DEVELOPMENT OF AN ANALYTICAL FRAMEWORK TO IDENTIFY PRINCIPAL OPERATIONAL PORT PERFORMANCE INDICATORS OF VARIOUS INDIAN PORTS FOR IMPORTED STEAM COAL

BY

TOTAKURA BANGAR RAJU

COLLEGE OF MANAGEMENT AND ECONOMIC STUDIES

SUBMITTED

IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY

TO

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

DEHRADUN

MARCH , 2012

“जननी जन्मभूमिश्च स्वर्गादपि गरीयसी”

“Mother and Motherland are greater than Heaven”

I dedicate this research work to my

Mother and Motherland

ACKNOWLEDGEMENT

This thesis arose due to my experience and working at Adani group. My association and working with great number of people in the company, with their vendors and customers has contributed in many ways to the research and making of this thesis. It is my pleasure to convey my gratitude to all of them in my humble acknowledgement.

I would like to record my first gratitude to **Dr. K.V. Mohana Rao** for his supervision, advice and guidance from the early stage of research. He provided me unflinching encouragement and support in many ways. His experience and knowledge in Port and shipping domain inspired and enriched my growth as research scholar. I am indebted to him more than he knows.

I gratefully acknowledge **Dr. B.V. Ramalingeswara Rao**, for his advice, supervision and crucial contribution which make him back bone for his thesis. His involvement has triggered and nourished my intellectual maturity which will benefit me for a long time to come.

My sincere thanks to Mr. Bhaven Bhatt, Essar group who has always been supportive and had played vital role in collecting the data for my research.

I would like to mention my special thanks to the Vice Chancellor, Governing body, FRC committee, faculty and other non teaching staff of the University of Petroleum and Energy studies who had helped me in the research process. I would like to mention in particular Dr. K.K. Pandey and Dr. Tarun Dhingra who had helped in the Research methodology. I am grateful to Dr. Devendra Kumar Punia and Dr. M.S. Pahwa for their constructive comments on this thesis. Also would like to mention my thanks Dr. I. Krishnamurthy, Dr. K.Ventateswara Rao and Dr. Ankur Mittal for their help in constructing the thesis.

I would not be here without the support of my family. My parents deserve special mention for their inseparable support and prayers. My mother**, Sugunavathi** in the first place is the person who put the continuous effort to develop my learning character and raised me with her caring and gentle love. My father, **Viswanadha Raju,** has always been the source of positive thoughts and encouragement to achieve new goals.

I would like to express my appreciation to my Wife **Visala**, Daughters **Kaushalya** and **Aishwarya** for their dedication, love and persistent confidence in me.

My thanks to my Classmates Mr. P. Venkata Rama Raju, Mr. P.V. Rajanarayana, Mr. A. Ashok, Mr. T.C.V.N. Rao, Mr. T.P.V.N. Rao, Mr. U. Murali Anand Varma, Mr. N. Subba Raju, Dr. R. Naresh kumar, Dr. A. Ramesh, Dr. G. Rakesh, Mr. G. Ranga Raju, who have always been supportive.

I would like convey my special acknowledgements to all the teaching faculty from Shri Vishnu Educational Society who have inspired me to take up this research work.

Finally, I would like to thank everybody who was important to the successful realization of thesis, as well as expressing my apology that I could not mention personally one by one.

DECLARATION

I hereby declare that this submission is my own and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

Totakura Bangar Raju

Date:

CONTENTS

India is the fifth largest importer of Steam Coal in World. From various sources of Power in India, Thermal power accounts for 54% of the total energy sources. Keeping in view the limitations in production of domestic supply of steam coal, there has been tremendous increase in physical imports of the steam coal from Indonesia, South Africa and Australia. Understanding various bottlenecks and high costs incurred at Indian ports for handling imported coal. There was a need to reduce these costs which were incurring due to port congestion, poor infrastructure and in proper planning for port investment. From the Literature survey, though a number of studies made to measure the port performance is general, but there was no study on research undertaken scientifically to find the most appropriate port performance indicators which are accounting (i.e. with specific to bulk commodity cargo handling at port) for major share in the total cargo handling costs at ports. There was a need to study appropriate Port Performance Indicators by which we could find methods to increase the port efficiency and reduce costs of Coal handling at port.

The eleven coal ports along east coast of India were chosen based on their geographical and strategic location. The first objective was to find the factors affecting the costs of coal handling and shipping operations. Then stakeholders Stevedores, importers, Power producers and Port authorities were given questionnaire and their responses were obtained based on Likert scale 5. Among all factors the Number of berths, draft at the port, port congestion, berth infrastructure, warehouse location, rail connectivity and road connectivity were found to be affecting costs of coal handling operations.

For the second objective the eight defined appropriate port performance indicators were selected based on UNCTAD guidelines. The data for of these Performance Indicators were collected for all eleven coal ports along the east coast of India. The data was analyzed using principal component analysis. The eight variables were reduced to two components called Ship Draft Index and Berthing Time efficiency based Eigen values.

From the research study it was found that the port draft played an important factor for coal ports. There was need for dredging operations coal ports so that larger ships could be accommodated and handled. This would decrease the number of shipments and also ocean freight costs.

The berthing time efficiency indicated that need for better unloading equipment and maintenance could reduce the ship turnover time. The approximate values could be saved were calculated. Thus research has brought forward the principal operational performance indicators for steam coal in Indian Port scenario.

GLOSSARY

Port : A place on a waterway with facilities for loading and unloading ships

Ship : A large buoyant vessel used to carry goods, passengers, goods, warfare and fishing. A merchant ship specially designed to transport bulk cargo like Coal, Iron ore, grains, fertilizers and cement is called as dry bulk carrier.

Major Port : The ports covered under the Major Port Trusts Act, 1963.

Non major Port:The ports not covered under the Major port Trust Act, 1963. They are governed and developed by the respective state governments.

Berth : A ship's allotted place at a wharf at the port.

Quay : A quay or Wharf is a structure on the shore of a harbor where ships may dock to load and unload cargo

Draft : the depth from the waterline to the bottom of hull of a ship.

1.1 Background for the study

Coal is a major source of energy in world scenario and Steam Coal which bituminous coal used for power generation is a major commodity being traded for this purpose. As per the IEA report [1] the major countries importing steam coal are Japan, China, Korea, Chinese Taipei, India, United Kingdom, Germany and Russian Federation.

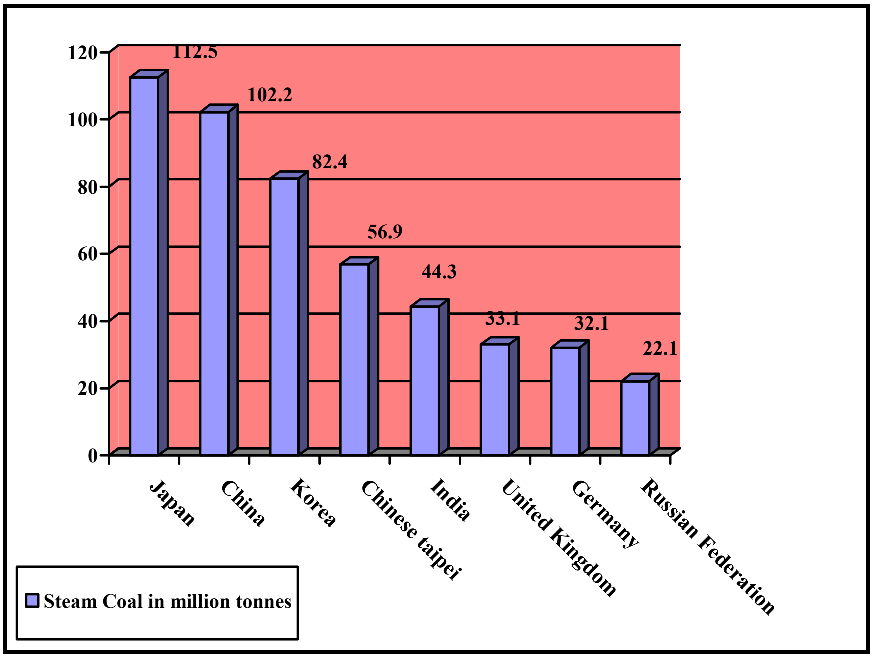


Figure 1.1 World Steam coal Importers Source: International Energy Agency

From the above figure 1.1 Japan is largest importer of Steam coal and India is the Fifth largest importer. There is decrease in imports by European countries and increase in imports by developing Asian countries like India and China. This clearly shows in world coal trade India is emerging to be one of the largest importer of Steam Coal.

The sector wise demand of steam coal in India as per Ministry of Coal report [2] is as follows

Table 1.1 Sector-wise demand of Steam Coal in India in million tons

Sector	2006-07	2007-08	2008-09	2009-10	2010-11
Power utilities	308	332	363	380	405
Captive power	28	29	34	38	40
Cement	20	21	19	21	26
Steel derivatives	17	21	20	23	29
others	55	61	77	89	85
Total	428	464	513	551	585

The above table clearly shows that the power utilities and captive power utilities are the largest and major consumers of steam coal in India.

In India the power sector has installed capacity of 1,73,626 Megawatts as of as March, 2011 as quoted by planning commission in [3]. Out this the thermal power's share is 64% of the total installed capacity. The coal fired thermal plants contribute to 54% of India's electricity capacity. The hydro power accounts for 22% and natural gas for 10%. The share of nuclear is 2.8% and that of renewable is 10.6%.

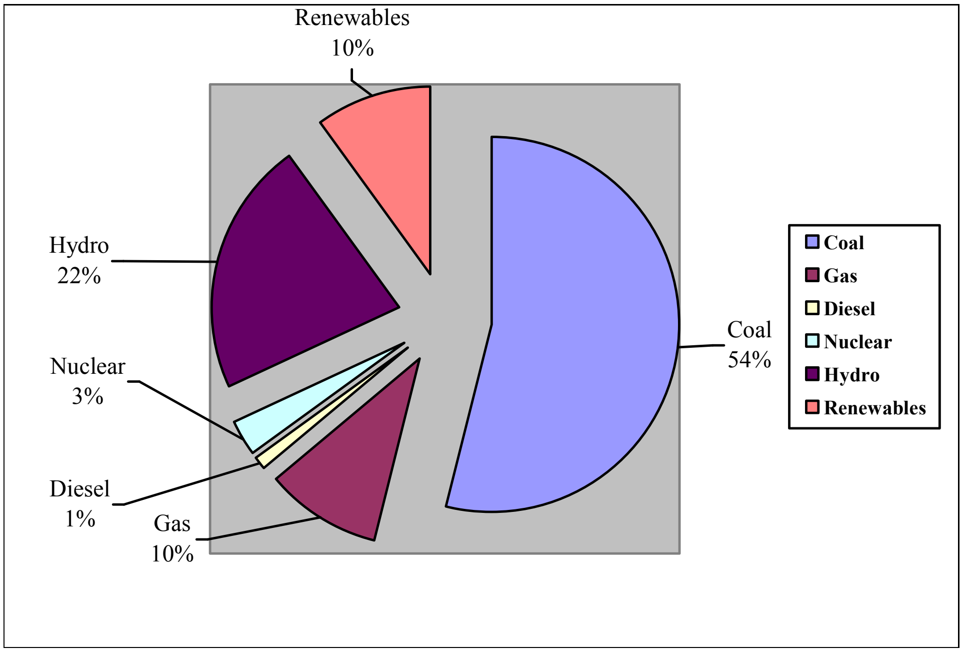


Figure 1.2 India's Power sources Source: Planning Commission

The above percentages do undergo a change when it is transformed in terms of energy generation for Hydro and renewable. Keeping in view the capacity factor which is less for Hydro power and renewable energy's share in electricity generation would be 14% and 2.4% respectively. This clearly shows India is very much dependent on Coal fired thermal Power for its future requirement.

The Ministry of Shipping as stated in [3], at the end of 12th five year plan, India would import 211 million tons of steam Coal per year which would account for 25% of its total requirement which would be 842 million tons.

All these imports need to be handled at the present ports in the Indian peninsula. Therefore, the ports are the major area of interest as stated by Patrick M Alderson in [5]. This is the area where most costs are incurred, delays occur and where cargoes come from.

The report by planning commission in [6] has brought key features of world ports compared to our Indian ports. The ports are large entities whose characteristics are defined by local economy. The port of Rotterdam in Europe is an Industrial complex with Industries and the port has to cater to the domestic and continental needs. The Rotterdam port handles, a wide range of cargo mix with state of art terminals for containers, liquid bulk, dry bulk and break bulk. A comparative analysis of Rotterdam with Indian Ports has been explained in the following table

Table no. 1.2 Indian ports vis-a-vis Rotterdam Port and Singapore ports

S no	Indian Ports	Rotterdam and Singapore Port
1	The extent of Mechanization is less in India	The level of mechanization is high with the latest technologies applied in all spheres
2	Most of the manufacturing Industries are located away from the port	Most of the manufacturing units are located within the port; thereby the evacuation of the cargo is very fast.
3	Land space is scarce in the ports.	Abundant land is available at the Rotterdam port.
4	India has dedicated terminals with less number of terminals and high pre berthing detention	There is no concept of pre-berthing detention as the berths are waiting for ships and they have longer quay.
5	Draft limitations exist and latest generation vessels cannot enter the Indian ports	There is no limitation for latest generation vessels due to high draft availability
6	Much of the bulk cargo is handled by conventional means due to poor infrastructure and archaic methods	The entire operation and management of terminals is conducted in electronic and EDI environment.

	handling resulting in poor productivity.	
7	High turnaround time of ship	The turnaround is very low and incomparable

From the above it is evident that at Indian ports the turnaround time is much higher and waiting time too for ships. The cargo handling infrastructure is not adequate. Thus the productivity at Indian ports is very low and high costs of cargo handling exist at port.

To calculate the productivity at ports as stated in the report of UNCTAD in [7], there are number of reasons to calculate various Port performance Indicators. The UNCTAD has brought forward the need to calculate two kinds of Port Performance Indicators

1. Financial port performance Indicators
2. Operational Port Performance Indicators.

1.2 NEED FOR STUDY

India over a period of time is increasingly depending on imported steam coal for its power generation. Keeping in view the increasing demand and prices of steam coal for its thermal power requirements, it is high time to bring down the costs of handling and shipping at various Indian ports. Due to the high costs of handling, there would be great impact on trade in regard to increase in inflation due to high costs of fuel. In the 12th five year plan, the Ministry of Shipping as stated in [4] has envisaged the need for investment for increasing port infrastructure in Indian Ports. It is highly imperative that there is need to identify key areas where the coal ports and berths need the investment for better infrastructure and identify bottlenecks that lead to congestion, thereby high costs.

The Indian Power consumers mainly consist of agricultural sector and domestic sector which account for 21% and 25% in the year 2008-09 as per Planning commission [3]. Thus cutting down costs of steam coal handling would lead lower power tariffs and thus farmers and consumers would benefit at the end. India's Power generation has growth rate of 8% since last sixty years, still there is a great peak shortage demand at around 10.3% as on the year 2010-11. The Industrial sector like Aluminum and Steel sector also need uninterrupted power. The services sector which is a growing at fast rate needs good uninterrupted power supply. Hence there is a need for looking towards cutting costs in supply chain of steam coal.

1.3 OUTLINE OF THE STUDY

The study consists of five chapters. The **First Chapter** is the introduction. In this chapter the coal scenario is discussed. Brief of present Indian Power scenario and need for imported steam coal is envisaged. The Port scenario and various functions with regard to world ports are compared. The problems faced by Indian ports and need for study of Port Performance Indicators for Imported Steam coal is discussed.

In the **Second Chapter,** review of literature with regard to Indian coal imports, infrastructure issues for steam coal ports, port performance indicators presented and various methods of analysis by authors have been discussed to formulate the strategies to measure the port and efficiency.

Research Methodology adopted for achievement of objectives of the study undertaken has been outlined in the third chapter. In this chapter the rationale for the study, statement of research problem, objectives of the study, scope of the study, research design, sampling process and tools used for analysis have been explained.

The analysis of data collected has been dealt in **Chapter Four**. The frequency analysis with regard to first objective and principal component analysis for the second objective are discussed. The findings from the analysis are also detailed.

In the **fifth chapter** findings and conclusions are presented. The Appendices and Bibliography have been added at the end for reference.

2.1 Review of Indian Ports and Port Infrastructure for handling coal

2.1.1 There has been tremendous increase in India's steam coal imports as per figures from [8]. From figure 2.1 the steam coal imports have steadily risen from 12.03 million tons in 2004-05 to 44.28 million tons in 2009-10. This trend brings forth the need of imported steam coal for India power Sector.

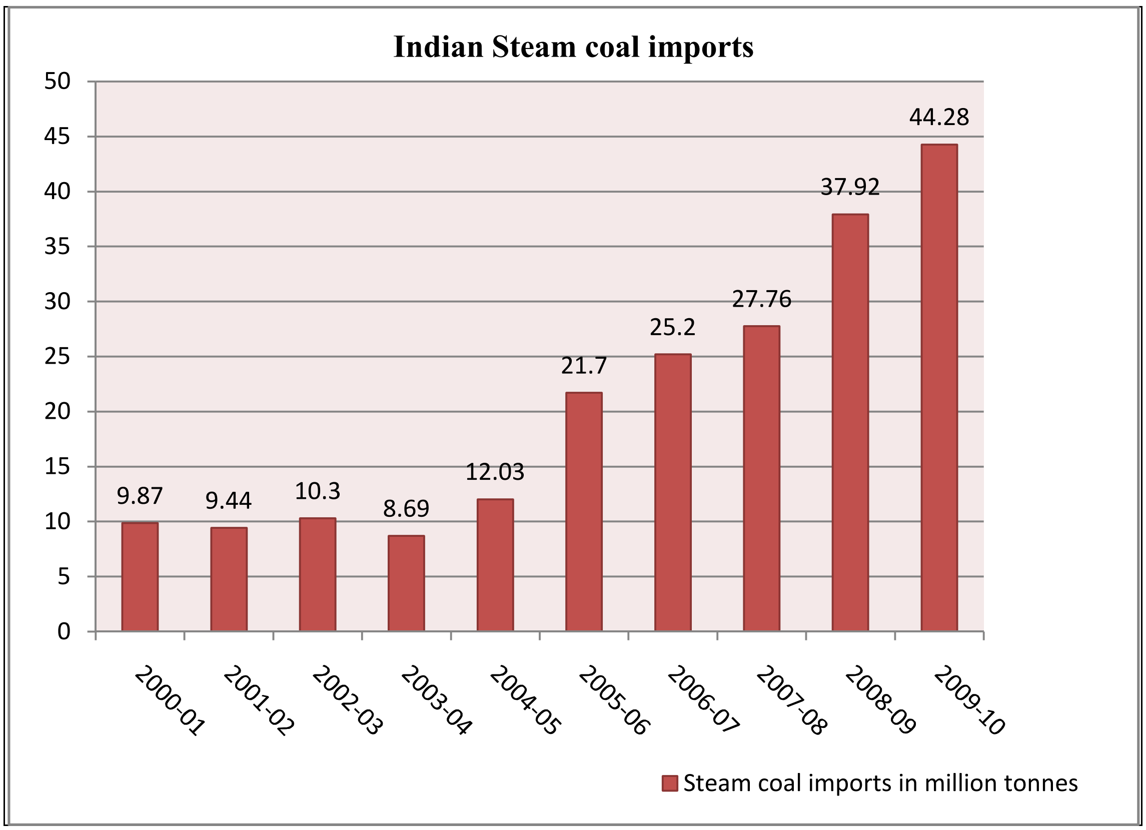


Figure 2.1 Steam Coal imports in India Source: Indiastat.com

The import of steam coal has been increasing due to rapid growth in power sector and the inferior quality of domestic coal. Also the Power plant operators in coastal regions of southern Indian and western India preferred imported coal due to rail transportation challenges faced due to congested rail network. Also the coal imported has higher Gross calorific value of around 4,750 to 6800 Kcal/Kg compared to Domestic coal with GCV at around 3,755Kcal/Kg.

In the report by Ministry of Shipping in [4] Steam Coal demand was assessed as shown below.

Table 2.1 Future Coal Demand and Coal availability scenario in Million tons

	2012-13	2013-14	2014-15	2015-16	2016-17
Steam Coal requirement	515	572	650	737	842
Indigenous Coal supply	416	436	471	521	550
Coal to be imported by Thermal power station designed on imported coal	32	40	47	49	50
Shortage	67	96	132	167	242
Coal to be imported for Thermal power stations designed on indigenous coal	45	64	88	111	161
Total estimated imports of Coal	77	14	135	160	211
Coal likely to be carried through western ports	27	38	53	67	97
Coal likely to be carried through eastern ports	**18**	**26**	**35**	**44**	**64**

From the above table at the end of twelfth five year plan the Thermal power stations designed on Indigenous coal would be importing 161 million tonnes and Thermal power stations designed on imported steam coal would be importing 50 million tonnes. Thus the total Imports of Steam coal would be 211 million tonnes.

Thus at the end of 12^{th} five year plan, 25% of the Coal demand would be met by imports. These imports would be routed through various existing Indian ports along east and west coast of India. The eastern ports play a significant role where up to 64 million tons would be handled at the end of twelfth five year plan.

2.1.2 **Port Infrastructure**

The various elements of Port Infrastructure for Coal as discussed in [9] are

1. Port Entrance or Channels
2. Break waters
3. Inner and outer Harbour
4. Dredging
5. Berth and Berth Infrastructure
6. Dry Bulk Berths
7. Port Conservancy
8. Pilotage
9. Towage
10. Lighterage and barging
11. Stevedoring
12. Bunkering

13. Land access infrastructure

14. Railways

1. Port Entrance or Channels

Port entrance channel is an artificially created navigational path, which provides required water depths for the ships to enter the allocated berth slots in the port area. It is created through dredging of the seabed as per required depth, width and length specifications. Deeper and wider the approach channel in a port enhance the capability of port to handle larger sized and more number of ships, which in turn helps lower the total cargo shipment costs by enabling larger parcel size of shipments. This is true in respect of most commodity freight segments, especially in dry bulk commodities like coal and iron ore, which are more economical to handle in, capsize vessels, besides the container cargo, where bulk of the global traffic volume is handled through large cellular ships.

