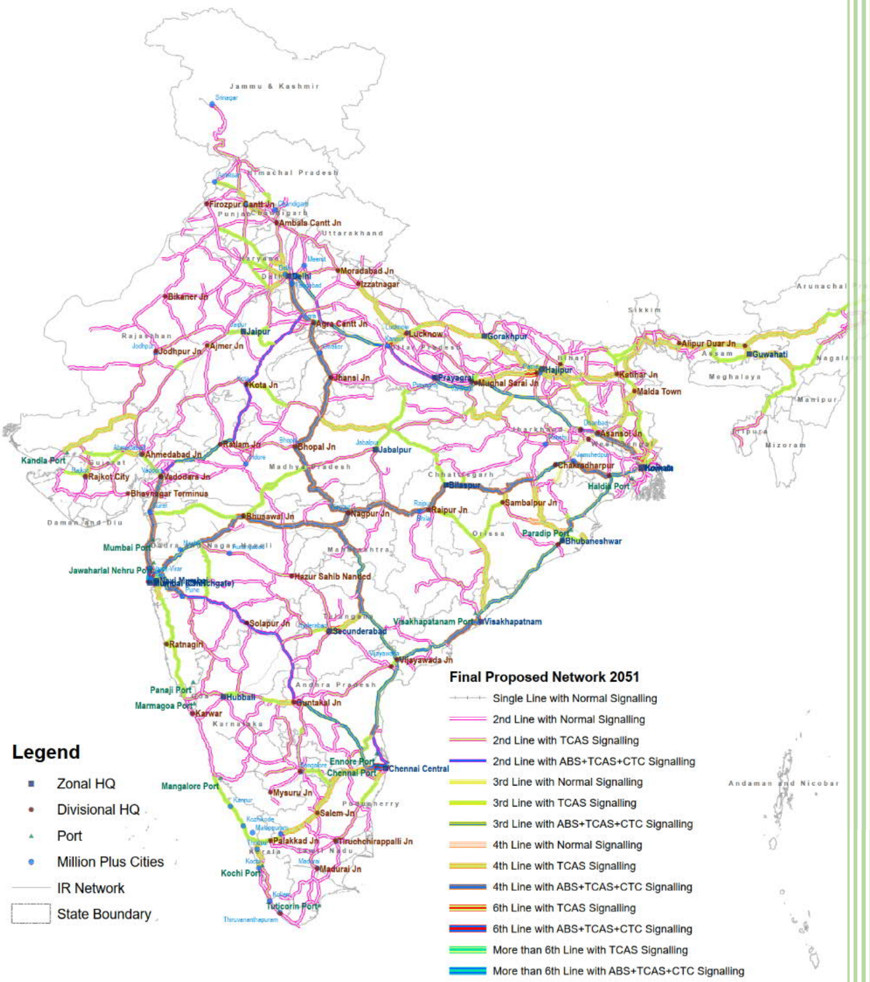
National Rail Plan - India



Executive Summary

EXECUTIVE SUMMARY

0.1. Background

Indian Railways is the 4th largest railway network in the world by size with 123,542 kilometres of total tracks over a 67,415 Kms route. In the fiscal year ending March 2019, IR carried 8.4 billion passengers and transported 1.2 billion tonnes of freight. Indian Railways runs 13,523 passenger trains and 9,146 freight trains daily on its network with passenger trains running at an average speed of 50.6kmph and freight trains at 24kmph. As of March 2019, Indian Railways rolling stock consisted of 2,89,185 freight wagons, 74,003 passenger coachers and 12,147 locomotives. Indian Railways had 1.3 million employees making it world's eighth largest employer.

Now moving forward and with a vision to develop Indian Railways as a world class system which shall be able to cater to the demand by keeping pace with growth and compliment the economic development, Ministry of Railways has envisioned the preparation of National Rail Plan (NRP) for India keeping the year 2050 as the horizon. For this purpose, Ministry of Railways has mandated RITES Limited to provide advisory services by further appointing a Consultant. In pursuance of the above and to enable preparation of National Rail Plan, the RITES have assigned the study to M/s AECOM India Private Limited.

0.2. Vision and Objectives of the Plan

The study was envisaged with keeping a following vision ….

"To enhance rail freight share …
… *to prepare a compressive strategy for the Rail Sector in the form of National Rail Plan for creation of adequate capacity* ***by 2030 that will cater to the demand up to 2050 i.e. to develop capacity*** *ahead of demand****"***

Keeping the vision in mind, the study is planned to meet the following objectives

- To assess **Present & Future Modal Share** of Railways
- To examine **Capacity Utilization** of Existing Railways Assets
- To provide a **Long-Term Rail Development plan** to meet demand for:
  - Dedicated Freight Corridor
  - High Speed Rail
  - Doubling of lines
  - Signalling
  - Electrification of Entire Network
  - 160 kmph Speed on Selected Corridors
  - Passenger Stations
  - Freight Terminals
  - Rolling Stock
- To identify **Options, Evaluation and Prioritization** of projects
- **Funding Requirements and Financing Strategies** for identified projects

0.3. Rail Network Mapping

One of the key tasks of NRP was to map the entire Indian Railway Network at GIS Platform along with their respective attributes and line features. This massive exercise was carried out as part of the study and entire network was mapped on GIS platform.

For the preparation of map for the Indian Rail Network, an authentic reference in the form of raster data was required. Based on this reference data, rail network has been digitized on GIS platform.

The maps of different zonal railways along with the information like line hierarchy (single, double, triple lines etc.), stations, closed lines, loop lines, lines under upgradation etc. were collected. These zonal maps collected were scanned, geo-referenced and digitised to convert them from paper maps to digital maps synchronised at GIS platform. All the features of a section were than attached as an attribute table so that with click of a mouse all the information about that section is visible on screen.

Geo Referencing of the System Maps

Geo referencing means to associate something with locations in physical space. Geo referencing can be applied to any kind of object or structure that can be related to a geographical location, such as roads, places, bridges, or buildings.

System map for all zones were scanned, and geo-referenced on GIS Map. Thus, these geo-referenced maps formed the base for digitization of the railway network.

The geo-referenced maps have been vectorised or digitised in different layers as per the requirement of different lines like all the single lines are in one-layer, double lines in another layer and so on. Similarly, different types of stations are also digitised in different layers like zonal headquarter, terminal station, closed station etc. Following features has been created during vectorisation of the maps.

Digitisation of Railway Network

In GIS Map, entire rail network has been digitised in various shapefiles. There are 23 types of layers created covering all the possible features like existing hierarchy of the lines, current traction status, number of trains passing through the section, upcoming proposals on the section like doubling, tripling, quadrupling etc. gauge status (BG, MG,NG etc) capacity of the section, current utilisation level with maintenance block or without maintenance block.

The complete railway link network with existing hierarchy of lines was created and shown in Figure 0-1

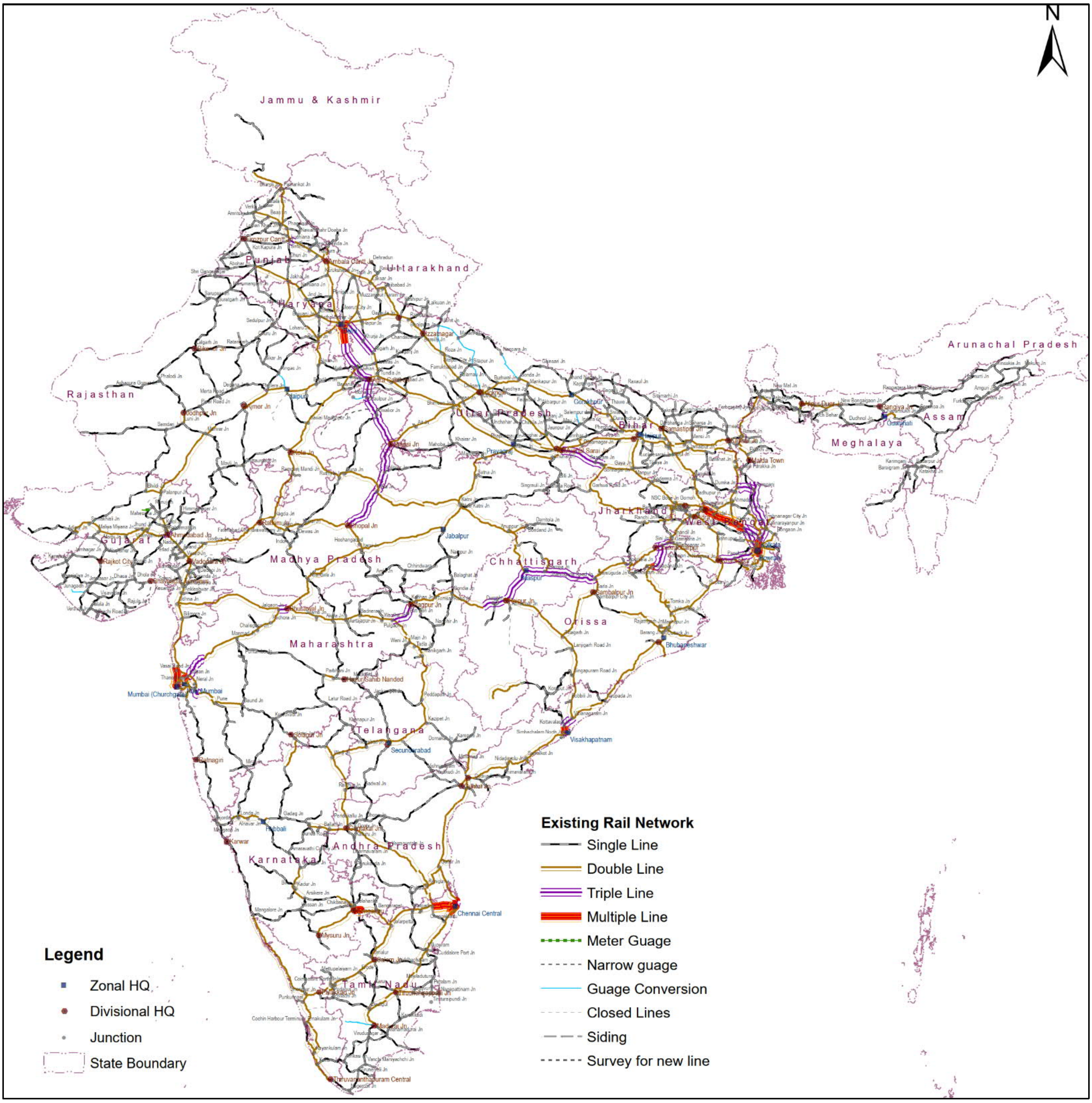


Figure 0-1: Hierarchy of Railway lines in Indian Railways Network

Digitization of Railway Stations

In GIS map, besides digitization of railway lines, digitization of railway stations has also been undertaken on basis of type of railway station. Stations and Junctions identified for the upcoming Dedicated Freight Corridor (DFC) are also digitised based on the location provided in the proposed alignment and digitised under following head:

- ➢ DFC Station,
- ➢ DFC Junction

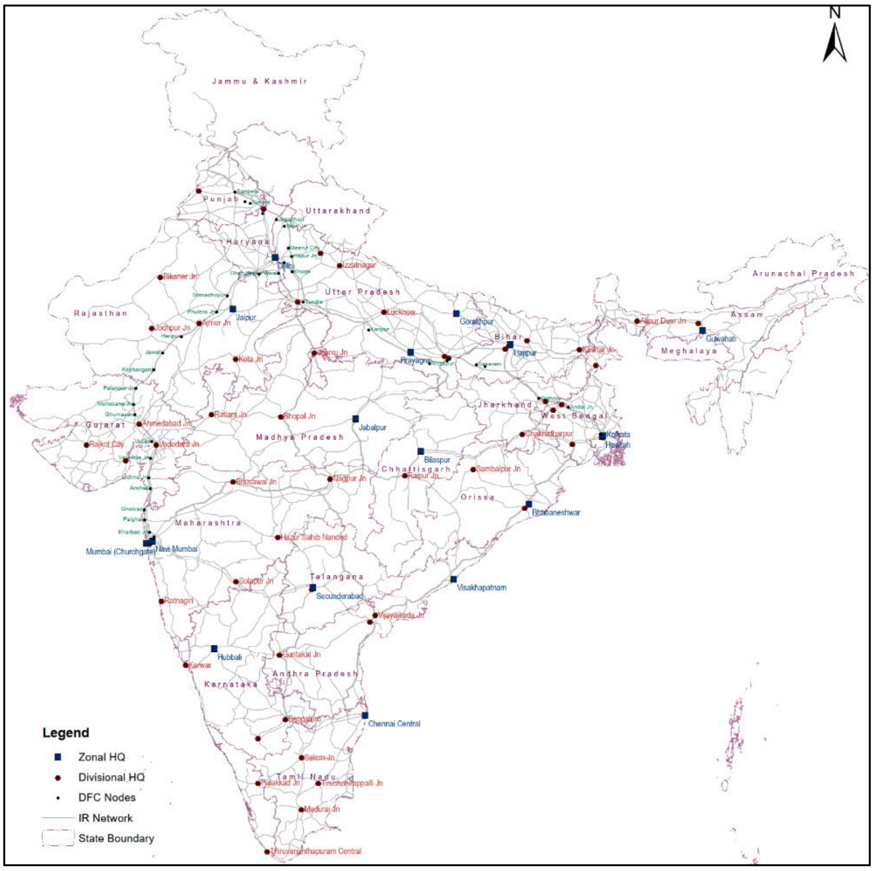


Figure 0-3: Zonal & Divisional HQ of Indian Rail Network

Data Attachment as Attribute to Vectorized or Digitised Network

Each Rail link has following information:

✓ *Section Name:* This contains the name of the start and end point of section e.g.

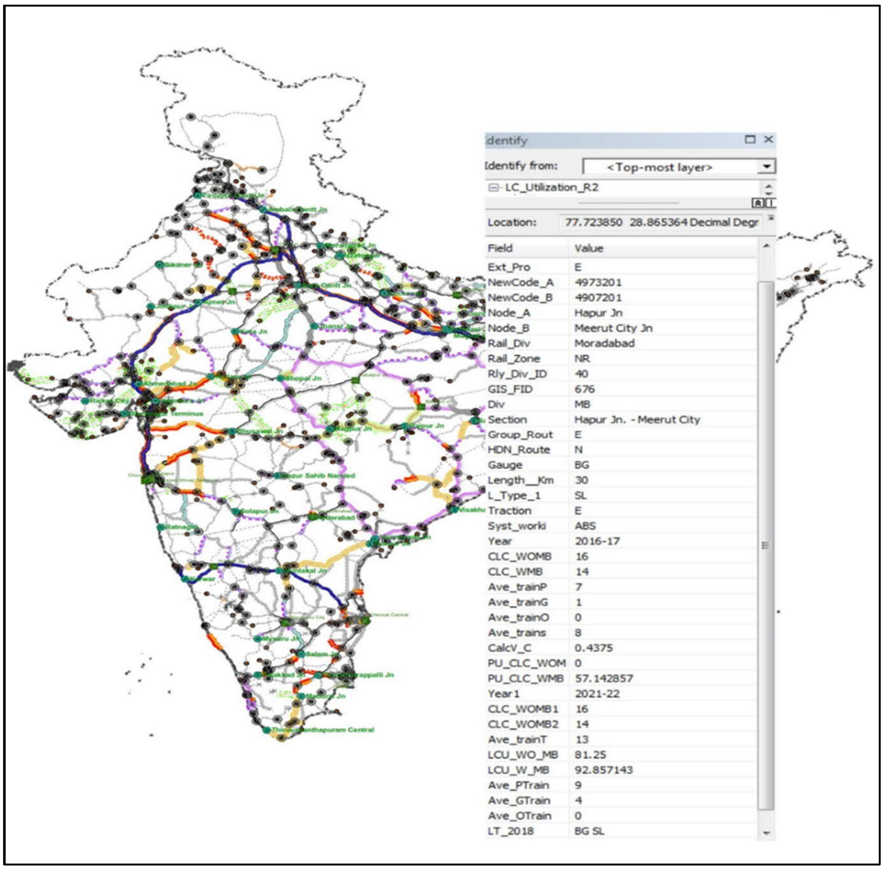


Figure 0-2: Data Heads Attached for all the Rail Links

Sahnewal – Ludhiana section

- ✓ *Group Route:* A/B
- ✓ *HDN Route*: Under this head the information about the high-density network has been provided.
- ✓ *Gauge*: This head contains the gauge information i.e. broad gauge, narrow gauge and meter gauge.
- ✓ *Length (Kms.):* This head contains the information about the length of section.
- ✓ *SL/TSL/DL/TL/ QL/QSL*: This head explains the type of the section discussed i.e. whether the section is single, triple, double line etc.
- ✓ *Traction:* It can define as the railway vehicle that provides the necessary traction power to move the train is referred as the traction or locomotive. This traction power can be diesel, steam or electric power
- ✓ *System of working*: ABS/Manual
- ✓ *Average Nos. of train services* each way i.e. Passengers, Freight, others and total number of trains

Other than the railway networks, other competing modes of transport like Highways, IWT and Aviation were also digitised at GIS platform so that shift from other competing modes to Railways can be assessed.

Railway network is spread along the length and breadth of the country but still there are some areas where railway connectivity is still deficient. After digitising the railway network at GIS platform, an analysis was to mode to identify the area deficient with rail connectivity. Analysis was made to understand the rail connectivity to all Class I and Class II towns. Other than the exiting class I and Class II towns, the towns whose population is growing rapidly, and classification of these town will change to Class I or Class II in next 10 years were also considered while analysing the rail connectivity. This will help to understand the missing links in rail connectivity. The class I and class II towns connected and not connected with railways are shown in following figures 04-& 05. Network for other modes of transport like Roads, IWT and Aviation is also show in Figures 06, 07 & 08

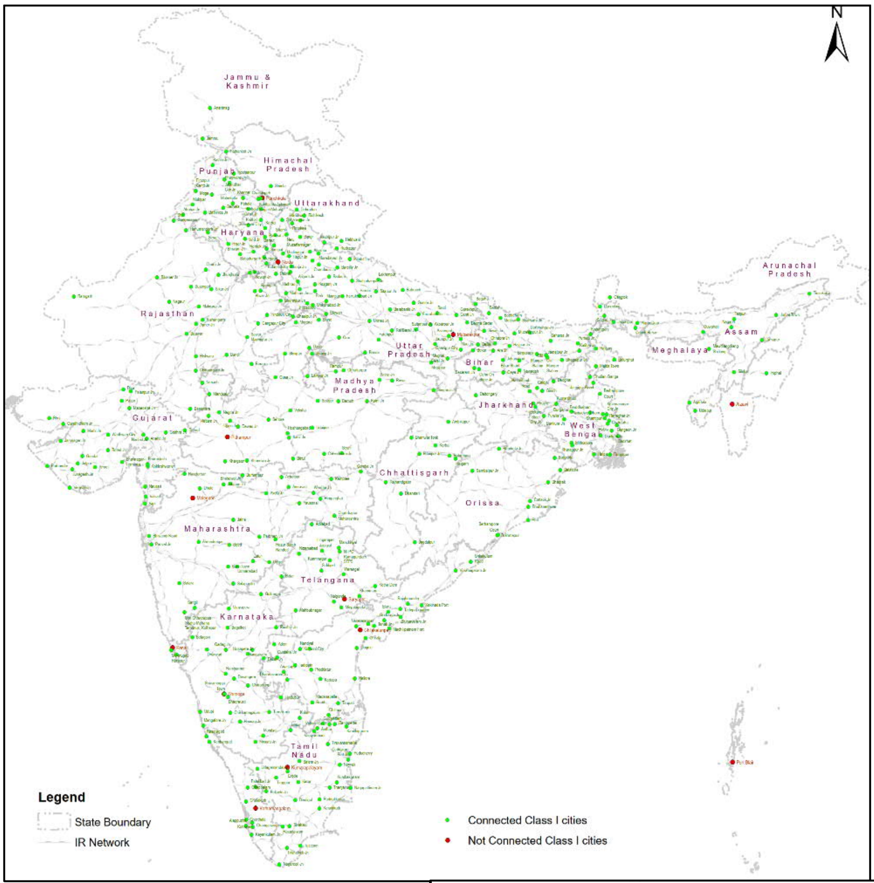


Figure 0-4 – Connectivity of Class I cities

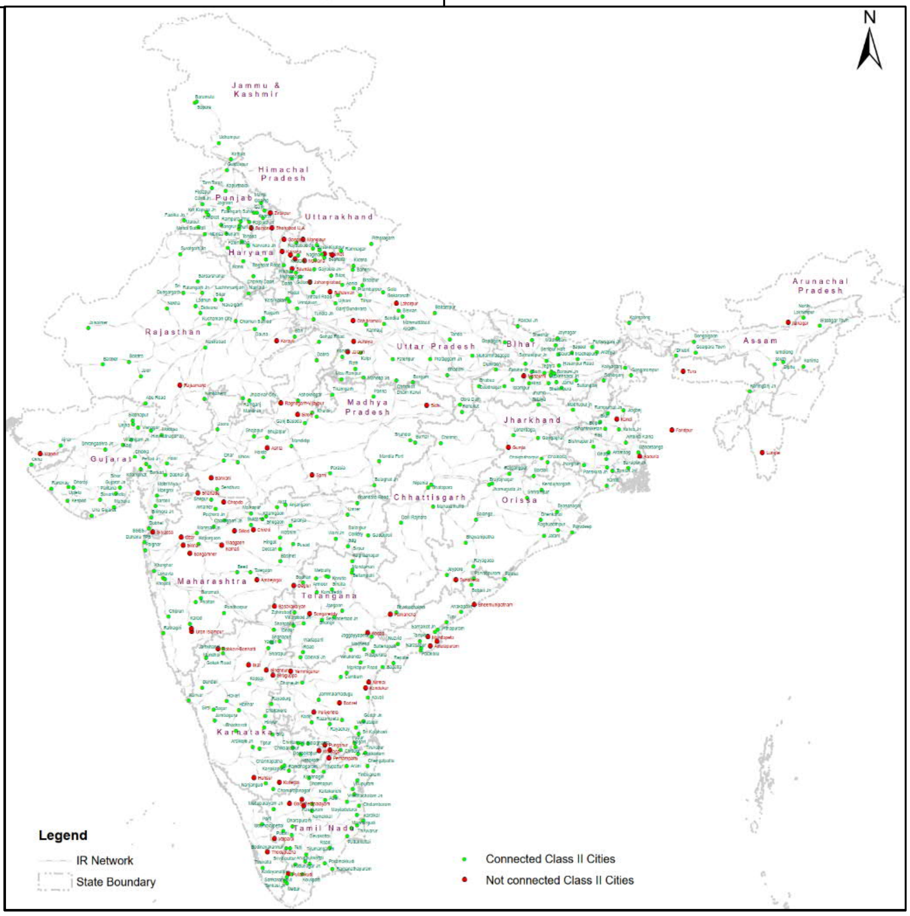


Figure 0-5 – Connectivity of Class II cities

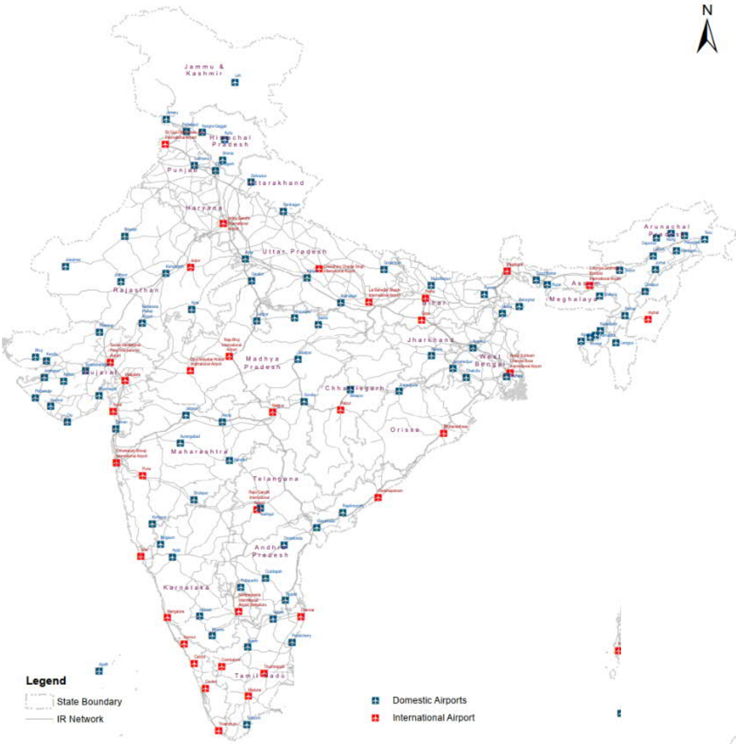


Figure 0-8 – Aviation Network – location of Domestic and international airports

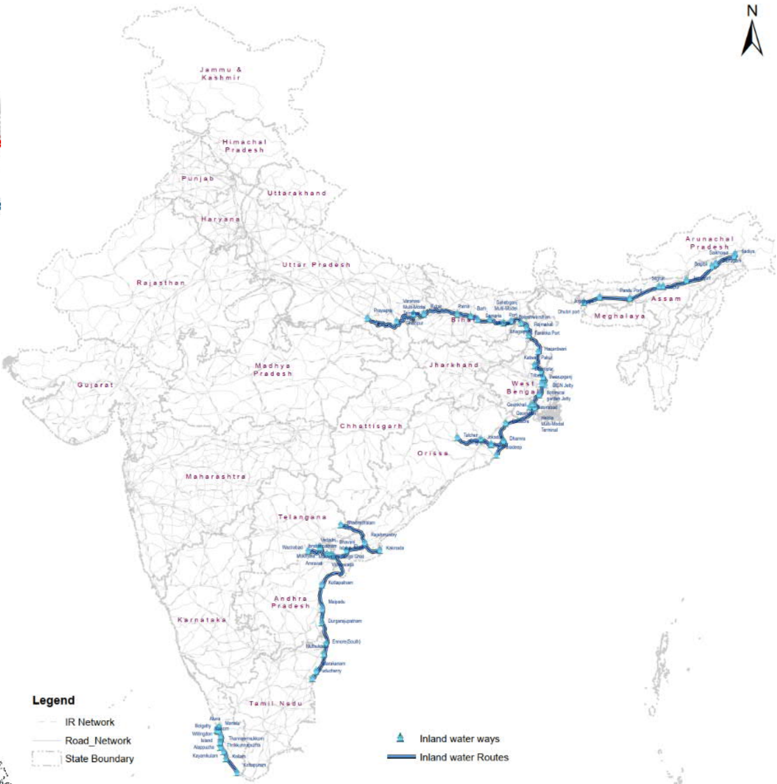


Figure 0-7 – IWT network

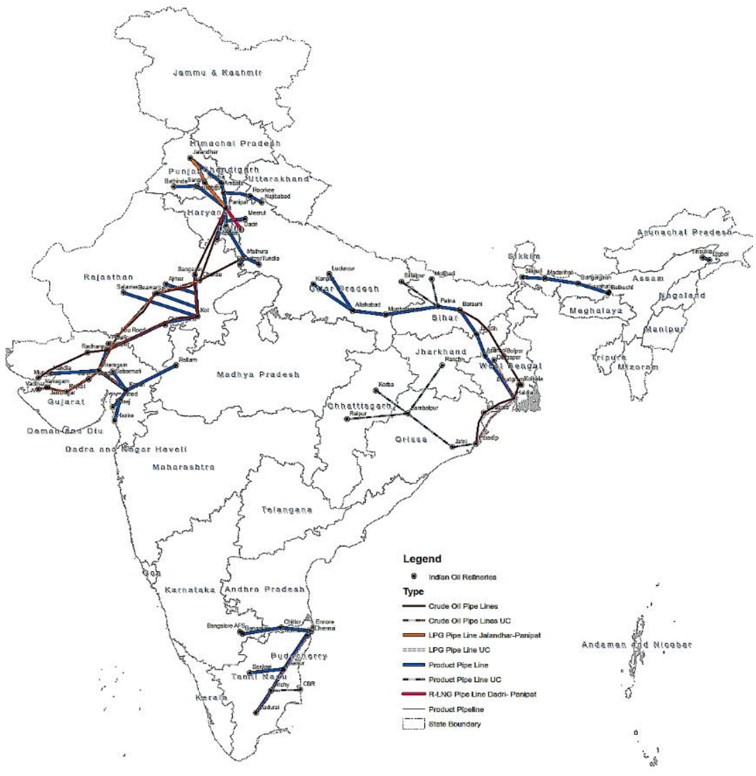


Figure 0-6 – Pipeline Network

0.4. Demand Forecast for Freight and Passenger Traffic of IR

To understand the requirements of future rail network, the first task is to understand the existing passenger and freight ecosystem and then how this ecosystem will change in future considering the growth in economy and socio-economic parameters.

As per the vision of NRP and NITI Aayog target given to Railways to increase the freight share from current 26% to 45% requires a detailed understanding of the freight volume currently using railways as preferred mode of transportation. This requires an extensive data, both from the primary and secondary sources, to be collected at national level.

Secondary Data Collection

Extensive secondary data from various sources and different stakeholders like Ministry of Railways and Ministries like Coal, Steel, Chemical, Fertilizers etc. was collected. The data collected from Ministry of Railways and various other sources are mentioned below:

Passenger Data:

- Passenger Reservation System (PRS): This is the system which allows a passenger anywhere to book train tickets from any station to any station. This data was collected to understand the current movement of passenger between different towns and cities.
- Unreserved Ticketing System (UTS): The unreserved ticketing from dedicated counters, replacing manual printed-card tickets with centralized online sales is done via this system. This information is very important as the share of the unreserved passenger is very exorbitant in overall passenger catered by railways.

Freight Ticketing Systems:

✓ The Freight Operation and Information System (FOIS): This system is responsible for optimized asset utilisation, management and control of freight movement and the generation of invoices. An electronic payment gateway is interfaced with the FOIS, and many of the large freight customers use this gateway for the payments.

Future Plan for Different Stakeholders

Sectoral reports of Ministry of coal, steel, petroleum, textiles, aviation, iron ore, and FMCG goods were collected to understand their future production plans. Discussion were also made with each of the identified stakeholders to understand any change in their plans or upcoming policy changes. These sectoral reports collected help in estimating the freight generation in future. Further, few ministries such Ministry of Civil Aviation and Ministry of Road Transport have initiated few nationwide policy measures such as UDAN, Bharatmala, development of Multi Modal Logistics Hubs (MMLP), Inland Waterways for freight movement.

All these have impact on future rail planning and therefore information on all these is required to plan for future rail network

The information collected from the secondary sources will help to understand the future freight ecosystem and travel pattern of the freight moving through railways. But there is substantial volume of freight traffic moving through road sector, one of major competitor to railways. It is important to collect the information of freight currently moving on roads in terms of major originating and destining zones, type and volume of commodities moving on roads including time and cost. This information is required to be collected through primary surveys as there is no secondary data available for the movement through road sector. The last comprehensive pan India report available where primary data/information on passenger and freight moving through road and other sectors was collected was 'Total Transport System Study, by RITES, 2008". As the report is quite old and there have been lot of development in road sector after 2008, so the information is required to be collected from primary sources.

As part of National Rail Plan, data of the freight and passenger moving on road sector is collected through primary surveys like traffic volume count and origin and destination surveys. This will help to forecast the total transport demand and planning for rail infrastructure.

✓ ***Primary Data Collection***

In order to establish the base line data for future demand, following traffic surveys were carried out:

- ✓ Classified Traffic Volume Counts
- ✓ Passenger and Goods Origin-Destination Survey
- ✓ Freight Stakeholders' Consultations

A total of 104 locations were selected for carrying out 24-hour CTVC and OD surveys on all 7 days of the week for this study. These survey locations have been identified using the following key parameters:

- Million Plus Cities, State Capitals and Union Territories
- Mine producing places
- NTPC, Major Refineries of India & Logistic Hubs
- Major Cement Production and Attraction Centres

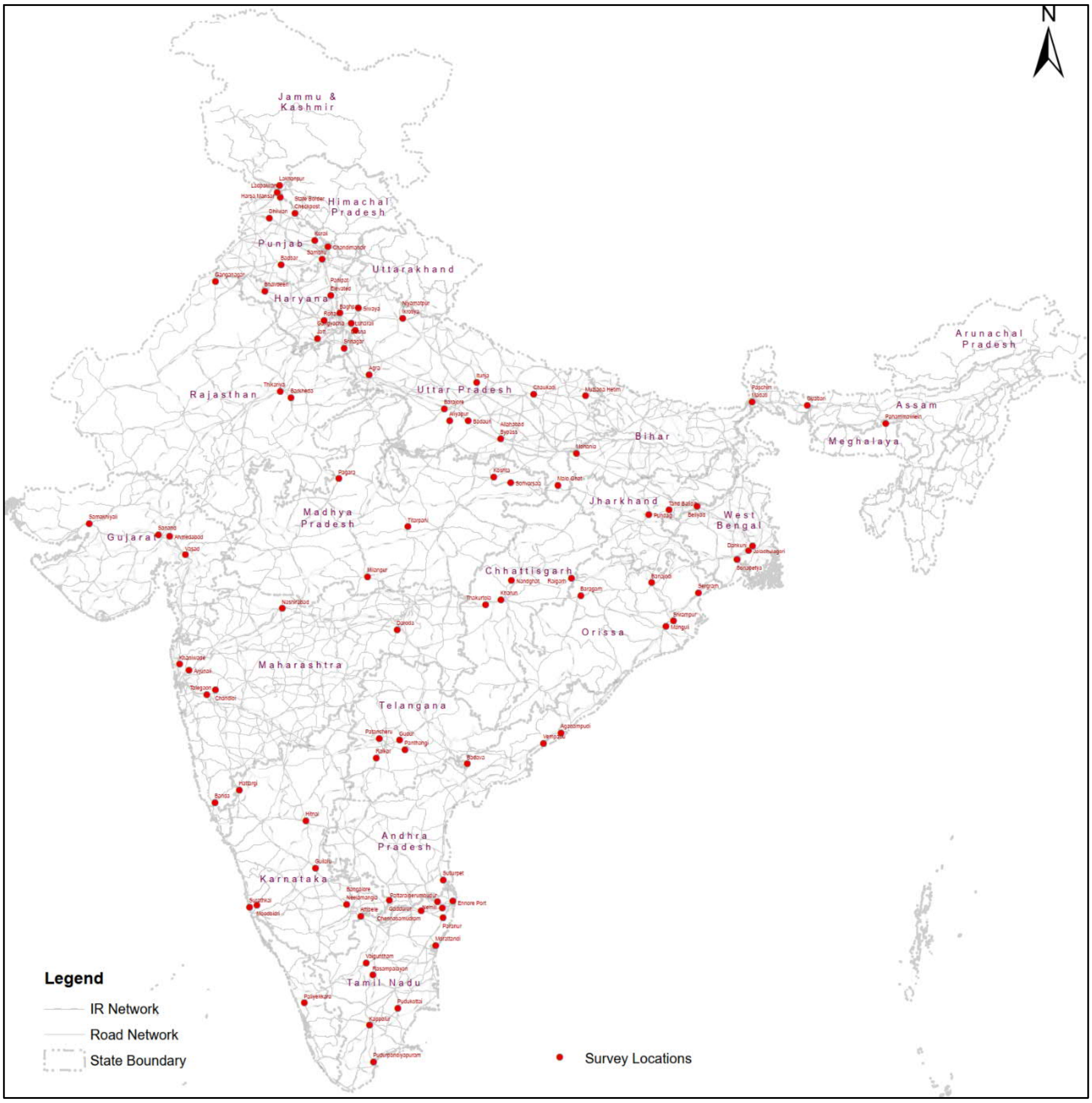


Figure 0-9: Classified Traffic Volume Count & OD Survey Locations

- FCI>10K
- Heavy Machinery production centres, Industrial Towns, FMCG;
- District Headquarters
- ICDs/ Dry Ports, Major Ports of India
- Coal Fields, Major Fertilizer Plants, Textile Hubs
- Religious Centres and Tourism Hubs
- Agricultural districts

After collection of primary and secondary data, analysis was made to understand the travel characteristics of passenger and freight traffic moving on different modes of transport. The analysed data will help to understand the past trends and to forecast the future growth trends.

Passenger Demand Forecast

The passenger data analysed from 2010-11 to 2017-18 for all passenger categories of Indian Railways shows that railway passengers have grown at a CAGR of 2% per annum. Maximum growth has been witnessed in AC category out of which 3rd AC passengers have increased at CAGR of 10.33%, 2nd AC at 6%, 1st AC at 6.74% and AC Chair Car and Executive class at 9% & 12% per annum respectively. In Non-AC category, Sleeper Class has grown at a rate of 4.4%, 2nd class sitting at 8.76% and unreserved at 0.89% per annum respectively.

Suburban passenger traffic has grown by 2.3% from 2008-09 to 2017-18. The share of suburban passengers to non-suburban passengers has also remained consistent from 55% in 2008-09 to 56% in 2017-18.

Table 0-1: Annual Growth of Passenger Traffic (Millions)

S. No	Class	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	CAGR
1	Sleeper Class	232.82	248.12	265.19	316.97	311.22	297.52	315.57	323.84	329.91	342.49	4.38%
2	3rd AC	38.61	45.03	53.25	60.35	70.08	68.60	78.27	84.48	89.08	93.54	10.33%
3	2nd Sitting	73.14	95.85	113.96	107.04	126.80	140.65	142.81	157.07	149.58	155.74	8.76%
4	Chair Car	13.54	14.56	16.69	19.44	22.13	24.46	25.89	26.52	27.42	29.28	8.94%
5	2nd AC	16.21	17.37	19.56	21.68	22.56	23.00	25.15	25.92	25.27	27.39	6.01%
6	1st AC	1.53	1.66	1.92	2.34	2.39	2.50	2.50	2.54	2.68	2.74	6.74%
7	Exe Chair Car	0.39	0.64	0.70	0.87	0.92	1.01	1.01	0.96	1.00	1.08	11.93%
8	1st Class	1.34	1.84	1.68	1.32	1.10	0.95	0.68	0.46	0.39	0.37	-13.28%
9	Unreserved	2,740.62	2,945.28	3,117.18	3,316.91	3,386.90	3,286.19	3,127.22	3,026.70	2,924.33	2,967.79	0.89%
	Total	**3,118.20**	**3,370.37**	**3,590.14**	**3,846.94**	**3,944.10**	**3,844.88**	**3,719.08**	**3,648.47**	**3,549.67**	**3,620.44**	**1.67%**
10	Suburban	**3,802.17**	**3,875.44**	**4,060.95**	**4,377.44**	**4,476.56**	**4,552.18**	**4,505.03**	**4,458.86**	**4,566.43**	**4,665.34**	**2.30%**
Grand Total		**6,920.37**	**7,245.80**	**7,651.09**	**8,224.38**	**8,420.66**	**8,397.06**	**8,224.12**	**8,107.33**	**8,116.10**	**8,285.77**	**2.02%**
Suburban Share (%)		**54.94**	**53.49**	**53.08**	**53.23**	**53.16**	**54.21**	**54.78**	**55.00**	**56.26**	**56.31**	**0.27**

In order to further analyse the growth trends, the above-mentioned classes were further clubbed into 3 broad categories namely; Long Distance AC passengers (LDAC), Long Distance non-AC passengers LDNA and Suburban.

Table 0-2 -Growth Trends in Passenger Traffic in mentioned Categories (Millions)

S. No.	Class	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	CAGR
1	LDAC	70.27	79.27	92.12	104.69	118.08	119.57	132.81	140.41	145.46	154.03	9.11%
2	LDNA	3,047.92	3,291.10	3,498.01	3,742.25	3,826.02	3,725.30	3,586.27	3,508.07	3,404.21	3,466.40	1.44%
Total		**3,118.20**	**3,370.37**	**3,590.14**	**3,846.94**	**3,944.10**	**3,844.88**	**3,719.08**	**3,648.47**	**3,549.67**	**3,620.44**	**1.67%**
3	Sub	**3,802.17**	**3,875.44**	**4,060.95**	**4,377.44**	**4,476.56**	**4,552.18**	**4,505.03**	**4,458.86**	**4,566.43**	**4,665.34**	**2.30%**
Grand Total		**6,920.37**	**7,245.80**	**7,651.09**	**8,224.38**	**8,420.66**	**8,397.06**	**8,224.12**	**8,107.33**	**8,116.10**	**8,285.77**	**2.02%**

Methodology for Passenger Demand Forecast

Passenger demand forecast was made using the following methodology:

- ✓ Stage 1 – Estimation of Horizon Year Production and Attraction Trips Ends: the origin destination matrices for passenger traffic were created from the data collected from various sources like PRS data, UTS data. Sum of all the horizontal rows of a Passenger Matrices is referred as Production Trip End and sum of all the columns of matrices is referred as Attraction Trip Ends.
- ✓ Stage 2 – Trip Distribution: The horizon year production and attraction trip ends have been distributed in rows and columns to obtain horizon year passengers matrices for LDAC, LDNA and Sub-urban Passengers for the years 2021,2026, 2031, 2041 and 2051.

Passenger Trip Generation

Growth rate of production trip ends was analysed with total population and growth rate of attraction trip ends was analysed with the total workers' quantum for each TAZ, for the purpose of estimating the elasticity of production and attraction.

Once the elasticity is estimated for production and attraction of Intercity AC (LDAC) Trips, Intercity Non-AC (LDNA) Trips and Sub-urban passengers, same has been applied on the forecasted population and workers quantum for estimating future passenger quantum produced or attracted by each of TAZ (Trip Ends) for the cardinal years of 2026, 2031, 2041 and 2051.

Forecast of Planning Variables

As described above, Population and Work Force Quantum have been used as planning variables for estimating production and attraction trip ends. Therefore, these planning variables have been forecasted for the purpose of estimating horizon year production and attraction.

Sub-urban Passenger Growth

The data related to suburban system expansion plans was collected from respective suburban rail corporations. All the cities where sub-urban system is operating such as Mumbai, Chennai, Kolkata and Hyderabad, have recently got prepared Comprehensive Mobility Plans (CMP) in which the daily suburban ridership has been forecasted. These estimates have been adopted as it is and are allocated in the respective zones of the matrix.

Future passenger growth rates were then estimated for the years 2021, 2026, 2031, 2041 and 2051.

Table 0-3: Adopted Railway Passenger Growth Rates

Years	Projected Population CAGR (%)	Projected CAGR (%) LDAC	Projected CAGR (%) LDNA	Projected CAGR (%) Suburban	Grand Total
2019-21	1.11%	7.87%	9.33%	1.52%	5.35%
2021-26	0.79%	8.50%	3.44%	1.17%	2.50%
2026-31	0.80%	9.02%	3.48%	1.07%	2.62%
2031-41	0.44%	6.47%	3.00%	0.85%	2.34%
2041-51	0.45%	5.43%	2.81%	0.64%	2.28%

Using the above-mentioned growth rates, the passenger forecast for different categories has been made and same is mentioned in the table below:

Table 0-4: Rail Passenger Forecast (Millions)

Categories	2018	2021	2031	2041	2051
LDAC	154.0	252.2	584.0	1,093.2	1,854.6
LDNA	3,466.1	4,529.8	6,364.0	8,555.3	11,289.1
Total	3,620.2	4,782.1	6,948.1	9,648.5	13,143.8
Sub-Urban	4,459.3	4,665.8	5,215.5	5,676.2	6,050.1
Grand Total	8,079.6	9,447.9	12,163.6	15,324.7	19,194.0

*Note: * Excludes Ridership Data of Kolkata Metro for the year 2017-18 which is otherwise included in Suburban Category*

Freight Demand Forecast

Freight Forecast Methodology

The potential overall requirements for transportation of commodities/ commodity groups were analysed & projected using the following framework.

