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A Comparative Study on the Performance of Indian Ports that Handle Bulk Cargo

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Abstract

The shipping industry is at present going through a phase of rapid technological change Hence investment decisions are risky and may prove uneconomic. The outcome of such decisions may be serious as port facilities are expensive and do not have any alternatives. Our country has a broad coastline that extends to 7500km. Maritime trade has a long history which dates back to several years and since sea transport is the most viable means of transport. EXIM trade through sea route plays a vital role in country's economic growth. India has 12 major ports among 1 corporatized Port(Ennore), there are 187 non major ports spread across various states. Gujrat has the most non-major ports and West Bengal has the least.The ports where bulk commodities are handled are Chennai, Ennore ,Tuticorin, vizag, paradip, New Mangalore, Kandla, Mumbai &JNPT.

As information systems increase operational efficiency they contribute to the competitive power of the port contributing to its marketing and commercial activity. To effectively manage various evolving port activities, which involve optimum resource utilization supported by timely and accurate information, it is important to deploy state-of-the-art technology practices at port and community level.

Keywords: Maritime trade, competitive power, marketing and commercial activity.

Introduction

- **Reasons for ports unable to meet the expected throughput levels**: - When the port is unable to meet the expected throughput levels its efficiency and effectiveness goes down. It is technically inefficient. This is often due to congestion that is due to insufficient

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infrastructure, fixed and mobile assets. Due to congestion the average pre-berthing time increases leading to greater turnaround time of vessels.

- **Pollution from Dry bulk commodities viz. coal and Iron Ore**: - Some of the dry bulk are major pollutants and to protect environment their handling is banned if the traffic inflow reaches higher levels. Coal and Iron ore release suspended granules that are hazard to health of dock workers and to the environment
- **Dry bulk posing greater handling difficulties as compared to container**: - The reason why some ports are lagging behind others is due to non-availabilty of adequate handling equipment for quick loading/unloading. Bulk cargo requires conveyors, hoppers, travelling cranes, grab type unloaders, loading booms for pouring the commodity into the vessel's hold. Many ports do not possess all types of equipment or special-purpose machines and hence the handling is slow. This results in limitations of the port in handling commodities.
- **Insufficient Storage space: -** Very Few ports in the country have capacity to store high volumes of traffic. Since the bulk ports are located far from the production centers the transport services required are more, the transport leg to and from the port should be efficient. There is need warehouses inside the port premises so that ports can attract higher volumes of cargo.
- **Insufficient Draft: -** In the past decades' ship have become bigger and shipping technology has improved, hence there is a greater need for port to increase the draught for improving the throughput. The draught of Indian ports is very low some of the new ports have 16 mts. while old ports have 8mts which is insufficient to serve bigger bulk carriers. For transport of bulk commodities, the bigger the ship the better, considering economies of scale, as transport costs/ton for larger carriers is less.

Objectives

- To analyze and compare the throughput of ports that handle different bulk commodities
- To address the port performance bottlenecks their causes and reasons
- To compare port performance indicator

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Scope of the study

The ports under the study are Chennai, Ennore, Tuticorin, vizag, paradip, New Mangalore, kandla, Mumbai, JNPT.

Why Specific Ports

1. **Chennai**: Chennai is the oldest artificial harbor on the East Coast of India. The major items of exports among bulk cargo are manganese ore, fish and fish products, coconut, copra etc. The imports among bulk cargo consist of coal, crude oil, fertilizers chemical products etc.

2. **Ennore**: - This is country's first corporate port. This port has recently been developed to reduce pressure of traffic on Chennai port. The major items of export are coal, iron ore, petroleum and its products, chemicals, etc. Its hinterland is a part of the hinterland of Chennai port
3. **Tuticorin:-** The port handles the traffic of coal, salt, food grains, edible oils, sugar and petroleum products. Its main purpose is to carry on trade with Sri Lanka as it is very near to that country
4. **Vizag**:- It is the deepest land-locked and protected port built at the coast of Andhra Pradesh. The primary export items among bulk are iron ore (especially from Bailadila mines to Japan), manganese ore, the imports comprise mainly of mineral oil, coal, luxury items and other industrial products
5. **Paradip: -** It is a deep water (depth 12 metres) and all weather port located on the Orissa coast about 100 km east of Cuttack. Because of its great depth, this port is capable of handling bulk carriers of over 60,000 DWT**. Large quantity of iron ore is exported to Japan through this port.**
6. **New Mangalore: -** This is an important port located at the southern tip of the Karnataka coast. **The major items of import among bulk commodities through this port are crude oil, and fertilizers. Its main importance lies in export of iron ore from the Kundremukh mine**.

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7. **Kandla: -** This port is located at the eastern end of Gulf of Kachchh. The traffic handled at Kandla among bulk cargo consists of crude oil, petroleum products, fertilizers, food grains, and cement. It has a vast hinterland covering large parts of Gujarat, Rajasthan, Haryana, Punjab, Delhi, Himachal Pradesh, Jammu and Kashmir and Uttaranchal.
8. **Mumbai: -** It handles approximately one-fifth of India's foreign trade with predominance in dry cargo and mineral oil from the Gulf countries. It handles foreign trade with the Western countries and East African countries. The opening of the Suez Canal in 1869 brought it much closer to the European countries. Mumbai has a vast hinterland covering the whole of Maharashtra and large arts of Madhya Pradesh, Gujarat, Rajasthan, Delhi.

