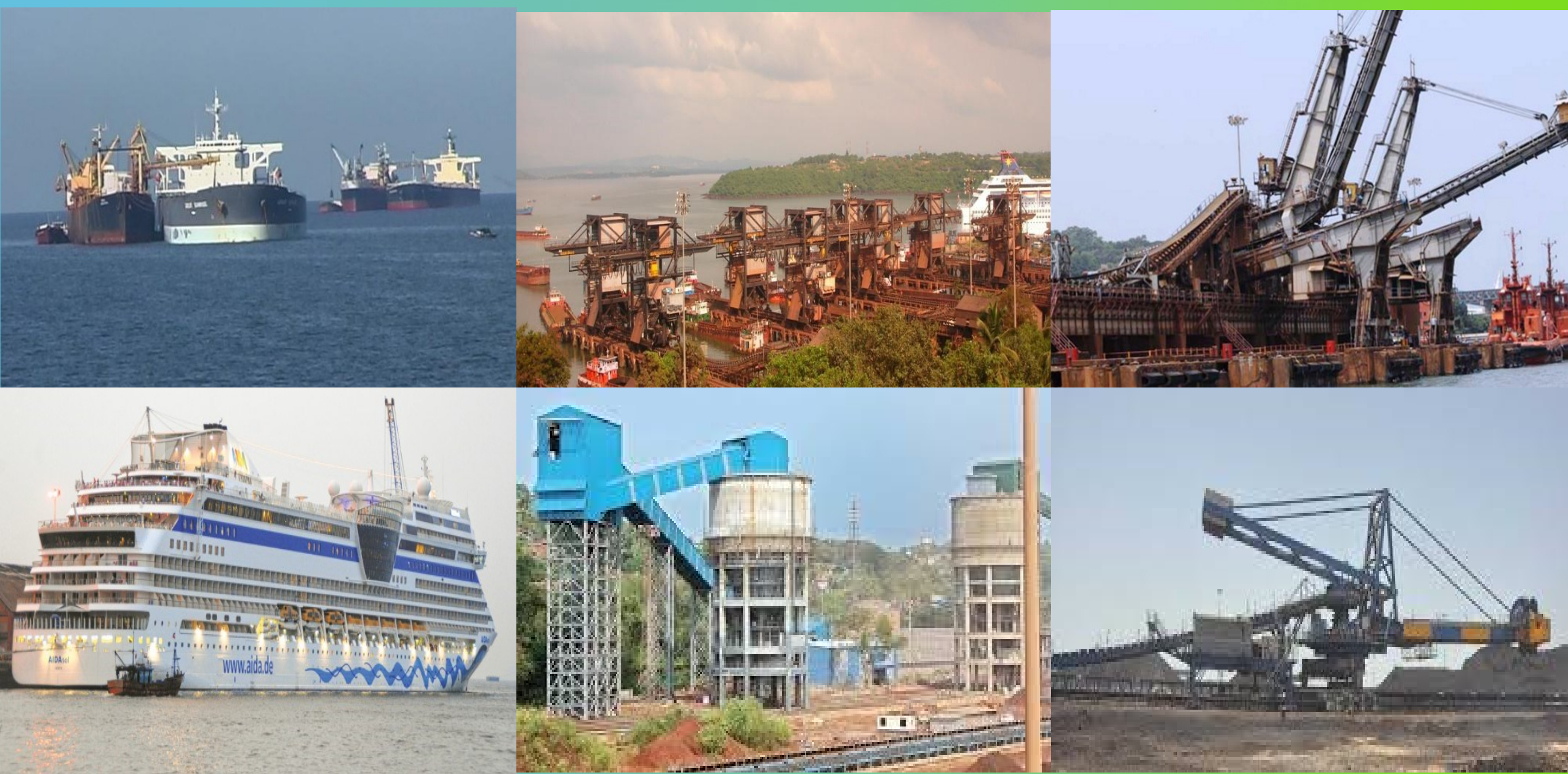
MASTER PLAN FOR MORMUGAO PORT



Master Plan for Mormugao Port

Prepared for

Ministry of Shipping
Government of India

Ministry of Shipping / Indian Ports Association

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1.0 INTRODUCTION

1.1 Background

The Sagarmala initiative is one of the most important strategic imperatives to realize India's economic aspirations. The overall objective of the project is to evolve a model of port-led development, whereby Indian ports become a major contributor to the country's GDP.

As shown in **Figure 1.1**, the Sagarmala project envisages transforming existing ports into modern world-class ports, and developing new top notch ports based on the requirement. It also aspires to efficiently integrate ports with industrial clusters, the hinterland and the evacuation systems, through road, rail, inland and coastal waterways. This would enable ports to drive economic activity in coastal areas. Further, Sagarmala aims to develop coastal and inland shipping as a major mode of transport for the carriage of goods along the coastal and riverine economic centres.

As an outcome, it would offer efficient and seamless evacuation of cargo for both the EXIM and domestic sectors, thereby reducing logistics costs with ports becoming a larger economy.

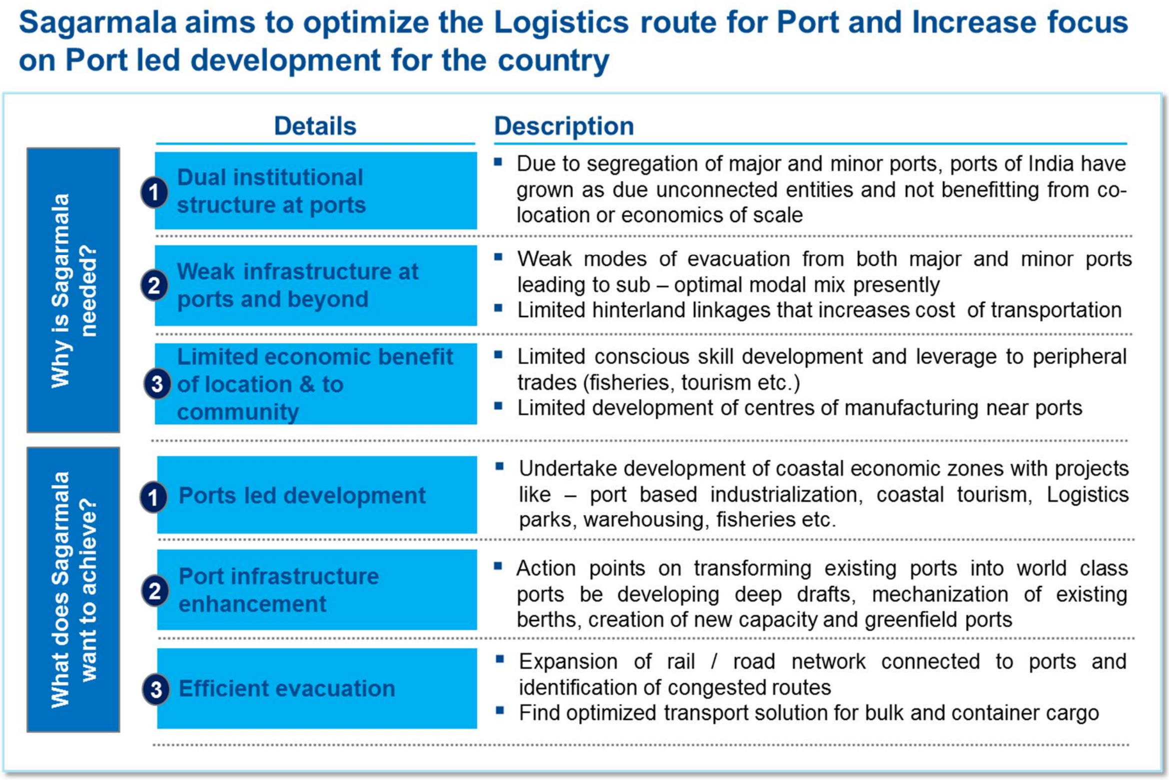


Figure 1.1 Aim of Sagarmala Development

In order to meet the objectives, Indian Port Association (IPA) appointed the consortium of McKinsey and AECOM as Consultant to prepare the National Perspective Plan as part of the Sagarmala Programme.

1.2 Scope of Work

The team of McKinsey and AECOM distilled learnings from the experience in port-led development, the major engagement challenge to develop a set of governing principles for our approach is shown in **Figure 1.2.**

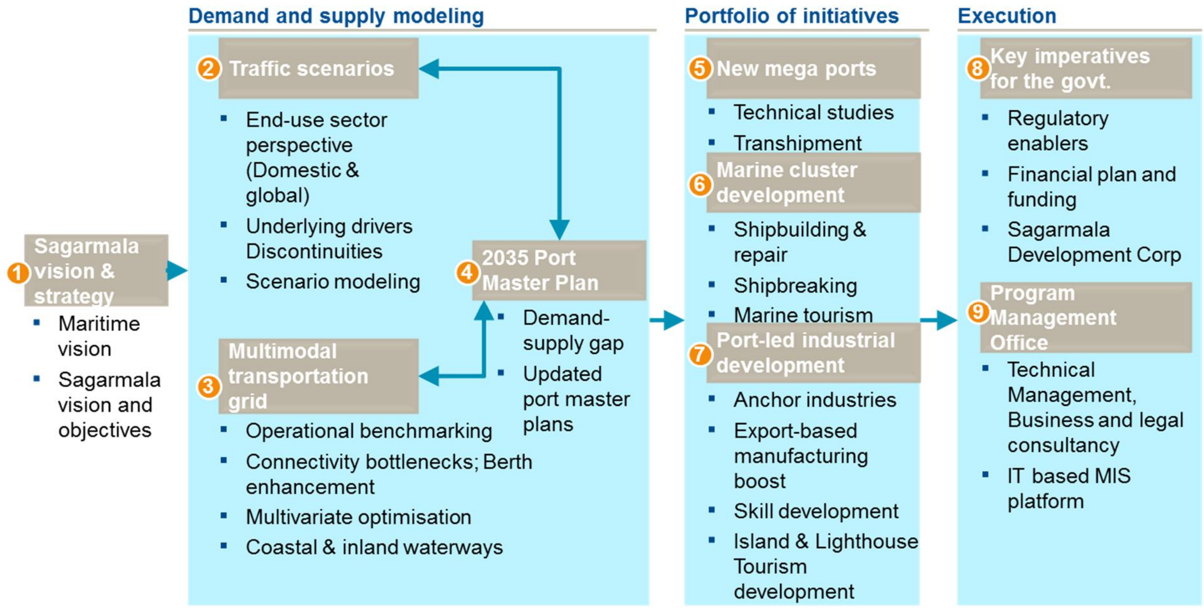


Figure 1.2 Governing Principles of Our Approach

As indicated above, the origin-destination of key cargo (accounting for greater than 85% of the total traffic) in Indian ports have been mapped to develop traffic scenarios for a period of next 20 years. The forces and developments that will drive change in the cargo flows shall also be identified. This would lead to the identification of regions along the coastline where the potential for expansion of existing port exists. The various activities involved in the port led developments are charted in **Figure 1.3**.

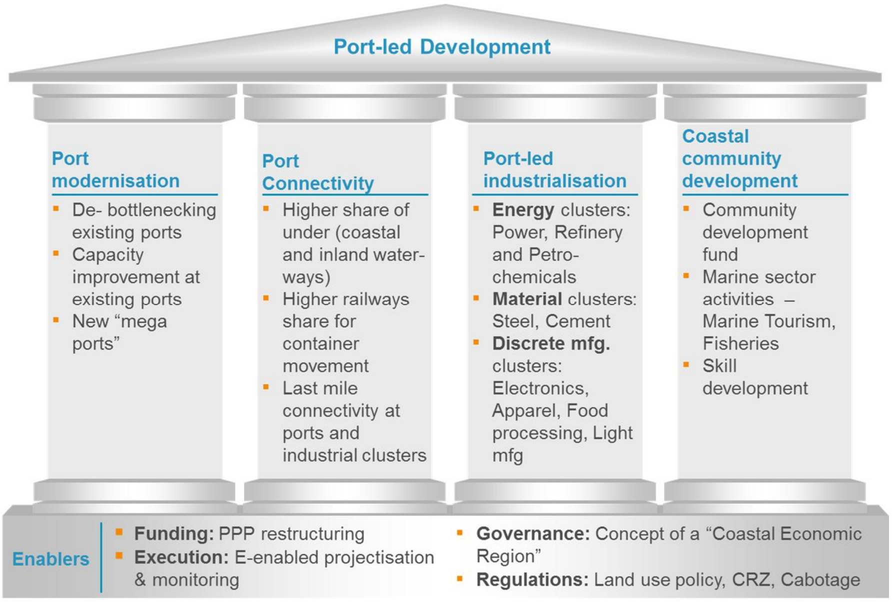


Figure 1.3 Port Led Developments

As part of the assignment, we are also expected to coordinate with the team working on "Benchmarking Operational Improvement Roadmap for Major Ports in India" study (which is being carried out simultaneously along with this assignment) and identify current and future logistic constraints (at the Major Ports) for the top 85% cargo categories based on analysis of current port capacity, productivity levels in comparison to international benchmark and evacuation bottlenecks in the logistics chain. This understanding should be an input in defining the 2035 Master Plan for each port.

Accordingly, this Master Plan report has been prepared taking into consideration the inputs provided on the future traffic and the benchmarking and operational improvements suggested for this port.

1.3 Present Submission

The present submission is the Final Report for Development of Master Plan for Mormugao Port as part of SAGARMALA assignment. This report is organised in the following sections:

Section 1 : Introduction

Section 2 : The Port and Site Conditions

Section 3 : Details of Existing Facilities

Section 4 : Performance, Options for Debottlenecking & Capacity Assessment

Section 5 : Details of Ongoing Developments

Section 6 : Traffic Projections

Section 7 : Capacity Augmentation Proposals

Section 8 : Scope for Future Capacity Expansions

Section 9 : Shelf of New Projects and Phasing

2.0 THE PORT AND SITE CONDITIONS

2.1 Mormugao Port as at Present

The Mormugao Port is a leading Major Port, located at the entrance of Zuari estuary on the west coast of India (State of Goa) at Latitude 15º 25' North and Longitude 73º 47' East. Mormugao Port is an excellent natural harbour and over the years, the port has deepened the channel and the harbour areas. Further, deepening of the channel and harbour basin is in process to enable handling of fully loaded capesize ships at the port. The port has good rail and road connectivity. The location of Mormugao Port in the state of Goa and its present layout is shown in **Figure 2.1**.

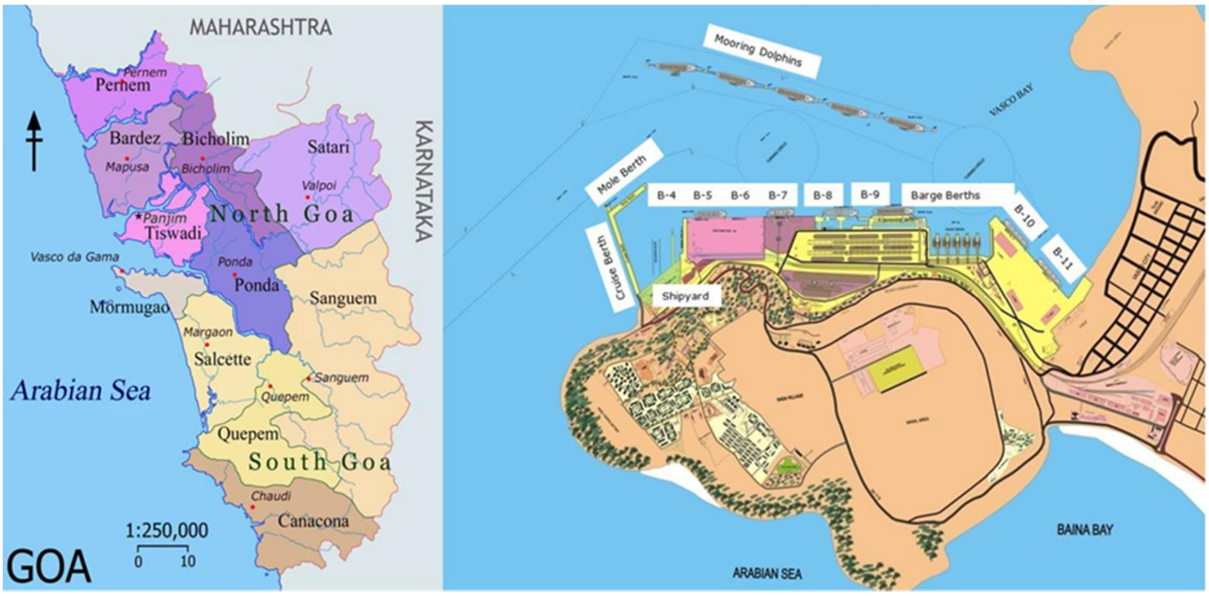


Figure 2.1 Location of Port and Berthing Facilities

Mormugao port has traditionally been one of the leading iron ore exporting port of India. Due to Hon'ble Supreme Court's ban on iron ore exports from Goa and subsequent restrictions on iron ore exports, the cargo volumes handled by Mormugao have fallen sharply. Today, the port is set to diversify into other commodities including containers. Coal/Coke is a major commodity handled at the port. During the year 2013-14, more than 7.5 MT of coal was handled at Mormugao Port. There are two dedicated coal terminals (berth 6 & 7) which are being operated by private operators. The demand for coal imports through Mormugao Port remains very strong. Along with the demand for coal, the general cargo traffic has witnessed a spurt during the past two years.

2.2 Road Connectivity

Mormugao Port is well connected with all major towns of not only Maharashtra and Karnataka, but the rest of India as well via the following National and State Highways:

- NH 17 (Panvel – Panaji – Mangalore – NH 47 Junction in Kerala)
- NH17A (Cortalim - Mormugao)
- NH17B (Ponda – Verna - Vasco)
- NH 4A (Panaji - Belgaum)

All-important destinations in India whether on the North, West or East could be accessed through any one of the above mentioned Highways as shown in **Figure 2.2**.

Figure 2.2 Road Connectivity to Mormugao Port

NH 17B passes along the port and have significant influence on Port Traffic movement. The port presently has 3 gates they're Gate 1, Gate 2 and Gate 9. Presently Gate 1 and Gate 9 are in use. Major vehicular movement is from Gate 9, whereas Gate 2 is mainly used for the passenger vehicles. The location of these gates is shown in **Figure 2.3**.

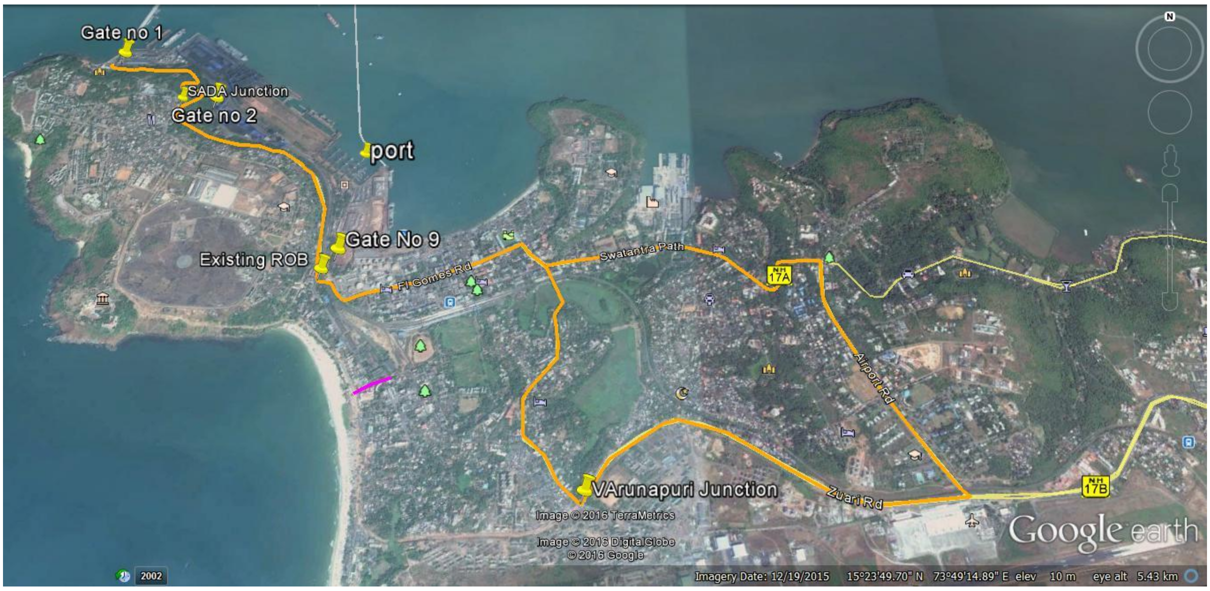


Figure 2.3 Location of Entry / Exit Gates at Mormugao Port

2.3 Rail Connectivity

The broad gauge railway system of the port serves the general cargo berths. Port Railway system is connected to south western railway through which it is also linked to Konkan Railway. Both these railway together facilitate easy access to the port from any part of the country through the vast network of broad gauge railway system.

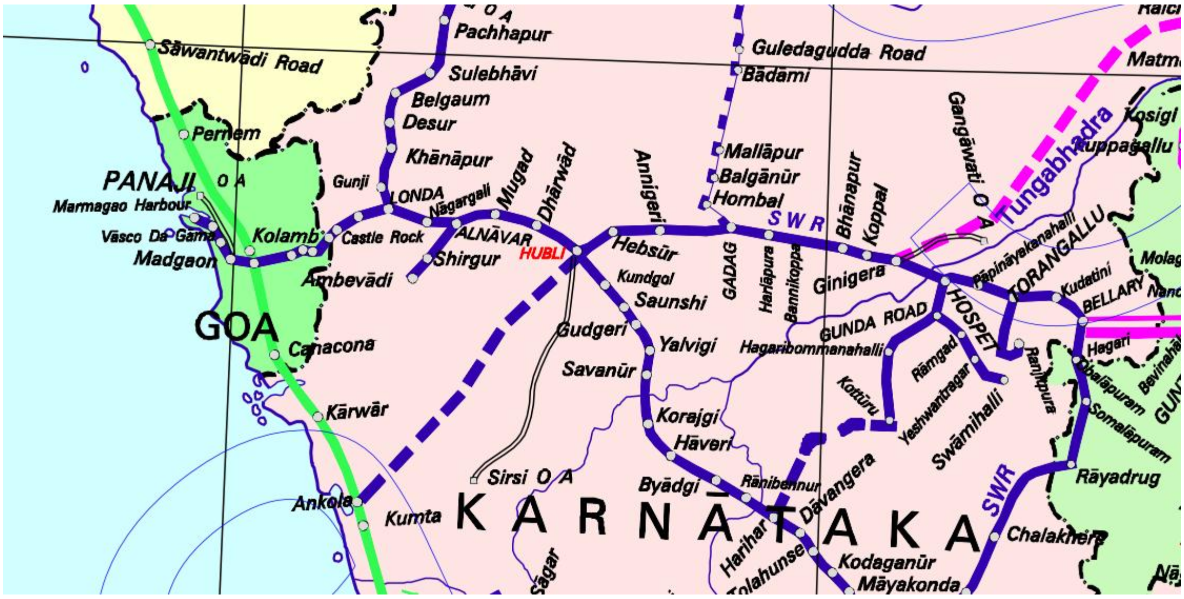


Figure 2.4 Rail Connectivity to Mormugao Port

Route No.	Rail Routes	Traffic Directions
1.	Vasco – Majorda – Madgaon – Loliem - Manglore	South (Along the coast)
2.	Vasco – Majorda – Madgaon – Kulem – Castle Rock – Londa -Belgaum – Miraj	East & North bound traffic
3.	Vasco – Majorda – Madgaon – Kulem – Castle Rock – Londa –Dharwad -Hubli – Hospet - Bellary	East & South East bound
4.	Vasco- Cansulim – Verna – Mapusa – Pernam – Ratnagiri -Mumbai	West (along the coast)

Vasco da Gama, the nearest railway station, is connected to the Port Trust Railway System from the south by double tracks which pass through the port rail gate. Also south of the port is a shop and engine house complex belonging to the Port Trust Railway. This complex has short tracks for storage of wagons and locomotives. Within the Port Trust rail gates, a spur track serves Berth 10 and Berth 11. Inside the port area there are presently four tracks dedicated to receipt and despatch (R&D) of single rakes. From the R&D lines, two lead tracks extend north for Berths 5A & 6A. These leads serve three tracks of 450 m for loading coal and steel coil. The port has taken up the work of augmenting the capacity of rail within the port. Additional lines will now be laid in the R&D yard. Separate rail facilities have been planned for berths 5A & 6A, berth 7, berth 11 and west of breakwater berths.