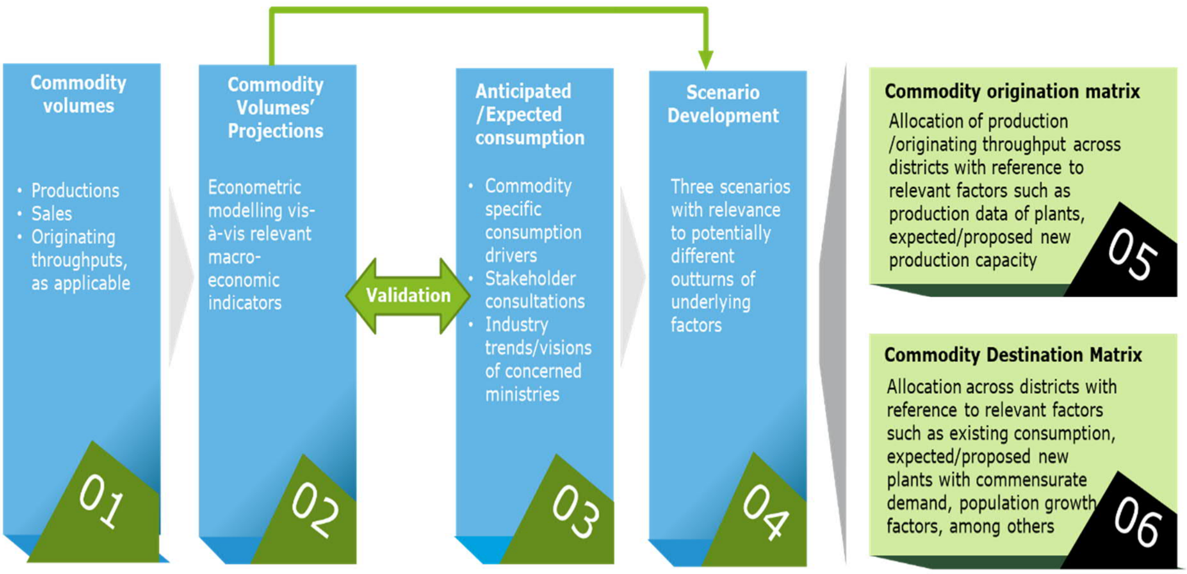


Figure 0-10: – Methodology for Freight Volume & Transportation Requirement Projections

Consolidated Projections

Total commodity volumes in the national freight ecosystem in FY 18-19 were projected at 4,708 MT as illustrated in figure below:

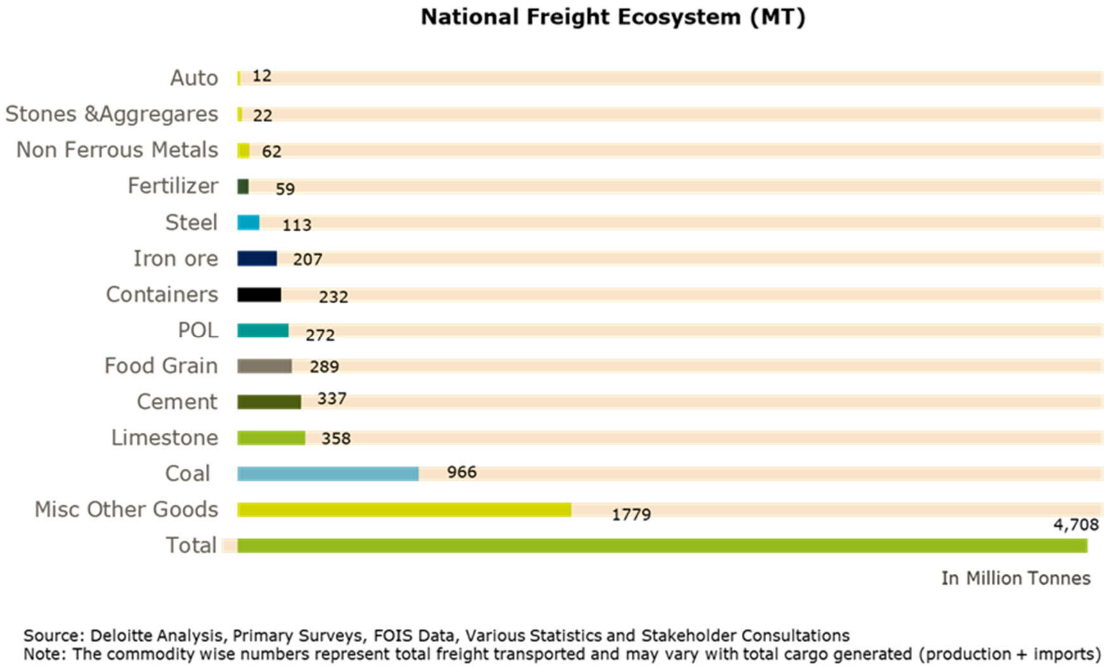


Figure 0-11: – National Freight Ecosystem

Production and consumptions will grow in future. For projection of Future demand of different commodities, different time frames are considered such as 2019-2021, 2021-2026, 2026-2031, 2031-2041 & 2041-2051. The Cumulative Annual Growth rate of different commodities are given in table below.

Table 0-5: Phase-wise CAGR of Commodities

Commodity wise CAGR	2019-2021	2021-2026	2026-2031	2031-2041	2041-2051
BOG	4%	7%	6%	3%	3%
Cement	14%	9%	6%	5%	5%
Coal	12%	3%	4%	3%	0%
Container	20%	5%	6%	5%	4%
Fertilizer	14%	6%	5%	4%	4%
Food grains	5%	3%	3%	3%	3%
Iron Ore	2%	6%	5%	4%	3%
Pig Iron	22%	6%	6%	4%	3%
POL	17%	8%	5%	4%	4%
Steel RM	6%	6%	5%	4%	3%
Total	9%	6%	5%	4%	3%

Total freight demand forecasted for different commodities are listed in table below.

Table 0-6: Projected Commodity Demand (in million tons)

Commodity (Demand)	2019	2021	2026	2031	2041	2051
BOG	2,172	1,922	2,638	3,499	4,774	6,309
Cement	339	399	601	813	1,355	2,114
Coal	965	1,052	1,237	1,502	2,081	2,136
Container	231	316	411	546	870	1,264
Fertilizer	61	74	100	128	196	284
Food grains	287	315	362	416	541	701
Iron Ore	207	221	295	377	569	798
Pig Iron	113	121	164	215	322	452
POL	273	329	484	629	930	1,323
Steel RM	61	56	74	95	143	200
Total	**4,709**	**4,805**	**6,366**	**8,220**	**11,780**	**15,583**

0.5. Estimation of Rail Freight Share

Total freight forecast by commodity has been presented in the table above. Subsequent to that, share of rail in carrying the commodities considering the future, production, demand and railway infrastructure improvement proposal has been estimated. For this purpose, mode split modal using Binary Logit has been prepared for the base year. The modal split model shall estimate the probability of share carried by railways based on certain parameters.

Railway Freight Growth Trends

Analysis of freight traffic through rail has grown at CAGR of 3.74% in last decade. Commodity-wise growth in different year is shown in table below:

Table 0-7: Railway Freight Growth Trends

Commodity	FY 9	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	CAGR
Coal	369.63	396.1	420.37	455.81	496.42	508.6	545.81	551.83	532.83	555.2	4.62%
RM for Steel	10.85	11.6	13.3	14.51	15.6	17.33	18.28	20.29	22.75	23.7	9.07%
Pig Iron & Finished Steel	28.58	31.85	32.82	35.15	35.31	38.95	42.84	44.79	52.41	54.36	7.40%
Iron Ore	130.58	132.74	118.46	104.7	111.4	124.27	112.77	116.94	137.55	139.8	0.76%
Cement	86.24	93.15	99.08	107.66	105.87	109.8	109.8	105.35	103.29	112.96	3.04%
Food grains	35.51	38.69	43.45	46.4	49.03	55.1	55.47	45.73	44.86	43.79	2.36%
Fertilizers	41.35	43.68	48.22	52.7	46.21	44.7	47.41	52.23	48.34	48.53	1.79%
POL	38.08	38.88	39.29	39.77	40.61	41.16	41.1	43.24	42.42	43.11	1.39%
Containers-Exim	23.29	25.32	26.58	28.54	31.69	32.61	37.88	36.79	37.01	42.82	7.00%
Containers-Domestic	7.05	9.63	11.01	9.48	9.35	10.93	10.5	9.04	10.34	11.12	5.19%
BOG	62.23	66.1	69.15	74.33	66.6	68.75	73.4	75.28	74.35	84.09	3.40%
Total	**833.39**	**887.74**	**921.73**	**969.05**	**1,008.09**	**1,052.2**	**1,095.26**	**1,101.51**	**1,106.15**	**1,159.48**	**3.74%**

Existing Scenario

A total freight movement of 4,464 million tonnes occurred across the country in year 2019. Of which 1,162 million tonnes were moved by rail, 2911 by road and remaining through other modes. Overall railways registered a market share of 26% in the total freight movement. The details are mentioned in table below;

Table 0-8: Share of Railways in Total Freight Movement (2017-18)

Mode	Tonnes (Millions)	Share (%)	NTKM (Billions)	NTKMS
Rail	1162.72	26%	616.38	29%
Road	2911.76	65%	1521.04	71%
Coastal Shipping	234	5%	N.A.	
IWT	72	2%	N.A.	
Pipeline	84	2%	N.A.	
TOTAL	**4464.48**	**100%**	**2137.42**	**100%**

Mode Choice Model

In order to estimate the rail share, binary logit model has been used. This model was first applied on the base year freight demand for the purpose of calibration so that the estimated modal parameters (co-efficient) provide results similar to what has been observed. These parameters will then be used to estimate future rail share.

Mode choice model has been developed based on the most evident factors of any freight transfer i.e. Travel Time and Travel Cost and the Probability of any Commodity to be transferred by any mode has been estimated by the Binary Logit Model. Utility equation is developed by the Difference of Travel time and Difference of Travel cost of the same Origin-Destination pairs of two different Modes (Road and Rail).

Scenario Building

Total 4 scenarios have been considered and these are explained below.

1. Scenario 1: Business as Usual (BAU): Rail Infrastructure Remain same but includes sanctioned projects such as Eastern and Western DFC, Mumbai Ahmedabad HSR and projects mentioned in the Pink Book. Whereas in case of Roads, projects like Bharatmala for highway development is considered as implemented.
2. Scenario 2: Enhancement of Average Rail Speed of Freight Trains from 25 Kmph to 50 Kmph.
3. Scenario 3: Enhancement of Speed by implementation of Railway projects corresponds to average speed to 50 Kmph from 25 Kmph & reducing cost on 4 items by 30%.
4. Scenario 4: Business as Usual (BAU) with reduction in Cost by 30%: Rail Infrastructure Remain same whereas, the cost being charged is reduced by 30%.

The Speed of Road and Rail and the cost of commodities considered are mentioned in table below.

Table 0-9: Comparison of Scenarios

Components	Existing Scenario	Scenario 1: BAU	Scenario 2: Enhancement Average Speed to 50 Kmph	Scenario 3: Enhancement of Average Speed to 50 Kmph with 30% less Tariff on selected Commodities	Scenario 4: BAU with Tariff Reduction by 30%
Operating Speed (kmph)	25	25	50	25-50	25
Railway Tariff		BAU	BAU	30% lesser than BAU on selected items	30% lesser than BAU
Daily Run in Road	350	450	450	450	450
Cost on Road	BAU	BAU	BAU	BAU	BAU
Rail Commodity Share (%)	**28%**	**24%**	**40%**	**30%-44%**	**31%**

For the purpose of estimation of rail share and working out the future network requirements, Scenario 3C has been recommended.

Scenario 3: Enhancement of Speed from 25 Kmph to 50 Kmph with 30% Reduced Tariff on Selected Commodities

In this scenario, the enhancement of speed from existing 25 Kmph has been considered. Speeds for freight trains considered as 50 Kmph to estimate the future rail share. Speed increase will reduce the travel time and attract the commodities to use railways

Further to adoption of above-mentioned speed differential, reduction of 30% in tariff has not been applied to commodities like Coal. Iron Ore, Raw material for Steel and Fertilizers. These commodities are traditional bulk commodities for railways and reduction in cost will not have much impact in increasing the share on railways. But for other commodities, reduction in cost will attract the commodities to use railways as preferred mode.

Table 0-10: Rail share for Scenario 3

Commodity	2051	2041	2031	2026	2021	2019	Existing
BOG	22%	20%	16%	9%	7%	7%	4%
Cement	51%	51%	50%	48%	46%	47%	37%
Coal*	74%	72%	70%	65%	61%	62%	65%
Container	48%	47%	43%	32%	29%	32%	24%
Fertilizer*	90%	90%	89%	87%	85%	85%	87%
Food grains	32%	32%	31%	28%	28%	26%	16%
Iron Ore*	82%	81%	77%	68%	60%	60%	65%
Pig Iron	70%	69%	69%	66%	64%	63%	49%
POL	48%	40%	28%	17%	15%	15%	18%
Steel RM*	60%	59%	58%	56%	55%	55%	56%
Total Percentage	**44%**	**43%**	**39%**	**33%**	**31%**	**30%**	**28%**
Point Percent Change	**+16%**	**+15%**	**+11%**	**+5%**	**+3%**	**+2%**	
Tonnes/ day, Scenario 3	18,863,731	13,857,702	8,676,969	5,742,684	4,108,379	3,357,614	
Million Tonnes/ Year	**6,885**	**5,058**	**3,167**	**2,096**	**1,500**	**1,226**	**1,162**
Tonnes/ day in Existing Situation	11,550,543	9,082,809	6,200,981	4,908,080	3,847,409	3,116,458	
Commodity Diversion (Tonnes/ Day)	**+7,313,187**	**+4,774,893**	**+2,475,988**	**+834,604**	**+260,971**	**+241,156**	

Comparison of Scenarios

Present modal share in Rail is 28% but if there is no augmentation in rail infrastructure and other modes particularly the road sector implements the Bharatmala Project which focus on improving the logistics efficiency of freight traffic than the rail share will come down to 24%.

Table 0-11: Rail Commodity Forecast by Scenarios in 2051 (Million Tonnes)

Commodity in million tonnes per year by Rail (2051)	Present	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Containerizable BOG	23	28	342	429	137
Non-Containerizable BOG	54	64	789	990	315
Total BOG	**77**	**92**	**1,131**	**1,419**	**452**
Cement	114	809	893	1,079	1,019
Coal	575	1,307	1,577	1,577	1,426
Container	54	202	560	610	370
Fertilizer	49	242	256	256	250
Food grain	45	117	151	225	200
Iron Ore	137	475	652	652	558
Pig Iron	40	222	259	318	296
POL	43	124	583	630	185
Steel RM	28	110	120	120	115
Grand Total	**1,162**	**3,701**	**6,182**	**6,885**	**4,872**

It is evident from the table above that out of the four scenario, Scenario 3 will attract the maximum traffic to railways. This is considered as the preferred scenario and has further been detailed out to find the share of different commodities under this scenario. This will help railways to plan for future infrastructure proposals as some commodities requires special wagons etc. to be procured to capture that commodity.

Forecast Rail Share

Forecast Rail Share by each commodities under Scenario 3 is presented in Table below:

Table 0-12: Rail Commodity Forecast for Scenario 3 (Million Tonnes)

Commodity	Existing	2021	2026	2031	2041	2051
Containerizable BOG	23	42	73	171	292	429
Non-Containerizable BOG	54	96	169	395	674	990
Total BOG	**77**	**138**	**242**	**567**	**966**	**1,419**
Cement	114	185	288	405	686	1,079
Coal	575	646	810	1,050	1,455	1,577
Container	54	90	132	234	374	610
Fertilizer	49	64	87	113	174	256
Food grain	45	88	103	127	165	225
Iron Ore	137	132	202	289	435	652
Pig Iron	40	77	108	147	221	318
POL	43	50	84	179	264	630
Steel RM	28	31	42	55	83	120
Total	**1,162**	**1,500**	**2,096**	**3,167**	**4,823**	**6,885**

From the table above, it is observed that substantial growth will be there in BOG i.e. containerize commodities followed by growth in Cement and Container traffic. This is future distribution of freight traffic on railways and accordingly railways have to plan for the infrastructure catering to the demand of these commodities

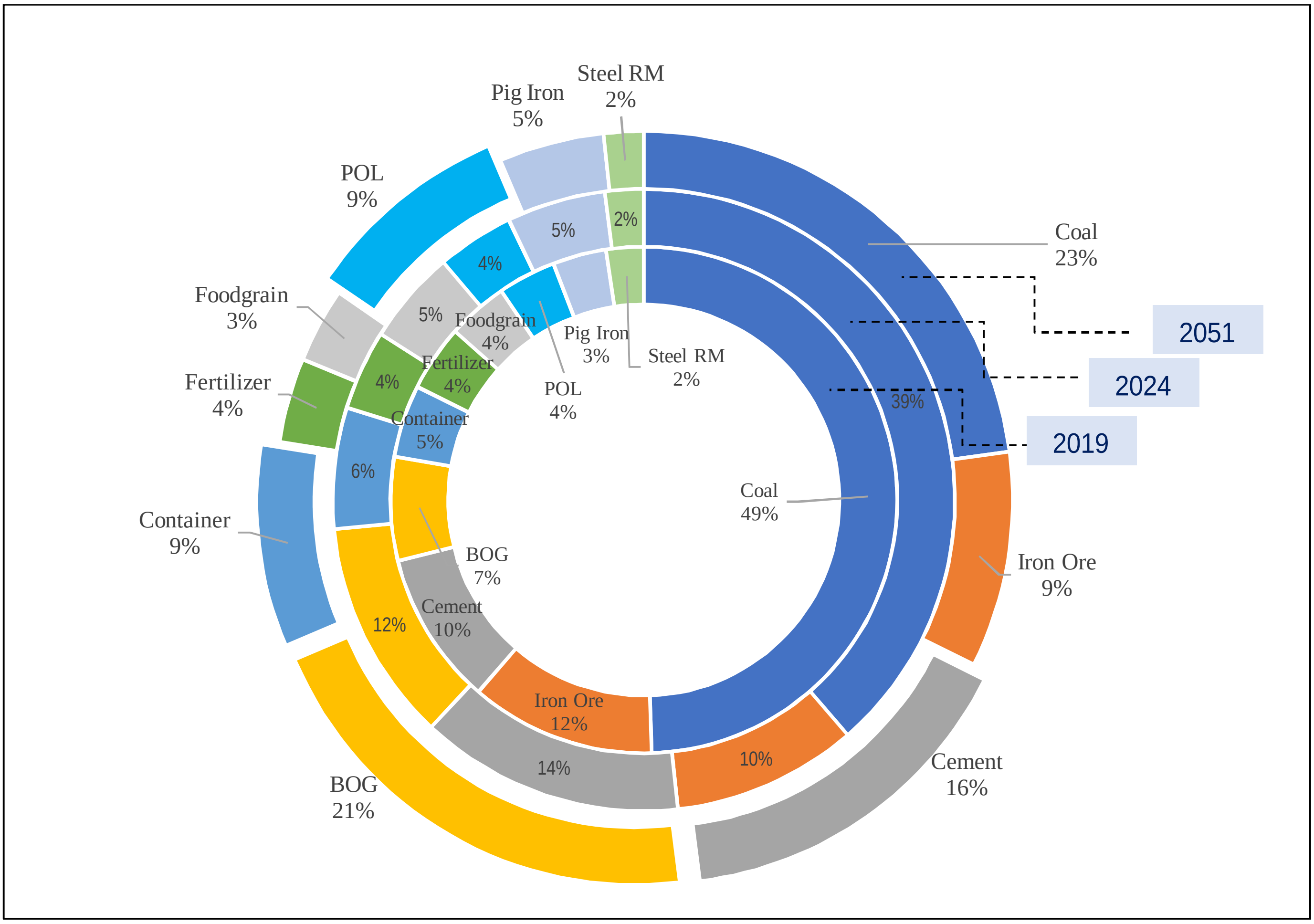


Figure 0-12 – Share of Commodities on railways in different cardinal years

0.6. Freight Flow and Modal Share Estimation

As discussed, a Binary Logit Model was developed to analyse potential freight movement over rail with reference to the two major parameters of overall logistics time and cost. As can be seen from the figure below, with a combination of higher than extant average speed of freight movement (at 50 km per hour) and reduction in the transport/ logistics cost by 30% from extant levels, the model estimates that based on relative cost-economics of various modes (including inter-modal transfers), railways could potentially cater to about 44% of the total freight movement.

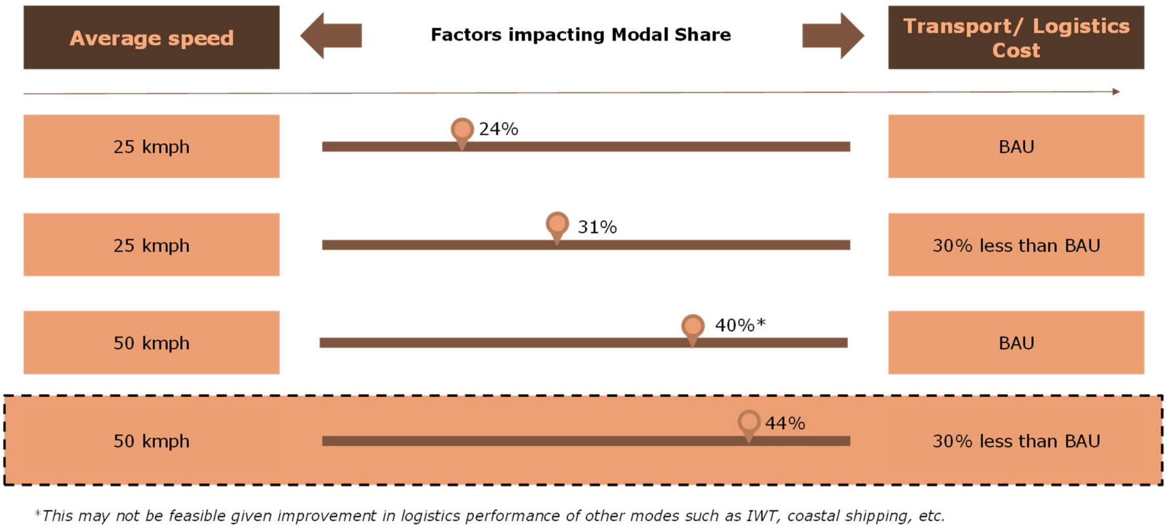


Figure 0-13. Rail modal share under different scenario runs of Logit Model

These changes in the two parameters of overall logistics time and cost could be affected as a function of a number of interventions targeted at improving provision, as well as transit speeds (and reliability).

Presently, the modal share of railways (at ~30%) in the national transport system is mainly attributable to transport of traditional bulk commodities (fertilizers, coal, iron ore and food grains) which constitute about 60% of Indian Railways' freight business.

Going forward, projections for potential freight transport demand in the national system suggest that commodity groups like Containers and Balance Other Goods would contribute a very significant proportion of the total demand (~48% in 2030).

As can also be seen from the figure (illustrating the existing rail usage/ share for various commodity groups), for enhancing its modal share, Indian Railways will need to cater to freight transport demand of other commodities (non-conventional as well as conventional high-value) which presently don't have a high rail co-efficient/ usage through appropriate interventions, strategies and product offerings.

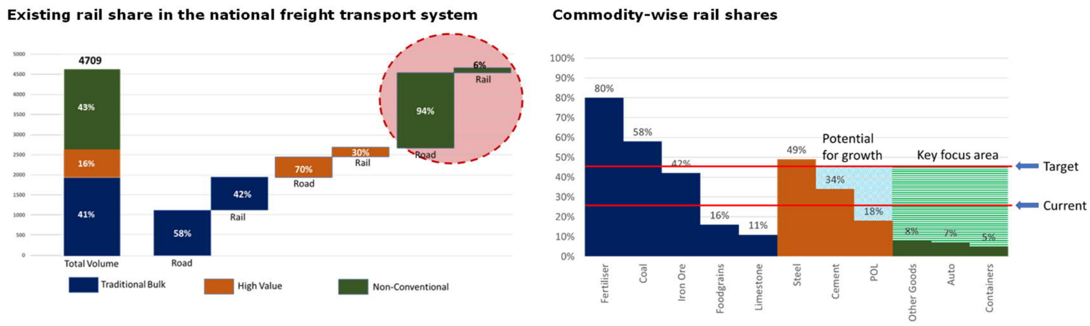


Figure 0-14 – Existing Commodity wise Rail Share

The analyses for the key commodity groups in terms of existing rail share/ usage, future growth potential for transport demand of such commodity groups, potential rail share/ usage and identification of key focus commodities for enhancement of overall rail freight share in the national transport system.

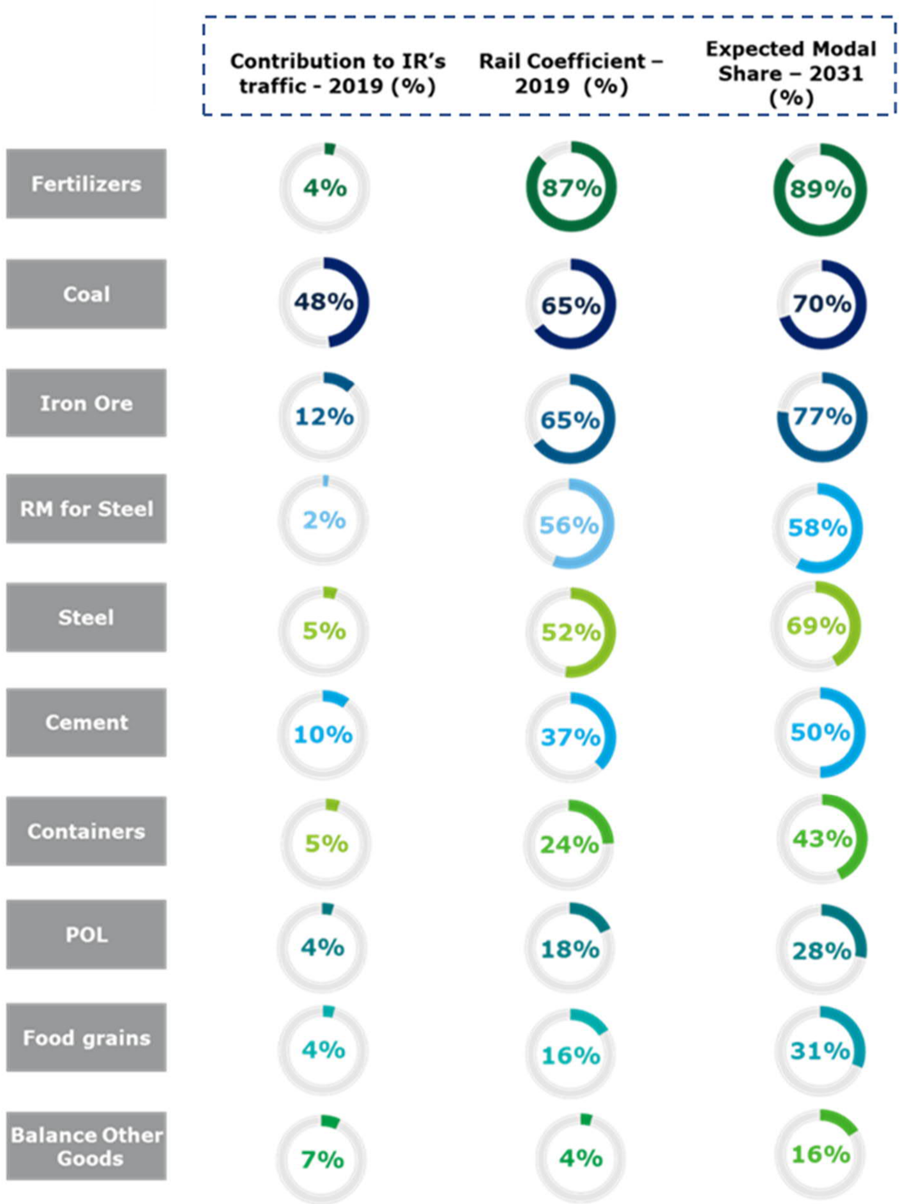


Figure 0-15. Key Commodity Groups, Existing Rail Share and Identification of Focus Commodities for IR

The key take-aways from the above analysis are:

- Commodities which already move substantially over the railway system may not contribute significantly to enhancement in rail freight share within the national transport system. In some cases, for instance coal and iron ore, introduction of slurry pipelines, pit-head power plant locations, increase in share of renewable energy sources in the electricity generation mix, etc. may start limiting further increase in movement of such commodities over the rail system.
- For certain commodities like POL and food grains, while the rail modal share is low, increase in transport demand of such commodities over the rail system may also remain limited due to inherent characteristics of such commodities, other developments and competitive position of other modes of transport – for instance, pipelines for movement of POL, and road transport for movement of foodgrains (shorter leads/ parcel sizes).
- Non-conventional commodities like containers and ‘balance other goods’ and conventional high-value commodities like steel and cement with need to be focused on for enhancing rail share in their transport over the national system. For containers and ‘balance other goods’, the overall rail share is low and these would be natural market segments of focus of railways given the projected growth in transport demand for such commodity groups. With substantial potential for increased containerisation of ‘balance other goods’, railways can enhance its competitive positioning for movement of such goods. For steel, while rail share even presently is sizable, there is further potential for transport of this commodity group vis-à-vis the MSME sector (almost 45% of the total throughput of the steel sector) which currently predominantly contributes to road transport. For cement, the potential cost advantage from converting bagged to bulk movements, could present a significant opportunity for increased transport by rail.

0.6.1. Framework for Considering Enablers for Rail Modal Share in India

Key enablers for consideration of Indian Railways for enhancing their modal share of freight transport have accordingly been considered with reference to the following framework. While the possible initiatives/ enablers categorized broadly under ‘service provision’ can be seen to be more material to users from the perspective of improvement in the overall logistics cost, initiatives/ enablers categorized broadly under ‘transit’ could be more material to users from the perspective of improvement in the overall logistics time.

Creation of adequate capacity in the network – in terms of track infrastructure, terminals as well as appropriate and adequate rolling stock – would also contribute to improvement of logistics time and cost experienced by users. While proposals for creation of track infrastructure as well as numbers and type of rolling stock have been discussed in other sections of this report, the requirement of freight terminals has been discussed as part of this section – including with reference to commodity types.

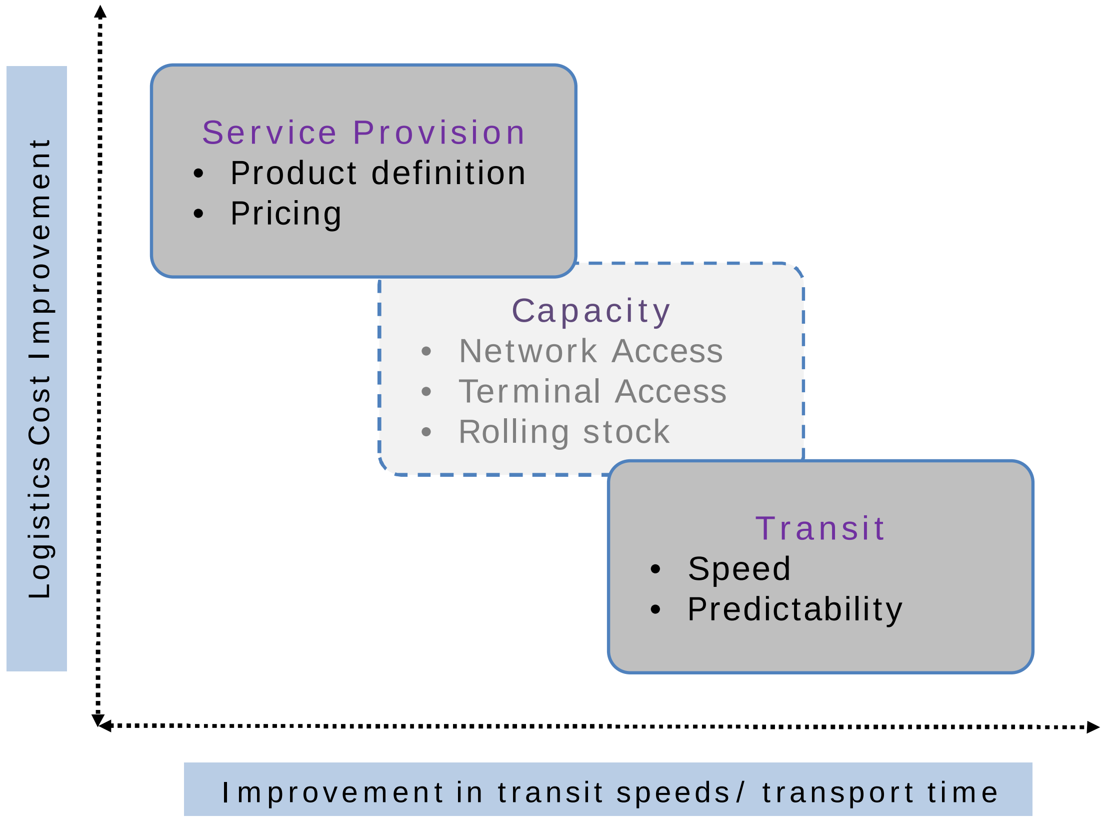


Figure 0-16. Framework for Considering Enablers for Rail Modal Share Enhancement

0.6.2. Service Provision

0.6.2.1. Marketing and Business Development

The Indian Railways' traditional role has been that of a supplier of 'terminal to terminal' rail transportation services. In the last 3 to 4 decades, this has further evolved in terms of movement of single commodity full train load or "rake" volumes. The attention of the Railways on carrying goods for which there is excess demand or a capacity shortage, has potentially contributed to the modal shift that has seen even some traditional customers move away from an organization.

Based on stakeholder interactions, discussions with market experts, and an evaluation of the existing policy framework for marketing and business development in the IR today, the following strategic initiatives merit consideration.

1. Setting up business development units that address the need for direct customer engagement.

2. A large part of the potential customer network – that which needs less than train load solutions, which needs hub-spoke operations, that for which pure terminal to terminal transport alone is not enough, a mechanism to engage such customers, through third party logistics service providers (LSPs)
3. IR could further leverage the availability of data within existing operating systems and harness the capacity of big-data analytics to provide more data driven solutions and provide much greater transparency in information availability to its customers.
4. Existing policy formulations are sometimes repetitive, at other times in conflict with each other, and mostly transactional rather than strategic in nature. There is also a tendency at times for such policy formulations to be restrictive/ conservative for investor returns, as a result of which they do not attract the extent of participation required or anticipated. There is therefore a need to re-vamp policy and make it more customer and investment friendly for Indian Railways to become relevant in its chosen markets.

1. ***<u>Business Development Units</u>***

Understanding customer needs and requirements is the first step in creating a viable solution, and this has already been initiated. The following table provides reference to some specific suggestions of customer groups. IR has already addressed some of the suggestions/ problem areas and is looking to find policy frameworks to address others.

Table 0-13: Certain Suggestions from Customer Groups Provided to IR

Commodity	Stakeholder Suggestions
Cement	- Assured Rake Availability - Improvement in Rail Connectivity to be developed by IR - Reclassification of Clinker as a Raw material - Development of special purpose wagons for Clinker - Infrastructure modernisation and innovation
Steel	- Piecemeal loading to be promoted - Easing of GPWIS policy to encourage investment in wagons - PCC of Coking coal to be revised downward - Waiver of Demurrage charges due to slump in market - Short lead discounts below 100 km - Long lead discounts for Iron Ore beyond 1400 kms - Proliferation of 25 T axle load routes - Reduction in frequent loading restrictions - Rebate in engine hire charges during lockdown period - Liberalise sanctions for imported coal

Commodity	Stakeholder Suggestions
	- Mini Rakes for Steel - Inter-plan Iron pellet transfers to be allowed
Automobiles	- Need to cast a wider net by targeting SUVs, 2 Wheelers and LCVs by modification of wagon design for BCABM - BCACBM is designed for 110 kmph in empty and 105 kmph in loaded condition, but currently only 90 kmph maximum speed is permitted - Increase wagon height from 4305 to 4877 mm (equivalent to dwarf container envelope) to allow double decker movement of bigger cars - New wagon design for 2-Wheeler movement - Notify design modifications so that cost of maintenance is not recovered from the AFTOs.
Containers	- Container Sector is most operationally ready to help increase modal share of rail - Three Key areas to be addressed for modal share increase – Transit, Terminals, Pricing - Request for policy on transit commitments instead of time-tabled trains - Rationalise CRT access – create a common user access platform and reduce costs - Simplify pricing – reduce cost of empties, remove CC and FAK segregation in container pricing, remove charging of container weight along with cargo, long term haulage commitments - Single rake-based pricing mechanism - Base universalisation for maintenance – moves toward private maintenance of wagons

Source: Experts from Minutes of meetings held by Railway Board (in the presence of MR) with Stakeholders of key commodities like Steel, Cement, Automobiles, Containers etc.

2. *Enablement of LSPs and provision of end to end services*

While rail transport is conventionally considered cheaper than road on a per/tonne-km basis for longer leads, the cost of first & last mile connectivity and additional handling cost at modal change terminals can often neutralize this cost advantage and even make the total cost for rail transport higher than that for end-to-end road transport.

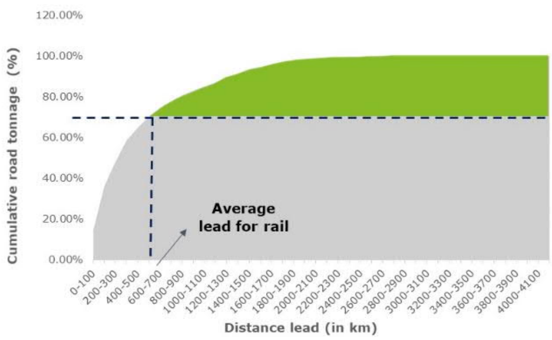


Figure 0-17. Road Traffic Distribution across Different Leads, FY 2019

The key benefits that involvement of LSPs can provide with respect to addressing the specific service needs and attracting cargo from these segments include:

a) Providing flexible parcel sizes by running consolidation services
b) Providing on demand end to end logistics solutions
c) Providing transit assurance at market/ competitive pricing

In order to attract and transport freight from this segment, IR needs to reach out to end shippers in a more efficient manner and establish an institutional mechanism wherein IR can partner with LSPs to leverage their superior market access and create end-to-end logistics products for prospective customers. LSPs can consolidate freight and provide single point of coordination as well as add on services to such customers. LSPs can also issue suitable documentation (negotiable instruments) and requisition rakes for mixed cargo needs, apart from providing first/last mile services through other service providers.

While IR's rail network provides considerable geographical reach, the lack of ability to provide terminal handling services and first and last mile connectivity prevents the Railways from being recognised as an integrated service provider. Creating a separate policy and institutional mechanism within the railways that focuses on developing or enabling these capabilities will allow the IR to leverage its long lead transport capability with value additions that can convert it to a formidable end to end logistics solutions provider.

In parallel to a policy framework for enabling LSPs, IR may also need to consider developing capabilities within the organisation to support provision of value-added services beyond the pure rail transport product. Instead of creating an organic 'Ground-up' Model where such skills are developed in-house, an alternative could be acquisition of / partnership with road freight operators/LSPs that provide end-to-end logistics services and combining their first and last mile offering with a rail solution. The roles and responsibilities to be fulfilled under such a partnership could include:

- Fleet operations and management;
- Monitoring of prevalent road prices and developing a suitable blended pricing model to keep cost of end-to-end product competitive with a pure road product;
- Providing additional value-added services such as storage, distribution, sorting of cargo etc. using the terminal locations already in place; and

- Identification of, and creating suitable partnerships with, potential partner companies/vendors (established freight forwarders, large logistics service providers or local trucking companies etc.) which specialize in providing first and last mile connectivity along with other value-added services like storage, packaging, labelling, track and trace etc.

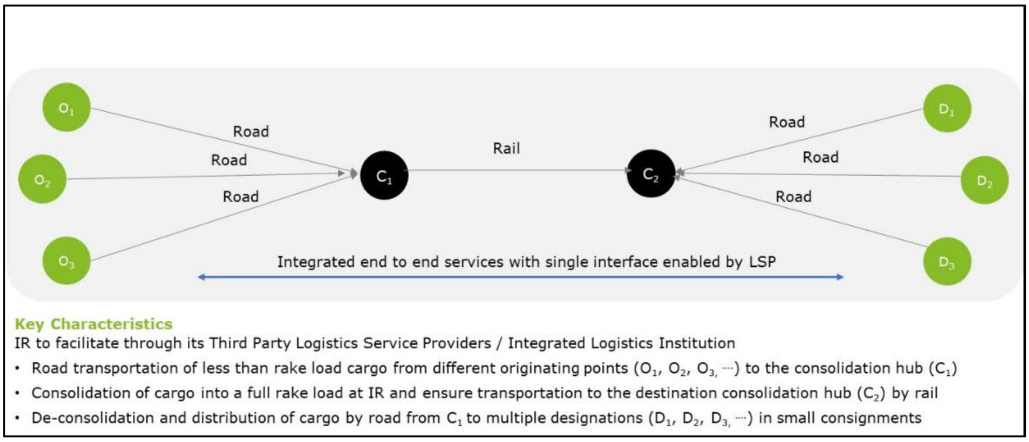


Figure 0-18. Salient Features of Proposed end to end Services by IR

A prime objective of creating such a partnership is to re-focus the commercial attention of IR from a supply-determined to a demand-driven organisation. A horizontal/ flat structure is therefore recommended for the unit, to allow for greater collaboration and promoting the ability to provide a holistic product offering. The institutional setup should ideally be structured around the following three functional themes:

a) *Customer Interface*: This would include understanding and analysing customer requirements, gathering market feedback, providing design inputs for product/service design, conflict management and resolution among others.
b) *Product/ Service Design*: This would include bridging gaps between the expected performance and current services offered by IR by way of designing comprehensive rail-road based solutions. Additionally, this role will also be responsible for reviewing global best practices and benchmarking activities in the domain of intermodal transportation and services over time.
c) *Operations and Management*: This would focus on aspects related to 'on ground' implementation of planned services comprising entering into

agreements/ contracts with respective logistics players across the value chain, allocating resources for conducting processes seamlessly, and scheduling activities in coordination with existing railway management systems.

Figure 0-19. Key themes of Operational structure of the Proposed Business Development Units

3. *Data Driven Solutions*

The process of rail freight transportation begins with a customer placing an indent (or demand for wagons/rake to load cargo), followed by sanction/approval of indent by IR, placement of a rake at the required loading terminal, loading and subsequently network transit.

