Ministry of Railways

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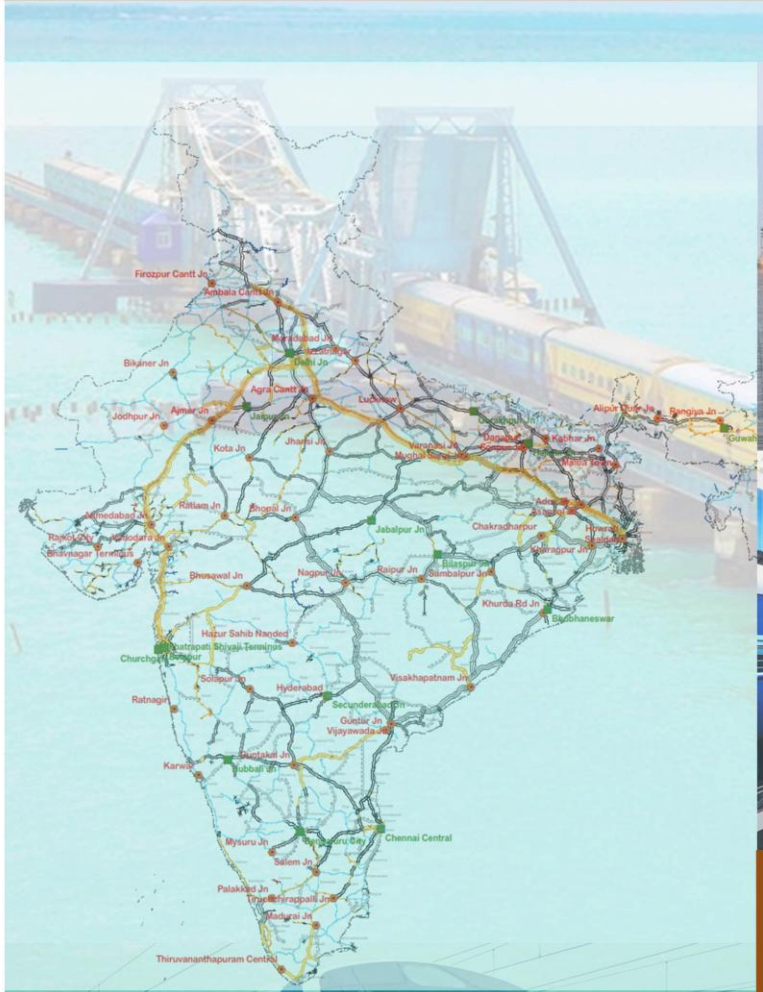
National Rail Plan (NRP)-India



EXECUTIVE SUMMARY

Demand Forecast Report

March 2020

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EXECUTIVE SUMMARY

1.0 Background

Indian Railways is the 4th largest railway network in the world by size with 121,407 kilometres (75,439 mi) of total track over a 67,368 Km route. In the year ending March 2018, IR carried 8.26 billion passengers and transported 1.16 billion tonnes of freight. 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 for India 2050. The plan shall also suggest the rail infrastructure to be created by 2030 which shall be able to cater the demand till the year 2050.

For this purpose, Ministry of Railways has mandated Rail India Techno Economic Services (RITES) 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.

AECOM commenced the study in January 2019 and submitted the Inception and Interim Reports as 1st and 2nd Deliverables. As part of Interim Report, extensive data was collected and analysed.

Present report is being submitted as Demand Forecast Report which is the 3rd Deliverable of the Study. The report details out the Total Transport Travel Demand Forecast till 2051 covering both Passengers and Freight along with future share of Railways till 2051.

