 DATA COLLECTION METHODS:

Quantitative Analysis: Collecting numerical data on container throughput, vessel calls, cargo types, storage capacity, container handling equipment, and other relevant metrics.

Qualitative Analysis: Gathering qualitative data through interviews, surveys, and observations to understand operational inefficiencies, customer satisfaction, infrastructure limitations, and regulatory issues.

Comparative Analysis: Analysing the collected data to compare the performance of different ports and container terminals within Tamil Nadu in terms of efficiency, productivity, infrastructure utilization, connectivity, and competitiveness.

3.3 DATA ANALYSIS

3.3.1 DATA COLLECTION TECHNIQUES:

Primary Data Collection: Conducting surveys, interviews, and direct observations at the ports to gather first-hand information.

Secondary Data Collection: Collecting existing data from reports, databases, and academic literature related to port operations, container handling, and performance metrics.

3.3.2 DATA PREPROCESSING:

Data Cleaning: Identifying and correcting errors, inconsistencies, and missing values in the collected data.

Data Transformation: Converting data into a suitable format for analysis, such as aggregating data over time intervals or converting categorical variables into numerical representations.

3.3.3 DESCRIPTIVE ANALYSIS:

Summary Statistics: Calculating basic statistics such as mean, median, mode, and standard deviation to describe the central tendency and variability of key performance indicators (KPIs) like container throughput, turnaround time, and berth occupancy.

Data Visualization: Creating graphs, charts, and maps to visually represent trends, patterns, and spatial distributions in port performance metrics using tools like matplotlib, seaborne, or Tableau.

3.3.4 COMPARATIVE ANALYSIS:

Benchmarking: Comparing the performance of different ports' container terminals against predefined benchmarks or industry standards to identify strengths, weaknesses, and areas for improvement.

Ratio Analysis: Calculating ratios such as container throughput per berth, average vessel turnaround time, or container dwell time to compare the efficiency and effectiveness of port operations.

3.3.5 PREDICTIVE ANALYSIS:

Regression Analysis: Building regression models to predict future trends in container traffic, vessel arrivals, or port capacity utilization based on historical data and relevant factors such as economic indicators, trade volumes, and infrastructure investments.

Time Series Forecasting: Using time series analysis techniques like ARIMA (Autoregressive Integrated Moving Average) or exponential smoothing to forecast short-term and long-term variations in port performance metrics.

3.4 LIMITATIONS AND ETHICAL CONSIDERATIONS

3.4.1 LIMITATIONS:

Data Availability and Quality: One of the primary limitations could be the availability and quality of data pertaining to container terminal performance. Data collection may be incomplete or inconsistent, leading to potential biases in the analysis.

Sample Size: The study may be limited by the number of ports and container terminals within Tamil Nadu that are included in the analysis. A small sample size could limit the generalizability of the findings.

Scope and Depth of Analysis: Depending on the resources and time constraints, the analysis may not cover all relevant factors influencing the performance of container terminals. This could limit the comprehensiveness of the study.

External Factors: The study may not account for external factors such as changes in government policies, economic conditions, or global trade dynamics, which could impact the performance of container terminals.

Methodological Limitations: The methodology used for performance comparison may have limitations, such as the choice of performance metrics, analytical techniques, or assumptions made during the analysis.

3.4.2 ETHICAL CONSIDERATIONS:

Data Privacy and Confidentiality: Ensuring the confidentiality of data collected from ports and stakeholders is essential to protect sensitive information and maintain trust with participants.

Conflict of Interest: Researchers should disclose any potential conflicts of interest that could influence the findings or interpretation of the study, especially if there are financial or professional ties to the ports being analysed.

Informed Consent: If the study involves human participants, such as port employees or stakeholders, obtaining informed consent is necessary to ensure that they understand the purpose of the research and voluntarily agree to participate.

Impartiality and Objectivity: Researchers should strive to maintain impartiality and objectivity throughout the research process, avoiding biases that could skew the findings or conclusions.

Respect for Stakeholders: Respecting the perspectives and interests of stakeholders involved in the study is important, and researchers should strive to represent their viewpoints accurately and fairly.

CHAPTER IV

PORT PROFILES AND OPERATIONAL OVERVIEW

4.1 DESCRIPTION OF MAJOR PORTS IN TAMIL NADU

Kamarajar Port Limited:

- Ennore Port, officially known as Kamarajar Port Limited, is a major port located near Chennai.
- It is primarily a bulk cargo terminal, handling commodities such as coal, iron ore, petroleum products, fertilizers and automobile.[22]
- The port is equipped with modern handling facilities, including conveyor systems, stackers, declaimers, and storage yards for efficient bulk cargo handling.
- It also has dedicated berths for liquid cargo and containerized cargo, catering to diverse shipping needs.

History and Development:

- Kamarajar Port was commissioned in 2001 with the aim of decongesting Chennai Port and catering to the growing demand for bulk cargo handling.
- Over the years, Kamarajar Port has witnessed significant development and expansion, including the addition of new berths, terminals, and handling equipment.
- Since its inception, the port has undergone significant development and expansion to enhance its capacity and capabilities.
- Kamarajar Port Trust has implemented modern technologies and best practices to improve operational efficiency, safety standards, and environmental sustainability.

Chennai Port Authority:

- Chennai Port is one of the oldest and largest ports in India, handling a diverse range of cargo, including containers, bulk cargo, and petroleum products. Its infrastructure includes:
- Multiple berths equipped with modern container handling cranes, bulk cargo handling equipment, and liquid cargo terminals.[23]

[22] https://www.ennoreport.gov.in
[23] https://www.chennaiport.gov.in

- Dedicated container terminals with state-of-the-art facilities for efficient container handling and storage.
- Rail and road connectivity to facilitate seamless movement of cargo to and from the port.
- Warehousing and storage facilities to cater to the storage needs of various types of cargo.

History and Development:

- Chennai Port has a rich history dating back to the British colonial period when it was established as a major trading hub on the eastern coast of India.
- Over the years, Chennai Port has undergone significant expansion and modernization to keep pace with the growing demands of international trade.
- Various development projects have been undertaken to enhance port infrastructure, including the construction of new berths, container terminals, and mechanized cargo handling facilities.
- Chennai Port Trust, the governing body overseeing port operations, has implemented technology-driven solutions and operational efficiencies to improve port performance and customer service.

V.O. Chidambaranar Port:

- V.O. Chidambaranar Port has multiple berths dedicated to handling different types of cargo. These include container berths, bulk cargo berths, and liquid cargo berths. The port has modern quay infrastructure equipped with container cranes, bulk handling equipment, and liquid cargo handling facilities.
- The port features a state-of-the-art container terminal equipped with modern container handling equipment such as quay cranes,[24] rubber-tired gantry cranes (RTGs), and reach stackers. The container terminal has facilities for storage, handling, and customs clearance of containerized cargo.
- V.O. Chidambaranar Port specializes in handling bulk cargo such as coal, iron ore, fertilizers, and cement. It has dedicated berths and terminals equipped with conveyor systems, loaders, and unloaders for efficient handling of bulk commodities.

[24] https://www.vocport.gov.in

- The port has facilities for handling liquid cargoes including petroleum products, chemicals, and edible oils. It has specialized liquid cargo berths with storage tanks and pipelines for loading and unloading operations.

History and Development:

- The history of V.O. Chidambaranar Port traces back to the early 20th century when the Tuticorin Port Trust was established in 1974. Initially, the port primarily served as a minor port catering to coastal trade.
- Over the years, the port witnessed significant expansion and development to meet the growing demands of maritime trade. Expansion projects were undertaken to enhance infrastructure, deepen berths, and increase cargo handling capacity.
- Renaming: In 2011, the Tuticorin Port Trust was renamed V.O. Chidambaranar Port Trust as a tribute to V.O. Chidambaram Pillai, a prominent freedom fighter and pioneer of the Swadeshi movement in Tamil Nadu.
- V.O. Chidambaranar Port has undertaken various modernization and expansion projects to enhance its infrastructure and operational efficiency. These projects include the development of new berths, construction of container terminals, dredging works, and installation of modern cargo handling equipment.