In case of ports like Mundra, Kakinada and Gangavaram they have natural deep draft, which do not require an artificially dredged channel. Whereas most ports in India are shallow draft ports, which require the depth of the approach channel to be artificially created and subsequently maintained on a regular basis. The global maritime trade is witnessing dramatic increases in ship sizes and the economies of scale in bulk cargo and container cargo movements increasingly favour large sized parcel movements, the ports are under pressure to provide the required facilities to shipping lines and bulk carriers to remain competitive. Hence draft has become a key factor in port infrastructure.

In Indian port sector, lack of adequate draft at the port entrance is one of the key strategic development issues that need to be addressed at a macro planning level for the port sector. The government and the port authority have so far been the key nodal agencies that have invested in the creation of this marine infrastructure at various ports. Dredging an approach channel is a highly capital-intensive activity that involves massive amounts of displacement and the cost of dredging is highly sensitive to the type of seabed to be dredged. As the profile of vessels calling on various ports widely differs, the design specifications for approach channels need to be planned meticulously factoring in the expected returns on investment in terms of likely growth of port traffic and expected earnings from port operations.

A number of major ports in India were established at a time when liquid and dry bulk cargo trade were carried out by smaller ships like handymax vessels which do not require very deep drafts and which manage to enter the ports using the tidal windows. However, as dry bulk and container ship sizes have grown, ports that are unable to handle these large ships have began to lose their cargo to other ports. Kandla and Mumbai are among the ports that have significantly lost their share of dry bulk cargoes to other competing ports like Mundra and New Mangalore.

The various major eastern ports which are handling coal are Haldia, Paradip, Vishakhapatnam, Ennore, Chennai, and V.O. Chidamabaranar. Keeping in view strategic location Cochin port also has been included for study. Paradip and Vishakhapatnam have draft up to 12 m. These two ports have been playing important role as point of distribution for coal along the east coast. Haldia has draft up to 9 m and V.O. Chidambaranar draft up to 11m. These two ports handle mostly Handymax ships. Ennore has a draft of 13m. The non major ports which have come into operational since over three years, Krishnapatnam have 17 m and Gangavaram has 20 m draft which can handle Capesize ships.

2. Break Waters

Ships that enter the port area need to be berthed in tranquil waters to facilitate smooth cargo loading and unloading operations. Breakwaters play an important role in enabling the desired water conditions to be created in the ship berthing area. Breakwaters involve construction of strong structural materials intended to break the force of the sea waves. These constructions are usually taken up outside an open harbour to protect it from long waves and make it possible for ships to berth safely in the port area.

In Indian port sector, the breakwater projects have always accounted for substantial investments made in several artificial ports like Chennai, Tuticorin, Ennore and Mormugao, located along the open harbour and subjected to strong ocean wave currents.

3. Inner & Outer Harbour

Some of the seaports enjoy long and multiple harbour fronts, with its shoreline withdrawing into natural estuaries, backwaters, creeks, canals and river deltas, offer opportunities for development of outer and inner harbours, which can accommodate several cargo terminals. The port development typically commences initially in the inner harbour, and as the need for cargo terminal area grows, the port begins to extend into the outer harbour

Among Indian major ports, Visakhapatnam has highly well demarcated inner and outer harbor fronts, with the maximum number of berths concentrated in the inner harbour. Bulk of the cargo handling is undertaken in the inner harbour and the port activity is rapidly extending into the outer harbour, which includes the proposed development of a container terminal in the multi-purpose berth in the outer harbour. The outer harbor at Visakhapatnam also enjoys a deeper approach channel draft at 17.5 meters, compared to lower draft of 10.7 meters in the approach channel for the inner harbor.

4. Dredging

The development of new berths and deepening of the port's approach channel require large volumes of dredging of seabed and involve sizeable investment. While different degrees of technological sophistication, in terms of the requirement of dredging vessels and other dredging equipment arc needed in different projects, bulk of the demand for dredging actually flows from two categories of dredging in the port sector, viz. capital dredging and maintenance dredging. Ports provide the main stay of demand for the dredging industry, accounting for bulk of the turnover of dredging companies. However, economies of scale in the dredging industry require support also in terms of many other non-port related dredging activities such as dredging for inland waterways, reclamation of sea land, construction of bridges etc.

5. Berth and Berth-side infrastructure in Indian ports

The ship berth is the most important single construction in a modern port. On its capacity and on the efficiency with which it is operated depends the speed of the ship turnaround. While marine infrastructure facilities at a port provide primary capabilities to handle ships and cargo, the berth-side infrastructure facilities is really what makes a port truly capable of offering its value-added services to its customers. The importance of any port is quite directly proportional to the level of investments that have been made in the development of berth-side infrastructure facilities and the manner in which these facilities are optimally used at the port.

The berth-side infrastructure comprises mainly of

a. Civil and mechanical constructions
b. Deep water quay
c. Cargo handling installations like grabs, Cranes, rail sidings, automated unloading systems like conveyor systems etc.
d. Quay sheds and warehouses

The construction of berths, jetties etc for cargo ships to dock and load or unload cargo is an important port asset that forms part of the port infrastructure. The berthing capacity of the port, in terms of number of berths available is indeed, a crucial measure of the capacity of the port to receive ships and cargo. However, the berthing capacity at a port is now increasingly getting segmented along the lines of the commodities being handled at the port and the trend is quite explicitly in favour of creation of specialized and dedicated berths and other innovative offshore solutions for handling of cargo.

Traditionally we have been developing multipurpose berths for all general cargo but the role of general cargo berths are being replaced by cargo specific dedicated berths.

This creation of dedicated cargo berths cannot in themselves solve the operational problems in terms of berthing efficiency and berthing productivity issues in the port sector. The overall management of berths along with the operations of cargo handling systems together decides the productivity and efficiency levels of berths and jetties. The shore- based berthing of vessels is also finding newer forms of substitution through various offshore floating storage and deep sea transfer solutions both in respect of liquid and dry bulk commodities.

6. Dry Bulk Berths

Dry bulk cargo handling in commodities like coal, iron ore, fertilizer, food grains, etc accounts for a large portion of the conventional operations of the major ports like Visakhapatnam, Chennai, Paradip, New Mangalore, Mormugao and Haldia. These ports have dedicated berths for handling coal, fertilizer and iron ore but the methods of cargo handling for the larger part of their existence have been through conventional handling systems, basically using geared ships and other equipments like mechanical slings and grabs and derrick cranes, whose cargo throughput levels are very low and operations time-consuming. At present the conventional handling of dry bulk cargo does not account for a sizeable share of the total dry bulk cargo handled in the Indian ports. Cargo handled by mechanical means has surpassed the dry bulk cargo otherwise handled by conventional methods.

The per day berth outputs of mechanized iron ore and coal handling berths at port like Visakhapatnam, for instance, arc quite low compared to the performance of dry bulk loading rates in several other international ports, because the performance levels of cargo handling equipment in the port is lower than their rated capacity, being aged. The berth-side handling equipment in the dry bulk ports like Visakhapatnam, Paradip and Mormugao are quite aged and need modernization and up gradation for handling larger vessels in the Capesize segments, instead of smaller vessels in the Handymax and Panamax segments it is mainly handling at present

The labour-intensive, low throughput conventional mechanical systems of handling dry bulk cargo are however, increasingly getting replaced with modern conveyor-based handling of dry bulk cargoes in modern dry cargo ports. Lately, Ennore and Paradip ports have come up with state of the art mechanical coal handling systems.

7. Port Conservancy

The port conservancy refers to functions performed by Harbour Master or Port Captain, which include measures aimed at ensuring the safety of navigation in all its aspects within port limits and its approaches. The effective discharge of port conservancy function requires, that a port conservator is able to exercise his powers independently and the port has under its control appropriate marine infrastructures, such as approach channels, break waters, dredging, obstruction/wreck removal, locks for impounding water to necessary levels, aids to navigation, marine communications such access to meteorological information. The port authority constituted under the relevant legislation is responsible for all the conservancy-related functions. Under the Indian Major Port Trusts Act 1963, the conservancy of major ports is vested with the trustees of the individual port trusts, while in case of non-major ports, the conservancy powers are vested with the respective state government or state maritime boards.

Some of the functions that port authority performs with respect to conservancy responsibilities include:

- Collection of bathymetric/hydro graphic data, tide observations, tide predictions, current observations etc.;
- Identification and removal of obstructions, wrecks, shallow waters and navigable channels;
- Establishing and operating port signal station/ port control stations and other communication centres;
- Protection and conservation of port land and waterfront from environmental damage and misuse;
- Dissemination of port-related information to national and international community etc.

Across the world, the port conservancy activities are considered to be basic function of the port authority under the national port laws, though some of the conservancy-centric functions, safety and fire fighting services, wreckage clearance, regular environmental monitoring and shoreline etc. may also be outsourced though undertaken by or assigned to other public or private agencies. In non-major ports of India, the conservancy functions are a residual responsibility of the State maritime board or the department of ports while actual powers and responsibilities are vested with appointed captain of ports or harbour master.

The scope of conservancy functions may be divided between public port authority and private players need to be more clearly defined, in the wake of growing trend towards privatization of various port assets and services in the Indian port sector, as any deficiency in discharge of these functions is bound to have serious implications for port and ship safety and larger public concerns about use or misuse of port assets and waterfront.

8. Pilotage

Pilotage is an essential part of traffic management and safe passage of vessels through a port area. The port authority provides the service to ships that need to be guided in and out of the port area. Trained and certified pilots employed by the port authorities render the service, which is compulsory under the Indian Ports Act 1908. As per the provisions of this act, no vessel of the size of 200 GRT or above can enter, leave or moved in any Indian port without the port authorized pilot, harbour master or an assistant on board. However, the compulsory nature of Pilotage service, while required in case of certain large ships calling on major ports is not consistent with the physical conditions prevalent in certain smaller ports, where Pilotage may not be necessary.

Currently, pilotage charges are an important part of the vessel-related charges levied on the shipping lines by the port authorities. Pilotage movements in ports, especially in a port like Visakhapatnam, with three harbour fronts - inner, outer and fishing harbours, consist of wide range of activities related to berthing and unberthing of ships, their shifting; operations of bunker barges etc. and constitute an important source of port earnings. Monopoly of public port authority in providing pilotage services has however, discouraged improvements in efficiency and bringing down the cost of pilotage operations. Pilotage charges are considered quite high in Indian ports compared to many other international ports.

9. Towage

Towage service in ports basically comprise of tug assistance provided during the berthing/sailing of ships and though not mandatory. Most major ports in India maintain their own fleet of tugs and also charter or hire tug vessels from private owners, whenever required. Several public ports like JNPT, Kandla and New Mangalore have time and again chartered tug vessels from private owners for operating their towage services in the ports. In recent times most of the Major ports, the private parties have been licensed to operate, as the tugs required for handling large Capesize vessels were quite costly requiring higher bollard pull.

10. Lighterage & Barging

Lighterage is the combination of several independent activities using small-sized barges or lighters for the purpose of earning cargo discharged from an ocean-going vessel in order to lighten or reduce its weight. On the other hand, 'Barging', is an integral part of the lighterage activities, involves carrying of cargo consignment in small vessels, where the intention may not be to lighten the mother vessel but to transport cargo from one place to another or carry potable water to the mother vessel. Though lighterage and barging are quite different activities, both have been considered together for purposes of simplification.

11. Stevedoring

Stevedoring involves operations relating to loading and discharging of cargo to and from the vessels to docks in the course of import and export trade and form an important part of the port superstructure services. The job of stevedores primarily involves the supply of equipment and labour, direction for the handling of cargo and loading and unloading of vessels in the port. However, there is a vital difference between the job of 'stevedoring' and 'loading" operations as the job of moving goods from ship's side until they are safely stored within the vessel is called "stevedoring", while "loading" refers to movement of goods from berth to ship's side. Stevedores only handle dry cargo of bulk, break bulk and containerized type. With increasing mechanization of cargo handling facilities for handling dry bulk cargo the scope of conventional stevedoring has been getting eroded.

12. Bunkering

Bunkering is a port-based specialized service, which involves activities like supply of fuel and water to ships berthed in the port, using bunkering vessels. The bunkering activity in Indian ports is however, limited due to high costs of fueling in India. Many large overseas ships entering Indian ports do not take local bunkering services or limit themselves to essential supplies. Nevertheless, bunkering forms an important service conventionally offered by port authority but also slowly coming under the sway of private operators. A large number of feeder and coastal shipping vessels do need bunkering services at ports, as they generally operate with minimal inventories of fuel and water.

13. Land Access Infrastructure

The development policy towards creation of port capacities in India has conventionally encouraged proximity to cargo hinterland, as one of the key criterion for developing a port location. Coupled with the government's long standing policy of establishing a major port in each of the coastal states, the creation of a multiple port system has ensured that national cargo volumes get distributed between different major ports and regions.

Ports however, need to have strong land access infrastructure to be in a position to offer efficient and competitive services to their customers. Ports that have strong and well-established inter-modal cargo evacuation and entry modes and linkages tend to attract more ships and cargo, compared to other ports that have weaker inter-modal linkages. The issue of land access infrastructure also assumes importance while determining the relative advantages and disadvantages of various port locations of India, as loading or discharge port.

Especially, with increasing expectations about integrated logistics, emphasizing on door-to-door seamless connectivity and deliverability of goods, the port's competitive advantage vis-a-vis other ports now crucially depends on how well-connected the port is with its cargo hinterland, in terms of inter-modal linkages and pipelines and other means of cargo evacuation and entry. The principal modes of inter-modal connectivity required for ports include: railways, roads, pipelines (for transporting moving crude oil petroleum products) and inland waterways.

The inter-modal connectivity in India port sector also has the additional dimension of involvement of multiple agencies in the formulation of administrative and development strategies towards various land-access infrastructure services - like the ministries of railways, surface transport, shipping, railways, civil aviation, including the various autonomous and operational agencies created under them. Besides, the different modes of transport have also followed their own independent path or development, often lacking in coordinated planning and thereby resulting in long-term problems and inefficiencies, with inbuilt mismatch of requirements, capacities, and efficient linkages.

Though currently most of the major ports are fairly well connected to their hinterlands by rail-road linkages there are a number of issues specific to each port relating to operational and cost efficiency factors like speed, timeliness, and adequacy of capacity of the existing infrastructure that need to be addressed at the level of policy and implementation.

14. Railways

The railways constitute one of the principal modes of domestic transportation of goods and commodities in country, including the movement of export-import cargo to various seaports. Railways play a major role in the movement of key bulk commodities like coal, iron ore, pig iron and finished steel, cement, food grains, fertilizer and petroleum products across the country.

The Indian Railways on the whole have a market share of 40 per cent in the movement of various cargoes (including container cargo) in and out of the ports of India, besides large volumes of other freight moved domestically between various inland locations. The share of the railways was initially higher upwards of 60 percent in terms of freight movements, when the road networks were not developed but subsequently have come down. The market share shift towards road has occurred in spite of the advantages enjoyed by the railways due to its inherent technological advantages. Currently, the existing share of the traffic is heavily weighted in favour of dry bulk commodities like coal and iron ore, besides container movements originating and destined from ICDs to and from important gateway ports.

The most common problems associated with railways are

- Irregular supply of wagons. Shippers are not often sure of the availability of wagon stock on demand. The variability in supply of wagons complicates the planning process for shippers and also increases inventory costs.

- Irregular delivery at destination. Shippers are not assured of the arrival of their consignments in a specified time frame.
- Inflexibility of service**.** While road transport provides door-to-door service, a similar service is not provided to the shipper by railways. All shipments by rail, which necessarily have a component of road transport at the dispatch/destination ends, to be arranged by shippers themselves.

2.1.3 **Stakeholders**

The various stakeholders for coal as discussed in the report [6] by government of India are

1. Customs: The department collects customs duties on import and export of Cargo. They also look after enforcement of various provisions in the Customs act like cargo, baggage and departure of vessels.
2. Port trusts: The organisation provides infrastructure facilities like equipment, storage, berths, navigational channels, facilitating process of examination of cargoes. They also provide berthing facilities, cargo handling facilities, manpower, and cargo storage space and recovery port related charges and also documentation formalities are taken care.
3. Port Health Organisation: The main responsibility of the agency is to inspect the hygiene of the ship and also the crew. This is to control the spread of infectious diseases from the ships entering the port.

4. Immigration Authorities: The agency acts as per immigration laws of the country and checks the needed documents for foreign crew and passengers to disembark and embark.
5. Terminal Operator: The operator manages to operations at the quay and storage yard and act as custodian of the cargo. Many functions performed by the terminal operators are common with the Port trust authority.
6. Ship operating Agent: Represents the shipping lines in specified territory acting on behalf of the ship owner and attends all the matters related to the customs and port formalities.
7. Stevedore: The Stevedore manages the operation of loading and unloading of a ship. The gears and equipments are owned which are used in loading and discharging operation and also engage labours who actually discharge the cargoes.
8. Customs House Agent: These representatives are responsible for completion of customs and port formalities. The person is engaged in providing service, directly or indirectly connected with clearing and forward operations.
9. Transport operators: The cargo cleared is transported by these operators to consignees.
10. Importers: The organisation which imports coal from the overseas mine owners and charters ship for delivery to port of destination.

2.1.4 **Ship unloaders**

The various Ship unloaders as discussed by UNCTAD in the report [10] are

1. Grabs

The main principle of unloading bulk steam coal by grab has not undergone any change over the past seven decades. The grab is normally used only for picking up material up from the ship hold and discharging it into hopper or trucks located on the quay edge. The attainable handling rate for each grab is determined by the number of handling cycles per hour and the average grab payload. The time of handling cycle is a function of the hosting speed and acceleration of the trolley, the horizontal and vertical distances and the closing time of the grab. Further, the factors affecting it, is the skill of the operator. The operator fatigue causes a limit on number cycles per hour.

For a given lift capacity, the main method of increasing the productivity is increasing the payload/dead weight ratio of the grab bucket. To achieve the desired unloading rate, it is often necessary for a single ship being served by multiple grabs. Thus an important advantage that if one of them fail, the others make up to maintain unloading rate.

2. Pneumatic systems.

These are very much suitable for handling coal as they have low specific gravity and viscosity. These are classifies as vacuum or suction types and pressure or blowing types. The former are suitable for collecting materials from several places to one spot whereas the latter are suitable for suitable for collecting materials from one spot to several places. The port has to have to consider capital, maintenance, and operating costs before taking a decision whether to adopt a pneumatic handling system or conventional mechanical handling system.

3. Vertical Conveyors

The chain conveyor unloader is a self contained unit working on the en masse principle. The free digging rate is generally 500 tonnes per hour. The conveying chain is carried inside a rectangular casing and its motion carries motion from the hold. It is economical to use this type of unit rather than the grab ship unloader, in spite of its high maintenance cost.

3. Bucket Elevators

Bucket elevators are alternatives with unloading rates at 5,000 tonnes per hour range. These continuous unloaders appear less efficient in terms of cost per ton unloaded than grabs. However the digging rates for these are high at 5000 tons per hour compared to grabs at 2500 tons per hour.

2.1.5 Key issues in development of port infrastructure in the 12th five year plan

As discussed in the report [4] by ministry of Shipping, the key areas to be focused in the 12th five year plan are

1. To evolve broad strategies to make the Indian ports competitive as per international standards in terms of productivity, efficiency and cost

effectiveness keeping in view the need for making Indian ports more competitive and to meet emerging requirements of sea transportation of Indian trade.

2. To formulate programme for development of port handling facilities during each year of the 12th five year plan.
3. To evolve productivity norms for machinery and man by suggesting measures to improve equipment productivity at the port and emerging use of computerization to reduce labour intensive mode of handling operations.
4. To assess dredging requirements of Major and non major ports and prepare a dredging plan for all major ports during 12th plan.
5. To look into areas of broad cooperation between Indian ports and ports of other countries. To identify matters and issues which inhibit international cooperation and suggest measures to remove these bottle necks.

2.1.6 **Port performance**

The report of working group for ports has discussed various aspects of port performance. The port performance Indicators discussed in the report are

1. Average Pre-berthing Detention also known as Waiting time.
2. Average turnaround time of Ships.
3. Average output per ship berth day also known as tonnes per ship hour at berth.
4. Average Berth Occupancy
5. Percentage of capacity utilisation of berth.

The total traffic and number of ships were not taken to indicate the efficiency of the port. These performance Indicators mentioned above are not in vogue in international ports in Asia, Europe, and United states. The concept of pre berthing detention does not exist in other world class ports since the capacity is very much higher than the actual traffic and also the planning is done accordingly. Therefore there is no ship waiting at anchorage.

As per UNCTAD in [11] the total turnover time is defined as per below diagram.

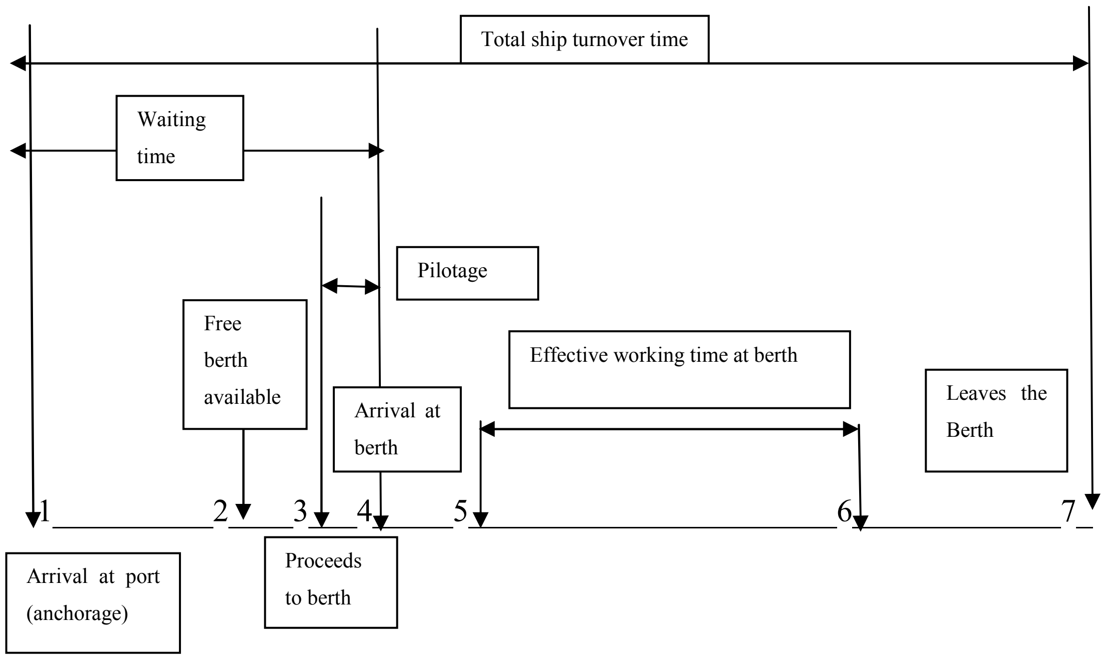


Figure 2.2 Ship time at Port

The ship turnaround time is from point 1 to point 7 as described above.