   Themajor items of export among bulk commodities are leather, Manganese, chemical goods etc. while the imports include crude oil.
9. **JNPT: -** Formerly known as Nhava Sheva port, this port was opened on 26th May, 1989. It has the country's first privatized container terminal NSICT onwed by Dubai Ports World by a 30 yr old BOT agreement between P&O Ports and the JNPT. The Terminal was built in 1997 and the first ship serviced was in 2000.The port is equipped with the most modem facilities having mechanized container berths for handling dry bulk cargo and service berth etc.

Hypothesis

This can be formulated in the following statements which assume that

Limitations

Western ports attract more bulk carriers due to greater draught.

1. Eastern ports are more efficient in handling bulk than Western ports in thecountry.
2. Due to time constraint, it was not being possible to visit the ports and conduct a primarysurvey. Data has been taken from secondary sources.
3. This would be a comparison port performance indicator based on bulkcommodities only

Review Literature

According to the working group's report of National Transport Development Committee on the transport of Bulk commodities. The surge in economic growth witnessed in recent years in India has strained the capacity of its transport system as well as energy supply, particularly electric

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power.

The government's ambitious development targets and plans in addressing such binding infrastructure constraints in a decisive manner over the next couple of decades in order to sustain high levels of economic growth and to make it more inclusive.

The future poses more profound challenges. Even if ambitious aims to improve energy intensity of the Indian economy are achieved, sustaining economic growth at 8-10 percent per annum over the next two decades will require massive increases in power generation and transportation of bulk commodities such as coal, iron and steel. The task ahead is rendered more difficult by the evolving economic geographyand structural changes in the energy system, such as the increasing role of natural gas and growingimports of coal that will impose new demands on the transport networks. Current projections for coal imports in 2031-32 and LNG imports in 2029-30 for example, are 355 million tonnes (Mt) and 162 million standard cubic meters per day (MMSCMD) respectively.

According to the text on Maritime Economics by Martin Stopford, there are four principles of designing a system for bulk transport

a) **Economies of scale**: -One of the fundamental principles of shipping economics is that unit costs can be reduced by increasing the size of the cargo on the shipping leg. Bigger ships have lower unit costs, and unit cargo handling and storage are also cheaper at high throughput volumes. As a result, the bulk trades are under constant economic pressure to increase the size of cargo consignments.
b) **Efficient Cargo Handling**: - Cargo handling is a major issue. Each time the product is handled during transport it costs money. A radical solution is to relocate processing plant to reduce the number of transport legs. Manufacturing plant such as steel mills can be relocated to coastal sites to avoid land transport of raw materials. Where cargo must be handled, the emphasis is on reducing cost by using specially constructed bulk handling terminals. Most large ports have specialist bulk terminals for handling crude oil, products, dry bulk and grain. The use of high-productivity cargo handling equipment contributes to the overall cost efficiency of the operation by reducing the unit cost of loading and discharging, and minimizing the time the ship spends handling cargo. Homogeneous dry bulks such as iron ore and coal can be handled very efficiently using continuous loaders and discharged with cranes and large grabs. Cargoes such as steel or forest products, which

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consist of large, irregular units, benefit from packaging into standard unit loads.

c) **Integration of transport modes employed:** - Cargo handling can be made more efficient if care is taken to integrate the various stages in the transport system. One way to do this is to standardize cargo units. Cargo is packaged in a form that can easily be handled by all stages in the transport system, e.g. a lorry or rail truck. Containerization is a classic example of this type of development. The standard container can be lifted off theship onto the lorry. In bulk shipping the use of intermediate units such as large bags,

packaged lumber and pallets can be used to reduce handling costs. Another is to design a system which covers all stages in the transport operation. This approach is used in many large industrial projects involving raw materials systems. **Ships, terminal facilities, storage areas and land transport are integrated into a balanced system**

d) **Optimizing stocks for the producer and consumer:** -The transport system must incorporate stockpiles and parcel sizes which are acceptable to the importer and the exporter. There are two aspects to consider. One is the size of the trade flow. Although it would be cheaper to ship manganese ore in a 170,000 dwt bulk carrier, steelmakers use much smaller ships. This is partly a matter of annual throughput which does not justify investment in high volume cargo handling facilities, but there is also inventory cost to consider. Even if the storage facilities are available to handle 170,000 tons of manganese ore, the cost of holding stock for a year could well exceed the freight saving. Under 'just in time' manufacturing systems the product should arrive at the processing or sales point as close as possible to the time when it is used, minimizing the need for stocks. This approach, which calls for a transport system with many small deliveries conflicts with Objective 1 which favours a few very large deliveries. The size of parcel in which a commodity is shipped is thus a trade-off between optimizing stockholding and economies of scale in transport. High-value cargoes, which are usually used in small quantities and incur a high inventory cost, tend to travel in small parcels. This is most noticeable in the minor bulk trades such as sugar, steel products and non-ferrous metal ores, where physical characteristics permit large bulk parcels but stockholding practices imposes a parcel size ceiling on the trade.