4.2 OPERATIONAL ASPECT

4.2.1 KAMARAJAR PORT CONTAINER TERMINAL

ADANI ENNORE CONTAINER TERMINAL (AECTPL)

On a global bidding process conducted by KPL port authority Adani Ports and Sze Ltd was declared as the successful bidder by port authority on 14th February 2014 and the concession 18 agreement was signed on 3rd March 2014 for the development of container in Rs 1270 Crores with 1.40 million TEUs per annum capacity in two phases on DBFOT basis. The first phase was completed on 29th October 2017 with 400m quay length of 0.8 million TEUs capacity and begun its operations.

FEATURES OF AECTPL:

- Terminal of quay length of 400m with a draft of 15m.
- Four dockside gantry cranes (4QCs) for loading and discharging operation with 22 across outreach.
- 12 e-RTGs for stacking the container in storage yard.
- 4000 ground slots and 150 Reefer points.
- 36.50 Ha of backup yard segregated into different section for the smooth handling of general cargo containers, reefers, dangerous goods etc.
- Capable of handling both 20ft and 40ft containers.
- SWL under cargo beam – 75 tons, SWL under spreader – 65 tons.
- Connected with all CFS in Chennai of EXIM and connected to ICD Whitefield, Marigold Logistics, CWC & HAL in Bangalore.
- The total cargo handled during the year 2022-23 is 10.62 Million Tonnes.[25]

FIG 4.1 ADANI ENNORE CONTAINER TERMINAL (AECTPL)

Source: KPL Website

[25] https://www.adaniports.com/ports-and-terminals/ennore-terminal

4.2.2 CHENNAI CONTAINER TERMINALS:

CHENNAI CONTAINER TERMINAL LIMITED (CCTL)

The first container terminal at the Chennai port, the Chennai Container Terminal L (CCTL), was finished in 1983. The 1.2 million TEU container terminal, which was privatised in 2001, has been run by DP World since November 30, 2001. CCT is managed by the Chennai Port Trust of the Indian government under a 30-year build-operate-transfer agreement. The terminal can handle fifth-generation boats up to 6,400 TEU and has direct connections to China, West Africa, Europe, and the United States. Out of the top 100 container terminals worldwide, CCT is currently rated 79th. It is one of India's terminals that is growing the fastest, with a CAGR of 20%.[26]

Container Terminals (CTB 1, CTB 2, CTB 3, CTB 4)

- CCTPL (Terminal - I) - Quay Length - 885m
- Depth - 13.5-15m
- Ground Slots - 3960
- Yard Capacity - 0.85 million TEUs/Year
- Reefer Plugs - 355
- Quay Cranes - 7
- RTG's - 22
- ICD Trains - Daily.

FIG 4.2 CHENNAI CONTAINER TERMINAL LIMITED (CCTL)

Source: CHPA Website

[26] https://www.dpworldchennai.com

4.2.3 CHENNAI INTERNATIONAL TERMINAL PRIVATE LIMITRD:

On June 22, 2009, Chennai International Terminal Pvt Ltd (CITPL), the second container terminal, opened with berths SCB1, SCB2, and SCB3. The build-operate-transfer facility was built for around US$110 million through a joint venture between PSA International and Sical Logistics Ltd, a company based in Chennai. The port has three berths with a combined quay length of 832 metres, 35 hectares (86 acres) of yard space, and an annual capacity of 1.5 million TEUs (2,730 ft.). It presently features 7 rail-mounted quay cranes (RMQC), 18 RTGs, 6 reach stackers, and 120 reefer plugs, also in addition of four post-Panamax quay cranes capable of lifting two 20-foot containers every move and eight RTGs.[27]

Container Terminal - 2 (SCB1, SCB2, SCB3)

- CITPL (Terminal - II) - Quay Length - 832m
- Depth - 15m
- Ground Slots - 3917
- Yard Capacity - 1.2 M TEUs/year
- Reefer Plugs - 304
- Quay Cranes - 7
- RTG's - 18
- ICD Trains - Daily

FIG 4.3 CHENNAI INTERNATIONAL TERMINAL PRIVATE LIMITRD

Source: CHPA Website

[27] https://india.globalpsa.com

4.2.4 V. O. CHIDAMBARANAR PORT AUTHORITY TERMINALS

DAKSHIN BHARAT GATEWAY TERMINAL

Dakshin Bharat Gateway Terminal Pvt Ltd is one of the leading south Indian container terminal operating at Berth no 8 of V O Chidambaranar Port Authority Tuticorin since 2014 DBGT stands at the forefront of technological advancements and has high productivity with an average Gross Crane rate of 32 moves hour, average berth productivity 67 moves/hour, average vessel gate moves 1200 containers day and Truck Turnaround Time (averaging at 20 minutes per trailer DBGT is the most efficient and competitive dwell time performer among the East Indian Container Terminals with import dwell time averaging at 1.7 days and exports at 2.5 days.[28]

Container Terminal (Berth 1)

- DBGT (Terminal) - Quay Length - 345m
- Depth - 14.2m
- Ground Slots - 8260
- Yard Capacity - 0.72 M TEUs/year
- Reefer Plugs - 112
- Quay Cranes - 3
- RTG's - 9
- ICD Trains - Daily

FIG 4.4 DAKSHIN BHARAT GATEWAY TERMINAL

Source: VOCPA Websit

[28] https://www.dbgt.in

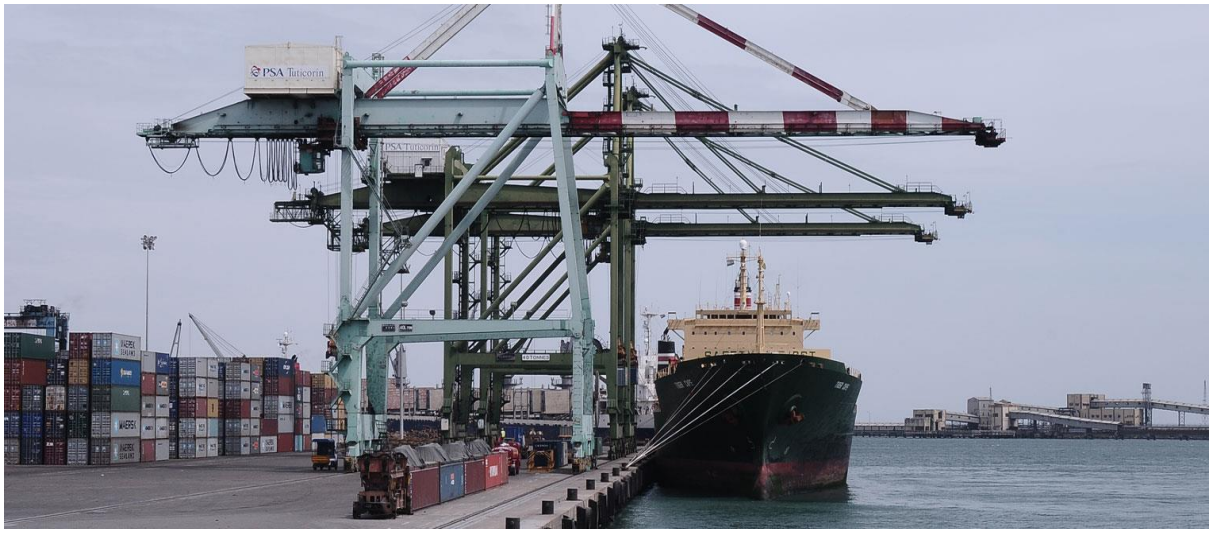
4.2.5 PSA SICAL TERMINALS LIMITED

PSA SICAL is a leading port operator on the southeast coast of the Indian subcontinent, providing best-in-class services. The best practices and operational procedures are accustomed to regional requirements in order to fulfil our customers' expectations. As a key gateway to Tuticorin and its hinterland region, PSA SICAL is continuously at the forefront when it comes to the adaptation of ease of doing business to more stringent requirements. Our parent company PSA International (PSA) is a leading port group and trusted partner to cargo stakeholders. With flagship operations in Singapore and Antwerp, PSA's global network encompasses 160 locations in 42 countries around the world.[29]