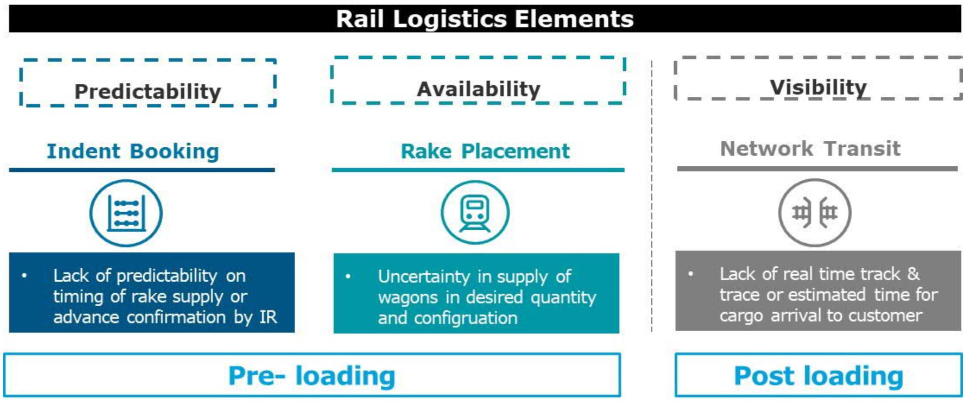


Figure 0-20. Key Elements of Rail Transit

Consultation with stakeholders across the various stages involved in this process indicate three primary areas of concern with respect to information provision/ certainty as indicated below:

a) Predictability in Wagon Supply – Customers find it difficult to plan their supply chain flows in advance if they use rail as a dispatch mode;
b) Availability of Wagons on Demand – Due to lack of visibility, and uncertainty in supply of wagons, any sudden demand spurts or supply line disruptions are usually met through road despatches; and
c) Adequate Track and Trace Functionality – Customers need to get better visibility of their cargo movements in order to integrate these with their larger supply chains, production, and market delivery plans.

There is accordingly a need for IR to provide information with adequate periodicity and transparency, to enable advance planning for rail services in line with customer requirements.

Figure 0-21. IT Based Tools

A. *IT Based Tools –*
- Using the existing FOIS platform, IR can extract historical data related to rake indents, identify existing gaps in rake availability for different terminals, zones, customers as well as commodities and devise appropriate solutions to create a more optimum match between demand and supply of rakes.
- Inputs can be further sought from potential customers, with regards to their load planning, and these can be integrated into a future rake movement plan to ensure that the most efficiently available rakes in terms of time, distance etc. are made available to customers based on their advance plans.
- In cases where there is a change in demand, this can be received from customers and used to create alternate supply patterns with least delay or inefficiency in terms of rake movements.
- Providing data on route and terminal restrictions along with details of likely lifting of such restrictions, as well as historical analysis of congestion outcomes based on demand raised for rakes or cargo movements along such routes/terminals.

B. Digital Customer Interface –
- A digital interface does exist through the FOIS system. This can be further enhanced for providing better visibility and enabling more active planning support (through tools) for IR customers. Some of the potential functionalities for such an interface could include:

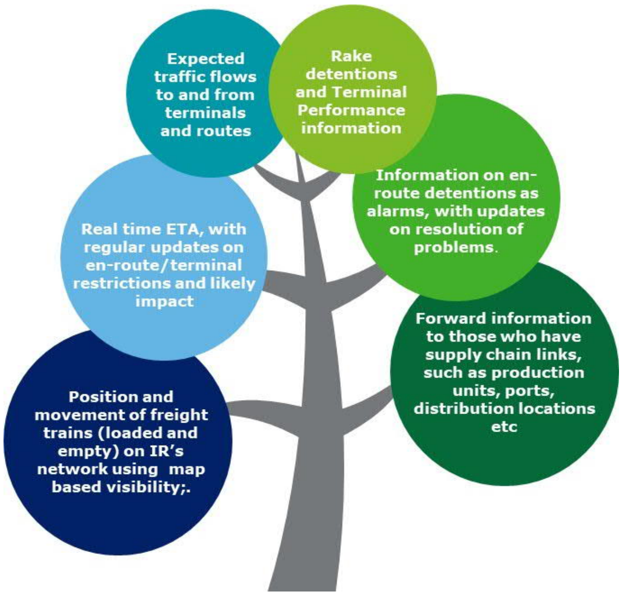


Figure 0-22. Key Functionalities of Proposed Digital Interface

- Such an interface will enable IR to extend and provide visibility to customers from the time of placement of indent with reference to 'how', 'when' and in "what" configuration rakes will be made available for loading. The information will further enable supply chain planning, reduction in inventory holdings, improved linkages with first/last mile and terminal operations, and in all help improve efficiency of transit for end-users.

C. Establishing service level commitments for rake supply and movements –

- In the present scenario, a customer has to pay a 'Wagon Registration Fee' as a security deposit at the time of placing indents. On successful delivery of the rake by IR, followed by timely loading of the rake by the customer, this amount is adjusted against the overall tariff that the customer has to pay. As a penalty for false or speculative indenting, the registration fee is forfeited in case of cancellation of the placed indent (after physical supply of wagon). There is also a penalty mechanism for detention to the wagon for loading beyond the allowed free time.
- Presently, there is no system of reverse penalty to be paid by IR in case there is a delay in the provision of the required rakes at a confirmed time. While a penalty backed transit assurance has been suggested earlier, as we move away from a supply-driven institutional set up to a market-oriented system, there is a need to introduce a 'two-way penalty' mechanism with respect to confirmation of rake availability, placing of trains for cargo handling, detentions for provision of locomotives etc. by IR.
- In addition, IR can also consider adopting a premium/differential pricing model based on the urgency of customer demand. This can be with relation to priority for rake allocations, transit, placing of trains for handling etc.

4. *Policy Formulation*

In order to support modal shift, railways need a stable policy framework with fair operating conditions and based on certain key tenets.

Clarity and Transparency – Ease of Access	**Implement ability – Lack of Complexity**	**Attractiveness for Investment on Win-Win basis**

Figure 0-23. Key tenets for stable policy framework

The existing policy framework with respect to freight operations on the Indian Railways is characterized by multiple policies and corrigenda over time that hinders transparency and clarity of such policies for rail users. Based on an overall analysis on this account, IR may consider the following recommendations.

a) All relevant policies be consolidated into a database with ease of searching across topics, updates etc. While the mere posting of policy and circular PDFs does place this information in the public space, it remains difficult to search and collate any information to support investment decisions, understand available use options, discounts, restrictions on applicability etc. An IT application needs to be developed for this purpose, which captures existing policy formulations on an as-is basis, and also creates a mechanism for updates and new policy introductions so that the commercial policy regime can be maintained as a searchable data-base with ease of access for rail users.

b) A strategic deep dive into existing policies and consolidation of these into broad sub-headings with simpler, more transparent, and investment friendly frameworks. Possible action agenda on two key areas reviewed as part of this study (and study of existing policies) - Pricing and Definition of Rail Products and Development of Terminals, have been presented in this section.

c) Presently, in the absence of a formal regulator, the Indian Railways (IR) itself functions as the operator, policy maker, service provider and regulator. This can lead to conflicts of interest and situations where key issues relating to pricing, and service quality remain unaddressed. There has been a substantial increase of private participation in various aspects of rail operations. There may be merit in considering an independent institutional mechanism for regulation at this stage. The institutional mechanism could span and also cover aspects pertaining to investment returns for private investors, as well as smooth operationalisation of Public Private Partnership (PPP) initiatives for development of rail infrastructure. This aspect has been discussed in another section of this report.

0.6.3. Pricing Reforms

It is estimated that while the operating ratio for IR's freight business in FY19 was 0.59, it was 1.92 for IR's passenger business. This inherent cross-subsidy is contributing to IR's haulage charges being higher than its global peers even after adjusting for purchasing power parity.

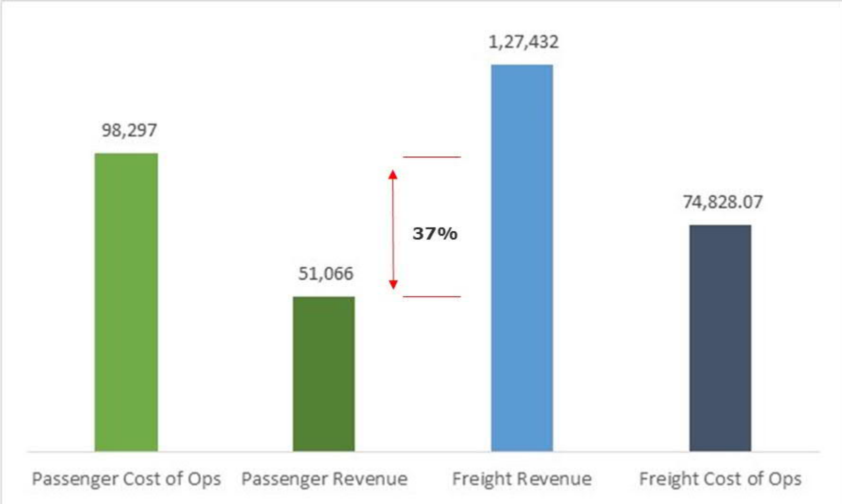


Figure 0-24. IR Passenger vs Freight Revenue, FY 2019 (Rs cr)

The haulage charges, and their market competitiveness/ impact, however, vary across commodities. Rail has a clear advantage/ competitiveness in transporting large and heavy volumes over longer leads, in terms of landed cost, for bulk commodities. As bulk commodity transportation involves point to point (e.g. mine to thermal plant for coal) movement with no first/last mile movement and automated handling, rail tends to be cheaper than road.

Also, since the market for certain bulk commodities like food grain, fertilizers etc. is often controlled or influenced by certain "National Policy Interests", rail pricing for such commodities (determined by their commodity classification in the IR goods tariff) often keeps them competitive vis-à-vis road movement.

For high value commodities such as steel and cement, and for non-bulk commodities like containers and 'other non-conventional domestic goods', rail tends to 'lose out' to the road sector on a landed cost basis even for longer leads. This is again due to the

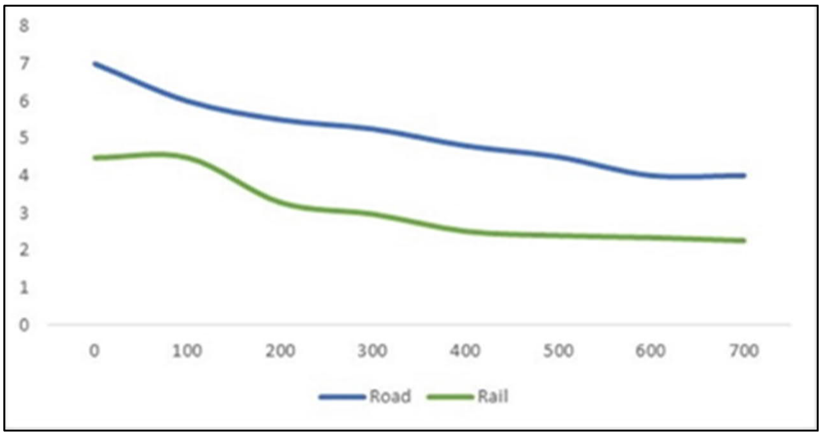
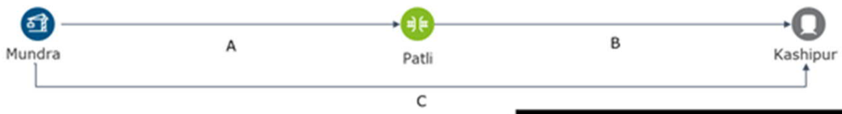


Figure 0-25. Logistics Cost for Bulk Commodities- Road vs Rail (Rs/Tkm)

impact of costs for first/last mile transportation, and terminal handling at one end, as well as the haulage charges such commodities being under a higher commodity class in the IR goods tariff on the other.



Mundra – Kashipur		
Cost Elements	Cost per FEU (in Rs.)	
Single Stack Operations (C)		
Cost per FEU	57,902	
Double Stack Operations	**Case 1 – Heavy FEU below and light above**	**Case 2 – Only 25 FEUs above**
Haulage Charge to Patli (A)	26,440	29724
THC/TAC	5400	10793
Haulage Patli – Kashipur (B)	10,793	3500
Rake holding cost	5,333	6857
Cost per FEU	47,966	50874
Savings	**17%**	**12%**

Mundra – Patli	
Cost Elements	Cost per FEU (in Rs.)
Single Stack Operations (A)	
Cost per FEU	43933
Double Stack Operations (A)	
Haulage Charge to Patli	26,440
THC/TAC	5400
Rake holding cost	4,000
Cost per FEU	35840
Savings	**19%**

Figure 0-26. Pricing Issues for Certain High-Value Commodities

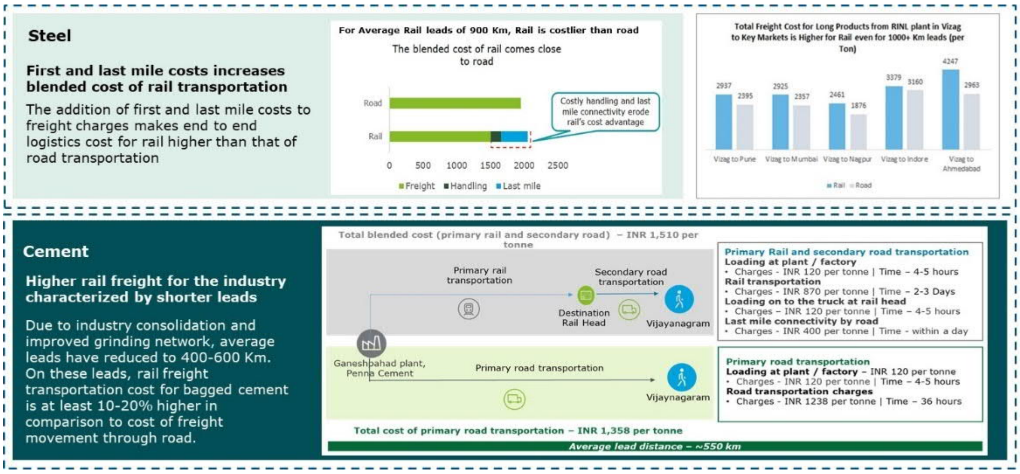


Figure 0-27. Potential Cost Savings for Double Stack Operations on DFCs – Mainly for Upper Stacked Containers

With the operationalisation of the eastern and western DFCs, rail logistics cost is expected to come down considerably (by 10 to 20%). However, such savings may not provide rail transport with a decisive edge over road transport mainly because of emerging technological as well as operational improvements in the road sector, which are expected to parallelly drive down trucking cost as well.

Considering this background, certain broad recommendations are provided below on issues related to pricing - on what needs to be considered to rationalize pricing and make it more aligned to market considerations.

1. *Financing Passenger Subsidies:*

IR must actively rationalize and reduce the burden of a much higher operating ratio of its passenger business on freight cost – potentially in a phased manner by gradually adopting alternative mechanisms to finance such subsidies.

a) Such mechanisms could include targeted subsidies through commitment/ support from specific government departments as required. For example, HRD ministry can support student discounts, Ministry of Social Justice and Empowerment can fund senior citizen discounts, Ministry of Defence can support discounts for defence personnel etc.
b) Besides direct funding of discounts, state governments and local bodies that seek to benefit from economically unviable passenger train services can be requested to provide budgetary support, through operational grants, for the same.
c) Finally, if there is an imperative (social) for keeping passenger charges pegged at "affordable" levels which are below reasonable cost of service provision, direct government budgetary support targeted at such passenger operations could be considered.

2. *Revision of Pricing Philosophy:*

The current pricing philosophy on Indian Railways has reference to a fully distributed cost model, with organizational inefficiencies contributing to higher costs across lines of businesses.

Table 0-14. Indian Railways Working Expenses (2018-19)

Expense Heads	% share	INR (bn)
General Superintendence & Services	4.28%	79.1
R&M-Pway & Works	7.89%	145.8
R&M-Motive Power	3.57%	66.1
R&M-C&W	8.28%	152.9
R&M-P&E	4.36%	80.6
Op Expenses-RS & Equip	7.46%	137.9
Op Expenses-Traffic	14.65%	270.7
Op Expenses-Fuel	16.44%	303.9
Staff Welfare & Amenities	3.89%	71.9
Misc. Working Expenses	3.84%	70.9
PF, Pension & other Retirement Benefits	1.26%	23.2
App. To DRF and Pension Fund	24.09%	445.1
TOTAL		**1,846.6**

As discussed earlier, for railways to enhance their market share of transportation of focus commodities, they would need to have reference to various aspects like total logistics costs for customers, varying discounting regimes during initial stages of market creation and capture, prioritisation with reference to net accretive contribution vis-à-vis volumes/ leads/ network utilization, etc.

Accordingly, there is need for IR to revisit its freight pricing levels and align them with competition considerations. This exercise would include:

a) Understanding pricing dynamics of road sector – IR could set up a market intelligence mechanism (which would ideally be independent or outsourced) for assessing the pricing structure of road sector and how it varies across commodity segments, peak/off peak seasons, empty load directions, and leads, among others.
b) Indexing rail price escalation based on transparent parameters – Freight tariff escalation linked to variation in specified parameters/ indices can help provide longer-term visibility and pricing guidance/ certainty for customers to plan their logistics networks/ operations.
c) Calculating demand elasticity to pricing changes – Based on analysis of the above two factors, assessment of price sensitivity of different commodities with respect to changes in road as well as rail haulage charges needs to be undertaken to establish the potential range within which rail haulage can be varied, as well as identify and subsequently monitor potential modal share changes/ benefits from such variations.

These changes will require modification of the existing pricing framework from a cost-driven to a data and market intelligence driven system. The primary objective of such an exercise would be to help identify commodity segments where IR can adopt differential pricing based on mechanisms of discounting and premium charges such that prices are competitive vis-à-vis costs for road transportation and can therefore be used to effect modal shift from road to rail.

3. *Specific Pricing Initiatives:*

(a) An Integrated Haulage Charge

As indicated in the figure below, the total logistics cost for customers incorporates multiple elements – rail haulage, terminal handling costs, first and last mile transportation costs and even empty wagon repositioning charges in some cases. In comparing transportation by rail versus road therefore, it is this overall cost that determines modal choice and not merely the per tonne/km rail and road haulage charges.

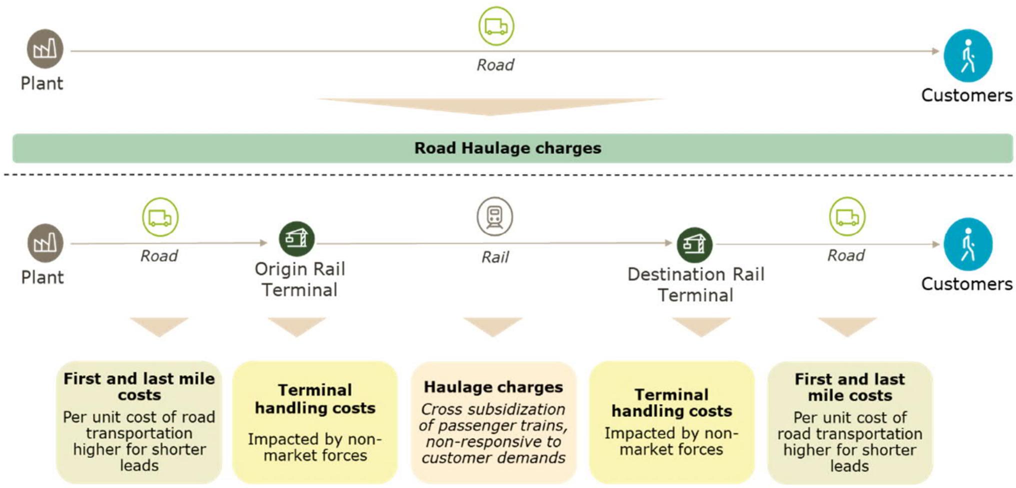


Figure 0-28. Total Logistics Costs for Customers Transporting Freight by Railways

As discussed earlier, IR needs to consider the possibility of providing/ enabling first and last mile connectivity, as well as terminal handling services for its customers through establishing relevant institutional and policy mechanisms and encouraging partnership with LSPs. The benefits of providing such end-to-end products, in terms of inducing modal shift to rail, can however only be fully realized by institutionalizing a pricing structure which makes the total logistics cost for customers of rail transportation competitive vis-à-vis that for road transportation.

Presently, first and last mile as well as terminal handling services are provided through the market, and customers are free to make their own arrangements for the same. This practice however has tended to create scale inefficiencies and certain market imperfections in the form of control of transport and handling services in certain locations, as a result of which such services are often provided at higher costs and with reduced efficiencies.

In this context, IR can consider offering a single landed price to its customers covering costs across the entire chain, with an apportionment mechanism for first and last mile or even terminal handling services. Vendors can be appointed for transport and handling activities through a competitive bidding process, with scale efficiencies being provided through commitment of volumes or clustering of locations.

Two factors however need to be kept in mind in this context. The first is that this activity should not be seen as a potential for generating incremental revenue for IR, as this could lead to a padding and inflation on costs. Accordingly, IR should not seek a revenue or margin share from potential vendors – other than as required for covering certain minimum administrative costs for provision of such a service. The incremental freight volumes that can be attracted through consolidated pricing should remain the primary focus of such an exercise. The second factor that needs to be kept in mind is that such a practice should not lead to market monopolization by selected vendors, as even with controlled pricing, such monopolization can lead to poor service efficiencies through reduced asset reliability or availability. In order to retain efficiency in both cost and service provision, either multiple vendors could be appointed for a single location, or private vendors allowed to continue to offer services in competition with selected vendors – creating choice for end users and driving market-based efficiency in operations.

(b) Volume and Train based pricing for Light Cargo

Presently, rail freight charges are based on a minimum weight per wagon basis. This often results in light cargo such as FMCG products, Consumer Durables, and many other general and Containerizable goods not finding rail transport competitive due to a relatively high component of dead-weight haulage being paid based on defined carrying capacity of wagons (rather than what is physically being carried). Even in instances where there are differing weight slabs offered for haulage, the baseline charging is linked with the heavier slabs as a result of which light cargo gets disadvantaged. In comparison, road either follows a volumetric charging concept for lighter cargo, and does not add the weight of the vehicle or container as part of the chargeable freight element. As investment planning under the NRP (as further fine-tune from time to time) generates additional capacity in the network, IR must look to develop a volume-based pricing mechanism to attract light cargo, which today has a miniscule share on the rail network. Increasing the envelope of moving dimensions where possible with the introduction of DFC corridors, and even within the existing rail network will also help increase the volume capacity on rail carriage and make volume-based pricing more effective for both IR as well as rail users.

Another possible mechanism for volume based pricing could be to price for some select commodity groups (especially those being carried in containers) on a “per train load” basis instead of on a “weight per wagon or slab” basis, allowing cargo consolidators and rake owners to determine the overall cargo mix based on a blended train rate instead of a targeted per wagon or per tonne rate.

(c) Station and Route Based Pricing

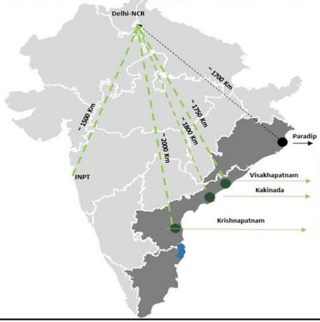
Presently, pricing on IR is independent of any OD specificities, as a result of which the same distance and weight-based rates are applicable irrespective of demand and supply conditions on specific routes. By offering innovative pricing structures on select routes or for select commodities, IR can induce modal shift from road in addition to shifting traffic from congested routes to underutilized routes. For instance, on select routes, IR may consider ‘Corridor Based Pricing’ instead of static pricing structure - which is route neutral, to promote new routes by offering discounts on:

- Top OD pairs for key commodities – For example special rates for rice and retail cargo exports from North India
- Routes with spare capacity

- Routes with specific imbalance – For example EXIM routes for containers between NCR and Punjab and ports on the West coast

Corridor Based Pricing

Reduction of haulage charge by upto 13.5% on eastern routes can open up 1–1.5 mn TEU market



Terminal	Containers Handled	Spare Capacity
PICT	6334 TEUs	-

Terminal	Containers Handled	Spare Capacity
VCTPL	388,289 TEUs	48%

Terminal	Containers Handled	Spare Capacity
KCTIPL	21,338 TEUs	78%

Terminal	Containers Handled	Spare Capacity
KPCT	479,552 TEUs	40%

	Delhi-JNPT	Delhi-Vizag
Charges		
Haulage	27,988	32,388
Handling	3500	3500
First/Last Mile	8500	8500
Total	39,988	44,388
Illustrative Charges		
Haulage	27,988	27,988
Handling	3500	3500
First/Last Mile	8500	8500
Total	39,988	39,988

Figure 0-29. Illustrative Example of Possible 'Corridor Based Pricing' on IR

Source: Industry Consultations, Indian Railways Goods tariff, Consultant Analysis

(d) Discounts provided by Indian Railways

The Indian Railways have provided incentives for attracting additional rail volumes through various discounting schemes that are presently in operation. These include encouraging empty flow movements, long term contracts and volume commitments, round trip moves, short lead and long lead incentives etc. among others. The following table shows the broad coverage of such initiatives along with recommendations for areas of improvement in extant policies.

Table 0-15. Broad Coverage of Existing Discounts/ Initiatives on IR and Possible areas of Improvement

IR Policy	Extant Features/Terms	Recommendations
Traditional Empty Flow Direction (TEFD) ***TCR/1078/2019/2*** ***Dated: 23/04/2020***	**Policy aims to reduce empty return ratio and generate additional revenue by attracting cargo in empty flow.** **Empty flow streams have been identified in the policy and FOIS auto discounts cargo moving on these routes.** **Allows small parcels of up to 10 wagons for covered, and 30 for open wagon types to be covered.** **All empty flows are charged at 100 Class rates.**	**Extend policy to include Containers as cargo imbalance is a major cost impediment for private rail operators.** **Removal of rule for applicability only beyond certain threshold volumes in instances will widen the scope and applicability of the discount and result in greater transparency.**
Long Term Tariff Contracts (LTTC) ***TCR/1078/2016/14*** ***Dated: 30/03/2017***	**Policy targets volume commitments, price stability, and incremental volumes.** **Rebate offered is increased based on percentage of volume growth committed from base year (5% growth is minimum).** **Overall volume linked discounts are also offered in the policy.** **No price escalation to take place in mid-year for participants, even if such increases have been announced by IR.**	**Extend to include containers and automobile operators, where long term customer contracts are the market norm.** **Consider reduction of eligibility from 1 MTPA to ½ MTPA to expand scope to customers offering light weight cargo.** **A pure volume-based discount tends to work more in favour of larger players – An alternate measure could be to offer discounts based on modal share of traffic offered by the customer rather than on overall volume.** **Relax the minimum three-year time commitment required to participate in the policy.** **For price stability, expand the concept to include longer price visibility with pre-agreed escalation terms on an annual basis.**
Round Trip Traffic (RTT) ***TCR/1078/2020/3*** ***Dated: 05/06/20***	**Policy targets empty flow reduction by incentivizing the booking of round-trip cargo** **If cargo is booked on round trip basis on exact circuit or within a 200 km range, the lower of the two commodity class rates is charged for both streams.**	**A round trip scheme is also needed for containers, but as containers are currently not charged on a commodity class basis, a fixed discount as a percentage can be considered for round trip moves.** **Policy is currently restricted in terms of applicability for some terminal categories – such restrictions should**

IR Policy	Extant Features/Terms	Recommendations
		be lifted for wider applicability and flexibility.
Short Lead and Long Lead Discounts ***TCR/1078/2020/07*** ***Dated: 30/06/2020***	**10-50% discounts are offered for leads up to 100 km.** **Discounts can be committed for long term up to 10 years basis customer commitments.** **Long lead discounts beyond 1400-1500 Km offered for Coal/Coke, Iron/Steel, and Iron Ore – Discounts are in the range of 15-20%.**	**The minimum distance for short lead discounts needs to be increased to at least 300 kms as many commodities like Cement have considerable road share on such short lead traffic.** **The extension of policy for Containers will help attract port to ICD volumes for facilities closer to the port area that are currently entirely based on road flows. (This can also help decongest port facilities whenever there are import surges.)** **There are some long lead domestic cargo circuits (such as Delhi-Chennai, Delhi-Bangalore, Mumbai-Kolkata, Delhi-Guwahati etc.) which will benefit from a long lead discount offering to other commodities like Auto, Containers and light weight cargo.**
Dynamic Pricing ***TCR/1078/2015/14*** ***Dated: 20/09/2015***	**Dynamic pricing is generally covered in three categories –** **Busy Season Surcharge** **Development Surcharge** **Congestion Surcharge** **At present a 9-month busy season surcharge of 15% stands withdrawn** **5% Development surcharge is applicable on all commodities** **Congestion surcharge of 25% and 20% is applicable on Bangladesh and Pakistan Cargo, while 10% Port congestions surcharge stands withdrawn**	**The system of surcharges should ideally be done away with as capacity is built into the system.** **A premium service charge may be considered where customers are provided commitments on transit, guaranteed wagon supply etc. but such a charge should also be accompanied with a corresponding penalty to be paid for failure on part of the IR to meet commitments for which premium is charged.** **The 5% development surcharge may be incorporated within the tariff structure for simplicity.**

Across various policies announced by IR from time to time, there are some common elements that also need to be addressed. These mostly relate to simplification and ease of use, and include the following:

- Most of the policies are aimed at retention of existing customers instead of targeting new ones. The focus needs to be expanded to attracting fresh cargo profile alongside expanding wallet share from existing customers.
- Automation of applicability through the FOIS system.
- Railways may also consider concurrent applicability of certain policies for key/ focus commodities, service types, etc.
- Instead of announcing policies only for limited validity, to provide certainty/ visibility to customers to plan their logistics/ operations, typically the default mode should be for policies to be valid for a certain minimum time period (1 or 2 years) unless the policy is only proposed to address a short-term issue/ tactical objective (which itself should be rare)
- Instead of updating policies through corrigenda, ideally the revised policy should be issued when changes are required, so users do not need to keep track of master circulars, and multiple changes over time.

(e) Weighment related issues:

Since all pricing on IR is based on cargo weight, accurate weighment of cargo, as well as means to identify the difference between tare weight of rolling stock and cargo payload are important factors to be addressed to bring about a fairness in the weighment process.

Presently, weighment of rakes is done on in-motion weighbridges located either inside private sidings, or at specified locations on the IR network. Some of the problems related to weighment of cargo include:

- Inaccuracy of weighbridges due to calibration problems – Difference in weighment between weighbridges often leads to disputes or high penalty impositions that act as a disincentive for rail movement.
- Inability for bi-directional weighment (especially at older sidings), leading to inability to weight empty wagons – Using printed tare weight of wagons leads to inaccuracy as wagons may increase in weight over time due to rusting, deposition of cargo residue etc.
- In the case of containerised cargo, the weight of containers is included as part of cargo weight as there is no mechanism for recognising container weight separately from cargo. As a result, almost 2.5 tonnes per TEU of dead freight has to be paid for containerised cargo, which leads to a competitive disadvantage in comparison to road freight for containerised or containerisable cargo.

Possible solutions to address/ ease some of these problems – to be implemented in conjunction with other suggestions on pricing reform/ initiatives above, could include:

- Streamlining of calibration process and gradual upgradation of older weighbridges with modern facilities that are not limited to uni-directional weighment and which have higher error tolerances to speed of movement for weighment.

- Legislating a standard container weight of 2.5 tonnes per TEU as container weight that can be excluded from chargeable weight in the case of containerized traffic.
- Accepting 'Said to Contain' cargo weight for charging for commodities where the actual carrying capacity for such commodities is below the permitted carrying capacity for the wagons given light weight of such commodities.
- Revising Permitted Carrying Capacities for wagons and commodity combinations to reduce the impact of dead freight haulage which disincentivizes rail transportation, especially for light cargo.

0.7. Transit

As discussed earlier, overall transport & logistics cost and time are often seen as the two key drivers in decision making on modal choice between road and rail. Customer requirements for shorter transit times stem from a need to reduce inventory levels in the supply chain by getting efficient, on-demand dispatches and deliveries. In the current market construct, road transport tends to deliver shorter transit times when compared to rail across multiple commodity segments as illustrated below.

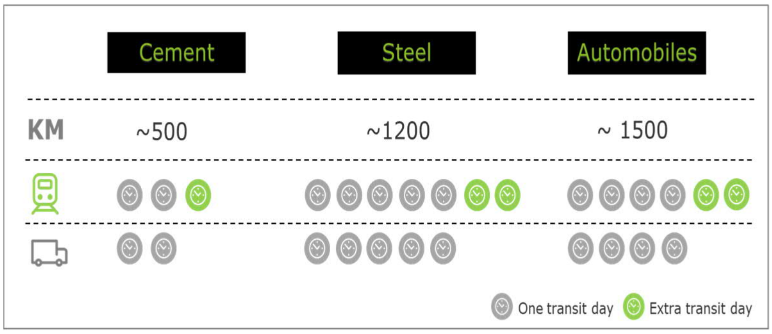


Figure 0-30. Transit Time for Key Commodities (Rail vs Road)

On the Indian Railway (IR) system, freight operates on an 'available path' instead of an 'allocated path' basis. As the overall network is currently overutilized, with 46% of the network operating at greater than 80% capacity utilization levels, there results a lack of predictability or

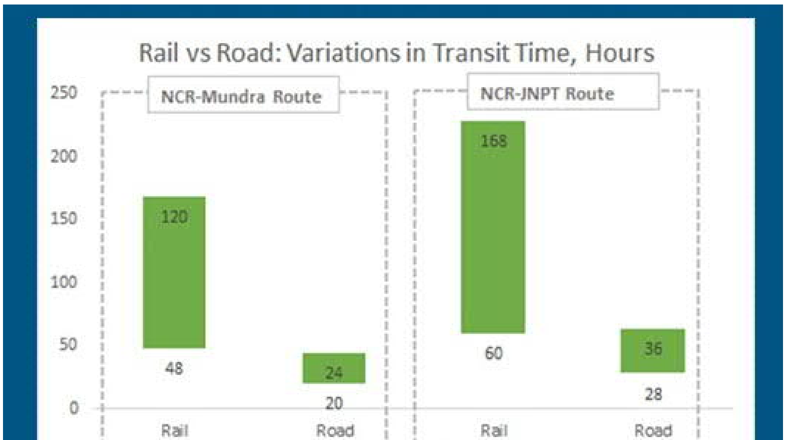


Figure 0-31. Illustrative Variance in Transit Time Between Road and Rail Modes

certainty for freight transit on a system where freight and passenger services are shared on common routes.

Besides overall transit times, IR's inconsistent service offerings with respect to transit are often incompatible with the desired value proposition of "service reliability" that is crucial for most shippers. This is especially so in case of EXIM and Domestic containers, Parcel traffic, and other higher value retail cargo, which is crucially dependent on predictable, on-time transit performance.

The issue of longer transit times and transit variability can be attributed primarily to the overall capacity constraints and system of operations in force on the IR network. While issues related to capacity enhancement are dealt with elsewhere in this report, some improvements can also be achieved through systemic or policy related changes.

0.7.1. Improving Daily Runs/ Average Speeds of Goods Trains

Freight traffic in the Indian scenario operates on a mixed traffic operational construct where freight trains compete with (and generally lose to) passenger trains for preference on train paths and line capacity on common track sections. This is evident from much lower average freight train speeds on Indian Railway's network compared to passenger trains[1], and also when Indian Railway freight train speeds are compared to its global peers as illustrated below.

In recent times, when passenger train services have been significantly impacted (terminated or considerably reduced) due the CoVID-19 pandemic, average freight train speeds on the IR network have seen an increase (from the earlier 24 kilometres per hour) to more than 40 kilometres per hour in the absence of (competing) passenger train services on common tracks.

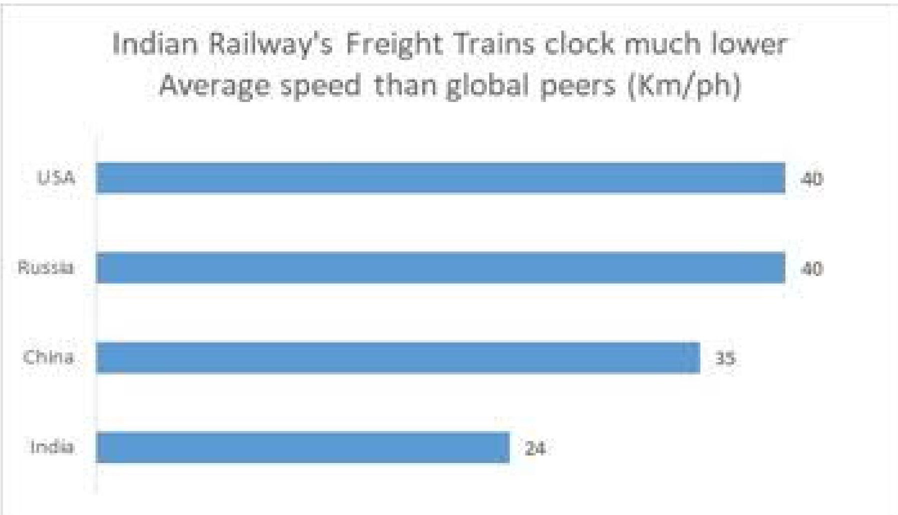


Figure 0-32. Average Speed of Freight Trains

[1] *Average speed of Goods trains on IR is 24 kilometers per hour (kmph), and for Passenger services (combined) it is 44 kmph*

While average speed does tell us how effectively the network is being leveraged, for the end-users or railway customers, it is not speed but instead transit (i.e. the time taken for goods to reach from one place to another) that is more important. The distance covered per day is therefore a better measure for evaluating effectiveness of network use if we look at it from a customer service lens.

In this context, the current average daily run of 200-250 km on Indian Railways remains low compared to what freight customers realize on road via trucking as illustrated below. It is pertinent to highlight that the daily runs for rail's main competitor viz. trucking are also expected to increase by at least 100-150 km per day in the coming decade with the advent of better/faster trucks[2], highway upgrades under the Bharatmala initiative, rise of new business models like relay trucking etc. In this context, for Indian Railways to attract and carry more freight, it must improve

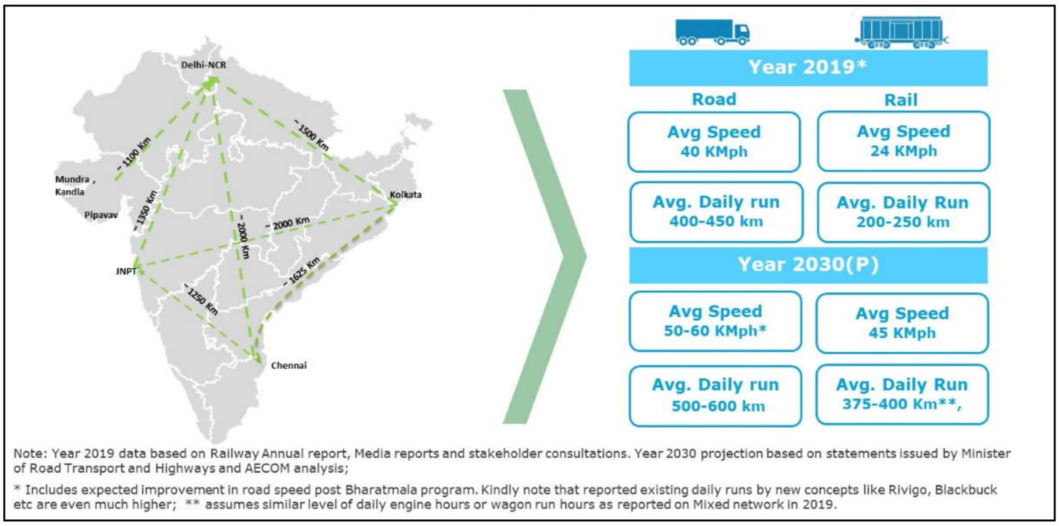


Figure 0-33. Average Daily Runs: Road vs Rail

its daily run performance for freight trains and achieve targets equating or bettering those that are prevalent for road-based transport.

Besides improving track capacity, the following can also facilitate improvement in daily run for freight trains:

5. **Maximum Permissible Speed for Rolling Stock**: As most new wagons being introduced on the IR network are already rated to operate at speeds of 70-100 kmph, the constraint of rolling stock speeds will likely get eased over time. Increased focus on private wagon procurement, and replacement of existing fleet with better designs after their useful life/ retirement will also ease this possible constraint to a higher average daily run outcome.
6. **Reducing time spent at Terminals**: Activities such as loading and unloading of cargo, waiting time for trains to be placed or removed from handling lines, and maintenance time for rolling stock, require considerable time which takes

[2] *Electric trucks provide operational cost savings for various heads in range of 5%-30%, further resulting in lifecycle cost savings in range of 5%-10% as per "Analysis of long-haul battery electric trucks in EU: Marketplace and technology, economic, environmental, and policy perspectives, 2018"*

away from the availability of rolling stock for open line movement. Optimization of terminal use/ time spent by improving terminal capacity and quality could also reduce some of the time spent at terminals and help improve time on open line – translating into a better performance in terms of average daily run for freight rolling stock.

7. **Reducing idle time when cargo is in transit**: Another enabler could be efficiency of track use and reduction of idle time or congestion while cargo is in transit. Reducing idle time would need a multipronged approach and some suggestions that could be considered independently of physical capacity expansion of track infrastructure are:

5. Shift from zone based planning to integrated corridor based planning:

Besides operational planning, which is done at Divisional and Zonal levels, IR's current planning process also entails individual zones and divisions developing line capacity renewal and expansion proposals.

However, several key corridors or routes fall under the operational jurisdiction of multiple zones/divisions. As a corridor's capacity is invariably driven by its weakest link, zone-based planning can lead to shifting of bottlenecks from one zone to another while the corridor as a whole remains congested. To illustrate this problem, if we look at the Delhi Kolkata corridor, a quick capacity impact analysis, corresponding to increasing rail traffic levels, reveals shifting bottlenecks across zonal jurisdictions. In this context, shift to a Corridor based integrated planning would ensure holistic resolution of capacity constraints on the IR Network.

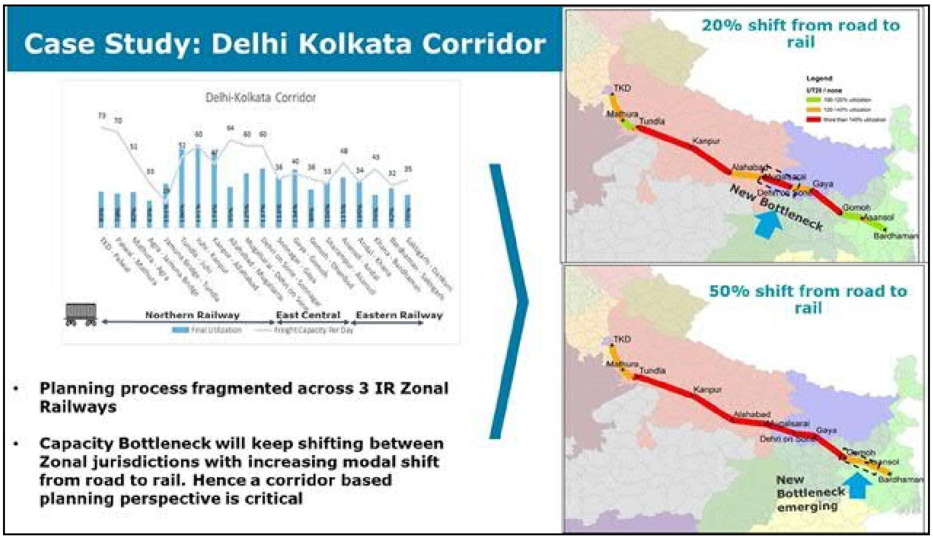


Figure 0-34. Corridor Based Integrated Planning

Source: IR's Sectional Line Capacity Charts showcasing capacities for FY 17 and FY 21 sourced from Indian Railways. Existing Road volumes along the corridor were sourced from primary surveys undertaken earlier in this study and assigned assuming One rake carries 3000 tons. The congestion in the network was estimated by adding resulting rake volumes to various sections.