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Data Collection and Analysis

Efforts are being made to improve the performance of India's ports. However, in addition to port-wise development plans, a comprehensive strategy needs to be evolved for the port sector. There are also issues of how poorly our ports compare with international benchmarks of performance. Perhaps most important, the level of connectivity of the ports to the hinterland needs to be considered because even the most modern and best performing port would be useless if it lacked sufficient connectivity to the destination of materials to be imported.

Table 1. Estimation of Port POL and coal traffic (Million Tons)

Commodity	2011-12	2016-17	2021-22	2026-27	2031-32
Thermal Coal	73	88	138	266	355
Coking Coal	32	65	108	173	238
POL	329	475	572	702	864
TOTAL	434	628	818	1,141	1,457

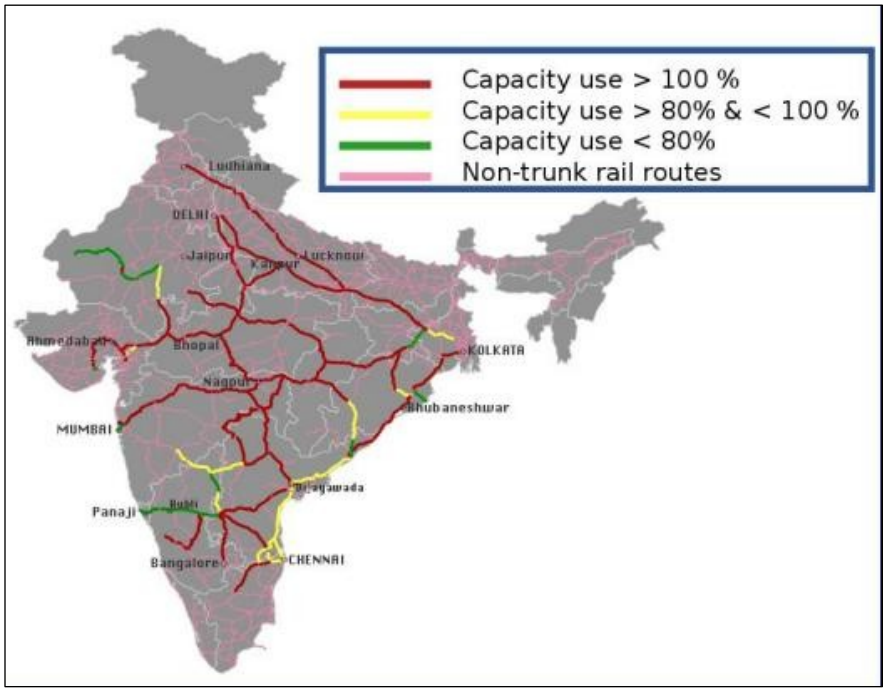

Figure 1. Major routes for transport for bulk commodities

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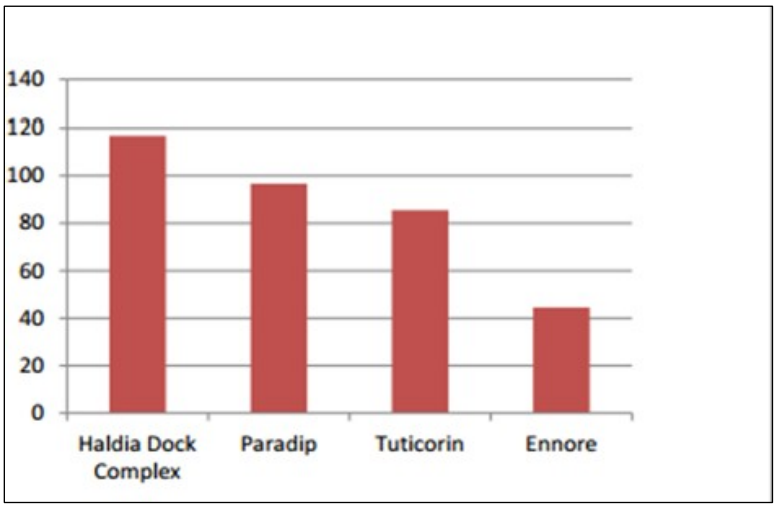

Figure 2. Percentage capacity utilization for coal at major ports

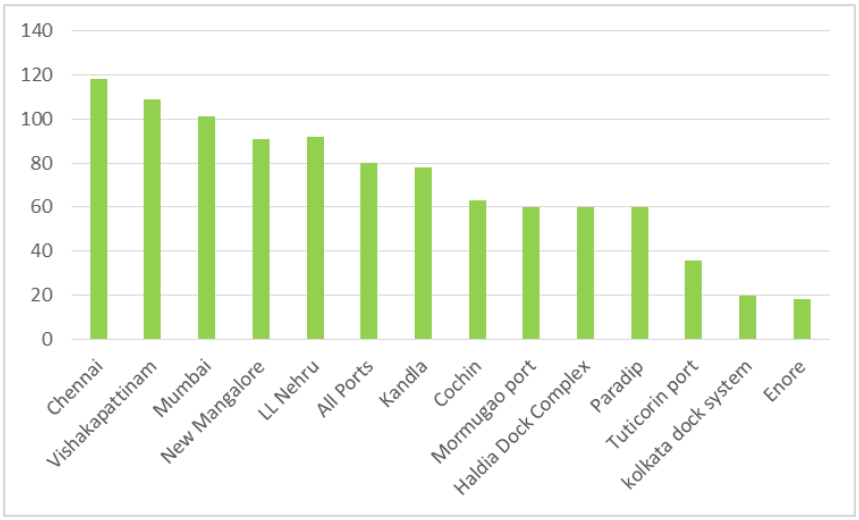

Figure 3. Percentage utilization of POL at major ports

Import and Export of Liquid Bulk

Rapid growth in domestic consumption of petroleum products and refining capacity has increased the country's dependence on imports of crude oil. On the other hand, India has not only become a net exporter of petroleum products, but is now the largest exporter of petroleum products in Asia.