As discussed in [3] the ship turnaround time is calculated without considering the waiting time. But as per above diagram, the waiting period needs to be considered. Performance indicator would differ from for various commodities. Study and comparison need to be made commodity wise and thus port efficiency could be arrived at. The berth occupancy level indicator gives sometimes a wrong picture. The Indicator does not indicate the efficiency of unloading rate of cargo and also effective utilization of service time or berthing time. Thus Indicator would not be suitable to measure performance of the port.

2.2 Research work examined

The Port performance Indicators have been brought forward and the following guidelines and importance of Port performance indicators were discussed by UNCTAD in [7].

There are various reasons for a need to calculate performance Indicators

1. The Data can be used for improving port performance.
2. These can provide an appropriate basis for future.
3. Port performance Indicators are measures of various aspects of Port's operation. To fulfil the purpose, these indicators are easy to calculate and simplified to understand. They provide insight to the management of port in the operation of key areas. These can be used to compare the performance with a benchmark and also to observe trend in performance levels. These indicators can also be used for negotiations on port congestion surcharges, port development, port tariff considerations and port development.
4. The main purpose for collecting information to maintain performance indicators is to provide an ideal management information system for planning and control.

5. A port authority has the responsibility for functioning of the port. The organisation has to maintain a set of performance indicators as the authority is confronted with an extremely large volume of data and its response may be either to collect too little data or to collect masses of data which are never analysed. The information is collected with a clear purpose and not merely for future undefined analysis.
6. These Performance Indicators must exist for each category of cargo since the port provides different facilities for different set of cargoes. The following are suggested as a set of cargo categories
    a. Coal
    b. Ores
    c. Unitized cargo
    d. Grains
    e. Liquid bulk
    f. Dry bulk like grain, cement and fertilizers
7. The port performance indicators are attractive due to following reasons
    a. Changing conditions: With the development of trade the port labour working rules, shipping lines change and port handling technology changes. The priorities assigned also change over a period of time. This makes it a necessary to build framework within which these changes can be measured and managed in consistent way.
    b. Scarcity of management personnel: In developing countries the scarcity of trained and qualified middle management is a common

feature. By developing the performance standards, by establishment of reporting systems and standardising of methods for collection and analysis of information can minimize the problems created by this deficiency.

c. Scarcity of capital resources: Port development is one among many strategic investments in a developing country. There is an opportunity cost involved in capital invested as it is obtained at the expense of other areas. In order o justify investments in these areas need justification. These performance indicators necessitate adequate information for development of long range plans.

8. Control of an operation is possible only if there is a feedback of performance. Feedback involves the measuring of an actual output and comparing it with desired output to determine what course of action to take.
9. Control is the compliment of planning and neither element is useful without the other. The main step in control is the measurement of deviation from goals and standards that have been set during the planning activity. Thus the selection and the maintenance of Indicators is a necessary step for ports to obtain effective control. A set of indicators will allow management to make improvised utilization of resources by highlighting problem areas and thereby improve service to port users and reduce unit costs. There would be additional benefits which could be derived from the proper use of indicators

a. Highlighting the start and the cause of a congestion period.
b. The negotiation of a reduction in a port congestion surcharge as a result of monitoring and documenting port performance.
c. The timely adjustment of port tariffs.
d. The provision of a sound information base for port planning and justification for capital development.

Performance indicators were classified as

1. Financial Port Performance Indicators.
2. Operational Port Performance Indicators.

The Financial Port Performance Indicators would deal with revenues generated from its operations and services. Various Financial Indicators to be calculated are

1. Total Tonnage worked
2. Berth occupancy Revenue per ton of cargo.
3. Cargo handling revenue per tonne of cargo.
4. Labour expenditure per ton of cargo
5. Capital equipment expenditure per ton of cargo.
6. Total contribution
7. Contribution per tonne of cargo.
8. Revenue produced from a service.
9. Cost of the service.

The functions of the port have been discussed in the book [12]. Various elements of port like the berth, cargo, Mechanization, labour, management and container traffic have been stressed upon. Special focus has been given on various unloading methods like mobile crane, mechanization, palletization and conveyor systems. The authors gave a though process for port of the future,

The various issues related to Coal carriage were discussed in the book [13]. The author has brought forward various issues related to coal carriage by sea. Various ships employed to carry coal, the loading and discharging methods of coal and chartering methods practiced have been brought forward. The author has discussed various factors affecting to coal handling operations at port for Steam coal.

Various aspects of port economics have been forward in the book [14]. The author has discussed about Stevedoring charges, queuing theory for berthing at ports, congestion costs. The authors also have brought forward negative effects of high rate of port capacity utilization besides queuing cost.

The report [9], has brought forward need for ports, has discussed about berth occupancy, waiting time, service time, seasonal variations, cost considerations for every port investment and port planning. Special focus has been given for bulk cargoes like ores, coal, bauxite, phosphates, fertilizers and grains. The characteristics of these terminals, handling equipment performance specifications, types of various ship unloading equipments, storage of these bulk cargo and standby facilities have been discussed.

In the report [15] the authors have made study to make international comparisons of port efficiency. They have stated that available studies have not provided sufficient answer for calculating comparative port efficiency. They have used Data Envelopment Analysis and have ranked five Australian and Eighteen international container ports. They found this analysis easy as the calculations were nonparametric and do not require knowledge of prior weights for inputs and outputs.

The relative efficiency of container ports was done in South Korea as detailed in [16]. The author has proposed a Hybrid Data Envelopment Analysis model by using real examples of major container terminals in South Korea.

The data analysis and TFP approach was done to measure the efficiency of Chinese container terminals as detailed in paper [17].

There were studies in regard to scenario analysis for supply chain integration in container shipping as in [18]. The authors have conducted their research for Indian Shipping scenario for container shipping.

The studies by Data Envelopment Analysis was made to bench mark and evaluate the operating performance of 69 major Asian container ports and generate efficiency ranking as in article [19].

A regression model for vessel turnaround time for container vessels was calculated as in [20]. Two ports in Port Kelang- West port and East port, data was collected to show that vessel turnaround time is highly correlated with crane allocation.

Studies with regard to logistics and supply chain management approach to port performance measurement were discussed in [21]. This approach could be beneficial to port efficiency by directing port strategy towards relevant value added logistics services.

The functional analysis of Port Performance as strategic tool for strengthening port's competitive and economics model was brought forward as discussed in [22]. The methodology discussed was to provide an efficient tool for analysis of functional strengths and weaknesses in ports. The traffic analysis and bottleneck assessment stages were discussed.

The sensitive performance measures in container port were identified in article [23]. The results indicate that the number of berths and capital deployed are the most sensitive measures impacting performance of container ports. The analysis also reveals that container ports located in different continents behave differently

A discrete simulation model was developed in [24] involving various berthing policies, terminal layout, performance of landside equipment, contractual agreements and associated penalties. The studies have proposed benefits of new berthing policies and ocean shipping contracts.

A study on efficiency of iron ore and coal ports using Data envelopment analysis method was made as detailed in [25]. The paper shows that main source of inefficiency in bulk terminals is related to scale. The authors recommend that national efficiency can be achieved either through a limited number of large ports or by combining smaller ports with complimentary characteristics.

A great deal of significant studies were made in measuring port efficiency as a determinant of Maritime cost as detailed in [26]. The authors have calculated operational performance indicators for nine Latin American Countries and have done Principal Component Analysis. The conclusions are relevant for the policy makers which show that port performance indicators are relevant for determining port's competitiveness. The authors could collect data only containerized cargo and could not collect for bulk cargoes.

UNCTAD [11] has brought forward on ways of measuring and evaluating port performance and Productivity. The author has detailed the process and guidelines for calculating various possible Performance Indicators at various ports and various categories of cargo.

UNCTAD [7] has given guidelines to various Port authorities in regard to data collection and also defined various possible performance indicators. It has suggested various formats and methods for the data to be kept in records and their need. It also discusses costs and benefits of such exercises.

The importance of Operational Performance indicators and Asset performance indicators were brought forward in [27]. The author has identified and defined various operational performance indicators, their importance and need.

One of the most significant contributions to the research studies for Indian port sector made in [28]. The author has made studies related to port performance indicators and labour endowment in determining port traffic. Also has detailed about port productivity growth in Indian ports with their significance in globalization scenario. The author also has made studies related to technological change in terms of its power and ability to improve the productivity of labour at port in Indian Scenario. Also there has been an attempt to measure the concentration and competition in Indian port sector which would be beneficial for national economies, consumers and exporting/importing industries.

2.3 Research gap

We understand that India would import 211 million tons at the end of 12th five year plan. Ports and Port infrastructure are of major concern for these imports due to high costs incurred. From the above literature survey we can find there is a huge research gap in regard to port and shipping studies. The Port Performance Indicators were calculated as a whole for all the commodities together but research work in regard to particular class of commodity like coal was not present. Also a lot of studies were done in regard to containers for which the data was easily accessible and the authors as discussed in [26] have mention the scope for studies in bulk cargoes like coal and iron ore.

The report [4] has discussed some Port Performance Indicators in regard to Major ports without taking cargo class in to consideration. The authors have also brought forward absence of appropriate performance Indicators for bulk cargoes like iron ore, coal and fertilizers. Hence there is need for study in Port Performance Indicators for imported steam coal.

3.1 Rationale of the study

There has been steady rise in steam coal imports to support the demand from coal fired power plants in India. The steady growth in power plants and shortage in domestic production have made our country dependant on imported steam coal. The ports have played a pivotal role handling coal. As per Patrick M Alderton in [5] the port is a major concern of interest as this is the location where most operational costs are incurred, delays occur which contribute to large unexpected costs, industries like power plants are located and many stakeholders are involved. From the importers and power producer's point of view, there are many bottlenecks due to which high ship turnaround time, low cargo discharging rates, low drafts and poor coal handling infrastructure have contributed to high costs of steam coal imports.

The study and analysis of operational performance indicators examined the key areas in port operations where these bottlenecks and handling costs can be reduced.

The objective is to study the most appropriate operational performance indicators and indentify where the efficiency of port operations could be improved. The research study identifies areas where the government needs to focus for infrastructure development. This study also tries to find various factors affecting the port operations for steam coal imports.

3.2 Statement of the problem

Maritime costs have been a major concern for Coal imports to India. High costs of shipping and port handling costs have been pushing up the landing prices of coal imports and the costs of power generation. Keeping in view the that India's energy policy which is becoming more dependent imported thermal coal. There is a need to identifying factors affecting the costs most at ports, as the coal imports take place by ships.

The study identifies appropriate Operational Port Performance Indicators for imported steam coal and identifies the areas where the costs of port operations could be reduced.

The statement is **"Development of an analytical framework to identify principal Operational Port Performance Indicators at Various Indian Ports for Imported Steam Coal".**

The study also analyses various variables affecting costs of operations for coal handling and shipping at various ports along east coast of India.

3.3 Objectives of the Study

1. To study various factors affecting shipping operations and handling of steam coal at various Indian ports along the east coast.

2. To identify principal Operational Port Performance Indicators for coal handling along east coast of India.

3.4 Scope of the study

The study's main focus has been on imported steam coal category of bulk cargo which is a major commodity of import by India. The ports along the east coast of India have been taken into consideration for this purpose. The ports are geographically and strategically located catering to thermal power plants and captive power plants located closer to east coast of Indian Peninsula. All Major and non major ports handling steam coal along east coast of India have been taken into consideration. The ports are Haldia, Paradip, Vishakhapatnam, Ganagavaram, Kakinada, Krishnapatnam, Ennore, Chennai, Karaikal, V.O. Chidambaranar and also Cochin. The data collected was for a period of one year from April 2010 till March 2011.

3.4.1 **First objective**

The Stevedores, Importers, Power Producers and Port Authorities were considered for study among all the stake holders. These stake holders are directly involved in coal handling operations at the ports. Ports like Gangavaram, Krishnapatnam, Ennore and Karaikal the port authority is the stevedore. Here the operations department was contacted for the research. The importers who were directly importing from overseas mines by chartering the ships were considered. The Power producers who were directly importing from overseas mines by chartering the ships were considered.

3.4.2 **Second objective**

The primary data was collected for one year from April 2010 till March 2011. The ship file and productivity file records maintained by port authority for all import shipments along east coast ports were collected and operational Performance Indicators were calculated. The format of Ship file and Productivity file has been shown in Annexure A13 and A14. The operational performance Indicators as suggested by UNCTAD in [7] were taken into consideration. The Operational Port Performance Indicators considered were

Table no.3.1 Operational port performance Indicators

S no	Operational performance Indicator	Description	Units
1	Waiting time	The time a ship has to wait at anchorage before getting entry into berth	Hours/ship
2.	Pilotage time	The time taken from to move the vessel from anchorage till berthing of ship at port	Hours/ship
3	Service Time	The total time the ship has spent at the berth.	Hours/ship
4	Tons per ship hour at berth	The total tonnage handled towards ship berthing time.	Tonnes/hour
5	Effective working time at berth	The time effectively used for discharging of cargo at port	days
6	Average tonnage per ship	The average cargo carried by the ships at the port.	Tonnes/ship
7	Average draft per ship	The vertical length of ship immersed in the water.	meters
8	Ships arrival rate	The number ships arriving over a period of time.	Ships/month

The performance indicators with regard to labour were not considered keeping in view that the focus was on to improve port infrastructure. All ports are not guided by any uniform labour laws and these indicators were not required for our objectives.

All the handling equipment, port location, port infrastructure, weather conditions and port topography was considered to be same for study. Factors related to environmental pollution and labour issues were not taken into consideration. All the time calculations other than documentation delays by the importer were considered to be in Port account.

3.5 **Research design**

3.5.1 **Data Collection**

The study consists of only primary data collected from various sources for both the objectives.The primary data required for first objective was collected using questionnaire from Stevedores, Importers, Power Producers and Port Authorities who are the main stakeholders in coal imports. A simple questionnaire as in Annexure A15 which could be understood by all the four categories of respondents was prepared. The questionnaire was prepared on Likert Scale 5 for easy understanding. The responses were taken for ten identified factors which affect the Costs of Coal handling operations and shipping as discussed in [5]. It was tested, revised and then was circulated to one representative from each firm involved directly in handling and shipping operations. The representatives of the firms involved from were contacted and requested to answer based on their perception.

Ports where the functions of both stevedore and port authority were performed by the same organization, response from the administration department and operations were obtained separately.

For the second objective the Port Authority personnel and Shipping surveyors were requested to share their documents related to shipments. The Ship file and productivity files were accessed and various operational performance indicators were calculated for each shipment. This method was obtained to gather first hand information from the facts recorded for every vessel which arrives to the port.

3.5.2 Sampling frame

For first objective the researcher has contacted all the Stevedores, Importers, Power producers and Port authorities who were involved in direct handling of steam coal for this period along various ports in East Coast of India.

The responses were obtained as per following

Table 3.2 Respondents mix

S no.	Category	Total no of stake holders in the Operations	Respondents
1	Stevedores	17	14
2	Importers	15	12
3	Power producers	4	4
4	Port Authorities	11	7

The total population was surveyed for the study and responses from 78.7% of the total population were taken for study. The appropriate personnel from above categories who were involved in the port operations were contacted who were located in different parts of the country. The stevedores and Port Authorities were located nearer to the ports and responses were obtained between September, 2010 and January, 2011.

Thus the sampling frame for the study consists of 37 respondents out of total 47 population size. Since the survey is 78.7% of the total census there is no need for test for adequacy of the sample.

For the second objective the primary data was collected from all eleven ports which were handling steam coal along the East Coast of India were considered for study. The productivity files and ship files for all shipments pertaining to steam coal shipments from April 2010 till March 2011 were obtained. The average values of the Operational Port performance Indicators were calculated Port wise.

3.5 **Tools for Analysis**

3.5.1 First Objective

The impact of a various factors affecting the coal handling and shipping operations were to be analyzed based on their perception. The questionnaire was based on Likert scale five. Hence simple frequency analysis was done. The following equations were used for each of the factors

1. Mean

$$\bar{X} = \sum \frac{Xi}{n}$$

2. Standard deviation

$$\sigma = \sqrt{\sum \frac{(X_i - \bar{X})^2}{n-1}}$$

3. Confidence interval

$$C.I = \bar{x} \pm (\text{z critical value}) \cdot \frac{\sigma}{\sqrt{n}}$$

3.5.2 **Second Objective**

The main idea of research was to form, from an existing set of Operational Performance Indicators a new set of reduced Indicators which would contain as much variability of the original data as possible. This could reduce the data which would be easy to handle and use it for further decision making purpose. For this Principal Component Analysis (PCA) was selected.

SPSS version 19 software was used for analysis.

4.1 **Data Analysis for factors affecting various the Steam Coal handling and shipping operations at the Indian Ports.**

Frequency Analysis has been worked out for the primary data collected through questionnaire as per Annexure A15

Table 4.1 Frequency Distribution table

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Stevedores	14	37.8	37.8	37.8
	Power producers	4	10.8	10.8	48.6
	Importers	12	32.4	32.4	81.1
	Port authorities	7	18.9	18.9	100.0
	Total	37	100.0	100.0	

The four categories of stakeholders involved directly in the steam coal trade are Stevedores, Power producers, Importers and Port Authorities.

The Stevedores who specially handle steam coal were found to be sixteen in number out of which responses from fourteen were. The Stevedores were found to play a critical role in understanding the Coal handling and shipping who were providing importing steam coal services were considered as they are also chartering the ships for coal carriage. These importers were paying higher freights due to various factors discussed in this chapter. The total direct importers were fifteen, out of which twelve have responded. The Power producers who were directly importing steam coal all the four have responded. The Port trust authorities or organizations who were responsible for providing services were taken in to consideration. Out of eleven ports taken up for study seven have provided the required information. The breakup of all responses from various stakeholders could be shown in figure 4.1 below

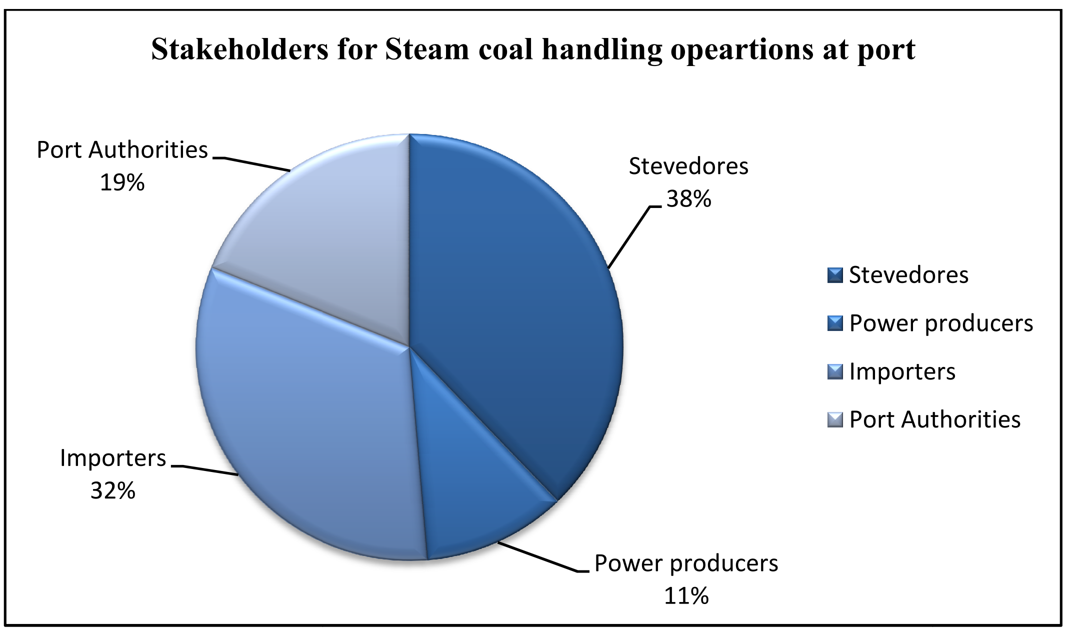


Figure 4.1 stake holders

From the figure the 38% of the census are stevedores, 11% are Power producers, 19% are Port Authorities and 32 5 are the importers.

4.1.1 **Analysis for number of berths affecting the costs of Steam coal handling and shipping operations at Indian ports**

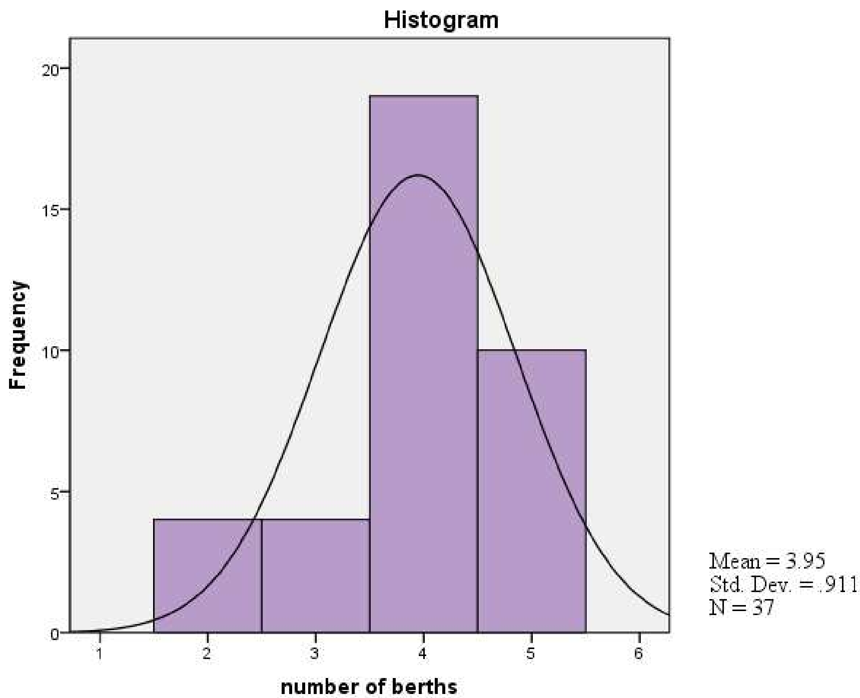


Figure 4.2 Histogram for number of Berths

Mean= 3.95

Standard deviation=.911

Variance=0.830

From the above values, the majority of the census somewhat agree that number of berths do affect the costs for coal handling and shipping operations at port since mean is 3.95. There is a standard a standard deviation of 0.911 and variance of 0.830 signifying that some respondents in the census do not agree to this.