6. *Carving out a Ring-Fenced Freight Sub-Network:*

Even with the operationalization of Eastern and Western Dedicated Freight Corridors (DFCs) and completion of other capacity enhancement works currently under execution, IR may not be able to generate adequate capacity for freight trains based on likely demand forecasts if operations are continued on an 'as-is' mixed network model. Capacity constraints on non-DFC corridors are expected to continue and even grow with several sections remaining saturated even after timely completion of all ongoing works[3]

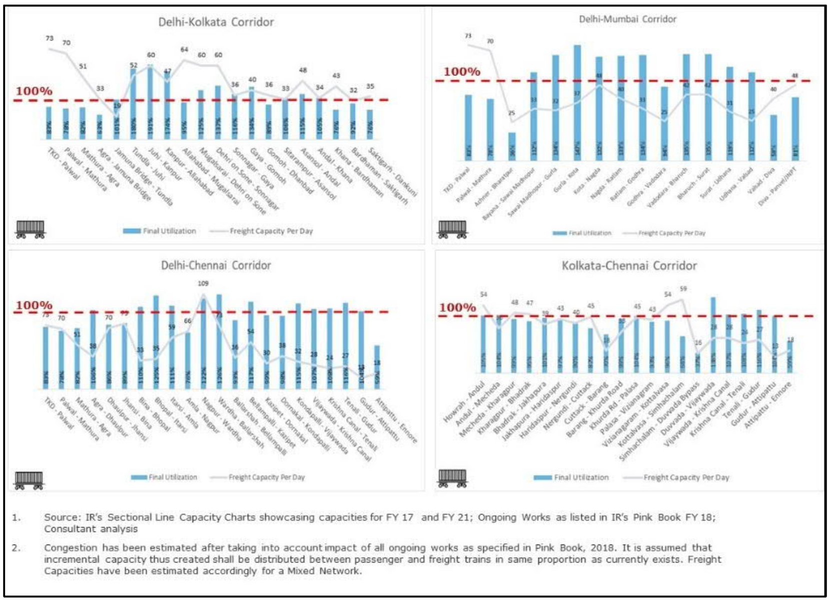


Figure 0-35. Capacity on Key Rail Corridors after Completion of Sanctions Works

A congested mixed network will continue to impede IR's capability to provide adequate logistics performance/ assurance to its customers as a result of which the daily running time and kilometer runs of freights trains will remain low. On the other hand, on dedicated freight sub-networks, the conflict with passenger trains for running slots is eliminated, and a larger number of paths for trains running on similar average speeds can be scheduled. This would directly lead to comparatively longer and uninterrupted running hours at sustained speeds, thereby generating higher daily kilometer runs.

This hypothesis has been borne out in the post COVID period where reduced passenger services on the network created a dedicated network type of a situation and led to increased freight speeds from 24 to 40 kmph.

It is therefore recommended that even beyond the execution of DFC projects, as capacity enhancement works are executed in the form of third and fourth line projects, separate passenger and freight sub-networks should be carved out in order to ring fence IR's freight operations and generate adequate capacity to carry targeted

3 As listed in Indian Railways pink Book, 2018 volumes at the desired level of logistics performance required to encourage further modal shift to rail.

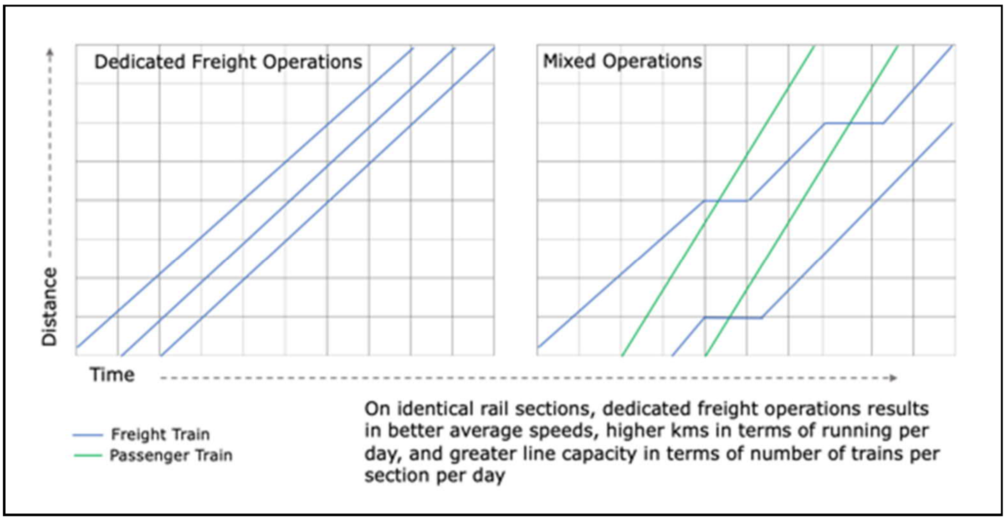


Figure 0-36. Increased Capacity for Dedicated Freight Operations

0.7.2. IT Enabled Operations Optimization and Train Planning Systems

Micro-level planning for current freight operations are generally undertaken at a "Divisional" level with train control horizon spans limited to sections of 60-200 km at a stretch. IT driven solutions that use data analytics, simulation modelling etc. can enable greater efficiency in rail planning.

On the IR system, there already exist multiple software systems – operated mostly through the Centre for Railway Information Systems (CRIS), that support train operations in different ways. These include FOIS (Freight Operations Information System), COA (Control Office Application) , ICMS (Integrated Coach Management System), SATSaNG (Software Aided Train Scheduling and Network Governance), CMS (Crew Management System), TMS (Track Management System), LMS/SLAM (Loco Maintenance System) etc. These have a large amount of historical and real-time train running information. An integrated system that uses data already available in various applications and can act as a decision support system to optimize train movements along a corridor is the need of the hour to optimise network usage for higher logistics performance for IR's customers. The proposed system would need to interface with current IR systems to achieve the following objectives:

- Efficient use of Railway Network by Freight and Passenger Trains leading to additional paths for traffic;
- Reduction in cost and time by optimal use of assets (rolling stock, crew, track etc.).

This would also enable IR to offer scheduled operations or assured transit-based logistics products to freight customers[4].

Some of the features that such a potential software/IT deployment could address are illustrated below

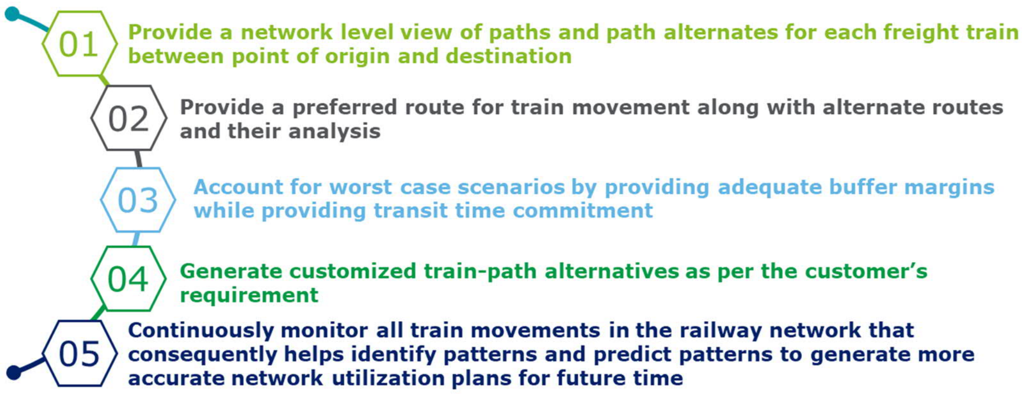


Figure 0-37. Features for Inclusion in Potential Software Deployment for Optimization and Train Planning

0.7.3. Transit Reliability as Service Offering by IR

While IT based tools and improved processes can help strengthen the decision-making process, they also need to be coupled with reward/penalty mechanisms that help ensure adherence of IR to the defined network plans and schedules.

Improved capability for service provision grants IR with the opportunity to provide premium and differentiated product offerings to its users. These could be defined using parameters such as priority given to customers over routes, priority given to movement of specific commodities among others, etc.

While capacity constraints on the system may limit such offerings for the time being across commodities, IR may consider providing such offerings for the container segment which can best utilize this and leverage more cargo on the rail system.

In the long run, as capacity constraints are eased, IR can look at introducing diverse service offerings related to different levels of transit commitment as depicted in figure below.

[4] *CRIS has already initiated an endeavor for development of such a system for "Route Optimization Using Operation Research Tools"*

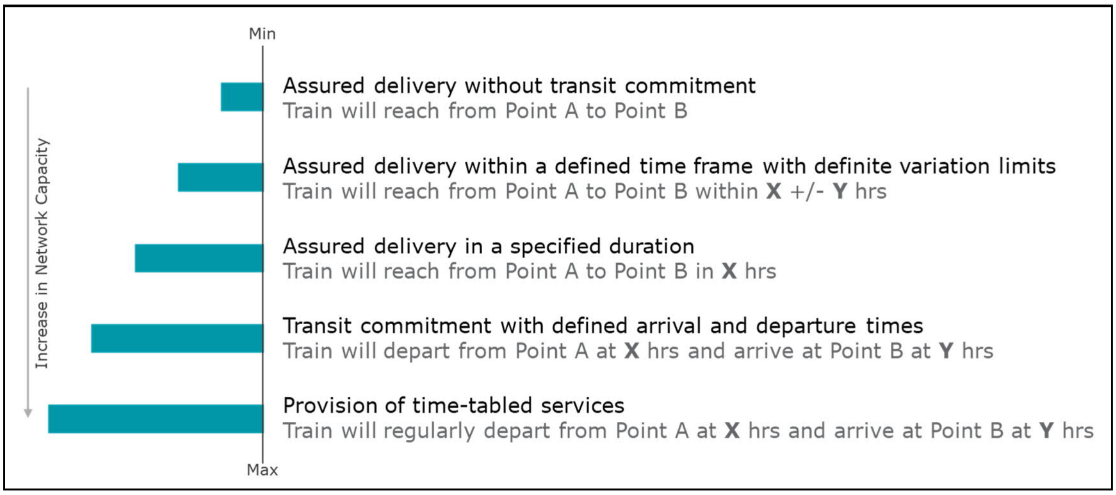


Figure 0-38. Potential Product Offerings with Enhanced Infrastructure/ Network

0.8. Terminals

0.8.1. Freight Terminal Capacity – a key enabler for rail modal share

The projected potential growth of freight transport demand in the national system – including potential modal share of rail discussed earlier in this section, indicate that freight traffic on railways has a potential for almost 2.5x growth over the next decade subject to improved ‘logistics performance’ on rail.

Key enablers for consideration of Indian Railways for enhancing their modal share of freight transport, vis-à-vis ‘service provision’ and ‘transit’, have been considered and discussed earlier in this section.

Creation of adequate capacity in the network – in terms of track infrastructure, terminals as well as appropriate and adequate rolling stock – would also contribute to improvement of logistics time and cost experienced by users.

While proposals for creation of track infrastructure as well as numbers and type of rolling stock have been discussed in other sections of this report, the requirement of freight terminals has been discussed as part of this section – including with reference to commodity types.

Any rail-based cargo transportation involves handling at terminals as well as first and last mile connectivity – unless it pertains to bulk commodity movement from point to point (e.g. mine to thermal plant for coal) with no first/last mile movement and automated handling instead of handling at terminals. Accordingly, additional freight terminal capacity will be required to service this potential traffic growth.

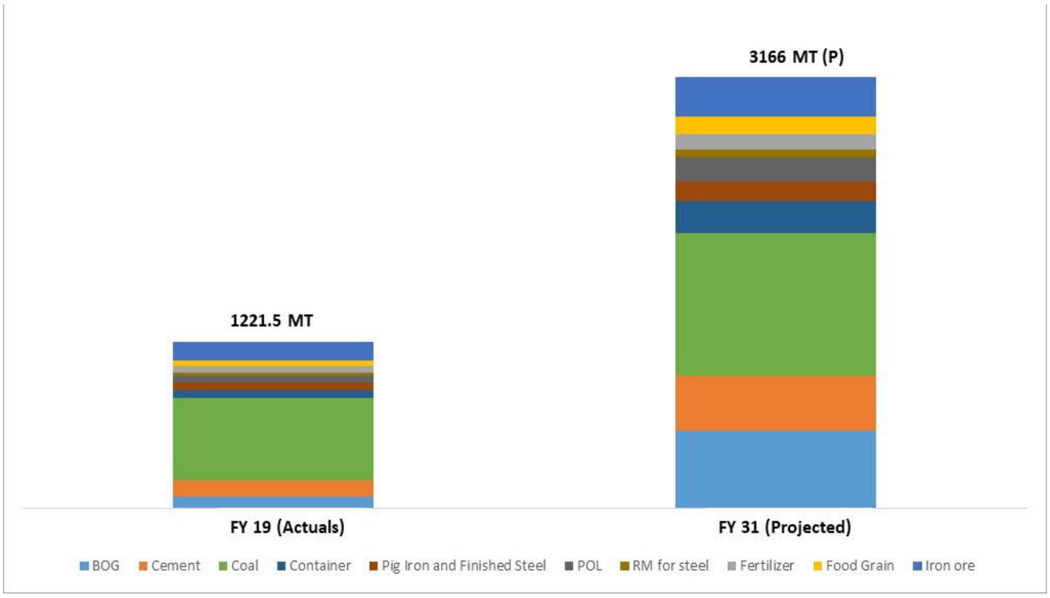


Figure 0-39: Potential Growth in Freight Transport Demand on Railways

Source: CRIS FOIS Data for FY 18, Indian Railways. FY 2031 Rail Traffic Projections; Consultant's Logit Model

During stakeholder consultations, issues were flagged with respect to lack of adequate terminal infrastructure capacity at desired locations, non-availability of facilities/mechanisms aligned with specific needs of different commodities, primitive nature of loading/unloading operations at existing terminals/good sheds, inefficiencies at terminals, etc. A summary of some of these issues and potential interventions for further terminal development is provided below.

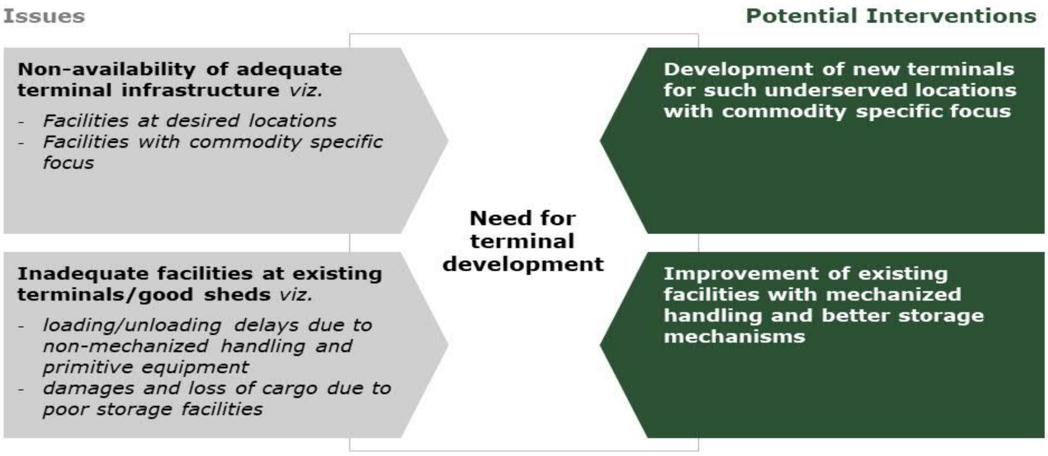


Figure 0-40 Issues and Potential Interventions with Respect to Freight Terminal Capacity

In this context, IR needs to consider upgradation as well as expansion of the extant rail freight terminal network with the following basic objectives:

1. Upgradation of existing terminals or development of new terminals in districts which are expected to be underserved in reference to projected freight volumes over the next decade; and

Improvement in terminal quality at existing freight-handling terminals/good sheds to induce better service reliability, reduce overall logistics time & cost and enable provision of value-added services.

0.8.2. Focus on Key Commodities and Terminal Requirements

Each of the key commodity groups identified for analyses in this study are characterised by certain specific storage and handling requirements at origin and destination points of cargo (based on underlying logistics needs and industry norms).

It has been estimated[5] that certain high-potential commodities such as steel, cement, EXIM containers, and other non-conventional goods have the potential to significantly contribute to rail transport demand in the future.

Each of these have specific handling/ terminal requirements which need to be addressed in planning the development of a terminal network that can support future growth in traffic.

	Origin Handling Point	Destination Handling Point
Fertilizer	Plant	Good shed *
Coal	Mine	Plant
Iron Ore	Mine	Plant
RM for Steel	Mine	Plant
Steel	Plant	Terminal ✓
Cement	Plant	Terminal ✓
EXIM Containers	Terminal ✓	Terminal ✓
POL	Refinery	Tank Farm
Food grains	FCI Siding	Terminal *
Domestic Other Goods	Terminal ✓	Terminal ✓

✓ Requirement of new terminal infrastructure
* Good shed upgradation will be adequate

For example, the cement industry is moving towards bulk movement and needs terminals with bulk handling capabilities. The steel industry is realizing the need and advantages of setting up integrated logistics cum processing facilities (e.g. cutting, shaping of steel products) within terminals, thereby providing customer-

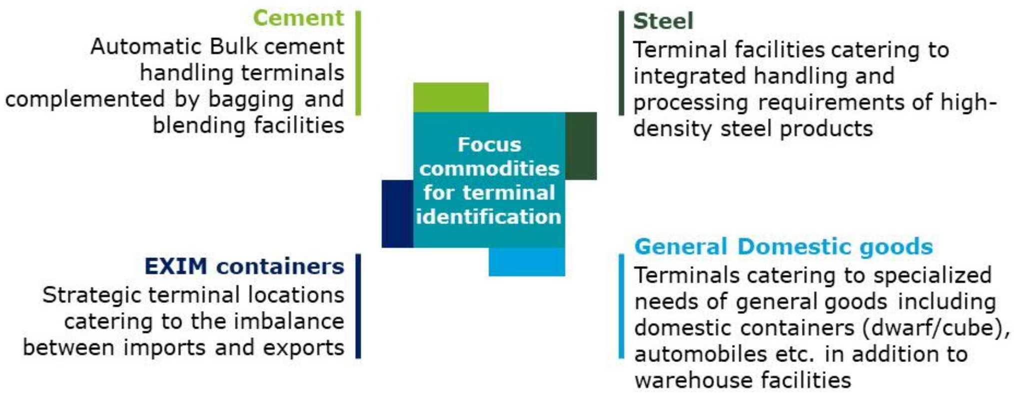


Figure 0-41 Terminal Infrastructure Required to Enable Modal Shift for Key Commodities

[5] *Refer Chapter 6: Optimum Modal Mix of Demand Forecast Report*

oriented services/ adding value closer to the consumption points. The need for terminals capable of handling containers at strategic locations across the IR network necessitates intermodal handling facilities. Further, potential for containerization of domestic other goods and specific facilities for Automotive handling are expected to require special handling infrastructure/facilities catering to the handling and rail transfer of such goods.

The following schematic presents the nature of terminal development that is likely to be required to enable modal shift strategies for key commodities.

Certain bulk commodities like Coal, Iron Ore, RM for Steel and POL products tend to predominantly move from or to locations with integrated rail handling infrastructure in the form of private or industrial sidings. Such commodities have therefore not been considered for assessment of demand for common user or multi-cargo rail freight terminals.

Certain other generic commodities like food-grains and fertilizer move mostly in bagged form and a basic upgradation of existing goods sheds/rail terminal facilities will likely be adequate for sustaining the desired modal share for these commodities. In many cases, these commodities are also loaded from existing fertilizer plant sidings or FCI depot sidings which do not fall within the ambit of the railways as far as development of multi-user handling facilities is required.

For identification of districts (lowest unit of analyses) with potential demand for development of additional freight terminal capacity, a multi-step approach has been adopted.

Based on the approach outlined above, potential districts were identified for development of additional rail freight terminal capacities (based on origin and destination demand) for the focus commodities.

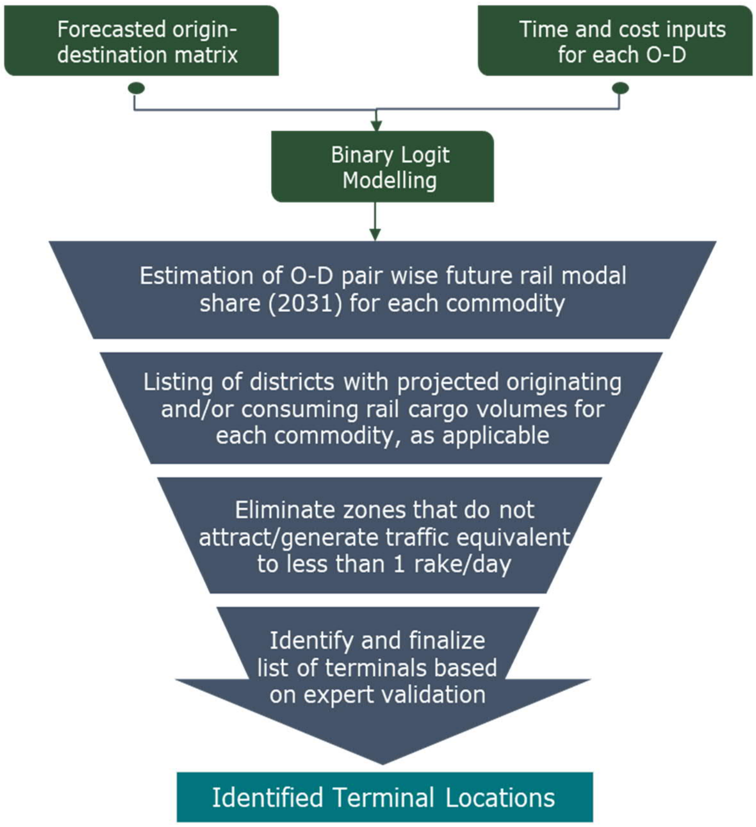


Figure 0-42 Approach for Identification of Districts with Potential Demand for freight Terminal Capacity

0.8.3. Multi-Commodity Terminals: Assessment of Potential co-location/ Clustering

Based on identification of potential districts for development of additional rail freight terminal capacities for the (four) focus commodities, a further assessment was undertaken to identify districts that are characterized by sizeable addressable freight volumes for more than one commodity.

In order to leverage potential economies of scale in development and operation of terminals, it is accordingly proposed that multi-commodity terminals be considered for such locations.

After identification of such locations, cargo potential in adjoining districts was also considered/ evaluated. Locations clusters (with more than one district) were accordingly identified such that terminal(s) could potentially cater to traffic produced and/or consumed within the cluster.

The process of cluster identification in itself was based on multiple factors including location/number of urban centres, geographic characteristics such as natural hinterland formation, freight volumes spread across districts etc.

Once the cargo clusters were identified, the volumes of cargo already being handled by rail in the base year 2019 were reduced from the projected volumes of potential rail cargo in the horizon year 2031 to enable reference/ consideration of incremental handling capacity requirements. Additional terminal capacity requirements were considered after account for potential upgradation/ capacity expansion of existing terminals based on certain industry norms (on aspects like number of lines that can be typically accommodated in a terminal, etc.)

A map with a consolidated view of clusters, thus arrived, having potential for development of multi-commodity terminals (with respect to overall cargo volumes), is presented below

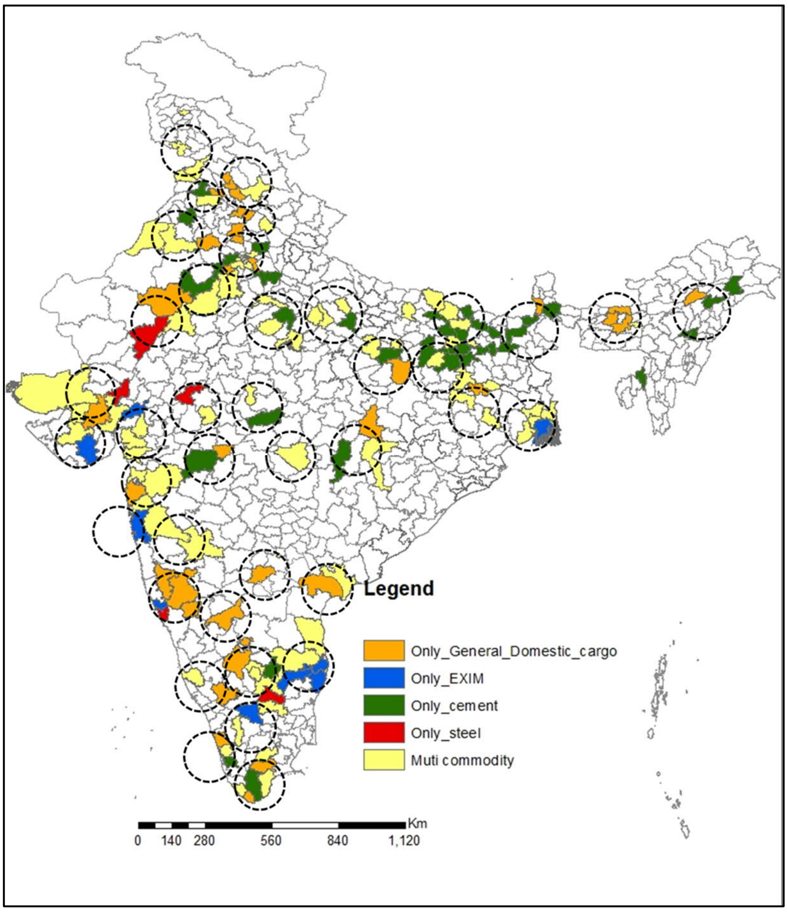


Figure 0-43 Map Illustrating Clusters with Potential for Development of Multi-Commodity Terminals

Finally, the list of identified clusters has been prioritized with reference to potential freight volumes produced/consumed within the cluster over the horizon period up to 2031.

Table 0-16 Prioritized Clusters for Development of Multi-Commodity Terminals

S. No	Cluster	Potential Districts	Projected Rail Traffic, 2031 (MTs)	Existing MMLPs
1	National Capital Region	Gurgaon/Hisar/Jhajjar/Karnal/Panipat/ Gautam Buddha Nagar/ Ghaziabad/Meerut/ Faridabad/South West Delhi/New Delhi/ Central Delhi/	142.38	Yes
2	Chennai	Chittoor/Nellore/Chennai/Kancheepuram/ Tiruvallur/Vellore	141.25	Yes
3	Kolkata	Haora/Hugli/Kolkata/North 24 Parganas/Purba Medinipur/ South 24 Parganas/	139.53	Yes
4	Bangalore	Bangalore Rural/Bangalore/Kolar/ Tumkur/Krishnagiri	116.48	Yes
5	Greater Mumbai	Mumbai/Raigarh/Thane	100.71	Yes
6	Ahmedabad	Ahmedabad/Kheda/Mahesana/ Surendranagar	82.67	Yes
7	Rewari-Jaipur	Mahendragarh/Rewari/Alwar/Jaipur/ Sikar	60.99	Yes
8	Hyderabad	Hyderabad/Mahbubnagar	55.61	Yes
9	Patna	Arwal/Aurangabad/Buxar/Gaya/Jehanabad/Lakhisarai/ Munger/Nalanda/Nawada/Patna/Rohtas/Saran/Vaishali	49.82	Yes

S. No	Cluster	Potential Districts	Projected Rail Traffic, 2031 (MTs)	Existing MMLPs
10	Pune	Pune/Solapur/	45.87	Yes
11	Morbi	Kachchh/Morbi	41.65	Yes
12	Guwahati	Baksa/Barpeta/Kamrup Metropolitan/ Kamrup	40.68	Yes
13	Kanpur	Kanpur Dehat/Kanpur Nagar/Lucknow/Rae Bareli	35.67	Yes
14	Surat-Vadodara	Bharuch/Surat/Vadodara	35.49	Yes
15	Coimbatore	Ernakulam/Kottayam/Thrissur/ Coimbatore	34.08	Yes
16	Jammu-Amritsar	Jammu /Srinagar /Amritsar /Gurdaspur	27.2	No
17	Gorakhpur	Darbhanga/Gopalganj/Muzaffarpur/ Paschim Champaran/Purba Champaran/Saharsa/Sitamarhi/ Gorakhpur/	25.72	Yes
18	Nashik	Valsad/Nashik/Palghar	22.69	Yes
19	Thiruvananthapuram	Thiruvananthapuram/Kanniyakumari/ Thoothukkudi/Tirunelveli/	22.53	Yes
20	Chandigarh-Haridwar	Chandigarh/Ambala/Yamunanagar/ Haridwar	22.29	Yes
21	Salem	Dharmapuri/Erode/Salem	21.91	Yes
22	Allahbad-Varanasi	Allahabad/Mirzapur/Sonbhadra/Varanasi	21.42	Yes
23	Ranchi	Purbi Singhbhum/Ranchi	20.28	Yes
24	Goa	North Goa/South Goa/Belgaum/ Dharwad/Kolhapur	19.73	Yes
25	Nagpur	Nagpur	19.47	Yes
26	Ajmer	Ajmer/Nagaur/Pali	17.83	Yes
27	Indore	Indore/Ratlam	17.55	Yes
28	Siliguri	Bhagalpur/Kishanganj/Purnia/Darjiling/ Jalpaiguri	17.19	No
29	Bilaspur	Bilaspur/Hamirpur/Shimla/Solan	16.76	Yes
30	Ludhiana	Jalandhar/Ludhiana/Shahid Bhagat Singh Nagar	16.06	Yes
31	Bokaro-Dhanbad	Bokaro/Dhanbad/Hazaribagh	15.13	Yes
32	Bhatinda	Bhatinda/Ganganagar/Hanumangarh	14.86	No
33	Rajkot	Amreli/Rajkot	11.17	No
34	Gwalior	Bhind/Gwalior/Jhansi	10.69	Yes
35	Guntur	Guntur/Krishna	10.2	Yes
36	Agra	Agra/Aligarh	10.16	Yes
37	Madurai	Madurai/Virudunagar	9.95	No
38	Mysore	Dakshina Kannada/Mysore	9.9	Yes
39	Tinsukhia-Dimapur	Lakhimpur/Sivasagar/Tinsukia/Dimapur/ Kohima	9.83	No
40	Bhopal	Bhopal/Hoshangabad	9.82	Yes
41	Jalgaon	Burhanpur/Jalgaon	6.65	Yes
42	Bellary	Bellary	5.61	No

The above list was analysed against existing MMLPs/Freight Terminal Network operated by CONCOR and private players in the country. There are several clusters in the above list where no Freight Terminals/MMLPs capacity presently exists.

In absence of any other facility, the comparative priority for terminal capacity development in these clusters could be higher and IR may take up development of freight terminal capacities in these clusters accordingly.

Commodity wise detailed analysis for changes in service provision, transit and other policy level changes to improve the modal share for railways are dealt in detail in the Draft Final Report.

Based on the suggested changes in the service provision and other policy level changes for each of the commodity segments, the requirement of Capacity Augmentation for railways to improve the modal share are discussed in the subsequent sections.

One of the main objectives of NRP is to identify potential demand corridors for passenger and freight based existing and forecasted traffic demand. The identified demand corridors shall lay the foundation for performing capacity analysis and identifying congested and bottlenecked corridors for which subsequently capacity enhancement proposals shall be provided. The improvement proposals are discussed in detail like the potential demand corridors for each of the demand segment are discussed in the following section.

0.9. Rail Network Demand Corridors

Railway Classification of High Demand Corridors

As per the Indian Railways classification of the network, a total of 7 High-Density Network (HDN) routes and 11 Highly Utilised Network (HUN) routes have been classified based on the passenger and freight volumes carried by these corridors. HDN network comprise of 16% (11,000 Km) of total Indian Railway Network and transports 41% of total traffic. HUN comprise of 35% (24,230 Km) of the total railway network and transports 40% of the total traffic moving on Indian Railway network. Combined HDN+HUN account for almost 50% (34,214 Km) of the total network and carries around 80% of the total volume of traffic moving on Indian Railways.

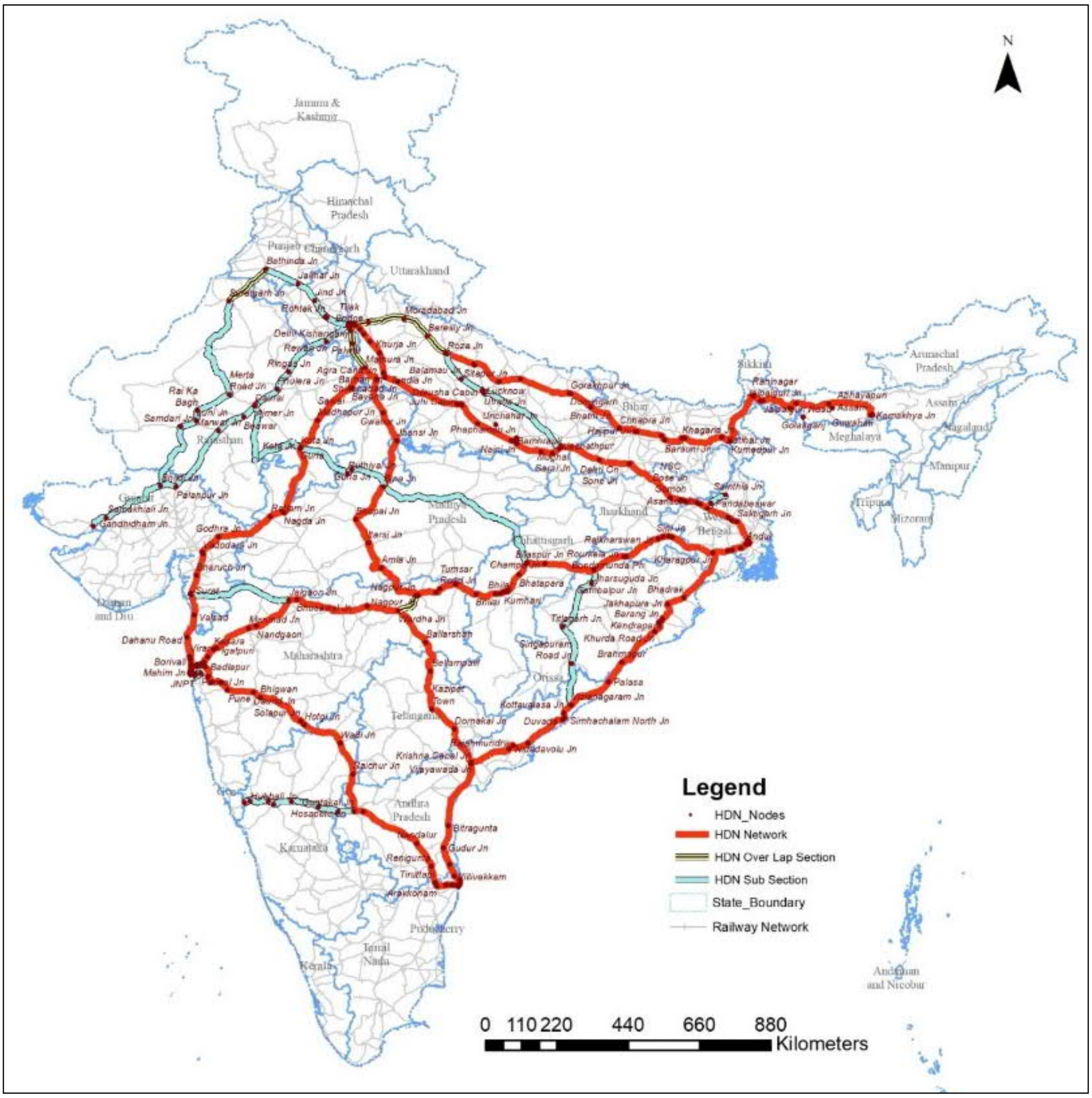


Figure 0-44: HDN Routes

Table 0-17: Indian Railways HDN Routes

HDN No	Routes
HDN1	Delhi Howrah Main Route via ALD MGS Gaya
HDN2	Howrah - Mumbai main route via Jalgaon, Nagpur, Bilaspur
HDN3	Delhi-Mumbai Main Route via Kota Ratlam
HDN4	Delhi-Guwahati via Rosa-Gorakhpur-Kumedpur
HDN5	Delhi-Chennai Main Route via BPL-NGP-BPQ-BZA-Gudur
HDN6	Howrah Chennai Main Route
HDN7	Mumbai-Chennai main route

Majority of the HDN Network is congested and the Capacity utilisation analysis of the HDN network shows that 80% of the network have utilisation level above 100% means this network requires immediate capacity augmentation.

Table 0-18: Existing Capacity Utilization of HDN

Capacity Utilization	Network KM	Share
0%-70%	189	2%
70%-100%	2,003	18%
100%-150%	6,326	58%
>150%	2,450	22%
Total	**10,969**	**100%**

Highly Utilized Network (HUN)

Similar to HDN, the Indian Railways have classified the next hierarchy of network catering to predominantly high traffic demand as Highly Utilised Network.

The fundamental difference between HDN and HUN is that, HDN caters to single line haul demand by connecting major metropolitans of the country. Therefore, the traffic that uses HDN has predominant share of passengers or freight either originating or destined to these

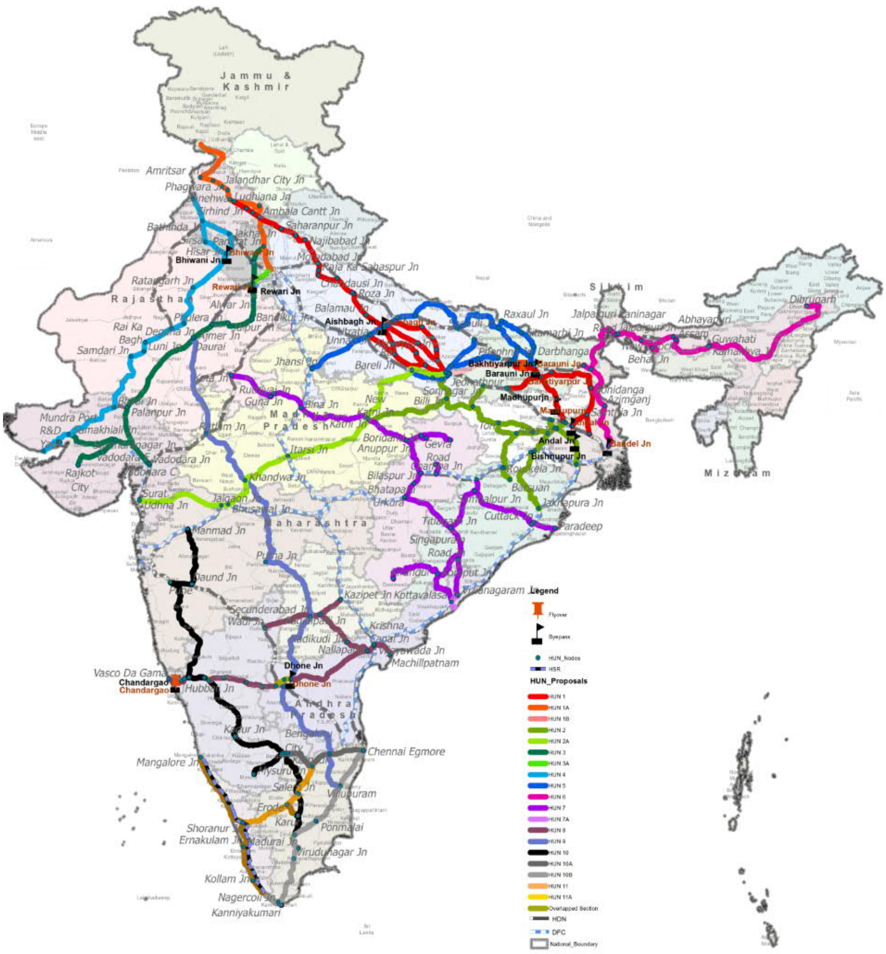


Figure 0-45: –HUN Network of Indian Railways

metros. However, in case of HUN, the demand is high but there is no single line haul corridor and it serves multiple origins and destinations. Trains uses HUN for shorter distances and then leave the network and again some trains further join the network. Thereby the total train volume in these sections remain high but there is no through movement. Also, in case of HDN, share of freight trains is quite high whereas in case of HUN passenger traffic is predominant.

A total of 11 routes have been identified as Highly Utilized Network (HUN), having a total length of 23,347 km. Indian Railways plan to electrify and double the HDN and highly utilized networks (HUN) network, with a length of 34,642 km, by March 2024.

Table 0-19: Indian Railways HUN Routes

S.NO	HUN Routes	HUN Routes	Length (Km)
HUN 1	Amrit Sagar Sampark Corridor	**Amritsar-Andal via** Amritsar-Jalandhar-Ludhiana-Ambala-Saharanpur-Moradabad, Moradabad - Chandausi – Chandausi - Barelli,Barelli – Roza – Lucknow – Sultanpur – Zafrabad – Varanasi – Mughalsarai – Patna – Bhaktiyarpur – Kiul –Bhagalpur – Sainthia - Andal, & Patna - Sonpur & Sainthia - Khana, Lucknow – Faizabad - Zafrabad, Lucknow - Raibareli - Chilbila – Pratapgarh - Janghai - Varanasi, Kanpur(Unnao) – Unchahar – Phaphamau - Janghai, Raibareli - Unchahar & Gaya-Kiul - Sitarampur.	3,049
HUN 2	Bengal Arab Sagar Sampark Corridor	**Kharagpur to Udhna via** Kharagpur – Bankura – Katni – Bhusawal - Udhna & Asansol – Adra – Bhojudih - Pradhankuntha (Dhanbad) & Purulia – Chandil - Sini & Muri – Barkakhana – Barkakhana - Tori & Ranchi - Barsuan & Garwa Rd. - Sonnagar & Billi - Chunar & Rajkharswan - Jakhapura.	3,035
HUN 3	Kathiawar Shivalik Sampark Corridor	**Chandigarh to Rajkot Via** Chandigarh-Panipat-Rohtak-Asthalbohar-Rewari -Jaipur-Palanpur-Vadodara & Ahmedabad-Surendanagar-Rajkot & Samakhiyali-Viramgam.	1,685
HUN 4	Sagar Sutlej Sampark Corridor	**Firozpur to Mundra Port via** Firozpur – Bhatinda – Bhatinda – Jakhal – Hissar – Degana – Luni - Samdhari – Bhildi -Kandla/Mundra & Bhatinda-Sirsa-Hisar.	1,529
HUN 5	Bundelkhand Tarai Sampark Corridor	**Jhansi to Muzaffarpur to Katni** Jhansi-Kanpur-Lucknow-Barabanki-Burhwal, Gonda-Anandnagar-Gorakhpur-Valmikinagar-Valmikinagar-Sugauli, Muzaffarpur-Bachwara and Narkatiyaganj-Raxual-Sitamarhi-Darbhanga-Samastipur, Sitamarhi-Muzafarpur-Hazipur including Bhatni-Varanasi-Naini(Allahabad)-Manikpur-Satna-Katni & Chhapra-Varanasi	2,151
HUN 6	Sagar Purvodaya Sampark Corridor	**Bandel to Dibrugarh via** Bandel – Katwa – Azimganj – Barsoi – Aluabari - New Coochbehar – Golakganj - Abhyapuri (Jogigopa) (NL under cosnstruction) - Goalpara Town – Guwahati – Lumding - Dibrugarh including Katihar - Kumedpur.	1,490
HUN 7	Sagar Chambal Sampark Corridor	**Vizianagaram/Paradeep to Kota via** Vizianagaram - Raipur, Bilaspur – Katni - Kota & Paradeep - Cuttack, Barang - Titlagarh & Sambalpur - Jharsuguda, Kottavalasa - Kinrandul, Singapur Rd. - Koraput, Champa - Gevra Rd. & Anuppur – Boridand - Ambikapur and Boridand - Chirimiri.	2,737
HUN 8	Purv Paschim Deccan	**Vasco to Machilipatnam via**	1,501

S.NO	HUN Routes	HUN Routes	Length (Km)
	Sampark Corridor	Vasco - Londa, Dharwad – Vijayawada - Machilipatnam & Guntur - Bibinagar & Kazipet - Wadi.	
HUN 9	Aravali Dakshin Sampark Corridor	**Ajmer to Dindigul via** Ajmer – Ratlam - Akola (under GC) – Nanded – Secundrabad – Dharmavaram - Villupuram - Dindigul & Katpadi - Jolarpettai & Chennai - Villupuram.	2,803
HUN 10	Satpura Coromandel Sampark Corridor	**Manmad to Kanyakumari via** Manmad - Daund, Pune – Hubli – Birur – Yashwantpur - Salem & Bypanhalli – Hosur, Hosur – Salem - Dindigul – Madurai - Kanyakumari & Bengaluru - Mysuru.	2,232
HUN 11	Konkan Malabar Sampark Corridor	**Mangalorev to Kanyakumari via** Mangalore – Shoranur - Kanyakumari (via Kottayam & Alapphuza) & Shoranur - Salem & Erode - Karur	1,134
Total			23,347

The entire HUN Network is very much congested. More than 46% of HDN network is operating beyond 100% of its capacity. Only 24% of network is having less than 70% capacity Utilization.