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We first estimate the requirements for crude oil which is based on the sum of domestic demand and the net exports of petroleum products.

The total amount of petroleum products that need to be produced in the country is equal to the Domestic demand plus net exports. In Table 1 this amount is shown as "**Total to be Produced."** Based on data provided by for the 12th Plan, a ton of crude oil yields about 0.93 tons of petroleum products. This estimate of yield is used to calculate the requirements for crude oil in the country. By 2031-32, this requirement is estimated to reach 556 Mt. Some of this requirement will be met by domestic production. Recent projections for the 12th Plan Period show a small decline in production over the plan period

Hence it is convenient to assume that domestic production will remain at current levels. Subtracting domestic production from total requirements for crude oil give us the amount of crude oil that needs to be imported. It is expected to reach 515 Mt by 2031-32. The sum of POL imports (crude oil and petroleum products) and exports (petroleum products) is shown in Table 1 and is expected toreach 631 Mt by 2031-32. Port traffic includes not just this amount but also some domestic crudethat is produced off-shore and crude oil and petroleum products moved by coastal ships. Estimating this amount directly is very difficult. Instead, we looked at POL traffic for the last several years and compared it with the total imports and exports of POL. It was found that the ratio of POL traffic to POL imports and exports over the last several years has varied between 1.25

-1.53 that is an average of 1.37.

The average of 1.37 to arrive at POL traffic has been used to estimate POL traffic at ports as estimated by the last line of Table 2.

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Table 2. Estimation of POL Traffic at Ports (MT)

		2011-12	2016-17	2021-22	2026-27	2031-32
1	Domestic Demand for Petroleum Products	147	186	245	322	424
2	Gross Exports of Petroleum Products	58	91	94	100	104
3	Gross Imports of Petroleum Products	10	11	11	11	11
4	Net Exports of Petroleum Products (2-3)	48	80	83	89	93
5	Petroleum Products to be Produced in India (1+4)	195	266	328	412	517
6	Requirements for Crude Oil (5/0.93)	210	286	353	443	556
7	Domestic Production of Crude Oil	38	41	41	41	41
8	Required Imports of Crude Oil (6-7)	172	245	312	401	515
9	Total Imports and Exports of POL (2+3+8)	240	347	417	513	631
10	Total POL Traffic at Ports (9 x 1.37)	329	475	572	702	864

Import of Coking Coal

The steel industry relies heavily on imports of coking coal. Currently, about 70 percent of the coking coal required by the steel industry is imported. Because the domestic production of cokingcoal is expected to remain stagnant or may even decline, the share of imports of coal is expected to increase to 75, 80 and 85 percent in 2016- 17, 2021-22 and 2026-27 respectively, and to remainat that level. Using these assumptions, the imports of coking coal for the steel industry have been estimated and are given in Table 3.

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Table 3. Imports of Coking Coal for Steel Industry by State (MT)

	2011-12	2016-17	2021-22	2026-27	2031-32
Odisha	7.8	15.8	26.4	42.2	58.2
Chattisgarh	4.2	8.5	14.1	22.6	31.2
Jharkhand	4.5	9.2	15.3	24.6	33.9
West Bengal	2.2	4.4	7.4	11.9	16.4
Karnataka	2.9	5.8	9.7	15.5	21.4
Tamil Nadu	1.0	2.1	3.5	5.5	7.6
Maharashtra	1.7	3.5	5.9	9.5	13.1
Andhra Pradesh	2.0	4.1	6.8	10.9	15.0
Gujarat	2.4	4.9	8.2	13.1	18.1
Other Locations	3.1	6.2	10.4	16.7	23.0
Total India	31.8	64.5	107.7	172.5	237.8

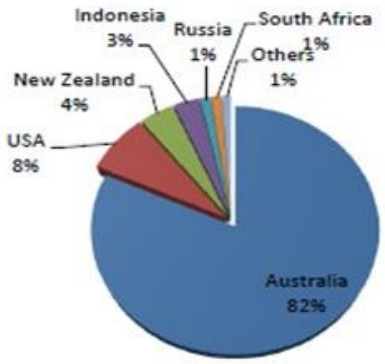

Figure 4. Import of Coking Coal by Country

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A Comparison of POL Trade

- Mumbai Port: - It has been a national gateway to Indian and has played a pivotal role in development of national economy, trade and commerce. It has diversifed in types of cargo handled from break-bulk to container. It has developed specialised berths for POL and chemicals. Mumbai Port is facing challenges due to Intra-Port competition, changing traffic patterns, inherent physical constraints and continuing labour intensive operations, etc. However, Mumbai Port is taking various measures to render cost effective and quality services to the trade.
- Kandla Port: - The storage facilities are
    a) Twelve Dry Cargo berths are available with Quay Length of 2532 mtrs.
    b) Six Oil Jetties.
    c) Total Custom Bonded Port Area inside the custom fencing is 253 hectares.
    d) One deep draft mooring and Four Cargo moorings in the inner Harbour area for stream handling.
- Oil offshore Terminal at Vadinar