4.1.2 Analysis for Berthing policy affecting costs of coal handling of steam coal and shipping operations at Indian ports.

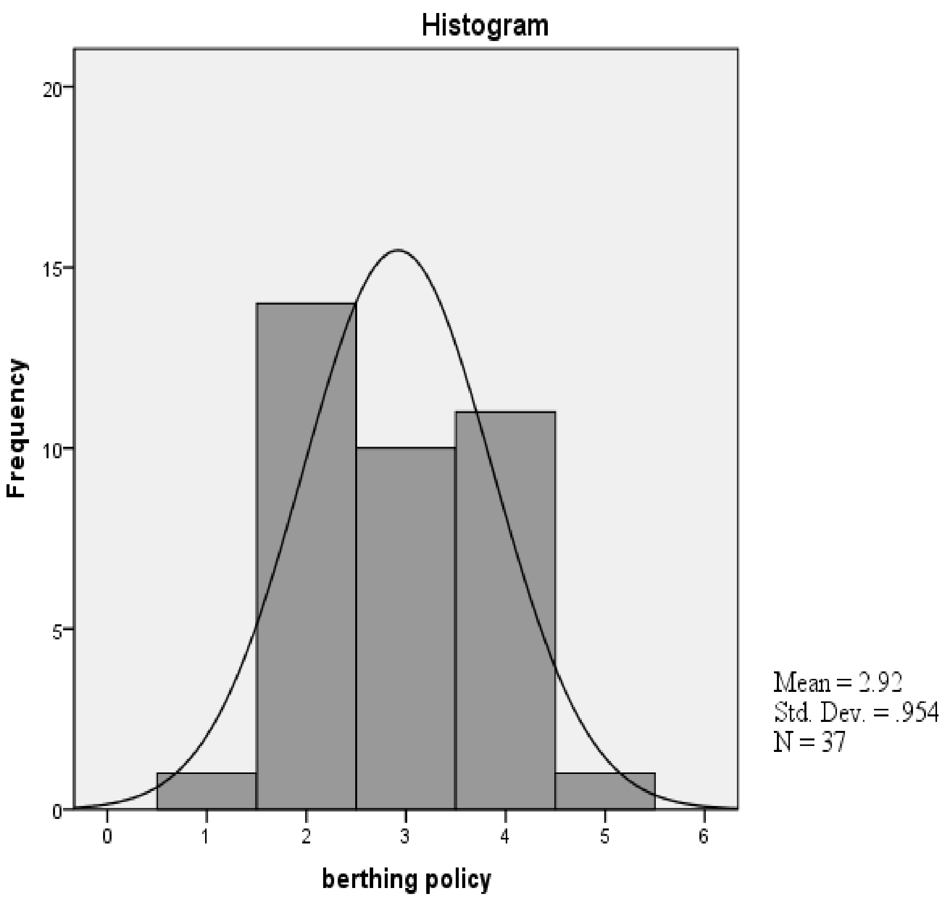


Figure 4.3 Histogram for Berthing policy

Mean= 2.92

Standard deviation=0.954

Variance=0.910

The berthing policy which is different for various ports does not seem to play a significant role and also most of the respondents in the census are unable to explain about the affect of this factor. Inspite of standard deviation being 0.954 which is significant, most respondents in the census are unable to agree about this factor.

4.1.3 Analysis of port congestion affecting costs of Steam coal handling and shipping operations at Indian Ports.

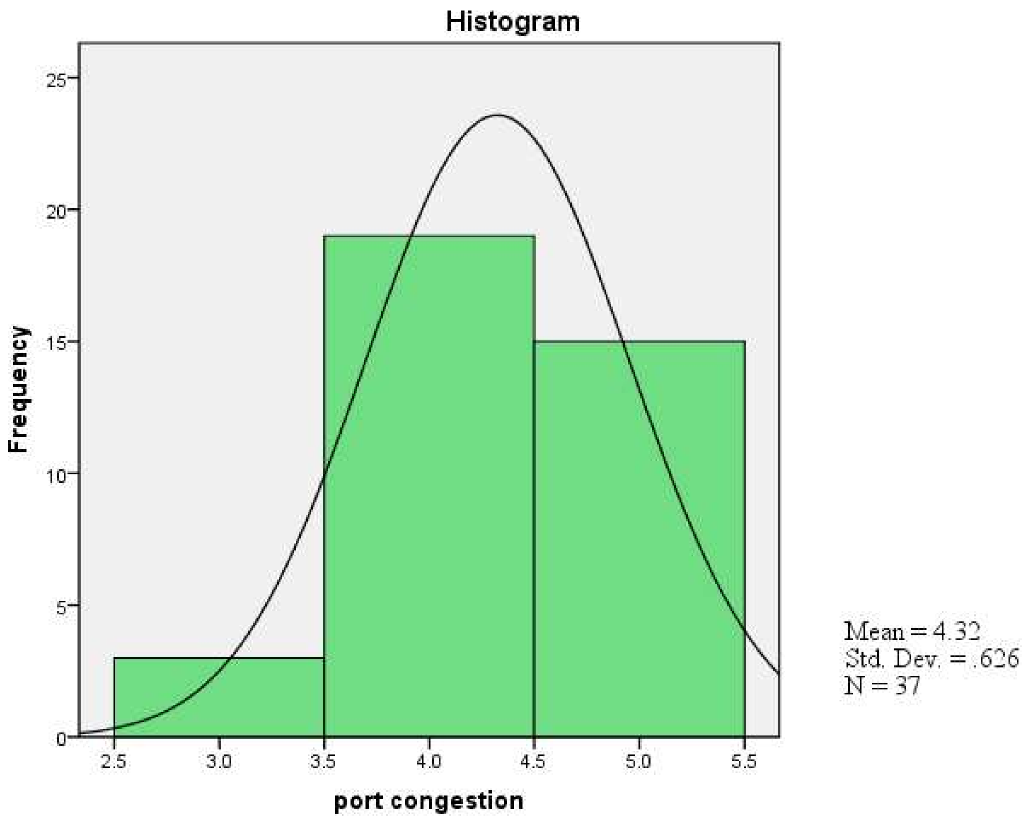


Figure 4.4 Histogram for Port Congestion

Mean= 4.32

Standard deviation=.626

Variance=0.392

Port congestion has been discussed in the literature as major factor for increase in costs of coal handling at Port. The majority of respondents in the census have agreed to this as the mean is 4.3. The values of standard deviation 0.626 and variance 0.392 signify that there is little difference of opinion in this regard among the respondents in the census.

4.2.4 Analysis of Navigational infrastructure is affecting costs of Steam coal handling and shipping operations for at Indian Ports.

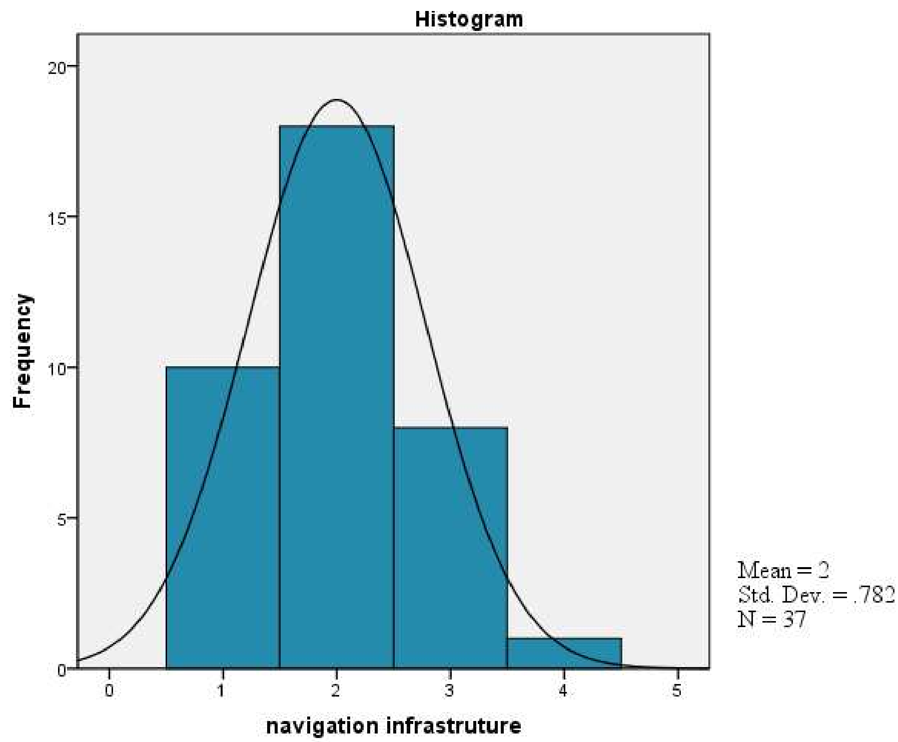


Figure 4.5 Histogram for Navigation Infrastructure

Mean= 2.00

Standard deviation=0.782

Variance=0.611

The navigation infrastructure does not affect the coal handling costs as per survey from the census. Also the standard deviation and variance with values 0.782 and 0.611 respectively signify that there is no significant variation in the opinion of the respondents in census.

4.1.5 Analysis of Draft at port is affecting the costs of Steam coal handling and shipping operations at Indian Ports.

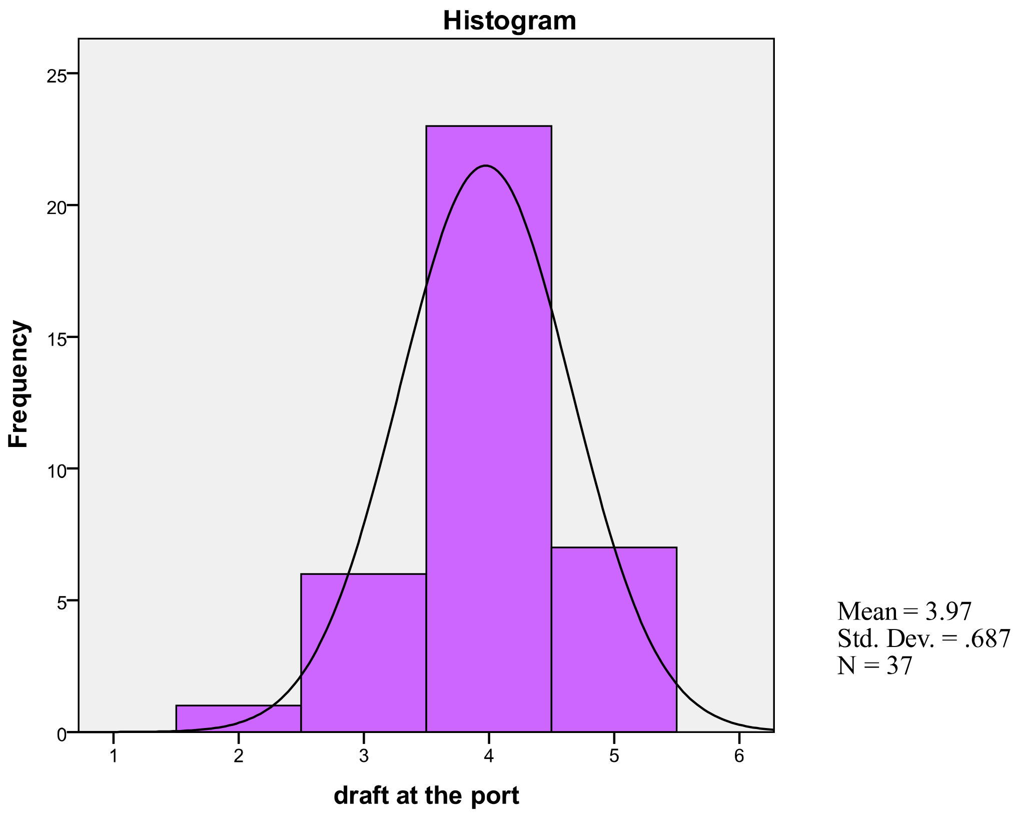


Figure 4.6 Histogram for Draft at the Port

Mean= 3.97

Standard deviation=0.687

Variance=0.471

The mean value of 3.97 reflects that most of the respondents in the census somewhat agree that draft at the port affects the costs of coal handling and shipping operations at the port. The standard deviation value of 0.687 and variance of 0.471 reflect that there is not much deviation in the opinion among the respondents in the census.

4.1.6 Analysis of Berth Infrastructure is affecting costs of Steam coal handling and Shipping operations at various Indian ports.

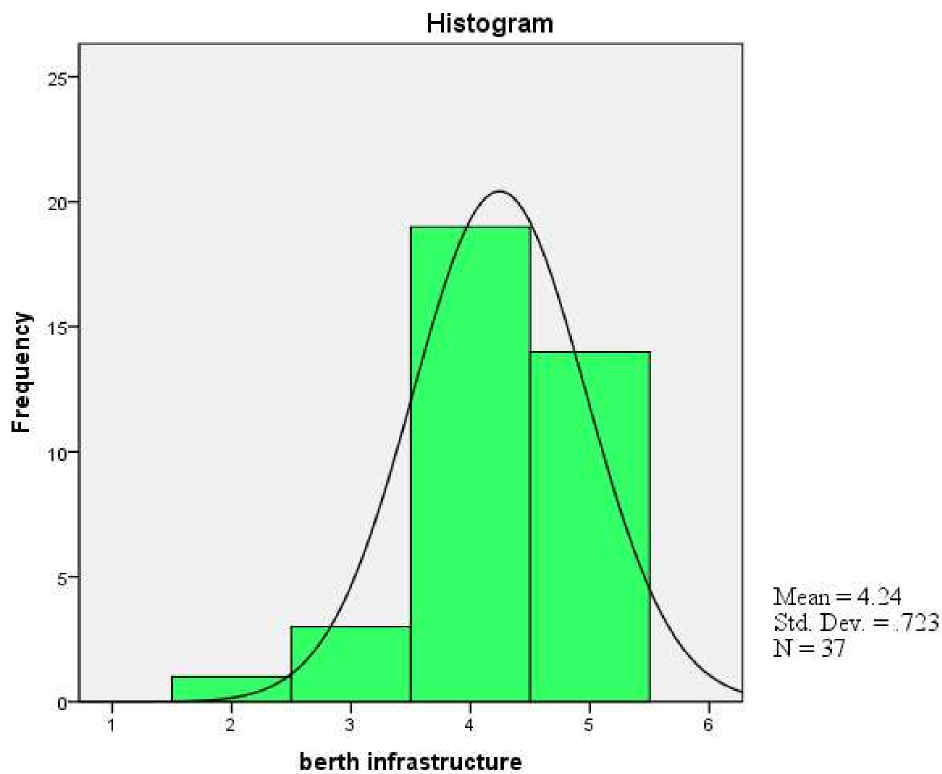


Figure 4.7 Histogram for Berth Infrastructure

Mean= 4.24

Standard deviation=0.723

Variance=0.523

Berth infrastructure affects the costs of coal handling as the mean is 4.24. The Standard deviation value of 0.723 reflects that majority of the respondents in the census accept that better berth infrastructure is required to cut down costs of coal handling.

4.1.7 Analysis of cargo warehousing infrastructure is affecting the costs of Steam coal handling and shipping operations at Indian ports.

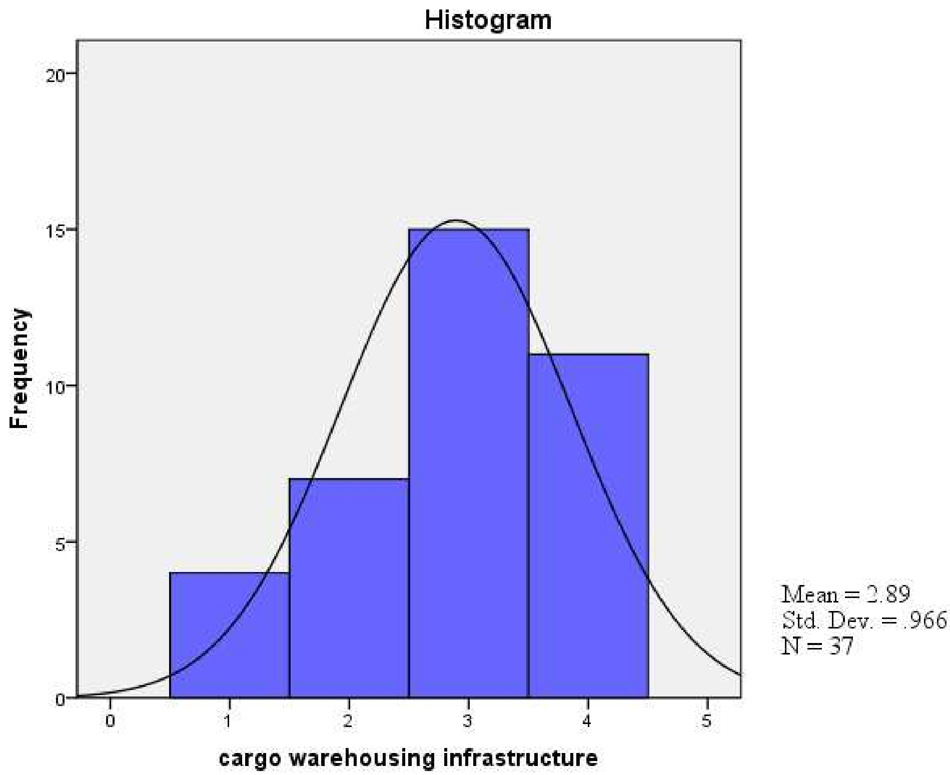


Figure 4.8 Histogram for cargo warehousing infrastructure

Mean= 2.89

Standard deviation=0.966

Variance=0.932

The mean for cargo warehousing is more closer to 3 and standard deviation of 0.966 which suggests that majority of the respondents in the census have wide variation of opinion for this factor. The census is almost equally agreeing and not agreeing that cargo warehousing factor affects the coal handling operations at port.

4.1.8 Analysis of Warehousing location affects the costs of Steam coal handling and shipping operations at Indian Ports.

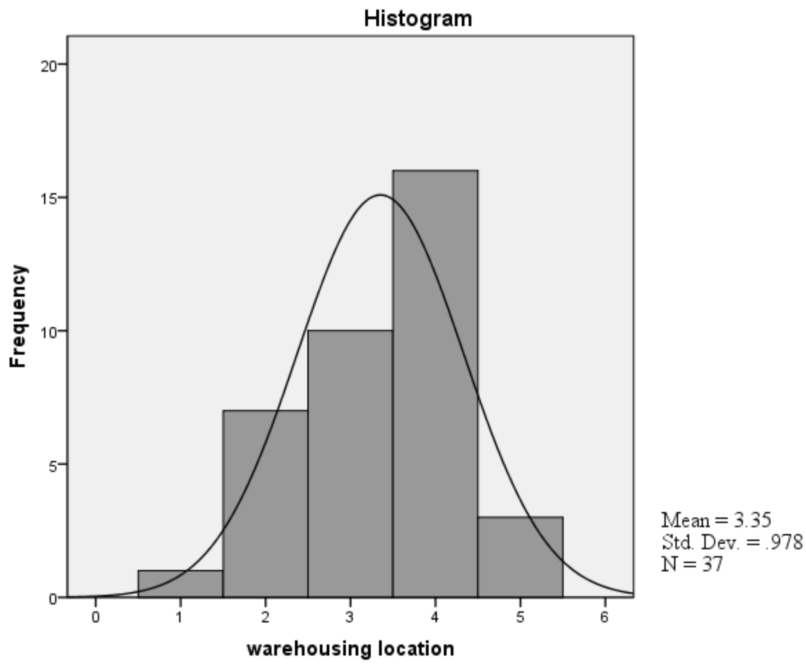


Figure 4.9 Histogram for warehousing location

Mean= 3.35

Standard deviation=0.978

Variance=0.956

Mean value of 3.35 suggests the respondents in the census cannot say whether warehousing location affects the steam coal handling; however the standard deviation value of 0.978 and variance of 0.956 implies there is a wide range of opinion.