Container Terminal (Berth 1)

- DBGT (Terminal) - Quay Length - 370m
- Depth - 11.7 m
- Ground Slots - 5260
- Yard Capacity - 0.45 M TEUs/year
- Reefer Plugs - 95
- Quay Cranes - 3
- RTG's - 7
- ICD Trains - Daily

FIG 4.5 PSA SICAL TERMINALS LIMITED



Source: VOCPA Website

[29] https://india.globalpsa.com/psasical

4.3 CURRENT PERFORMANCE LEVELS

4.3.1 ADANI ENNORE CONTAINER TERMINAL (AECTPL)

The terminal at ennore, boasting a quay length extending up to 400 meters and a draft of 15 meters, stands as a beacon of efficiency in maritime logistics. Equipped with four dockside gantry cranes (4QCs), each with an impressive 22 across outreach, the terminal ensures swift and seamless loading and discharging operations for vessels of varying sizes. Complementing this infrastructure are 12 electric Rubber-Tired Gantry Cranes (e-RTGs), facilitating the efficient stacking of containers in the storage yard. With a capacity of 4000 ground slots and 150 Reefer points, the terminal caters to a diverse range of cargo, including perishable goods requiring temperature-controlled environments.

Spanning across 36.50 hectares, the backup yard is meticulously segregated into different sections, ensuring the smooth handling of general cargo containers, reefers, dangerous goods, and more. This segmentation optimizes operational efficiency and minimizes the risk of logistical bottlenecks, thereby enhancing overall productivity. The terminal's versatility is further underscored by its capability to handle both 20-foot and 40-foot containers, catering to the diverse needs of shippers and consignees.

Safety and reliability are paramount at the terminal, as evidenced by the Safe Working Load (SWL) specifications. With a cargo beam SWL of 75 tons and a spreader SWL of 65 tons, the terminal's equipment is engineered to meet stringent safety standards while maintaining optimal operational performance. This commitment to safety instils confidence among stakeholders and underscores the terminal's reputation as a trusted partner in maritime trade.

Beyond its physical infrastructure, the terminal's connectivity plays a pivotal role in facilitating trade flows. Seamlessly connected to all Container Freight Stations (CFS) in ennore, the terminal serves as a vital link in the region's export-import ecosystem. Moreover, its connectivity extends beyond Chennai, with direct links to key logistics hubs such as ICD Whitefield, Marigold Logistics, CWC, and HAL in Bangalore. This extensive network enhances the terminal's accessibility and reinforces its status as a strategic gateway for regional and global trade.

The terminal's performance is a testament to its operational excellence and commitment to customer satisfaction. During the fiscal year 2022-23, the terminal handled a total cargo volume of 10.62 million tonnes, underscoring its role as a key facilitator of trade and commerce. This impressive throughput is a reflection of the terminal's efficiency, resilience, and ability to adapt to dynamic market conditions.

Looking ahead, the terminal remains poised for further growth and expansion, driven by a relentless pursuit of innovation and continuous improvement. With India's economy poised for robust growth and increasing integration into global supply chains, the terminal is well-positioned to capitalize on emerging opportunities and contribute significantly to the nation's economic development.

4.3.2 CHENNAI CONTAINER TERMINAL LIMITED (CCTL)

At CCTPL (Terminal - I), efficiency and capacity intertwine to form the backbone of maritime operations. With a commanding quay length stretching an impressive 885 meters, the terminal stands as a beacon of maritime prowess on the waterfront. Anchored by a depth ranging from 13.5 to 15 meters, it accommodates vessels of varying sizes, ensuring smooth berthing and unloading operations. The terminal's ground slots, totalling 3960, provide ample space for the storage and movement of containers, contributing to streamlined logistics operations.

A testament to its operational excellence, CCTPL boasts a formidable yard capacity of 0.85 million TEUs per year. This substantial throughput capacity underscores the terminal's pivotal role in facilitating trade and commerce, serving as a vital conduit for the movement of goods both domestically and internationally. Complementing this capacity are 355 reefer plugs, catering to the storage and transportation needs of perishable goods, pharmaceuticals, and other temperature-sensitive cargo.

The terminal's infrastructure is further bolstered by its fleet of quay cranes and Rubber-Tired Gantry Cranes (RTGs), which ensure the efficient handling and movement of containers within the terminal premises. With seven quay cranes standing sentinel along the waterfront, and 22 RTGs orchestrating the choreography of container stacking and

retrieval in the storage yard, CCTPL operates with precision and agility, optimizing turnaround times and maximizing productivity.

Connectivity lies at the heart of CCTPL's operations, with ICD trains plying daily to and from the terminal, facilitating the seamless movement of cargo between the port and hinterland destinations. This robust rail connectivity enhances the terminal's accessibility and extends its reach beyond the confines of the waterfront, linking it to key industrial and commercial centres across the region. By leveraging multimodal transport networks, CCTPL strengthens its position as a strategic gateway for trade and commerce, driving economic growth and prosperity.

Beyond its physical infrastructure and operational capabilities, CCTPL prides itself on its commitment to innovation, sustainability, and customer satisfaction. Through continuous investment in technology and infrastructure upgrades, the terminal remains at the forefront of industry trends, adapting to evolving market dynamics and customer needs. Moreover, CCTPL prioritizes environmental stewardship, implementing initiatives to reduce carbon emissions, minimize waste, and conserve natural resources, thereby contributing to a greener and more sustainable future.

The year ahead holds promise and potential for CCTPL, as it continues to expand its footprint, enhance its capabilities, and solidify its position as a leading maritime gateway. With India's economy poised for growth and globalization accelerating, the terminal is poised to play a pivotal role in facilitating trade flows, driving economic development, and fostering prosperity for the nation and its people.

4.3.3 CHENNAI INTERNATIONAL TERMINAL PRIVATE LIMITRD

CITPL (Terminal - II) epitomizes efficiency and capacity, standing as a cornerstone of maritime operations within the bustling port of Chennai. Boasting an extensive quay length of 832 meters and a depth of 15 meters, the terminal offers ample berthing space and navigational clearance for vessels of varying sizes, ensuring smooth and efficient cargo handling operations. With 3917 ground slots available for container storage, CITPL provides a robust infrastructure backbone for the seamless movement and storage of cargo within its premises.

The terminal's yard capacity is nothing short of impressive, with a staggering capability of handling 1.2 million TEUs per year. This substantial throughput capacity underscores CITPL's pivotal role in facilitating trade and commerce, serving as a key enabler for the efficient movement of goods both domestically and internationally. Complementing this capacity are 304 reefer plugs, catering to the storage and transportation needs of perishable goods, pharmaceuticals, and other temperature-sensitive cargo, thereby ensuring the integrity of goods throughout the supply chain.[30]

CITPL's operational prowess is further accentuated by its fleet of quay cranes and Rubber-Tired Gantry Cranes (RTGs), which play a pivotal role in the seamless handling and movement of containers within the terminal premises. With seven quay cranes standing sentinel along the waterfront and 18 RTGs orchestrating container stacking and retrieval in the storage yard, CITPL operates with precision and agility, optimizing operational efficiency and maximizing productivity.

Connectivity lies at the heart of CITPL's operations, with daily ICD trains facilitating the seamless movement of cargo between the terminal and hinterland destinations. This robust rail connectivity not only enhances the terminal's accessibility but also extends its reach beyond the confines of the waterfront, linking it to key industrial and commercial centres across the region. By leveraging multimodal transport networks, CITPL strengthens its position as a strategic gateway for trade and commerce, driving economic growth and prosperity.

Beyond its physical infrastructure and operational capabilities, CITPL is committed to innovation, sustainability, and customer satisfaction. Through continuous investment in technology and infrastructure upgrades, the terminal remains at the forefront of industry trends, adapting to evolving market dynamics and customer needs. Moreover, CITPL prioritizes environmental stewardship, implementing initiatives to reduce carbon emissions, minimize waste, and conserve natural resources, thereby contributing to a greener and more sustainable future.