2.4 Site Conditions

2.4.1 Meteorology

2.4.1.1 Winds

The mean wind speed varies from 2 on Beaufort scale in November (3.4 to 5.4 m/s) to 4 (5.5 to 7.9 m/s) in July, the annual mean wind speed being 13.6 km/h. In an average year, there are 316 days with wind speed varying from 0 to 3 on Beaufort scale (0.0 to 5.4 m/s) and 48 days with winds scaling 4 to7 on Beaufort scale (5.5 to 17.1 m/s), and one calm (0.0 to 0.2 m/s) day.

The predominant wind direction changes with the time of the year. During June to September wind direction is from W and SW and during the remaining period the direction is from NE and ESE.

2.4.1.2 Rainfall

The average annual rain fall in Mormugao is about 2,611.7 mm and the average number of rainy days in a year are100. During June to September, Mormugao receives 89% of the annual rainfall.

2.4.1.3 Air Temperature

Mean dry bulb temperature varies from 24.3° C in January to 29.8° C in May. The mean daily maximum temperature varies from 27.8° C in August to 31.5° C in May and the mean daily minimum temperature from 21.4° C in January to 26.9° C in May. The annual average daily maximum and minimum temperatures are 29.5° C and 23.7° C respectively.

2.4.2 Oceanography

2.4.2.1 Tides

The tide prevailing at Mormugao harbour is mainly semi-diurnal exhibiting two high and two low waters in a tidal day. The mean tidal variation is of the order of 1.6 m at spring tides and 0.7 m at neap tides. The Chart Datum is 4.8449 m below the principal Bench Mark established by the port.

Based on this datum and Indian Naval Hydrographical Chart No. 2020 the tide levels are as follows:

- *Higher High Water at Spring (HHWS) + 2.3 m*
- *Mean Higher High Water (MHHW) + 1.9 m*
- *Mean Lower High Water (MLHW) + 1.8 m*
- *Mean Higher Low Water (MHLW) + 1.0 m*
- *Mean Lower Low Water (MLLW) + 0.5 m*
- *Mean Sea Level (MSL) + 1.3 m*

2.4.2.2 Currents

The currents in the region outside the sheltered harbour have been found to be generally less than one knot during fair weather season and are mainly caused by the tidal flow. Within the sheltered harbour, indicated current strengths are of the order of 0.30 to 0.40 m/s. During heavy monsoon rains, the current pattern is altered from that during the fair season but the current strengths do not get altered appreciably.

2.4.3 Geotechnical Data

Based on the geotechnical investigations carried out at port from time to time within the port during its growth it is observed that the seabed is generally covered by soft sand / silty sand / silty clay, though at few places, the seabed is covered with dense to very dense, silty, fine to medium sand. General characteristics of the Soil strata based on site investigations at Vasco Bay are as under:

- *Top layer* *8 – 10 m* *Loose silty sand with value of N = 0 to 5*
- *Next layer* *10 m thick* *Medium to dense sand " N = 15 to 30*
- *Bottom layer* *24 – 26 m* *Weathered to hard rock " N > 100*

The characteristics of soil strata in the area 250 m away from the face of Berths 10 and 11 indicate that the silty clay deposit varies in depth from 5 m to 10 m. This layer is intercepted at places by sand, shells, and kankar patches. A layer of medium to dense fine sand underlies this soft layer. Beyond 27 to 32 m, the hard rock is noticed.

3.0 DETAILS OF EXISTING FACILITIES

3.1 Approach Channel

The approach channel of the port comprises an outer channel 5,200 m long and an inner channel 2,300 m long. The channel is 250 m wide. The harbour basin has two turning circles of 480 m diameter each.

The outer channel is dredged up to -14.4 m CD. The inner channel and the turning circle are dredged to -13.1 m CD. The channel is one way navigation channel. The details of Approach Channel are as follows:

- Length of Outer Channel : 5.2 km
- Length of Inner Channel : 2.3 km
- Width of Channel : 250 m
- Depth : 14.4 m to 13.1 m below CD
- Turning Basins : 2 no. of 480 m diameter
- Tidal Range : Springs- 2.3 m / Neaps-1.0 m

The port has already awarded the contract for deepening the channel to -19.8 m CD to enable handling of cape size ships.

3.2 Breakwater

The port has a 522 m long breakwater aligned slightly east of north at the western end of the port/berthing facilities. A mole of 270 m long runs from the tip of the breakwater in an easterly direction. The breakwater and the mole give protection to the berths from W and NW waves during monsoons.

3.3 Berthing Facilities

The location plan of the berths is shown in the **Figure 3.1**

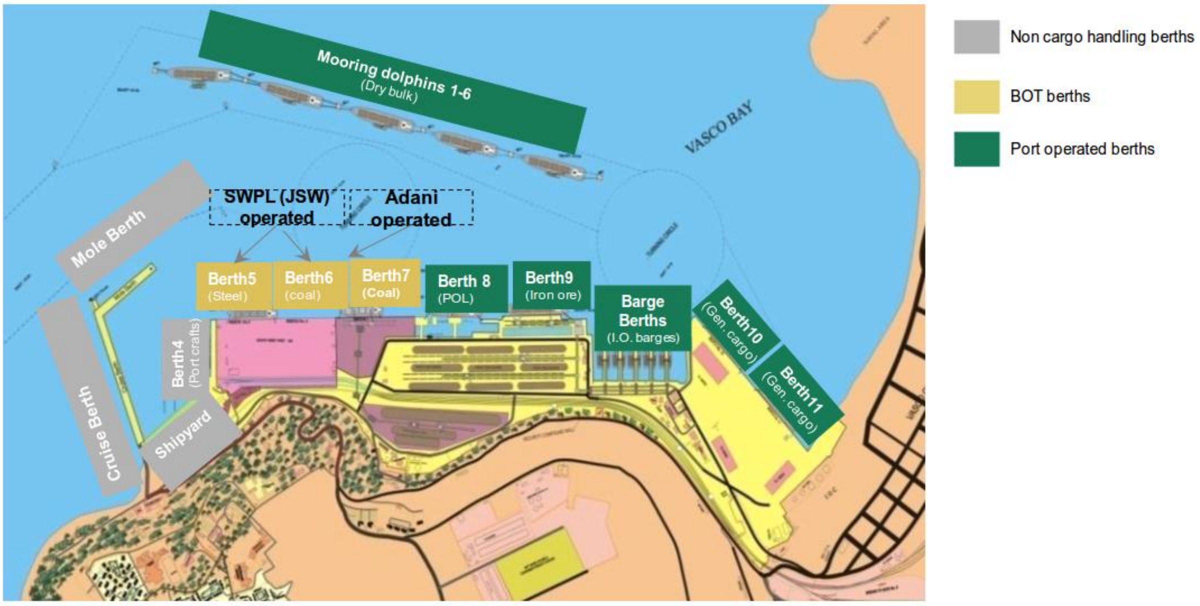


Figure 3.1 Existing Berthing Facilities

The details of all the berthing facilities are provided in the **Table 3.2**.

Table 3.2 Berthwise Details

Berth No.	Type of Berth	Designed / Depth (m)	Quay Length (m)	Planned for Maximum Size of Vessel	
				Length Overall (m)	DWT Approx. (T)
1, 2 and 3	Shipyard	-	-	-	-
4	Non-cargo berth	8	194	190	-
5	General Cargo	13.1	210	190	50,000
6	General Cargo / Coal	14.1	240	225	70,000
7	Coal Cargo	14.5	300	300	1,60,000
8	Liquid Bulk	13.1	116 / 298*	260	1,25,000
9	Iron Ore	14.1	222 /357.5*	335	2,75,000
10	General Cargo	13.1	250	225	55,000
11	General Cargo	13.1	270	225	65,000
-	Non-Cargo Berth New cruise Terminal (along the breakwater	9.50	450	-	-
-	Mole Berth (along the mole)	9.50	250	200	-
-	Between Mooring Dolphins no.1&2	14.1	340	225	70,000

Berth No.	Type of Berth	Designed / Depth (m)	Quay Length (m)	Planned for Maximum Size of Vessel	
				Length Overall (m)	DWT Approx. (T)
-	Between Mooring Dolphins no.2&3	14.1	340	225	70,000
-	Between Mooring Dolphins no.3&4	14.1	340	225	70,000
-	Between Mooring Dolphins no.4&5	14.1	340	225	70,000
-	Between Mooring Dolphins no.5&6	14.1	340	225	70,000
-	East of Mooring Dolphins no.1	12.8	-	-	-

** Length between extreme mooring dolphins*

Brief descriptions of the above berthing facilities are given below.

3.3.1 Berth 1, 2 and 3 (Shipyard)

Berth 1, 2 and 3 form part of a modern ship repair complex with floating dry dock facilities leased to M/s Western India Shipyard Limited (WISL)

3.3.2 Berth 4 (Non Cargo Berth)

Berth 4 is a Non Cargo Berth, presently being used for port crafts berthing. This berth can accommodate vessel up to LOA 190 m.

3.3.3 Berths 5 and 6 (Steel Products and Coal)

The Berths 5 and 6 are operated by SWPL (subsidiary of JSW). Berth 5 is dedicated for export of steel products from JSW steel plant in Tornagallu in Vijayanagara, located about 410 km from the Mormugao port and berth 6 is dedicated for import of coking coal that is required at the plant.

The total length for berths 5 and 6 is about 450 m with an available draft of -14.1 m CD. These berths are planned for handling about 70,000 DWT vessels. These berths are equipped with 3 mobile harbour crane having a total discharge capacity of 40,000 TPD. The receiving conveyors (from berth to stackyard) have a rated capacity of 3,000 TPH and the despatch conveyors (from stackyard to despatch) have a rated capacity of 1,800 TPH.

The stackyard has the cargo storage capacity of about 180,000 T (3 stockpiles of 280 m long with 10 m stacking height) served by two Stacker / Reclaimer units of 2,400 TPH nominal capacity for stacking and 1,800 TPH nominal capacity for reclaiming.

An in-motion wagon loading station connected by pipe conveyor has been installed for loading one full rake of 59 wagons (3,600 T) in about 1 hour. The wagon loading station has a silo of 4,000 T.

3.3.4 Berth 7 (Coal)

Berth 7 is leased to M/s. Adani Mormugao Port Terminal Private Limited (AMPTPL). This berth with a length of 300 m has a design draft of -16.5 m CD and is designed for handling upto 160,000 DWT ships. The berth is equipped with two mobile harbour cranes, each with a rated capacity of 1,750 TPH.

The fully mechanised material handling system consisting of conveyor systems, two tripping conveyors in the yard closer to the berth and one stacker cum reclaimers unit with stacking capacity of 3,500 TPH and reclaiming capacity of 2,500 TPH has been provided, in the other yard parallel to the berth. The stackyard has a total area of 97,000 m^2 with effective storage area of about 54,000 m^2.

An in-motion wagon loading system with a silo of capacity 4,000 T is provided for faster evacuation through rail. Two truck loading stations, with an independent hopper of capacity of 500 T, are provided for evacuation through trucks.

3.3.5 Berth 8 (Liquid Bulk)

Specialised facilities are available at berth 8 for handling petroleum products and other liquid cargoes like caustic soda, ammonia, molasses etc.

Generally, hoses are used to transfer bulk liquids between the tankers and onshore pipeline system. A mobile mechanical unloading arm is provided to handle Ammonia.

3.3.6 Berth 9 and Barge Jetties (MOHP)

The berth 9 is dedicated for the handling of Iron Ore with Mechanized Ore Handling Plant (MOHP). This berth is 357 m long and having dredged level of -14.1 m CD. It can handle vessel up to LOA 335 m. However, due to the Supreme Court's ban on iron ore exports from Goa and subsequent restrictions on iron ore exports, the berth is not being utilised at present.

The port also has total 5 numbers of barge berths for unloading of iron ore, brought to the port through barges. The details of MOHP are presented in **Table 3.1**:

Table 3.1 Details of MOHP

S. No.	Description of Equipment	No.	Rated Capacity (TPH)
1.	Barge Unloaders	8	750
2.	Continuous Barge Unloader	1	1,250
3.	Stackers	3	4,000
4.	Reclaimers	2	4,000
5.	Ship Loaders	2	4,000

Stackyard at MOHP has an area of 80,000 sqm and have a storage capacity of 1.0 MT of iron ore.

3.3.7 Berths 10 and 11 (Bulk and Breakbulk)

These two berths have combined length of about 520 m and are operated as general cargo berths by port. The major cargo handled in the berths include containers, steel coils, granite blocks, MOP, wood chips etc. Some quantity of Phosphoric acid and petroleum products are also handled at these berths.

3.3.8 Mooring Dolphins

Six mooring dolphins capable of accommodating panamax size vessels are also available for handling ore and other bulk cargo using ship's own gears.

3.3.9 Cargo Handling Equipment for General Cargo/Containers

The details of cargo handling equipment are provided in the **Table 3.2**.

Table 3.2 Details of General Cargo / Containers Handling Equipment

S. No.	Description	No.	Capacity
1.	Mobile Harbour Crane	1	100 T capacity
2.	Reach stacker	2	40 T capacity each
3.	Plug points of suitable capacity to cater to the reefer containers	84	440 V
4.	Locomotive	2	1400 HP

3.4 Berths for Cruise Ships

The berth along lee side of the Breakwater is used for berthing of the Cruise Ships.

3.5 Berth for Navy/Coast Guard Vessels

The mole berth adjoining the head of breakwater is used for berthing of the Navy and Coast Guard Vessels.

3.6 Storage Facilities

Storage facilities comprise of covered storage area in the form of transit sheds, warehouses and open storage area and tanks for liquid cargo area as presented in **Table 3.3** and **Table 3.4** below:

Table 3.3 Details of the Storage Facilities for General Cargo / Containers

Description	No. of Plots/Sheds	Area (m^2)	Storage Capacity (T)
Covered Storage			
· Owned by the Port	7 sheds	24,985	47,497
· Owned by Others: FCI/CWC	4 sheds	14,480	22,216
Total Covered storage	**11 sheds**	**39,465**	**69,713**
For Containers	-	14,823	(489 ground slot / 862 TEUs)
Open Storage for other cargo	-	131,681	292,895
Total Open Storage	**-**	**146,504**	**304,726**

Table 3.4 Details of Storage Facilities for Liquid Cargo

S. No.	Commodity	No. of Tanks	Capacity (in KL)
1.	**POL Product**		
a	IOC -Vasco	5	34,660
b	HPCL - Vasco	8	33,700
c	ZIL - Zaurinagar	4	27,500
d	Ganesh Benzoplast- Sada	2	46,000
2.	**Phosphoric Acid**		
a	ZIL- Zaurinagar	3	13,670
3.	**Caustic Soda Molasses & Other Liquids**		
a	Ganesh Benzoplast- Sada	2	46,000
b	IMC- Harbour (Port area)	9	15,000
c	JRE (Port Area)	2	7,800
4.	**Ammonia**		
a	ZIL- Zaurinagar	1	3,000 T
b	ZIL- Sada/Jetty	1	5,000 T

4.0 PERFORMANCE, OPTIONS FOR DEBOTTLENECKING & CAPACITY ASSESSMENT

4.1 General

The total cargo handled through the existing facilities, during the past 5 years is presented in the **Table 4.1**.

Table 4.1 Cargo Handled During Last 5 Years (in MT)

Commodity	2011-12	2012-13	2013-14	2014-15	2015-16
Liquid Cargo	1.4	1.0	0.9	1.1	1.06
Iron Ore Including Pallet	29.4	7.4	0.3	0.8	3.96
Fertilizer	0.1	0.08	0.2	0.2	0.22
Thermal Coal	1.2	0.77	0.0	1.9	3.73
Coking Coal	5.7	6.61	7.5	6.6	7.81
Coke	0.4	0.43	0.3	0.7	0.74
Container	0.2	0.21	0.2	0.2	0.35
Steel	0.5	0.8	1.3	1.7	0.84
Other	0.2	0.34	1.1	1.4	2.07
Total	**39.0**	**17.6**	**11.7**	**14.7**	**20.78**

4.2 BCG Benchmarking Study

BCG, as part of their benchmarking study, has looked into the operation of the berths and has suggested various measures for improving the performance. The report of BCG pertaining to Mormugao Port is given in the **Appendix 1**. The key observations and relevant details for the port master planning are as follows:

4.2.1 SWPL (JSW) Terminal (Berth 6)

The port has planned for deepening of the channel to a level of -19.8 m CD along the approach channel, turning circle, JSW terminal and to a level of -16.5 m CD at Adani terminal. It was suggested that upgradation of the terminal infrastructure should also take place for handling cape size vessels so that current throughput could be increased.

4.2.2 General Cargo Berths 10 & 11

According to BCG, General Cargo berths 10 & 11 are having high berth occupancy and also they are being operated at low productivity. Additionally, evacuation is also seen as a major constraint. The following are the initiatives suggested by BCG:

- Minimising the loss of time during the shift change by way of implementing hot seat change, bookings through hand held devices etc.
- Performance improvement of HMC operators by way of training.
- Deployment of an additional HMC at the berths.
- Improvement of gate process is required through automation and process simplification for greater throughput.

4.3 Capacity Assessment of Existing Facilities

4.3.1 General

The cargo handling capacity of port is based on many factors like the vessel size, fleet mix, equipment provided, possible handling rates, time required for peripheral activities, capacity of stackyard, number of users, grades, capacity of evacuation system etc.

Another factor that is important while arriving at the berth capacity is the allowable berth occupancy which is expressed as the ratio of the total number of days per year that a berth is occupied by a vessel (including the time spent in peripheral activities) to the number of port operational days in a year. High levels of berth occupancy will result in bunching of ships resulting in undesirable pre-berthing detention. For limited number of berths and with random arrival of ships, the berth occupancy levels have to be kept low to reduce this detention. The norms generally followed for planning the number of berths in modern port to minimise the pre-berthing detention are given in **Table 4.2**.

Table 4.2 Recommended Berth Occupancy

No. of Berths	Recommended Berth Occupancy Factor
1	60%
2	65%
3 & above	70%

The capacity of existing berths/terminals is calculated assuming the type of cargo being currently handled at these berths and the corresponding parcel sizes.

4.3.2 Coal Berths

<u>4.3.2.1 Berth 6</u>

Berth 6 is equipped with three mobile harbour cranes with connected hoppers. The coal unloaded from ship is discharged to the mobile hoppers with connected conveyor system, which takes the coal to stackyard.

It is understood that while this berth substructure can cater to the higher dredged levels and the cape size ships, the existing equipment is not suitable for unloading the capesize ships. Significant modifications to the berth superstructure would be needed for either installing the ship unloaders or providing high capacity mobile harbour cranes.

This berth handles coking coal, lime stone, met coke, steam coal etc. which are brought in different parcel sizes and therefore the handling rate is also different. The average productivity achieved at this berth is in the range of 25,000 TPD only, which is on a lower side considering the fully mechanised system and handymax to panamax size ships calling at the berth. The capacity and cycle time of existing mobile harbour cranes appear to the reason for low handling rate. Considering optimal berth occupancy of only 70% for this captive berth, the annual capacity works out to only 6.2 MTPA, against which it handled over 8 MT during last year but at very high berth occupancy, which resulted in significant waiting time of ships. For increasing the berth productivity, there is an urgent need for the upgradation of handling system not only for increasing the handling rate but also to be able to cater to the cape size ships.

<u>4.3.2.2 Berth 7</u>

Berth 7 is equipped with two mobile harbour cranes, which are of much higher capacity as compared to the mobile harbour cranes provided at berth 6. This berth is highly underutilised and handled only 0.86 MT of cargo last year. The average parcel size of ships handled was also low at about 40,000 T and therefore the productivity achieved was about 25,000 TPD as against an average of about 35,000 TPD that could have been achieved at this berth based on the equipment provided. Based on the equipment, the capacity of this berth is calculated as about 8.5 MTPA, at berth occupancy of about 70%. The effective stackyard area for the berth 7 is only about 45,000 m^2. Based on the stacking arrangement at the yards, it is observed that about 0.2 MT of coal could only be stacked. To match the berth capacity output the coal stored would need to have a turnover ratio of 48 (i.e. dwell time of 7 days), which is very high meaning that the stackyard area would remain a key constraint to the capacity of the terminal.

4.3.3 Berth 8 (Liquid Cargo)

Berth 8 handles various liquid cargoes like Caustic Soda, Furnace Oil, H.S.D., Liquid Ammonia, motor spirit, palm oil etc. These products are received in smaller tankers carrying low parcel size. The unloading rate is governed by on board ship pumps and is relatively very low. The average productivity achieved at this berth is about 9,000 TPD only. The capacity of this berth is calculated as about 2.2 MTPA at berth occupancy of about 70%.

4.3.4 Breakbulk Cargo

4.3.4.1 Berth 5

Berth 5 mainly handles captive cargo of JSW comprising of steel products using the mobile harbour cranes or ship's gears (when the mobile harbour cranes are deployed on berth 6). The cargo comprises of Steel Coils (Cold Rolled), G. I. Coils, HR Sheets, HR Steel Coils (Hot Rolled), Steel Bar Rods, Steel Plates and Sheets, Steel Slabs and Steel Coils (Wire Rolled). It is observed that an average productivity achieved is about 7,000 TPD, which seems broadly in order considering the diverse nature of products handled. Accordingly, the capacity of this berth is assessed as about 1.7 MTPA at allowable berth occupancy of 70%.

However, it may be noted that consequent to the deepening of the channel and the berthing areas, capesize vessels would be able to call at the port. This would mean that berth 5 and 6, which have a total berth length of 450 m would be able to handle one cape size ship only. This would affect the availability of berth 5 resulting in low throughput.

4.3.4.2 Berths 10 and 11

Table 4.3 illustrates the quantity handled by multipurpose berths 10 and 11 and their performance.

Table 4.3 Performance of Multipurpose Berths 10 and 11

Cargo	Working Time at Berth (Hrs)	Total Cargo Handled (T)	Productivity (TPD)
Granite Blocks	1,873	2,07,784	2,218
Alumina	344	21,000	1,220
Containers (Import / Export)	1,499	2,62,677	3,505
Steel Products	2,784	6,51,433	4,680
Iron Ore Lumpy	166	80,065	9,646
Iron Ore Pellets	79	49,158	12,393
Liquid Cargo (Aviation Oil + HSD + Furnace Oil+ LSHF + Kerosene Oil + Phosphoric Acid)	1,008	5,55,100	11,012
Machinery, Spares, Accessories & Appliance	5	80	331
Muriate of Potash	1,127	2,24,900	3,992

Cargo	Working Time at Berth (Hrs)	Total Cargo Handled (T)	Productivity (TPD)
Nickel & Nickel Products	173	14,021	1,623
Sugar	100	35,513	7,085
Urea	151	12,902	1,715
Wood (Logs, Timber, Bamboos, etc.)	1,876	4,19,633	4,475
Bauxite	157	1,08,500	13,800
Grand Total	**11,342**	**26,42,766**	

Berths 10 and 11, though named separately, form a single quay and even three small ships could be handled simultaneously. It could be seen that currently the average productivity at these berths is about 4,700 TPD. These berths are deployed with only one mobile harbour crane and therefore most of the cargo is handled using the ship's gear. Basis above the current total capacity of these two berths is only about 2.3 MTPA at 70% occupancy.

The capacity of any multipurpose berth depends upon the type of cargo handled, vessel parcel size, mode of handling, capacity of equipment deployed, speed of evacuation and so on. The type of cargo handled at these berths is highly variable in terms of density, mode of handling (grab, hook etc.) and therefore the handling rate achieved would significantly vary from cargo to cargo.