4.1.9 **Analysis of Rail connectivity affects costs of Steam coal handling and shipping operations at Indian ports.**

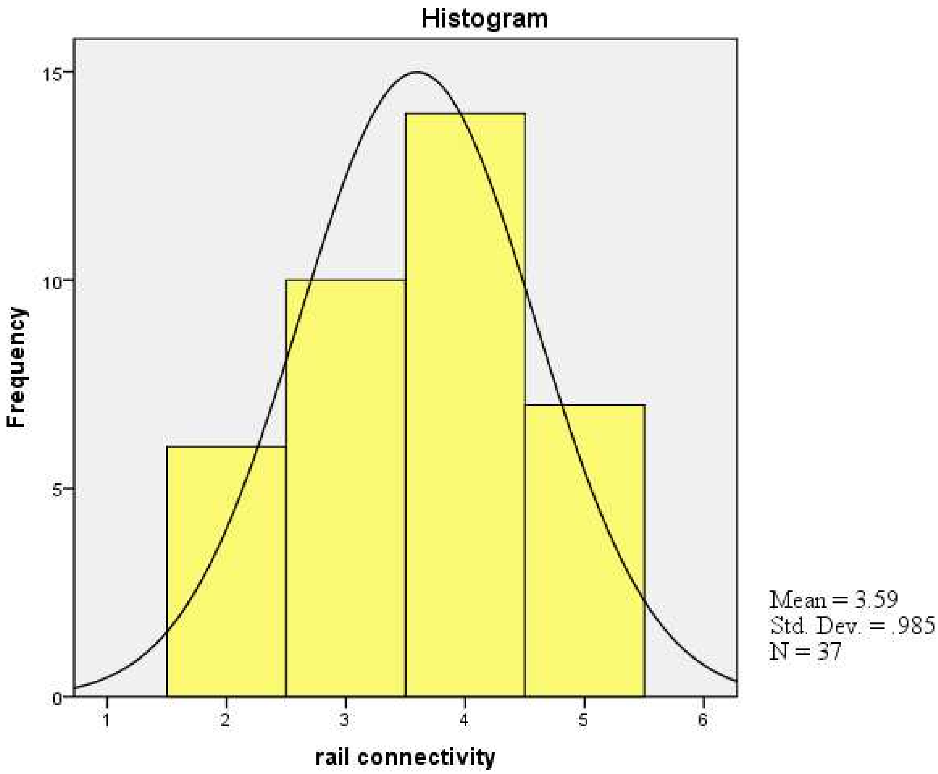


Figure 4.10 Histogram for rail connectivity

Mean= 3.59

Standard deviation=0.985

Variance=0.970

Rail connectivity may affect the costs of coal handling at the ports as the mean is 3.59. The standard deviation is significantly high which suggests there is a quiet a difference of opinion among the respondents in the census.

4.1.10 **Analysis of Road connectivity affecting the costs of Steam coal handling and shipping operations at Indian Ports.**

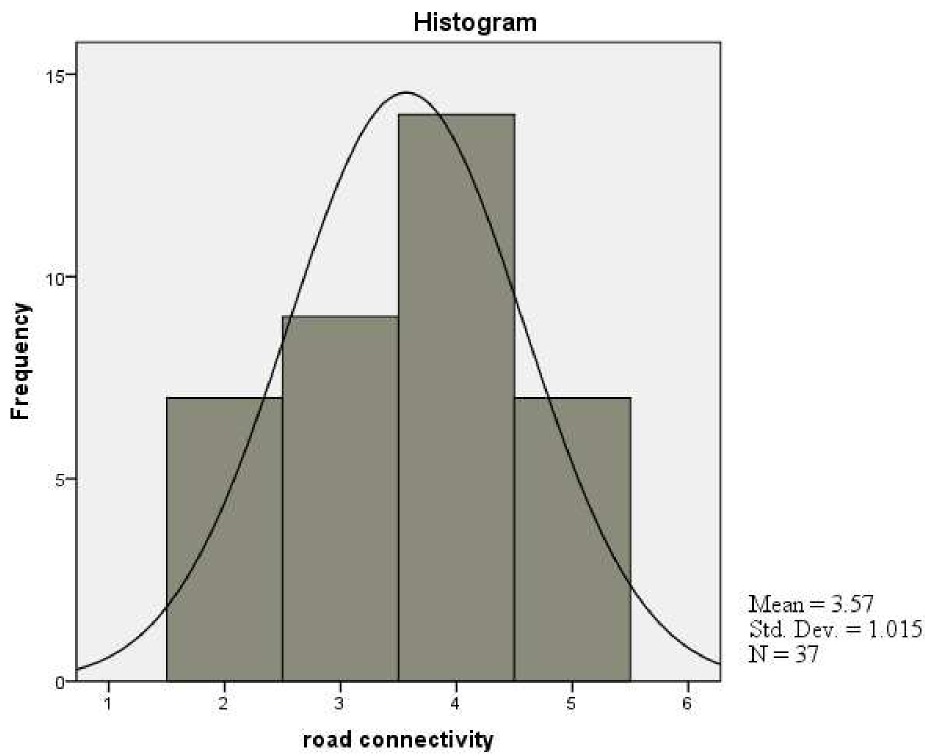


Figure 4.11 Histogram for Road connectivity

Mean= 3.57

Standard deviation=1.015

Variance=1.030

Like Rail connectivity, the Road connectivity also affects the costs of steam coal handling with mean of 3.57. However the standard deviation is 1.015, which is highest among all the other factors which imply there is great difference of opinion among the respondents in the census.

From the above frequency analysis of all the factors, **Number of berths**, **Draft at the port, Port congestion, Berth Infrastructure, Warehouse location, Rail connectivity and road connectivity** were affecting the costs of coal handling at Port.

4.1.2 Confidence **Interval**

The Confidence Interval for the mean for the above factors which were affecting the costs of coal handling and shipping at port was calculated.

The confidence interval was calculated to find the degree of confidence which is also called confidence level.

Here for the data 95% confidence interval was calculated.

Formula

$$C.I = \bar{x} \pm (\text{z critical value}) \cdot \frac{\sigma}{\sqrt{n}}$$

C.I. = Confidence Interval

$\bar{x}$ = Mean

Z critical value= 1.96 for 95% confidence level.

n = number of respondents

σ = Standard deviation

Confidence interval for Port congestion factor

= 4.32+/- 1.96 X .626/√37

= (4.11, 4.52)

This implies that with 95% confidence the Port congestion affects the costs of Coal handling and shipping operations. The value of confidence interval from 4.11 to 4.52 indicates that the respondents strongly agree to this factor.

Confidence interval for Berth infrastructure factor

= 3.97 +/- 1.96 X .687/√37

= (3.75, 4.19)

The value of Confidence interval from 3.75 to 4.19 implies that with 95% confidence we can conclude that the respondents somewhat agree that Berth infrastructure affects the costs of coal handling at port.

Confidence interval for Warehousing location factor

= 3.35 +/- 1.96 X .978/√37

= (3.03, 3.66)

From the values of confidence Interval between 3.03 and 3.66, we can infer that with 95% of confidence that the respondents cannot say whether warehousing infrastructure affects the costs of coal handling.

Confidence interval for Rail connectivity factor

= 3.59+/-1.96 X 0.985/√37

= (3.27, 3.90)

From the above values of Confidence interval, with 95% confidence we can conclude that respondents somewhat agree that Rail connectivity affects the coast of coal handling operations at ports.

Confidence interval for Road connectivity factor

= 3.57+/- 1.96 x 0.1.015/√37

= (3.24, 3.89).

Road connectivity affects the costs of coal handling operations as with 95% of confidence we can accept that the population somewhat agrees with this factor.

4.2 Analysis of Operational Port performance Indicators

The objective of the study was to find the principal Operational Port Performance Indicators for steam coal handling and shipping operations. Average values of eight operational Performance Indicators for eleven ports were calculated. The purpose was to form, from the existing set of Performance Indicators a new set of Indicators which are few in number as possible that contain as much variability of the original data as possible. These new Indicators would represent some sort of index of certain property that is measured by the original Indicators. For this the Principal Component Analysis was chosen.

4.2.1 Principal Component Analysis

Values of Eight Port Performance Indicators were calculated for eleven ports as per table 4.2 below.

Table 4.2 Values of Port Performance Indicators

Port	Waiting time in days	Pilotage time in Hours	Service time in days	Tons per ship at berth in tons/hour	Effective working time at berth in days	Average tonnage in '000 tons/ship	Average draft per ship in metres	Ships arrival rate in ships/month
Haldia	5.95	7.80	2.77	395	2.21	20.30	9.15	4.33
Paradip	18.15	6.60	5.18	470	3.65	43.70	12.35	3.25
Gangavaram	0.60	5.20	2.85	1288	2.64	81.60	13.60	4.92
Vishakhapatnam	4.22	6.30	6.25	485	4.31	45.40	12.18	4.75
Kakinada	6.30	7.50	3.83	605	3.10	44.30	10.60	4.25
Krishnapatnam	2.08	5.75	3.45	810	3.13	59.50	12.70	6.91
Ennore	0	4.95	3.41	760	3.08	54.90	12.40	2.30
Chennai	1.68	6.85	4.35	560	3.75	47.60	11.30	7.91
Karaikal	0	5.50	2.43	840	2.06	53.70	11.20	4.83
Chidambaranar	1.75	7.60	5.73	425	5.05	48.70	11.60	6.25
Cochin	0.90	9.60	1.87	445	1.34	20.00	8.30	0.16

Here the total variance of the data is considered for the analysis. The correlation matrix was made as per Annexure no. A 16

The data was collected from all the ports along the east coast. Since the data has been collected from the entire population was collected there is no need to test any hypothesis.

The values of Kaiser-Meyer-Olkin and Bartlett's Test of Spericity were calculated. The values were found to be

Kaiser-Meyer-Olkin Value	=	**0.595**
Bartlett's test of Spericity		
Approximate Chi-Square	=	**86.194**
Df	=	**28**
Sg	=	**0.000**

The number of factors here were determined based on Eigen values. An Eigen value represents the amount of variance associated with factor. In this approach, only Performance Indicators (factors) with Eigen values greater than 1.0 were retained. The other indicators (factors) were not included in the model.

Table 4.3 **Total Variance Explained**

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.786	47.326	47.326	3.786	47.326	47.326	3.698	46.220	46.220
2	2.571	32.138	79.464	2.571	32.138	79.464	2.660	33.244	79.464
3	.964	12.046	91.510						
4	.415	5.184	96.695						
5	.216	2.704	99.399						
6	.029	.361	99.760						
7	.014	.176	99.937						
8	.005	.063	100.000						

Extraction Method: Principal Component Analysis.

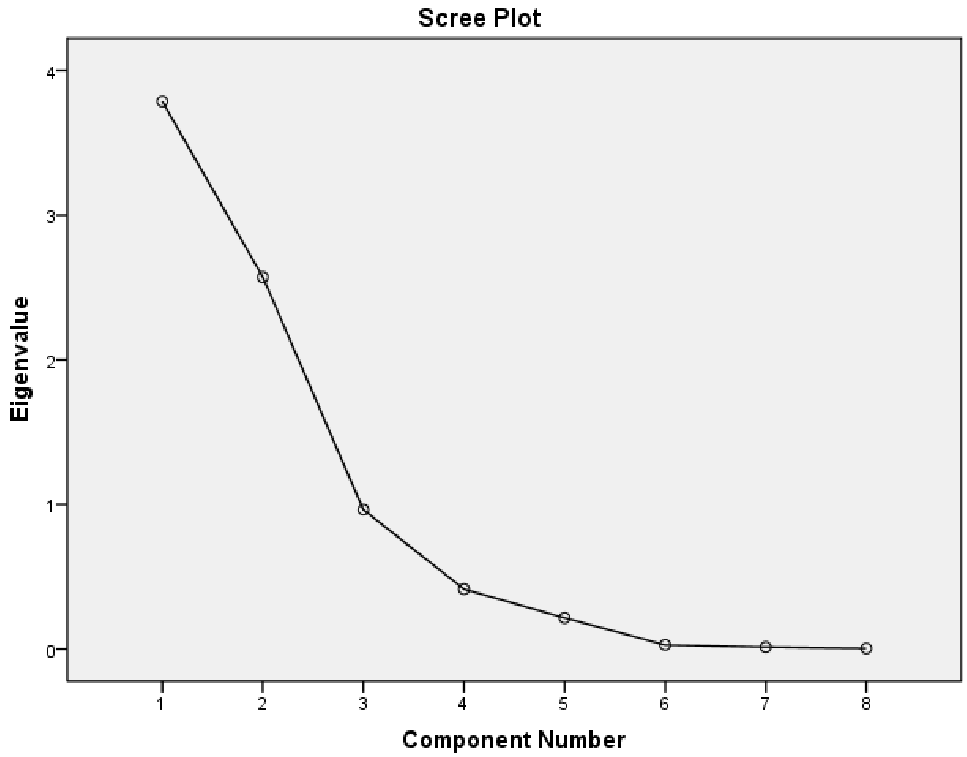


Figure 4.12 Scree Plot for the Principal component Analysis

Table4.4 **Component Matrix**

	Component	
	1	2
average draft per ship	.961	.082
average tonnage per ship	.944	-.261
pilotage time	-.872	.217
ships arrival rate	.602	.298
service time	.349	.910
effective working time at berth	.495	.817
tons per ship hour at berth	.685	-.693
waiting time	-.112	.621

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

The PCA analysis reduced the eight variables into two components were extracted taking Eigen values greater than 1. The two components account for 79% of the total variance.

Using the varimax rotation, an orthogonal rotation of the factor tends to maximize the variance of squared factor loadings of a factor on all variables. Thus it minimizes the number of factors, which have large factor loadings on the given factor.

Table 4.5 **Rotated Component Matrix**[a]

	Component	
	1	2
average tonnage per ship	**.979**	.003
average draft per ship	**.903**	.338
pilotage time	-.898	-.026
tons per ship hour at berth	.846	-.482
ships arrival rate	.499	.449
service time	.090	**.970**
effective working time at berth	.257	**.920**
waiting time	-.276	.568

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

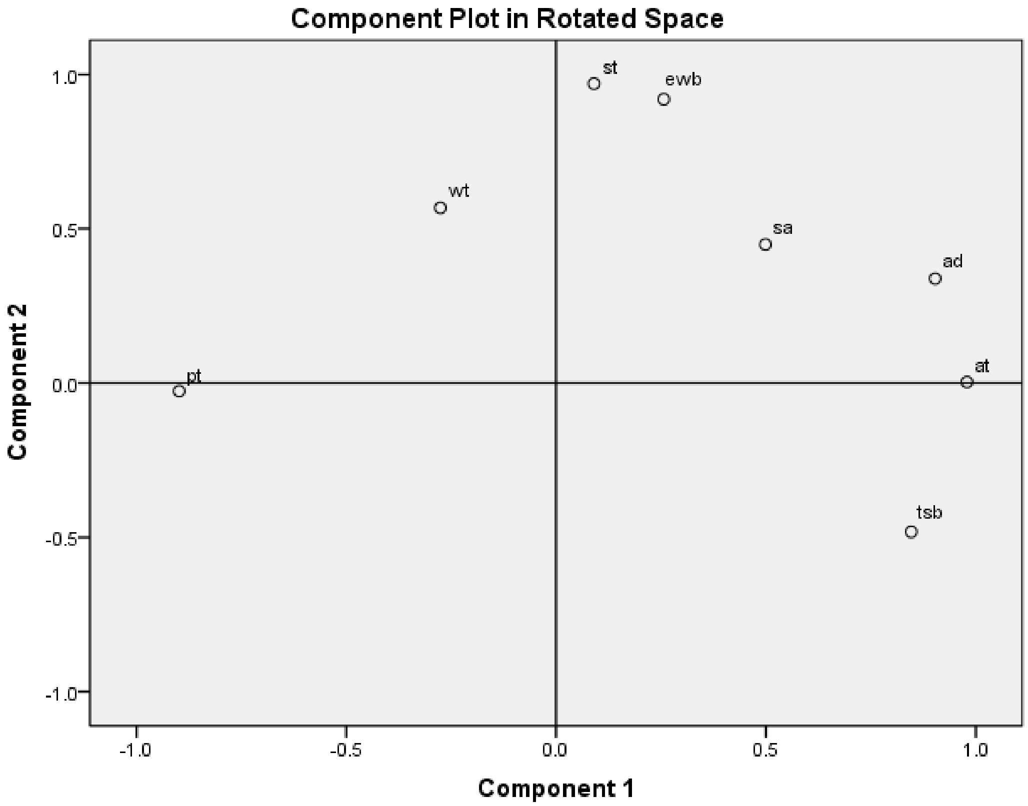


Figure 4.13. Component plot in rotated space

From the rotated component matrix two components extracted are

Table 4.6 Final components

Component 1 **Ship draft Index**	Average tonnage per ship (0.979) Average Draft per ship (0.903)
Component 2 **Berthing time Efficiency**	Service Time (0.970) Effective working time at Berth (0.920)

The efficiency of a port depends on port performance. In general the following parameters are considered to assess the efficiency of a port

1. Average Pre-Berthing Detention of Vessels (in hours).
2. Average Turnaround time in ship days.
3. Average Output per ship berth day in tons.
4. Average berth occupancy.
5. Percentage of capacity utilization of berths.
6. Average gang Output per shift.

However, the total traffic, number of ships handled depends on the port infrastructure and in particular the channel depth, draft availability and turnaround time of the ships beside the factors mentioned above.

When the practices followed internationally, these parameters were not given due diligence while planning for port infrastructure and development. The primary reason being the capacity would be higher than actual traffic and the planning is done in those terms. The average turnaround time depends on parcel size, of the ship, length of the channel in which pilotage takes place, mode of discharge and commodity. This cannot be generalized as average of all elements which give different picture, and convey wrong results which further lead to wrong interpretations. Comparisons need to be done commodity wise and it gives fair comparison of port efficiency. But it does not indicate non-shore efficiency and port capacity to serve demands of the future trade. It assumes that port has built adequate capacity and no waiting time exists.

The reasons for weak port performance are due to handling large number of ships because of low drafts, and as a result congestions took place.

Research Findings

From the initial considered ten factors affecting the costs of coal handling from the analysis only seven factors have been chosen based on whose mean values are more then 3.

1. Number of berths
2. Draft at the port
3. Port congestion
4. Berth Infrastructure
5. Warehouse location
6. Rail connectivity
7. Road connectivity

From the Principal component analysis, two components were identified which have a major bearing on the coal handling costs at ports.

1. **Ship draft Index**
2. **Berthing time efficiency.**

The two were the major components identified and identified from factor analysis are

Component 1 **Ship draft Index**	Average tonnage per ship (0.979) Average Draft per ship (0.903)
Component 2 **Berthing time Efficiency**	Service Time (0.970) Effective working time at Berth (0.920)

Conclusions

By improving the draft

1. The size of vessel can be increased.
2. Parcel sizes could be larger thereby less number ships required.
3. The freight rates would less and cost per ton of coal would be reduced.

By improving berthing time efficiency

1. The ship turnaround time would be reduced.
2. Effective utilization of unloading equipment.
3. Decrease in waiting time of the ships.

I. The monetary benefits accrued from the increase in the draft has been demonstrated with the following example

The draft at the port plays a critical role for the coal Imports. The approximate maximum drafts of various ships sizes are

1. Handymax= 10.5 metres.
2. Panamax= 12.5 metres.
3. Capesize= 20 metres.

At present only two ports Krishnapatnam and Gangavaram have sufficient draft for handling capsize vessels.

If the coal importing ports in India through dredging upgrade for 20 m draft the all the coal imports could be carried by Capesize ships.

The Capesize have freight advantage of US$ 5 over Panamax and US$ 8 over Handymax considering imports from Indonesia and South Africa.

Understanding from report [3] from Planning commission, at the India would be importing 211 million tons at the end of XII five year plan i.e. 2017.

Then the total reduction in costs for this tonnage in terms of Ocean freight only would be

Total cost saved if cargo is carried by Capesize over Panamax

= **211 X 5** **=** **1055 million US$ per Year.**

Total costs saved if cargo is carried by Capesize over handymax

= **211X 8** **=** **1688 million US$ per Year**

In addition, the non tangible benefits of cleaner environment at the ports (less number of ships for shorter duration at ports) would be higher.

II. Berthing time efficiency.

In the in the period April 2010 till March 2011 there have been close to 600 shipment have been done along all the ports in east coast of India for steam coal. There has been high waiting time up to 18 days and also high Ship turnover time.

There is a need to reduce the service or the berthing at the port.

Even though we cannot exactly quantity the loss but still can estimate taking into view the time charter rates for the Ships of various sizes.

Considering at the present time charter rate during this period the Panamax ship rates at around 14,000US$/day, Capesize ship rates at around 19,000US$/day and Handy max ship rates at around 9000 US$ per day based on these rates, the approximate amount that could be saved every day can be calculated as below.

Number of Shipments by Capesize= 47.

Approximate Costs saved= 47 x 2 x 21000= 2 million US $.

Number of shipments by Panamax: 425.

If reduction of Waiting time and ship turnover by two days, then

Approximate Costs saved= 425 x 2x 14,000= US $ 11.9 million per year.

Number of Shipments by Handymax = 126.

Approximate Costs saved= 126 x 2 x 9000=US$ 2.2 million per year.

Total costs saved= US$ 2 +11.9+2.2=16.1 million US$.

Therefore it is strongly recommended that the components derived from the research should be considered for planning and port infrastructure development by Government of India.

5.3 Further Scope of Study

1. Modular Approach could be done where the functional relationship between variables through Regression Analysis.
2. Study related to Financial Port Performance Indicators could also be undertaken for Indian Ports.
3. Further research could be made for similar bulk commodities like fertilizers, Coking coal and Iron ore.

References

[1] International energy Agency, Coal Information 2010, IEA publications, 2010: table 3.12, part III page 34.

[2] Ministry of Coal, Report of the working of Coal and Lignite for formulation of eleventh five year plan, Government of India, 2006.

[3] Planning commission, Annual report 2011-12 on working of state power utilities and Electricity departments, Government of India, 2011.

[4] Ministry of Shipping, Report of Working Group for Port Sector for the Twelfth Five Year Plan (2012-2017), Government of India, 2011.

[5] Patrick M Alderton, Reeds Sea Transport- Operation and Economics, Aldard Coles Nautical, 2004: 274-305

[6] Planning Commission, Report of the Inter Ministrial Group, Reducing dwell time of cargo at ports, Government of India, 2011.

[7] UNCTAD, Port Performance Indicators, United nations, 1976.

[8] http//www.Indiastat.com, [retrieved, November, 2011].

[9] I-maritime research and consulting division, India port Report, 2003: 33-50.

[10] UNCTAD, Port development- A handbook for planners in developing countries, United nations, 1985.

[11] UNCTAD, Monograms for port management-Measuring and Evaluating Port Performance and Productivity, United States, 1987.

[12] R.B. Oram and C.C. R. Baker, the Efficient Port, Pergamon Press, 1971

[13] Philip Rogers,J. Strand and B. Studd, Coal carriage by Sea, LLP Professional Publishing, 1997.

[14] Jan Owen Jansson and Dan Shneerson, Port economics, Massachussets institute of technology, 1982.