Table 0-20: Existing Capacity Utilization of HUN

Capacity Utilization	Network KM	Share
0%-70%	5,896	24%
70%-100%	6,887	28%
100%-150%	8,361	34%
>150%	3,121	12%
Total	24,266	100%

Passenger Demand Corridors

Based on the volume of passenger traffic on the network, top 10 passenger corridors were identified. Majority of the passenger demand is in between the cities which are located on HDNs and 3 HUNS corridors namely HUN 1, HUN 9 and HUN 10.

Both AC and Non-AC passenger demand has been summed up and assigned on the rail network in order to identify total passenger demand corridors. Passenger demand corridors are described in table below:

Table 0-21: Overall Rail Passenger Demand Corridors

Corridors	Total 2018		Total 2026		Total 2031		Total 2041		Total 2051	
	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)
Mumbai - Howrah via Nagpur - Jharsuguda	258.68	6.00	868.76	10.30	1,045.83	9.70	1,547.68	8.90	2,117.24	8.30
Delhi - Chennai via Jhansi - Bhopal	242.32	5.60	605.26	7.20	802.91	7.50	1,256.75	7.20	1,776.61	7.00
Kharagpur - Udhna via Bhusawal	256	5.90	550.15	6.50	675.49	6.30	1,144.05	6.60	1,767.96	6.90
Delhi - Mumbai via Kota - Ratlam	284.15	6.60	582.56	6.90	688.31	6.40	971.67	5.60	1,418.06	5.60
Vizianagram/Paradeep - Kota	160.83	3.70	438.34	5.20	569.35	5.30	964.78	5.60	1,460.96	5.70

Corridors	Total 2018		Total 2026		Total 2031		Total 2041		Total 2051	
	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)	Passenger Km (Million)	Share (%)
Amritsar - Andal via Mughalsarai - Patna	257.72	6.00	346.44	4.10	448.59	4.20	721.79	4.20	1,131.89	4.40
Delhi - Howrah via Kanpur - Gaya	227.72	5.30	312.2	3.70	444.37	4.10	654.95	3.80	1,054.77	4.10
Kolkata - Vijayawada via Jharsuguda - Sambalpur	109.14	2.50	286.14	3.40	355.79	3.30	646.68	3.70	949.14	3.70
Manmad - Kanyakumari via Hubli - Birur	189.52	4.40	344.55	4.10	453.14	4.20	701.8	4.00	878.27	3.40
Mumbai - Chennai via Guntakal - Hospet	135.81	3.20	307.44	3.70	398.71	3.70	642.36	3.70	818.37	3.20
Delhi - Guwahati via Moradabad - Chhapra - Katihar	124.63	2.90	230.82	2.70	305.97	2.80	553.83	3.20	886.83	3.50
Vasco - Machlipatnam via Dharwad - Vijaywada	101.79	2.40	213.62	2.50	262.89	2.40	456.38	2.60	620.15	2.40
Chandigarh - Rajkot Via Panipat - Rewari	109.86	2.50	200.53	2.40	284.21	2.60	397.14	2.30	626.66	2.50
Ajmer - Dindigul via Nanded	109.65	2.50	188.48	2.20	262.99	2.40	379.35	2.20	546.43	2.10
Bandel - Dibrugarh via Azimganj - Barsoi	48.21	1.10	95.01	1.10	145.61	1.40	299.34	1.70	504.78	2.00
Jhansi - Muzaffarpur - Katni	94.36	2.20	146.37	1.70	192.56	1.80	281.16	1.60	464.28	1.80
Firozpur - Mundra Port via Bhatinda-Jakhal	61.41	1.40	144.74	1.70	217.31	2.00	260.87	1.50	391.25	1.50
Mangalore - Kanyakumari via Shoranu	78.02	1.80	126.79	1.50	164.6	1.50	305.29	1.80	414.57	1.60
Total of Top 10	2849.82	66	5988.2	71	7718.63	72	12185.87	70	17828.22	70
Entire Network	**4,310.230**	**100**	**8,407.980**	**100**	**10,776.250**	**100**	**17,341.100**	**100**	**25,544.630**	**100**

Share of High Passenger Demand Corridors

The identified corridors shall continue to cater to higher share of passenger traffic the respective share of these corridors shall be 64-67% till 2051.

Table 0-22: Passenger Share on Demand Corridors

	Passenger Category	2018	2026	2031	2041	2051
Total Passenger Km (Million)	LDAC	409.88	984.79	1,501.60	2,748.64	4,733.47
	LDNAC	3,900.35	7,423.19	9,274.66	14,592.46	20,811.17
	Total	**4,310.23**	**8,407.98**	**10,776.25**	**17,341.10**	**25,544.63**
Passenger Km on High Demand Corridors	LDAC	266.61	667.07	1,016.21	1,853.39	3,183.24
	LDNAC	2,488.88	5,130.28	6,436.61	9,905.03	14,002.32
	Total	**2,755.49**	**5,797.35**	**7,452.82**	**11,758.42**	**17,185.56**
Share of High Demand Corridors	LDAC	65.0%	67.7%	67.7%	67.4%	67.2%
	LDNAC	63.8%	69.1%	69.4%	67.9%	67.3%
	Total	**63.9%**	**69.0%**	**69.2%**	**67.8%**	**67.3%**

Freight Demand Corridors

Based on the volume of freight moving on the network, major freight corridors where share of freight traffic > 50% have been further considered for development of Dedicated Freight Corridors (DFCs). These are listed below:

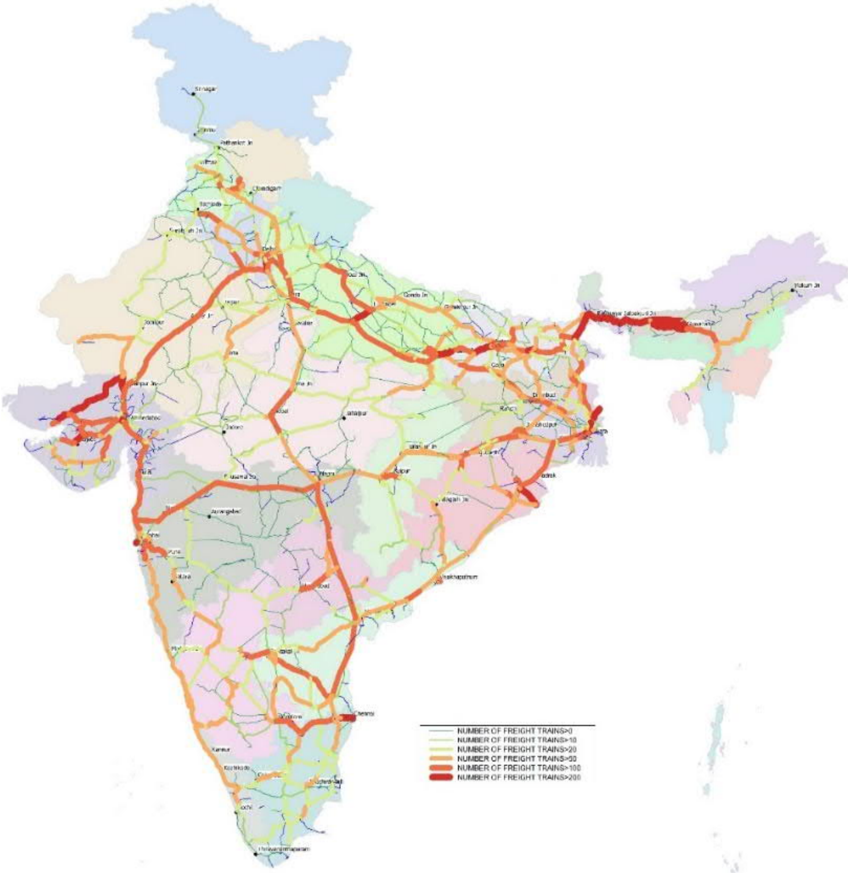


Figure 0-46: Freight Demand (Trains) Corridors -2051

- Kharagpur- Vishakapatnam- Vijayawada- Guntakal
- Delhi- Agra- Bhopal- Nagpur- Vijayawada- Chennai
- Agra- Mughalsarai- Gaya- Dhanbad- Kolkata
- Mumbai- Nashik- Nagpur- Raipur- Bilaspur- Jharsuguda- Jamshedpur- Kharagpur
- Mumbai- Pune- Guntakal- Chennai
- Delhi- Kota- Surat- Mumbai
- Delhi- Ajmer- Ahmedabad

Table 0-23: Major Freight Corridors

Route	Rake Km 2018	Rake Km 2026	Rake Km 2031	Rake Km 2041	Rake Km 2051
Delhi - Mumbai via Kota - Ratlam	142,646	128,116	128,065	253,709	607,395
Mumbai - Howrah via Nagpur - Jharsuguda	153,322	191,886	284,575	302,143	556,427
Delhi - Chennai via Jhansi - Bhopal	115,208	194,157	191,792	329,236	514,105
Amritsar - Andal via Mughal Sarai - Patna	88,587	118,788	185,734	237,116	436,096
Kharagpur - Udhna via Bhusawal	127,437	109,995	189,481	345,518	411,105
Vasco - Machilipatnam via Dharwad - Vijayawada	39,373	37,102	52,356	131,095	397,948
Vizianagaram/Paradeep - Kota	144,061	201,973	278,433	371,369	380,241
Delhi - Guwahati via Moradabad - Chhapra - Katihar	64,102	213,776	260,253	377,942	342,465
Delhi - Howrah via Kanpur - Gaya	125,474	72,888	174,326	204,722	341,716
Kolkata - Vijayawada via Jharsuguda - Sambalpur	65,425	143,314	201,958	265,061	298,949
Bandel - Dibrugarh via Azimganj - Barsoi	32,330	77,377	88,269	144,652	274,620
Ajmer - Dindigul via Nanded	27,163	21,154	37,437	128,934	268,808

Route	Rake Km 2018	Rake Km 2026	Rake Km 2031	Rake Km 2041	Rake Km 2051
Chandigarh - Rajkot Via Panipat - Rewari	74,797	71,354	144,795	178,936	225,608
Jhansi - Muzaffarpur - Katni	43,542	72,708	112,270	190,810	215,763
Manmad - Kanyakumari via Hubli - Birur	37,650	42,495	67,090	113,590	187,530
Mumbai - Chennai via Guntakal - Hospet	39,624	32,510	47,117	107,025	174,203
Firozpur - Mundra Port via Bhatinda-Jakhal	53,199	50,325	93,634	113,955	170,565
Mangalore - Kanyakumari via Shoranu	17,076	17,111	27,900	40,100	58,892

0.10. Capacity Utilization and Identification of Bottlenecked Sections

Other than the HDN, HUN and major passenger and freight corridors utilisation, it is important to understand the utilisation level of the remaining network. This will help to identify bottleneck on the Indian railways network. To understand the utilisation level of different corridor, line capacity utilisation charts shared by the Indian Railways were used. The utilisation level observed for different corridors are given in the table below

Table 0-24: Existing Capacity Utilization

Network	<70%	70%-100%	100%-150%	>150%
Entire Network	45%	29%	25%	1%

Existing capacity utilization was calculated as per the LC data. Existing number of Passenger trains, Goods Trains and Other Trains running on the section were used to assess the existing capacity utilization and mapped accordingly. Some of the salient findings are listed below:

- 74% of the overall entire network is operating below 100% capacity utilization, 25% of entire network is operating in-between 100%-150% capacity utilization and 1% of network is operating 1.5 times higher than its capacity.
- HDN network has the highest utilization, 20% of the entire HDN network is operating below 100% capacity utilization and only 2% is operating below 70% utilization.
- 58% of HDN network is operating in-between 100%-150% capacity utilization and 22% of network is operating with capacity utilization higher than 150%.

The network utilization is also shown in the figure below

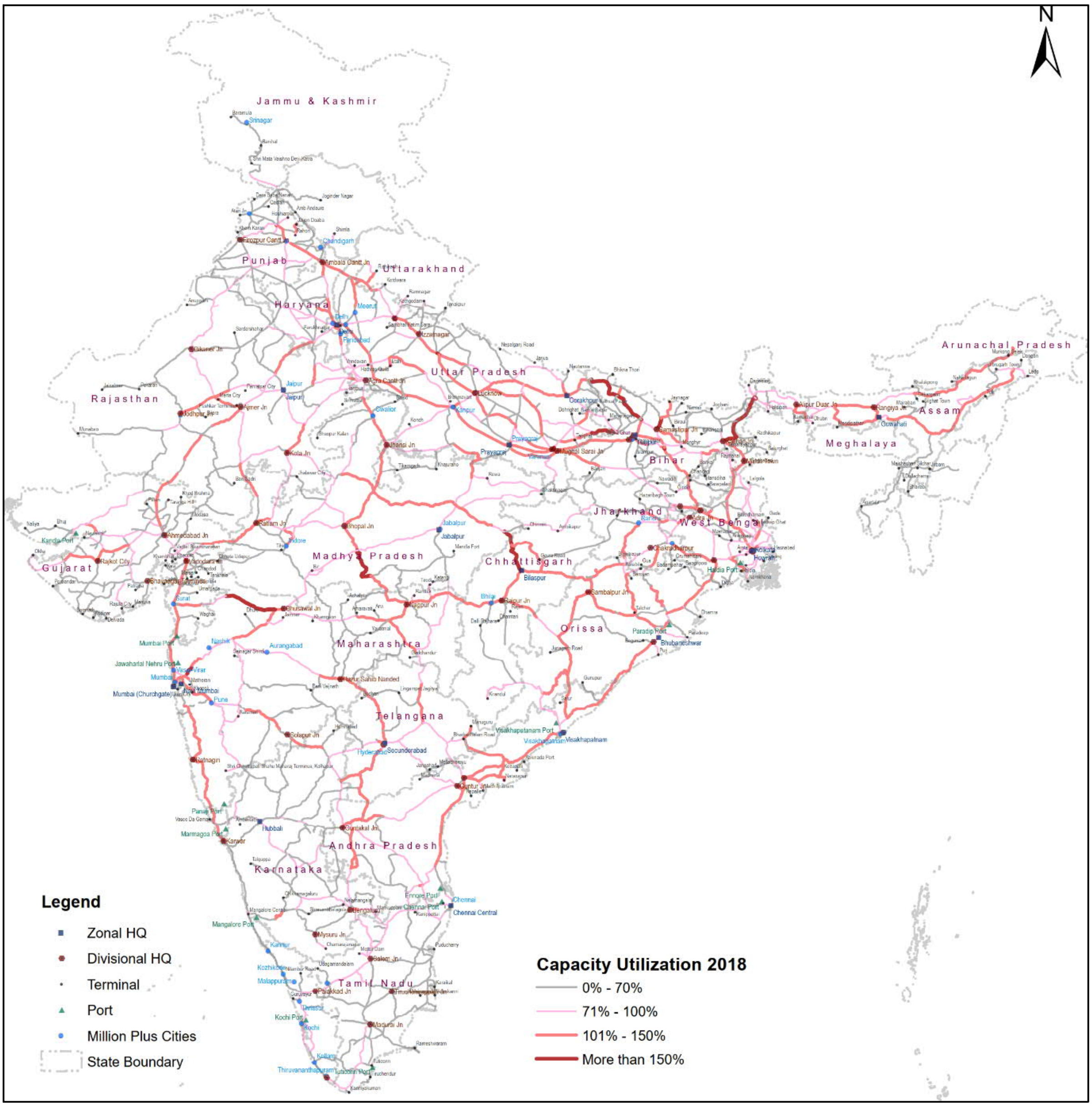


Figure 0-47: Existing Capacity Utilization

To remove the bottleneck in the network, Indian Railways has taken up capacity augmentation projects which includes addition of new lines, developing Eastern and Western DFC, Mumbai Ahmedabad HSR corridor, bypasses etc.

The projects mentioned in the Pink Book of 2019 were considered to work out the future capacity utilisation once all the proposed projects are constructed by 2022. After that the projected demand for 2022 was assigned on the network to understand the capacity utilisation of the network.

Future Capacity Utilization and Bottlenecked Sections

Future capacity utilizations were calculated for each cardinal year 2026, 2031, 2041 and horizon year 2051.

It has been estimated that by 2051, 33% of the entire network will be operating below 100% capacity and 24% below 70% of utilisation. Whereas 11% of the network will be operating between 100%-150% of capacity utilization and 57% of network will exceed 1.5 times of its capacity.

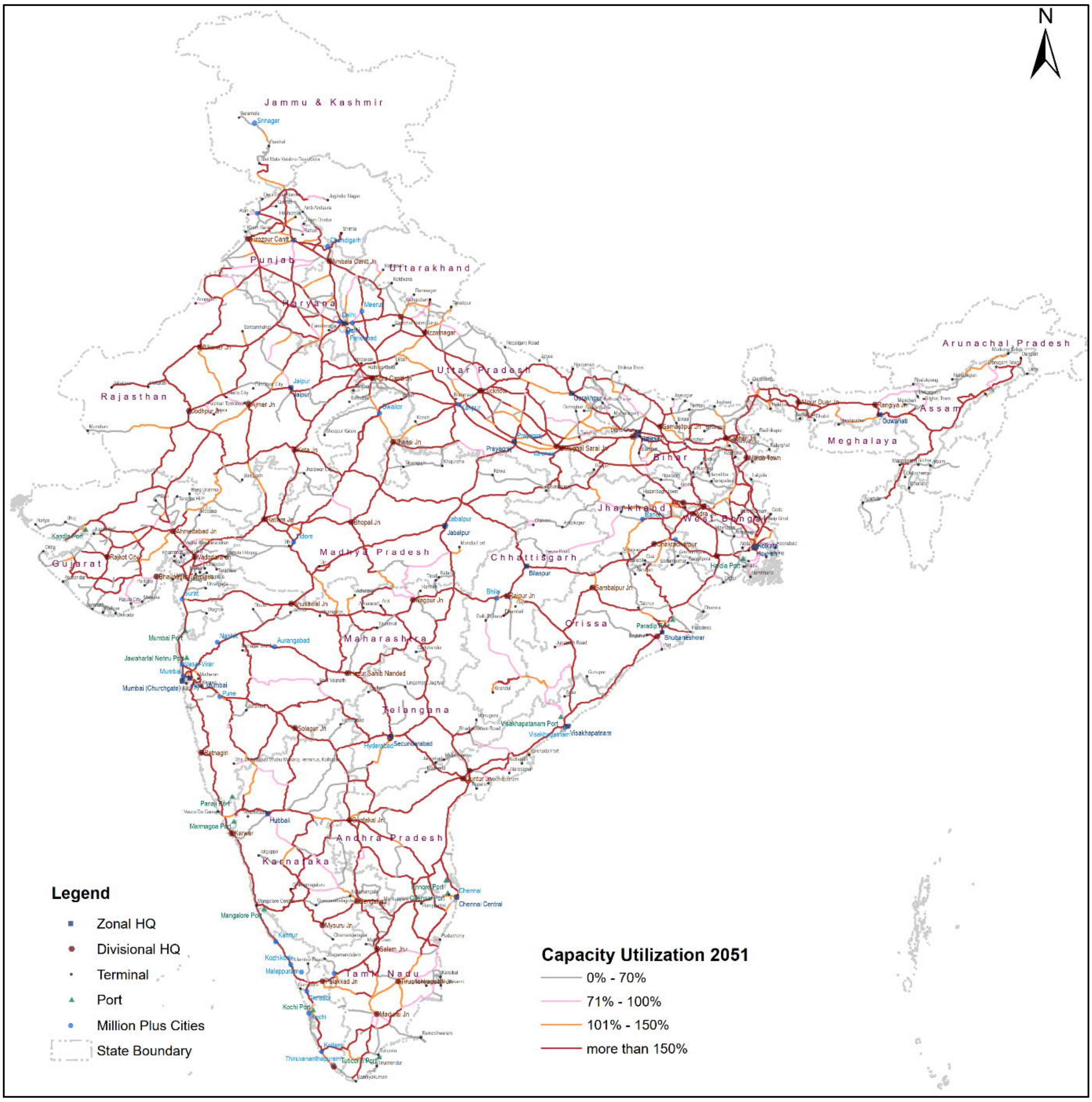


Figure 0-48: Capacity Utilization - 2051

In case of HDN by 2051, 92% network shall be operating on capacity utilisation higher than 150%.

In case of HUN, 8% of the network will be operating below 100% capacity, whereas 14% network is operating in between 100%-150% capacity and 82% of network will exceed 1.5 times of its capacity by 2051.

This means if only the pink book projects are implemented, and no other capacity augmentation measures are taken than the complete railway network and specifically HDN and HUN will have utilisation more than 100% i.e. the complete network will come to halt.

Table 0-25: Rail Network Future Capacity Utilization

Network Type	<70%	70%-100%	100%-150%	>150%
2026				
Entire Network	55%	16%	17%	12%
HDN	5%	27%	45%	24%
HUN	41%	23%	19%	17%
HDN+HUN	30%	24%	28%	18%
2031				
Entire Network	44%	15%	18%	24%
HDN	2%	9%	39%	50%
HUN	22%	19%	27%	32%
HDN+HUN	16%	17%	30%	37%
2041				
Entire Network	30%	9%	14%	48%
HDN	0%	1%	10%	89%
HUN	6%	11%	20%	63%
HDN+HUN	4%	8%	17%	71%
2051				
Entire Network	24%	9%	11%	57%
HDN	0%	0%	7%	92%
HUN	3%	5%	14%	78%
HDN+HUN	2%	3%	12%	82%

0.11. Methodology for Identifying Network Improvements

After understanding the capacity to be handled by railways in future and capacity utilisation after implementation of Pink Book project, we need substantial capacity augmentation. But a clear methodology is required to suggest what kind of capacity augmentation proposals are required to be accompanied with certain assumptions or underlying parameters that will help in concluding the projects. The following section details out various options for enhancing capacity and methodology for sequencing the same along with assumptions that have been adopted for framing projects for HSR, DFC, HDN, HUN, etc.

Overall Methodology

The process of identification for interventions in carried out as peer following steps.

0.12. Dedicated Freight Corridors (DFCs)

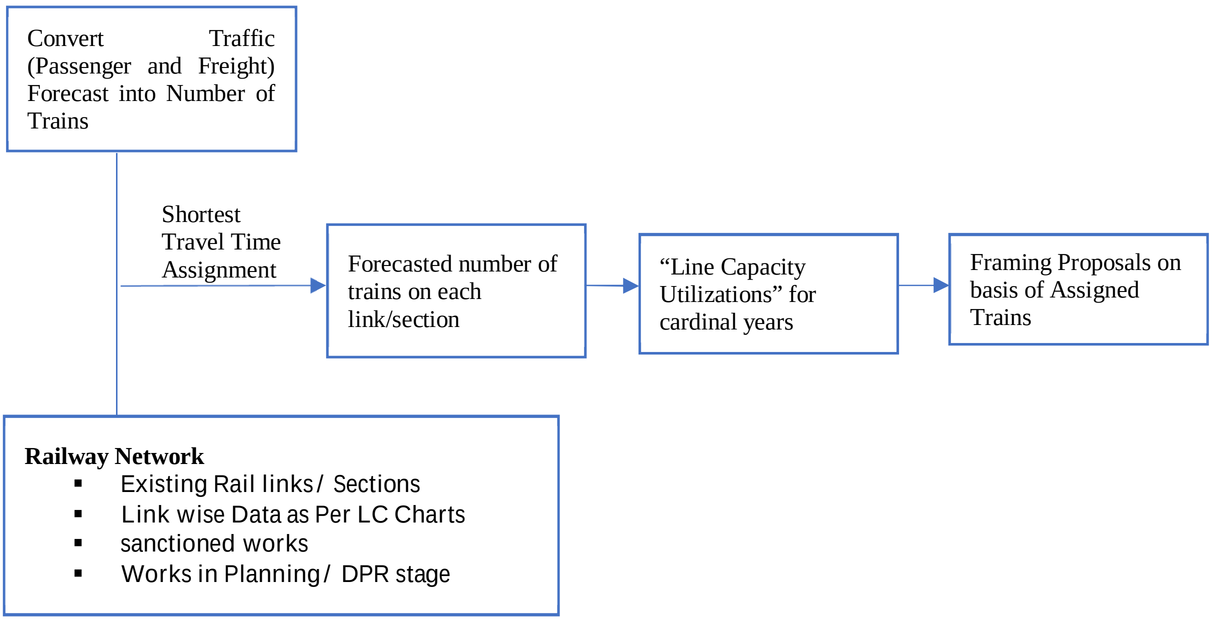


Figure 0-49: – Overall Methodology for Network Requirements

The eastern and western DFC are already under construction. The other 3 identified DFCs are also concurrent with the proposals identified under National Infrastructure Pipeline (NIP). These are discussed in the following sections.

The East-West DFC

East West DFC connects Palghar to Dankuni.

Proposed Route

- East-West DFC starts from Palghar (on Western DFC, near Vangaon station on IR), as direct connectivity with Mumbai is not feasible.
- On the Eastern end, one route ends at Andal (on Eastern DFC station) and the other route at Kamarkundu (new station on Eastern DFC, near Dankuni), as direct connectivity with Howrah/Dankuni is not feasible.

- Total route length of East-West Dedicated Freight Corridor between Howrah (Andal/Kamarkundu near Dankuni) and Mumbai (near Palghar) is 2,328 km.
- Total of 37 Junction Stations (31 on Palghar - Andal Line and 6 on Rajkharswan – Kamarkundu Line) and 29 Crossing Stations are proposed on this corridor.

The North- South DFC

Proposed route:

- North-South DFC starts from Pirthala (on Western DFC, near Palwal station on IR), as direct connectivity with Delhi is not feasible at the Northern-end.
- At the Southern-end, the proposed Arakkonam station is connected with Chennai-Bangalore line.
- One connection is proposed towards Chennai at IR station Trubalangadu and another connection is proposed with Melapakkam towards Bangalore side.
- Total route length between Pirthala (near Delhi) and Arakkonam (near Chennai) is 2,327.6 km.
- A total of 21 Junction Stations and 43 crossing stations have been proposed along the North-South DFC.

The East Coast DFC

Proposed Route

- East-Coast DFC starts from Hijli (near Kharagpur), as direct connectivity with Kharagpur is not feasible.
- At the Southern-end, the proposed Vijayawada DFC terminal is connected with Vijayawada IR station and North-South DFC line.
- Total route length from Kharagpur to Vijayawada is 1,114.7 km.
- This route has 31 stations between Kharagpur and Vijayawada, out of which 15 are junction stations and 16 are crossing stations.

Table 0-26: Proposed Phasing of DFC Network

Phasing	**2026**	**2031**	**2041**	**2051**
Length (Km)	**2,807**	**3,278**	**1,206**	**751**
New DFC Corridors	**Eastern DFC**, 1,324 Km (Under Construction till Sonnagar)	**East Coast DFC**, 1,265 Km (Kharagpur to Vijayawada)	**North South DFC**, 1,206 Km (Itarsi to Chennai via Nagpur and Vijayawada)	**North South DFC**, 751 Km (Palwal to Itarsi)
	Western DFC 1,483 Km (Under Construction)	**East West DFC**, 2,013 Km (Palghar to Dankuni and EDFC Connectors)		
		Eastern DFC, 515 Km (Sonnagar to Dankuni)		

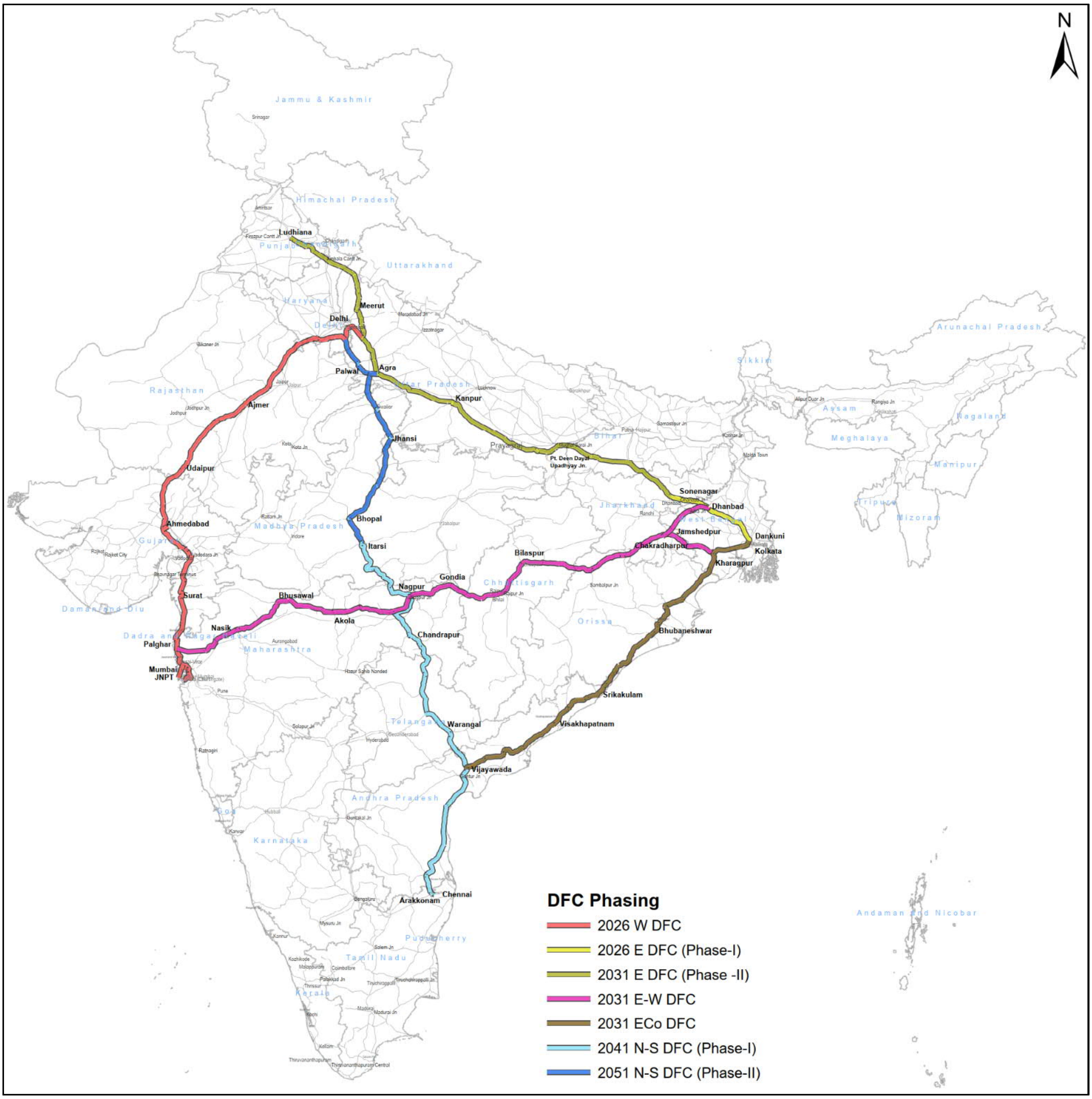


Figure 0-50: –Proposed DFC Master Plan and Phasing

0.13. High Speed Rail (HSR) Corridors

HSR Corridors as proposed as part of National Infrastructure Pipeline (NIP) have been reviewed with an objective of enhancing the outreach of HSR network and increasing the connectivity to cities of importance.

Given the long lead time and inherent risk in high-speed rail investments, it is essential that suitable corridors are selected where the conditions exist to support strong passenger demand for high-speed services. In other words, it is critical to identify the corridors across the country with the maximum potential to support high-speed rail in order to minimize this investment risk.

To do so, a ranking system based on an index of five criteria was developed to judge the extent of demand for high-speed rail between any two city pairs. Each city pair consists of two cities, each with a population of at least 10,00,000 that are separated by a distance of 300 to 700 Km.

The criteria are listed below:

1. City Population (> 1 million)
2. Distance between city pairs, confined to distances between 300-700 Km
3. City GDP
4. High levels of congestion
5. Passenger flow between city pairs- AC rail and air trips
6. Corridors having AC passenger share of more than 50% were identified.

<u>Recommended High Speed Rail (HSR) Corridors as per National Rail Plan (NRP)</u>

With an aim to meet the growing passenger demand and to optimise the high-speed rail connectivity between major cities/ commercial/economic centres, the following high-density passenger routes were identified for developing High Speed Railway (HSR) corridors.

The corridors are more or less same as proposed as part of NIP. In addition, certain extensions/ new corridors have been proposed for enhancing HSR outreach and providing connectivity to other towns:

1. Delhi- Chandigarh- Ludhiana - Jalandhar- Amritsar HSR Corridor is recommended to be extended to Jammu via Pathankot for enhancing regional connectivity and for giving economic boost to the Jammu and Pathankot Region. It will cater to the religious tourism potential of Vaishno Devi Shrine and other places.
2. Delhi- Agra- Kanpur- Lucknow- Varanasi- HSR corridor is recommended to route via Ajodhya due to Religious Tourism Potential.
3. Delhi- Agra- Kanpur- Lucknow- Varanasi- HSR corridor is also recommended to be extended to connect Patna and Kolkata.
4. Additional HSR Line from Patna to Guwahati via Katihar and New Jalpaiguri thereby connecting Guwahati with Delhi Varanasi Kolkata HSR Corridor.

5. Additional HSR Line between Hyderabad and Bengaluru by extending Mumbai Hyderabad HSR Line. This shall connect Mumbai with Chennai and also will bring North India from Jammu – Amritsar – Delhi – Jaipur – Ahmedabad – Mumbai – Hyderabad – Bengaluru – Chennai on HSR corridor and all the major towns of North, West and South India shall be connected with 1 HSR Corridor. This will help in boosting the regional economy.
6. Additional HSR line is proposed between Nagpur and Varanasi by extending the Mumbai – Nashik – Nagpur HSR Corridor. This shall connect Mumbai with Varanasi which will further connect with Delhi – Varanasi – Patna – Guwahati HSR corridor.

Table 0-27: Proposed HSR Phasing

Phasing	2026	2031	2041	2051
New HSR Corridors	Mumbai Ahmedabad, 508 Km (As per NIP also)	Delhi Varanasi via Ajodhya, 855 Km (As per NIP also, Ajodhya included)	Hyderabad Bangalore, 618 Km (New)	Mumbai Nagpur, 789 Km *(As per NIP)*
		Varanasi to Patna, 250 kms (New)	Nagpur Varanasi, 855 Km (New)	Mumbai Hyderabad, 709 Km *(As per NIP)*
		Patna to Kolkata, 530 Km (New)		Patna Guwahati 850 Km (New)
		Delhi Udaipur Ahmedabad 886 Km *(As per NIP also)*		Delhi Chandigarh Amritsar, 485 Km *(As per NIP)*
				Amritsar - Pathankot - Jammu, 190 Km (New)
				Chennai to Mysuru via Bangalore, 462 Km *(As per NIP)*
Length (Km)	508	2,521	1473	3485

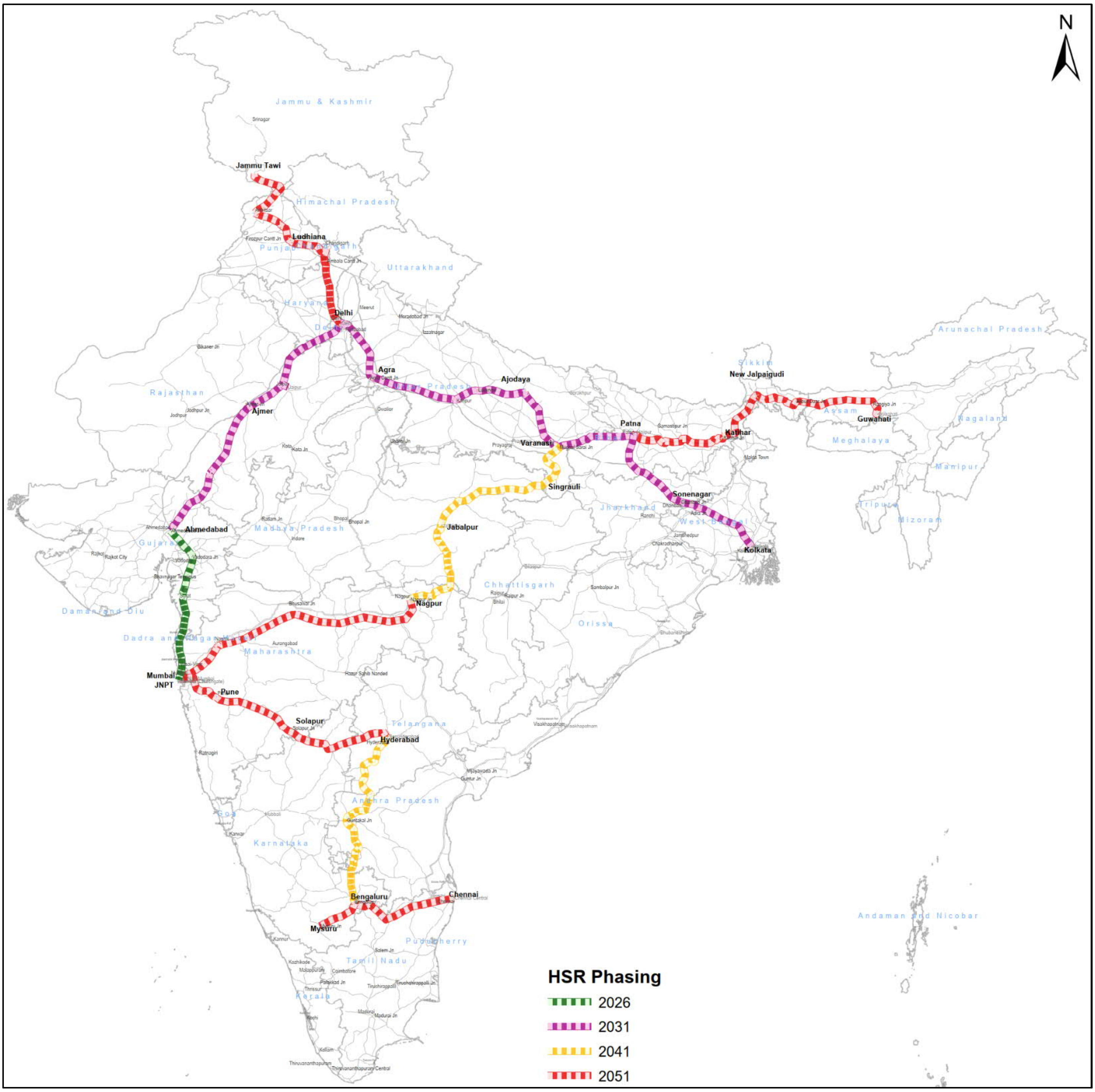


Figure 0-51: – Proposed HSR Corridors and Phasing

0.14. Network Improvement Proposals for Highly Dense Network (HDN)

Majority of the HDN Network is congested. Capacity utilisation of entire HDN is presented in table below.

Table 0-28: Existing Capacity Utilization of HDN

Capacity Utilization	Network KM	Share
0%-70%	189	2%
70%-100%	2,003	18%
100%-150%	6,326	58%
>150%	2,450	22%
Total	**10,969**	**100%**

HDN 1 – Delhi Howrah Main Route via Prayagraj, Mughalsarai and Gaya

Majority of the sections of HDN 1 are operating beyond their capacity in terms of number of trains/ days which is causing congestion, delay in passenger operations and enormous delay in freight operations.

Table 0-29: Existing Capacity Utilization of HDN 1

Capacity Utilization	Network KM	Share
0%-70%	0	0%
70%-100%	262	18%
100%-150%	1187	81%
>150%	15	1%
Total	**1463**	**100%**

HDN 1 has been recommended to be upgraded to triple line for the entire length.

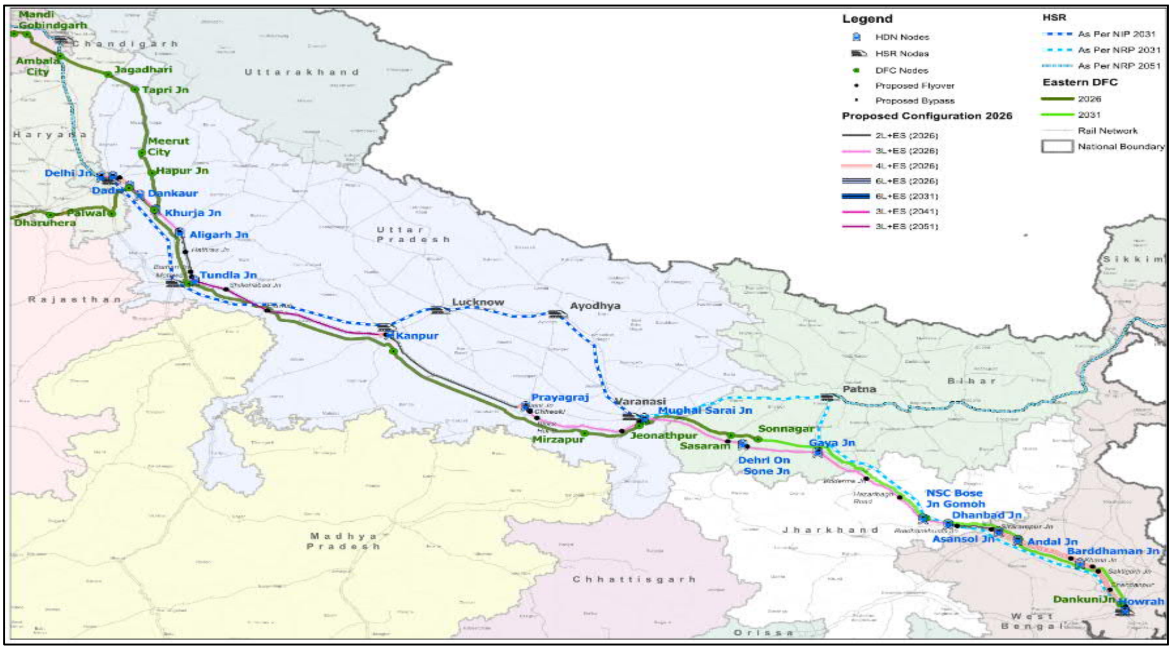


Figure 0-52: Network Upgradation Proposals - HDN 1

Table 0-30: HDN 1 – Additional Line Requirements (2051)

Configuration Conversion	Network Km	Line KM
Double to Triple Line	191	191
Quadruple Line to 6 Lines	9	18
Total	200	209

HDN 2 – Mumbai to Howrah via Jalgaon, Nagpur, Bilaspur, Jharsuguda and Tata Nagar

HDN 2 is a part of Golden Diagonal, from Kolkata (Howrah) to Mumbai via Jalgaon, Nagpur, Bilaspur and Jharsuguda.