In order to improve the productivity and hence the berth capacity additional equipment needs to be deployed. In addition any hindrances to the traffic movement from berth to yard and vice versa need to be removed.

Deployment of mobile harbour cranes and effective operations is constraint in part of the berth 10 due to the presence of shed T2. It is suggested that the cargo like granite, machinery etc. that are brought in smaller parcel sizes should be handled at berth 10 using ships gears. The annual capacity of this berth could then be taken as about 1.0 MTPA considering average productivity of about 4,000 TPD for handling such cargo. However, in the eventuality other cargo may also be handled at this berth as per requirements.

The quay on the berth 11 side should be prioritised for handling of bulk and other breakbulk cargo like alumina, wooden chips, iron ore lump etc. using the mobile harbour cranes. The existing mobile harbour crane needs to be augmented with another one so that the two cranes together can effectively unload ship for faster turnaround time. Matching equipment for transfer of cargo between yard and berth would also need to be provided. This would enable higher productivity at this berth and capacity of the single berth itself could go upto 2.5 MTPA considering average productivity of about 10,000 TPD. Therefore the overall capacity of berths 10 and 11 at 70% occupancy works out to about 3.0 to 3.5 MTPA.

5.0 DETAILS OF ONGOING DEVELOPMENTS

5.1 Construction of 4 Lane Road from Verna Junction on NH-17 to the Port

The Tripartite Agreement between National Highway Authority of India (NHAI), Murmugao Port Trust (MPT) and Govt. of Goa (GoG) has been signed on 02.11.2014. The subject work is to be executed by GoG as per the directives of the Hon'ble Supreme Court. The GoG had appointed M/s. S.N. Bhobe & Associates, Mumbai as consultant for preparation of project reports, designs, drawings & estimates etc. for the work.

Figure 5.1 4 Lane Road to Varunapuri Junction to the Port

As per the Tripartite Agreement, a new 4 lane road is proposed to be constructed from Varunapuri Junction at chainage 13+100 to the Port. It has partial elevated section and partial at-grade section from Varunapuri junction and continues at grade till chainage 14+080. After this, it is elevated and near Rabindra Bhawan it is split into two arms. One arm takes eastern direction after crossing ROB passes through the existing temporary shed after which it comes at grade level. The other arm goes straight and comes down at grade after traversing a length of about 650 m and ends at Desterro. Then it continues further at grade and reaches at SADA junction. In addition, two ramps have been proposed connecting the arm leading to the port.

5.2 Augmentation of Railway Network

In order to cater to the increased traffic due to various projects like Development of Berth 7, Berth 11 and west of breakwater, the rail cargo handling capacity was augmented by providing additional lines. The work of laying of additional tracks has been completed in July 2014. Construction of the Signalling building is in progress and will be completed in September 2016. Tendering work for Signalling and Telecommunication of Railway yard is in progress.

There is a proposal to provide additional rail lines 7, 8 over and above the existing lines 1 to 6 and also provide 30 m paved area along the additional lines for storing the rail bound cargo.

5.3 Deepening of Approach Channel for Capesize Vessels at Mormugao Port

Mormugao Port has taken up the work to deepen the existing channel to facilitate handling of cape size vessels under annuity model. The work is to deepen the outer channel from -14.4 m to -19.8 m CD and inner turning circle from -14.1 m to -19.5 m CD. The work has already been awarded to Dredging Corporation of India (DCI).

5.4 Redevelopment of Berths 8, 9 & Barge Berths

Mormugao Port has already taken up the redevelopment of berths 8, 9 and barge berths to create facilities for coal and breakbulk handling. This would require shifting of the liquid handling at some other location or new berth would need to be developed. The work has already been awarded to Vedanta.

6.0 TRAFFIC PROJECTIONS

6.1 General

The port of Mormugao currently handled roughly 14.7 MTPA of cargo, in the year 2014-2015, catering primarily to the hinterlands of South Maharashtra, Northern Karnataka and Goa. One of the major bottlenecks hindering the growth of the port is the lack of good connectivity due to the Western Ghats. The port used to be the largest gateways of Iron Ore from the country which was largest export from the port but with the mining ban and Brazil taking over the China market for the supply of ore, the volumes at the port have gone down drastically.

The origin-destination of key cargo (accounting for greater than 85% of the total traffic) for all Indian ports and development of traffic scenarios for a period of next 20 years has been carried out by **McKinsey & Co.** as mandated for this project. Accordingly, based on a macro-level analysis the future traffic for Mormugao up to 2035 has be derived as presented in this section.

6.2 Major Commodities and their Projections

6.2.1 Coking Coal

The port currently imports 6.6 MTPA of coking coal from Australia and South Africa. This coking coal is primarily used by Steel plants in the vicinity of the port; JSW Vijaynagar consumes nearly 5 MTPA and JSW Dolvi consumers the remaining 1.6 MTPA.

Going into the future the volumes of steel handled at the port is expected to grow with the steel multiplier relative to the GDP. The overall traffic of coking coal is expected to grow to 14 MTPA by 2020, 19-21 MTPA by 2025 and 34-40 MTPA by 2035.

6.2.2 Thermal Coal

The port currently imports 1.9 MTPA of coal primarily for non-thermal power plant purposes. Going into the future the demand is expected to grow to roughly 2.6 MTPA by 2020, 3.5 MTPA by 2025 and 5-6 MTPA by 2035.

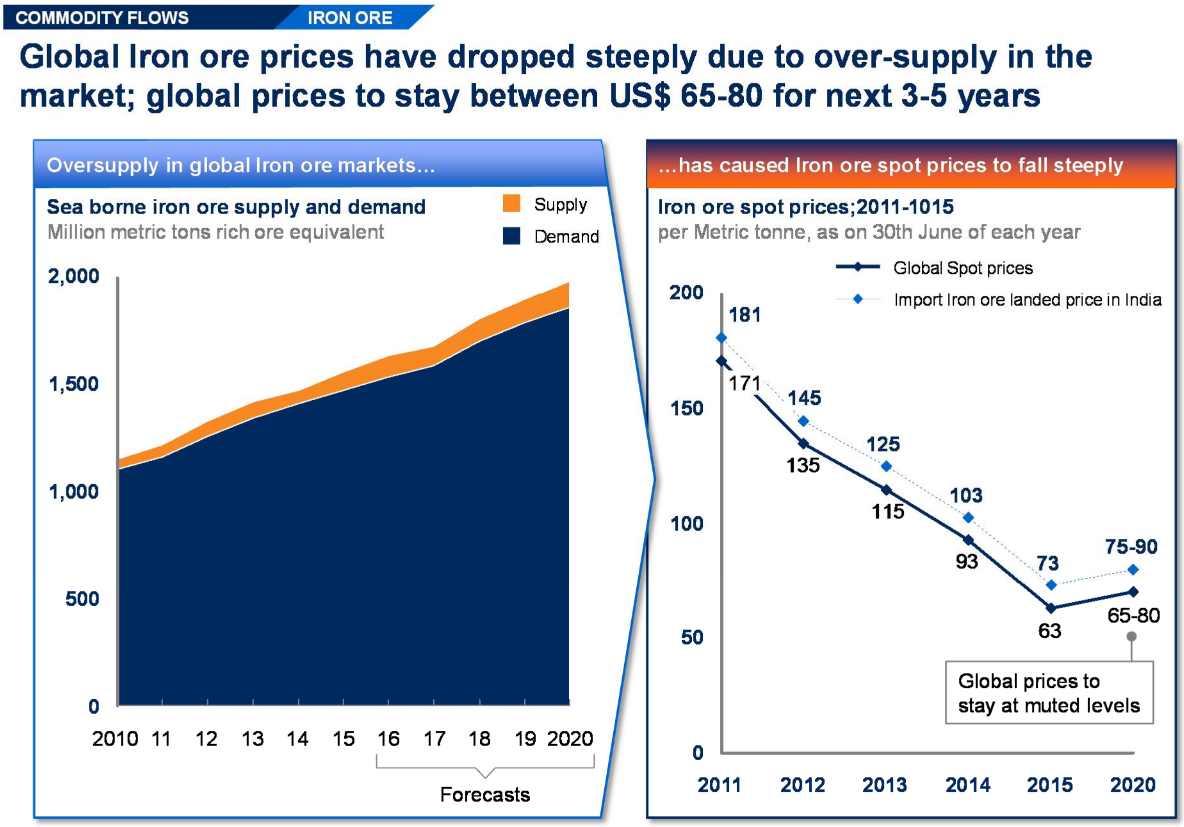
6.2.3 Steel

Being close to key JSW steel plants, the port is an ideal location to export finished steel products from these plants both coastal and to locations outside India. The port exports ~1 MTPA HR Steel Coils from the nearby plants, going into the future with natural steel multiplier growth we expect the volumes of exports to grow up to 2.4 MTPA by 2020, 3-4 MTPA by 2025 and 6-7 MTPA by 2035.

6.2.4 Iron Ore

During the peak of Iron ore exports from the country prior to the ban on mining in Goa the Mormugao port used to export around 41 MTPA of Iron Ore (2010-11), in the last few years the volumes have gone down significantly and now the port only exports ~0.6 MTPA.

Even after lifting of the ban the high landed price of Iron Ore from India has led to sluggish growth rather as Brazil has taken up a major chunk of the markets and the global prices has fallen down to as low as USD 45 / T owing to oversupply of ore in the market as shown in **Figure 6.1**.



SOURCE: World steel association; expert interviews; Bloomberg

Figure 6.1 Trend of Iron Ore Prices

Unless the market rates pick up it is expected the volumes of the ore exported from the port to be muted at below 18 MTPA till 2035. If the prices pick up only then one can expect to see traffic of ~50 MTPA by 2035.

6.2.5 Additional Potential

There is an additional potential of handling ~11 MTPA by 2025 once the Betul port takes off. The traffic projections for 2025 include commodities like wood chips, gypsum, bauxite, granite, steel coil, LPG, edible oil, cement and sand.

6.2.6 Overall Traffic Projections

The overall commodity wise projections for the port (including those expected to be handled at Betul port) are shown below in **Table 6.1**:

Table 6.1 Traffic Projection for Mormugao Port

Units: MMTPA (except Containers)

Mormugao Port - Traffic Projections

xx Base Scenario xx Optimistic Scenario

Commodity	2014-15	2020	2025		2035		Remarks
Liquid Cargo							
POL product	0.6	1.0	1.5	1.8	2.2	2.7	Some part of crude might be imported if a green-field mega refinery comes up in southern Maharashtra- the impact of the same has not been taken in traffic projections
Chemicals	0.5	0.7	0.8	1.0	1.3	1.9	
Dry and Break Bulk Cargo							
Thermal Coal (Loading)	0.0	0.0	0.0	0.0	0.0	0.0	
Thermal Coal (Unloading)	1.9	2.6	3.4	3.6	5.7	6.4	▪ Overseas imports likely to decline; may attract ~14 MT from Belekeri
Coking Coal	6.6	14	19	21	34	40	
Coke	0.7	1.0	1.3	1.4	2.4	2.8	
Iron Ore	0.8	8	11	35	18	50	▪ Exports; includes pellets; Optimistic case is related to volumes handled before ban
Steel	1.7	2.4	3.3	3.5	5.8	6.7	
Fertilizers	0.2	0.5	0.7	0.7	1.0	1.1	
Containers and other Cargo							
Containers (MnTEU)	0.02	0.04	0.10	0.13	0.15	0.18	
Others	1.4	2.4	3.1	3.3	5.2	5.9	▪ Highly fragmented
Others (once Betul port takes off)	NA	9.0	10.0	12.0	16.6	21.5	▪ Major commodities: woodchips, gypsum, bauxite, granite, steel coil, LPG, Edible oil, cement and sand
Total (MMTPA)	**14.7**	**42.1**	**55.35**	**84.9**	**94.1**	**141.3**	

Conversion Factor Used for Containers Projections: 1 TEU = 12.5 Tons

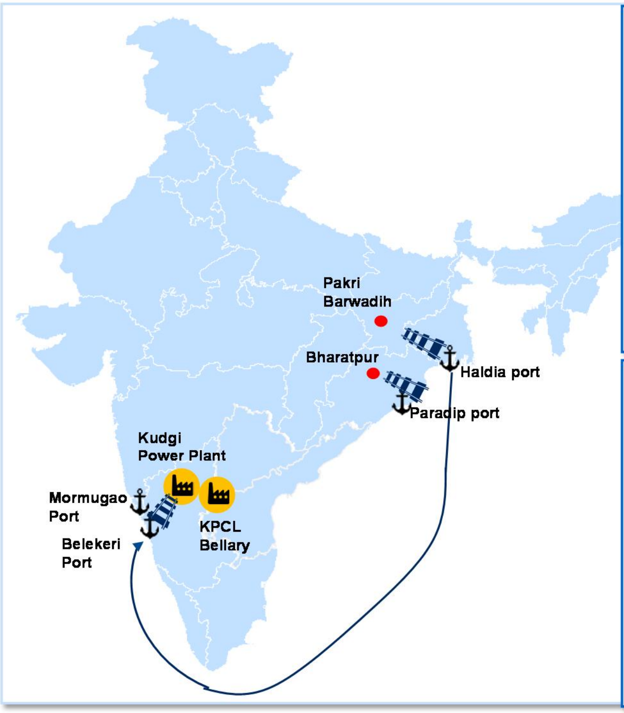
6.3 Coastal Shipping Potential

Apart from the above mentioned traffic, there is additional opportunity of coastal shipping that can be potentially tapped. Thermal coal can form the significant share in coastal shipping while small volumes of other commodities like steel can be moved coastally.

- **Thermal coal:** Coal can prove to be a major commodity which can be coastally shipped to the port of Mormugao. The plants of NTPC Kudgi and KPCL Bellary can shift to coastal shipping and receive their coal from the Mormugao port, if Belekeri port doesn't come up in the near future.

COMMODITY TRAFFIC | COAL

~11 MTPA Coal can be moved from Pakri Barwadih to Kudgi[1] and ~2.4 MTPA from Bharatpur to Bellary via coastal shipping through Mormugao port



Pakri Barwadih to Kudgi (Optimimum route: 1)

S. No.	Route (Modal combination)	Distance Kms	Cost Rs/tonne
1	Road-Rail-Port-Road-Rail	3,833	2,883
2	Road-Rail	2,035	3,300

Bharatpur to Bellary (Optimimum route: 1)

S. No.	Route (Modal combination)	Distance Kms	Cost Rs/tonne
1	Rail-Port-Rail	3,308	2,250
2	Rail	1,435	2,298

1 Considering linkage rationalization from Pakri Barwadih to Talcher does not happen

Figure 6.2 Coastal Shipping Potential of Coal from Pakri Barwadih to Kudgi and Bharatpur to Bellary

The overall outlook of coastal shipping from Mormugao port is as shown in **Table 6.2**:

Table 6.2 Mormugao Port – New Opportunities Possible via Coastal Shipping

Mormugao Port – New Opportunities Possible via Coastal Shipping

Units: MMTPA (except Containers)

Commodity	2020	2025	2035
Thermal Coal (Unloading)	13.37	13.37	13.37
Steel (Loading)	0.49	0.65	1.17
Steel (Unloading)	0.67	0.89	1.59
Cement (Loading)	0.39	0.52	0.93
Cement (Unloading)	0.01	0.02	0.03
Fertilizer (Loading)	0.03	0.04	0.06
Fertilizer (Unloading)	0.06	0.07	0.10
Food Grains (Loading)	0.00	0.00	0.00
Food Grains (Unloading)	0.14	0.18	0.26

- Additional Coastal shipping Potential if Belekeri is not built and NTPC Kudgi I in Bijapur and KPCL Bellary adopt coastal shipping

7.0 CAPACITY AUGMENTATION R PROPOSALS

7.1 General

The capacity augmentation requirements shall be based on the difference between the projected traffic for the particular commodity and the capacity of the port available (after debottlenecking and physical improvements) for handling that particular commodity.

7.2 Summary of Debottlenecked Port Capacity

Based on the analysis of existing port infrastructure, the current capacity of the port is assessed as given in **Table 7.1**.

Table 7.1 Existing Port Capacity

Berths	Cargo Handled	Capacity (MTPA)
Breakbulk - Berth 5	Steel Products	1.7
Coal - Berth 6	Coking Coal	6.2
Coal - Berth 7	Thermal Coal	8.5
Liquid - Berth 8	Oil	2.2
General Cargo - Berths 10 and 11	Breakbulk, Containers	3.5
Iron Ore - Berth 9 and barge berths	Iron Ore	0
Total		**22.1**

[Note: The capacity of offshore mooring is not considered in the above and it is assumed that berth 9 and barge berths do not handle any cargo as they are in the process of redevelopment]

7.3 Requirement for Capacity Expansion

Even though prima facie it appears that the overall capacity is slightly more than the overall traffic, there is shortfall on facilities for handling specific cargo. There is also a need to improve the operational efficiency in cargo handling and storage by way of better circulation plan of traffic of breakbulk cargo.

The traffic projections indicate the significant capacity augmentation requirement for the coal unloading facilities over a period of time. Apart from that additional facilities would also be needed for steel cargo and other breakbulk cargo. The phase wise incremental facilities required are indicated in **Table 7.2**.

Table 7.2 Capacity Augmentation Required

Cargo Handled	I/E	Current Capacity (MTPA)	2020		2025		2035	
			Projected Traffic (MTPA)	Capacity Augmentation Required Over Current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation Required Over Current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation Required Over Current (MTPA)
Coal & Coke	I	14.7	17.6	2.9	23.7	9.0	42.1	27.4
Breakbulk and Container	I/E	5.2	5.8	0.6	8.4	3.2	13.9	8.7
Iron Ore	E	0.0	8.0	8.0	11.0	11.0	18.0	18.0
Crude/ POL	I	2.2	1.7	0.0	2.3	0.1	3.5	1.3
Total	**I/E**	**22.1**	**33.1**	**11.5**	**45.4**	**23.3**	**77.5**	**55.4**

Notes:

1. The capacity of offshore mooring is not considered in the above table

2. If additional cargo projected on account of Betul shall be handled there only and not at Mormugao Harbour

It may be noted that with regard to the iron ore traffic, the current market outlook does not necessitate providing any additional facility for iron ore and the small projected throughput could be handled at the moorings. However, in an optimistic scenario, significant quantity of iron ore is expected to be handled at the port for which additional facilities would need to be created.

As per **Table 7.2** above, it could be seen that additional facilities for coal unloading, breakbulk cargo and containers are required to be augmented at the port in a phased manner.

7.4 Assessment of Rail Capacity

The traffic projections for any port are based on the unconstrained cargo flow in and out of the port. However, the actual cargo that could be handled at a port would be limited by least of the berth capacity, storage capacity and the evacuation capacity. In particular case of Mormugao port, it is assessed that capacity of rail evacuation may pose a constraint to cargo handling capacity of the port. The same is assessed as below:

Presently, the port is connected to Vasco da Gama yard with a double line leading from the yard of the Port to Vasco da Gama station. The length of this link is approximately 3 km. The existing yard at the port has 6 lines and handles approximately 10-11 rakes every day. There is a space available for the expansion of this yard by another 3 lines. With the addition of these 3 lines and a properly designed yard it should be in a position to send out 30 rakes per day.

A double line link between the port and Vasco da Gama yard is capable of carrying over 30 rakes for onward destinations. However, this can only happen if Vasco da Gama yard is remodelled i.e. expansion of the yard takes place. In other words, more full length lines would be required to be added. It is however noted that there is no space for expansion of the yard unless more land is acquired by the Indian Railways for the purpose. If the additional land is acquired for adding another 2 to 3 lines, it should be possible to cater to the outward traffic of 30 rakes, without which the capacity may be limited to about 15 rakes only. Vasco da Gama yard is sandwiched on both sides with heavily built up areas. Experience shows that acquisition of such areas for the projects of this type generally becomes a long drawn process.

Beyond Vasco da Gama the connectivity of Railways is only towards one direction as Vasco da Gama is a dead end. This connectivity is through a single line section for over 300 km. Even if we expand the yard, the single line section would pose to be a bottleneck. Railways doubling project was initiated a few years back, with railways sanctioning the grants for doubling the line from Goa to Hospet. The works from the port to Hospet at each intermediate station are at different stages of completion.

- The stretch between Hospet and Tinai Ghat (241 km) is under progress and expected to be complete by 2017.
- The stretch between Tinai Ghat and Castle Rock is 12.5 km long; survey work is under progress and forest land to be transferred to railway. It is expected to be complete by 2019.
- The stretch between Castle Rock and Kulem (25 km) is one of the steepest gradients in the country making it technically challenging and is expected to complete by 2019.
- The stretch between Kulem and MPT is 58 km long. 10 ha. of land patches to be acquired however it is stalled from past 3 years due to constraints in land acquisition.

Doubling of the line has to be completed with last mile connectivity by 2019 in order to improve the port's evacuation capacity. Local government has to be pressurized from the centre for the completion of doubling of the line.

It should be noted that the stretch between Castle Rock and Kulem of about 25 km has the distinction of having the steepest gradient (1 in 37) encountered anywhere on the Indian Railway system. It is understood that 5 locos have to be attached to the rake passing through this section. This significantly reduces the line capacity and it is assessed that even after doubling the capacity of this stretch shall be limited to 25 to 30 rakes only. Considering that this stretch passes from ecologically sensitive area involving Wild Life Sanctuary, tripling of the line is unlikely.

Therefore the rail evacuation capacity from the port is likely to be limited to 30 rakes each way only even after completion of the proposed projects.

7.5 Redevelopment of Berths 8, 9 and Barge Berths into Multipurpose Terminal

Berth 8 is currently handling liquid cargo and berth 9 has a mechanised iron ore export system, which is lying ideal. It is proposed that the liquid traffic be shifted from berth 8 either to offshore moorings or to a new berth located east of berths 10 and 11. The combined berths 8, 9 and full/part of barge berths could provide a continuous quay length.

It also needs to be ensured that the berth is contiguous to the backup area for optimal utilisation and the structural arrangement would need to be devised accordingly. One of the possible options is to provide a frontage with the touch piles to act as an earth retaining structure and the same shall be anchored by rows of piles in the rear. This scheme would necessitate shifting of berthing line to the front by about 5 m. The exact details could be worked out during detailed engineering stage.

The possible alternative schemes of redevelopment are shown below:

7.5.1 Scheme 1

In this scheme, a continuous quay is built utilising the entire face of the berths 8, 9 and barge jetties. The total quay length that could be created in this scheme is about 1050 m. The backup area is created by means of filling behind the berth (**Figure 7.1**).

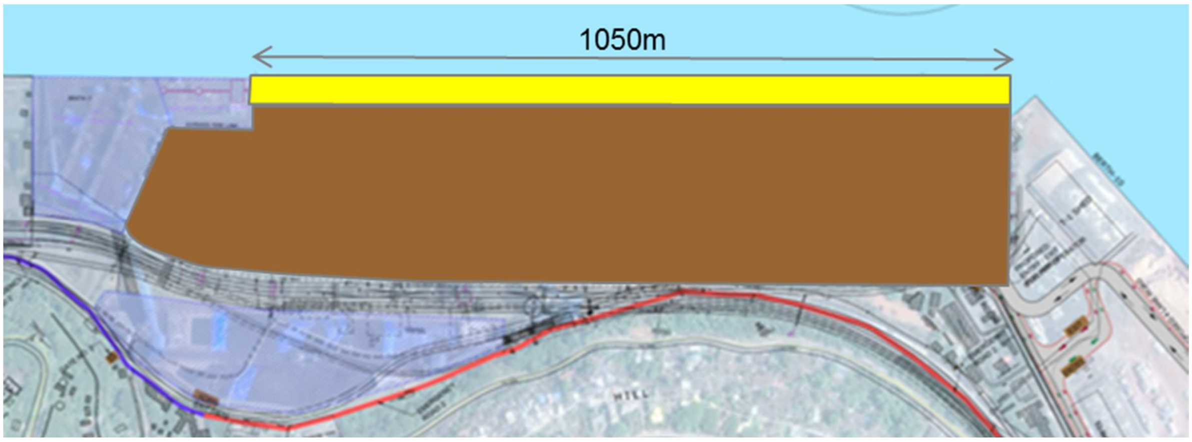


Figure 7.1 Scheme 1 - Revedelopement of Berth 8, 9 and Barge Berths

7.5.2 Scheme 2

In this scheme, a continuous quay is built utilising the entire face of the berths 8, 9 and only part of barge jetties. The total quay length that could be created in this scheme is about 850 m. This berth length is adequate to cater to one coal berth and two multipurpose berths (350 m + 250 m +250 m) Apart from that two barge jetties would be available i.e. one perpendicular to the face of the new quay and two on either side of the finger jetty. As in scheme 1 the backup area is created by means of filling behind the berth.