[15] Geoffrey Poitras, Jose Tongzon and hongyu Li, (1996). Measuring port efficiency: An application of Data envelopment analysis, <http://www.bus.sfu.ca/homes/poitras/PORTS2.pdf>,[retrieved July 2011].

[16] Hokey Min,(2004). A Hybrid data envelopment analysis and simulation methodology for measuring capacity utilization and throughput efficiency of containers terminals, <ceb.nccu.edu.tw/proceedings/APDSI/2004/pdf/066.PDF> [retrieved August, 2010].

[17] Bing-Lian Liu, Wai-Lin Liu, Cheng-Ping Cheng, Efficiency Analysis of Container terminals in China: An Application of DEA Approach, Asian-Pacific conference , August 17-19, 2006: 40-65

[18] Jasmine Siu lee lam, Eddy Van de Voorde, (2011).Scenario analysis for supply chain integration in container shipping, Maritime policy and management, Vol. 38, No. 7, Taylor and Francis, 705-725.

[19] Sushila Muniswamy, Gurcharan Singh,(2011).Benchmarking the efficiency of Asian container ports, African journal of Business management, Vol. 5(4), Academic journals, 1397-1407.

[20] Kasyapi Mokhtar, Dr. Muhammad Zaly Shah,(2006), A Regression model for vessel turnaround time, Tokyo Academic, Industry and Cultural Integration Tour, Shibaura Institute of technology, Japan: 10-19.

[21] Khalid Bichou, Richard Gray(2004). A logistics and supply chain management approach to port performance measurement, Maritime Policy and Management, Vol. 31, no. 1, Taylor and Francis: 47-67.

[22] Diego Teurelincx, (2000). Functional Analysis of Port performance as a strategic tool for strengthening a Port's competitive and economic Potential, International Journal of Maritime economics, volume II, no.2:119-140.

[23] Jie Wu, Hongyan, John liu,(2010). DEA models for identifying sensitive performance measures in container port evaluation, Maritime economics and Logistics, vol. 12, Macmillan publishers, 215-236.

[24] J. Fernando alvarez, Tore Longva and Erna S. Engebrethsen(2010), A methodology to assess vessel berthing and speed optimization policies, Maritime economics and logistics, Vol. 12, 4, macmillan publishers: 327-346.

[25] Gabriel figueiredo De Oliveira and Pierre Cariou,(2011). A DEA study of the efficiency of 122 iron ore and coal ports and of 15/17 countries in 2005, Maritime Policy and Management, Vol 38, no. 7, Taylor and Francis: 727-743.

[26] Ricardo J. Sanchez, jan Hoffman, Alejandro Micco, Georgina V. Pizzilitto, Martin Sgut, Gordon Wilmsmier (2003), Maritime Economics and Logistics, Vol. 5, Palgrave macmillan Ltd, 199-218.

[27] Kek Choo Chung, Port performance Indicators, Infrastructure notes, Transportation, Water and Urban Development Department, The World bank, 1993.

[28] Prabir De, Globalization and the changing face of port infrastructure- The Indian Perspective, Peter Lang Ag, 2009

1. Bing-Lian Liu, Wai-Lin Liu, Cheng-Ping Cheng, Efficiency Analysis of Container terminals in China: An Application of DEA Approach, Asian-Pacific conference , August 17-19, 2006.
2. Diego Teurelincx, (2000). Functional Analysis of Port performance as a strategic tool for strengthening a Port's competitive and economic Potential, International Journal of Maritime economics.
3. Geoffrey Poitras, Jose Tongzon and hongyu Li, (1996). Measuring port efficiency: An application of Data envelopment analysis
4. Hokey Min,(2004). A Hybrid data envelopment analysis and simulation methodology for measuring capacity utilization and throughput efficiency of containers terminals,
5. I-maritime research and consulting division, India port Report, 2003:
6. Ignacy Chrzanowski, An Introduction to Shipping economics, Fair Play Publications, 1985.
7. International energy Agency, Coal Information 2010, IEA publications, 2010.
8. Gabriel figueiredo De Oliveira and Pierre Cariou,(2011). A DEA study of the efficiency of 122 iron ore and coal ports and of 15/17 countries in 2005, Maritime Policy and Management, Vol 38, no. 7, Taylor and Francis.
9. Jan Owen Jansson and Dan Shneerson, Port economics, Massachussets institute of technology, 1982.
10. Jasmine Siu lee lam, Eddy Van de Voorde, (2011).Scenario analysis for supply chain integration in container shipping, Maritime policy and management, Vol. 38, No. 7, Taylor and Francis.
11. Jie Wu, Hongyan, John liu,(2010). DEA models for identifying sensitive performance measures in container port evaluation, Maritime economics and Logistics, vol. 12, Macmillan publishers.

12. J. Fernando alvarez, Tore Longva and Erna S. Engebrethsen(2010), A methodology to assess vessel berthing and speed optimization policies, Maritime economics and logistics, Vol. 12, 4, Macmillan publishers.

13. Kasyapi Mokhtar, Dr. Muhammad Zaly Shah,(2006), A Regression model for vessel turnaround time, Tokyo Academic, Industry and Cultural Integration Tour,Shibaura Institute of technology, Japan:

14. Khalid Bichou, Richard Gray(2004). A logistics and supply chain management approach to port performance measurement, Maritime Policy and Management, Vol. 31, no. 1, Taylor and Francis:

15. Kek Choo Chung, Port performance Indicators, Infrastructure notes, Transportation, Water and Urban Development Department, The World bank, 1993.

16. Ministry of Coal, Report of the working group on Coal and Lignite for formulation of eleventh five year plan, Government of India, 2006.

17. Ministry of Shipping, Report of Working Group for Port Sector for the Twelfth Five Year Plan (2012-2017), Government of India, 2011.

18. Philip Rogers,J. Strand and B. Studd, Coal carriage by Sea, LLP Professional Publishing, 1997

19. Planning commission, Annual report 2011-12 on working of state power utilities and Electricity departments, Government of India, 2011.

20. Patrick M Alderton, Reeds Sea Transport- Operation and Economics, Aldard Coles Nautical, 2004.

21. Planning commission, Integrated Energy policy-Report of Expert Committee, Government of India, 2006

22. Planning Commission, Report of the Inter Ministrial Group, Reducing dwell time of cargo at ports, Government of India, 2011.

23. Prabir De, Globalization and the changing face of port infrastructure- The Indian Perspective, Peter Lang Ag, 2009.

24. R.B. Oram and C.C. R. Baker, the Efficient Port, Pergamon Press, 1971.

25. Ricardo J. Sanchez, jan Hoffman, Alejandro Micco, Georgina V. Pizzilitto, Martin Sgut, Gordon Wilmsmier (2003), Maritime Economics and Logistics, Vol. 5, Palgrave Macmillan Ltd, 199-218.

26. Sushila Muniswamy, Gurcharan Singh,(2011).Benchmarking the efficiency of Asian container ports, African journal of Business management, Vol. 5(4), Academic journals.

27. UNCTAD, Port Performance Indicators, United nations, 1976.

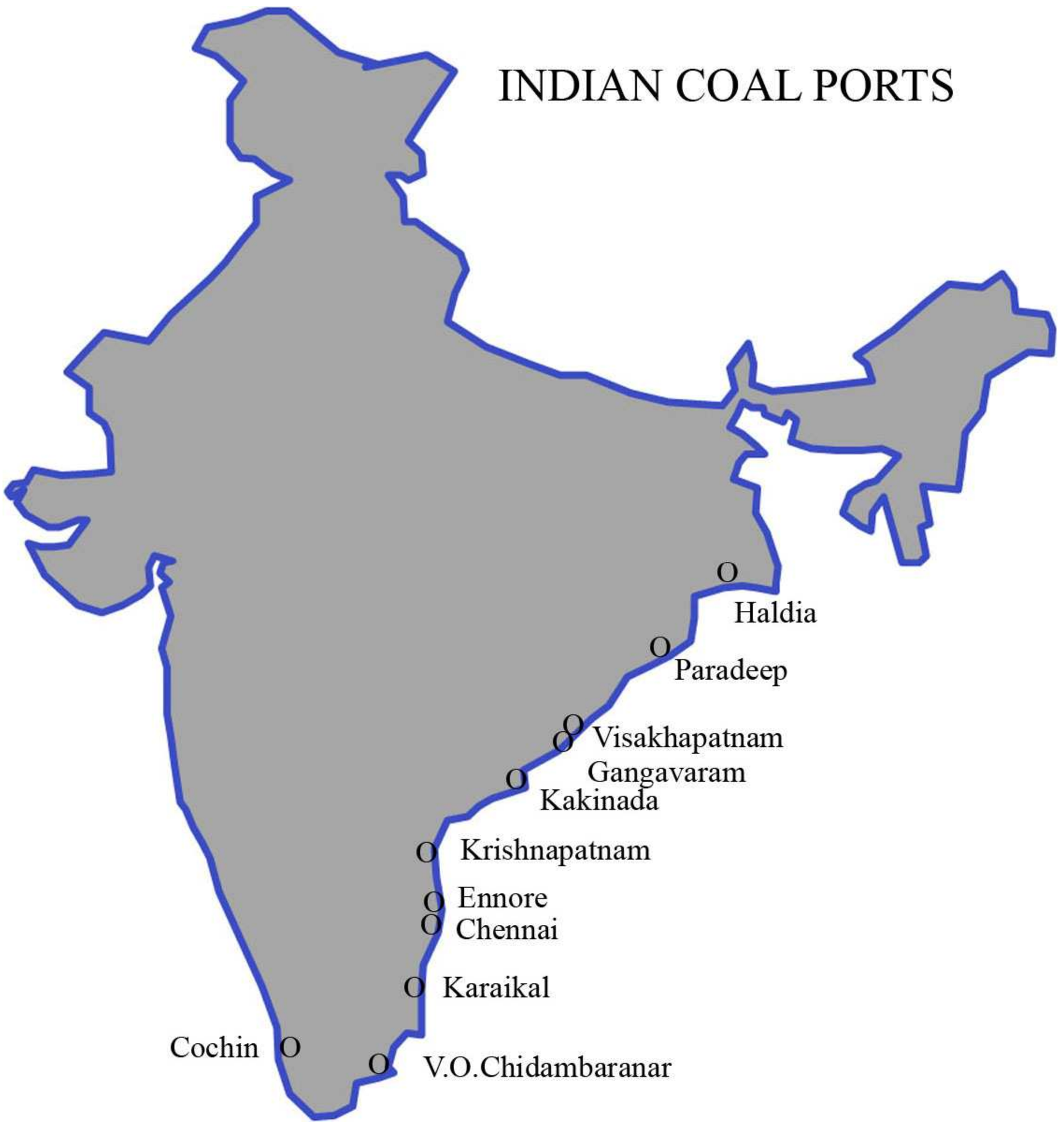
28. UNCTAD, Port development- A handbook for planners in developing countries, United nations, 1985.

29. UNCTAD, Monograms for port management-Measuring and Evaluating Port Performance and Productivity, United States, 1987.

30. UNCTAD, Review of Maritime Transport, United States, 2011.

Websites

1. http:// www.Indiastat.com
2. http://shipping.gov.in/


INDIAN COAL PORTS
Haldia
Paradeep
Visakhapatnam
Gangavaram
Kakinada
Krishnapatnam
Ennore
Chennai
Karaikal
Cochin
V.O.Chidambaranar

The Haldia Dock complex is a part of Kolkata port which is a Major port located at 104 kms away from Kolkata city, 130 kms upstream from Sand heads, and 45 kms upstream from Pilotage station in West Bengal. The port was commission in 1977 and is situated at

Latitude: 22° 02´ North and Longitude: 88° 06´.

The annual capacity of the port is 38 million tons and is to be upgraded to 50 million tons. The port comprise of 3 riverine oil jetties, 12 berths inside an impounded dock and two riverine barge jetties and Haldia anchorage for Lash growth of port based and port oriented Industries vessels. The average available draft is 8.5 meters.

The port has state of the art radar surveillance through automatic Identification System and Vessel traffic Management system for effective and safe guidance to vessels.

Facilities

The port has two steam coal berths and eight multipurpose berths.

There is expansive open storage yard for stacking thermal coal.

The equipment available for handling Steam coal at various berths is

Two wagon tipplers, six stacker cum reclaimers, two wagon loaders, two wagon feeding systems and two mechanized Grab handling systems

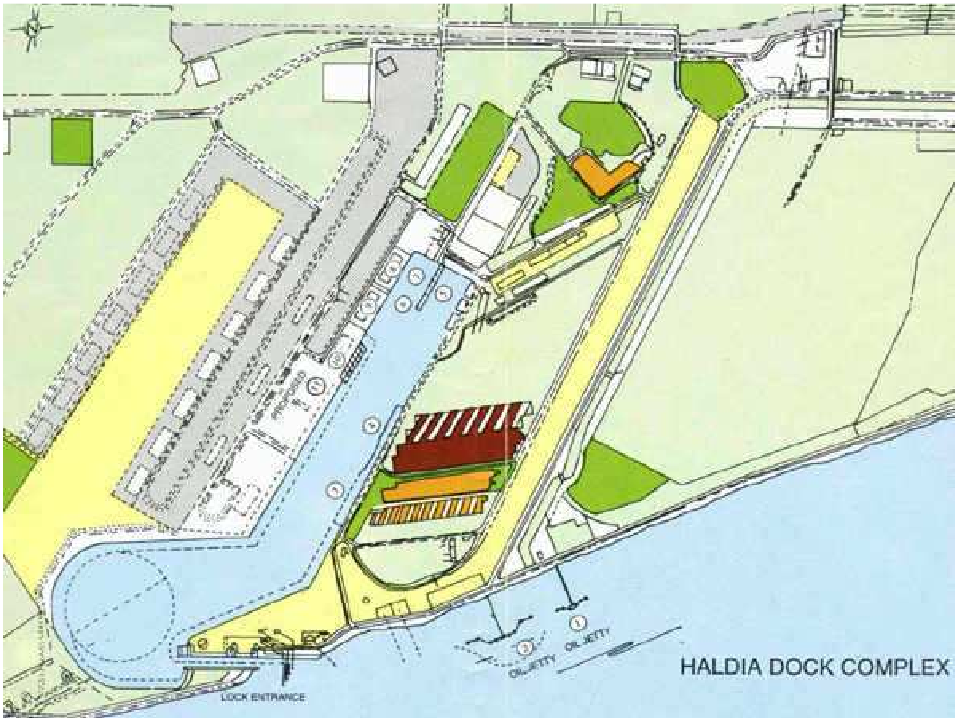


Figure A2.1 Plan of Haldia Port

Paradip Port is one of the Major Ports of India serving the Eastern and Central parts of the country. Its hinterland extends to the states of Orissa, Jharkhand, Chhatishgarh, West Bengal, Madhya Pradesh and Bihar. The Port mainly deals with bulk cargo apart from other clean cargoes. There is unprecedented growth in the traffic handled at this Port in the last five years and the Port has got ambitious expansion programme to double its capacity to meet the ever increasing demand.

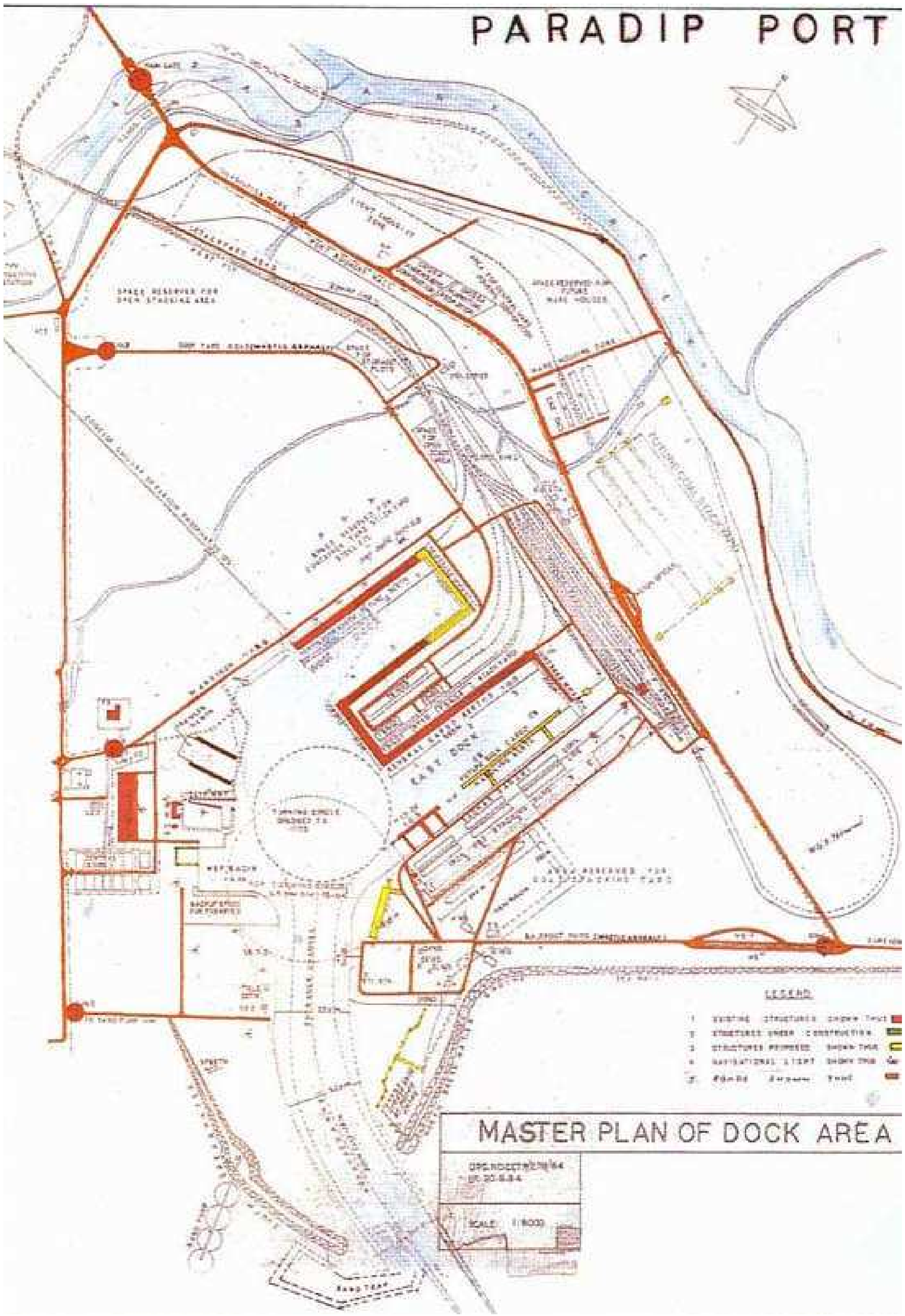
Paradip port is situated 210 nautical miles south of Calcutta and 260 nautical miles north of Visakhapatnam at Latitude 20° - 15'-55.44" N and Longitude 86° -40'-34.62" E.

Facilities

The Port has two coal berths and and thirteen berths for other cargoes.

The equipment available for coal handling is

Two wagon tipplers, two stackers and reclaimers and one ship loaders and a stack yard capacity of over one million tons for coal.



A3.1 Plan of Paradip Port

Port of Visakhapatnam is one of the leading ports of India. The Port is located on the east coast of India at a latitude of $17^{0}41^{'}$ North and longitude of $83^{0}17^{'}$ East and the time zone is GMT + 5:30. The Port has three harbours viz., outer harbour, inner harbour and the fishing harbour. The outer harbour with a water spread of 200 hectares has 6 berths and the inner harbour with a water spread of 100 hectares has 18 berths. Bestowed with natural deep water basins, the outer harbour is capable of accommodating 150,000 DWT vessels and draft upto 17 meters. The inner harbour is capable of accommodating vessels upto 230 meters LOA and draft upto 11 meters

Berthing facilities

INNER HARBOR NORTHERN ARM - EAST SIDE				
	Berth length (Mtrs)	**Permissible beam (Mtrs)**	**Permissible draft (Mtrs)**	**Crane deployment**
East Quay-1	167.64	32.50	10.06	4 Nos. 15T. wharf Cranes
East Quay-2	167.64	32.50	10.06	4 Nos. 10T. wharf Cranes
East Quay-3	167.64	32.50	10.06	4 Nos. 10T. wharf Cranes
East Quay-4	231.00	32.50	10.06	4 Nos. 15T. wharf Cranes
East Quay-5	167.64	32.50	11.00	4 Nos. 15T. wharf Cranes
East Quay-6	182.90	32.50	10.06	3 Nos. 10T. wharf Cranes
East Quay-7	255.00	32.50	11.00	4 Nos. 20T. wharf Cranes
* East Quay-8	255.00	32.50	11.00	3 Nos. 104T. Harbour mobile cranes of B.O.T. Operator
* East Quay-9	255.00	32.50	11.00	--
*** Awarded to B.O.T. Operator M/s. Vizag Seaport Pvt. Ltd.**				

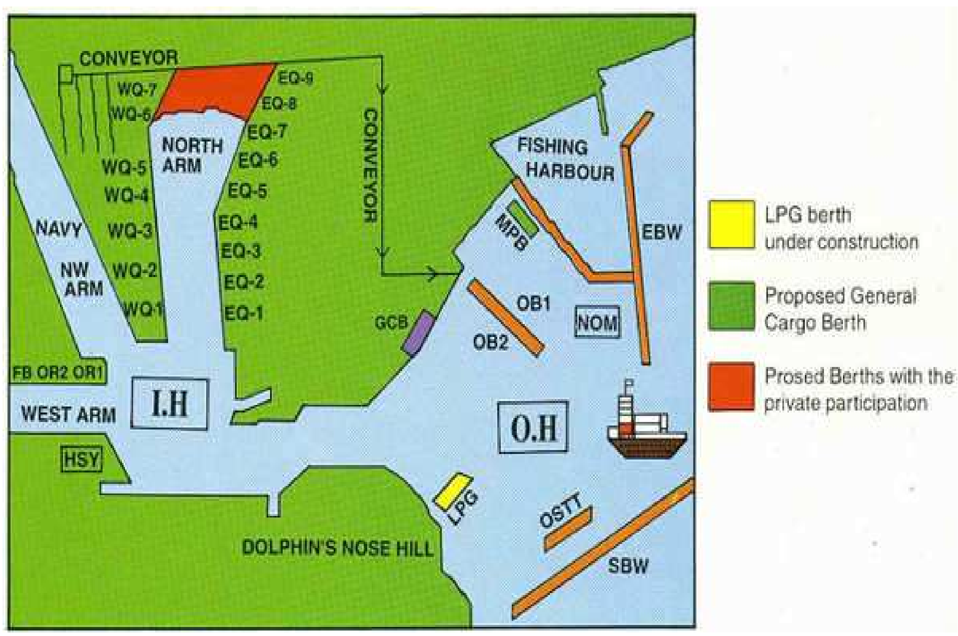
INNER HARBOUR NORTHERN ARM - WEST SIDE		
West Quay-1	212.00	11.00
West Quay-2	226.70	11.00
West Quay-3	201.12	11.00
West Quay-4	243.00	11.00
West Quay-5	241.70	11.00
RE WQ-1	170.00	8.00

INNER HARBOUR NORTH WESTERN ARM		
Fertiliser berth	173.13	10.06
Oil Refinery Berth-1@	183.00	10.06
Oil Refinery Berth-2@	183.00	9.75
@ Subject to a max. 195 Mts. at one of the two berths		

OUTER HARBOUR			
Ore Berth-1	270.00	48.00	16.50 on rising tide of 0.3 Mtrs.
Ore Berth-2	270.00	48.00	16.50
Oil Mooring	250.00	48.00	15.00
General Cargo Berth	356.00	42.00	14.5 0 on rising tide of 0.5 Mtrs.
Offshore Tanker Terminal	408.00	48.00	17.00 on rising tide of 0.5 Mtrs.
L.P.G.	370.92	42.00	14.00
CONTAINER TERMINAL**	451.00	42.00	14.50
** Operated byM/s. Visakha Container Terminal Pvt. Ltd.			