    The Kandla Port Trust had commissioned the Off-shore Oil Terminal facilities at Vadinar in the year 1978 jointly with Indian Oil Corporation, by providing Single Buoy Mooring (SBM) system, having a capacity of 54 MMTPA, which was first of its kind in India. Further, significant quantum of infra structural upgradation has been effected; excellent maritime infrastructure has been created for the 32 MMTPA Essar Oil Refinery at Vadinar

Table 4. Percentage of POL as Compared to Other Cargo

YEAR	Cargo Traffic (in tonnes)		POL Traffic (in tonnes)		% of POL in Total Cargo	
	KANDLA	MUMBAI	KANDLA	MUMBAI	KANDLA	MUMBAI
2007-08	64920	52364	38225	37074	58.88	65.07
2008-09	72224	57038	45538	34571	63.05	67.23
2009-10	79500	51876	46970	34538	59.08	67.12
2010-11	81880	54586	48426	32990	59.1	60.47
2011-12	41568	56186	24047	16459	56.9	29.29
2012-13(P)	44687	28788	25931	17161	58.02	59.61

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POL in India

The Indian economy is at a critical stage of development where energy requirement is increasing at a phenomenal pace. Even though, large part of the developed world is struggling to recover from the recession, the relatively faster emerging countries like, China and India are attempting to meet the requisite demand for Hydrocarbons and other alternative energy resources. Given the limited domestic availability of oil and gas, the country is compelled to import over 75% of its domestic requirement and subject itself to the vagaries of a volatile international price scenario.

In order to meet burgeoning demand for petroleum products in the country, the Ministry of Petroleum & Natural Gas has taken several measures to enhance exploration and exploitation of petroleum resources including natural gas and Coal Bed Methane (CBM), apart from improved distribution, marketing and pricing of petroleum products.

It may be seen that despite considerable variations in International prices of crude oil, imports of crude oil have followed a steady growth primarily to meet domestic demand of a burgeoning economy, apart from re-exports of petroleum products.

A comparative Analysis

Performance Indicators

Ship time in Port (Turnaround Time): - The total time a ships spends in port form its arrival to departure. It includes the pre-berthing time (detention days), i.e. time spent waiting for the operational berth, waiting time at berth, operational time (ship working hr) and free time

Null Hypothesis H0: There is no significant difference in vessel turnaround time between Kandla and Mumbai Port.

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Table 5. Comparison of Ship's Avg Time in Port

Year	KANDLA	MUMBAI
2007-08	1.55	2.12
2008-09	1.5	2.35
2009-10	1.31	2.3
2010-11	1.37	2.21
2011-12	1.53	2.13

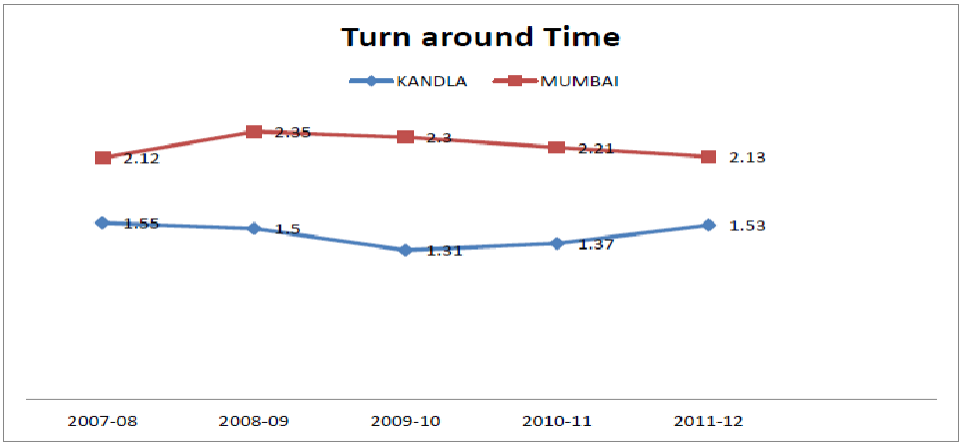

Figure 5. Turnaround Time

Table 6. P Value

P(T<=t) one-tail (Calculated value)	11.7178
t Critical one-tail (Table value)	1.8595

Inference

The researcher has observed that the calculated value 11.7178 is greater than the table value 1.859548038, the critical value at 5% level of significance. The null hypothesis is rejected. Thus we may conclude that there is significant difference in vessel turnaround time between Kandla port and Mumbai ports.

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Avg Pre-berthing time (Detention time): - The time spent by the ship waiting for the operational berth from the time it gets anchored.

Null Hypothesis H0: There is no significant difference pre-berthing time (detention) between Kandla and Mumbai Port.