It is apparent that in scheme 2, there would be a benefit of having barge jetties that would enable handling of barges utilised in coastal movement or IWT. Apart from that one of the barge jetties could also be used for port crafts. The additional berth length of 200 m obtained in scheme 1 is not of much significance but that option can anyway be exercised later depending upon the performance of the barge jetties. It is therefore suggested to adopt scheme 2 for implementation.

It is proposed that 300 m length of the quay adjacent to berth 7 shall be installed with fully mechanised coal unloading system comprising of two gantry type ship unloaders and connecting single stream of conveyor. The existing stackyard of MOHP shall be utilised for stacking of coal using stackers. The coal shall be reclaimed from the stackyard using reclaimers and then loaded to wagons using in motion wagon loading system.

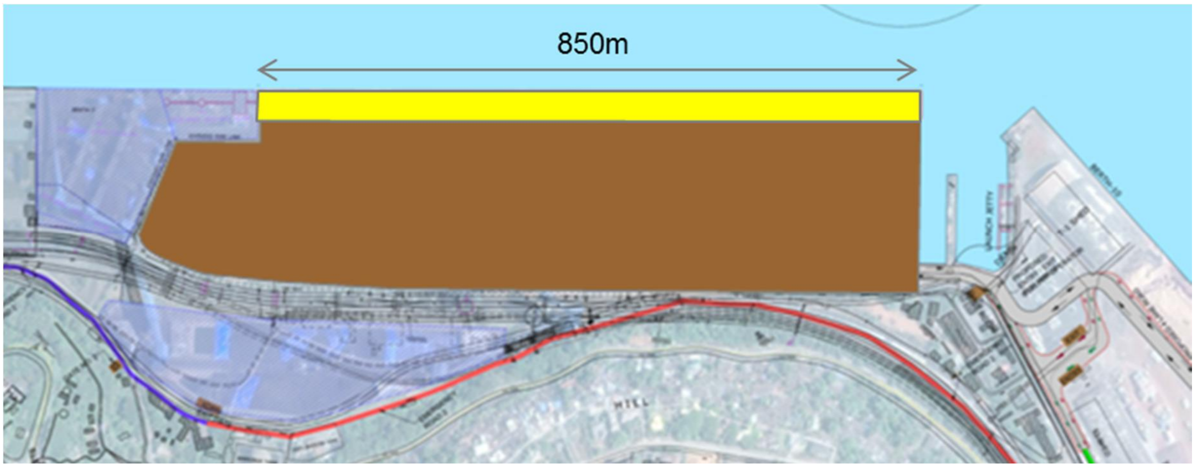


Figure 7.2 Scheme 2 – Redevelopement of Berth 8, 9 and Barge Berth

The remaining 500 m of berth length would be adequate for handling of breakbulk cargo. It is proposed to deploy two mobile harbour cranes on the south western part of the quay for handling the steel products and other heavy cargo. The cargo handling at the central berth is proposed utilising the ship's gears and therefore no specific equipment is planned. If the coal throughput picks up this berth could later be converted to an exclusive coal berth by installing a fully mechanised coal handling system. Similarly, in case, iron ore traffic picks up a mechanised iron ore loading system could be provided at one of these berths.

7.6 Finger Jetties at Vasco Bay for Liquid Cargo, Coastal, Passengers and Fishing

Due to the proposed redevelopment of the berth 8 for handling bulk and breakbulk cargo, it is required to build a liquid cargo handling berth. There is also a requirement to develop the coastal berth, passenger berth and the fishing jetties at the port. It is proposed to develop all these facilities towards the east side of berths 10 and 11.

The location and layout of the proposed facilities are shown in **Figure 7.3**.

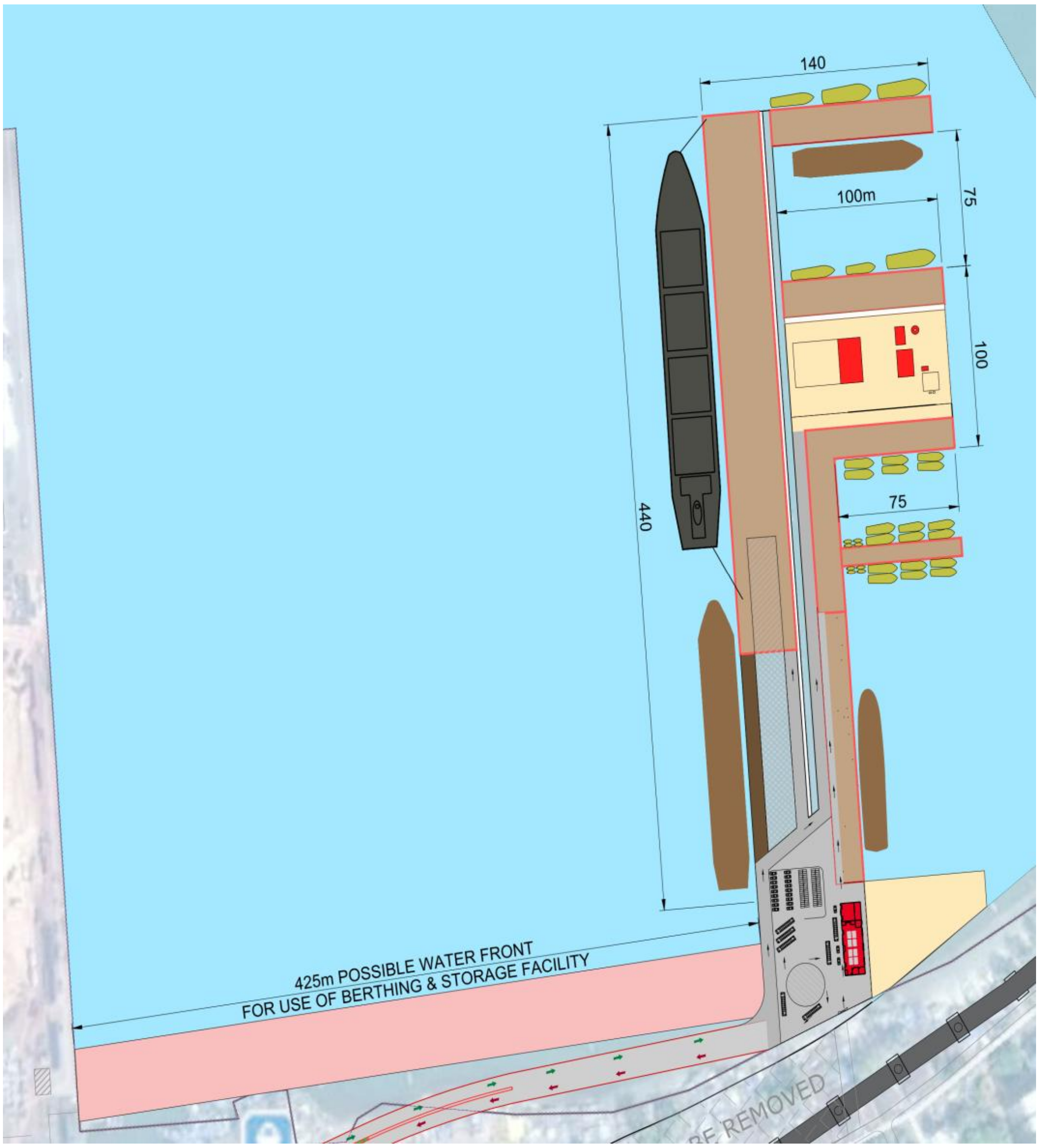


Figure 7.3 Proposed Layout of Liquid Jetty, Passenger Jetty, Fishing Jetty and Coastal Berth

Details of the proposed facilities are provided below:

1. The overall length of the cargo handling berth is proposed to be 440 m out of which northern side shall be used for handling liquid cargo and the southern side for coastal cargo. The total width of the berth/ backup area shall be 30 m beyond which a boundary wall of 3 m high shall be built to separate these berths from the facilities on the eastern side.

2. The eastern side would have a passenger terminal closer to the shore at an appropriate area. The berth face of 440 m can also be used for handling the large cruise ships. The passengers shall be transferred to this berth by buses after they have checked in at the terminal building located onshore. Adequate turning space shall be kept available at the liquid berth by suitable aligning the pipelines.

3. A fish landing centre on a platform of size 150 m × 100 m size shall be built, towards north of passenger jetty, to provide facilities such as net mending, net drying, auction hall, refrigeration etc. A total quay length of about 225 m shall be provided for fishing boats.

4. Towards north of fish landing centre with a total quay length of about 300 m shall be provided for berthing of the port crafts.

5. The entire construction shall be on piled foundation so that flow conditions in the bay are not affected and thus minimising any issues from fishermen, who would be relocated towards the eastern side.

6. A provision for the future berth, perpendicular to the southern end of berth 11, is kept to handle future traffic in terms of break bulk cargo. However, due to the limited backup area these berths would be suitable for handling liquid cargo or a limited amount of breakbulk cargo with deployment of suitable equipment for shifting the cargo to storage area located away from the berths.

The proposed arrangement is conceptual only and needs to be finalised after due discussions with the various stakeholders at the DPR stage.

7.7 Development of Two Berths with Connecting Flyover for Indian Navy and Coast Guard at Vasco Bay

It is proposed to provide dedicated berths for Navy and Coast Guard at north of Vasco Bay as shown in the **Figure 7.4**. The proposed facility shall have the total berth length of 700 m with reclamation of about 10 acres and these berths shall be dredged to -11.0 m CD. These berths shall be connected by an elevated roadway. These facilities shall be for exclusive use of the Navy and Coast Guard and not for EXIM cargo. However, these shall be constructed by MPT.

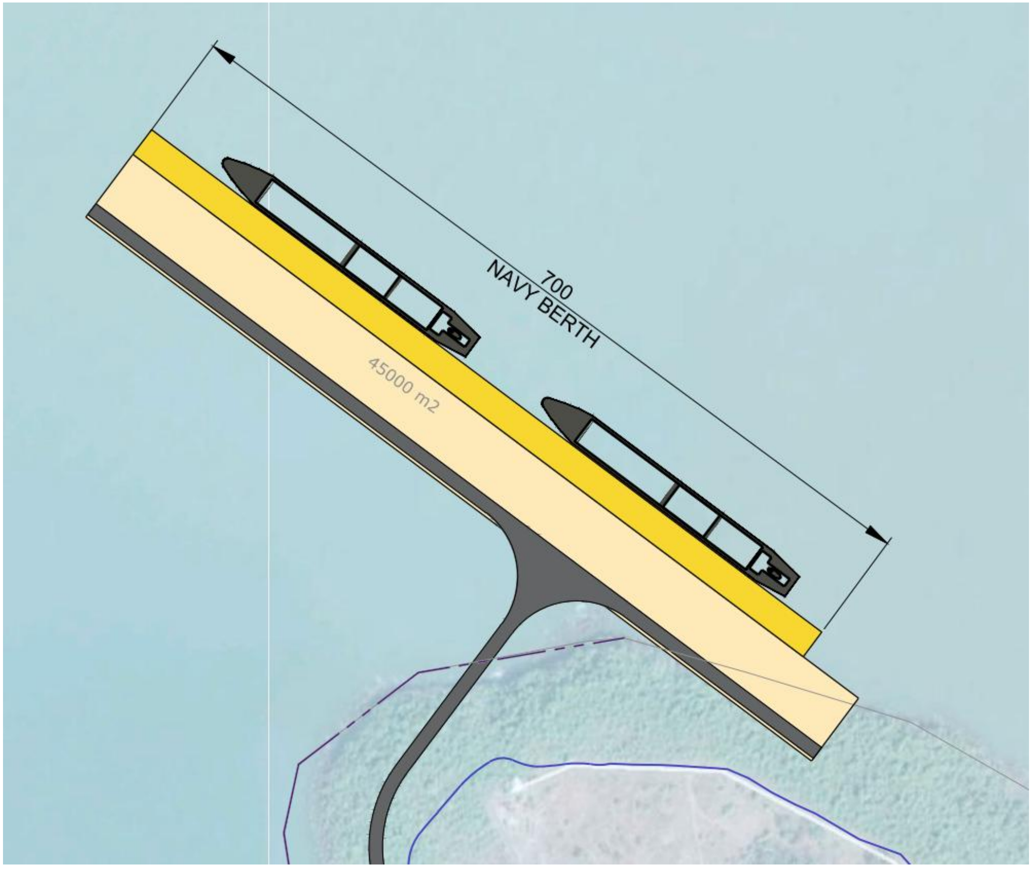


Figure 7.4 Dedicated Navy and Coast Guard Berth at Vasco Bay

7.8 Development of Workshop Area at Baina

The workshop area at Baina is lying unutilized and the possibility of developing it as CFS needs to be explored. Once the new PPP multipurpose berth becomes operational there will likely to be demand for a CFS.

7.9 Circulation Plan for Ease of Movement of Break Bulk Cargo

7.9.1 Traffic Circulation

It is proposed to segregate the vehicular traffic movement of the port. The present Gate no. 1 is proposed to be used by ADANI and JSW while the other traffic (from berths 10, 11, proposed PPP terminal) will use the new 4 lane flyover and new 4 lane road.

7.9.1.1 Traffic Circulation from Present / New Gate no. 9

A 4 lane highway with significant elevated portion has been planned for the faster evacuation of cargo. The landing point of that highway is at the end of temporary shed adjacent to shed 3 of the general cargo terminal i.e. berths 10 and 11. Therefore a proper traffic circulation planning is proposed so as to have entry-exit gates, weigh bridges at appropriate locations duly considering the existing sheds and current as well as proposed future operational areas.

It is understood that the rail sidings serving half rake at berths 10 and 11 shall be removed and the rail cargo shall be handled at the new sidings developed. Therefore it is proposed that the new 4 lane road at grade shall be taken around T3 shed and taken upto the location of existing road from gate no. 9 to provide new entry/ exit gates. Thereafter, the road shall be taken towards the proposed PPP terminal and in between a rotary shall be provided for entry/exit for berths 10, 11. Adequate queuing space shall be provided for the vehicles intended to use the weighing bridge / Container screening machine. Necessary slip / service road will be provided to have smooth traffic movement.

The overall road circulation plan for movement to berths 10, 11, new PPP terminal, liquid/ passenger/ coastal terminals is shown in **Figure 7.5**.

Figure 7.5 Overall Road Circulation Plan

This circulation plan would provide additional backup area for the berths 10 and 11. While it is proposed to retain the shed T1 and T3 initially, in the long run these old sheds would need to be dismantled and relocated so as to free up more storage area for the bulk and breakbulk cargo requiring open storage space.

One of the possible locations for locating these sheds is the IOC tankfarms lying contiguous to the southern boundary and store hazardous cargo. After the lease expiry, they can be relocated at Zuarinagar.

This would enable port getting the contiguous area for handling the bulk and breakbulk cargo at berths 10 and 11, which would improve the productivity and enable faster turnaround time of cargo.

7.9.1.2 Proposed Traffic Circulation from Present Gate No. 1

Presently, the Gate no. 1 is manually operated and need to be upgraded in future to handle more traffic.

Present road connecting Gates 1 and 2 needs to be upgraded for uniform configuration. The present road is of concrete pavement. It is proposed to maintain 12 m wide configuration throughout the length as shown in **Figure 7.6**. Further the traffic will use existing NH 17B till Sada junction before meeting with the new 4 lane road.

Figure 7.6 Traffic Circulation Plan from Gate 1

8.0 SCOPE FOR FUTURE CAPACITY EXPANSION

8.1 Outer Harbour for Iron Ore/ Coal Terminal

With the development of the proposed 8, 9 and barge berths as well as the new liquid and passenger jetty, the port facilities would be adequate to handle the projected traffic upto 2025.

In case the ban on iron ore is lifted and its traffic goes up as projected in optimistic scenario in **Table 6.1** additional iron ore export berth (apart from berth 9A being planned at present) would be needed. The ideal location for this could be in a harbour basin protected by a new breakwater towards the west side of the existing breakwater. The harbour would have deep water iron ore export berths apart from handling barge jetties for bringing iron ore through the IWT mode. The indicative layout of the iron ore terminal is shown in **Figure 8.1** below.

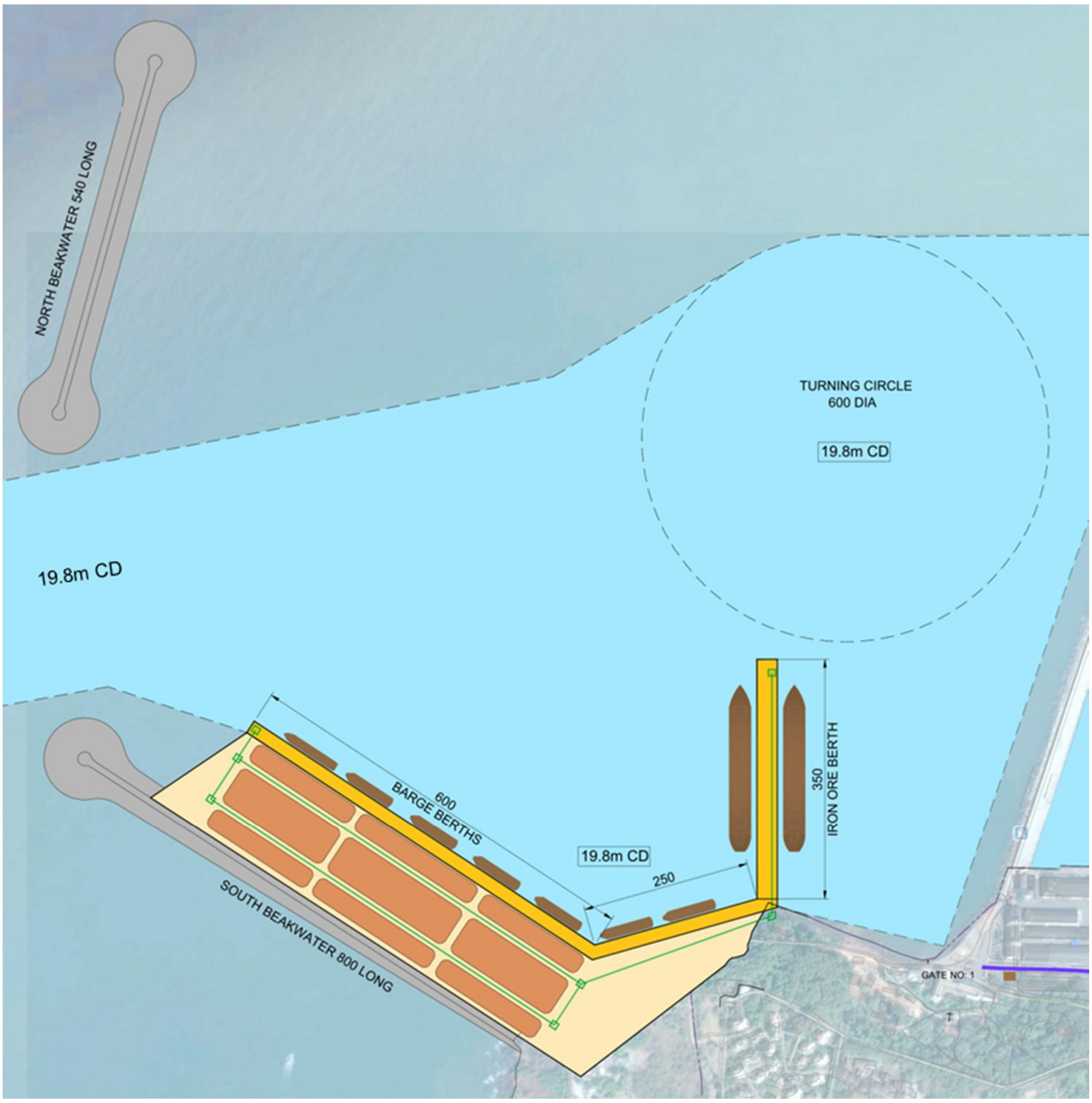


Figure 8.1 Proposed Layout of the Iron Ore Terminal

Similarly, there is requirement of significant capacity augmentation for coal unloading. The facility for the same could also be provided in outer harbour, though the layout could be slightly different as shown in **Figure 8.2** shown below:

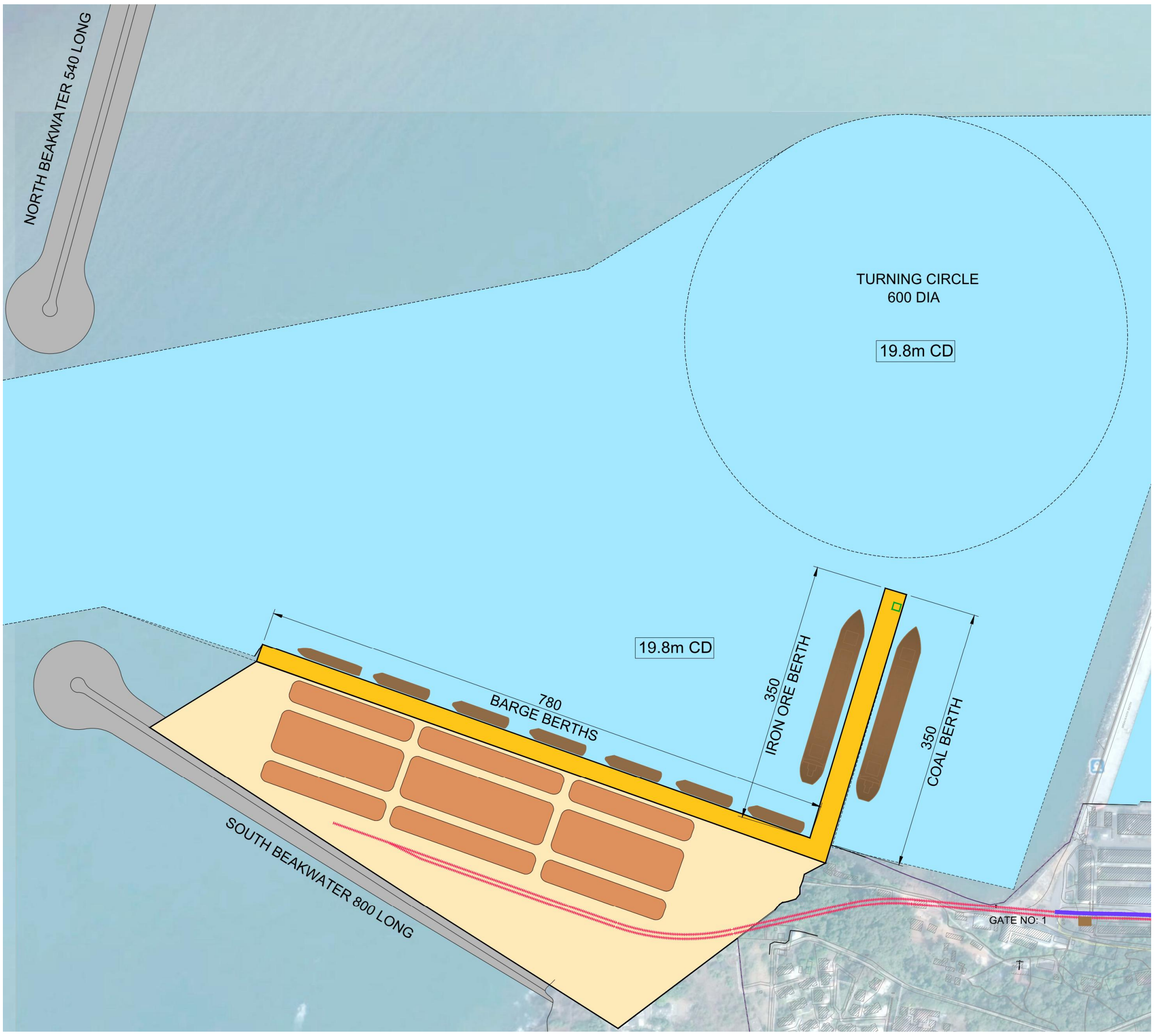


Figure 8.2 Coal / Iron Ore Handling at Outer Harbour

The exact layout of outer harbour shall however need to be worked out depending upon the specific requirement of cargo handling envisaged at the implementation phase and also the proper testing of the layout through mathematical model studies to assess its suitability and impact on the existing features.