Cargo handling equipment

Electric Wharf Cranes	10T	09
Electric Wharf Cranes	15 T	10
Electric Wharf Cranes	20 T	04
Harbour Mobile Cranes (on hire)	140 T	02
Harbour Mobile Cranes (BOT operator)	104 T	03
Locos (General Traffic)	1400 HP	08
Locos (O H C)	1430 HP	07
Locos (General Traffic)	3100 HP	03
Floating crane (Bheema)	140 T cap	01
Floating crane (Hanuman)	55 T cap	01



A4.1 Plan of VISHAKHAPATNAM PORT

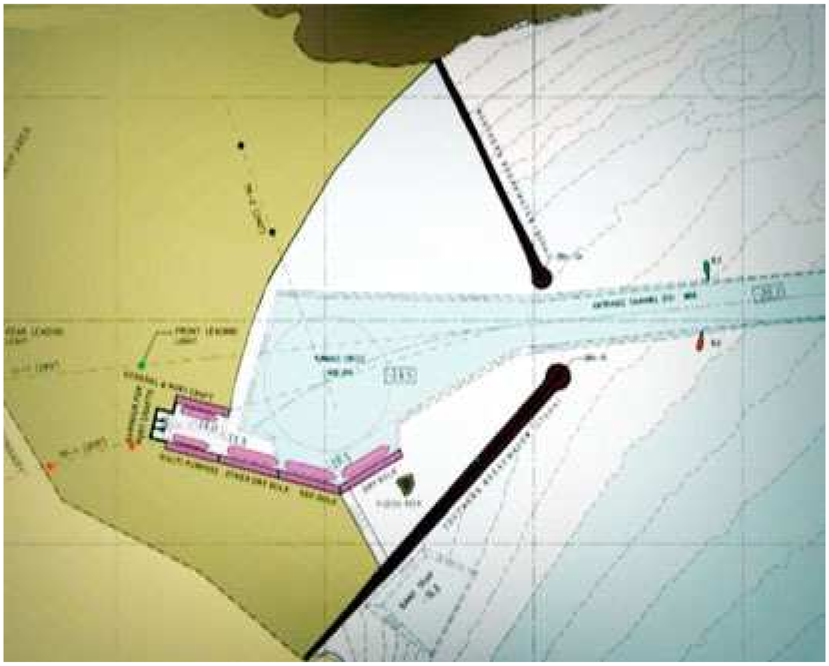
Gangavaram Port Limited which is a non major porthas been mandated to develop and operate the Green field port at Gangavaram, is a JV between the State Government of Andhra Pradesh, India and a consortium led by Mr. DVS Raju. The Port has the unique distinction of being one of the few Greenfield port projects in India which has been implemented on schedule. Construction at the site commenced in December 2005 and the Port commenced trial operations in August 2008.

Gangavaram Port has been developed as all weather, multipurpose port with water depth upto 21 meters, making it the deepest and only port in the country capable of handling fully laden Super Cape size vessels of upto 200,000 DWT. Gangavaram Port with its deep draft berths and efficient operations has become the gateway port for a hinterland spread over 8 states across Eastern, Western, Southern and Central India. Its ability to handle larger vessels efficiently has resulted in substantial savings to trade and port users. Gangavaram Port provides efficient cargo handling services for a variety of bulk and break bulk cargo groups including Coal, Iron Ore, Fertilizer, Limestone, Bauxite, Raw Sugar, Project Cargo, Alumina, Steel products etc.

The Port, its related facilities and material handling system are among the most advanced in Asia and meet the highest standards in terms of pollution prevention and safety.

The port is located at Vshakapatnam, the industrial nerve center of Andhra Pradesh around latitude of 17^{O} 37’ North and Longitude of 83^{o} 14’ East, about 15 kms from Vishakhapatnam port and is the deepest port in the country offering completely mechanized and efficient cargo handling services resulting in significant cost savings to Importers and Exporters in the hinterland.

The port has state of the art unloading equipment for it two coal berths, with stackers and Reclaimers alongh with conveyor systems for automated handling of steam coal.



A5.1 Plan of Gangavaram port

KAKINADA SEAPORTS LIMITED is a non major port which is a dynamic gateway port on East Coast of India which is ideally located between Visakhapatnam and Chennai Ports. Hope Island, a natural formation offers protection as natural breakwater for Kakinada Port and 1.2 Km breakwater of tetra pods provides tranquil bay conditions round the year for vessels to operate in sheltered waters of Kakinada Deep Water Port.

The advantage is the position of Port, which gives a unique opportunity to handle a mix of bulk, liquid, break bulk, containers, project cargoes & service offshore Oil & Gas exploration activities of Krishna – Godavari Basin. KSPL team is truly committed to Customer needs, safe working practices, supply chain management and environment protection.

Kakinada Deep Water Port was constructed with a quay length of 610 Meters by Government of Andhra Pradesh and it was commissioned in November 1997

In line with national port privatization policy, Government of Andhra Pradesh has given concession to operate Kakinada Deep Water Port under OMST scheme on 16.12.1998

Main Jetty has five cargo berths & one OSV berth.

Maximum permissible draft is 10 m.

A6.1Plan of Kakinada port

Krishnapatnam Port Company Ltd. (KPCL) which is a non major port was formed by winning the mandate from the Govt. of Andhra Pradesh to develop the existing minor port into modern, deep water & high Productivity port, on BOST (Build–Operate-Share-Transfer) concession basis for 50 years. The port is being built in three phases. Post the completion of the first phase in a record time of 18 months, Krishnapatnam Port was dedicated to the nation on July 17, 2008. Currently the second phase of development is underway. Port has numerous strengths like its area, location, weather and the credentials of CVR Group that is promoting this port.

The port is located at 14^{o} 15' North Latitude and 80^{o} 08' East Longitude. It is 180 km from Chennai and in Nellore district of Andhra Pradesh on NH 5. The Port has a draft of 18 metres.

Facilities

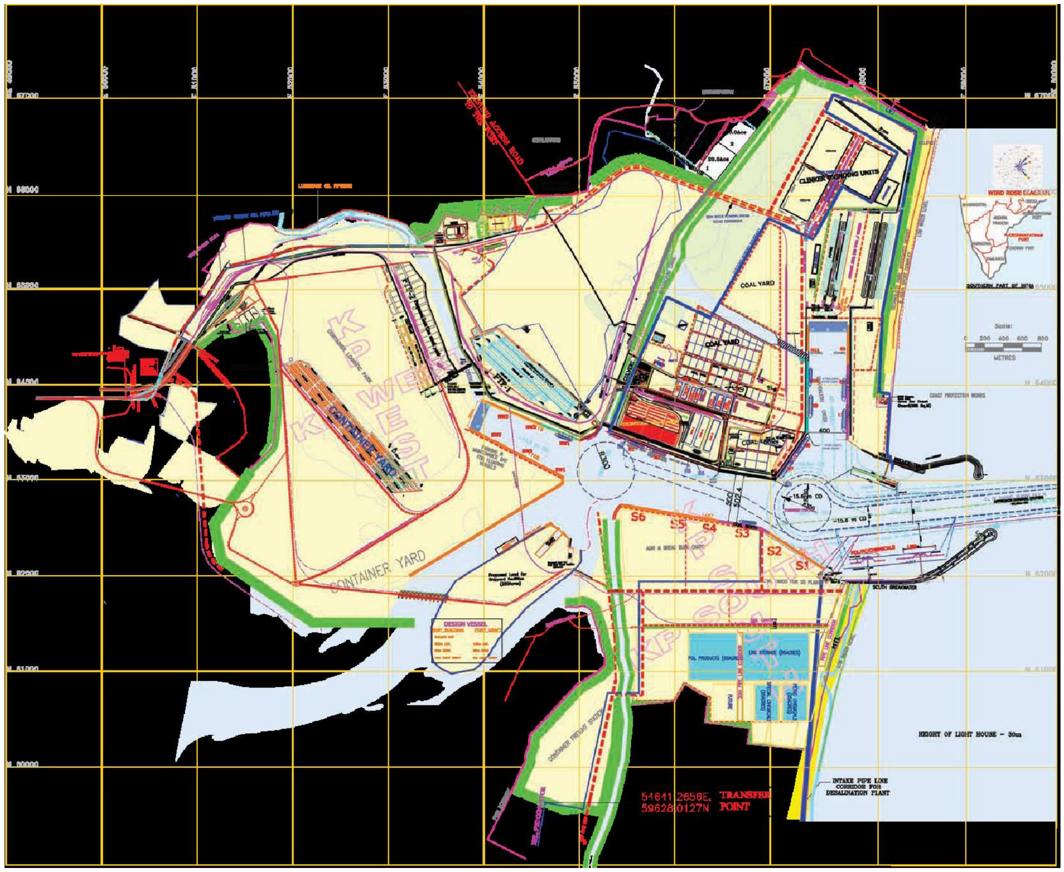
8 Liebherr cranes: 2 nos. of LHM600 with 204 MT capacity & 6 nos. of LHM500 with 140 MT capacity; all having outreach of 52 mtrs.

2 Gottwald cranes (GHMK6406) - 110 MT capacity, outreach of 46 mtrs.

1 Sennebogen crane: model no.: 880EQ - Green line - Crawler Type - outreach of 33 mtrs - SWL in hook mode 35 mtrs & Grab mode 20 mtrs. These cranes provide a discharge rate of 750 to 1,000 MT per hour per crane.

Presently there are 8 hoppers with a capacity of 120 CBU.

Dedicated port owned cargo handling equipment like tippers, loaders, excavators, dozers, etc.



A7.1 Plan of Krishnapatnam Port

Ennore is situated on the coromandal coast about 24km north of Chennai Port along the coast line, in the State of Tamil Nadu, India. It is the 12the Major Port in India and the first Corporatised Major Port in India.

The pollution and environmental hazards caused while handling iron ore and coal in the Chennai harbour and nearby habitations also necessitated shifting these cargo items from the Chennai Port

This was the rationale behind planning of berths for coal berth (for users other than TNEB) Iron ore, LNG, POL, Chemical and other liquids and Crude to serve various industries that would come up on the proposed Perto Chem Park. These factors have contributed to the evolution of Ennore Port as a multi-functional energy port of the New Millennium.

The Phase I development of Ennore was completed in 2001. The port was inaugurated and dedicated to the Nation by the Honourable Prime Minister of India on 1.2.2001. Commercial operations commenced with Handymax geared vessels for unloading of thermal coal on 22.6.2001. With the deployment of self-unloading and gearless vessels of 65000/77000 DWT, full-fledged operations were started since December 2002.

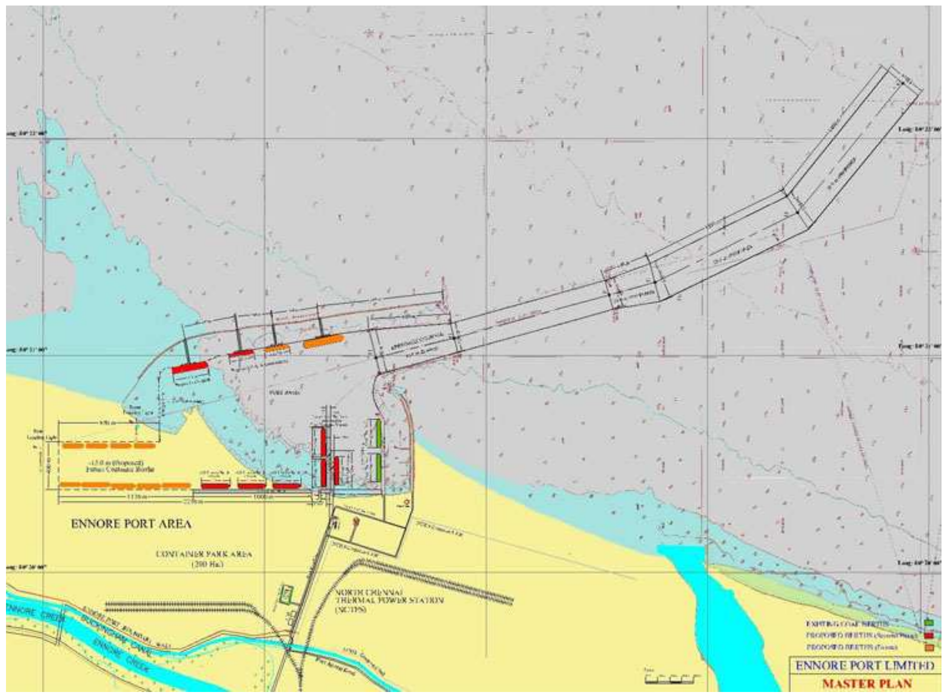
The Port has two coal berths with maximum permissible draft of 13.5 metres.

Facilities

The port has state of the art unloaders and conveyor system which can unload upto 20,000MT per day.

Two shore based Gantry type cranes with capacity of 2000 tons per hour.

One Mobile hopper to receive coal from crane hopper and self unloading ship at the rate of 4000 tons per hour.



A8.1 Ennore port Plan

Chennai Port, the third oldest port among the 12 major ports, is an emerging hub port in the East Coast of India. The port with three Docks, 24 berths and draft ranging from 12m to 16.5m has become a hub port for Containers, Cars and Project Cargo in the East Coast. The port has handled an all time high of 61.06 Million tonnes of cargo registering an increase of 6.2% over previous year. An increase of 10.14% in handling of cars from 273917 Units in the year 2009-10 when compared with 248697 Units in the year 2008-09 and an increase of 6.39% in handling of containers from 1143373 TEUs in the year 2008-09 to 1216438 TEUs in the year 2009-10. The long term plan for Chennai Port envisages that the Port will mainly handle 4C's i.e. Containers, Cars, Cruise and Clean Cargo.

Facilities

Coal Conveyor (JD IV and JD VI)

Semi mechanized closed conveyor system for coal handling comprises of two streams.
Commissioned on November 2009.
Capacity - 15 million MT/annum
Handling rated capacity - 1500 MT/Hr/stream
Coal discharged into the Hoppers located at JD IV and JD VI is conveyed to coal plots through conveyors/Tripper cars - Equipped with Belt Weigher.

However due to Environmental concerns the Port has banned coal handling from November, 2011, as per directions from the Madras high court.

Karaikal Port Private Ltd (KPPL) is a subsidiary of MARG Ltd, a leading infrastructure and real estate developer along the Chennai IT corridor with interest ranging across various areas that include Residential Projects, Commercial Real estate projects, SEZs, Ports, Townships, IT Parks, Malls, etc.

MARG Karaikal Port is envisaged to have a total of 9 berths capable of handling 47 MMTPA by 2018. The port is envisioned to be developed in 3 phases with the final phase getting operational in 2017. Phase - I of development, which was completed in April 2009, comprises two Panamax size general cargo berths. The Port hosts various other infrastructure facilities such as covered warehousing, open storage and Mobile Harbour Cranes. The Port has excellent evacuation facilities with 3 railway sidings and National Highways within a Kilometer from the gate. An area of around 600 acres is covered by the Port boundaries.

The port will be developed in 3 phases, which are detailed in the table below:

Phases	Development Years	No of Berths	Capacity
Phase 1	2006-2008	2	5.2 MMTPA
Phase 2A	2009-2012	3	22.7 MMTPA
Phase 2B	2015-2017	4	19.0 MMTPA
Total		**9**	**46.9 MMTPA**

Currently MARG Karaikal port has five berths, three for general cargo and two for coal. Present handling capacity of the port is 28.0 MMTPA.

Berth no.	Length overall (m)	Width(m)	Depth (m)	Type of Vessel	Cargo
Berth no.1	260	21	14.5	Panamax	Liquid/General Cargo
Berth no.2	230	21	14.5	Panamax	Container/General Cargo
Berth no.3	360	35.6	15.5	Capesize	Coal
Berth no.4	365	35.6	15.5	Capesize	Coal
Berth no.9	220	20	11	Handymax	Container/General Cargo

Karaikal Port is equipped with the latest state-of-the-art equipment to enable fast, smooth and safe unloading and evacuation of all types of cargo.

S.No	Particulars	Units
1	Leibherr LHM 400	3 Nos
2	Stacker Reclaimer System (under construction)	2 Nos
3	Ship Unloader System (under construction)	2 Nos
4	Reach Stackers (under construction)	4 Nos
5	12 CBM Grab	4 Nos
6	Automatic Bagging Machine	5 Nos
7	Hopper	4 Nos
8	Conveyor System (under construction)	5,500 Mts
9	In-Motion Wagon Loading System (under construction)	1 Nos
10	Truck Loading Stations (Coal - 1 & Liquid Cargo - 1) (under construction)	2 Nos
11	General Purpose Crane	1 Nos

In addition to these, the Port is fully equipped with all the requisite material handling equipment such as Loaders, Excavators, Tippers and Fork-Lifts etc., for efficient handling. Truck loading system with a capacity of 900 TPH capable of loading 3 trucks at the same time all with their respective weigh bridge is being installed. Active engineering support to both port and ship facilities such as Electrical and Mechanical workshops have also been proposed within the premises.

MARG Karaikal port is located on the Eastern coast of India in Karaikal District of Puducherry state around 300 Km along the coast south of Chennai.

The Port is at Vanjore Village, Karaikal Taluk, Puducherry at a latitude of 10^{0} 50' N and 79^{0} 51'.

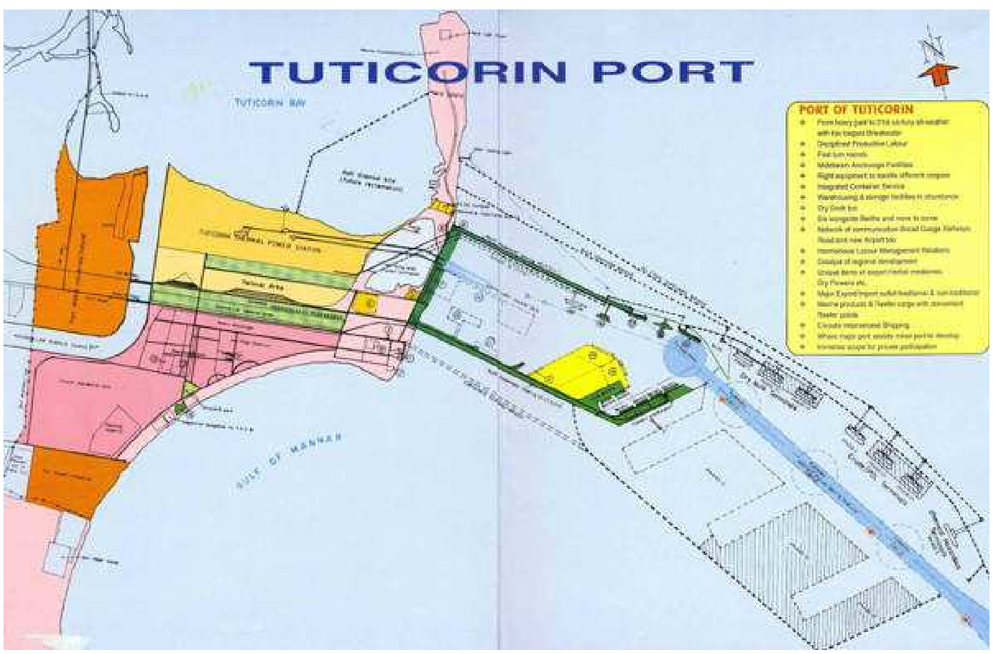
The Shoreline of the port falls between 10^{0} 50' 56" N and 10^{0} 49' 44" N.

The Port is situated between the banks of Pravadayanar and Vettar rivers.

Figure A10.1 PLAN OF KARAIKAL PORT

V.O.Chidambaranar Port is located strategically close to the East-West International sea routes on the South Eastern coast of India at latitude 8^O 45'N and longitude 78^O 13'E. Located in the Gulf of Mannar, with Sri Lanka on the South East and the large land mass of India on the West, V.O.Chidambaranar Port is well sheltered from the fury of storms and cyclonic winds. The port is operational round the clock all through the year.

V.O.Chidambaranar Port is an artificial deep-sea harbour formed with rubble mound type parallel breakwaters projecting into the sea for about 4 km. (Length of North breakwater is 4098.66 m, length of South breakwater is 3873.37 m and the distance between the breakwaters is 1275m).



A11.1 PLAN OF CHIDAMBARANAR PORT

Cochin port is the maritime gateway to peninsular India, Cochin is the fastest growing logistic centre emerging in to a major International transshipment terminal. An all-weather natural Port, and located strategically close to the busiest international sea routes Cochin is promoting a major liquid terminal, bulk terminal and maritime industries in its port based SEZs .