As CITPL looks to the future, it is poised for growth and expansion, fuelled by India's economic potential and the increasing integration of global supply chains. With its strategic location, state-of-the-art infrastructure, and unwavering commitment to

[30] Behera, S. K. 2016. *Indian container market report*. Drewry and gateway research. Chennai, India: Maritime Gateway

excellence, CITPL stands ready to play a pivotal role in shaping the future of maritime trade in Chennai and beyond.

4.3.4 DAKSHIN BHARAT GATEWAY TERMINAL

DAKSHIN BHARAT GATEWAY TERMINAL (DBGT) stands as a pivotal player in the maritime landscape of Chennai, epitomizing efficiency, reliability, and strategic importance. Despite its quay length of 345 meters, DBGT commands attention with its impressive depth of 14.2 meters, ensuring the accommodation of vessels of varying sizes and draughts. This capability, coupled with an astounding 8260 ground slots, positions DBGT as a formidable hub for cargo handling and storage, facilitating the seamless movement and organization of containers within its expansive premises.

While DBGT's yard capacity of 0.72 million TEUs per year may seem modest compared to some counterparts, its operational efficiency and utilization rates make it a vital component of Chennai's port infrastructure. The provision of 112 reefer plugs underscores the terminal's commitment to catering to diverse cargo requirements, including perishable goods and pharmaceuticals, while maintaining stringent temperature controls throughout the supply chain.

Operational agility is a hallmark of DBGT, exemplified by its fleet of three quay cranes and nine Rubber-Tired Gantry Cranes (RTGs). Despite the relatively smaller number of cranes, the terminal maximizes their utilization to optimize loading and unloading operations, ensuring swift turnaround times for vessels and minimizing berth occupancy. This efficiency is further enhanced by the daily operation of ICD trains, facilitating seamless connectivity between the terminal and hinterland destinations.

The significance of DBGT extends beyond its physical infrastructure, as the terminal serves as a vital link in Chennai's maritime ecosystem, driving economic growth and fostering trade relations. Its strategic location and robust connectivity contribute to its role as a gateway for regional and international commerce, linking businesses to markets across the globe. Moreover, DBGT's commitment to sustainability and environmental stewardship underscores its dedication to responsible business practices and community engagement.

As DBGT looks towards the future, it remains poised for growth and expansion, guided by a vision of excellence and innovation. By leveraging emerging technologies and

industry best practices, the terminal seeks to enhance its operational efficiency, customer satisfaction, and environmental sustainability. Through strategic partnerships and investments, DBGT aims to solidify its position as a leading maritime hub, driving economic prosperity and contributing to the sustainable development of Chennai and beyond.

4.3.5 PSA SICAL TERMINALS LIMITED

PSA SICAL TERMINALS LIMITED, operating as a key maritime hub in Chennai, embodies efficiency, reliability, and strategic importance within the bustling port landscape. Despite its depth of 11.7 meters, the terminal is adept at accommodating a diverse range of vessels, ensuring smooth berthing and cargo handling operations. With 5260 ground slots available for container storage, PSA SICAL TERMINALS LIMITED offers extensive capacity for the efficient organization and movement of cargo within its premises, contributing significantly to the fluidity of logistics operations.

While the yard capacity of 0.45 million TEUs per year may seem modest in comparison to some counterparts, PSA SICAL TERMINALS LIMITED prioritizes operational efficiency and customer satisfaction to optimize throughput. The provision of 95 reefer plugs underscores the terminal's commitment to meeting the diverse needs of its clientele, including the storage and transportation of perishable goods and pharmaceuticals, while maintaining strict temperature controls throughout the supply chain.

Operational agility is a defining characteristic of PSA SICAL TERMINALS LIMITED, showcased by its fleet of three quay cranes and seven Rubber-Tired Gantry Cranes (RTGs). Despite the relatively small number of cranes, the terminal maximizes their utilization to ensure swift loading and unloading operations, minimizing vessel turnaround times and enhancing overall productivity. The daily operation of ICD trains further bolsters the terminal's connectivity, facilitating seamless cargo movement between the port and hinterland destinations.

Beyond its physical infrastructure, PSA SICAL TERMINALS LIMITED plays a pivotal role in Chennai's maritime ecosystem, driving economic growth and fostering trade relations. Its strategic location and robust connectivity make it a preferred choice for businesses seeking efficient access to regional and international markets.

CHAPTER V

COMPARATIVE PERFORMANCE ANALYSIS

5.1 COMPARATIVE FRAMEWORK

Comparison criteria include location, infrastructure, operational efficiency, safety, environmental sustainability, customer service, technological advancement, regulatory compliance, financial performance, and reputation. These factors assess terminals' capabilities in facilitating trade, ensuring efficiency, and meeting industry standards, contributing to their overall competitiveness and success.[31]

TABLE 5.1 COMPARITION OF TERMINLAS

Container Terminal Name	Chennai Container Terminal	Chennai International Terminal	Adani Ennore Container Terminal	SA SICAL Tuticorin Container Terminal	Dakshin Bharat Gateway Terminal
Called us	CCTL	CITPL	AECT	TCT	DBGT
Operated by	DP World	PSA Chennai	Adani Ports & SEZ Ltd	Sical and PSA International	Dakshin Bharat Gateway Terminal Pvt Ltd
Year of Commission	2001	2009	2017	1999	2014
Draft (m)	15	15.5	18	11.9	14.2
Berths	3	3	1	1	1
Quay Length (m)	885	832	400	370	345
Installed Capacity (TEUs)	12,00,000	12,00,000	14,00,000	4,50,000	6,00,000
Throughput	6,53,675	9,63,167	4,56,987	3,52,010	3,86,376
Import share	55%	58%	74%	50%	50%
Export share	45%	42%	26%	50%	50%
Yard Area (Hectares)	18	28	36	10	10
Total Ground Slots (TGS)	3960	5424	4000	1000	1725
Reefer Plugs	355	306	150	84	112
Quay Cranes	8 Super Post Panamax	3 Post Panamax and 4 Super Post Panamax	4 Super Post Panamax Cranes	3 Post Panamax	3 (Twin)
Rubber Tyred Gantry Cranes (RTGC)	23	18	12	8	9
Rail Mounted Gantry Cranes (RMGC)	3	0	0	0	0
Reach Stackers	2	6	0	2	2
Fork Lifts	1	0	0	1	1
Capacity Utilization(%)	54%	80%	75%	78%	64%

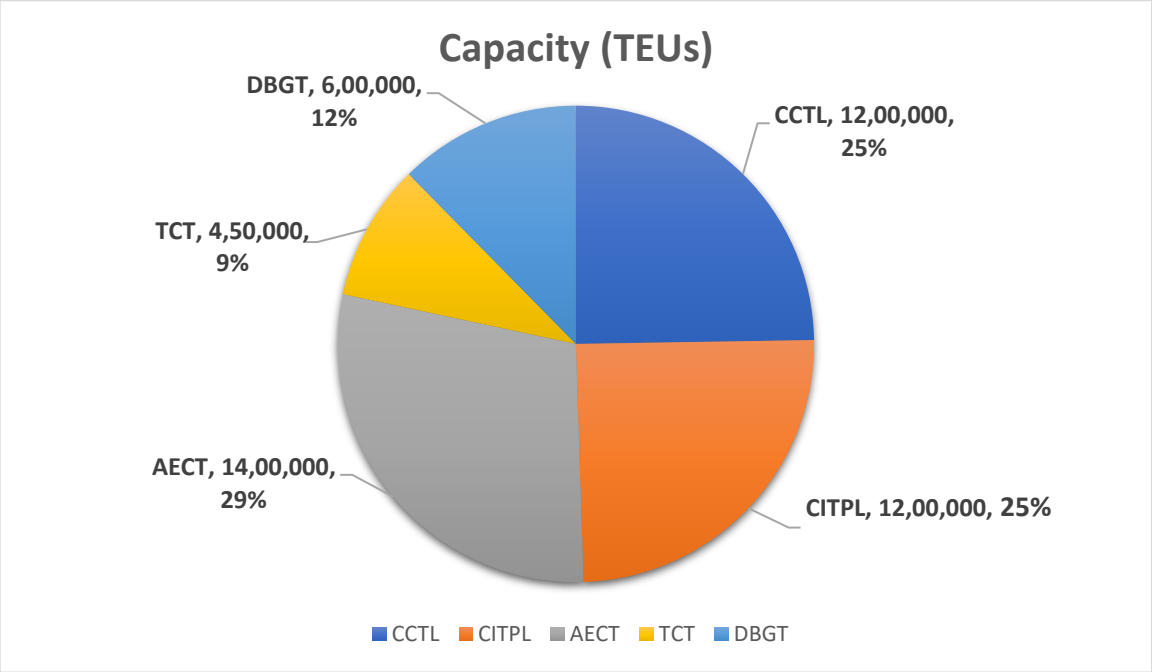
Source: Port Data Management Portal (PDMP)