8.2 Multipurpose Terminal at Betul

Bauxite mines are located at Betul about 35 km south of the Mormugao port. There are significant bauxite reserves at this location (over 200 MT). Therefore Mormugao Port can explore the possibility of developing a port at Betul for export of Bauxite. The port at this location can also be used for handling some quantity of iron ore brought by trucks.

The location plan of the proposed port site and the Bauxite mines is shown in **Figure 8.3** below.

Figure 8.3 Location of Project Site

This could either be a developed as a direct loading port for all weather or fair weather operations. Alternatively, a barge terminal could be planned at Betul for loading the mother ships inside the Mormugao harbour. The logistically most optimum solution could be worked out by a way of a detailed study.

However, at this initial stage without having any information on the exact site characteristics in terms of bathymetry and more particularly the rock levels and onshore area available for development, only initial alternative layouts have been developed to assess the magnitude of development. It is assessed that only one breakwater would be adequate to provide the tranquil operating conditions round the year.

- ***Alternative 1*** involves offshore harbour option where the harbour area is located away from the shore. This alternative involves longer time of construction and more cost for breakwater but less for dredging.

- ***Alternative 2*** is a coastal harbour option where the harbour area is located close to the shoreline. As compared to alternative 1, this layout involves high dredging and but requires smaller breakwater.

The indicative alternative layouts are shown in **Figure 8.4** and **Figure 8.5** respectively.

Figure 8.4 Betul Port Layout - Alternative 1

Figure 8.5 Betul Port Layout - Alternative 2

These layouts need to be refined during the DFR/DPR stage after completing the site surveys and investigations and mathematical model studies duly supported by the specific study on potential traffic that could be handled at this location.

9.0 SHELF OF NEW PROJECTS AND PHASING

As part of the Mormugao Port Master Plan several projects have been identified which need to be taken up in phased manner with the built up in traffic. The proposed phasing, capacity addition and the likely investments are discussed in paragraphs below.

It may be noted that apart from these projects there could be several other projects which port would be implementing as part of the routine operations and maintenance of the port facilities. Further the phasing proposed is not cast in stone but could be reviewed periodically and revised based on the economic scenario and demand for port at that particular point of time.

9.1 Ongoing Projects

The details of the projects which have already been awarded and development is ongoing are given below in **Table 9.1**

Table 9.1 Ongoing Projects

S. No.	Project Name	Investment Required (Cr)	Capacity Addition (MTPA)	Mode of Implementation
1.	Deepening of Approach Channel	193	2.0	Port's funds

9.2 Projects to be completed by Year 2020

The details of the projects which are envisaged to be completed by year 2020 are given below in **Table 9.2**

Table 9.2 Projects to be completed by Year 2020

S. No.	Project Name	Investment Required (Cr)	Capacity Addition (MTPA)	Mode of Implementation
1.	Road circulation plan for ease of movement of break bulk cargo	50	-	Port's funds
2.	Redevelopment of berths 8 and 9 – Coal Terminal	400	10.0	PPP
3.	Finger Jetty at Vasco Bay for Liquid Cargo, Passenger and Fishing	250	5.0	Port's funds
4.	Development of Two Berths with Connecting Flyover for Indian Navy and Coast Guard at Vasco Bay	500	-	Navy's funds
5.	Vasco Yard Expansion	25	-	Port's funds

The port layout after completion of ongoing projects shall be as shown in **Figure 9.1**.

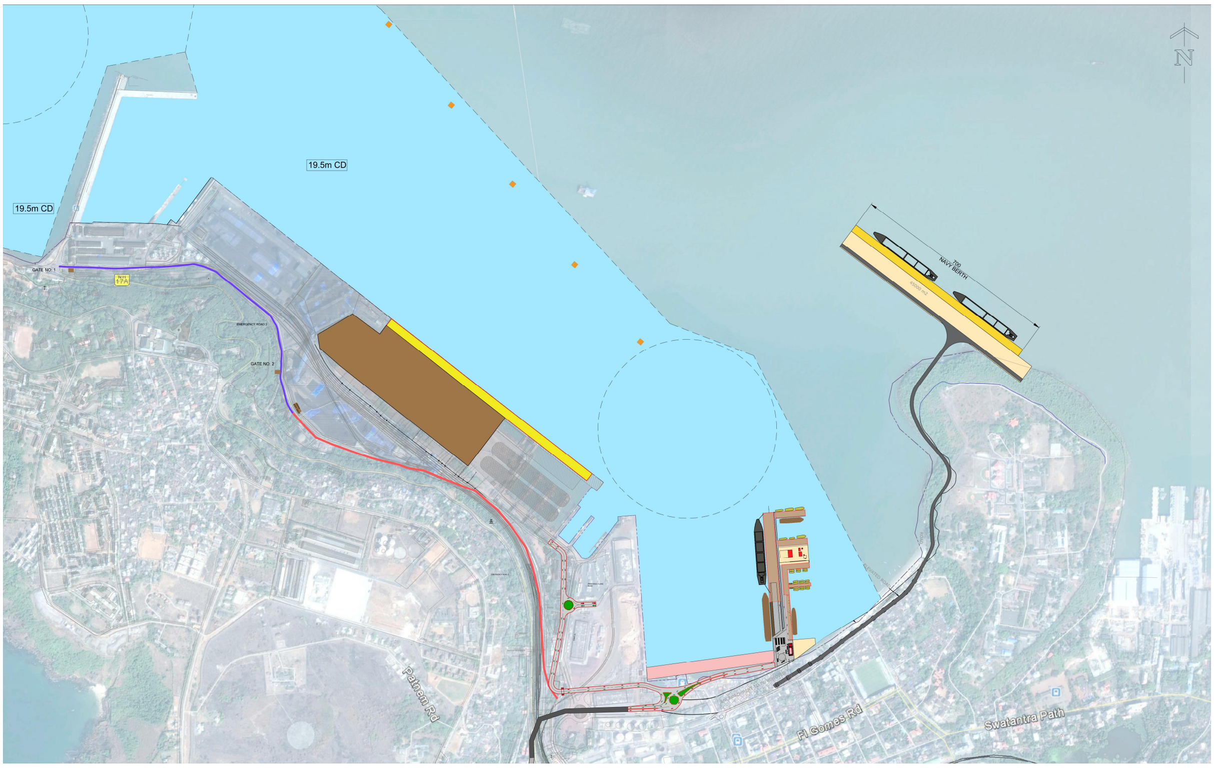


Figure 9.1 Layout Plan 2020

9.3 Projects to be completed by Year 2025

The details of the projects which are envisaged to be completed by year 2025 are given below in **Table 9.3**

Table 9.3 Projects to be completed by Year 2025

S. No.	Project Name	Investment Required (Cr)	Capacity Addition (MTPA)	Mode of Implementation
1.	Redevelopment of berths 8 and 9 - Ore and Multipurpose berths	685	15.0	PPP
2.	Multipurpose Terminal at Betul	1200	6.0	PPP

The port layout after completion of projects mentioned above shall be as shown in **Figure 9.2**.

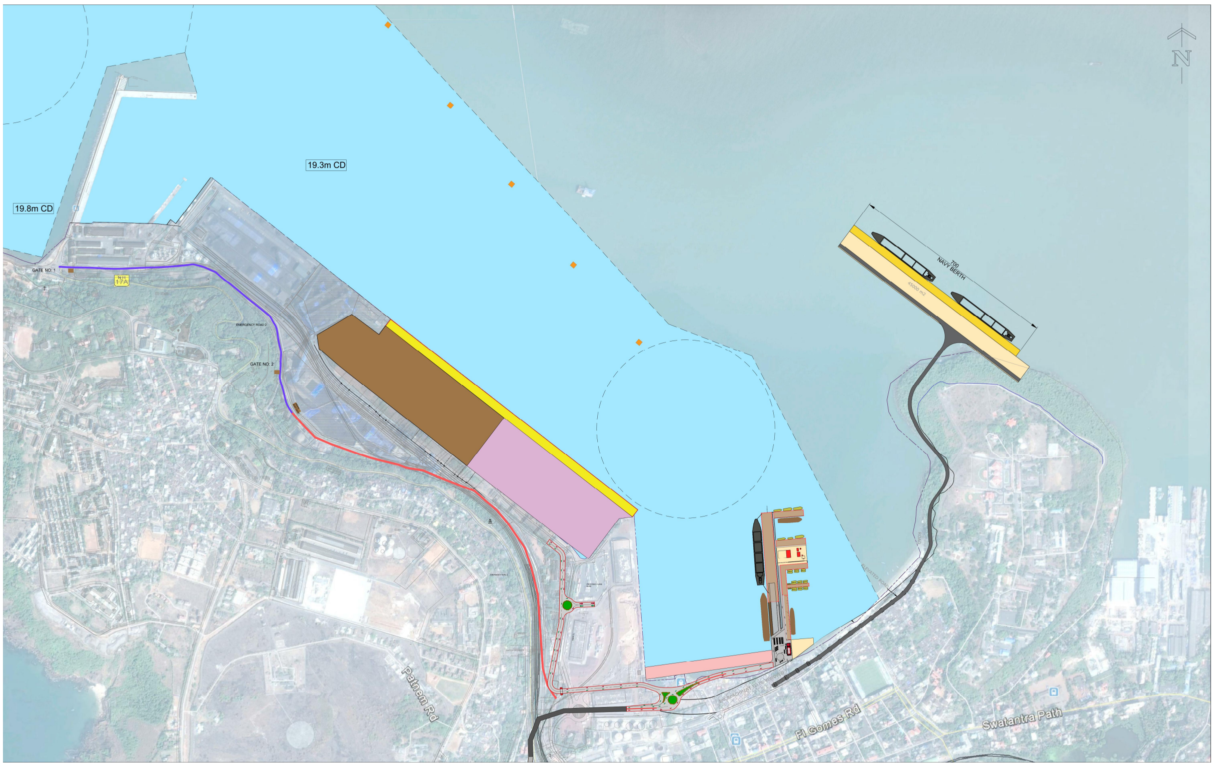


Figure 9.2 Layout Plan 2025

9.4 Projects to be completed by Year 2035

The details of the projects which are envisaged to be completed by year 2035 are given below in **Table 9.4**

Table 9.4 Projects to be completed by Year 2035

S. No.	Project Name	Investment Required (Cr)	Capacity Addition (MTPA)	Mode of Implementation
1.	Outer Harbour for Iron Ore/ Coal Terminal	1400	30	PPP

The port layout after completion of mentioned above shall be as shown in **Figure 9.3**.

Figure 9.3 Layout Plan 2035

Appendix 1 - **BCG Benchmarking Study for Mormugao Port**

11 Mormugao Port Deep-dive

11.1 Port overview

Mormugao Port Trust (MPT) is located on the western coast of India at Goa. It has 7 cargo handling berths, of which 3 are under private concession—2 berths on concession to JSW, and 1 berth on concession to Adani. The port operates 2 general cargo berths. Additionally, the port also has an MOHC berth used for handling iron ore, and a POL berth. Berth layout at MPT is given in the figure below.

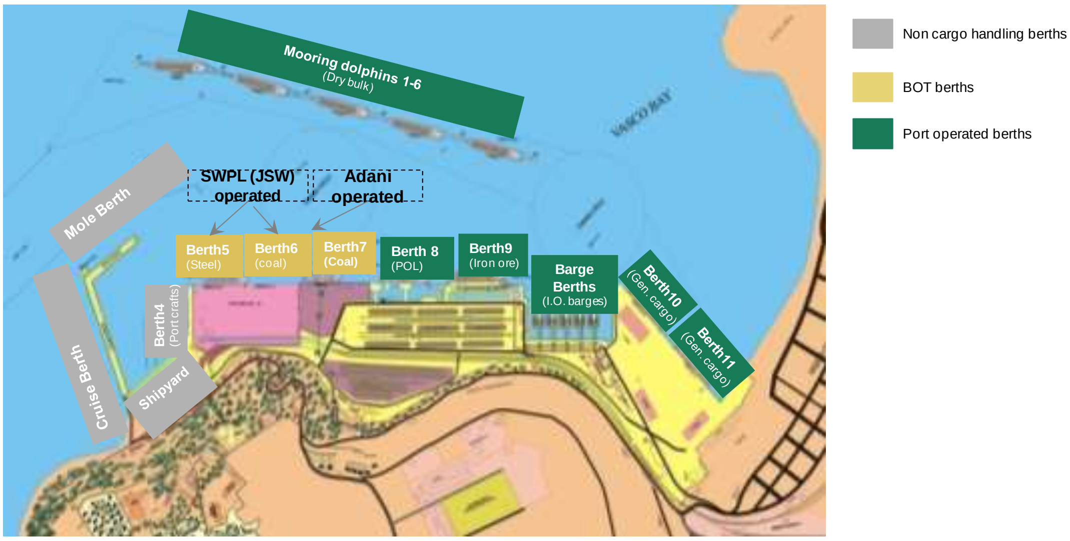


Figure 322: Layout of Mormugao port

Mormugao port has traditionally been one of the leading iron ore exporting ports of India. Due to the Supreme Court's ban on iron ore exports from Goa and subsequent restrictions on iron ore exports, the volumes handled by Mormugao have fallen sharply. As a result, the port has been making losses since the last 3 fiscal years. However, due to growth in other cargo volumes, there has been a slight recovery in margins last year.

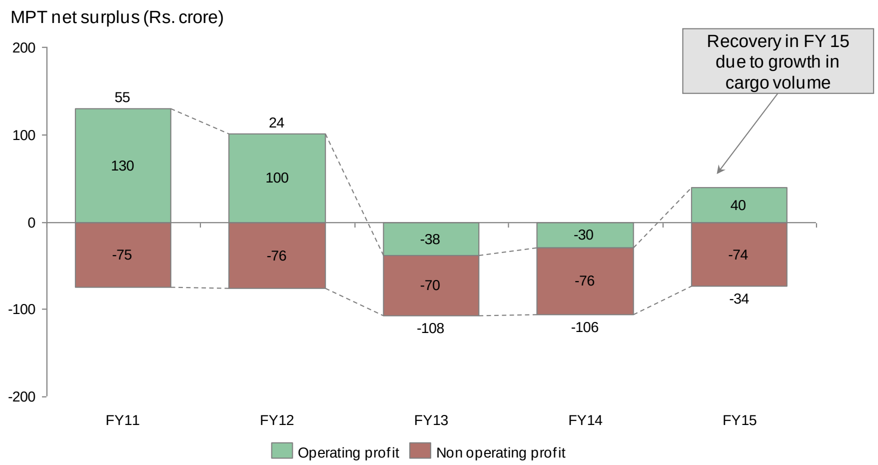


Figure 323: Operating and non-operating margin at Mormugao port

MPT has lost ~40 million tons of iron ore exports from FY11. The other commodities have witnessed 10% CAGR over the last 5 years—primarily driven by coal, HMC coils, granite blocks and woodchips.

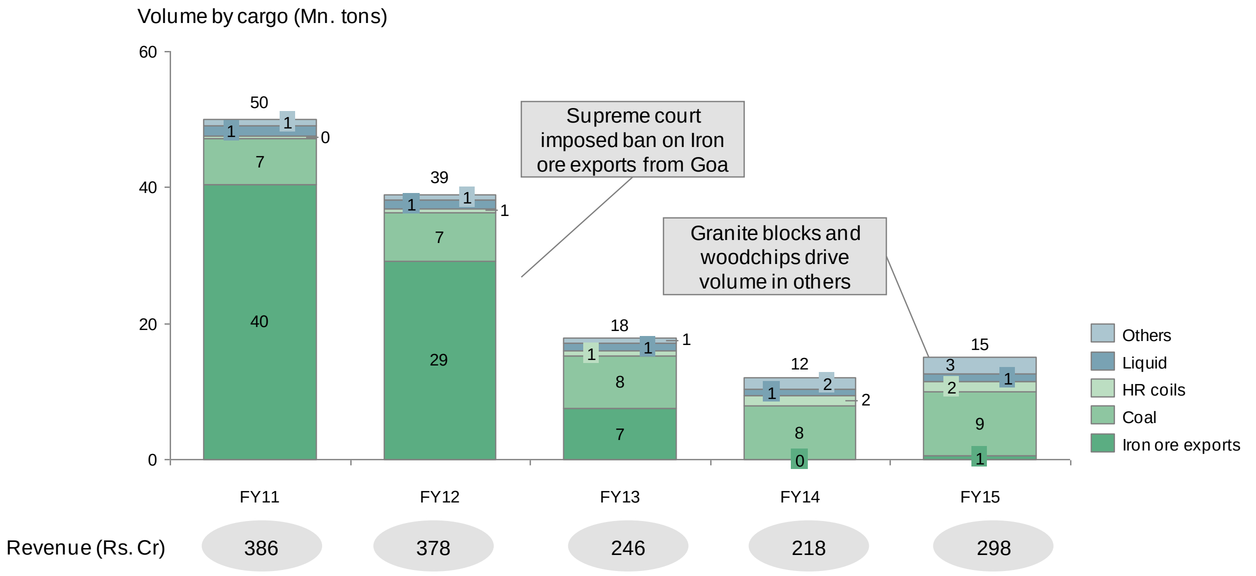


Figure 324: Volume split and revenue at Mormugao port

Expenses have remained stable in spite of drop in volumes. Salaries and pension costs account for ~60% of expenses, with salaries seeing a bump from 34% in 2011 to 40% in 2015.

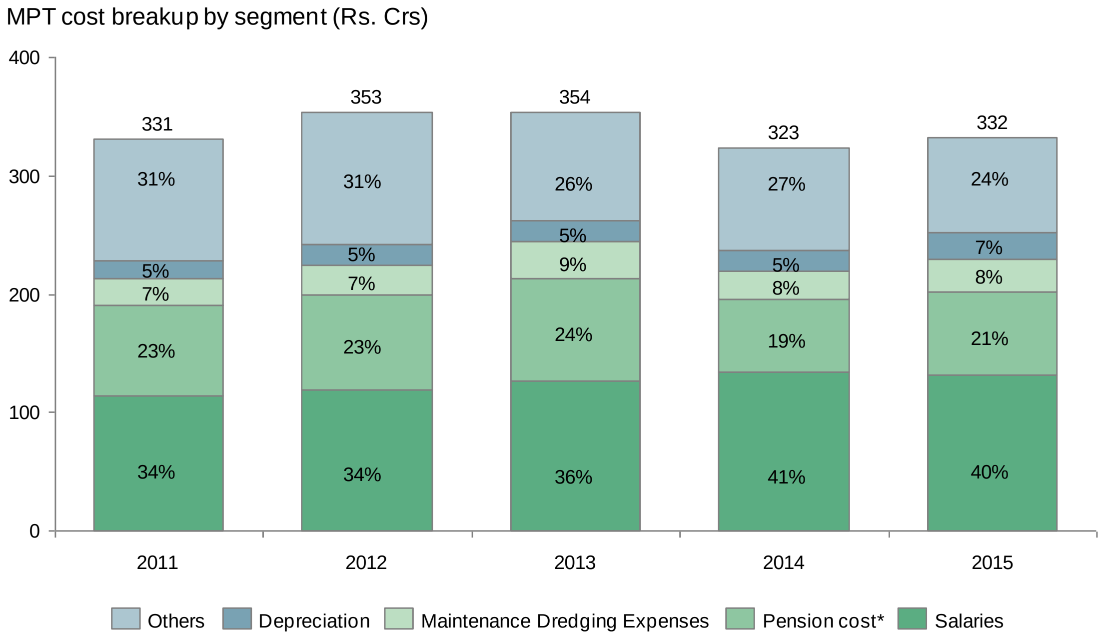


Figure 325: Cost break-up at Mormugao port

11.2 Key findings and initiatives from deep-dive

MPT has 7 cargo handling berths:

- SWPL (subsidiary of JSW) operates 2 berths (Berth 5 and berth 6)
- Adani operates 1 berth (Berth 7)
- Port operates liquid terminal, mechanical iron ore handling complex (MOHC) and 2 general cargo berths

In addition to this, there are 6 mooring dolphins where the cargo is being handled through floating cranes.

The occupancy at berth 6 (JSW coal terminal), and general cargo berths is higher at ~80%, while occupancy at other berths is lower than 40%. Operations at the high occupancy berths are constrained by capacity bottlenecks, whereas low occupancy berths are constrained by demand.

Iron ore handling complex is not being used for iron ore exports due to Supreme Court ban on ore exports in 2011. Occasionally, some bulk cargo such as bauxite is handled at this berth.

Demand for the liquid cargo in Goa is limited and there are no signs of increase in cargo growth due to limited requirement in the hinterland. Hence, the occupancy of this berth would not increase in the near future.

We have focused on the bottlenecks at capacity constrained berths (6, 10 and 11) and the demand projections of major cargo in the future.

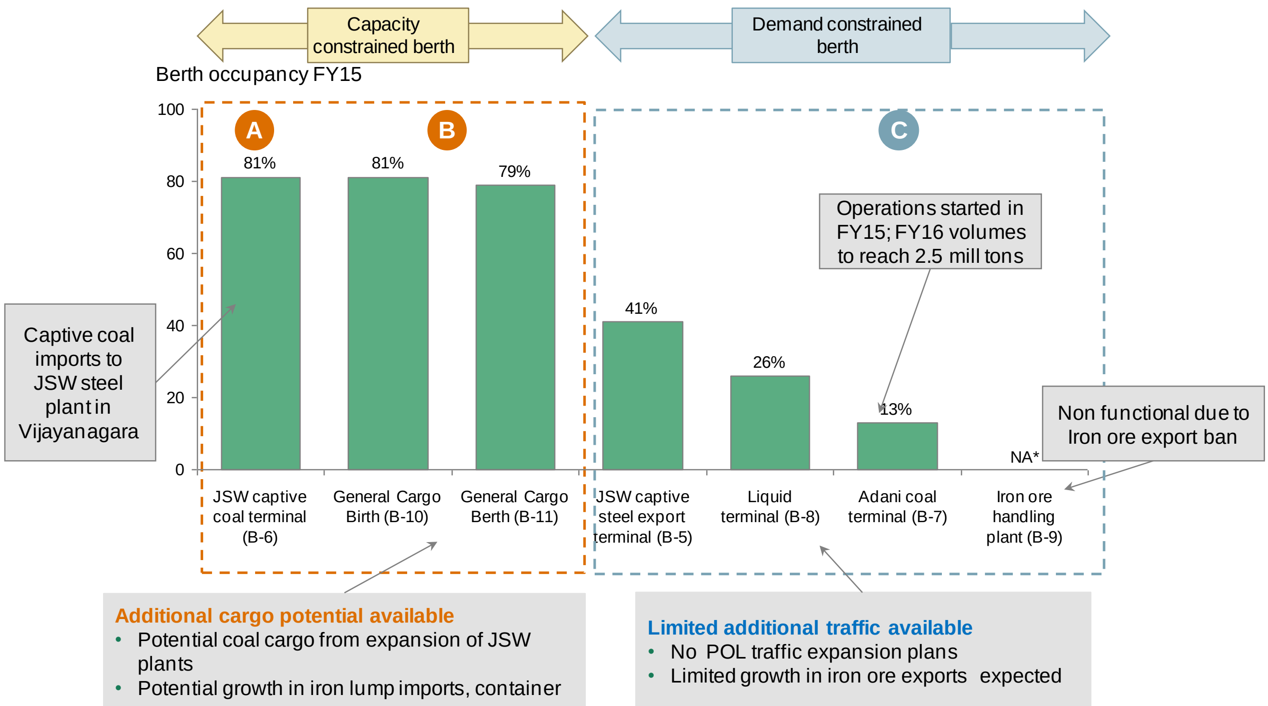


Figure 326: Berth occupancy Mormugao port

Three key focus areas emerged from the MPT diagnostics and initiatives have been identified across these areas to release current operational bottlenecks, enhance capacity and improve profitability.