MARINE SERVICES

All ships on approaching Cochin are to contact Cochin Port Control on VHF Channel 15 / 16 and report their E.T.A. to receive instructions on Pilot boarding / anchoring. Cochin Port Control is equipped with Radar / A.I.S. based V.T.M.S. and monitors the approach of vessels towards the fairway buoy.Open anchorage is S.W. of the Fairway buoy with clay and sand bottom offering good holding ground.Pilots board ships in the vicinity of the Fairway Buoy (Deep drafted vessels - about 0.5 n.m. West of the Fairway buoy)Pilot ladders are to be rigged on the lee side 1.5 m above the water line.The Pilots embark from F.R.P. Pilot boats white superstructure / red hull with 'PILOTS' marked on the sides.

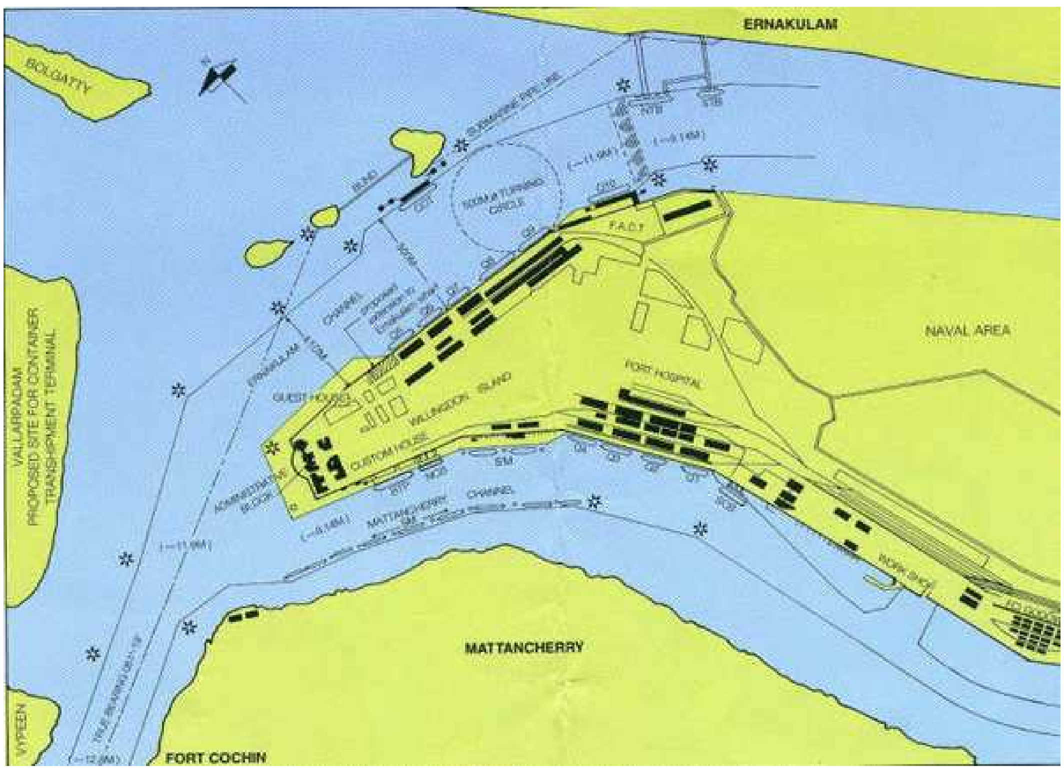
Port Channels:

The entrance to the harbour is by a 10000m long and 200 m wide 13.5 m deep outer approach channel marked with five sets of buoys numbered from 1 to 10. The outer approach channel is beign widened from 200m to 260m, lengthened from 10000m to 16500 m and deepened from a maximum draft of 12.5m to 14.5m. The number of buoys are being increased from 10 to 16 buoys.

Inner harbour is divided into two navigational channels – Ernakulam Channel of 2800m long and 300 – 500 m wide with depths from 9.75 to 13.5 m and Mattancheri Channel of 2200 m long and 180 – 250 m wide with a depth of 9.75m. Mattancheri Channel has the berths Q1 to Q4, North and South Coal berths and B.T.P.Ernakulam Channel has berths Q5 to Q10, North and South Tanker Berths and Cochin Oil Terminal.

Mooring launches:

Four mooring launches are available for passing mooring lines at Tanker, Coal and fertilizer (Q10) berths. On other berths lines are passed by heaving lines.



Plan of Cochin port

(1) NAME OF THE SHIP :
(2) OWNER :
(3) SHIP AGENT :
(4) FLAG :
(5) LENGTH D.A :
(6) BREADTH :
(7) D.W.T :
(8) G.R.T :
(9) N.R.T :
(10) SPEED :
(11) DRAFT INWARD (MAX/MIN) :
(12) PORT OF FINAL DESTINASTION :
(13) PORT OF CALL ENROUTE :
(14) PORT OF NEXT CALL :
(15) PORT OF LAST CALL :
(16) CARGO ON BOARD (TONNES ON ARRIVAL) : DEPATURE ---

(17) ANALYSIS OF STAY :

	AT ANCHORAGE FROM	TO	AT THE TIME OF SHIFTING FROM	TO	BEFORE SAILING FROM	TO
(A) BERTH NOT AVAILABLE						
(B) UN-FAVOURABLE WEATHER CON-DITION						
(C) WAITING FOR TIDE						
(E) AWAITING CHANNEL CLEARANCE						
(F) STRIKE						
(G) NON-AVAILABILITY OF TUGS						
(H) NON-AWAILABILITY OF PILOT						
(I) NIGHT NAVIGATION RESTRICTIONS						
(J) OTHER (PL. SPECIFY)						

SHIPPiNG ASSISTANT
DY. CONSERVATOR'S OFFICE

VISAKHAPATNAM PORT TRUST
RESEARCH PLANNING DEPARTMENT
ARRIVAL RREPORT

(1) DATE	:		
(2) NAME OF THE VESSEL: m.v/m.T		MOVEMENT NO:	
(3) VESSEL SIGHTED	:	HOURS	DT.
(4) VESSEL IDENTIFIED AT	:	HOURS	DRAFT: A: F:
(5) VESSEL CAME TO ROADS AT	:	HOURS	L. O. A : BEAM :
(6) VESSEL ANCHORED AT	:	HOURS	L. P. C :
(7) (P) FLAG HOISTED	:	HOURS	
(8) INFORMED PILOT AT	:	HOURS	
(9) PRE.MOVEMENT COMPLETED AT	:	HOURS	
(10) PILOT CAME TO OFFICE AT	:	HOURS	
(11) PILOT LAUNCH AVAILABLE AT	:	HOURS	
(12) PILOT BOARDED AT	:	HOURS	
(13) VL. WEIGHED ANCHOR AT	:	HOURS	
(14) TUGS ATTENDED AT	:	HOURS	
(15) VESSEL VACATED	:	HOURS	
(16) MOORING CREW ARRIVED AT	:	HOURS	
(17) VESSEL VACATED	:	HOURS	
(18) TUGS RELEASED AT	:	HOURS	
(19) VL. MOORING COMPLETED AT	:	HOURS	

(20) TUGS NAME (1) (2) (3) (4)

(21) IF MORETHAN TWO TUGS ARE USED,
THE REASONS FOR THE SAME

(22) PILOT DIS-EMBARKED AT	:	HOURS
(23) NAME OF THE PILOT	:	CAPT……………………………
(24) PILOT'S REMARKS	:	

H.M PILOT S.C

VISAKHAPATNAM PORT TRUST
RESEARCH PLANNING DEPARTMENT

SHIFTING REPORT

Movement No.

01. Date :
02. Name of the vessel : Draft F: A:
03. VESSEL HOISTED “S” FLAG :
04. INFORMED POLOT AT :
05. PREVIOUS MOVEMENT COMPLETED :
06. PILOT CAME TO OFFICE AT :
07. PILOT LAUNCH AVAILABLE AT :
08. PILOT BOARDED AT :
09. MOORING CREW ARROIVED AT :
10. TUGS ARRIVED AT :
11. CHANNEL CLEARANCE GIVEN AT :
12. VESSEL VACATED BERTH AT :
13. VESSEL OCCUPIED BERTH AT :
14. TUGS RELEASED AT :
15. TUGS NAMES :
    (1) (2) (3) (4)
16. PILOT LAUNCH AVAILABLE AT :
17. PILOT DISEMBARKED AT :
18. TOTAL TIME TAKEN FOR SHIFTING :
19. NAME OF THE PILOT :
20. PILOT REMARKSN :

SHIPPING ASST PILOT H.M

VISAKHAPATNAM PORT TRUST
RESEARCH PLANNING DEPARTMENT

MOVEMENT NO:

DEPARTURE REPORT

01. DATE :		
02. NAME OF THE VESSEL: M.V/M.T/S.S		
03. VESSEL HOISTED B/W/R	AT	HRS.
04. INFORMED PILOT	AT	HRS.
05. PREVIOUS MOVEMENT COMPLETED	AT	HRS.
06. PILOT CAME TO OFFICE	AT	HRS.
07. PILOT LAUNCH AVAILABLE	AT	HRS.
08. PILOT BOARDED	AT	HRS.
09. MOORING CREW ARRIVED	AT	HRS.
10. TUGS ARRIVED	AT	HRS.
11. CHANNEL CLEARANCE GIVEN	AT	HRS.
12. VESSEL VACATED BERTH	AT	HRS.
13. TUGS RELEASED	AT	HRS.

14. NAME OF THE TUGS

(1) (2) (3) (4)

15. IF MORE THAN 2 TUGS USED REASONS FOR THE SAME:

16. PILOT LAUNCH AVAILABLE	AT	HRS.
17. PILOT LAUNCH AVAILABLE	AT	HRS.

18. NAME OF THE PILOT. CAPT.

19. PILOT'S REMARKS:

H.M PILOT Sh. Asst.

NEXT PORTOF CALL :

DRAFT F :

A :

A14 PRODUCTIVITY FILE

B.T	NAME OF SHIP	VESL.NO.	
S.T./NWB	BERTHED AT Hrs., on		
OSBD	SAILED AT Hrs., on	PORT A/C	OTHERS
	(I) GANGWAY LOWERED		
	SURVEY/DOC/HOS.CON / Ini. Arrangements		
1) BEARTH:	LAB. TEST / P.Q.TEST / CUSTOMES CLEARENCE		
W.Comm:	BERTHED IN SHIFT END		
	(II) WORKING ARRANGEMENTS		
W.Comp:			
	DLB DELAY / BROKE-OFF		
NWT:			
Tonnage:			
	SHIP EQU. REPAIR		
	PORT EQU.REPAIR		
	RAIN AND BAD WEATHER		
	SHORE CLEARENCE		
	WANT OF CARGO		
	SHIFTING ARRANGEMENTS		
	TIME SENT AT NWB		
	(III) SHIP ACCOUNT		
	SURVEY/DOC/HOUSE DIS-CONNECTION		
	EARLIER MOVEMENTS / AWAITING XH. XLEARENCE		
	WINDOW PERIOD		
	AWAITING TIDE		
	UN-MOORING		
N.W.T :	TOTAL		

Dear Sir,

This is to convey that I am doing my research in coal logistics focusing on various factors affecting the costs at ports for imported steam coal. In this regard I request to please answer the following questionnaire.

I. To which category you could fit in as described below, please tick the most appropriate

a. Importer - Who imports steam coal directly from the mines located overseas and sells to the end user directly or indirectly.

b. Stevedorer- Who handles the cargo at ports performing various activities like unloading, moving the cargo to warehouses, customs clearance etc.

c. Power producer- A company which has facility to generate electricity and also who is importing coal directly from other countries.

d. Port Authority- An entity which operates the port and develops infrastructure.

The below mentioned questions describe various factors affecting the costs at ports. You may choose and tick any one of the options as described below

1. Strongly disagree
2. Somewhat agree
3. Can’t say
4. Somewhat agree
5. Strongly agree.

II. Do you agree that number of berths is a factor affecting the costs for Steam coal imports?

1__ 2__ 3__ 4__ 5__

III. Berthing Policy is a factor affecting the costs at ports.

1__ 2__ 3__ 4__ 5__

IV. Port Congestion is a factor affecting costs at port.

1__ 2__ 3__ 4__ 5__

V. Navigational infrastructure is affecting the costs at the ports.

1__ 2__ 3__ 4__ 5__

VI. Draft at the Port is factor affecting the costs.

1__ 2__ 3__ 4__ 5__

VII. Berth infrastructure affecting the costs at the port.

1__ 2__ 3__ 4__ 5__

VIII. Cargo Warehousing infrastructure is factor affecting the costs at port.

1__ 2__ 3__ 4__ 5__

IX. Warehousing location is affecting the costs of port operations.

1__ 2__ 3__ 4__ 5__

X. Rail connectivity is affecting the costs of operations at ports.

1__ 2__ 3__ 4__ 5__

XI. Road connectivity is affecting the costs of port operations.

1__ 2__ 3__ 4__ 5__

Name :

Designation:

Organisation:

Date:

Thanking you for your feedback and time spent to answer the questionnaire .

T. Bangar Raju

A16 CORRELATION MATRIX

		waiting time	pilotage time	service time	tonnes per ship hour at berth	effective working time at berth	average tonnage per ship	average draft per ship	ships arrival rate
Correlation	waiting time	1.000	.102	.467	-.413	.255	-.249	.084	-.127
	pilotage time	.102	1.000	-.099	-.703	-.194	-.820	-.855	-.349
	service time	.467	-.099	1.000	-.386	.943	.104	.417	.392
	tonnes per ship hour at berth	-.413	-.703	-.386	1.000	-.247	.860	.623	.158
	effective working time at berth	.255	-.194	.943	-.247	1.000	.268	.512	.555
	average tonnage per ship	-.249	-.820	.104	.860	.268	1.000	.900	.437
	average draft per ship	.084	-.855	.417	.623	.512	.900	1.000	.442
	ships arrival rate	-.127	-.349	.392	.158	.555	.437	.442	1.000
Sig. (1-tailed)	waiting time		.383	.074	.103	.224	.230	.403	.354
	pilotage time	.383		.386	.008	.284	.001	.000	.146
	service time	.074	.386		.121	.000	.380	.101	.117
	tonnes per ship hour at berth	.103	.008	.121		.232	.000	.020	.321
	effective working time at berth	.224	.284	.000	.232		.212	.054	.038
	average tonnage per ship	.230	.001	.380	.000	.212		.000	.090
	average draft per ship	.403	.000	.101	.020	.054	.000		.087
	ships arrival rate	.354	.146	.117	.321	.038	.090	.087	

There are two types of carriers based on unloading facilities

1. Geared Carriers - these have their own cranes which unload and load the cargo on their own.

2. Gearless Carriers – these do not have their own cranes or unloading and loading facilities. They depend on port facilities for unloading.

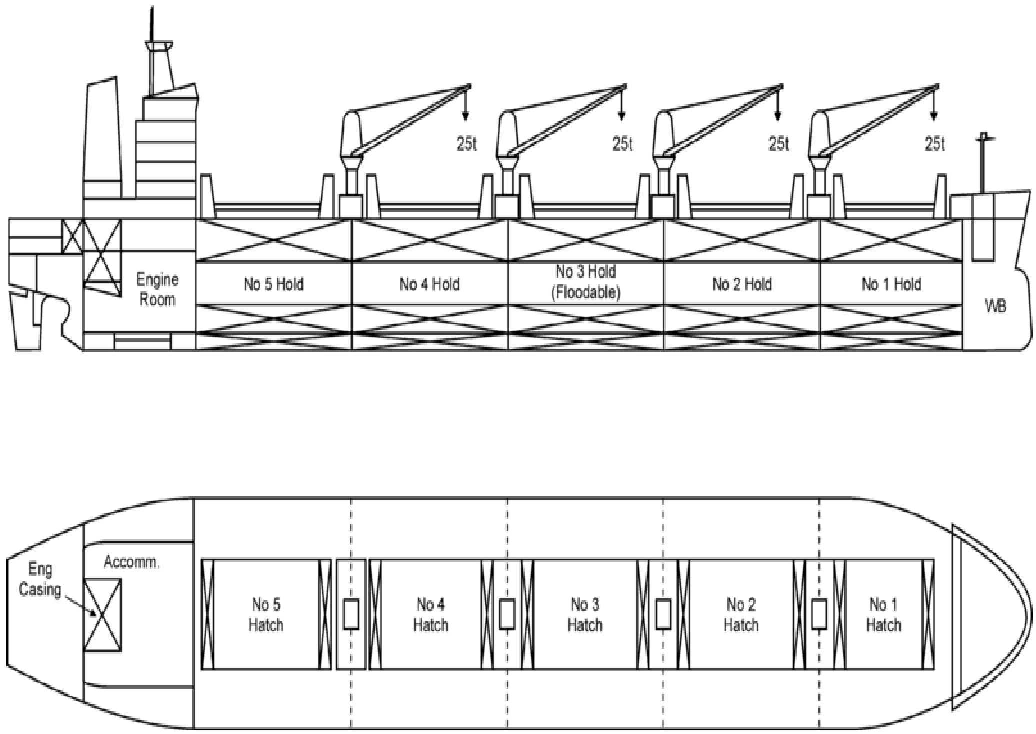
Categories

The dry bulk carriers are also categorized based on sizes. The dry cargo carriers are segregated into six categories as shown below.

S.No	Name	Size in Dead weight tonnage(DWT)
1	Mini Bulkers	Upto 10,000 DWT
2	Handysize	10,000 to 25000DWT
3	Handymax	25,000 to 50,000DWT
4	Supramax	50,000DWT to 60,000DWT
5	Panamax	60,000DWT to 80,000DWT
7	Capesize	80,000DWT and over
8	Valemax	4,00,000DWT

Mini bulkers are small vessels with capacity upto 10,000DWT which carry upto 2500 tonnnes of dry cargo and are designed for river transport. Handysize and

Handymax vessels are used for general cargo. At present For coal imports to India mostly Handymax carriers which carry from 52000tons to 58000tons of coal tons are used. These have five cargo holds and four cranes.



Typical plan of a Handymax Carrier

The Panamax carriers by name are limited by the Panama canal lock chambers which can allow a ship upto a draft of 12 m. Capesize carriers are large carriers which travel through Cape Horn, Cape of Good Hope between Pacific, Indian and Atlantic oceans. These are generally used to carry Coal and Iron ore. Valemax are ships recently designed to carry Iron ore from South America to China with capacity of 4,00,000DWT.

Table A18.1 Steam Coal traffic at Major Ports of India

		in 000 tons			in 000 tons
Name of the east coast Port	**Period**	**steam coal**	**name of the west coast port**	**Period**	**steam coal**
Haldia	2002-03	3379	Cochin	2002-03	187
	2003-04	3195		2003-04	142
	2004-05	3157		2004-05	210
	2005-06	3408		2005-06	199
	2006-07	2443		2006-07	219
	2007-08	1797		2007-08	246
	2008-09	1915		2008-09	259
	2009-10	1489		2009-10	148
paradip	2002-03	9853	Mormugoa	2002-03	0
	2003-04	11013		2003-04	103
	2004-05	10942		2004-05	284
	2005-06	12529		2005-06	378
	2006-07	12475		2006-07	350
	2007-08	13348		2007-08	357
	2008-09	14698		2008-09	449
	2009-10	14818		2009-10	957
Viskhakapatnam	2002-03	3197	Mumbai	2002-03	0
	2003-04	2493		2003-04	0
	2004-05	2524		2004-05	0
	2005-06	2740		2005-06	1844
	2006-07	2406		2006-07	2533
	2007-08	2895		2007-08	2951
	2008-09	3440		2008-09	3265
	2009-10	3771		2009-10	3745
Chennai	2002-03	2754	Kandla	2002-03	0
	2003-04	1838		2003-04	0
	2004-05	1976		2004-05	0
	2005-06	1914		2005-06	0
	2006-07	2180		2006-07	293
	2007-08	1888		2007-08	935
	2008-09	2435		2008-09	1406
	2009-10	1218		2009-10	2296
Ennore	2002-03	8485			

	2003-04	9277			
	2004-05	8856			
	2005-06	8387			
	2006-07	8802			
	2007-08	9051			
	2008-09	9708			
	2009-10	9279			
Tuticorin	2002-03	5015			
	2003-04	5266			
	2004-05	5374			
	2005-06	6146			
	2006-07	5608			
	2007-08	6112			
	2008-09	5880			
	2009-10	5603			

Name : TOTAKURA BANGAR RAJU

Date of birth : 20th August,1974.

Family Status : Married and blessed with two daughters.

Qualifications

1. Bachelor of Engineering in Mechanical stream from Andhra University.
2. Two year full time PGDBM from Fortune institute of International Business, New Delhi.

Work Experience

- Worked with JSW, Bellary (Sajjan Jindal Group Integrated steel plant) for a period of four years as Junior manager Exports.
- Worked as Manager- Energy and Minerals, at Adani Enterprises Limited, for the Iron ore and coal trading division.
- Been Head of the department-MBA, at Shri Vishnu Educational society, Bhimavaram.
- Presently Consultant for Export and Imports, International Logistics and Supply chain management for Coal.

Core Strengths

- Widely travelled to Middle East and other countries.
- Good exposure and knowledge in regard all major and non major ports in India.
- Well versed with International trade logistics and supply chain practices.

1. Dr. B.V. Ramalingeswara Rao, Dr. K.V. Mohana Rao, T. Bangar Raju, "Analysis of Coal imports through Major and Minor ports with reference to Indian east and west coast ports" International Journal of Business Management and Social Sciences,Vol.1, issue 7(II), March 2012.
2. Dr. K.V. Mohan Rao, Dr. B.V. Ramalingeswara Rao, T. Bangar Raju, " An Analysis of Steam Coal import Logistics in India and factors affecting the costs in the supply chain with reference to Indian Power Sector", Global Conference in Operations and Supply Chain Management", Asia Pacific Journal of Operations Research, Global Research Agency, Indonesia, March 2012,

Contact details

Email: Bangarraju@gmail.com, bangar_rajut@yahoo.com

Mob: +917893377779