[31] INDIAN CONTAINER MARKET REPORT-2019

5.1.1 COMPARITON OF TREMINAL CAPACITY (TEU)

Comparing terminal capacity, measured in Twenty-foot Equivalent Units (TEUs), assesses a port's capability to handle containerized cargo. It involves evaluating factors like the number and size of container terminals, ongoing expansion projects, operational efficiency, and technological advancements. This comparison informs stakeholders about a port's competitiveness, economic impact, and attractiveness to shipping lines. Benchmarking against national and global standards sets targets for infrastructure development and efficiency improvements. Ultimately, terminal capacity comparison guides investment decisions and enhances a port's position in the global maritime trade landscape.

FIG: 5.1 TERMINALS CAPACITY (TEU)

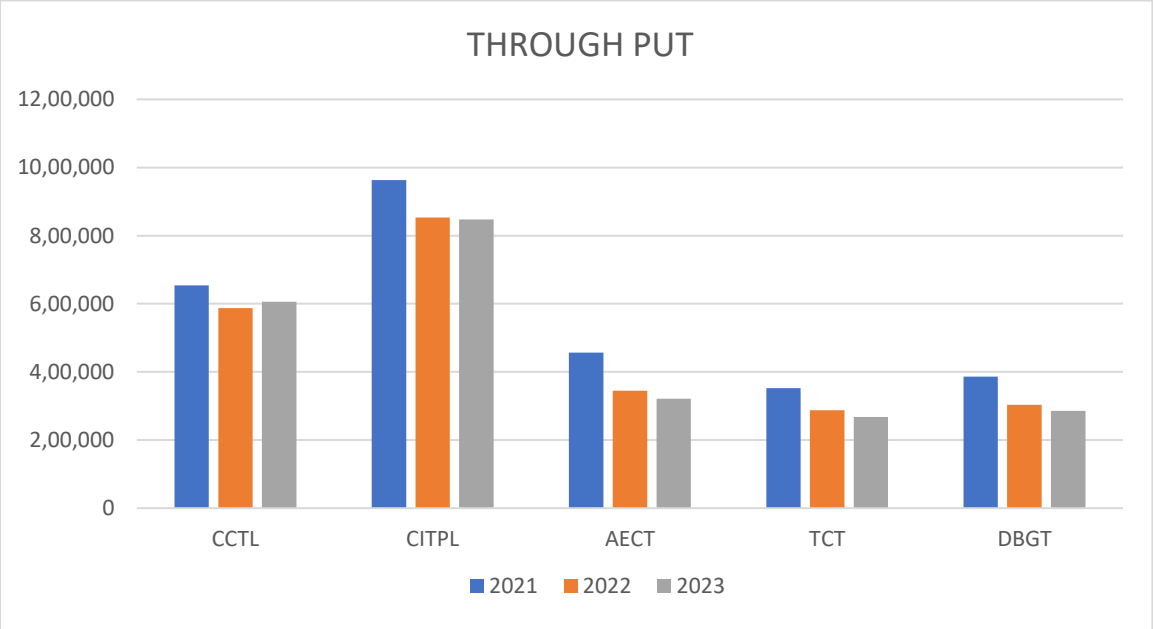


Source: computed

5.1.2 TERMINALS LOST 3 YESRS THROUGH PUT COMPARITION

Comparing terminals' lost throughput over three years involves analysing the decrease in cargo handling capacity or throughput within that period. Factors such as infrastructure constraints, operational inefficiencies, labour disputes, or natural disasters may contribute to lost throughput. By examining the decline in throughput across terminals, stakeholders can identify areas for improvement and strategic interventions. Understanding the reasons behind lost throughput enables port authorities to implement corrective measures, such as infrastructure upgrades, process optimization, or workforce training, to mitigate future losses. This comparison aids in enhancing terminal efficiency, maintaining competitiveness, and sustaining growth in the maritime trade sector.

FIG: 5.2 TERMINALS THROUGH PUT

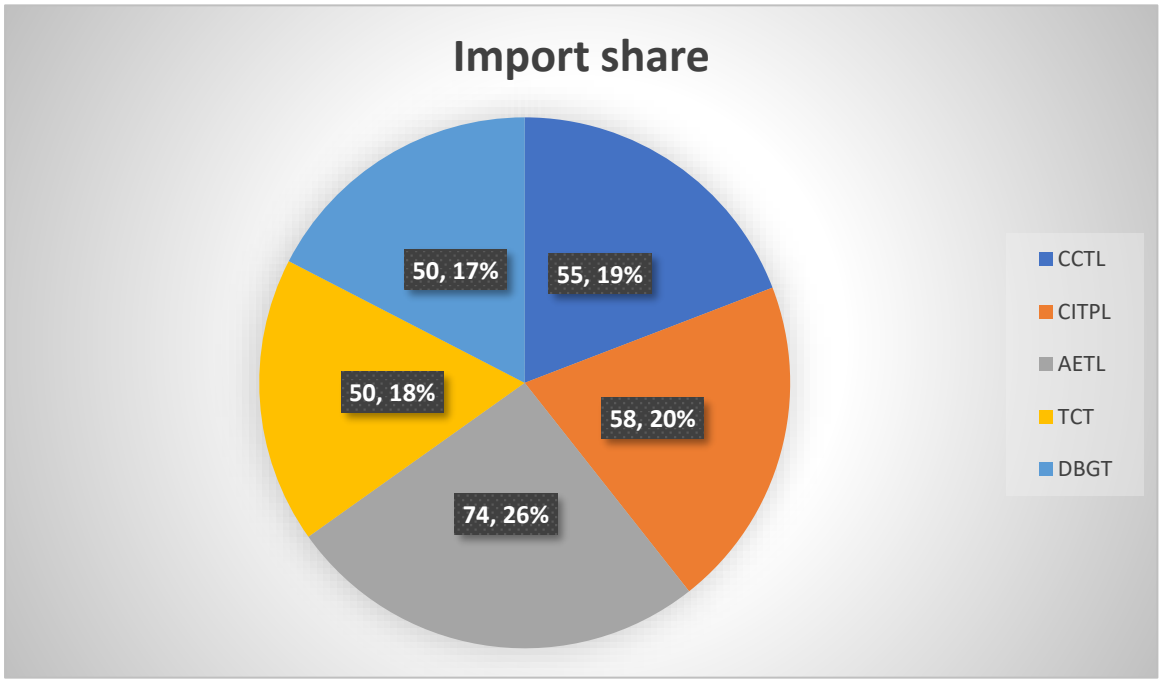


Source: computed

5.1.3 IMPORT SHERE OF EACH TERMINALS

he exports share of container terminals refers to the proportion of outbound containerized cargo handled by a terminal compared to total container throughput. This metric provides insights into a terminal's role in facilitating exports from a region or country. Higher export shares indicate a terminal's significance in supporting local industries and contributing to the economy through trade. Understanding export shares helps port authorities, policymakers, and businesses gauge the terminal's connectivity, efficiency, and competitiveness in facilitating outbound shipments. By analysing export shares, stakeholders can identify opportunities to enhance trade infrastructure, streamline export processes, and promote economic growth through increased export activity.