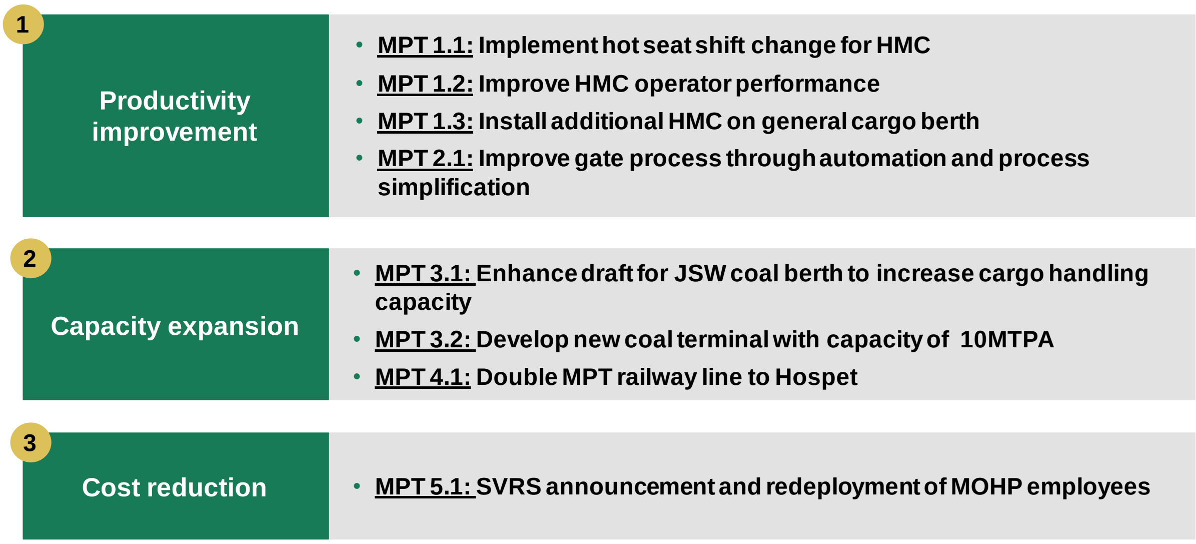


Figure 327:

11.2.1 General cargo berths 10 & 11

MPT has two port-operated general cargo berths with combined berth length of ~520 m. Both berths are at present running with high occupancy of ~80%. The major cargo handled at the berths includes containers, steel coils, granite blocks, MOP and wood chips.

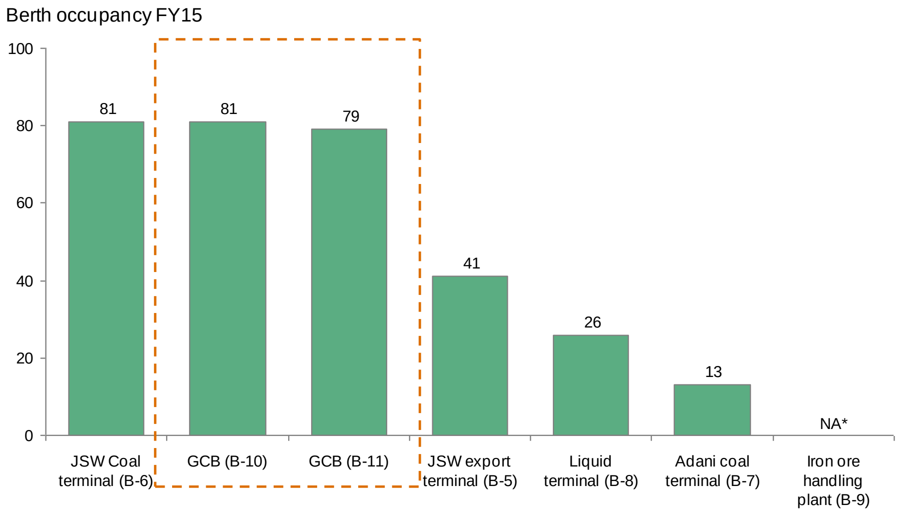


Figure 328: MPT berth occupancy

The berth productivity of the general cargo berths is at present lower than the productivity witnessed in other major ports. Additionally, evacuation is also seen as a major constraint for the terminals.

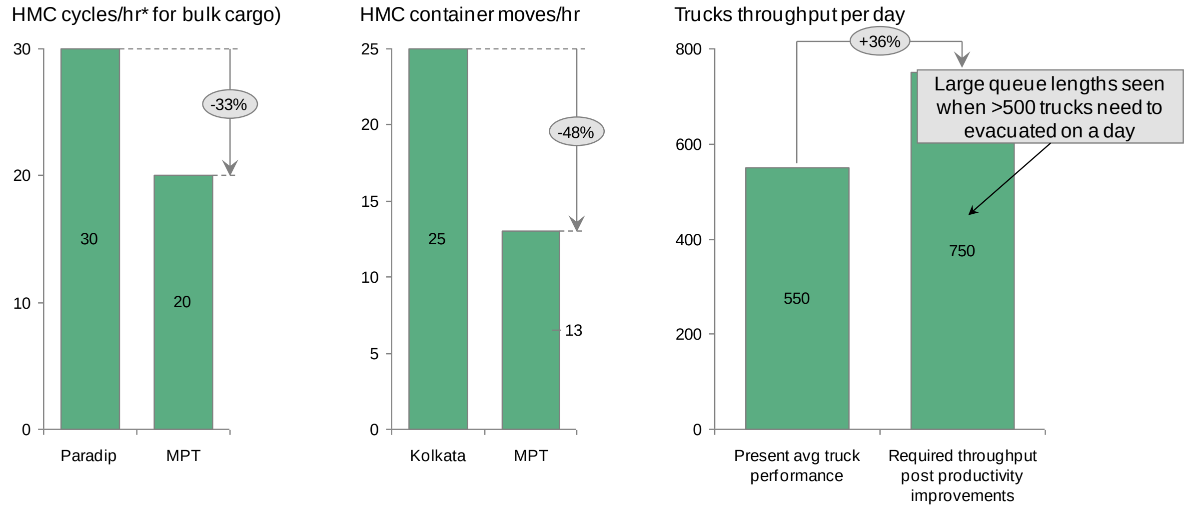


Figure 329: General cargo berths' poor performance at MPT

Low productivity of these general cargo berths are mainly due to

- High non working time of HMC
- Low productivity of HMC operator
- Sharing of one HMC between tow berths

Key initiatives are identified to address these bottlenecks.

11.2.1.1 Initiative: MPT 1.1 Implementation of hot seat shift change

Initiative Overview

The time study of the HMC operations reveals 37% non-working time, driven mainly by the shift change delays of operators. Around 14% of overall operating time of HMC is lost due to shift changes. The shift change time varies from 1 hour to 1 hour 30 minutes.

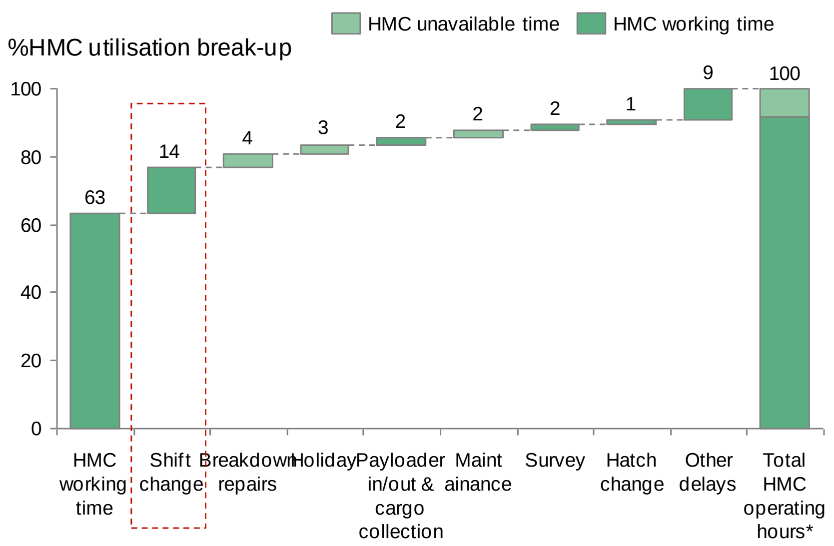


Figure 330: HMC utilization breakdown at MPT

Key Findings

The operators stop HMC operations usually 30–45 minutes before the shift ending time. Similarly, the next operator commences operations 30–45 minutes after the shift begins. The operator reaches the terminal and then reports for booking at the traffic department when the shift starts. After completing the booking process, he walks to the berth and climbs up the HMC. This entire process takes 30 to 45 minutes.

Recommendations

To reduce the shift change loss, the port is to implement 'hot seat shift change' for the HMC. This means the HMC will be operational throughout with no loss due to shift changes.

To ensure "hot seat shift change" is fully implemented, the following needs to be completed:

- Booking needs to be done through a mobile/tab
- Car is to be provided for transporting operator from the terminal gate to the berth
- Non-HMC duties (booking, climbing, etc.) is to be completed 15 minutes before shift start/end
- Operators to stop HMC operations at shift end

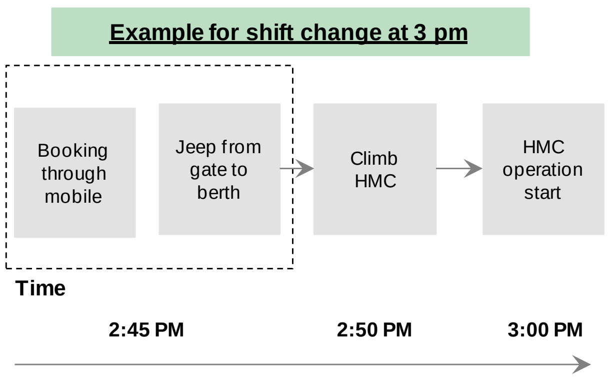


Figure 331: Illustration of hot shift seat change implementation

Reporting of operators has to be monitored strictly and a required tracking mechanism has to be in place. Any lag or delay in operator's reporting or commencement of HMC operations, or halting operations before shift end, has to be penalized.

Expected Impact

HMC utilization will get improved by 14% due to implementation of hot seat shift changes. The additional revenue will be generated through additional cargo capacity created, and through HMC usage charges. Total benefit to port is estimated to be Rs. 4-5 Crs.

11.2.1.2 Initiative: MPT 1.2 Improve HMC operator performance

Initiative Overview

HMC operator productivity at MPT is low when compared to the benchmarks at other major ports. The operators' productivity at MPT is 20 cycles per hour where as the best performing norms are 30 cycles per hour. The container moves by HMC are 13 per hour while it is 22-25 moves per hour at Kolkata port.

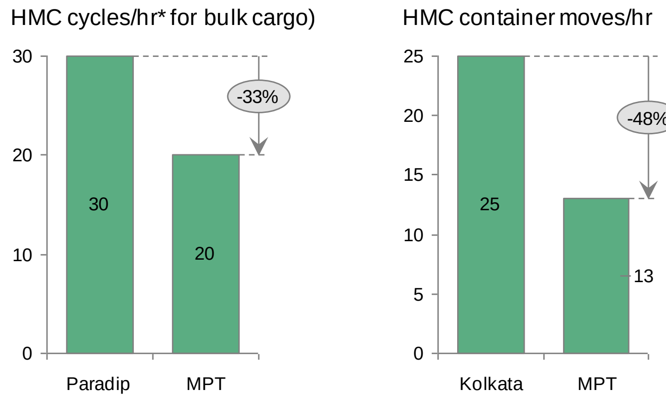


Figure 332: MPT HMC performance vs. benchmarks among major ports

Key Findings

There is significant difference in operator's performance at MPT compared to other major ports is driven by two factors.

1. Operator skill

It is observed that during container handling, operators require multiple attempts to place the container on the truck. Similarly, during dry bulk handling, the *slewing in* and *grab* engage process is not efficient. The operators' skill can be improved through better training.

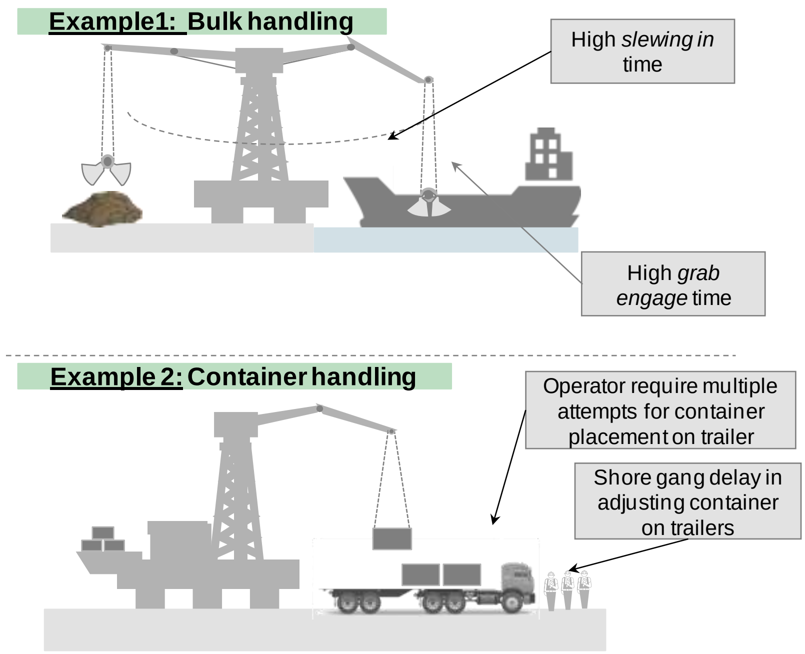


Figure 333: MPT HMC bulk and container handling illustrative

Also, the shore gangs are not supervised due to which they delay in reaching out to the trailer when the operator lowers the container on to the trailer.

2. Operator incentives

There are no performance linked incentives devised for HMC operators for dry bulk and container cargo, which accounts for 50% of the cargo handled by HMC. Incentive scheme of ship gear for break bulk is adopted for HMC.

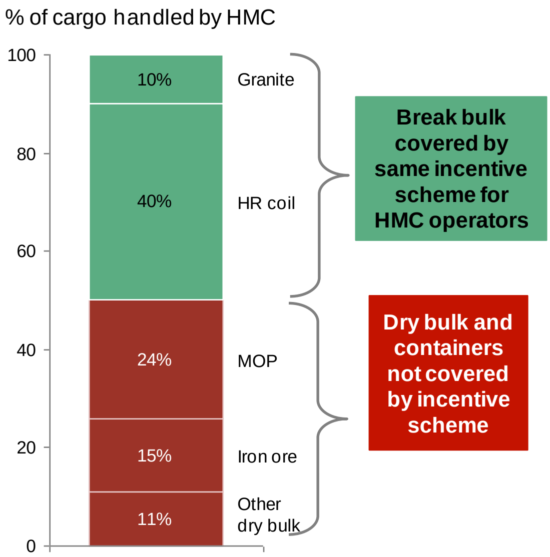


Figure 334: Split of cargo handled by HMC at MPT

Break bulk incentive scheme is based on the throughput per shift of the HMC operator: Less than 70 tons/shift, no incentive; between 70 to 100 tons/shift, Rs 1.05/ton; between 100 to 150 tons/shift, Rs 1.35/ton; more than 150 tons/shift, Rs 1.95/ton. The thresholds for the incentive scheme for break bulk are much lower than the benchmark productivity levels. Under current incentive scheme, everyone gets high incentives.

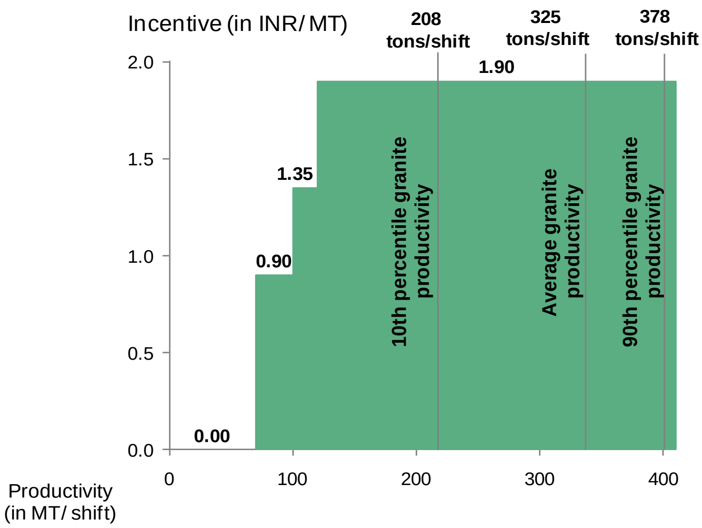


Figure 335: Granite incentive slabs for operators

Recommendations

New incentive scheme has been devised based on benchmark and current baseline for containers and dry bulk. Incentive scheme for existing break-bulk is adjusted based on current performance of operators and benchmarks. Each operator's performance has to be monitored by each shift, and the incentive has to be linked to the average performance throughout the shift. Progressive incentive scheme is prepared with higher thresholds and steeper incentive curve by cargo type. Incentive scheme is to be revised annually based on the performance of operators in the previous year.

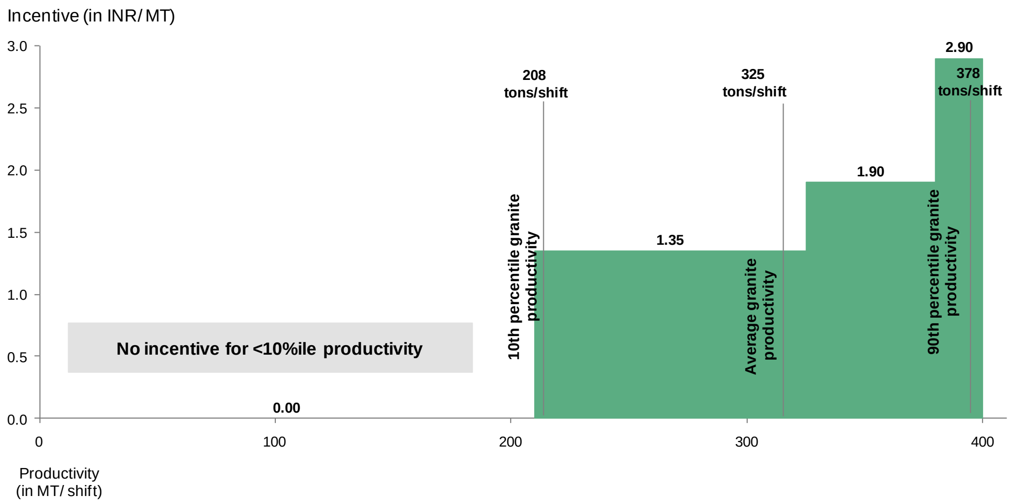


Figure 336: Progressive incentive scheme for break bulk

Illustrative

Cargo	Metric	Slab 1	Slab 2	Slab 3	Slab 4
HR Coils	**Tons/shift**	750	800	850	900
Granite	**Tons/shift**	270	300	330	350
Containers	**Moves/hr**	18	20	22	25
MOP	**Tons/hr**	552	600	648	720
Iron ore / Iron ore lumps	**Tons/hr**	644	700	756	840
Woodchip	**Tons/hr**	345	375	405	450

Incentive = (Total tonnage lift – Slab 1 tonnage) * Rate per ton

Figure 337: Illustration of slabs for incentive by cargo

Expected Impact

Efficiency of HMC can be increased by ~30-50%. This will enhance the capacity of the berth, creating an estimated value of Rs. 7 Crs.

11.2.1.3 Initiative: MPT 1.3 Addition of HMC on general cargo berths

Initiative Overview

The general cargo berths 10 and 11 are adjacent to each other. In the general cargo berths 10 and 11, HMC usage is mandated when it is available. However, there is a single HMC available for both the berths. As a result, at many instances, cargo is handled only by ship gears due to lack of HMC availability. The productivity of the vessel is lower when only ship gears are engaged.

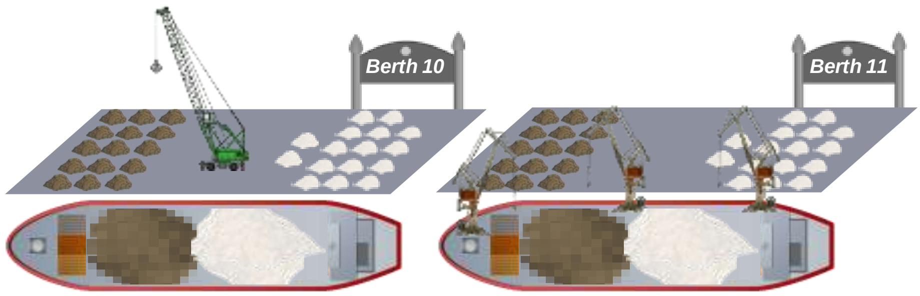


Figure 338: HMC and ship gear operations demo at general cargo berths in MPT

Key Findings

Engagement of one HMC can achieve ~30% of productivity improvement. Engagement of two HMCs can increase the total productivity by 88%. The performance is significantly low as only ship gears are engaged. Difference in productivity varies between 30-50%, depending on the cargo and number of hooks engaged.

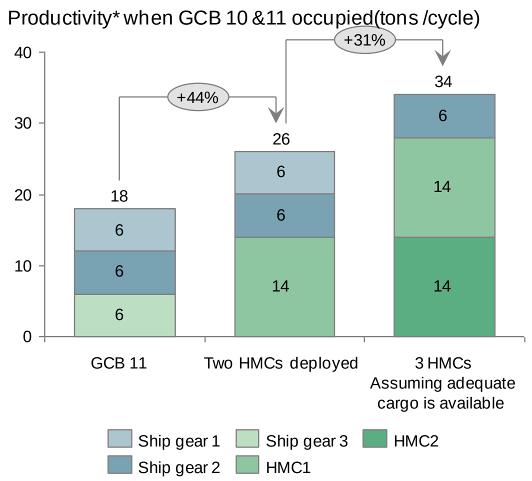


Figure 339: Productivity of vessels comparison using HMC and ship gear

In FY15, both GCB 10 and 11 berths were simultaneously occupied by vessels for ~3,120 hours. Due to significant overlap of vessel berthing, the HMC is not available for a substantial period of time.

Recommendations

The port is to deploy an additional HMC in GCB 10 and 11. This will increase the productivity at GCB significantly. Deployment of the third HMC can also be explored in the future on the basis of growth in cargo volumes.

Expected Impact

Additional 8-10% of capacity can be added to general cargo berths by deploying a second HMC. This would result in an estimated value creation Rs. 1.5 Crs. The HMC should be deployed through a PPP mode, which will help the port avoid any capital expenditure on purchase of the HMC.

11.2.1.4 Initiative: MPT 2.1 Improve gate process through automation and process simplification

Initiative Overview

Cargo handled at general cargo berths is evacuated through road. Also, the export cargo is carried by trucks to the port. Currently ~2 million tons of cargo is evacuated/carried through trucks. The truck evacuation process is slightly complicated at MPT. Multiple constraints at each gate process increases the congestion inside the port and reduces the overall truck evacuation capacity. With the existing constraints with truck evacuation, the capacity of the cargo at general cargo berths cannot be increased further. Hence, truck evacuation has to be simplified for greater throughput.