Table 7. Comparative Study

Year	KANDLA	MUMBAI
2007-08	0	0.21
2008-09	0	0.30
2009-10	0	0.32
2010-11	0	0.33
2011-12	0	0.31

Table 8 Comparison: Average detention days (in days)

P(T<=t) one-tail (Calculated value)	13.6192
t Critical one-tail (Table value)	1.8595

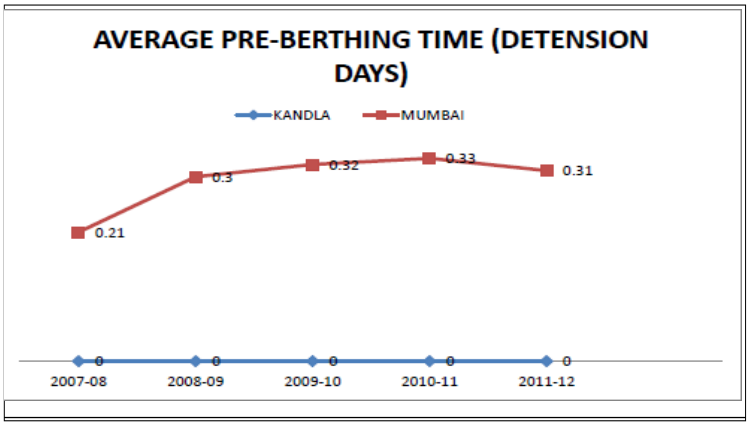

Figure 6. Average Per-Breathing Time

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INFERENCE

The researcher has observed that the calculated value 13.6192 is greater than the table value 1.859548038, the critical value at 5% level of significance. The null hypothesis is rejected. Thus we may conclude that there is significant difference in average pre-berthing time (detention) between Kandla port and Mumbai ports.

Ship Working Hour: - **The** amount of cargo that is handled at the berth when that particular ship is at berth

Null Hypothesis H0: There is no significant difference in ship working Hour between Kandla and Mumbai ports.

Table 9. Comparation of Kandla and Mumbai

Year	KANDLA	MUMBAI
2007-08	20976	5717
2008-09	25466	6122
2009-10	25259	6042
2010-11	23815	7909
2011-12	23023	7395

Table 10. Comparison: Average Output per Ship working Hr (in Tonnes)

Calculated Value	18.4622
Table Value	1.8595

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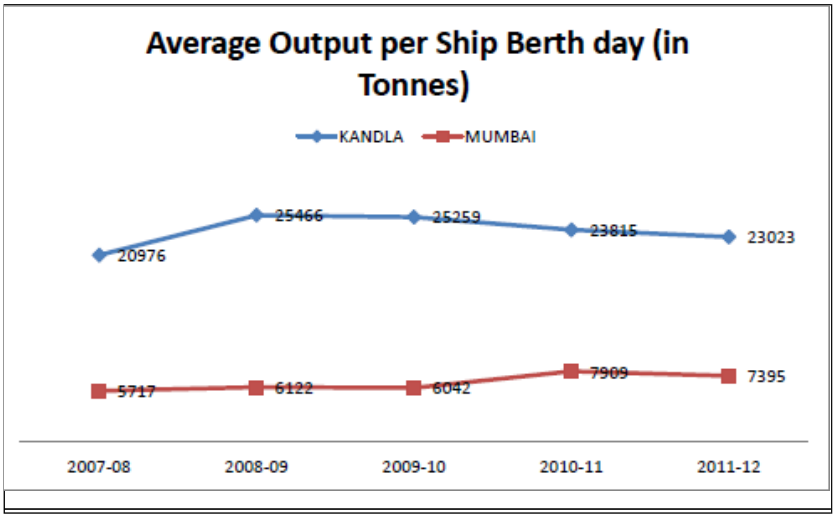

Figure 7. Average output per ship Berth Day

Inference:

The researcher has observed that the calculated value 18.4622 is greater than the table value 1.859548038, the critical value at 5% level of significance. The null hypothesis is rejected. Thus we may conclude that there is significant difference in Average Output per Ship Berth-day between Kandla port and Mumbai ports.

Per Tonne Handling Cost: The cost incurred in handling one tonne of cargo: loading/unloading

Null Hypothesis: There is no significant difference in per tonne handling cost between Kandla and Mumbai ports.

Table 11. Comparation of Kandla and Mumbai

Year	KANDLA	MUMBAI
2007-08	39.99	113.87
2008-09	38.19	119.66
2009-10	45.20	144.21
2010-11	45.34	159.60
2011-12	46.67	171.81

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Table 12. Comparison: Per tonne handling cost (in Rs)