FIG: 5.3 TERMINALS IMPORT SHERE

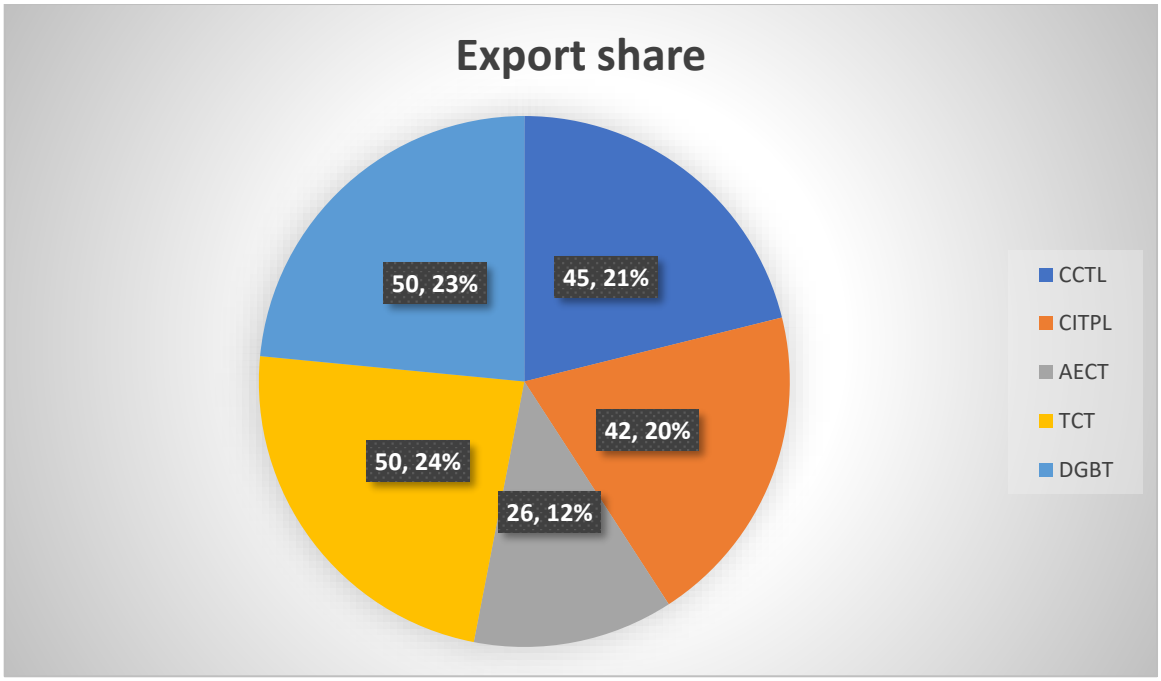


Source: computed

5.1.4 EXPORT SHERE OF EACH TERMINALS

The import share of container terminals represents the portion of inbound containerized cargo handled by a terminal relative to total container throughput. This metric is crucial for understanding a terminal's role in facilitating imports into a region or country. A higher import share indicates the terminal's significance in supporting local consumption and meeting demand for imported goods. Analysing import shares helps stakeholders assess the terminal's connectivity, efficiency, and competitiveness in managing inbound shipments. It also informs decisions regarding infrastructure development, logistics planning, and trade policy formulation aimed at optimizing import processes and enhancing the economy's import capabilities through efficient terminal operations.

FIG: 5.4 TERMINALS EXPORT SHERE

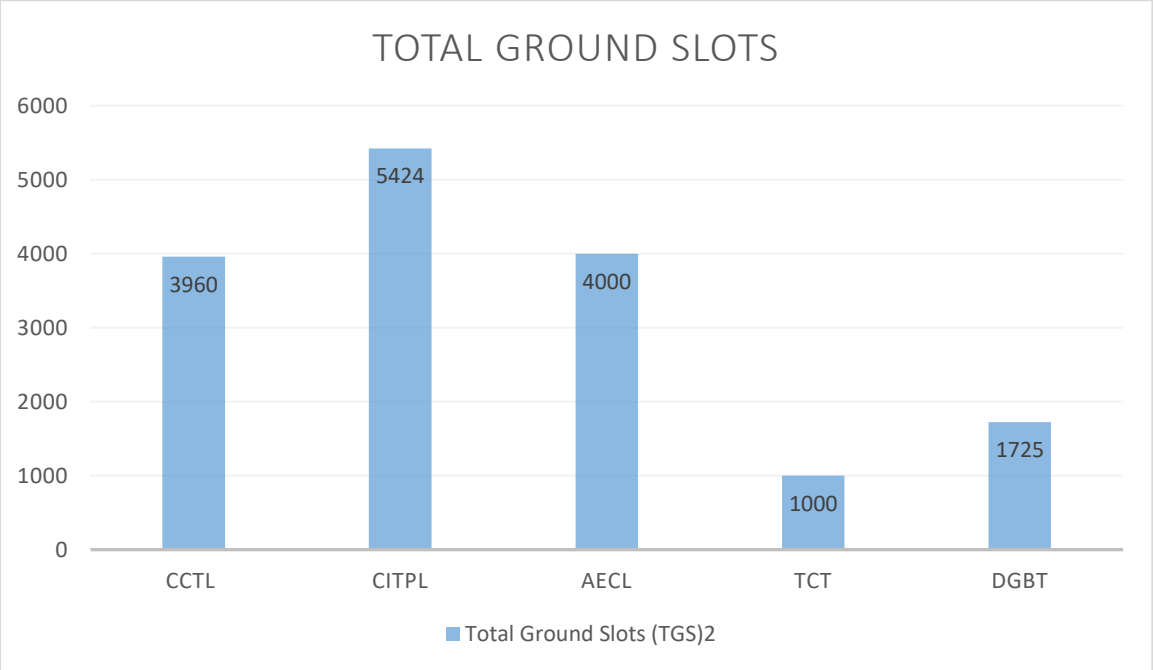


Source: computed

5.1.5 TERMINALS YERD CAPACITY (GROUND SLOTS)

Ground slots of container terminals refer to designated areas where containers are stored on the terminal's premises. These slots are crucial for efficiently managing containerized cargo and facilitating seamless operations within the terminal. Ground slots are typically organized based on factors such as container size, type, destination, and import/export status. Efficient allocation and utilization of ground slots help optimize terminal space, minimize congestion, and streamline container handling processes. Terminal operators use advanced yard management systems to track container movements, monitor slot availability, and maximize the utilization of ground slots to ensure smooth cargo flow and enhance overall terminal productivity.