Table 0-31: Existing Capacity Utilization of HDN 2

Capacity Utilization	Network KM	Share
0%-70%	17	1%
70%-100%	130	7%
100%-150%	1509	80%
>150%	233	12%
Total	**1,889**	**100%**

HDN 2 has been recommended to be upgraded to triple or quadruple lines for the entire length.

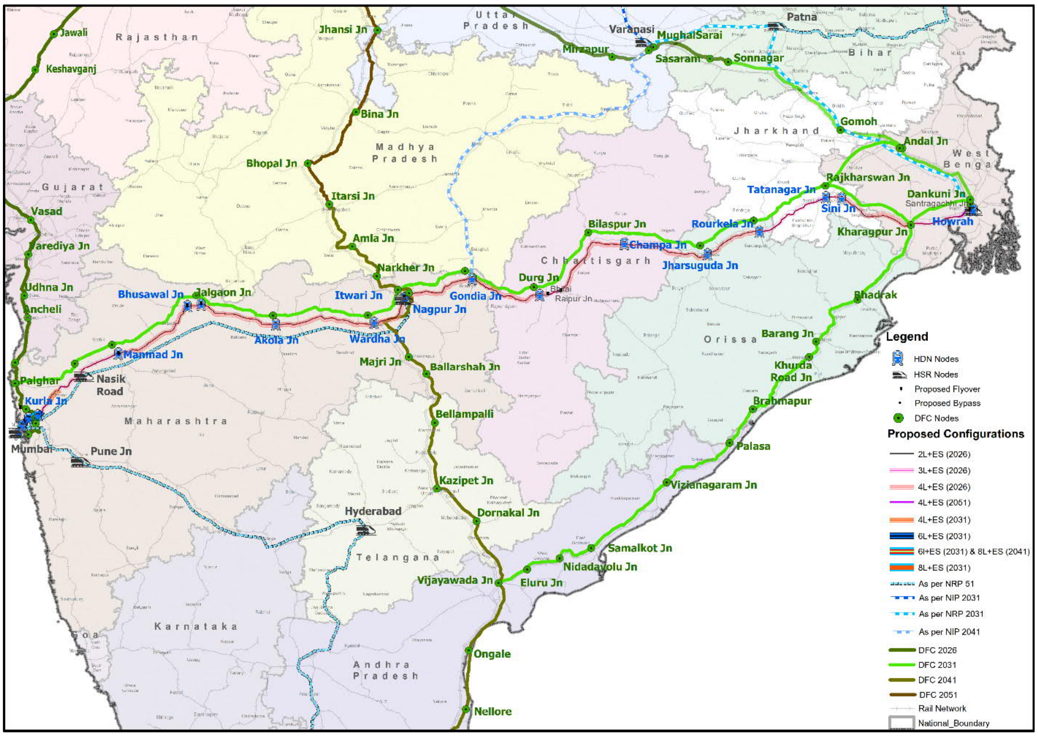


Figure 0-53: Consolidated Network Upgradation Proposals - HDN 2

Table 0-32: HDN 2 – Additional Line Requirements (2051)

Configuration Conversion	Network (Km)	Line (Km)
Triple to Quadruple Line	64	64
Triple Line to 6 Lines	11	33
Quadruple Line to 6 Lines	32	64
6 Lines to 8 Lines	17	34
Total	124	195

HDN 3 – Delhi to Mumbai via Kota, Bharatpur, Ratlam, Ahmedabad and Vadodara

HDN 3 is a part of Golden Quadrilateral, running from Delhi to Mumbai via Kota, Bharatapur and Ratlam.

Table 0-33: Existing Capacity Utilization of HDN 3

Capacity Utilization	Network KM	Share
0%-70%	0	0%
70%-100%	170	12%
100%-150%	1148	83%
>150%	70	5%
Total	**1,889**	**100%**

HDN 3 has been recommended to be upgraded to triple or quadruple line.

Table 0-34: HDN 3 – Additional Line Requirements (2051)

Configuration Conversion	Network Km	Line KM
Double to Triple Line	562	562
Triple to Quadruple Line	338	338
Quadruple Line to 6 Lines	7	14
6 Lines to 8 Lines	2	4
Total	**909**	**919**

Western DFC is proposed from and Khurja to JNPT (before year 2026) along the HDN 3 to handle the freight demand and leave the HDN 3 as a passenger only operation for a higher efficient operation and maintaining higher speed.

High Speed Rail Corridor is proposed from Mumbai to Delhi via Surat, Ahmedabad.

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HDN 3 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

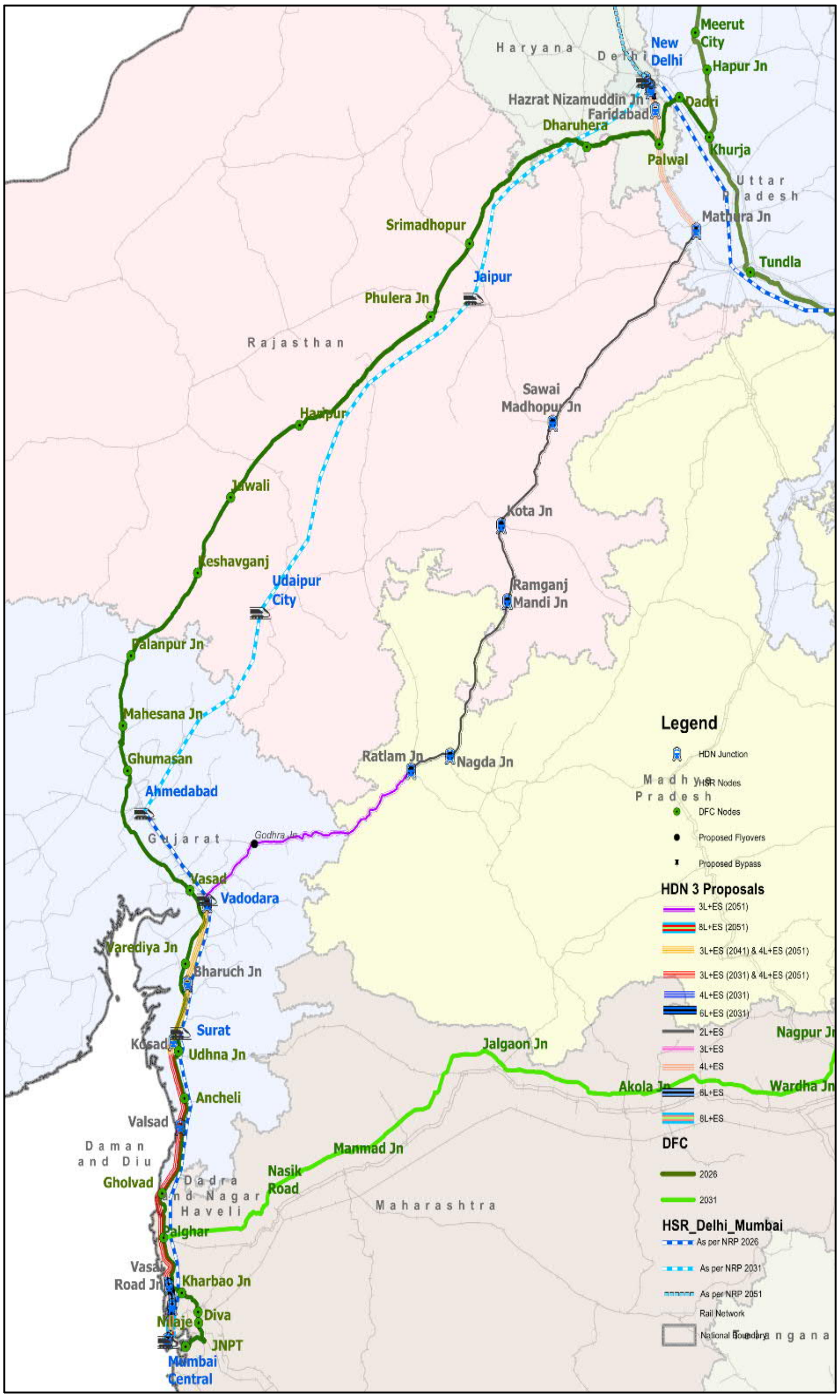


Figure 0-54: –Consolidated Network Upgradation Proposals – HDN 3

HDN 4 – Delhi to Guwahati via Rosa and Gorakhpur

HDN runs from Delhi to Guwahati via Rosa and Gorakhpur. It is the shortest route between cities of Delhi and Guwahati having a length of 1,845 Km. As the route is connects the North-Eastern India with National Capital via 3 more metropolitan cities, the passenger demand as well as the freight demand is very high.

At present most of the HDN 4 is operating over 100% of capacity Utilization. Only 27% below 100% and nothing below 70%. This is one of the most highly congested networks and requires infrastructure Upgradation.

Table 0-35: Existing Capacity Utilization of HDN 4

Capacity Utilization	Network KM	Share
0%-70%	0	0%
70%-100%	498	27%
100%-150%	840	46%
>150%	507	27%
Total	**1,845**	**100%**

HDN 4 has been recommended to be upgraded to triple line for the entire length.

Table 0-36: HDN 4 – Additional Line Requirements (2051)

Configuration Conversion	Network Km	Line KM
Double to Triple Line	637	637
Double to Quadruple Line	456	912
Triple to Quadruple Line	978	978
Total	2070	2,526

Figure 0-55: –Consolidated Network Upgradation Proposals – HDN 4

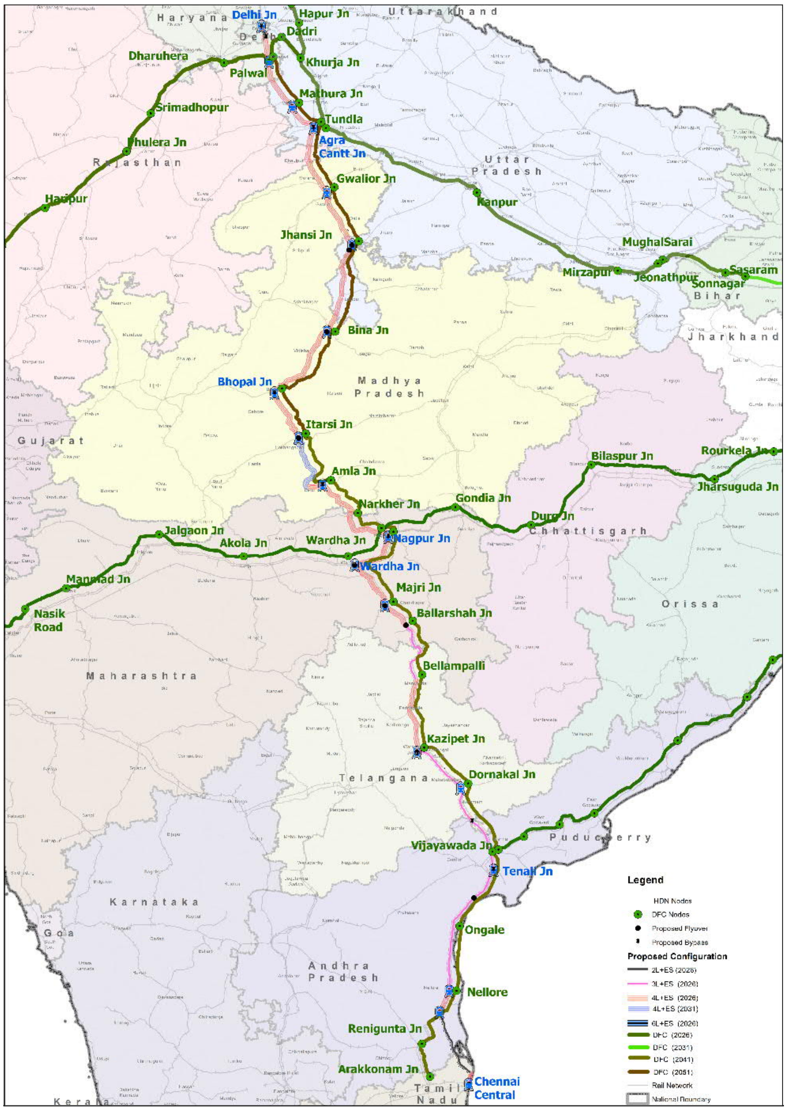


Figure 0-56: –Consolidated Network Upgradation Proposals – HDN 5

HDN 5 – Delhi to Chennai via Bhopal, Nagpur, Vijayawada

HDN 5 is a part of Golden Diagonal, running North South, it connects Delhi with Chennai via Bhopal, Nagpur, Vijayawada and Gudur. Having a length of 2,048 Km. the corridor provides connectivity of North India with South India and therefore caters to huge passenger and freight demand.

At present most (83%) of the HDN 5 is operating over 100% of capacity Utilization. Only 2% is below 100% and 6% below 70%. This is one of the highly congested networks and requires infrastructure Upgradation.

Table 0-37: Existing Capacity Utilization of HDN 5

Capacity Utilization	Network KM	Share
0%-70%	121	6%
70%-100%	33	2%
100%-150%	1693	83%
>150%	201	10%
Total	**2,048**	**100%**

HDN 6 – Kolkata to Vijayawada via Kharagpur and Vijayanagaram

HDN 6 is a part of Golden Quadrilateral, starting from Kolkata (Howrah) to Vijayawada via Kharagpur and Vijayanagaram and is also connected to HDN 5.

Table 0-38: Existing Capacity Utilization of HDN 6

Capacity Utilization	Network KM	Share
0%-70%	0	0%
70%-100%	62	6%
100%-150%	978	88%
>150%	72	6%
Total	**1,113**	**100%**

At present most (94%) of the HDN 6 is operating over 100% of capacity Utilization. Only 6% is below 100% and none is below 70%. This is one of the highly congested networks and requires infrastructure Upgradation.

HDN 6 has been recommended to be upgraded to triple line or quadruple for the entire length.

Table 0-39: HDN 6 – Additional Line Requirements (2051)

Configuration Conversion	Network Km	Line Km
Triple to Quadruple Line	158	158
Total	158	158

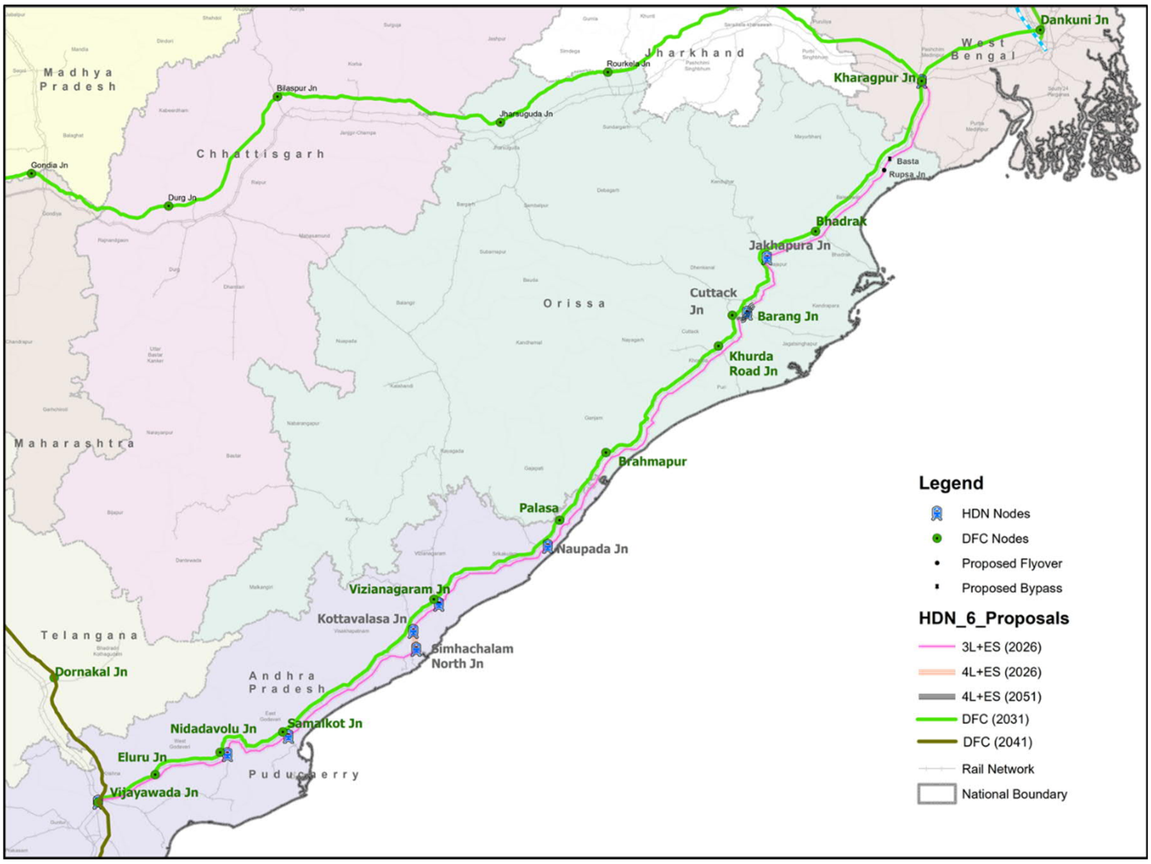


Figure 0-57: –Consolidated Network Upgradation Proposals – HDN 6

HDN 7 – Mumbai to Chennai via Pune

HDN 7 is a part of Golden Quadrilateral, starting from Mumbai to Chennai passing through Pune, Wadi, Nandalur. It is the shortest route between Mumbai and Chennai having a total length of 1,224 km.

Table 0-40: Existing Capacity Utilization of HDN 7

Capacity Utilization	Network KM	Share
0%-70%	58	5%
70%-100%	466	38%
100%-150%	675	55%
>150%	25	2%
Total	**1,224**	**100%**

HDN 7 has been recommended to be upgraded to triple line or quadruple for the entire length.

Table 0-41: HDN 7 – Additional Line Requirements (2051)

Configuration Conversion	Network Km	Line Km
Double to Triple	379	379
Quadruple to 6 Lines	38	76
Total	**417**	**455**

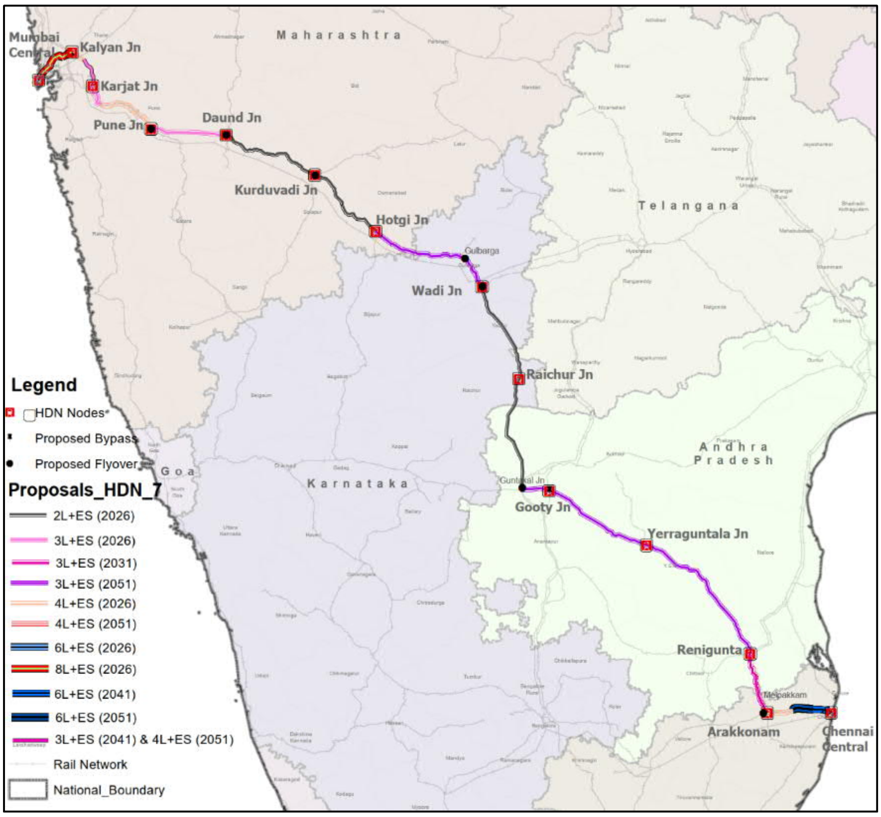


Figure 0-58: –Consolidated Network Upgradation Proposals – HDN 7

0.15. Network Improvement proposals for Highly Utilized Network (HUN)

Similar to HDN, the Indian Railways have classified the next hierarchy of network catering to predominantly high traffic demand as Highly Utilised Network.

A total of 11 routes have been identified as Highly Utilized Network (HUN), having a total length of 23,347 km.

The entire HUN Network is very much congested. More than 46% of HDN network is operating beyond 100% of its capacity. Only 24% of network is having less than 70% capacity Utilization.

Table 0-42: Existing Capacity Utilization of HUN

Capacity Utilization	Network KM	Share
0%-70%	5,896	24%
70%-100%	6,887	28%
100%-150%	8,361	34%
>150%	3,121	12%
Total	**23,347**	**100%**

Entire HUN is recommended to be upgraded for Automatic Signalling with TCAS

HUN wise detailed capacity augmentation proposals are discussed in the subsequent sections

0.15.1.1. HUN 1 – Additional Line Requirements

The network will be upgraded to triple line for the entire stretch.

Table 0-43: HUN 1 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	49	14	205	120	**388**	49	14	205	120	**388**
Double Line to Triple Line	98	102	298	133	**631**	98	102	298	133	**631**
Double Line to Quadruple Line	46	103	41	394	**584**	92	206	82	789	**1168**
Triple Line to Quadruple Line	43	19	193	183	**437**	43	19	193	183	**437**
Quadruple Line to 6 Lines	0	0	0	40	**40**	0	0	0	80	**80**
Total	**235**	**238**	**737**	**871**	**2,081**	**281**	**340**	**778**	**1,305**	**2,705**

0.15.1.2. Capacity Enhancement – HUN 1

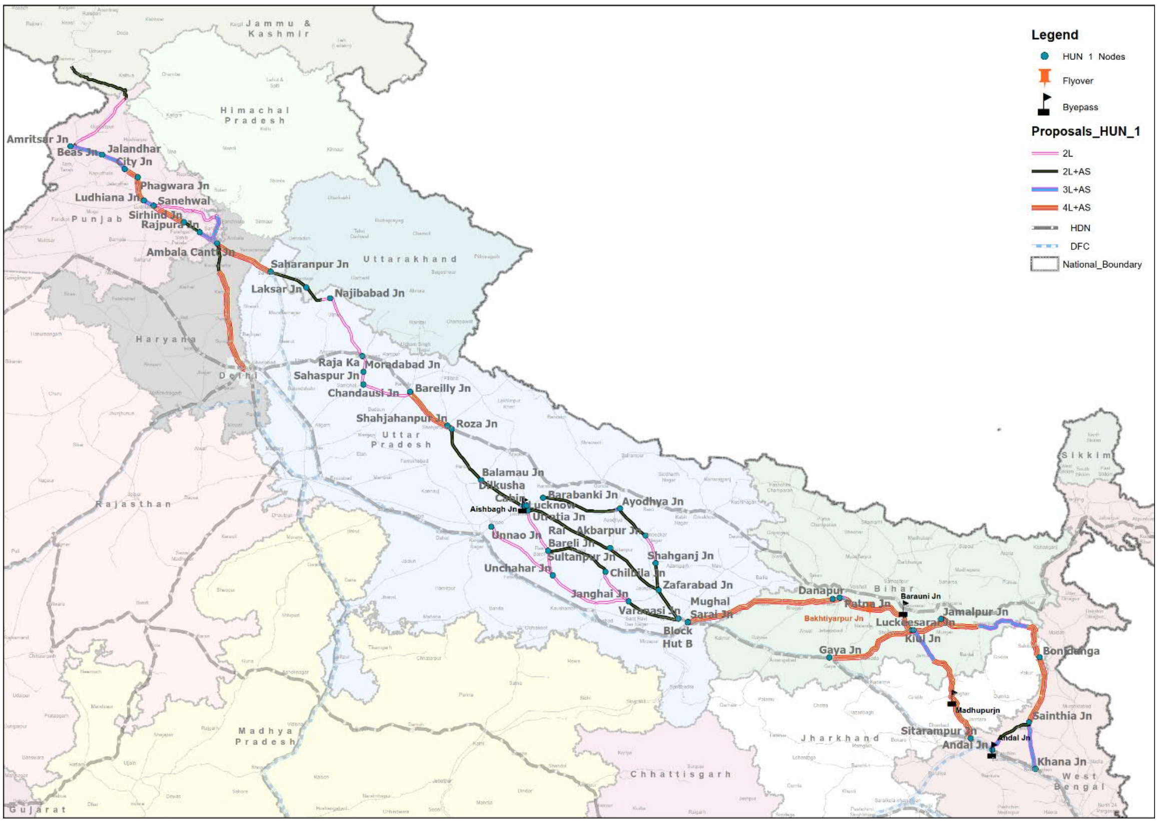


Figure 0-59: –Consolidated Network Upgradation Proposals – HUN 1

Capacity analysis has been carried out for each section of HUN 1 considering the proposals for estimating capacity utilisation till 2051.

It has been concluded that the suggested improvement proposals will reduce the line capacity utilization of HUN 1 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-44: Capacity Utilization Post Implementation of Projects – HUN 1

Line Capacity Utilization	Network km				% Share			
	2026	2031	2041	2051	2026	2031	2041	2051
0%-70%	2402	2654	1707	2078	65%	72%	47%	57%
70%-100%	1247	904	1922	1593	34%	25%	52%	43%
100%-150%	23	113	42	0	1%	3%	1%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**3,671**	**3,671**	**3,671**	**3,671**	**100%**	**100%**	**100%**	**100%**

0.16. HUN 2 – Bengal Arab Sagar Sampark Corridor

HUN 2 is Bengal Arab Sagar Sampark Corridor from Kharagpur to Udhna via Kharagpur - Bankura - Katni - Bhusawal - Udhna & Asansol - Adra - Bhojudih - Pradhankuntha (Dhanbad) & Purulia - Chandil - Sini & Muri - Barkakhana - Barkakhana - Tori & Ranchi - Barsuan & Garwa Rd. - Sonnagar & Billi - Chunar & Rajkharswan - Jakhapura.

0.16.1. Recommended Modifications

the recommendations and modifications for HUN 2 corridor are listed below:

For the purpose of having connectivity between HDN 3, HDN 1, HDN 4 and HDN 5, Section of Katni to Prayagraj has been excluded from HUN 5 and included in HUN 2. With this connection a continuous corridor connecting Surat to Prayagraj via Bhusawal, Jalgaon, Itarsi, Katni is created.

Original Length was **3,035 km** and Length **after modification is 3,507 km**

0.16.2. Existing Capacity Analysis

The entire HUN 2 is built up to handle passenger trains as well as freight trains. Some of the part of the network acts as a feeder to DFCs. At present most of the HUN 2 is operating over 100% of capacity Utilization. Only 40% below 100%, 21% below 70%.

Table 0-45: Existing Capacity Utilization of HUN 2

Capacity Utilization	Network KM	Share
0%-70%	729	21%
70%-100%	672	19%
100%-150%	1316	38%
>150%	789	23%
Total	**3,507**	**100%**

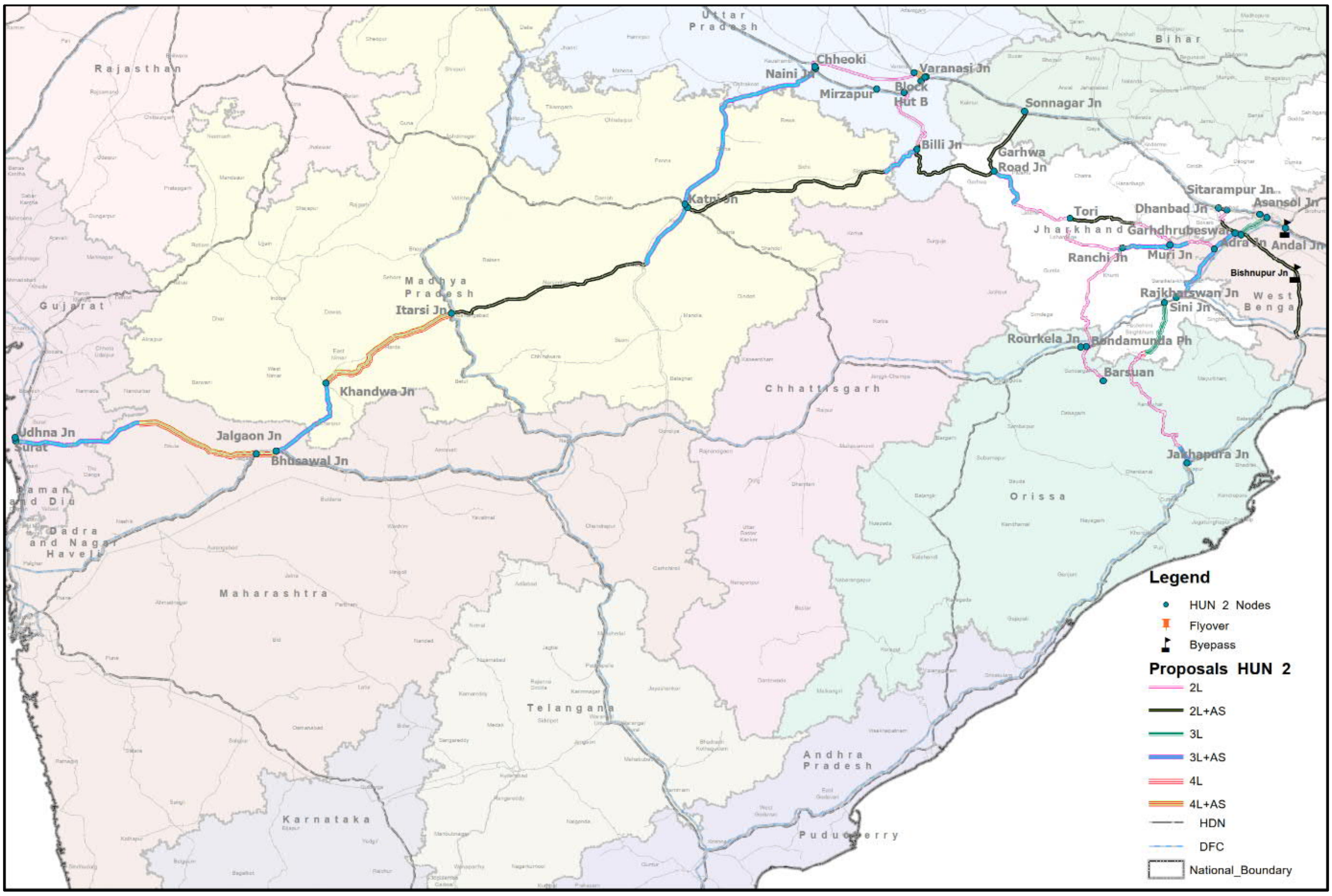


Figure 0-60: –Consolidated Network Upgradation Proposals – HUN 2

Table 0-46: HUN 2 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	76	106	0	4	**186**	76	106	0	4	**186**
Single Line to Triple Line	0	0	0	6	**6**	0	0	0	12	**12**
Single Line to Quadruple Line	0	0	21	0	**21**	0	0	62	0	**62**
Double Line to Triple Line	0	184	500	267	**951**	0	184	500	267	**951**
Double Line to Quadruple Line	0	0	206	0	**206**	0	0	412	0	**412**
Triple Line to Quadruple Line	0	0	16	0	**16**	0	0	16	0	**16**
Total	**76**	**290**	**742**	**277**	**1,386**	**76**	**290**	**990**	**284**	**1639**

0.16.2.1. Capacity Enhancement – HUN 2

Capacity analysis has been carried out for each section of HUN 2 considering the proposals for estimating capacity utilisation till 2051. It has been concluded that the the suggested improvement proposals will reduce the line capacity utilization of HUN 2 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-47: Capacity Utilization Post Implementation of Projects – HUN 2

Line Capacity Utilization	**Network km**				**% Share**			
	2026	2031	2041	2051	2026	2031	2041	2051
0%-70%	2251	2275	2301	1399	65%	66%	67%	41%
70%-100%	791	1170	1145	2047	23%	34%	33%	59%
100%-150%	127	0	0	0	4%	0%	0%	0%
>150%	276	0	0	0	8%	0%	0%	0%
Total	**3445**	**3445**	**3445**	**3445**	**100%**	**100%**	**100%**	**100%**

0.17. HUN 3 – Kathiawar Shivalik Sampark Corridor

HUN 3 is Kathiawar Shivalik Sampark Corridor. From Chandigarh to Rajkot Via Chandigarh - Panipat - Rohtak - Asthalbohar - Rewari -Jaipur-Palanpur - Vadodara & Ahmedabad - Surendanagar - Rajkot & Samakhiyali - Viramgam. Total corridor length is 1688 Km

0.17.1. Recommended Modifications

Some of the recommendations and modifications are listed below:

For the purpose of creating continuous corridor Chandigarh Panipat Section is included in HUN 1. Also, there is no continuous Passenger Corridor from Chandigarh to Rewari. Remaining section of HUN 3 caters maximum to Delhi Jaipur Ahmedabad Traffic for which Bijwasan Satellite Terminal is being developed.

Therefore, it is prudent to include Delhi, Gurugram Rewari Section in HUN 3. Further, Surendranagar to Sabarmati Jn via Viramgam has been proposed as DFC Feeder.

- ✓ Original Length: **1685 km**, Length after Alteration: **1688 km**

0.17.2. Existing Capacity Analysis

The entire HUN 3 is built up to handle passenger trains as well as freight trains. Some of the part of the network acts as a feeder to DFCs. Currently most of the HUN 3 is operating over 100% of capacity Utilization. Only 43% below 100%, 24% below 70%.

Table 0-48: Existing Capacity Utilization of HUN3

Capacity Utilization	Network KM	Share
0%-70%	411	24%
70%-100%	314	19%
100%-150%	546	32%
>150%	418	25%
Total	**1688**	**100%**

0.17.3. HUN 3 Network Upgradation Proposals

Based on demand forecast and as described in the methodology for identifying improvement proposals in Error! Reference source not found., a series of network upgradation projects covering various components such as signalling, line addition have been worked out.

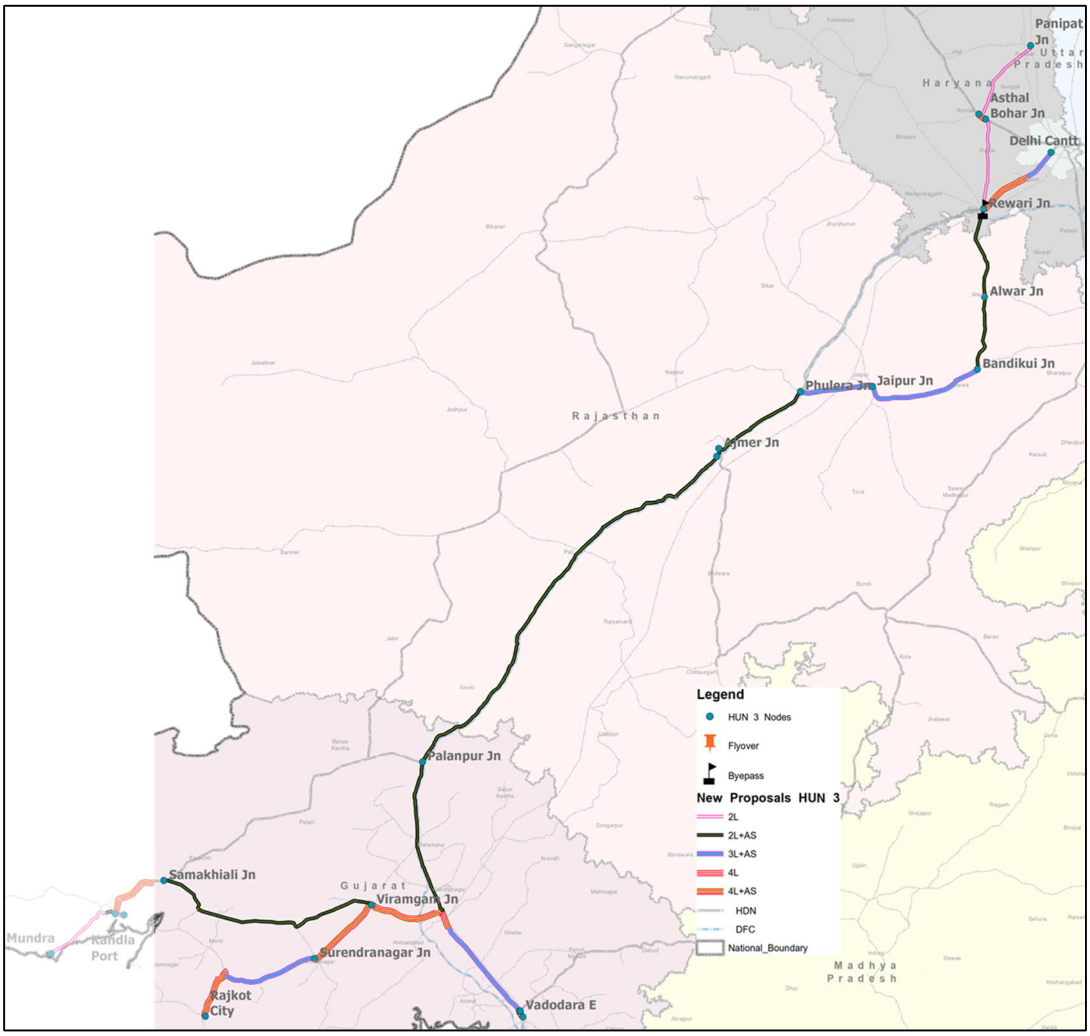


Figure 0-61: –Consolidated Network Upgradation Proposals – HUN 3

Table 0-49: HUN 3 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	113	0	0	0	**113**	113	0	0	0	**113**
Double Line to Triple Line	0	159	292	259	**709**	0	159	292	259	**709**
Double Line to Quadruple Line	0	0	0	6	**6**	0	0	0	13	**13**
Triple Line to Quadruple Line	0	0	94	51	**145**	0	0	94	51	**145**
Total	**113**	**159**	**386**	**316**	**974**	**113**	**159**	**386**	**323**	**981**

0.17.3.1. Capacity Enhancement – HUN 3

Capacity analysis has been carried out for each section of HUN 3 considering the proposals for estimating capacity utilisation till 2051.

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 3 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-50: Capacity Utilization Post Implementation of Projects – HUN 3

Line Capacity Utilization	Network km				% Share			
	2026	**2031**	**2041**	**2051**	**2026**	**2031**	**2041**	**2051**
0%-70%	1062	1306	872	1113	63%	77%	52%	66%
70%-100%	626	324	788	575	37%	19%	47%	34%
100%-150%	0	58	28	0	0%	3%	2%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**1,688**	**1,688**	**1,688**	**1,688**	**100%**	**100%**	**100%**	**100%**

0.18. HUN 4 – Sagar Sutlej Sampark Corridor

HUN 4 is Sagar Sutlej Sampark Corridor running along the India's Western Boundary. The corridor starts from Firozpur to Mundra Port via Firozpur - Bhatinda - Bhatinda - Jakhal - Hissar - Degana - Luni - Samdhari - Bhildi -Kandla / Mundra & Bhatinda - Sirsa - Hisar. Total length of corridor is 1,529 Km.

0.18.1. Recommended Modifications

Some of the recommendations and modifications are listed below:

Section between Gandhidham and Palanpur via Samkhyali provides connectivity to Kandla Port and therefore shall be a connector to WDFC. Section between Bhildi Jn to Palanpur is recommended to be included as part of HUN 4.

Therefore, Gandhidham - Samkhyali - Bhildi - Palanpur is proposed as WDFC Connector for Mundra and Kandla Port and shall be proposed to be upgraded to additional 2 lines for dedicated freight operations.

Original Length: 1,529 km, Length after Alteration: 1527 km.

0.18.2. Existing Capacity Analysis

The entire HUN 4 is built up to handle passenger trains as well as freight trains. Some of the part of the network acts as a feeder to DFCs. The corridor is not that much congested. 73% of the network is below 100% capacity utilisation and 64% of network below 70%.

Table 0-51: Existing Capacity Utilization of HUN 4

Capacity Utilization	Network KM	Share
0%-70%	974	64%
70%-100%	143	9%
100%-150%	154	10%
>150%	255	17%
Total	**1527**	**100%**

0.18.2.1. HUN 4 – Additional Line Requirements

The network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 4 is presented below

Table 0-52: HUN 4 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	555	0	100	43	698	555	0	100	43	698
Double Line to Triple Line	0	53	300	0	353	0	53	300	0	353
Triple Line to Quadruple Line	0	0	53	203	255	0	0	53	203	255
Total	555	53	453	246	1306	555	53	453	246	1306

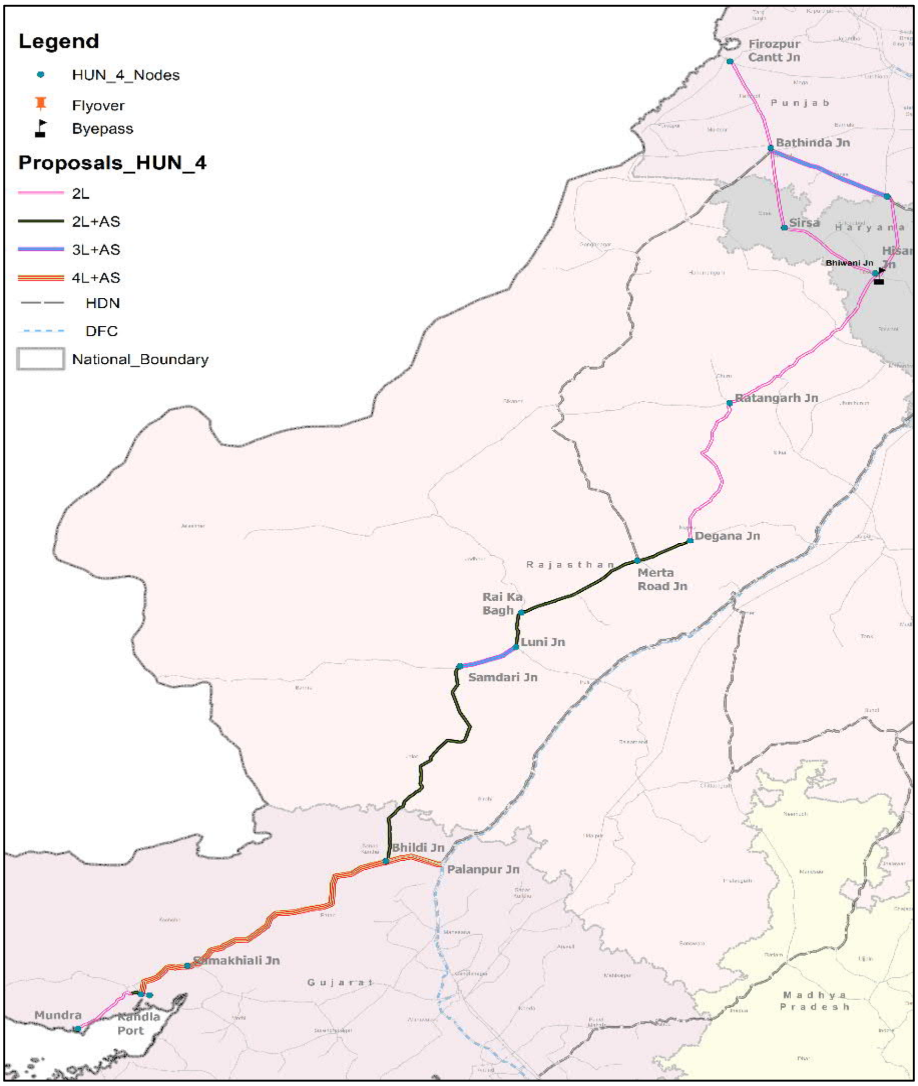


Figure 0-62: –Consolidated Network Upgradation Proposals – HUN 4

0.18.2.2. Capacity Enhancement – HUN 4

Capacity analysis has been carried out for each section of HUN 4 considering the proposals for estimating capacity utilisation till 2051.