Calculated Value	8.74
Table Value	1.8595

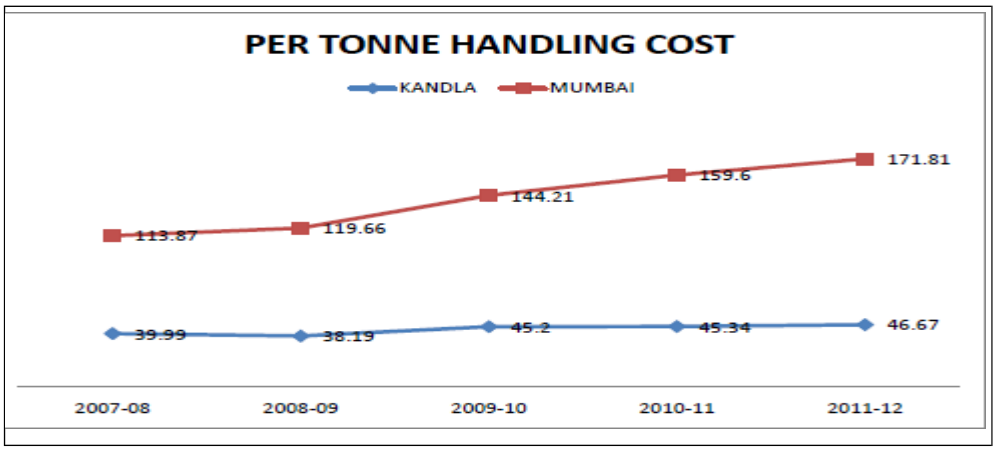

Figure 8. Per Tonne Handling Cost

Inference:

The researcher has observed that the calculated value 8.7465 is greater than the table value 1.859548038, the critical value at 5% level of significance. The null hypothesis is rejected. Thus we may conclude that there is significant difference in per tonne handling cost time between Kandla port and Mumbai ports

Idle Time at Berth: The time which the vessel has to spend at the berth when no work (loading/unloading).

Null Hypothesis: - There is no significant difference in idle time at berth cost between Kandla and Mumbai ports.

Table 13. Comparative Study

Year	Kandla	Mumbai
2007-08	23	23.10
2008-09	22	28.18
2009-10	20	28.68
2010-11	21	29.05
2011-12	21	27.24
Calculated Value	10.4030	
Table Value	1.8595	

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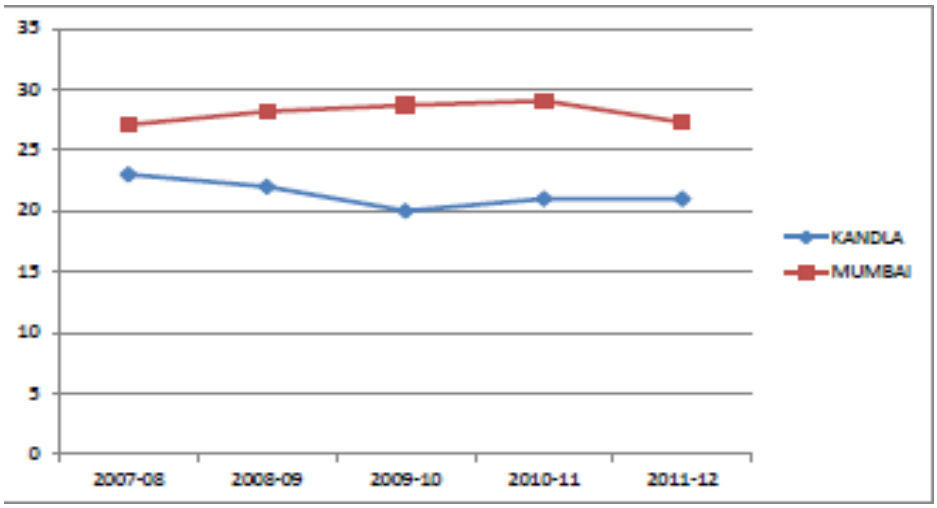

Figure 9. Comparative Study of Kandla and Mumbai

Inference: Since the Calculated value as shown above is greater than table value. The null hypothesis is rejected. There is significant difference in the Idle time at berth of ships in Mumbai and Kandla port.

Findings

- Port traffic was at its all-time high in March 2014 on the back strong thermal coal, Iron & Steel and other cargo traffic and also because of rise in Iron Ore traffic. However, it had declined at the level of 43.75 million tons in February 2014 and again showing an upward trend thereafter.

- Seven out of twelve major ports reported growth in cargo traffic for the month of Jan. 2015. Mormugao port reported highest increase of 47.92% year on year, followed by Kolkata (34.73% year on year), Chennai (16.17% yoy), Paradip (11.90% yoy), Cochin (9.14%), Tuticorin (8.44% yoy) and Kandla (4.35% yoy).

- In our comparative analysis between Mumbai and Kandla port, Mumbai port has developed specialised berths for POL and chemicals. Mumbai Port is facing challenges dueto Intra-Port competition, changing traffic patterns, inherent physical constraints and continuing labour intensive operations, etc

- It has been found from the comparative study that there is significant variation in the performance indicators of Kandla and Mumbai Port i.e. vessel Turnaround time, working hour etc.

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a) All the null hypotheses were rejected so the kandla is performing far better in all the parameters

b) There would be increase in the ship working hour, reduction in turnaround time which can be seen from the comparison.