FIG: 5.5 TERMINALS GROUND SLOTS

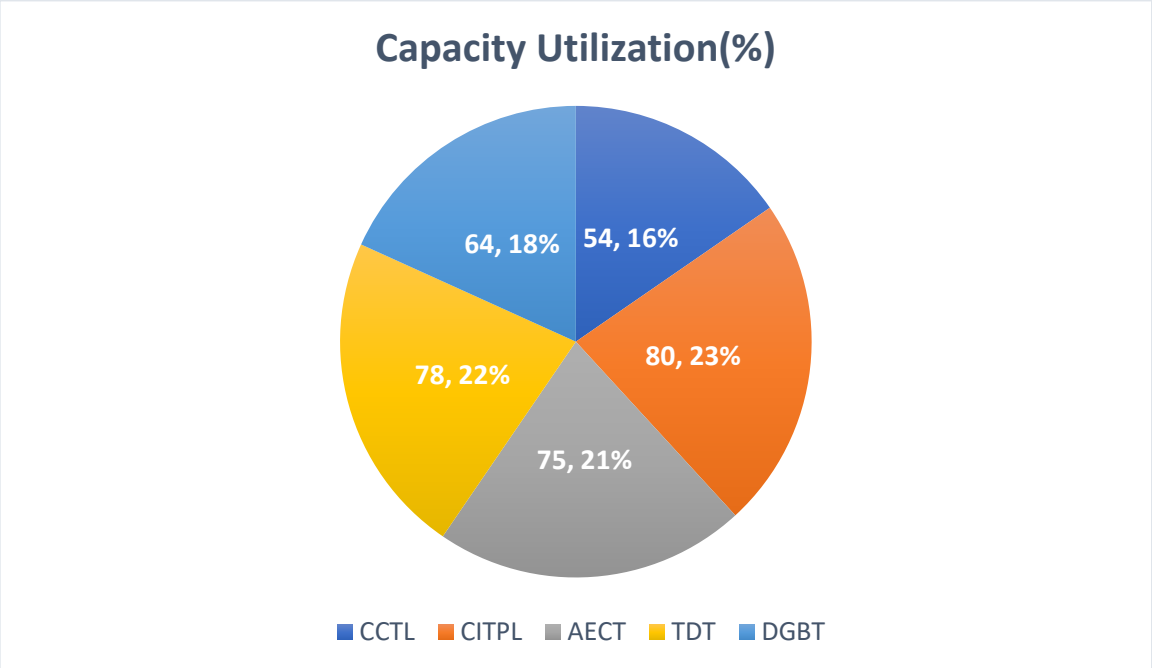


Source: computed

5.1.6 EACH TERMINAL CAOACITY UTILIZATION

Capacity utilization of container terminals refers to the extent to which a terminal's operational capacity is being utilized. It measures the ratio of actual container throughput to the terminal's maximum capacity over a specific period. High capacity utilization indicates efficient use of terminal resources, optimal workflow, and effective management of cargo volumes. However, excessive utilization can lead to congestion, delays, and decreased efficiency. Terminal operators monitor capacity utilization closely to balance operational efficiency with capacity constraints, ensuring smooth cargo flow, minimizing downtime, and optimizing terminal performance to meet demand fluctuations and maintain competitiveness in the maritime industry.

FIG 5.6 CAPACITY UTILIZATION



Source: computed

5.2 PERFORMANCE BENCHMARKING

Tamil Nadu is home to several major ports, including Chennai Port, Ennore Port, and Tuthukudi Port, each playing a crucial role in the state's maritime trade and economy. These ports serve as significant gateways for both domestic and international trade, facilitating the movement of goods and fostering economic growth.

Chennai Port, being the oldest and one of the largest ports in Tamil Nadu, has historically been a key player in the region's maritime trade. It boasts extensive infrastructure for handling various types of cargo, including containers, bulk, and liquid cargo. However, in recent years, Chennai Port has faced challenges in maintaining its competitive edge due to capacity constraints, outdated infrastructure, and congestion issues.

On the other hand, Ennore Port, also known as Kamarajar Port Limited, has emerged as a modern and efficient port facility in Tamil Nadu. It has been developed as a satellite port to relieve pressure on Chennai Port and cater to the growing demand for handling bulk cargo, particularly coal and other raw materials for industries in the region. Ennore Port's strategic location, deep draft, and advanced equipment have contributed to its success in handling large volumes of cargo efficiently.

Tuthukudi Port, located in the southern part of Tamil Nadu, primarily focuses on handling containerized cargo, bulk cargo, and petroleum products. It has undergone significant expansion and modernization efforts in recent years to enhance its capacity and efficiency. Tuthukudi Port's proximity to international shipping routes and its well-developed infrastructure make it an important player in the maritime trade landscape of Tamil Nadu.

When comparing the performance of these ports against each other, factors such as cargo handling capacity, turnaround time, vessel productivity, and customer satisfaction metrics need to be considered. Chennai Port, despite its challenges, still maintains a significant share of the region's maritime trade due to its historical prominence and diverse cargo handling capabilities. Ennore Port, with its modern infrastructure and strategic focus on specific cargo types, has been able to carve out a niche for itself as a reliable and efficient port facility. Tuthukudi Port, while smaller in size compared to Chennai and Ennore, has

shown steady growth and improvement in its operational efficiency, particularly in handling containerized cargo.[32]

In comparison to national and global standards, Tamil Nadu ports face both opportunities and challenges. On one hand, they benefit from India's ambitious maritime infrastructure development initiatives such as Sagarmala and efforts to improve port connectivity and efficiency. These initiatives aim to bring Indian ports up to par with global standards by investing in infrastructure upgrades, technology adoption, and streamlining regulatory processes.

5.3 ANALYSIS OF FINDINGS

The comparative analysis of Chennai Container Terminal (CCT), Chennai International Terminal (CIT), Adani Ennore Container Terminal (AECT), SA SICAL Tuticorin Container Terminal (SSTCT), and Dakshin Bharat Gateway Terminal (DBGT) offers valuable insights into their performance regarding cargo throughput, import and export shares, and capacity utilization. Understanding the strengths and weaknesses of each port in these aspects is crucial for optimizing their operations, attracting investments, and fostering economic growth.

Starting with Chennai Container Terminal (CCT), it holds a significant share in both import and export cargo throughput due to its strategic location and extensive connectivity. CCT benefits from modern infrastructure and equipment, allowing it to handle large volumes of containers efficiently. Its strengths lie in its capacity to accommodate various types of cargo and its proximity to industrial hubs in Tamil Nadu. However, CCT faces challenges such as congestion and capacity constraints, which can impact its ability to fully utilize its potential. Addressing these challenges through capacity expansion projects and operational optimizations could enhance CCT's competitiveness and attractiveness to importers and exporters.

Chennai International Terminal (CIT) also commands a considerable share in cargo throughput, particularly in the container segment. Its strengths include advanced technology integration, streamlined operations, and strong customer service orientation. CIT's efficient operations contribute to its significant export share, as it provides exporters with reliable and seamless cargo handling services. However, CIT faces

[32] https://mrt.greatlakes.edu.in

challenges related to land constraints and limited hinterland connectivity, which can hinder its capacity utilization and growth potential. Investing in infrastructure upgrades and improving connectivity to the hinterland would be crucial for unlocking CIT's full capacity and sustaining its competitiveness.

Adani Ennore Container Terminal (AECT) represents a modern and efficient facility catering to bulk and container cargo. Its deep draft berths and advanced handling equipment enable it to handle large vessels and diverse cargo types effectively. AECT's strengths lie in its capacity to accommodate growing container volumes and its strategic location outside the Chennai port complex, which reduces congestion and offers flexibility to shipping lines. However, AECT faces challenges in attracting sufficient cargo volumes to optimize its operational capacity fully. Strengthening marketing efforts and enhancing hinterland connectivity could help AECT capitalize on its strengths and attract more cargo traffic, both for imports and exports.

SA SICAL Tuticorin Container Terminal (SSTCT) plays a crucial role in handling containerized cargo in the southern part of Tamil Nadu. Its strengths include deep draft berths, state-of-the-art infrastructure, and efficient operations, contributing to its significant share in cargo throughput. SSTCT benefits from proximity to international shipping routes and offers comprehensive services for container handling, supporting both import and export trade activities. However, it faces challenges related to competition from nearby ports and hinterland connectivity limitations, particularly for industries located in northern Tamil Nadu. Enhancing connectivity through road and rail networks and diversifying cargo handling capabilities could further strengthen SSTCT's position and increase its share in cargo throughput.[33]

Dakshin Bharat Gateway Terminal (DBGT), located in Tuticorin, Tamilnadu, serves as a Gateway hub for containers in the region. Its deep draft berths, advanced handling facilities, and strategic location along international shipping routes contribute to its significant cargo throughput share. DBGT's strengths lie in its efficient Gateway t operations and connectivity to major global ports, supporting both import and export.

[33] Anwar, M., L. Henesey, and E. Casalicchio. 2019. “Digitalization in container terminal logistics: A literature review.” In Proc., 27th Annual Conf., of Int. Association of Maritime Economists, 1–25. Greece: International Association of Maritime Economists.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMARY OF KEY FINDINGS

The comparative analysis of Chennai Container Terminal, Chennai International Terminal, Adani Ennore Container Terminal, SA SICAL Tuticorin Container Terminal, and Dakshin Bharat Gateway Terminal offers valuable insights into their performance regarding cargo throughput, import and export shares, and capacity utilization. Understanding the strengths and weaknesses of each port in these aspects is crucial for optimizing their operations, attracting investments, and fostering economic growth.

Starting with Chennai Container Terminal, it holds a significant share in both import and export cargo throughput due to its strategic location and extensive connectivity. Benefits from modern infrastructure and equipment, allowing it to handle large volumes of containers efficiently. Its strengths lie in its capacity to accommodate various types of cargo and its proximity to industrial hubs in Tamil Nadu. Faces challenges such as congestion and capacity constraints, which can impact its ability to fully utilize its potential. Addressing these challenges through capacity expansion projects and operational optimizations could enhance competitiveness and attractiveness to importers and exporters.