Key Findings

Truck evacuation process (for imports) at MPT and key constraints at each process:

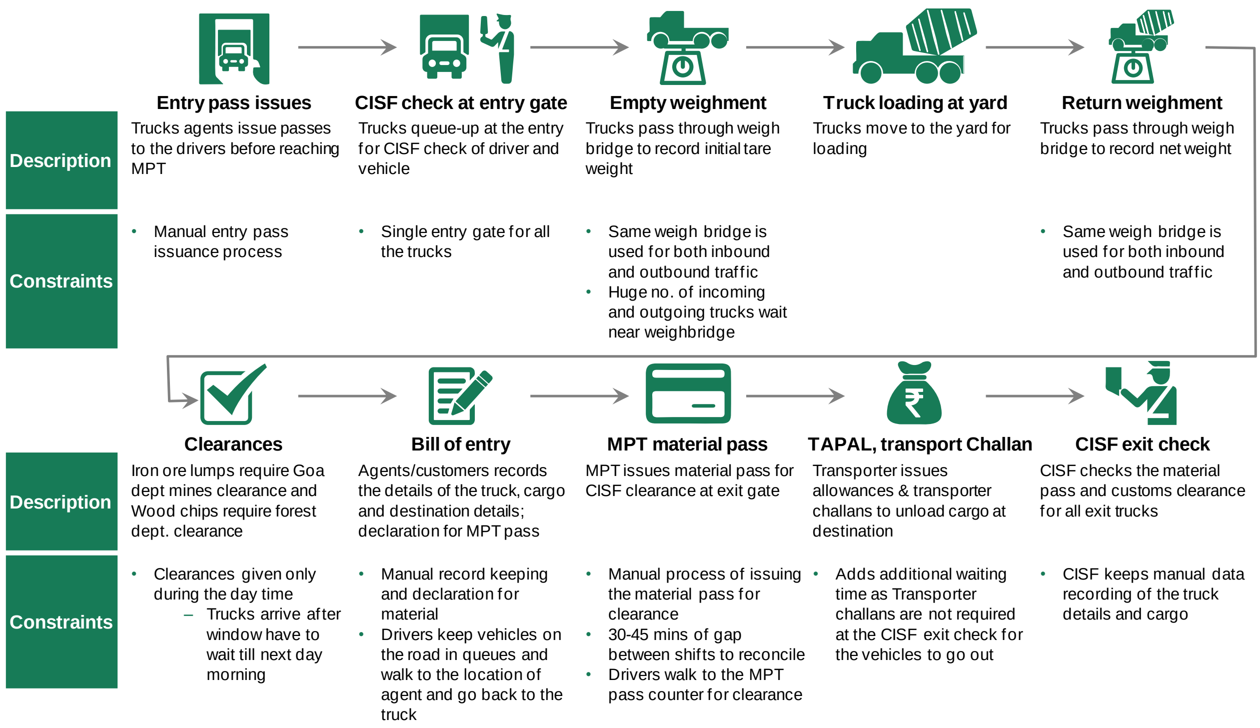


Figure 340: As-is gate process at MPT

The throughput at each gate is estimated as shown below:

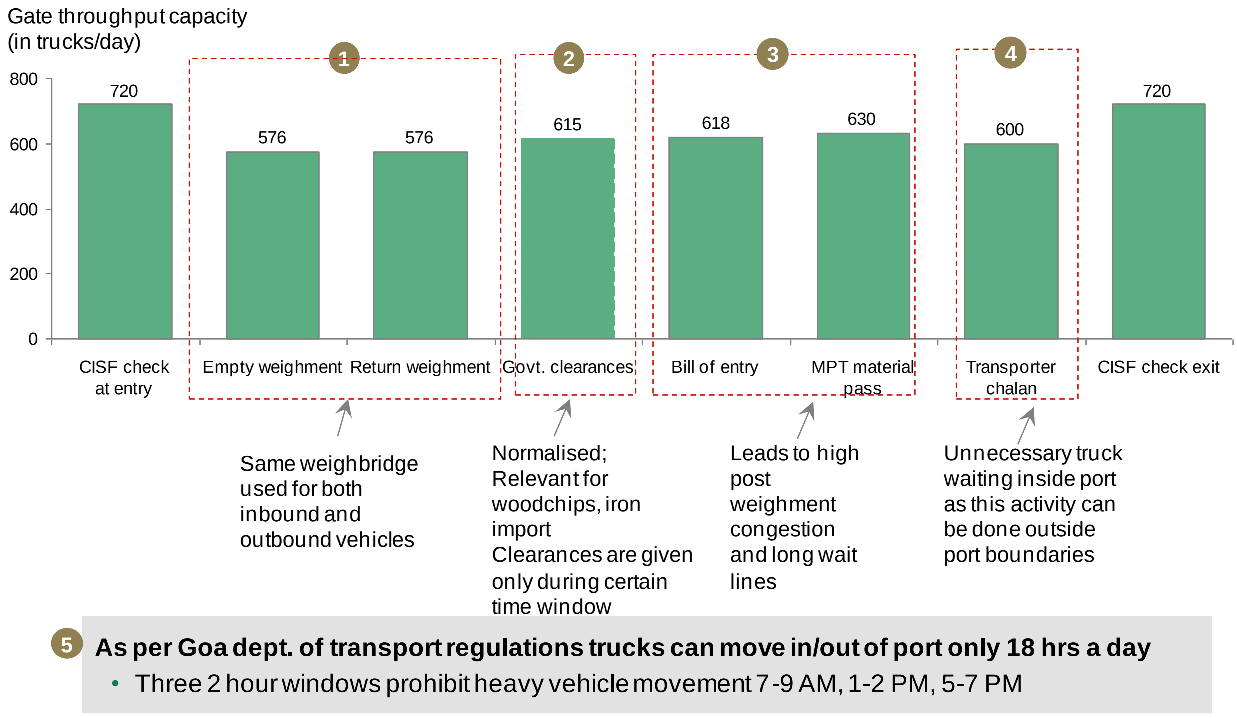


Figure 341: Throughput at each gate

Bottlenecks identified in gate process:

Weighment

- Single weigh bridge for both inbound/outbound trucks (empty/loaded)
  - Two separate queues near weighment, for inbound/outbound trucks and a main queue at weighment
  - Vehicles move on to main queue alternatively form each queue
- Driver stops the truck, gets out to the kiosk, collects receipts and gets inside the truck

Figure 342: Return weighment

Clearances

Woodchips:

Trucks carrying wood chips require forest clearance to move cargo outside Goa. A forest officer is deployed at the port between 9 AM to 5 PM to issue special forest transit pass.

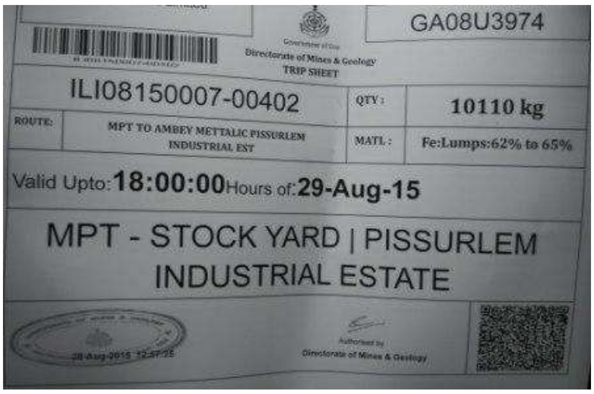
Drivers park vehicles along the road (connected to entry/exit gate), walk to the forest officer desk to obtain pass. This increases the congestion as every loaded woodchips truck moves out of the yard. Also, during night, most of the times there is no clearance given, hence, trucks are stuck inside the port during night time till the clearance is issued next day in the morning.

Figure 343: Forest clearance pass

Iron ore lumps:

Trucks carrying iron ore lump imports require clearance from Goa department of mines. The truck load has to be less than 10MT to get a clearance from the mines department. Usually, at the time of return weighment, a trip sheet is generated online for cargo issued by the department of mines. However, this process is only during the working time of the mines department. Vehicles are stuck inside the port during non-working hours (night time) of the mines department. This increases the congestion of trucks inside the port, especially during the night along with wood chips trucks waiting for clearance.

Also, we have observed weighment uses data card instead of broadband, and it faces frequent connectivity issues. When the connectivity is poor, clearance process takes longer (2-3 minutes) and reduces gate throughput.



GA08U3974
Directorate of Mines & Geology
TRIP SHEET
ILI08150007-00402
QTY: 10110 kg
ROUTE: MPT TO AMBEY METTALIC PISSURLEM INDUSTRIAL EST
MATL: Fe:Lumps:62% to 65%
Valid Upto: 18:00:00 Hours of: 29-Aug-15
MPT - STOCK YARD | PISSURLEM INDUSTRIAL ESTATE
Authorised by Directorate of Mines & Geology

Figure 344: Iron ore lumps clearance pass

MPT material pass and Bill of entry

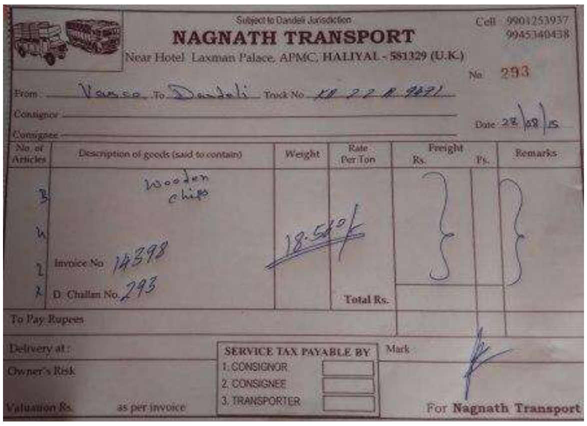
MPT-authorized material pass is required for the CISF to allow the cargo outside the port boundaries. Issuance of material pass for cargo is a manual process. The material pass requires agent/party's declaration of the vehicle.

Drivers keep vehicles on the main road after weighment and clearances, walk to the agent/party. Party/agent notes down truck, cargo details and issues a declaration for material pass. Drivers then walk back to the pass office building and submit weighment slip, clearances, and agent declaration. Port staff, upon manual verification of the documents, issues a material pass. This entire process takes 15-20 minutes, sometimes even more as the driver has to walk to two different places separated by 50-100 meters and wait in the queue. During all this process, the trucks keep waiting on the roads and, with every truck completing return weighment, the congestion levels increase.

TAPAL/Transporter challan

Transporters give diesel, food and other allowances to drivers after the material pass is obtained by drivers. Also, a challan is given to authorize unloading of cargo by the truck at the destination.

After obtaining material pass, drivers continue keeping trucks on the road and go to the transporter. This increases the truck waiting time inside the port and, hence, increases congestion.


Subject to Dandeli Jurisdiction
NAGNATH TRANSPORT
Near Hotel Laxman Palace, APMC, HALIYAL - 581329 (U.K.)
Cell 9901253937
9945340438
No. 293
From Vasco To Dandeli Truck No
Consignor
Consignee
Date 28/08/15

No. of Articles	Description of goods (said to contain)	Weight	Rate Per Ton	Freight Rs.	Freight Ps.	Remarks
	Wooden chips Invoice No 14398 D. Challan No. 293	18.510				
			Total Rs.			

To Pay Rupees
Delivery at :
Owner's Risk
Valuation Rs. as per invoice
SERVICE TAX PAYABLE BY
1. CONSIGNOR
2. CONSIGNEE
3. TRANSPORTER
Mark
For Nagnath Transport

Figure 345: Transporter challan

Restricted city transit of heavy vehicles

Goa department of transport doesn't allow trucks in/out of port to Vasco city during peak hours from 7AM-9AM, 1AM-2PM and 4PM-7PM. Only 18 hrs of inbound/outbound truck movement is allowed in and out of the Vasco city. During the restricted timings, trucks keep waiting on the road resulting in increased congestion and reduced capacity at the prior gate operations.

Figure 346: Trucks waiting in front of gate during non-city transit period

Recommendations

Automation of gate process is adopted by all the world class ports to reduce the truck turn round time inside the port, eliminating the manual processes involved at every step.

Below four step approach simplify and streamline gate process at MPT:

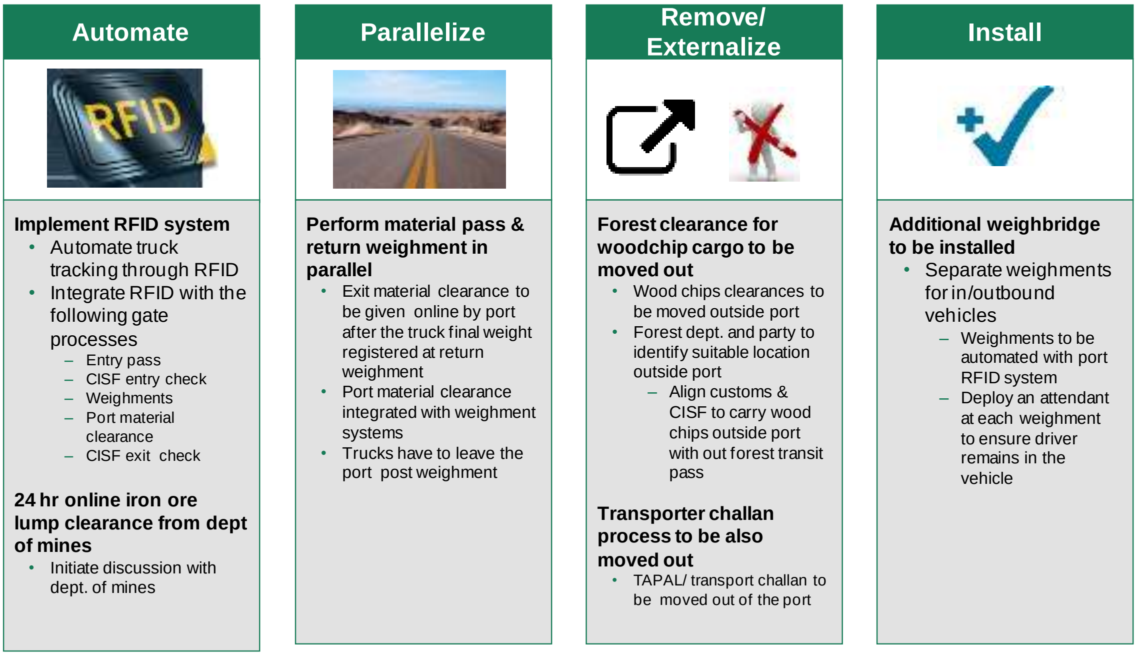


Figure 347: Simplification of gate process

Weighment

To increase the weighment throughput:

- Separate weighments each for inbound and outbound vehicles have to be deployed
  - Separate weighments each for inbound and outbound vehicles
  - Weighments have to be automated and integrated with port RFID system
- Deploy an attendant at each weighment to ensure driver stays in the vehicle
  - Attendants from MOHC can be deployed
  - Attendant hands over any documents to be given to the driver

This will increase the weighment gate output to 1100-1200 trucks per day.

Clearances

Wood chips

Two options are suggested to reduce congestion due to wood chips cargo clearance:

I. **Moving forest clearances outside port premises**
   a. Forest department and party to identify suitable location outside the port
   b. Align customs and CISF to carry wood chips outside port without forest transit pass

II. **One-time cargo clearance given by forest department for entire cargo carried by ship**
   a. Forest officer to visit the port when the ship arrives, and give clearance on the total surveyed volume
   b. Party issues acknowledgement to the truck along with forest clearance outside port premises

First option is preferred as it eliminates non-port related activities inside the port and simplifies the process.

Iron ore lumps

- Ensure 24hr window clearance for iron ore lumps
  - Initiate discussion with department of mines to run servers 24 hours for online clearance
  - Additional manpower can be deployed at the operator-end to run the clearance system in the department of mines
    - Can explore the possibility of manpower funding by importers
- Provide broadband connectivity to the weighment, solving the connectivity issue

MPT material pass and Bill of entry

Agent's manual acknowledgement will not be required any longer for the port to give material pass to trucks. The RFID has to be integrated with weighment.

Bill of entry process is not required.

TAPAL/Transporter challan

Transporter challans are not required at the CISF exit check and it is a non-port related activity. Also, the allowances can be given later. Hence, this process has to be shifted outside the port premises. Transporters have to be informed to identify optimal location outside port premises for this process.

Restricted city transit of heavy vehicles

Develop buffer parking space inside the port premises:

- Parking space has to be developed for ~100 vehicles near the outbound weighment
- Vehicles have to be moved directly to parking space after completing the weighment during restricted timings

Expected Impact

The throughput of the trucks will be increased from ~600 trucks per day to ~1,000 trucks per day.

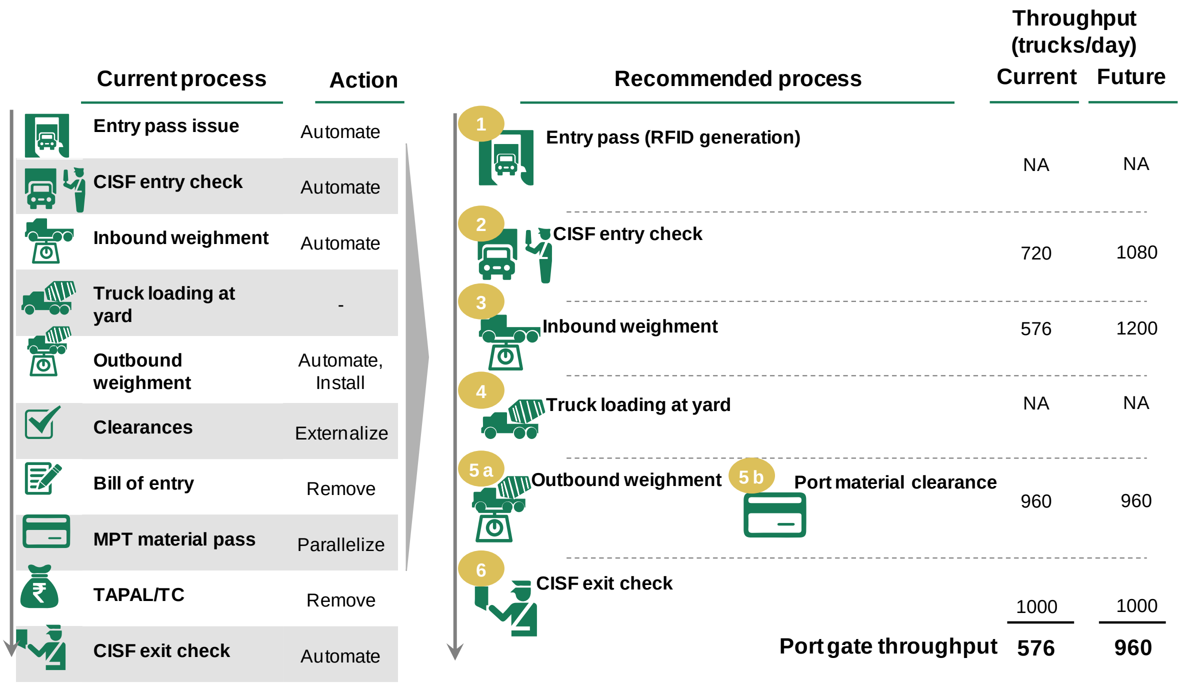


Figure 348: Simplification of gate process

11.2.2 SWPL (JSW) terminal

SWPL is operating berth 5 and 6 at Mormugao port. SWPL berths are captive for its parent company JSW's steel plant in Tornagallu at Vijayanagara, located ~410 kms from the Mormugao port. JSW's berth 5 is dedicated for export of steel products from JSW plant, and berth 6 is dedicated for import of coal required at the plant.

The total terminal length for berths 5 and 6 is 450 meters and the draft is 14.1 meters. Berth 5 has exported 1 million tons of steel products in FY15 and has occupancy of 41%. Berth 6 has imported ~8 million tons of coal cargo in FY15 and has occupancy of 81%.

11.2.2.1 Initiative: MPT 3.1 Enhance draft for JSW coal berth to increase cargo handling capacity

Initiative Overview

The JSW coal berth B-6 handles coal for the JSW Vijayanagara plant's coking coal requirements. The plant currently has a demand of 15MTPA (FY15) and it is expected to increase to 17 MTPA in the next 1-2 years. JSW is currently handling 8 MTPA at its coal terminal in MPT and the remaining volume is imported through Krishnapatnam port. JSW is planning to import the majority of its coal requirements in cape size vessels to save on logistics. While Krishnapatnam has cape handling capacity, MPT's current draft only allows Panamax vessels. If the draft continues to be the same, there is a risk of coal cargo getting shifted from MPT to Krishnapatnam port.

Key Findings

The port will undertake capital dredging initiative for deepening of the channel to 19.8 meters along the approach channel, turning circle, JSW terminal, and 16.5 meters at the Adani terminal. After capital dredging, the capacity at JSW terminal will increase to 14MTPA due to increase in productivity. As mentioned earlier, the additional capacity created at the terminal will be used up by the JSW plant in Vijayanagara.

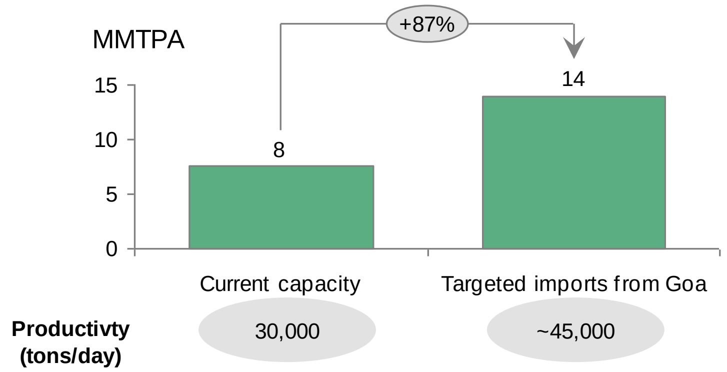


Figure 349: JSW coal terminal capacity

To leverage the advantage of increase in depth due to dredging, JSW has to upgrade the terminal infrastructure for handling cape size vessels and increase the current throughput to ~45,000 tons per day. The new tariffs need to be set accounting for the added investment on the terminal infrastructure.

Expected Impact

Additional coal cargo of 6MTPA can get handled in the port. This will create ~Rs. 25 crores per annum of additional value for the port. The capital dredging is expected to require a capital expenditure of Rs. 310 crores, and further annual maintenance dredging cost of Rs. 38 crores per annum.

11.2.3 Capacity expansion

11.2.3.1 Initiative: MPT 3.2 Development of 10MTPA new coal terminal

Initiative Overview

In the MPT hinterland, MOUs are signed for many coal based power plants and coking plants. Most of them are expected to be completed in the next 5 to 10 years. This will bring a surge in the demand for both coking and steam coal in the hinterland. However, current MPT coal handling capacity is 12MTPA (JSW 7.5 MTPA, Adani 4.5MTPA). This would not suffice the future coal demand expected in this region. So, MPT has to develop additional coal handling capacity.

Key Findings

MPT's primary hinterland includes Goa, North Karnataka, and southern Maharashtra. Both public and private sectors have huge investment plans for steel plants as well as coal based power plants. We have identified multiple plants in the pipeline at Bellary, Hospet, Belagaum, Hubli Dharwad, Kudgi, Solapur, Bijapur, Gulbarga, Vijayanagara, and Raichur.