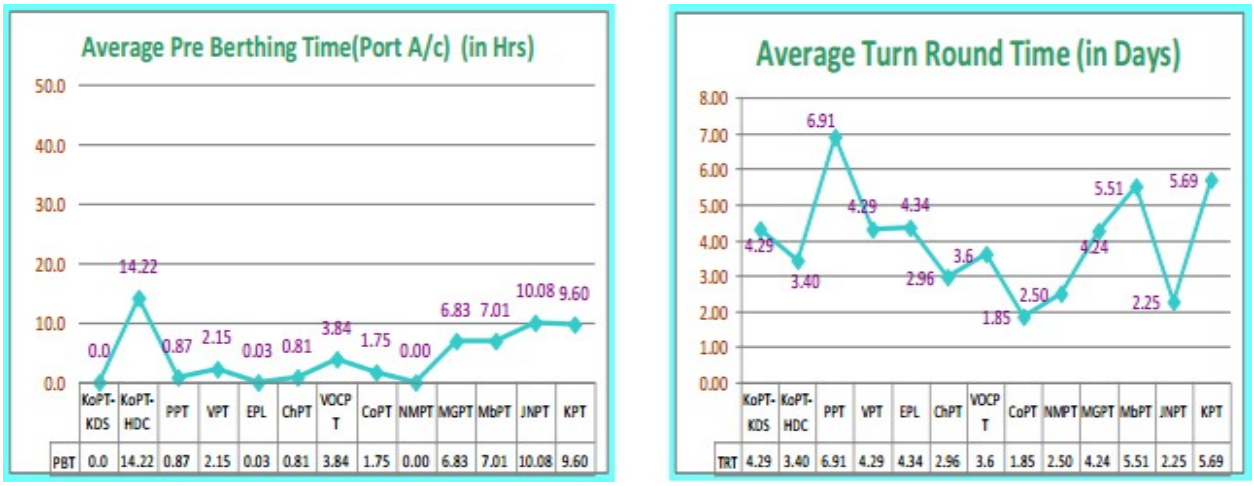

Figure 10. Port Performance indicators April 2014 to January 2015

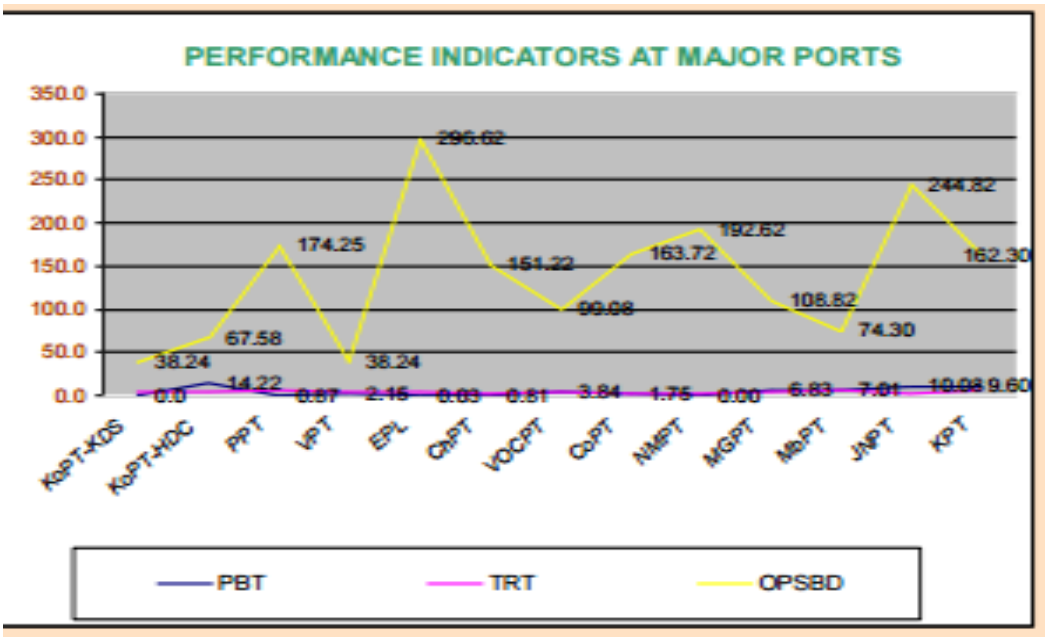

Figure 11. Port Performance Indicators

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Suggestions and Recommendations

- Deployment of special purpose equipment for specific cargoes that speeds up handling thereby increasing the operational time and reducing the ship's time in port.
- Increasing the no of Bulk Terminals which is a remedial measure for insufficient storage space. This is a capital investment decision which require analysis about the viability of the project. Various capital budgeting techniques can be used.
- Many ports that handle bulk commodities cannot accommodate cape size and other bigger vessels due to draft restrictions. Dredging should be done but it involves high cost especially in riverine ports where there is heavy siltation. The best solution is the port should be strategically planned so that it has a natural harbor, open sea connectivity with naturally deeper draft.
- Proper maintenance schedule of equipment should be followed so that there is no breakdown during operations.
- Port congestion is the reason of lower throughputs in port and can be reduced by

    a) Constructing more berth, purchasing more equipment so that more cranes are employed and increasing the storage space for cargo inside the port premises. These are long term solutions in short term the remedy can be
    b) providing better training to labor, reducing dwell time of cargoes, speeding up customs clearance, improving handling Techniques, providing incentives to labor increasing ship working hr.

Bringing ports under PPP projects and privatization of port facilities like superstructure will improve the performance. When the port is governed by a private firm it much more aware of changing market dynamics than the port trust and since its motive is to earn profit it will ensure better utilization of resources.

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