Chennai International Terminal also commands a considerable share in cargo throughput, particularly in the container segment. Its strengths include advanced technology integration, streamlined operations, and strong customer service orientation. Efficient operations contribute to its significant export share, as it provides exporters with reliable and seamless cargo handling services. However, faces challenges related to land constraints and limited hinterland connectivity, which can hinder its capacity utilization and growth potential. Investing in infrastructure upgrades and improving connectivity to the hinterland would be crucial for unlocking full capacity and sustaining its competitiveness.

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Chennai port complex, which reduces congestion and offers flexibility to shipping lines. Faces challenges in attracting sufficient cargo volumes to optimize its operational capacity fully. Strengthening marketing efforts and enhancing hinterland connectivity could help capitalize on its strengths and attract more cargo traffic, both for imports and exports.

SA SICAL Tuticorin Container Terminal plays a crucial role in handling containerized cargo in the southern part of Tamil Nadu. Its strengths include deep draft berths, state-of-the-art infrastructure, and efficient operations, contributing to its significant share in cargo throughput. Benefits from proximity to international shipping routes and offers comprehensive services for container handling, supporting both import and export trade activities. However, it faces challenges related to competition from nearby ports and hinterland connectivity limitations, particularly for industries located in northern Tamil Nadu. Enhancing connectivity through road and rail networks and diversifying cargo handling capabilities could further strengthen position and increase its share in cargo throughput.

Dakshin Bharat Gateway Terminal (DBGT), located in Tuticorin, Tamilnadu, serves as a Gateway hub for containers in the region. Its deep draft berths, advanced handling facilities, and strategic location along international shipping routes contribute to its significant cargo throughput share. Strengths lie in its efficient Gateway t operations and connectivity to major global ports, supporting both import and export trade flows. However, it faces challenges related to limited hinterland connectivity and competition. Strengthening multimodal connectivity and collaboration with regional stakeholders could further enhance competitiveness and increase its share in cargo throughput.

In conclusion, the comparative analysis of these terminals highlights the importance of optimizing capacity utilization, improving infrastructure, and enhancing connectivity to sustain growth and competitiveness in the maritime sector. By leveraging their strengths and addressing weaknesses, Tamil Nadu's ports can effectively serve the needs of importers and exporters, drive economic development, and contribute to regional integration and prosperity. Collaboration among port operators, government agencies, and industry stakeholders is crucial for implementing strategic initiatives and fostering a conducive environment for sustainable growth in the maritime sector.

6.2 IMPLICATIONS FOR POLICY AND PRACTICE

1. Invest in Infrastructure Upgrades: Policymakers should prioritize investments in infrastructure upgrades for container terminals, focusing on expanding berth capacity, dredging navigational channels to accommodate larger vessels, and improving road and rail connectivity to facilitate seamless cargo movement to and from the terminals. Upgrading terminal facilities, such as container yards and handling equipment, will also enhance operational efficiency.

2. Facilitate Hinterland Connectivity: Enhancing connectivity to the hinterland is essential for attracting cargo volumes and increasing the utilization of container terminals. Policymakers should collaborate with relevant stakeholders to improve road and rail networks connecting terminals to key industrial and consumption centres in Tamil Nadu and neighbouring states. Developing multimodal logistics parks and inland container depots (ICDs) near terminals can further improve last-mile connectivity.

3. Promote Digitalization and Automation: Port authorities should embrace digitalization and automation technologies to streamline operations, reduce turnaround times, and enhance productivity at container terminals. Implementing port community systems (PCS), electronic data interchange (EDI), and automated container handling systems can improve efficiency and transparency in cargo processing and reduce paperwork and administrative burdens.

4. Foster Public-Private Partnerships (PPPs): Policymakers should encourage public-private partnerships (PPPs) to attract private investment in container terminal development and operation. Partnering with experienced terminal operators can bring in expertise, technology, and capital to upgrade and expand terminal facilities, while also sharing risks and responsibilities. Clear regulatory frameworks and transparent tendering processes are essential to attract private investors.

5. Focus on Environmental Sustainability: Port authorities should prioritize environmental sustainability in terminal operations by implementing green initiatives and adopting eco-friendly practices. This includes investing in shore power facilities to reduce emissions from docked vessels, implementing energy-efficient technologies, and managing waste and pollution effectively. Compliance with environmental regulations and obtaining eco-certifications can enhance the reputation of container terminals and attract environmentally conscious customers.

6. Strengthen Marketing and Trade Promotion: Port authorities should actively market container terminals in Tamil Nadu to attract shipping lines, cargo owners, and logistics providers. Participating in trade exhibitions, organizing promotional events, and offering incentives for new shipping services can help increase cargo volumes and diversify trade routes served by the terminals. Strengthening relationships with trade associations and chambers of commerce can also facilitate trade promotion efforts.

7. Improve Regulatory Frameworks: Policymakers should review and streamline regulatory frameworks governing port operations to reduce bureaucratic hurdles and enhance ease of doing business at container terminals. This includes simplifying customs procedures, reducing port-related fees and charges, and ensuring consistent and transparent regulatory enforcement. Regular dialogue with industry stakeholders can help identify regulatory bottlenecks and address them effectively.

6.3 SUGGESTIONS FOR FUTURE RESEARCH

Here The List of Suggestion for Major Ports Container Terminals Implementation of These Suggestion Lead the Port in to International Standard Contributing India GDP, As Well as International Tread Tacking in to India Better Level Among Comparative Country

1. Infrastructure Upgrades: Invest in infrastructure upgrades to expand berth capacity, upgrade handling equipment, and improve terminal facilities. This will enhance operational efficiency and accommodate larger vessels, increasing throughput capacity.

2. Hinterland Connectivity: Focus on improving road and rail connectivity to the hinterland to facilitate seamless movement of cargo to and from the terminals. Enhancing multimodal transport infrastructure will reduce logistics costs and attract more cargo volume

3. Technology Integration: Embrace digitalization and automation technologies to streamline operations, reduce turnaround times, and enhance productivity at container terminals. Implementing port community systems and automated handling equipment will improve efficiency and transparency.

4. Environmental Sustainability: Implement green initiatives such as shore power facilities, renewable energy integration, and emission reduction programs to minimize the environmental impact of port operations. Adopting eco-friendly practices will enhance the terminals' reputation and attract environmentally conscious customers.

5. Trade Promotion: Strengthen marketing efforts to attract shipping lines, cargo owners, and logistics providers. Participate in trade exhibitions, organize promotional events, and offer incentives for new shipping services to increase cargo volumes and diversify trade routes.

6. Regulatory Reforms: Review and streamline regulatory frameworks governing port operations to reduce bureaucratic hurdles and enhance ease of doing business. Simplifying customs procedures and ensuring transparent regulatory enforcement will improve the overall business environment at the terminals.

7. Public-Private Partnerships: Encourage public-private partnerships to attract private investment in terminal development and operation. Partnering with experienced terminal operators will bring in expertise, technology, and capital to upgrade facilities and enhance competitiveness.

8. Community Engagement: Foster positive relationships with local communities by addressing their concerns and promoting social responsibility initiatives. Engage in dialogue with stakeholders to build trust and ensure sustainable port development.

By implementing these suggestions, the container terminals at major ports in Tamil Nadu can improve their competitiveness, efficiency, and sustainability, thereby contributing to the state's economic growth and development.

6.4 CONCLUDING REMARKS

The comparative analysis of major ports container terminals within Tamil Nadu underscores the diverse strengths and challenges faced by each terminal.

Some terminals excel in infrastructure and operational efficiency, others struggle with congestion and connectivity limitations.

Addressing these challenges requires concerted efforts from policymakers, port authorities, and stakeholders to invest in infrastructure upgrades, enhance regulatory frameworks, and foster collaboration.

By leveraging their strengths and implementing strategic initiatives, container terminals in Tamil Nadu can enhance their competitiveness, optimize performance, and contribute to the state's maritime trade growth.

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