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 4 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-53: Capacity Utilization Post Implementation of Projects – HUN 4

Line Capacity Utilization	Network km				% Share			
	2026	2031	2041	2051	2026	2031	2041	2051
0%-70%	1285	1169	1195	1012	84%	77%	78%	66%
70%-100%	242	357	332	515	16%	23%	22%	34%
100%-150%	0	0	0	0	0%	0%	0%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**1,527**	**1,527**	**1,527**	**1,527**	**100%**	**100%**	**100%**	**100%**

0.19. HUN 5 – Sagar Sutlej Sampark Corridor

This Corridor connects Jhansi to Muzaffarpur to Katni via Jhansi - Kanpur - Lucknow - Barabanki - Burhwal, Gonda - Anandnagar - Gorakhpur - Valmikinagar - Valmikinagar - Sugauli, Muzafarpur - Bachwara and Narkatiyaganj - Raxual - Sitamarhi - Darbhanga - Samastipur, Sitamarhi - Muzafarpur - Hazipur including Bhatni - Varanasi - Naini (Allahabad) - Manikpur - Satna - Katni & Chhapra - Varanasi. Total length of the corridor is 2,151 Km.

0.19.1. Recommended Modifications

As explained above in previous sections, Katni to Paryagraj section included to HUN 2. Therefore, the Corridor length after modification is 1,786 km.

0.19.2. Existing Capacity Analysis

The entire HUN 5 is built up to handle passenger trains as well as freight trains. The corridor is congested. 30% of the network is below 100% capacity utilisation and 13% of network below 70%.

Table 0-54: Existing Capacity Utilization of HUN 5

Capacity Utilization	Network KM	Share
0%-70%	240	13%
70%-100%	314	17%
100%-150%	815	44%
>150%	479	26%
Total	1786	100%

0.19.2.1. HUN 5 – Additional Line Requirements

The network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 5 is presented in table below.

Table 0-55: HUN 5 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	83	0	0	227	310	83	0	0	227	310
Double Line to Triple Line	53	9	100	37	198	53	9	100	37	198
Double Line to Quadruple Line	17	0	0	0	17	34	0	0	0	34
Triple Line to Quadruple Line	0	124	0	44	168	0	124	0	44	168
Quadruple Line to 6 Lines	0	0	0	18	18	0	0	0	37	37
Total	153	133	100	326	711	170	133	100	344	747

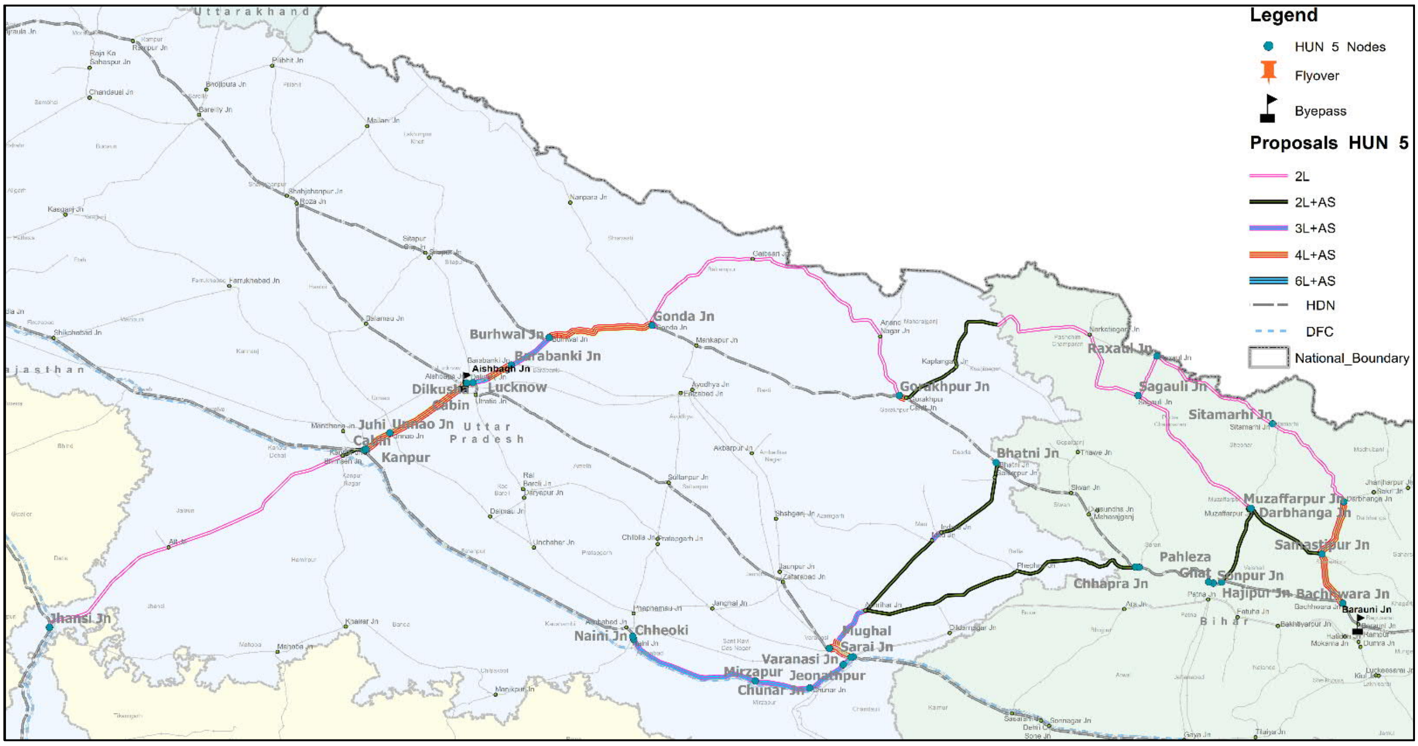


Figure 0-63: –Consolidated Network Upgradation Proposals – HUN 5

0.19.2.2. Capacity Enhancement – HUN 5

Capacity analysis has been carried out for each section of HUN 5 considering the proposals for estimating capacity utilisation till 2051. It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 5 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-56: Capacity Utilization Post Implementation of Projects – HUN 5

Line Capacity Utilization	Network km				% Share			
	2026	2031	2041	2051	2026	2031	2041	2051
0%-70%	1514	1561	1395	1169	82%	84%	76%	63%
70%-100%	333	287	452	678	18%	16%	24%	37%
100%-150%	0	0	0	0	0%	0%	0%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**1,786**	**1,786**	**1,786**	**1,786**	**100%**	**100%**	**100%**	**100%**

0.20. HUN 6 – Sagar Purvodaya Sampark Corridor

HUN 6 runs from Bandel to Dibrugarh via Bandel - Katwa - Azimganj - Barsoi - Aluabari - New Coochbehar - Golakganj - Abhyapuri (Jogigopa) (NL under construction) - Goalpara Town - Guwahati - Lumding - Dibrugarh including Katihar - Kumedpur. Total length is 1,490 Km. Part of this corridor has an Overlapping Section with HDN 4 (Delhi Guwahati). It is passing through the “Chicken Neck” and making it the only corridor connecting North East States with rest of country, which makes is a highly utilized network and therefore requires capacity augmentation.

0.20.1. Existing Capacity Analysis

The entire HUN 6 is built up to handle passenger trains as well as freight trains. The corridor is congested. 30% of the network is below 100% capacity utilisation and 13% of network below 70%.

Table 0-57: Existing Capacity Utilization of HUN 6

Capacity Utilization	Network KM	Share
0%-70%	82	5%
70%-100%	270	18%
100%-150%	975	65%
>150%	163	11%
Total	**1,490**	**100%**

0.20.1.1. HUN 6 – Additional Line Requirements

HUN 6 network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 6 is presented in Table below

Table 0-58: HUN 6 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	174	204	177	35	590	174	204	177	35	590
Double Line to Triple Line	0	0	180	0	**180**	0	0	360	0	**360**
Double Line to Quadruple Line	0	223	43	143	**410**	0	223	43	143	**410**
Triple Line to Quadruple Line	0	118	182	0	**300**	0	236	363	0	**600**
Quadruple Line to 6 Lines	0	0	223	0	**223**	0	0	223	0	**223**
Total	174	546	805	179	1704	174	664	1167	179	2183

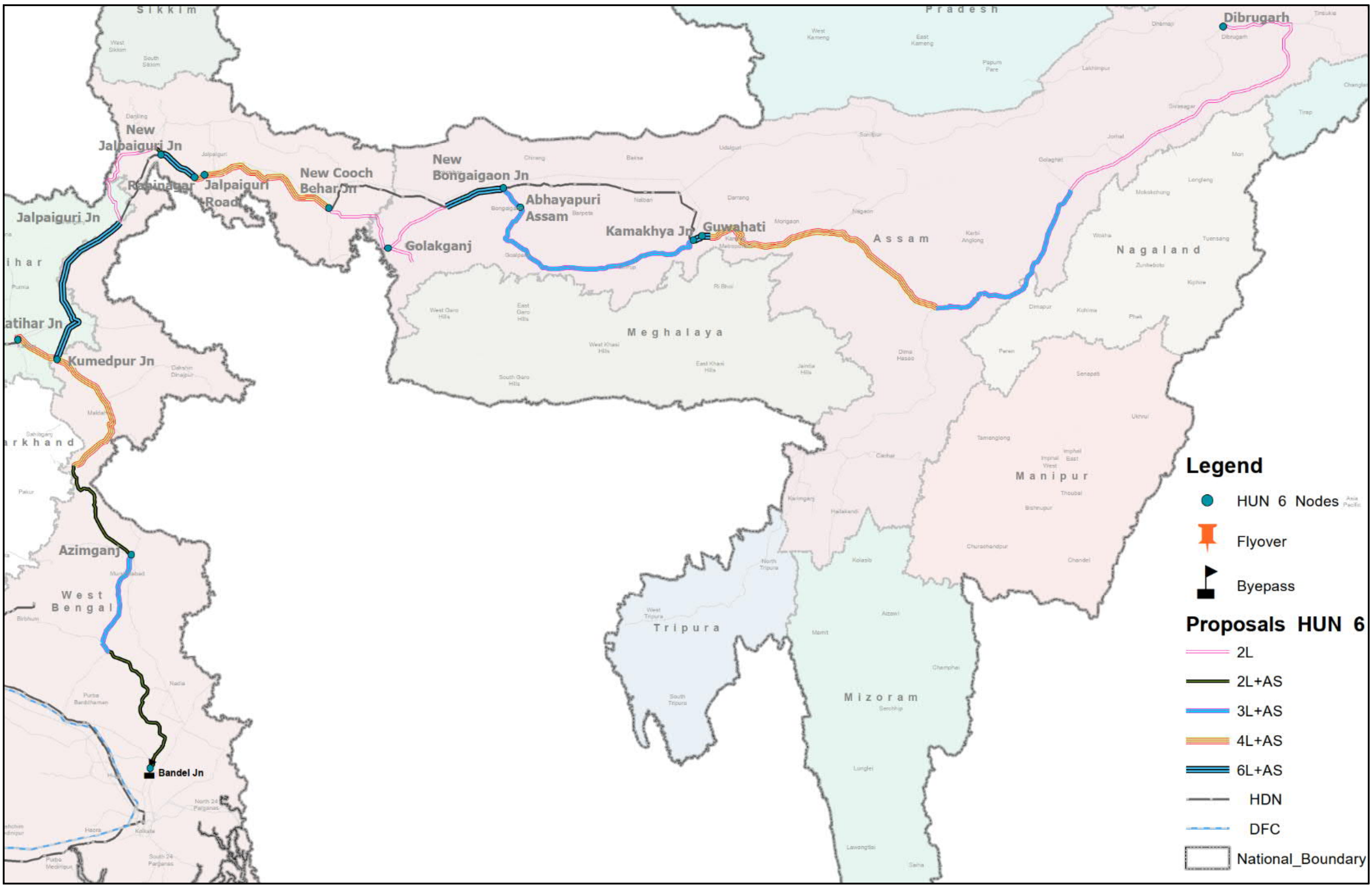


Figure 0-64: –Consolidated Network Upgradation Proposals – HUN 6

0.20.1.2. Capacity Enhancement – HUN 6

Capacity analysis has been carried out for each section of HUN 6 considering the proposals for estimating capacity utilisation till 2051.

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 6 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-59: Capacity Utilization Post Implementation of Projects – HUN 6

Line Capacity Utilization	Network km				% Share			
	2026	2031	2041	2051	2026	2031	2041	2051
0%-70%	809	1338	1213	1159	54%	90%	81%	78%
70%-100%	540	152	277	331	36%	10%	19%	22%
100%-150%	145	0	0	0	10%	0%	0%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**1,490**	**1,490**	**1,490**	**1,490**	**100%**	**100%**	**100%**	**100%**

0.21. HUN 7– Sagar Chambal Sampark Corridor

HUN 7 is Sagar Chambal Sampark Corridor connecting Vizianagram/Paradeep to Kota via Vizianagram - Raipur, Bilaspur - Katni - Kota & Paradeep - Cuttack, Barang - Titlagarh & Sambalpur - Jharsuguda, Kottavalasa - Kinrandul, Singapur Rd. - Koraput, Champa - Gevra Rd. & Anuppur - Boridand - Ambikapur and Boridand - Chirimiri.

Total length of this corridor is 2,737 Km.

0.21.1. Recommended Modifications

Some of the recommendations and modifications are listed below:

- Vijayanagaram to Vishakhapatnam are important OD pairs but were not included as part of HUN 7 and therefore are recommended to be included. However, Vijayanagaram to Vishakhapatnam section is also a part of HDN 6 (Kharagpur to Vijayawada).
- Bina to Katni section has predominant passenger only demand. Paradeep Port to Barang via Jagatsinghpur is recommended as DFC Connector.

Original Length: 2737 km, Length after modification: 3212 km

0.21.2. Existing Capacity Analysis

The entire HUN 7 is built up to handle passenger trains as well as freight trains. The corridor is congested. 40% of the network is below 100% capacity utilisation and 13% of network below 70%.

Table 0-60: Existing Capacity Utilization of HUN 7

Capacity Utilization	Network KM	Share
0%-70%	418	13%
70%-100%	876	27%
100%-150%	1727	54%
>150%	192	6%
Total	**3,212**	**100 %**

0.21.2.1. HUN 7– Additional Line Requirements

HUN 7 network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 7 is presented in **table below**

Table 0-61: HUN 7 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	0	0	385	0	**385**	0	0	385	0	**385**
Double Line to Triple Line	100	0	0	508	**607**	100	0	0	508	**607**
Double Line to Quadruple Line	0	0	45	12	**58**	0	0	91	24	**115**
Triple Line to Quadruple Line	0	136	397	0	**533**	0	136	397	0	**533**
Total	**100**	**136**	**827**	**520**	**1,583**	**100**	**136**	**873**	**532**	**1,640**

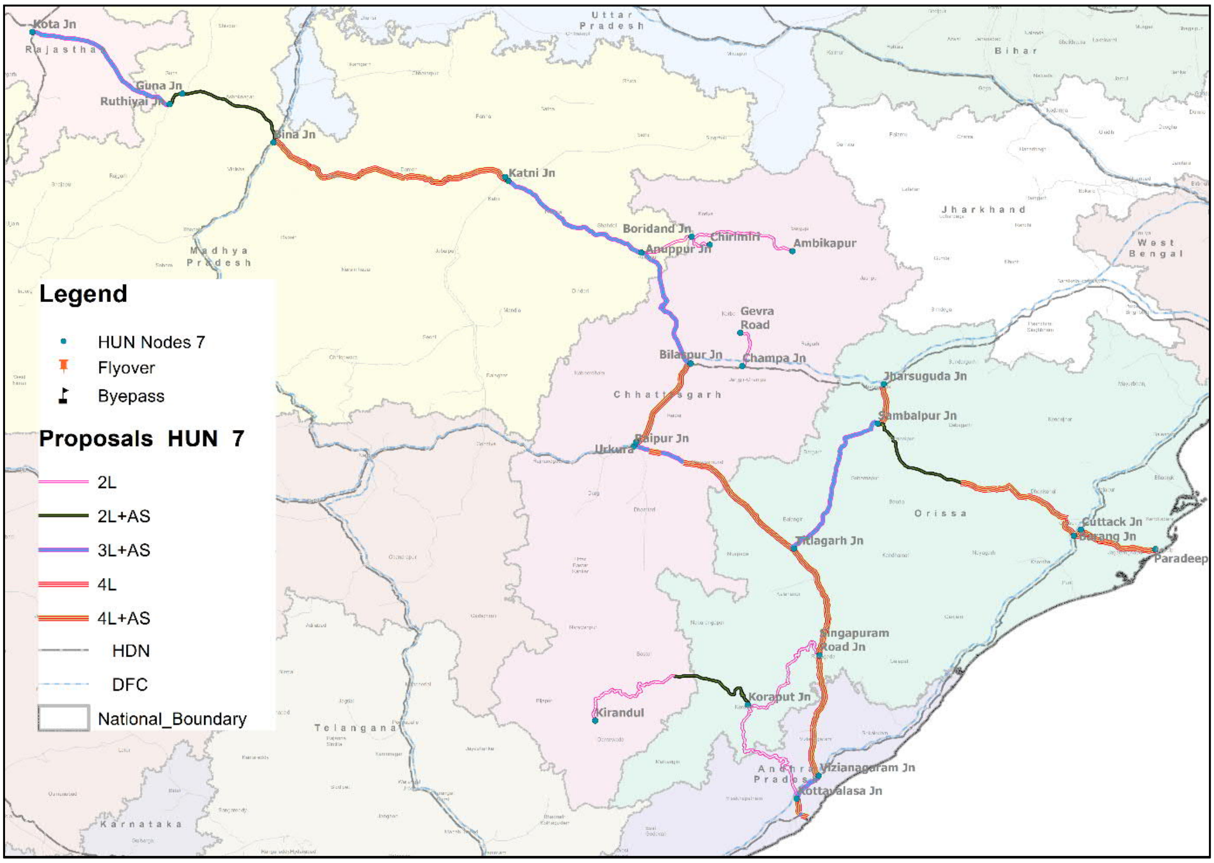


Figure 0-65: –Consolidated Network Upgradation Proposals – HUN 7

0.21.2.2. Capacity Enhancement – HUN 7

Capacity analysis has been carried out for each section of HUN 7considering the proposals for estimating capacity utilisation till 2051.

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 7 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-62: Capacity Utilization Post Implementation of Projects – HUN 7

Line Capacity Utilization	Network km				% Share			
	2026	**2031**	**2041**	**2051**	**2026**	**2031**	**2041**	**2051**
0%-70%	2679	2986	2289	2522	83%	93%	71%	79%
70%-100%	527	226	923	690	16%	7%	29%	21%
100%-150%	6	0	0	0	0%	0%	0%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**3,212**	**3,212**	**3,212**	**3,212**	**100%**	**100%**	**100%**	**100%**

0.22. HUN 8– Purv Paschim Deccan Sampark Corridor

HUN 8 is Purv Paschim Deccan Sampark Corridor connecting Vasco with Machlipatnam via Vasco - Londa, Dharwad - Vijayawada - Machilipatnam & Guntur - Bibinagar & Kazipet - Wadi. Total length of the corridor is 1501 corridor. Hyderabad to Warangal (Kazipet) Section has been recommended to be developed as Feeder Route to DFC in the year 2041.

0.22.1. Existing Capacity Analysis

The entire HUN 8 is built up to handle passenger trains as well as freight trains. The corridor is not much congested. 81% of the network is below 100% capacity utilisation and 21% of network below 70%.

Table 0-63: Existing Capacity Utilization of HUN 8

Capacity Utilization	Network KM	Share
0%-70%	327	21%
70%-100%	895	60%
100%-150%	278	19%
>150%	0	0%
Total	**1501**	**100%**

0.22.1.1. HUN 8– Additional Line Requirements

The network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 8 is presented in **table below**

Table 0-64: HUN 8 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single Line to Double Line	41	0	239	0	**280**	41	0	239	0	**28**
Double Line to Triple Line	0	0	138	139	**278**	0	0	138	139	**278**
Double Line to Quadruple Line	0	0	138	0	**138**	0	0	276	0	**276**
Triple Line to Quadruple Line	0	0	0	64	**64**	0	0	0	64	**64**
Quadruple Line to 6 Lines	0	0	0	38	**38**	0	0	0	77	**77**
Total	**41**	**0**	**515**	**242**	**798**	**41**	**0**	**653**	**281**	**974**

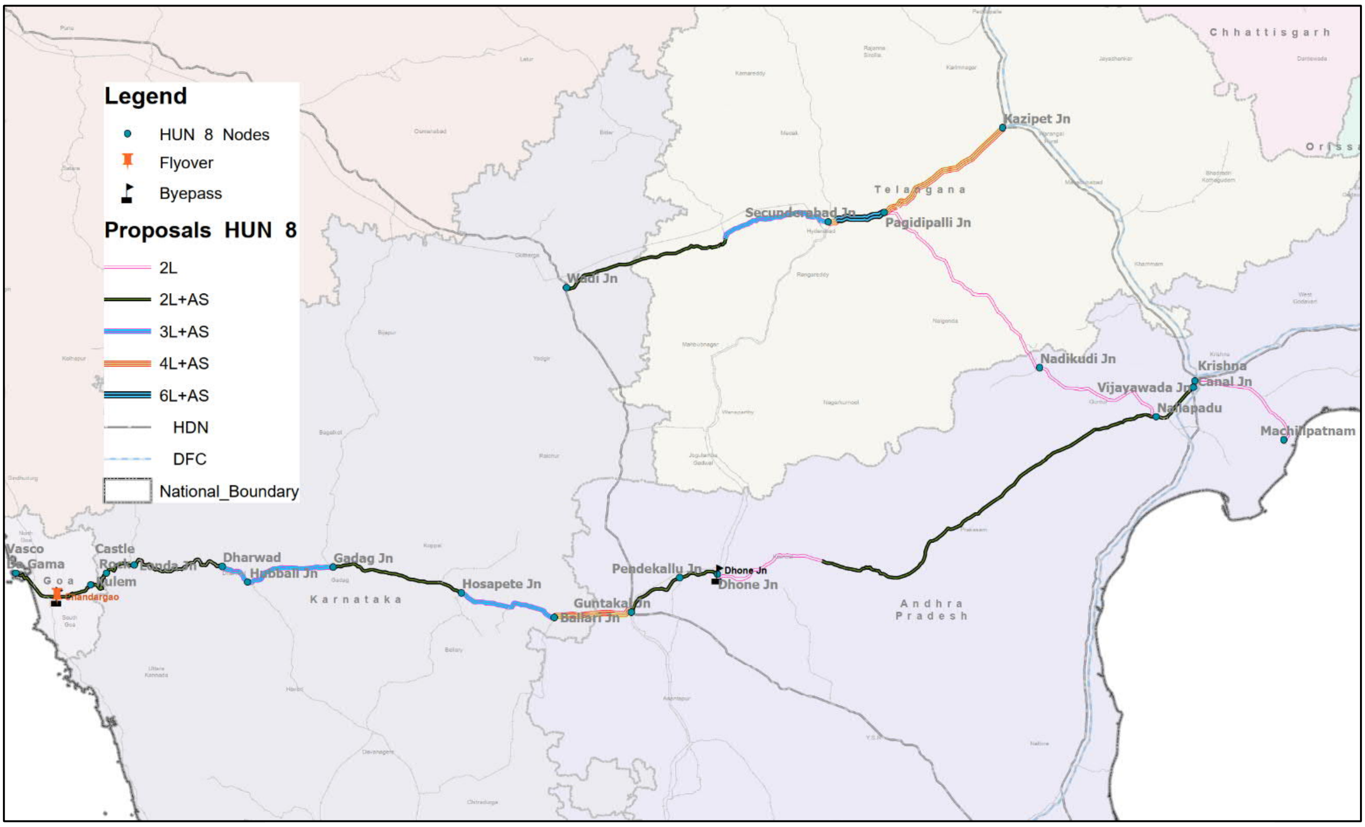


Figure 0-66: –Consolidated Network Upgradation Proposals – HUN 8

0.22.1.2. Capacity Enhancement – HUN 8

Capacity analysis has been carried out for each section of HUN 8 considering the proposals for estimating capacity utilisation till 2051.

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 8 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-65: Capacity Utilization Post Implementation of Projects – HUN 8

Line Capacity Utilization	Network km				% Share			
	2026	2031	2041	2051	2026	2031	2041	2051
0%-70%	981	487	955	653	65%	32%	64%	44%
70%-100%	415	1009	386	848	28%	67%	26%	56%
100%-150%	5	5	160	0	0%	0%	11%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**1501**	**1501**	**1501**	**1501**	**100%**	**100%**	**100%**	**100%**

0.23. HUN 9– Aravalli Dakshin Sampark Corridor

HUN 9 is Aravalli Dakshin Sampark Corridor. Starting from Ajmer till Dindigul the corridor passes through Ajmer - Ratlam - Akola (under GC) - Nanded - Secundrabad - Dharmavaram - Villupuram - Dindigul & Katpadi - Jolarpettai & Chennai - Villupuram. Total length of the corridor is 2803 Km.

0.23.1. Recommended Modifications

Some of the recommendations and modifications are listed below:

- Bangalore to Jolarpetai is part of HUN 10, Jolarpetai to Katpadi is part of HUN 9, Katpadi to Chennai Part of HDN 7, therefore for creating continuous section from Bangalore to Chennai, Jolarpetai to Katpadi is recommended to be excluded from HUN 9 and included in HUN 10.
- Similarly, section of Madurai to Chennai via Tambaram, Chengalpattu, Villupuram section Excluded from HUN 9 and added to HUN 10 for creating a continuous corridor from Trivandrum to Chennai.

Original Length: 2803 km, Length after modification: 2240 km

0.23.2. Existing Capacity Analysis

The entire HUN 9 is built up to handle passenger trains as well as freight trains. The corridor is congested. 61% of the network is below 100% capacity utilisation and 49% of network below 70%.

Table 0-66: Existing Capacity Utilization of HUN 9

Capacity Utilization	Network KM	Share
0%-70%	1099	49%
70%-100%	263	12%
100%-150%	641	29%
>150%	237	11%
Total	**2,240**	**100%**

0.23.2.1. HUN 9– Additional Line Requirements

The network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 9 is presented in Error! Reference source not found..

Table 0-67: HUN 9 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single to Double Line	875	207	39	387	1508	875	207	39	387	1508
Double to Triple Line	0	0	2	13	**15**	0	0	2	13	**15**
Double to quadruple Line	0	0	7	0	**7**	0	0	13	0	**13**
Total	**875**	**207**	**48**	**400**	**1530**	**875**	**207**	**55**	**400**	**1536**

0.23.2.2. Capacity Enhancement – HUN 9

Capacity analysis has been carried out for each section of HUN 9 considering the proposals for estimating capacity utilisation till 2051.

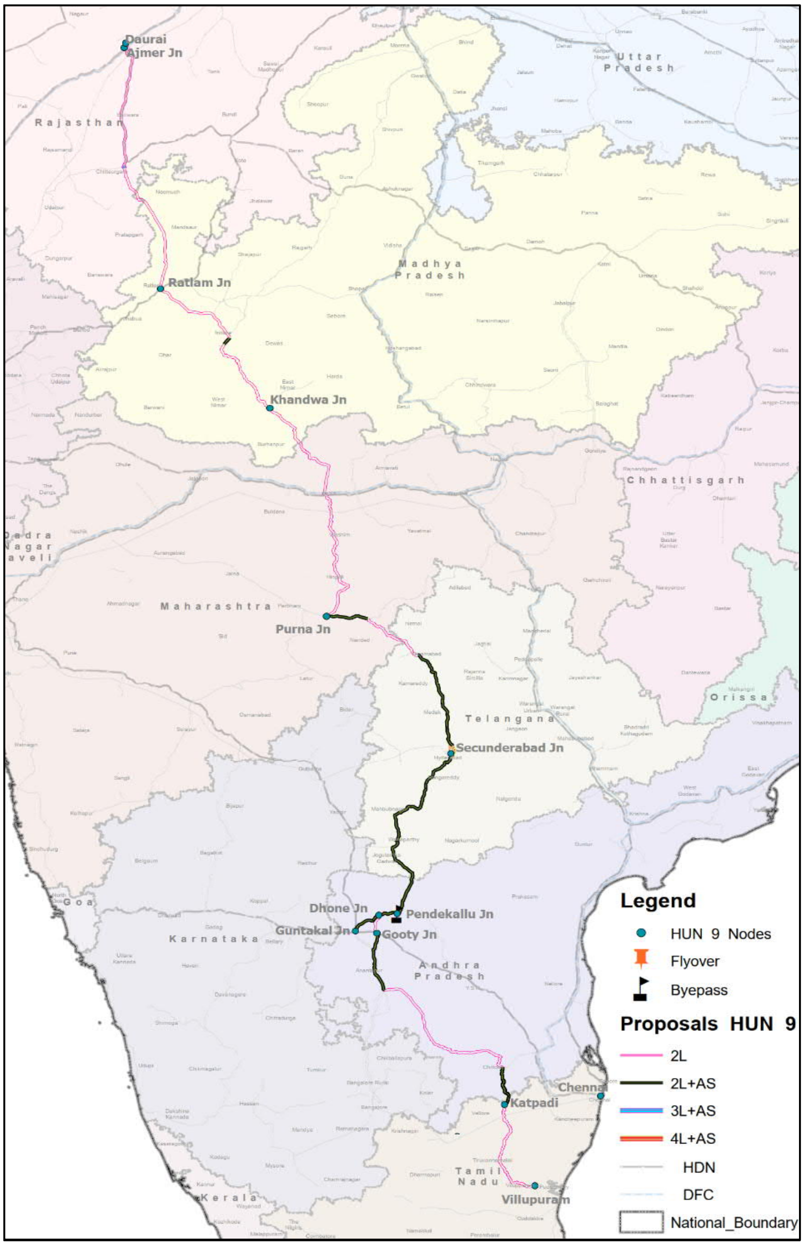


Figure 0-67: –Consolidated Network Upgradation Proposals – HUN 9

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 9 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-68: Capacity Utilization Post Implementation of Projects – HUN 9

Line Capacity Utilization	Network km				% Share			
	2026	**2031**	**2041**	**2051**	**2026**	**2031**	**2041**	**2051**
0%-70%	2085	1702	1870	1353	93%	76%	83%	60%
70%-100%	141	538	370	887	6%	24%	17%	40%
100%-150%	14	0	0	0	1%	0%	0%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**2,240**	**2,240**	**2,240**	**2,240**	**100%**	**100%**	**100%**	**100%**

0.24. HUN 10– Satpura Coromandel Sampark Corridor

HUN 10 is Satpura Coromandel Sampark Corridor starting from Manmad to Kanyakumari via Manmad - Daund, Pune - Hubli - Birur - Yashwantpur - Salem & Bypanhalli - Hosur, Hosur - Salem - Dindigul - Madurai - Kanyakumari & Bengaluru - Mysuru. The total length of the corridor is 2,232 Km

0.24.1. Recommended Modifications

Some of the recommendations and modifications are listed below:

- Jolarptai to Salem is recommended to be excluded from HUN 10 and included in HUN 11 for creating a continuous corridor from Thrissur to Chennai.
- Bangalore to Jolarpetai was a part of HUN 10 & Jolarpetai to Katpadi part of HUN 9 and Katpadi to Chennai is a part of HDN 7 therefore, Jolarpetai to Katpadi recommended to be excluded from HUN 9 and included in HUN 10 for creating a continuous corridor from Bangalore to Chennai via Jolarpetai and Katpadi.
- Madurai to Chennai section recommended to be excluded from HUN 9 and added to HUN 10 for creating a continuous corridor from Trivandrum to Chennai.

Original Length**: 2,232 km**, Length after Alteration: **3,028 km**

0.24.2. Existing Capacity Analysis

The entire HUN 10 is built up to handle passenger trains as well as freight trains. The corridor is congested. 89% of the network is below 100% capacity utilisation and 36% of network below 70%.

Table 0-69: Existing Capacity Utilization of HUN 10

Capacity Utilization	Network KM	Share
0%-70%	1081	36%
70%-100%	1619	53%
100%-150%	13	0%
>150%	315	10%
Total	3,028	100%

0.24.2.1. HUN 10– Additional Line Requirements

The network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 10 is presented in **table below**

Table 0-70: HUN 10 – Additional Line Requirements (2051)

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single to Double Line	147	0	117	74	**338**	147	0	117	74	**338**
Double to Triple Line	177	0	122	343	**642**	177	0	122	343	**642**
Double to Quadruple Line	3	0	0	0	**3**	5	0	0	0	**5**
Triple to Quadruple Line	0	177	0	0	**177**	0	177	0	0	**177**
Quadruple to 6 Lines	0	0	0	38	**38**	0	0	0	76	**76**
Total	**327**	**177**	**239**	**455**	**1,199**	**330**	**177**	**239**	**493**	**1,239**

0.24.2.2. Capacity Enhancement – HUN 10

Capacity analysis has been carried out for each section of HUN 10 considering the proposals for estimating capacity utilisation till 2051.

It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 10 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-71: Capacity Utilization Post Implementation of Projects – HUN10

Line Capacity Utilization	Network km				% Share			
	2026	**2031**	**2041**	**2051**	**2026**	**2031**	**2041**	**2051**
0%-70%	2551	2402	1920	2341	84%	79%	63%	77%
70%-100%	477	626	1108	687	16%	21%	37%	23%
100%-150%	0	0	0	0	0%	0%	0%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**3,028**	**3,028**	**3,028**	**3,028**	**100%**	**100%**	**100%**	**100%**

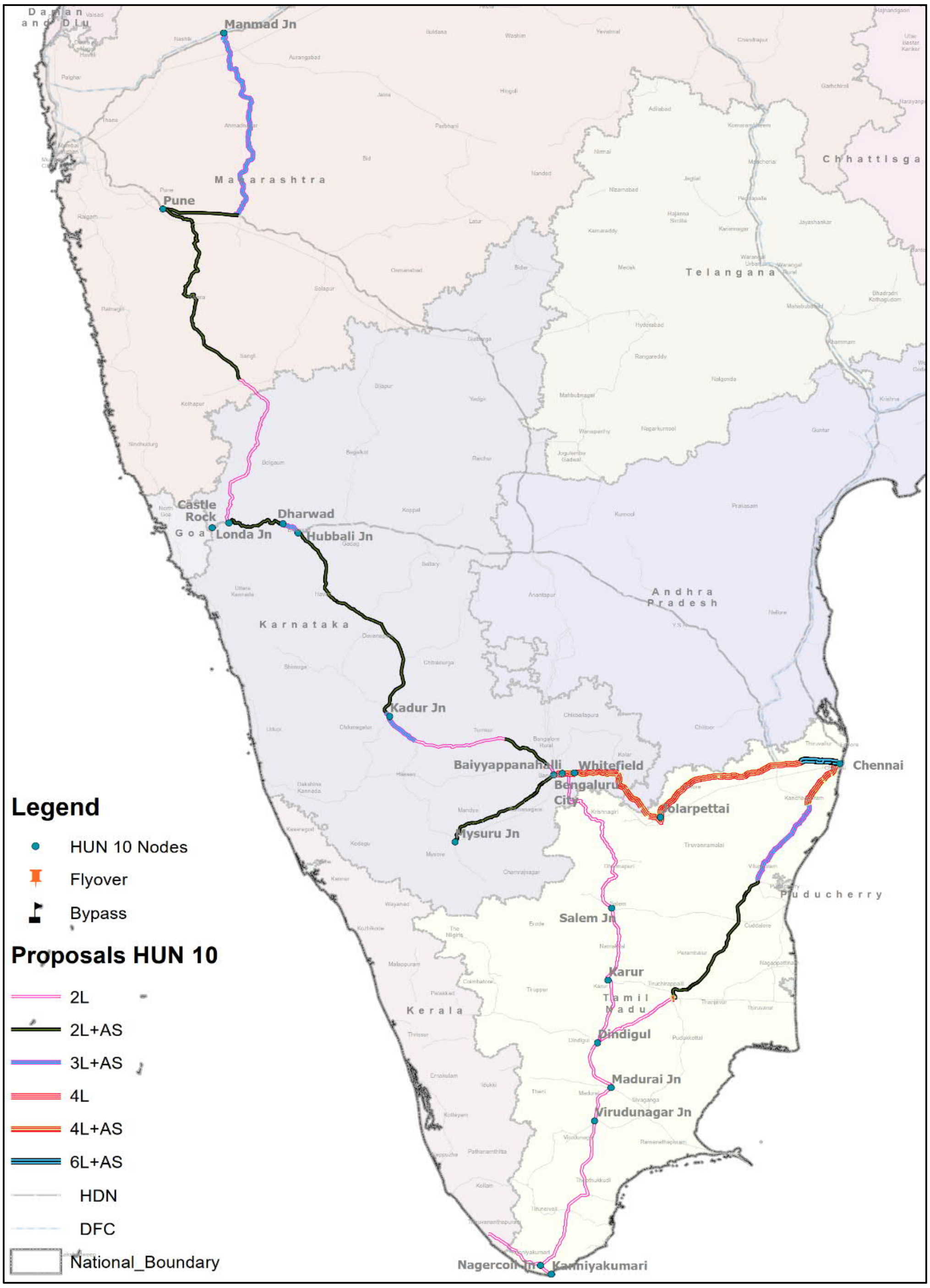


Figure 0-68: –Consolidated Network Upgradation Proposals – HUN 10

0.25. HUN 11– Konkan Malabar Sampark Corridor

HUN 11 is Konkan Malabar Samapark Corridor. From Mangalore to Kanyakumari via Mangalore - Shoranur - Kanyakumari (via Kottayam & Alappuzha) & Shoranur - Salem & Erode - Karur. The total length of the corridor is 1,134 Km

0.25.1. Recommended Modifications

Some of the recommendations and modifications are listed below:

- HUN 11 Continuous corridor, created from Tiruchchirappalli to Jolarpetai via Coimbatore, Erode & Salem, which will eventually connect Bangalore and Chennai by HUN 10. Trivandrum to Madurai section Excluded from HUN 11 and added to HUN 10 for creating a continuous corridor from Trivandrum to Chennai.
- Kerala Rail Development Corporation Limited (KRDCL) has envisioned Semi HSR Corridor, from Trivandrum to Kasadgod via Kollam, Chengannur, Kottayam, Ernakulam, Thrissur, Malappuram, Kozhikode, Kannur, Kasargod. This has been included in HUN 11

✓ Original Length: 1134 km, Length after Alteration: 1050 km

0.25.2. Existing Capacity Analysis

The entire HUN 11 is built up to handle passenger trains as well as freight trains. The corridor is congested. 89% of the network is below 100% capacity utilisation and 36% of network below 70%.

Table 0-72: Existing Capacity Utilization of HUN 11

Capacity Utilization	Network KM	Share
0%-70%	145	14%
70%-100%	906	86%
100%-150%	0	0%
>150%	0	0%
Total	**1050**	**100%**

0.25.2.1. HUN 11– Additional Line Requirements

The network will be upgraded to triple line for the entire stretch. Consolidated upgradation proposals by cardinal years for entire HUN 11 is presented in Error! Reference source not found..

Table 0-73: HUN 11 – Additional Line Requirements (2051)

	Network Km					Line Km				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single to Double Line	11	65	0	0	**76**	11	65	0	0	**76**
Double to Triple Line	0	184	83	346	**613**	0	184	83	346	**613**
Triple to Quadruple Line	0	0	184	185	**369**	0	0	184	185	**369**
Total	**11**	**249**	**267**	**531**	**1059**	**11**	**249**	**267**	**531**	**1059**

0.25.2.2. Capacity Enhancement – HUN 11

Capacity analysis has been carried out for each section of HUN 11 considering the proposals for estimating capacity utilisation till 2051. It has been concluded that the above-mentioned proposals will reduce the line capacity utilization of HUN 11 below 100% till 2051 and substantial network shall operate below 70% capacity utilisation.