Coal power plants in the pipeline in the hinterland:

Project	Capacity (MW)	District	Status	Expected year of completion
Shree Renuka Energy	1050	Belgaum	Under planning	2020
KPCL	700	Bellary	Under Construction	2015
JSW Energy	660	Bellary	Under planning	2018
NTPC	2400	Bijapur	Under Construction	2017
NTPC	1600	Bijapur	Implementation	2018
Flamingo Energy	1320	Bijapur	Under planning	2025
KPCL	1500	Bijapur	Under planning	2025
KPCL	1000	Bijapur	Under planning	2025
NTPC	1320	Solapur	Under Construction	2016
Atlas Power	1320	Gulbarga	Under planning	2020
KPCL	1000	Gulbarga	Under planning	2025
North Karnataka Power Private	1320	Gulbarga	Under planning	2025
PCKL	1320	Gulbarga	Under planning	2020
Surana Power	420	Raichur	Under Construction	2016
KPCL	1600	Raichur	Under Construction	2017
KPCL	800	Raichur	Implementation	2018
KPCL	1000	Raichur	Under planning	2025

Steel plants in the pipeline in the hinterland:

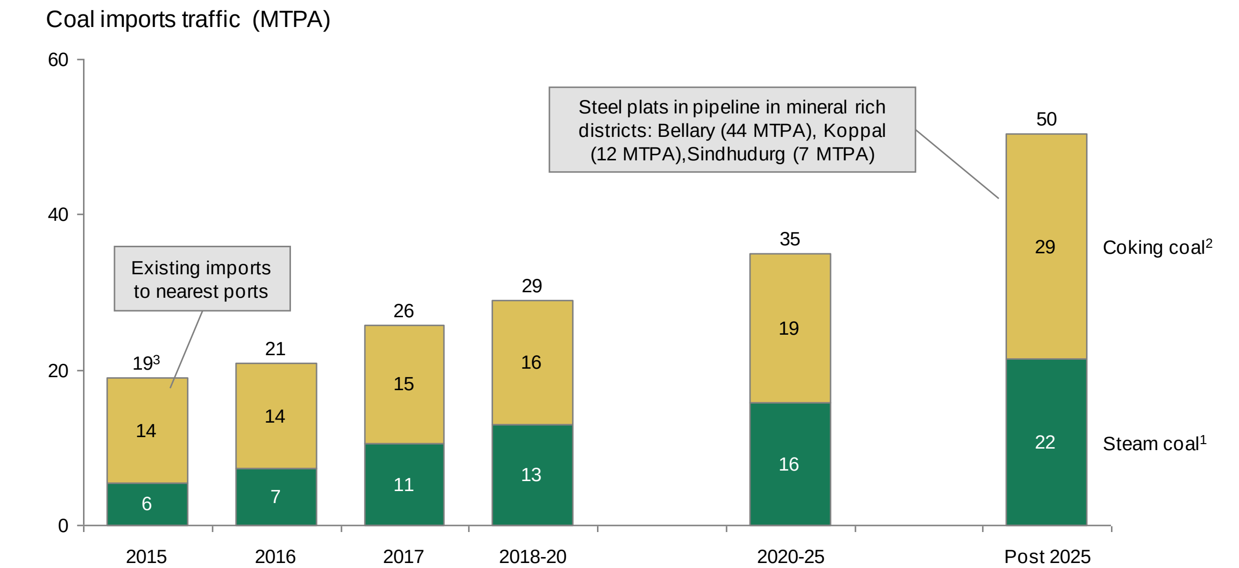
Project	Steel Capacity (MTPA)	District	Status	Expected year of completion
Aaress Iron & Steel	3.5	Koppal	Under Execution	after 2020
JSW Steel	6.0	Bellary	Under Execution	2022
Uttam Galva Steels	3.0	Sindhudurg	Planning	2019
Tata Metaliks	6.0	Haveri	Planning	after 2020
Shree Uttam Steel & Power	3.0	Sindhudurg	Planning	after 2020
KIOCL	5.0	Bellary	Planning	after 2020
JSW Steel	2.0	Bellary	Planning	2017
NMDC	3.0	Bellary	Planning	2017
Arcelor-Mittal India	6.0	Bellary	Planning	2020
Ravindra Trading & Agencies	6.0	Bellary	Planning	after 2020
Dhaaturuttama Power & Ispat	1.2	Sindhudurg	Planning	after 2020
Adhunik Metaliks	2.2	Raichur	Planning	2020
VIC Steels	2.0	Bellary	Planning	after 2020
Jindal Pipes	1.0	Koppal	Planning	after 2020
Uttam Galva Steels	6.0	Bellary	Planning	after 2020
Surana Industries	1.0	Raichur	Planning	after 2020
Vishwaraj Sugar Industries	0.5	Belgaum	Planning	after 2020

Project	Steel Capacity (MTPA)	District	Status	Expected year of completion
Zawar Steel	7.0	Bellary	Planning	after 2020
BMM Ispat	0.0	Bellary	Under Execution	after 2020
R M Steels	5.0	Koppal	Planning	after 2020
ILC Iron & Steel	2.1	Koppal	Planning	after 2020
JSW Steel	1.0	Bellary	Under Execution	after 2020

As per the CEA (central electrical authority) directive, all the boilers of future thermal coal power plants have to be designed for blend ratio by weight of 30:70 (or higher) imported/high GCV coal:indigenous coal. However, power plants can use 100% indigenous coal, but the boiler runs at a low efficiency. For the purpose of demand projections, we have considered 15% of imported coal will be used on average across these power plants.

Steel plants would require ~ 770 kgs of coking coal per ton of steel making. We have assumed 70% of the plants will be commissioned in the future with 50% of the coal requirement will be met through imports.

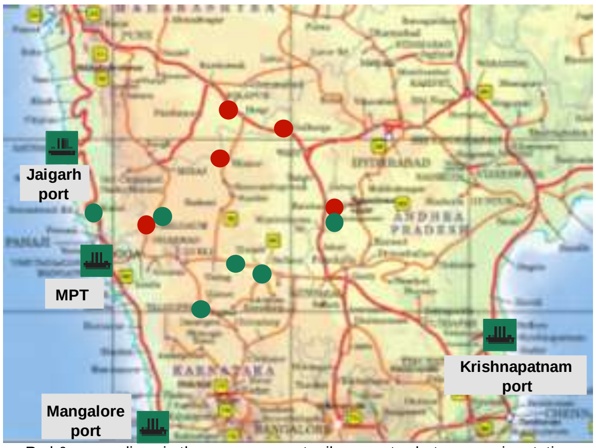
Based on estimates, the MPT hinterland demand for coking and steam coal is as shown below:



1 Assumed 70:30 blending ratio of domestic coal vs imported coal, 15% of imported coal usage; 2. 70% of steel plants post 2020 expected to be commisioned; 50% of the coking coal requirements to be imported;3. MPT hinterland imports to various ports - MPT 9MTPA, K. Patnam 7MTPA, Mangalore 2MTPA, Jaigarh 1MTPA
Note: Projects with MoUs signed and no clear commissioning date not available are assumed to be completed in 10 years, considering the conducive gover nment
Source: CEA; BCG analysis; Lit search; Govt. websites`

Figure 350: Coal demand projections in Goa hinterland

Goa is strategically located with shorter distance to districts where the new plants are to be commissioned.



Red & orange lines in the map represent railway routes between major stations

Power plants   Steel plants

	MPT	Krishnapatnam	Mangalore port	Jaigarh port
Bellary	445	478	589	774
Hospet	380	543	654	709
Belgaum	197	828	634	527
Dharwad	216	706	614	546
Hubli	236	686	594	566
Kudgi	445	779	803	775
Solapur	593	805	951	766
Bijapur	484	818	842	814
Gulbarga	676	692	904	879
Raichur	616	548	760	945
Tornagallu	412	510	621	742

Distance in km from Source to Destination

Figure 351: MPT vs. competitor ports' distance from hinterland

However, the current capacity at MPT will not be able to cater to the demand in the hinterland.

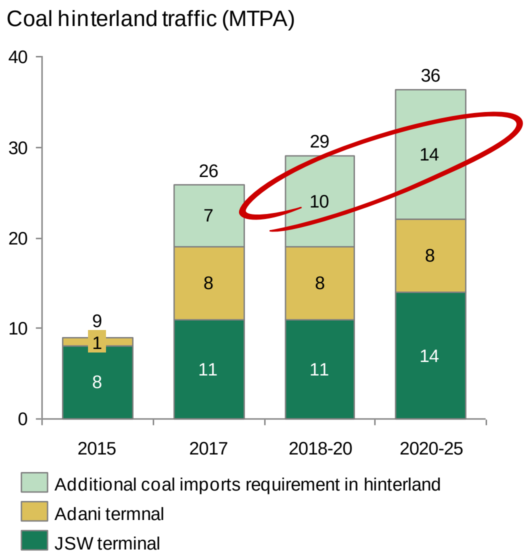


Figure 352: Surplus coal demand in the hinterland

Recommendations

MPT has to develop additional coal terminal in the next 4 years to cater to the surge in coal demand.

MOHC and Barge berths can be decommissioned to build a new coal terminal; estimated project cost is INR. 500 Crore.

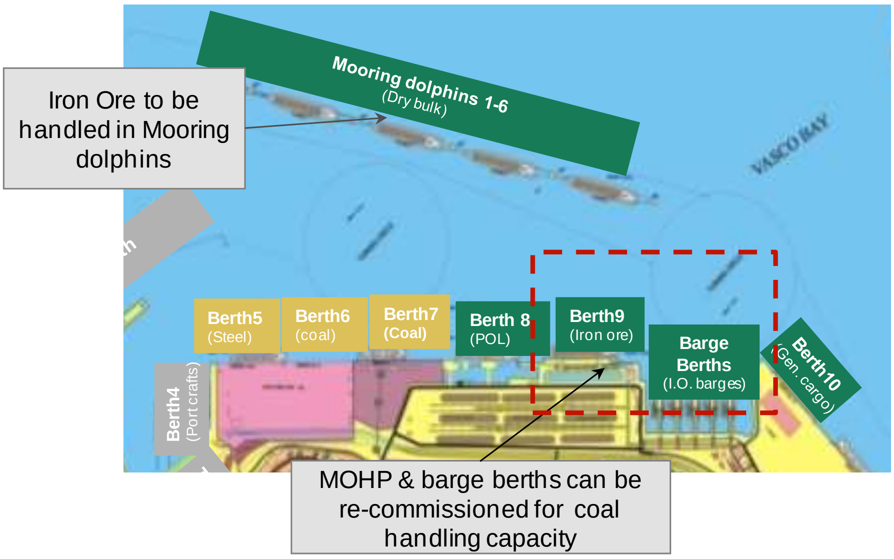


Figure 353:

Expected Impact

Rs. 100 Cr annual value creation from additional coal terminal along with rail line doubling.

POL demand

MPT has one dedicated POL berth (Berth 8) and two general cargo berths which can handle liquid cargo. Among liquid cargo phosphoric acid is handled in the General cargo berths and remaining POL cargo is currently handled at Berth 8. The following figure gives the split of POL cargo handled in berth 8.

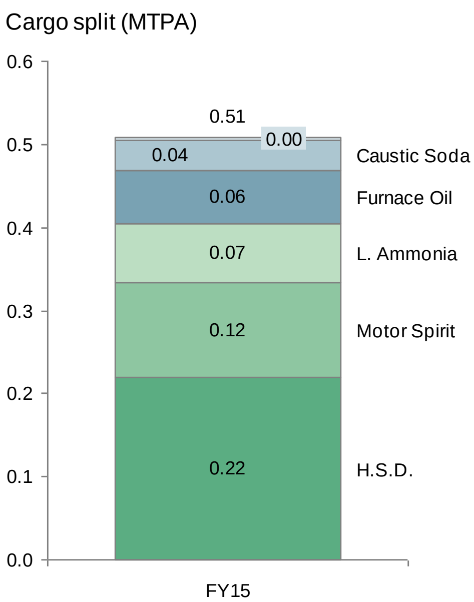


Figure 354: Distiribution of liquid volume handled in MPT

~70% of POL imports in MPT is for retail consumption as fuel for automobiles and barges. The fall in barge movement with ban on iron-ore export and decline in Goa tourism volumes which accounts for major POL consumption in Goa has resulted in decline in POL imports in MPT. POL cargo at MPT has declined by 8% in the last 5 years. POL volumes are not expected to grow significantly as fuel consumption will remain steady in Goa.

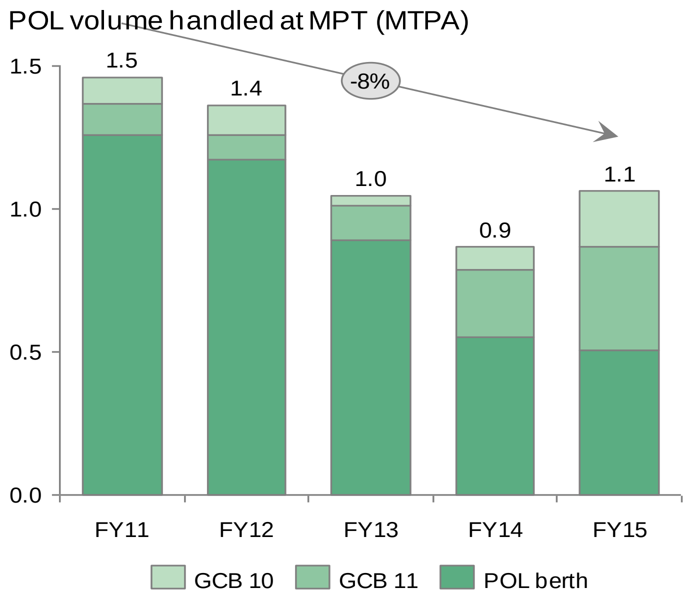


Figure 355: POL volume trend in MPT

Currently the berth occupancy for Berth 8 is low at ~30%. The parcel size of POL handled in MPT is also low at ~5-6,000 MT which is today handled by small vessels with draft of up to 8 m. Neither the berth occupancy, nor the parcel size is expected to grow significantly in the future due to low POL demand. Hence, Berth 8 can also be utilized for coal or other cargo in the future if coal demand picks up in MPT. However, the MOHC berth and the iron-ore barge berths must be prioritized over Berth 8 for decommissioning to develop coal terminals.

11.2.3.2 Initiative: MPT 4.1 Doubling of MPT railway line to Hospet

Initiative Overview

Port railway system is connected to South Western Railway through which it is also linked to the Konkan Railway. Both these railways together facilitate easy access to the port from any part of the hinterland. Currently, there is only one line that connects the port to the hinterland. The capacity of this line restricts the total cargo that can be evacuated from the port to 15MTPA. After dredging, the combined capacity of JSW coal terminal and Adani is ~19MTPA. Hence, the railway line has to be doubled.

Key Findings

The line capacity is 14 rakes, of which, recently, railways committed to send 11 rakes to the port. This would enable the port to evacuate a maximum of 15MTPA of coal from the port. Evacuation remains a bottleneck at the port. Hence, doubling of the line is essential for the port to increase capacity.

Railways doubling project was initiated a few years back, with railways sanctioning the grants for doubling the line from Goa to Hospet. The works from the port to Hospet at each intermediate station are at different stages of completion.

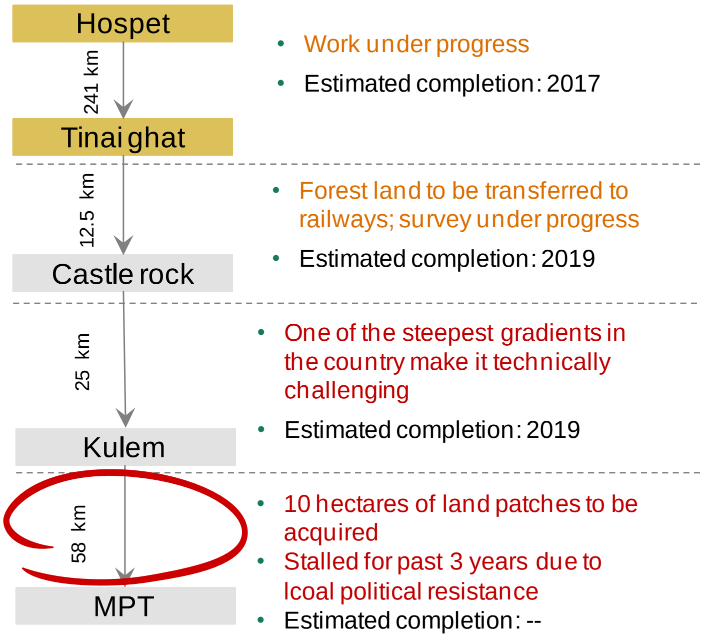


Figure 356: MPT rail line doubling status

Recommendations

Doubling of the line has to be completed with last mile connectivity by 2019 in order to ensure the port's evacuation capacity is in line with terminal capacity and demand in the hinterland. This is the most important initiative and lifeline for the port operations in the future. Local government has to be pressurized from the center for the completion of doubling of the line.

Expected Impact

Doubling of the line enables the port to handle additional demand in the hinterland. The expected benefit, along with new terminal construction in the long term, would be Rs. 100 Crs per annum.

11.2.3.3 Initiative: MPT 5.1 SVRS announcement and redeployment of MOHC employees

Initiative Overview

Operations at MOHC are stalled since FY12 after the ban on iron ore exports by the Supreme Court. Recently the ban was removed; however, there is a limit on iron ore exports from Goa. This would not require the operations to be reinstated at MOHC. Hence, the 435 employees under MOHC continue to have no duties assigned in the future. On the other hand, many departments have shortage of staff and are paying overtime salaries to the employees. This calls for redeployment of the MOHC staff.

Key Findings

The limit of iron ore exports from Goa is 20MTPA. MOHC and the mooring dolphins can handle iron ore exports. Also, Panjim port handles iron ore exports.

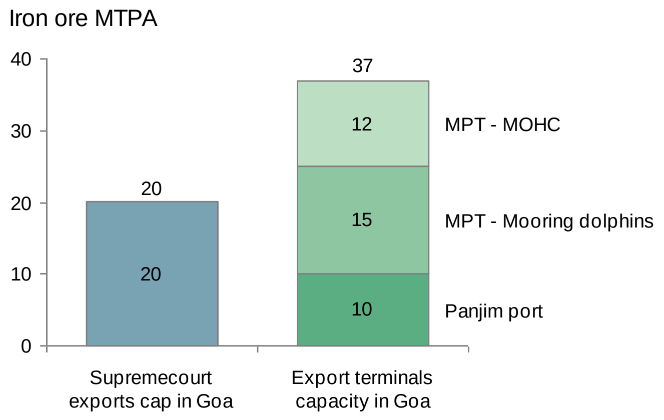


Figure 357: Iron ore exports handling scenario in Goa

Assuming 75% of iron ore imports are handled at MPT and 25% of exports at Panjim port in the future, MOHC operations would not be required since the mooring dolphins can handle up to 15MTPA through ship gear or floating cranes.

MOHC has 435 employees under different sections.

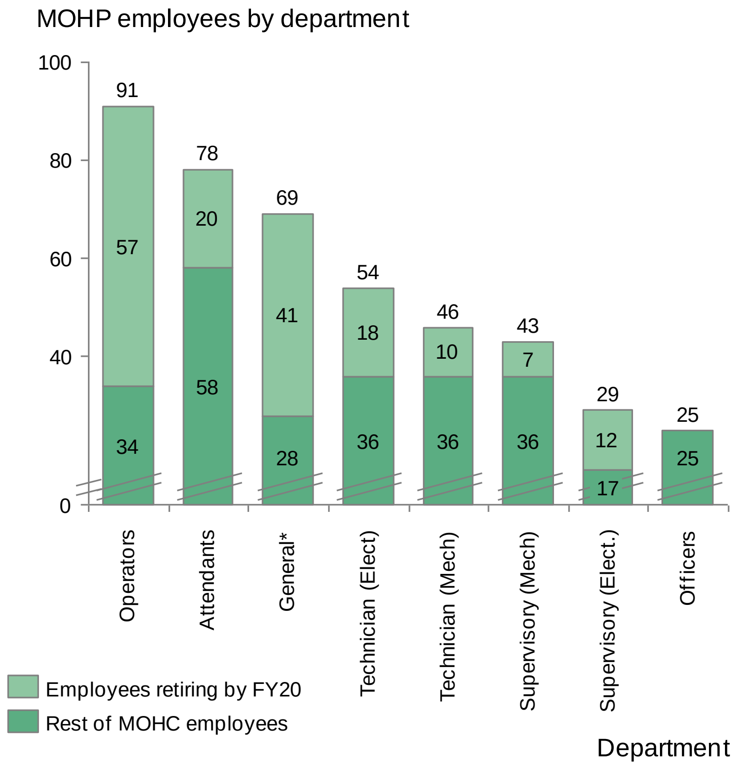


Figure 358: MOHC employee profile

They have been largely idle in the last 3 years as the plant is non-functional. Of these total 435 employees, 165 employees retire in the next 5 years. As MOHC operations are highly unlikely to start, 270 employees continue to be idle in the long run.

Overtime

MPT has paid Rs. 6 Crs of overtime salary payments in FY15.

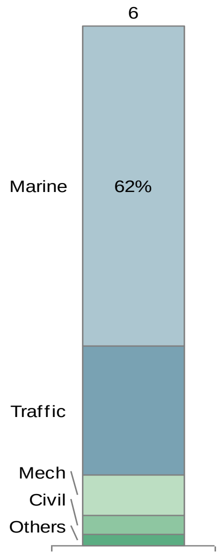


Figure 359: Overtime payment by department at MPT

Many sections across departments have staff shortage.

Recommendations

These 270 employees have to be given an option to choose between redeployment to the departments with shortage of staff or SVRS.

Overtime

Top 15 sections with high overtime hours account for 85% of the overtime salary expense.

Dept	Cost centre	# of emp.	Addl Staff required
Marine	Fenders, Wraps, Shoregang	25	19
Marine	Tug Chapora (Navi) (P&D)	23	11
Marine	Tug Tiracol (Navi) (P&D)	22	10
Marine	Ml Shingly Pilot Launch Marine P&D	16	9
Marine	Fire Fig staff&office estbl. (P&D)	15	9
Marine	Fire Crash tender & Oth Equi - (P&D)	6	4
Marine	Port Signal Station (P&D)	9	3
Marine	Ml Puli Vasal Pilot Launch Marine P&D	27	7
Marine	M.L. Survey Launch Ii (P&D)	2	3
Marine	Mooring Barge Vasco Da Gama (P&D)	20	3
Traffic	Marshall Yards and sidings - (Rail)	62	21
Traffic	Shed&Wharv Outdoor Staff	73	4
Traffic	Winch crane operators & chld labor	278	11
Civil	Water Supply Inst.-(Civil) (P&D)	42	5
Mech.	Workshop-Of-Rly	19	3

Figure 360: Top 15 cost centers with high overtime

Additional staff required in each department is calculated based on the number of overtime hours registered in FY15.

About ~150 employees of MOHC who are not retiring in the next 5 years can be redeployed into sections with additional staff requirement. The redeployment has to be based on skill match. Port has to facilitate certifications or trainings required for the new role. To encourage employee participation for redeployment, one time incentive can be offered to the employees.

SVRS

The scheme has to target rolling off ~100 people from employer payroll in order to save the long term costs associated with the employees. VRS will be considered for those employees for whom the cash outgo on VRS is lesser than cash outgo on superannuation. Employees with low service years (<5 years) left should not be preferred for the VRS scheme. Port management will be the final decision makers in announcing SVRS.

The SVRS has to target employees with more number of service years left in order to maximize the savings.

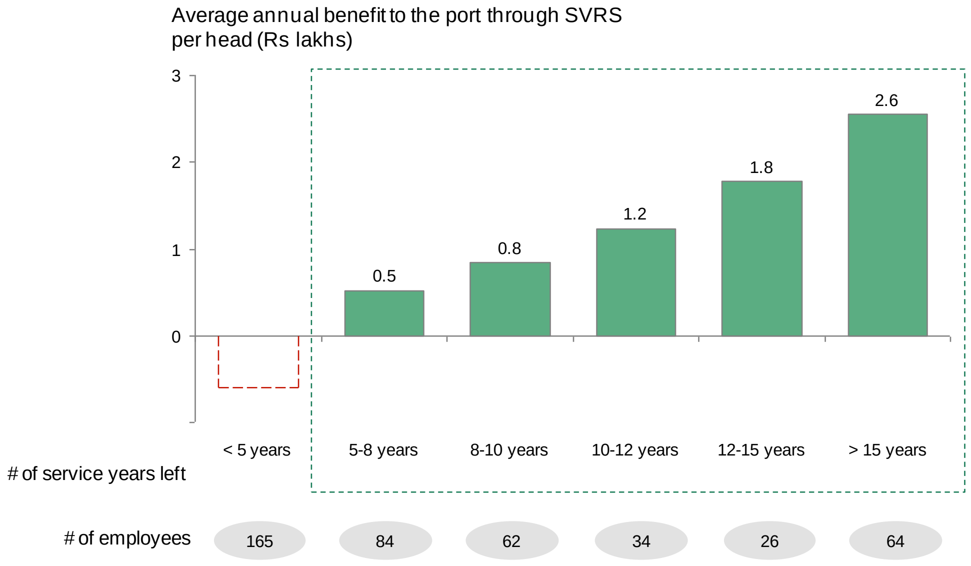


Figure 361: SVRS benefit by age profile

Expected Impact

Savings of Rs. 4-5 Crs of overtime payments through employee redeployment, Rs. 2-2.5 Crs of annual benefit through SVRS.