Table 0-74: Capacity Utilization Post Implementation of Projects – HUN 11

Line Capacity Utilization	Network km				% Share			
	2026	2031	2041	2051	2026	2031	2041	2051
0%-70%	329	661	852	982	31%	63%	81%	93%
70%-100%	721	390	198	69	69%	37%	19%	7%
100%-150%	0	0	0	0	0%	0%	0%	0%
>150%	0	0	0	0	0%	0%	0%	0%
Total	**1050**	**1050**	**1050**	**1050**	**100%**	**100%**	**100%**	**100%**

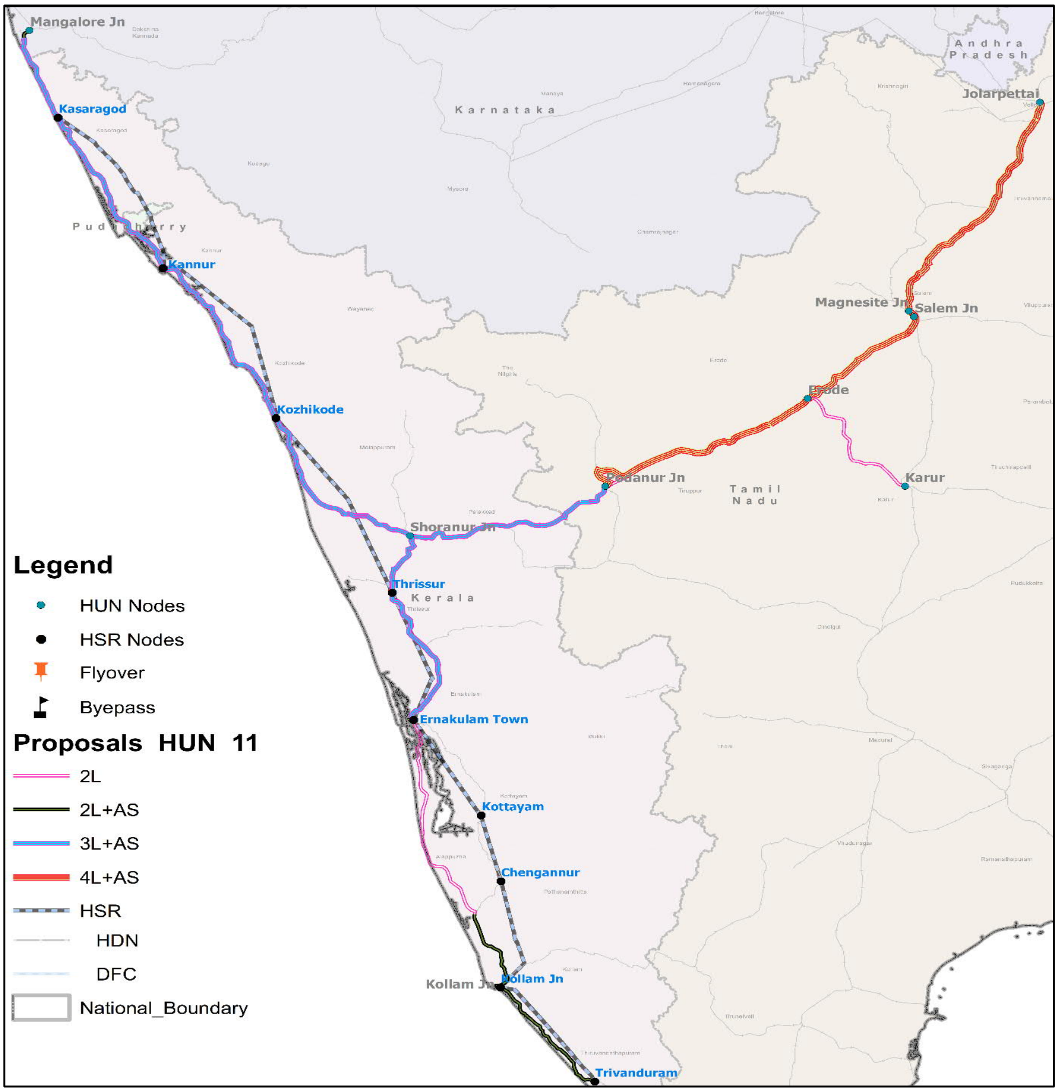


Figure 0-69: –Consolidated Network Upgradation Proposals – HUN 11

0.26. Consolidated HUN Infrastructure Upgradation Proposals

Detail infrastructure recommendations for each of the HUN has been explained in sections above. In this section, the recommendations have been classified by their respective nature and type. These are presented in detail in tables below. Of the total HUN, 13,710 Km of network shall be upgraded by provision of additional line that translates to 15,391 of HUN Line Km.

Table 0-75: Consolidated Additional Line Requirement for HUN

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single to Double Line	1,966	596	963	829	4,354	1,966	596	963	829	4,354
Single to Triple Line	0	0	180	6	186	0	0	360	12	372
Single to Quadruple Line	0	0	21	0	21	0	0	62	0	62
Double to Triple Line	428	913	1,783	2,188	5,312	428	913	1,783	2,188	5,312
Double to Quadruple Line	66	221	619	413	1,318	132	442	1,237	826	2,637
Triple to Quadruple Line	43	451	1,160	730	2,384	43	451	1,160	730	2,384
Quadruple to 6 Lines	0	0	0	135	**135**	0	0	0	270	**270**
Total	2,502	2,181	4,725	4,302	13,710	2,568	2,402	5,565	4,856	15,391

0.27. Network Improvement proposals for Port Connectivity

A total of 2,722 network km has been selected for Port Connectivity. This includes part of HUNs and HDNs also. For port Connectivity, the undermentioned sections are selected as per the connectivity of the port to Nearest HDN or DFC corridor. The details are mentioned in the table below.

Table 0-76: Port Connectivity Doubling Proposals

Section	Port Name	Configuration after completion of Works as per Pink Book	Proposed Configuration			
			2026	2031	2041	2051
Attipattu - Gummidipundi	Chennai/ Ennore Port	2L	2L+ ABTS	-	-	-
Chennai Beach - Chennai Egmore		4L	-	4L+TC	-	-
Chennai Beach - Royapuram		4L	4L+ TC	-	-	-
Chennai Egmore - Tambaram		4L	4L+ TC	-	-	-
Ennore - Attipattu		4L	4L+ ABTS	-	-	-
Gummidipundi - Sullurupeta		2L	2L+ ABTS	-	-	-
Korukkupet Jn. - Tiruvottiyur		3L	3L+ ABTS	-	-	-
Royapuram - Washermanpet.		4L	-	-	4L+TC	-
Sullurupeta - Gudur		2L	2L+ ABTS	-	-	-
Tiruvottiyur - Ennore		4L	4L+ ABTS	-	-	-
Gandhidham - Adipur	Kandla Port	2L	-	-	-	2L+TC
Jhund - Maliya Miyana		2L	-	-	2L+TC	3L+TC
Maliya Miyana - Samakhiyali		2L	-	-	2L+TC	-
Samakhiyali - Gandhidham		2L	2L+TC	3L+TC	4L+TC	-
Shoranur Jn. - Kozhikode	Kozhikode Port	2L	-	2L+TC	-	3L+TC
Andul - Uluberia	Kolkata/Haldia Port	3L	3L+ ABTS	-	-	-
Mecheda - Panskura		3L	3L+ ABTS	-	-	-
Panskura - Haldia		2L	-	-	-	2L+TC
Panskura - Kharagpur		3L	3L+ ABTS	-	-	-
Santragachi - Andul		3L	3L+ ABTS	-	-	-
Uluberia - Mecheda		3L	3L+ ABTS	-	-	-
Kulem - Vasco - Da - Gama	Madgaon Port	2L	-	-	2L+TC	-
ROHA - Madgaon	Mangalore Port	1L	2L	-	3L+TC	-
Kannur - Netravati		2L	-	-	2L+TC	3L+TC
Kozhikode - Kannur		2L	-	2L+TC	-	3L+TC
Mangaluru Jn. - Thokur		1L	2L	-	-	2L+TC
Netravati - Mangaluru Jn.		2L	-	-	-	2L+TC
Chhatrapati Shivaji Terminus, Mumbai - Dadar	Mumbai port	4L	4L+ ABTS	-	-	-
Dadar - Kurka		4L	4L+ ABTS	6L+ ABTS	8L+ ABTS	-
Dadar - Mahim Jn		6L	6L+ ABTS	-	-	8L+ ABTS
Bhildi - Samakhiyali		1L	2L	2L+TC	3L+TC	4L+TC
Budhapank - Rajathgarh	Paradeep	4L	-	-	-	4L+TC
Cuttack - Barang		3L	3L+ ABTS	-	-	-
Cuttack - Paradeep		2L	-	-	-	3L+TC
Haridaspur- Paradeep		1L	2L+TC	-	-	4L+TC
Nergundi - Cuttack		3L	3L+ ABTS	-	-	-
Talcher - Budhapank		1L	4L+TC	-	-	-
Gopalpatnam - Duvvada	Vishakhapatnam	3L	3L+ ABTS	-	-	-
Gopalpatnam - Visakhapatnam		3L	3L+TC	4L+TC	-	-

Section	Port Name	Configuration after completion of Works as per Pink Book	Proposed Configuration			
			2026	2031	2041	2051
Kottavalasa - Simhachalam North		4L	4L+ ABTS	-	-	-
Simhachalam North - Duvvada (By - Pass)		2L	2L+TC	-	-	-
Simhachalam North - Jaggayyapalem		3L	-	-	-	-

The consolidated proposal for the port connectivity projects in terms of single, doubling or quadrupling of the lines is given in the following table. An addition of 2092 line kms is required to connect all the major ports with Indian Railway network

Table 0-77: Port Connectivity Doubling Proposals

	Network KM					Line KM				
Conversion	**2026**	**2031**	**2041**	**2051**	**Total**	**2026**	**2031**	**2041**	**2051**	**Total**
Single to Double Line	218	137	81	215	**650**	218	137	81	215	**650**
Single to Quadruple Line	141	0	0	0	**141**	424	0	0	0	**424**
Double to Triple Line	0	53	160	475	**687**	0	53	160	475	**687**
Double to Quadruple Line	0	0	0	76	**76**	0	0	0	151	**151**
Triple to Quadruple Line	0	6	53	92	**151**	0	6	53	92	**151**
Quadruple to 6 Lines	0	6	0	0	**6**	0	12	0	0	**12**
6 Lines to 8 Lines	0	0	6	2	**8**	0	0	12	5	**17**
Total	**359**	**202**	**299**	**859**	**1720**	**642**	**208**	**305**	**937**	**2092**

0.28. Trans Asian Rail Connectivity

While discussion on Capacity Expansion up to now centred around, internal rail connectivity – both sectional and terminal, it is necessary also to discuss the issues of South East Asian Rail Connectivity. While Trans-Asian Rail networks of North and Central Routes involving China, Russia, Far East have taken off and maturing fast, the connectivity of the Trans Asian South Route, is still in a fledgling state.

The connectivity status to neighbouring countries is depicted hereunder:

Table 0-78: Connectivity Status to Neighboring Countries

	Traffic Interchange Points	Remarks
India-Pakistan		
Existing Links	Attari (India)-Wagah (Pakistan)	Freight and Passenger Services
	Munabao (India) —Khokrapar (Pakistan)	Passenger Services
India-Bangladesh		
Existing Links	Gede (India)- Darshana (Bangladesh)	
	Singhabad (India)- Rohanpur (Bangladesh)	
	Petrapole (India)-Benapole (Bangladesh)	
New links under Execution	Agartala (India)- Akhaura (Bangladesh)	

	Mahisasan (India) – Zero Point Bangladesh) 2.7km	
New Links Surveyed	**Belonia (India) – Belonia (Bangladesh) 3km**	
India-Nepal		
Existing Links	Raxaul-Birganj	Train services w.e.f. 16.07.2004 after operationalization of Birganj ICD
New links under Execution	Jogbani-Birammpr (18kms)	Sanctioned in 2010-2011
	Jayanagar-Bijalpura with extn. To Bardibas (69 kms)	Sanctioned in 2010-2011
New links surveyed		
	Baba Jang (India)- Nepalganj (Nepal)- 15.75 kms	
	Nautanwa (India)- Bhairahawa (Nepal)- 25 kms	
	Naxalbari (India)- Kakarbhita (Nepal) - 16 kms	
	Raxaol (India) – Katmandu (Nepal) – 136 km	
India-Bhutan		
New links Surveyed	Hashimara (India)- Phuentaoling (Bhutan)- 17.5 kms	
	Rangia (India)- Samdrupjongkhar (Bhutan) via Darranga	
	Khokrajhar (India)- Gelephu (Bhutan)	
	Banarhat (India)- Samtae (Bhutan)	
	Pathshala (India)- Nanglam (Bhutan)	
	Mujnai (India) – Nyoenpaling (Bhutal) 36km	
India-Myanmar		
New links under Execution	Jiribam and Imphal	
Survey for new links planned/ in progress	Imphal-Moreh (India)	Taken up in 2012-13
	Tamu- Kalay (in Myanmar)	
India-Sri Lanka		
	Rameshwaram (India)- Talaimannar (Sri Lanka)	Ferry services being planned

	Traffic Interchange Points	Remarks
India-Pakistan		
Existing Links	Attari (India)-Wagah (Pakistan)	Freight and Passenger Services
	Munabao (India) —Khokrapar (Pakistan)	Passenger Services
India-Bangladesh		
Existing Links	Gede (India)- Darshana (Bangladesh)	

	Singhabad (India)- Rohanpur (Bangladesh)	
	Petrapole (India)-Benapole (Bangladesh)	
New links under Execution	Agartala (India)- Akhaura (Bangladesh)	
	Mahisasan (India) – Zero Point Bangladesh) 2.7km	
New Links Surveyed	Belonia (India) – Belonia (Bangladesh) 3km	
India-Nepal		
Existing Links	Raxaul-Birganj	Train services w.e.f. 16.07.2004 after operationalization of Birganj ICD
New links under Execution	Jogbani-Birammpr (18kms)	Sanctioned in 2010-2011
	Jayanagar-Bijalpura with extn. To Bardibas (69 kms)	Sanctioned in 2010-2011
New links surveyed		
	Baba Jang (India)- Nepalganj (Nepal)- 15.75 kms	
	Nautanwa (India)- Bhairahawa (Nepal)- 25 kms	
	Naxalbari (India)- Kakarbhita (Nepal) - 16 kms	
	Raxaol (India) – Katmandu (Nepal) – 136 km	
India-Bhutan		
New links Surveyed	Hashimara (India)- Phuentaoling (Bhutan)-17.5 kms	
	Rangia (India)- Samdrupjongkhar (Bhutan) via Darranga	
	Khokrajhar (India)- Gelephu (Bhutan)	
	Banarhat (India)- Samtae (Bhutan)	
	Pathshala (India)- Nanglam (Bhutan)	
	Mujnai (India) – Nyoenpaling (Bhutal) 36km	
India-Myanmar		
New links under Execution	Jiribam and Imphal	
Survey for new links planned/ in progress	Imphal-Moreh (India)	Taken up in 2012-13
	Tamu- Kalay (in Myanmar)	
India-Sri Lanka		
	Rameshwaram (India)- Talaimannar (Sri Lanka)	Ferry services being planned

0.29. Rail Connectivity with Industrial Corridors

National Industrial Corridor Development Programme is India's most ambitious infrastructure programme aiming to develop new industrial cities as "Smart Cities" and converging next generation technologies across infrastructure sectors.

Govt. of India is developing various Industrial Corridor Projects as part of National Industrial Corridor programme which is aimed at development of futuristic industrial cities in India which can compete with the best manufacturing and investment destinations in the world. The same will create employment opportunities and economic growth leading to overall socio-economic development.

11 Industrial Corridors Projects are being taken up for development with 30 Projects to be developed in 04 phases up to 2024-25:

1. Delhi Mumbai Industrial Corridor (DMIC);
2. Chennai Bengaluru Industrial Corridor (CBIC);
3. Amritsar Kolkata Industrial Corridor (AKIC);
4. East Coast Industrial Corridor (ECIC) with Vizag Chennai Industrial Corridor (VCIC) as Phase 1;
5. Bengaluru Mumbai Industrial Corridor (BMIC);
6. Extension of CBIC to Kochi via Coimbatore;
7. Hyderabad Nagpur Industrial Corridor (HNIC);
8. Hyderabad Warangal Industrial Corridor (HWIC);
9. Hyderabad Bengaluru Industrial Corridor (HBIC);
10. Odisha Economic Corridor (OEC);
11. Delhi Nagpur Industrial Corridor (DNIC).

Table 0-79: Rail Connectivity Proposals for NICDC Projects

S. No	National Industrial Corridor	State	Phase	District Name	Existing	Proposed	DFC	HSR
1	Dholera Special Investment Region (22.5 sq. kms)	Gujarat	Phase 1	Ahmedabad	2L	4L+TC	DFC (2026)	HSR
2	Shendra Bidkin Industrial Area (18.55 sq. kms)	Maharashtra	Phase 1	Aurangabad	3L	4L+TC	DFC (2026)	-
3	Integrated Industrial Township – Vikram Udyogpuri (1,100 acres)	Madhya Pradesh	Phase 1	Ujjain	2L	3L+ABTS	-	-
4	Integrated Industrial Township – Greater Noida (747.5 acres)	Uttar Pradesh	Phase 1	Gautam Buddh Nagar	4L	4L+ABTS	DFC (2026)	-
5	Integrated Multi-Modal Logistics Hub – Nangal Chaudhary (886 acres)	Haryana	Phase 1	Mahendragarh	2L	2L	DFC (2026)	-
6	Krishnapatnam Industrial Area (2,500 acres)	Andhra Pradesh	Phase 2	Nellore	4L	4L+ABTS	DFC (2031)	-
7	Tumakuru Industrial Area (1,736 acres)	Karnataka	Phase 2	Tumkur	1L	2L+TC	-	-

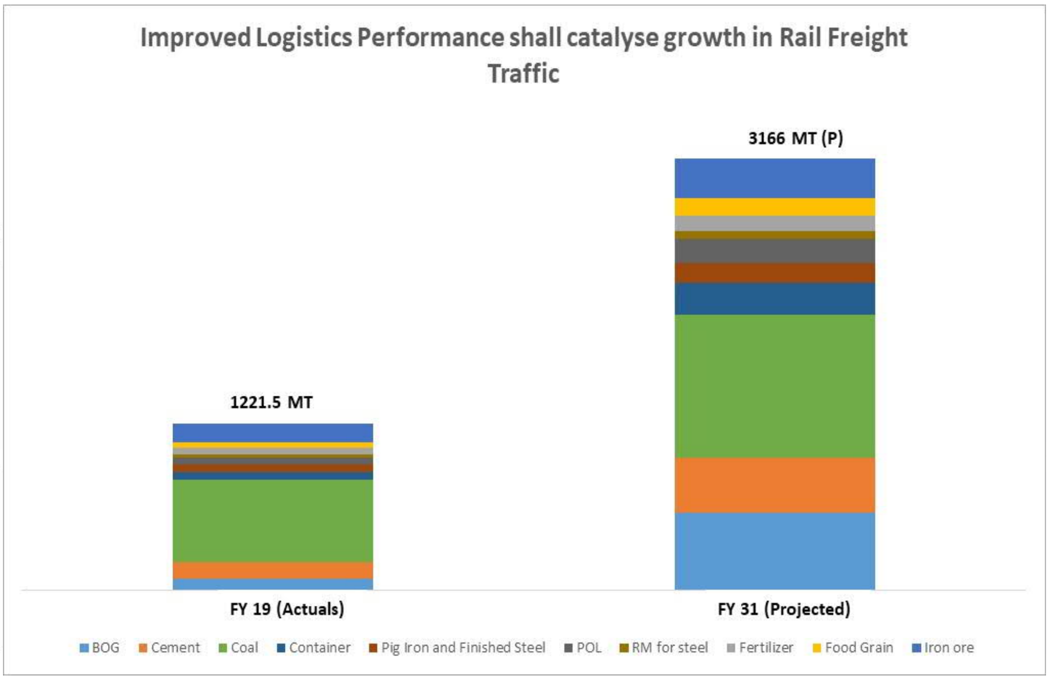
S. No	National Industrial Corridor	State	Phase	District Name	Existing	Proposed	DFC	HSR
4	Multi Modal Logistics Hub & Multi Modal Transport Hub (MMLH & MMTH) (1,208 acres)	Uttar Pradesh	Phase 2	Ghaziabad	4L	4L+ABTS	DFC (2026)	-
8	Multi Modal Logistics Park, Sanand (500 acres)	Gujarat	Phase 2	Ahmedabad	2L	4L+TC	DFC (2026)	HSR
9	Dighi Port Industrial Area (7,413 acres)	Maharashtra	Phase 2	Pune	4L	4L+ABTS	-	HSR
10	Zaheerabad Phase 1 (3,500 acres)	Telangana	Phase 2	Sangareddy	2L	4L+TC	-	-
11	Hyderabad Pharma City Phase 1 (8,000 acres)	Telangana	Phase 2	Hyderabad	2L	4L+TC	-	-
12	Raghunathpur Industrial Park (2,483 acres)	West Bengal	Phase 2	Purulia	3L	3L	-	-
13	Ponneri Industrial Area (4,000 acres)	Tamil Nadu	Phase 3	Tiruvallur	4L	6L+ABTS	DFC (2031)	-
14	Salem (1,773 acres)	Tamil Nadu	Phase 3	Salem	2L	4L+TC	-	-
15	Palakkad Industrial Area (1,878 acres)	Kerala	Phase 3	Palakkad	3L	4L+TC	-	-
16	Koparthy Industrial Area (4,085 acres)	Andhra Pradesh	Phase 3	Srikakulam	3L	3L+ABTS	DFC (2031)	-
17	Chitoor Industrial Area (2,346 acres)	Andhra Pradesh	Phase 3	Chittoor	2L	3L+ABTS	DFC (2031)	-
18	Vishakhapatnam Industrial Area (1,100 acres)	Andhra Pradesh	Phase 3	Visakhapatnam	4L	4L+ABTS	DFC (2031)	-
19	Hisar Integrated Manufacturing Cluster (4,000 acres)	Haryana	Phase 3	Hisar	2L	3L+TC	-	-
20	Prag Khurpia Integrated Manufacturing Cluster (2,935 acres)	Uttarakhand	Phase 3	Udham Singh Nagar	1L	2L	-	-
21	Rajpura Patiala	Punjab	Phase 4	Patiala	2L	2L+TC	DFC (2026)	-
22	Kanpur	Uttar Pradesh	Phase 4	Kanpur Nagar	4L	6L+ABTS	DFC (2026)	HSR
23	Ghamariya	Bihar	Phase 4	Gaya	3L	3L+ABTS	DFC (2031)	-
24	Bahri	Jharkhand	Phase 4	Hazaribagh	1L	2L+TC	-	-

S. No	National Industrial Corridor	State	Phase	District Name	Existing	Proposed	DFC	HSR
25	Sangli / Satara / Solapur	Maharashtra	Phase 4	Sangli	2L	2L+TC	-	-
			Phase 4	Satara	2L	2L+TC	-	-
			Phase 4	Solapur	2L	2L+ABTS	-	-
26	Dharwad	Karnataka	Phase 4	Dharwad	2L	3L+TC	-	-
27	Hyderabad Bengaluru Industrial Corridor	Orvakal/Anantapur/Hindupur	Phase 4	Kurnool	2L	2L+ABTS	-	HSR
				Anantapuramu	2L	4L+TC	-	-
28	Odisha Economic Corridor	Khurda-Cuttack-Jagatsinghpur/ Jajpur-Kendrapara-Bhadrak	Phase 4	Khordha	3L	3L+ABTS	DFC (2031)	-
				Cuttack	4L	4L+TC	DFC (2031)	-
				Jagatsinghpur	2L	4L+TC	-	-
				Jajpur	3L	4L+ABTS	DFC (2031)	-
				Kendrapara	1L	4L+TC	-	-
				Bhadrak	3L	3L+ABTS	DFC (2031)	-
29	Delhi Nagpur Industrial Corridor		Phase 4	Nagpur	4L	4L+ABTS	DFC (2031)	HSR
			Phase 4	Delhi	3L	4L+TC	DFC (2041/ 2051)	HSR

0.30. Multimodal Freight Terminal

Rail transportation inherently involves handling of cargo at terminals as part of the chain. Any rail-based cargo transportation chain therefore invariably involves both, terminal handling as well as first and last mile operations, as additional activities in comparison with road-based transportation, which in turn potentially adds to cost as well as time spent in the transit process, when compared to road-based movement of cargo alone.

The projected potential growth of freight traffic on rail, as discussed in the demand forecast report, indicates that rail traffic has a potential for almost 2.5x growth over the next decade subject to improved 'logistics performance' on rail. This additional demand will clearly throw up an inherent need for corresponding additional capacity for MMLPs/Freight Terminals to service the same.



Note: FY 19 Rail Traffic sourced from Indian Railways. FY 31 Rail Traffic Projections sourced from AECOM Logit Model

During the course of consultations with multiple Industry stakeholders, various issues were raised, ranging from lack of adequate terminal infrastructure capacity at desired locations, non-availability of facilities/mechanisms aligned with specific needs of different commodities, primitive nature of loading/unloading operations at existing terminals/good sheds, inefficiencies at terminals, etc

0.31. Multi Modal Passenger Terminals

Based on the existing travel demand pattern which has been derived from the ticket sales data, total number of passengers from each of the railway terminal has been estimated for the base year (2018). There are around 24 (no.) terminals (station clusters) that handle more than 2,00,000 passengers per day.

The passenger demand in terms of the footfall at the various Railway Stations has been forecasted using the results of the travel demand forecast model. This demand has been forecasted for all the cardinal years using the Passenger OD Matrices where the total number top 24 clusters (identified earlier which have a demand of more than 2,00,000 Passengers per day).

These 24 terminal/ station clusters are proposed to be taken up for upgradation immediately. The upgradation plan / interventions for each these clusters will have to be drawn up depending on the proposed footfall. As a first preference, the major station of these clusters will be taken up for upgradation so that the demand can be met. However, in case, there are physical, land or any other constraints to expand any station to meet the demand, directional terminals for the main station may be considered in the same district.

It is forecasted that with time more terminals /stations clusters will be added to this list which will handle more than 2,00,000 passengers/ day.

Additional stations have been identified for upgradation where a multimodal integration is required with other Rail modes such as High-Speed Rail, RRTS, etc.

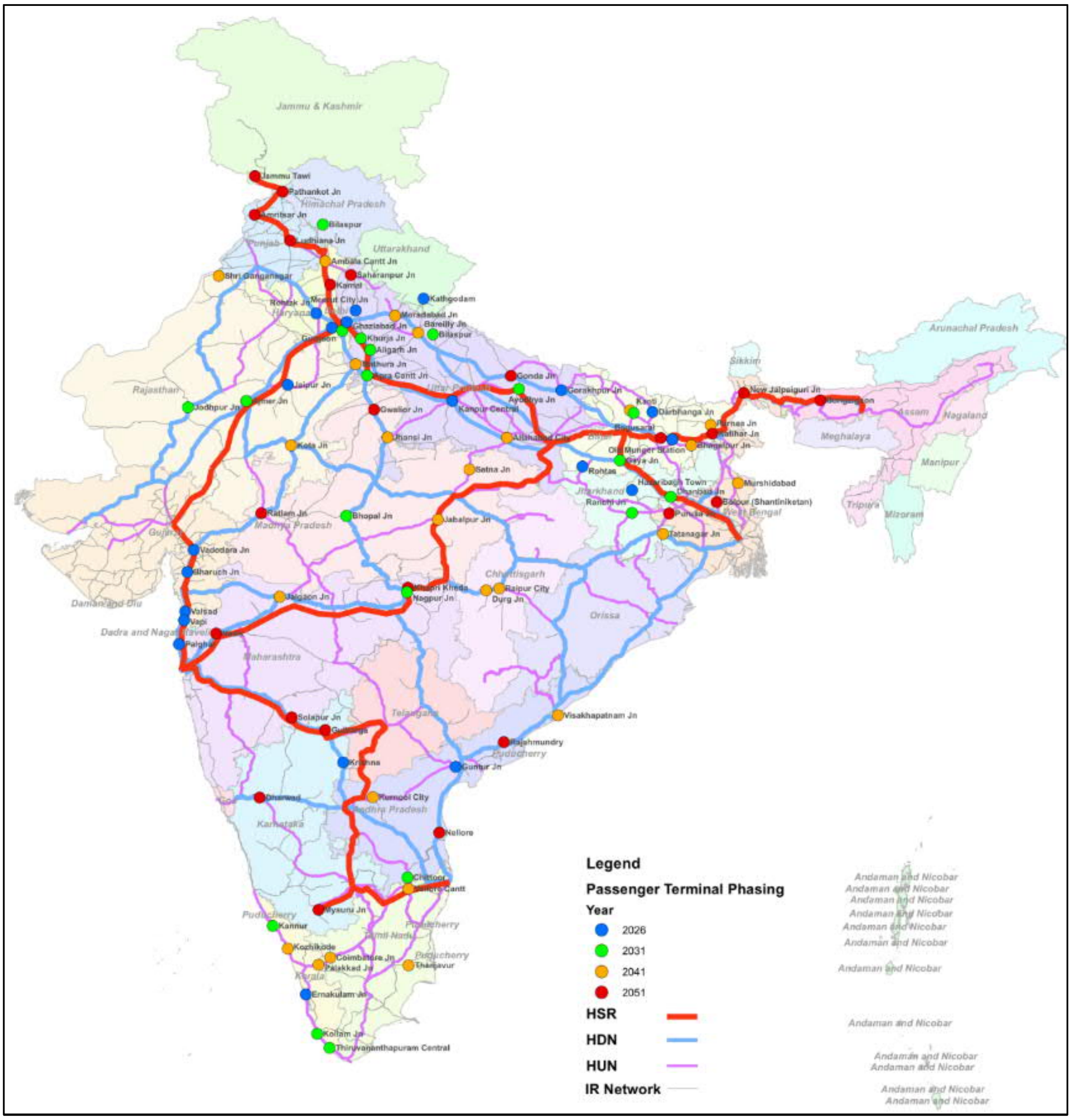


Figure 0-70: –Passenger Terminal Phasing

There are 13 (no.) stations that overlap with the proposed HSR corridors but do not appear in the list of stations to be upgraded. Similarly, three (no.) stations i.e. Bharuch, Vadodara, Jodhpur and Dhanbad stations which appear in the original list, but their upgradation has been preponed so that it is in line with the proposed corridor development.

The list of stations to be upgraded has been revised to include the stations that will be developed for multi-modal integration. The revised list is given at table below.

Table 0-80: Updated List of Stations for Upgradation

S. No	New Stations to be taken up for upgradation in the year			
	2026	**2031**	**2041**	**2051**
1	Jaipur	Gaya	Allahabad	Gwalior
2	Rohtas	Saran	~~Dhanbad~~	Gonda
3	Munger	~~Vadodara~~	Bhagalpur	Saharanpur
4	Palghar	Chittoor	Purnia	Nashik
5	Kanpur Nagar	Bhopal	Bareilly	Ratlam
6	Ernakulam	Bilaspur	Raipur	Kheda
7	Guntur	Kollam	~~Jodhpur~~	Amritsar
8	Valsad	Muzaffarpur	Moradabad	Mysore
9	Darbhanga	Nagpur	Mathura	Sri Potti Sriramulu Nellore
10	Hazaribagh	Ranchi	Jalgaon	~~Bharuch~~
11	Gorakhpur	~~Ghaziabad~~	Vellore	Karnal
12	Krishna	Agra	Visakhapatnam	Birbhum
13	Gurgaon	Ajodhya	Murshidabad	Dharwad
14	Kathgodam	Ajmer	Palakkad	Solapur
15	Vapi	Jodhpur	Khordha	Puruliya (Purulia)
16	Vadodara	Dhanbad	Thanjavur	~~Rohtak~~
17	Bharuch	Thiruvananthapuram	Kota	East Godavari
18	Ghaziabad	Kannur	East Singhbhum	Ludhiana
19	Meerut	Hapur	Ambala	Gulbarga
20	Rohtak	Khurja	~~Kannur~~	Begusarai
21		Aligarh	Jhansi	Katihar
22		Faridabad	Jabalpur	New Jalpaiguri
23			~~Meerut~~	New Bongaigaon
24			Kozhikode	Pathankot
25			Coimbatore	Jammu
26			Sri Ganganagar	
27			Durg	
28			Kurnool	
29			Katni	
30			Satna	
Total No. of Stations	**20**	**20**	**27**	**23**

A total of 90 stations qualify for upgradation. This list may undergo slight modifications after the DPRs for the HSR and RRTS corridors are carried out and the location of new stations are finalised.

0.32. Rolling Stock Requirement

The projections for the rolling stock have been made to meet the forecasted demand for passenger and freight in the travel demand model that has been made for the study. The following are considered as components of rolling stock :

- Electric Locomotives
  a. Freight
  b. Passenger
- Freight Wagons
  c. Open Wagons
  d. Closed Wagons
  e. Container Wagons
  f. Flat Wagons
  g. Tank Wagons
  h. Other special purpose wagons for the Automobiles
- Passenger Coaches
  i. Air Conditioned (AC) Coaches
  j. Non-AC Coaches
- Mainline Electric Multiple Units (MEMUs)
- Train Sets

The projections made in the plan for different components of the Rolling stocks are based on the characteristics of the existing operations, Emerging trends in Freight and passenger movement, future plans of Indian Railway and results of the travel demand model

0.32.1. Demand for Locomotives

Demand for locomotives has been assessed in four steps:

1. Assessment of total demand for locomotives for passenger operations
2. Assessment of total demand for locomotives for freight traffic operations
3. Condemnation Plan of Existing fleet based on the age profile
4. Procurement plan to meet total demand and supply

The demand for total locomotives required are summarised in table given below

Item	**2026**	**2031**	**2041**	**2051**
Total Coaching Locomotives Required	3,494	4,782	8,687	13,498
Total Freight Locomotives Required	13,305	15,957	22,894	32,519
Total Locomotives Required	**16,799**	**20,739**	**31,581**	**46,017**

0.32.2. Demand for Wagons

Total Number of wagons required for all categories including the Special Purpose Wagons that are required to meet the freight demand in the cardinal years is given at the table below:

Type of Wagon	2018	2026	2031	2041	2051
BCN	84,128	1,57,456	2,12,727	2,79,539	3,54,684
BOXN	1,31,573	1,47,738	1,71,242	2,22,115	2,59,050
BCACBM	-	6,523	10,221	14,293	19,754
BLC	30,073	48,162	73,525	1,15,135	1,65,333
BRN	20,622	29,671	35,243	47,895	68,413
BCFC	290	4,158	7,979	21,074	57,413
BTPN	13,189	14,062	34,288	79,020	1,43,483
Total	2,79,876	4,07,769	5,45,225	7,79,071	10,68,130

0.32.3. Demand for Coaches

Total Number of AC and Non-AC Coached that are required to meet the passenger demand in the cardinal years is given at the table below:

Type of coach	2018	2026	2031	2041	2051
AC	4,074	8,311	11,546	19,067	30,685
Non-AC	39,343	52,430	60,569	87,360	1,21,824
Total	43,417	60,741	72,115	1,06,427	1,52,509

0.32.4. Demand for Mainline Electric Multiple Units (MEMUs)

It is proposed that the MEMUs operations will carry around 50% of the total Non-AC passenger demand on the entire network. Considering that MEMUs shall have a provision only for the seating, it is further proposed that the Passenger demand for non-AC on these corridors with the Average Trip Length less than 200 Km shall be carried through MEMUs. Accordingly, total Number of MEMUs that are required to meet the demand in the cardinal years is given at the table below:

Year	2018	2026	2031	2041	2051
Total EMUs Required	653	1284	1487	1767	2045

0.32.5. Demand for Mainline Electric Multiple Units (MEMUs)

It is proposed that Golden Quadrilateral and Golden Diagonal shall be developed with an infrastructure which will allow the train sets to operate at speed of 160 KMPH. Thus, it is proposed that the Train Sets will run on these corridors. Considering that Train Set shall have a provision for car chairs, it is further proposed that the Passenger demand for AC on these corridors with the Average Trip Length between 200 to 700 Km shall be carried through Trains Sets. Accordingly, total Number of Train Sets that are required to meet the demand in the cardinal years is given at the table below:

Year	2018	2021	2026	2031	2041	2051
Trains Required	42	70	100	144	214	306

The procurement plans for each of these rolling stock components will requires modification after considering the existing fleet size and their age profile.

0.33. Costing and Phasing

Indian Railways must invest on the capacity augmentation of the railways carrying capacity to serve the huge upcoming demand on its network. Passengers will increase and the freight will be increased as well. To serve the multi-fold demand, a lot of projects to be taken up and finished as per the timeline suggested in the National Rail Plan. This includes the dedicated freight service in terms of DFC, Dedicated world class Passenger service as High Speed Rail, Semi-Highspeed Rail. Doubling works of the existing network, Improvement of the existing signalling system, flyovers and bypasses for the decongestion of the bottlenecks, Passenger terminals, Freight Terminals. In addition to that procurement of Rolling stock coaches, MEMU, Train Sets for passengers and Wagons for Freight and Locomotives to run the trains.

0.33.1. Comprehensive NRP Cost

Total Cost of the proposals given in National Rail Plan is 38 lakh 20 thousand and 516 crore rupees

Table 0-81: Comprehensive Cost Table

Head		2021-26	2026-31	2031-41	2041-51	Grand Total
DFC						
DFC Corridors	1		East Cost DFC Kharagpur to Vijayawada	North South DFC Itarsi to Chennai via Nagpur and Vijayawada	North South DFC Palwal to Itarsi	
			1265 km	1206 km	751 km	
			50,600	48,240	30,040	
	2		East West DFC Palghar to Dankuni and EDFC Connectors			
			2013 km			
			80,520			
	3		Eastern DFC Sonnagar to Dankuni			
			515 km			
			20,600			
	DFC Corridor Total					
	Length in KM		**3793 km**	**1206 km**	**751 km**	**5750 km**
	Cost (in Crore Rupees)		**151,720**	**48,240**	**30,040**	**230,000**

Head		2021-26	2026-31	2031-41	2041-51	Grand Total
HSR						
HSR Corridor	1		Delhi Varanasi via Ajodhya	Hyderabad to Bangalore	Mumbai to Nagpur	
			855 km	618 km	789 km	
			171,000	123,600	157,800	
	2		Varanasi to Patna	Nagpur to Varanasi	Mumbai to Hyderabad	
			250 km	855 km	709 km	
			50,000	171,000	141,800	
	3		Patna to Kolkata		Patna to Guwahati	
			530 km		850 km	
			106,000		170,000	
	4		Delhi Udaipur Ahmedabad		Delhi to Amritsar via Chandigarh	
			886 km		485 km	
			177,200		97,000	
	5				Amritsar - Pathankot - Jammu	
					190 km	
					38,000	
	6				Chennai to Mysuru via Bangalore	
					462 km	
					92,400	
	HSR Corridor Total					
	Length in KM		**2521 km**	**1473 km**	**3485 km**	**7479 km**
	Cost in Crore Rupees		**504,200**	**294,600**	**697,000**	**1,495,800**
IR Network						
HDNs	HDN 1	2,698	0	349	2,852	5,898
	HDN 2	4,014	2,540	188	257	6,999
	HDN 3	2,373	3,325	2,069	8,663	16,429
	HDN 4	1,729	19,000	12,394	7,141	40,265
	HDN 5	4,257	0	0	0	4,257
	HDN 6	2,119	0	0	2,418	4,537
	HDN 7	2,054	980	3,488	2,493	9,015
	All HDN	**19,244**	**25,846**	**18,487**	**23,825**	**87,402**
HUNs	HUN 1	5,155	5,467	12,273	20,156	43,051
	HUN 2	2,278	4,684	15,233	4,514	26,708
	HUN 3	1,935	2,522	6,350	5,268	16,075
	HUN 4	9,102	960	6,922	4,086	21,071
	HUN 5	3,000	2,046	1,631	5,401	12,078
	HUN 6	3,242	10,026	17,957	2,927	34,152
	HUN 7	2,297	2,175	13,839	8,643	26,953
	HUN 8	636	123	10,267	4,490	15,516
	HUN 9	12,717	3,143	923	6,660	23,443
	HUN 10	5,607	2,687	4,078	7,833	20,204
	HUN 11	383	4,078	4,185	8,052	16,697
	All HUN	**43,717**	**37,797**	**87,583**	**76,703**	**245,800**
Others	**Other than HDN/HUN Network**	**65,813**	**17,254**	**117,960**	**82,647**	**283,673**
Ports	**Port Connectivity**	**11,858**	**1,978**	**4,923**	**14,351**	**33,110**
Total Network	**Overall**	**126,914**	**71,358**	**221,456**	**181,967**	**601,696**

Head		2021-26	2026-31	2031-41	2041-51	Grand Total
Flyovers and By-Passes						
Flyovers	178 No.	71,200				71,200
By-passes	58 No.	8,700				8,700
	Total	**79,900**	**0**	**0**	**0**	**79,900**
Terminal						
Terminal Development Cost	Passenger Terminal Development Cost	54,316	16,175	9,325	4,041	83,857
	Freight Terminal Development Cost	6,241	4,161			10,402
	Terminal Total	**60,557**	**20,336**	**9,325**	**4,041**	**94,259**
Rolling Stock						
Rolling Stock	**Locomotives**					
	Electric Locomotives	**154,336**	**65,044**	**189,140**	**235,718**	**644,238**
	Wagons					
	- BOXN	3,749	11,992	20,795	25,513	62,049
	- BCN	17,820	11,120	19,253	26,330	74,523
	- BTPN	1,290	8,677	19,094	27,881	56,943
	- BLC	5,603	8,751	14,000	20,169	48,523
	- BRN	5,595	2,671	6,505	10,697	25,468
	- BCACBM	3,339	1,893	2,084	2,795	10,111
	- BCFC	1,442	1,325	4,543	12,605	19,916
	Wagon Total	**38,838**	**46,430**	**86,274**	**125,990**	**297,532**
	Coaches					
	- NAC	75,582	33,442	48,222	62,035	219,283
	- AC	15,545	9,279	16,170	24,979	65,973
	MEMU	5,150	2,718	3,615	3,844	15,335
	Train Sets	25,000	11,000	17,500	23,000	76,500
	Coach Total	**121,276**	**56,439**	**85,508**	**113,858**	**377,091**
	Broad Cost Estimates	**314,450**	**167,913**	**360,922**	**475,566**	**1,318,861**
Grand Total		**581,821**	**915,527**	**934,543**	**1,388,614**	**3,820,516**

0.34. Funding Requirements Identified Under NRP and Potential Financing Strategies

The scope for this module of the study on National Rail Plan was enunciated as follows:

- *Assess funding requirement for above capacity enhancement plans*
- *Conduct Sensitivity Analysis under critical assumptions and by identifying key risks*
- *Evolve a detailed financing strategy plan including budgetary support, PPPs, enabling financing environment*

This section presents analyses of these scope elements based on inputs from earlier sections of the report on identified capacity augmentation works and required projects/ investments.

0.34.1.1. Estimated funding requirements for capacity enhancement plans under NRP (2022-2051)

With IR's focus on augmenting railway infrastructure to facilitate movement of freight and passengers, as discussed earlier under this study, investments will be needed over 2022 to 2051 to address capacity constraints and make multi-modal transportation more efficient for users – dovetailing with existing and planned transport infrastructure in the country.

Such investments/ capital expenditure requirements have been estimated under earlier modules of NRP for three major asset categories viz. tracks, terminals and rolling stock, and are presented in the following exhibits.

As can be observed, till 2031, capital expenditure requirements in track infrastructure (including investments in DFC, HSR and Core Track Infrastructure i.e. doubling and Signalling works across HDN, HUN and other networks) along with construction of flyovers and bypasses) account for a majority of the total capital expenditure requirements i.e. ~66% - with a year-on-year increase in investment requirements for DFC as well as HSR. Capital expenditure requirements for rolling stock (wagons, coaches and locomotives) account for ~29% of the total capital expenditure requirements with the balance ~5% of the total capital expenditure requirements pertaining to development of terminal infrastructure (including both passenger and freight terminals).

This trend continues in the future. Of the total capital expenditure requirements estimated beyond 2031 under this study - i.e. till 2051, capital expenditure requirements in track infrastructure are estimated to constitute ~60% of the total capital expenditure requirements, that for rolling stock are estimated to constitute ~39% of the total capital expenditure requirements with the balance pertaining to development of terminal infrastructure

0.34.2. Potential sources of funding for Core Track Infrastructure

As mentioned above, India follows a state-owned monopoly model for Railway track infrastructure where both the segments ("Above the rail" and "Below the rail") are provided by a single entity, i.e. Indian Railways. Since it is difficult in such a scenario to segregate revenue from individual projects or even to asses returns for such projects which are part of a larger network, the ideal option for cost recovery of track development and maintenance is through internal accruals generated from the passenger and freight services. However, with the high operating ratio being experienced by IR, it would be challenging to fund such track infrastructure projects through internal accruals.