1.1 Study Objective

The objective of the study is to prepare a compressive strategy and master plan for the Rail Sector for creation of adequate capacity ahead of demand. The study objectives listed below:

- assess the level of utilization, potential and deficiencies in the present system of Indian Railways;
- determine the strengthening requirement of existing corridors and requirement of new rail corridors between different cities/ ports/ region;
- study the existing road and rail network characteristics for passenger and goods traffic;
- study the existing rail infrastructure deficiencies in various parts of the country and suggest the ways to overcome the same;
- Estimate the existing and forecast travel demand for both passengers and freight that can be shifted to Indian Railways network by mapping existing and proposed growth centers/ major cities/ industrial production centers/ SEZs/ Ports/ Freight Terminals.
- develop and use a country level transport planning model appropriate to the conditions and planning needs and develop alternative transport strategies;

- Prepare a multimodal, integrated and prioritized master plan for entire rail network comprising of recommendations and proposals for upgradation of rail infrastructure and providing connectivity to ports/ cities and other locations of strategic importance;
- select the appropriate strategy and recommend short, medium- and long-term comprehensive Railway Development strategy up to the year 2050;
- identify various projects and provide pan India prioritized rail investment plan and implementation timelines;

2.0. Passenger Demand Forecast

2.1. Past Growth Trends of Rail Passengers

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.

Reason for stagnation in the growth of unreserved/ non-AC category may be due to stagnation in supply. Since the seats in the unreserved category are limited so a meagre growth witnessed in this category.

Table 0-1: Annual Growth of Passenger Traffic (in 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; LDAC, LDNA and Suburban.

Table 0-2 -Growth Trends in Passenger Traffic in mentioned Categories (in 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%**

The reclassification of passenger's data shows that long distance AC category passengers have grown at an average annual growth rate of 9% in the last 10 years. Whereas, long-distance non-AC category passengers shows a growth of 1.44% and Suburban passengers traffic growth observed is 2.30%.

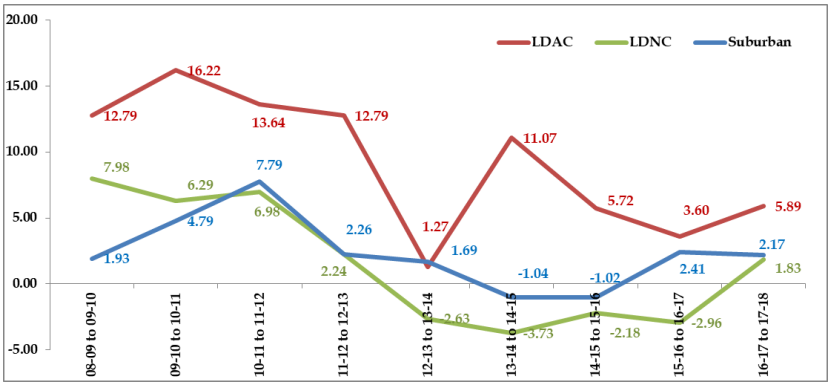


Figure 0-1: – Rail Passengers Growth Trends

Overall, long distance passengers show a growth of 1.67% and overall passengers growth observed is 2% in the last 10 years.

2.2. PASSENGER DEMAND FORECAST

To forecast the passenger demand for horizon year 2050 and different cardinal year a detailed methodology was developed and described in the following section.

The base year rail passenger data was collated using the ticket sales data for each station provided by CRIS for the years 2016-17 and 2017-18. This data was classified into 3 broad categories as :

- Intercity AC (LDAC)
- Intercity Non-AC (LDNAC)
- Sub Urban (Sub)

Base year passenger matrices for the above categories were developed showing the passenger movement from each station. This data was further analysed to forecast horizon year passenger demand as described in following stages.

Stage 1 – Estimation of Horizon Year Production and Attraction Trips Ends:
'Production Trip Ends' refers to sumtotal of all the passenger trips originating from a particular area (zone) and Attraction Trip Ends refers to the sumtotal of all the passengers destining in a particular area (zone). For simplicity, sumtotal of all the horizontal rows of a Passenger Matrix is referred as Production Trip End and sumtotal of all the columns of a Matrix is referred as Attraction Trip Ends.

- *Stage 2 – Trip Distribution*: the matrices developed in Stage I was assigned on the horizon year rail network for obtaining forecasted rail passengers on different rail sections.

  Once the horizon year production & attraction trips are finalised than the same shall be distributed in the categeories of LDAC, LDNA and Sub-urban Passengers for different years 2021, 2031, 2041 and 2051.

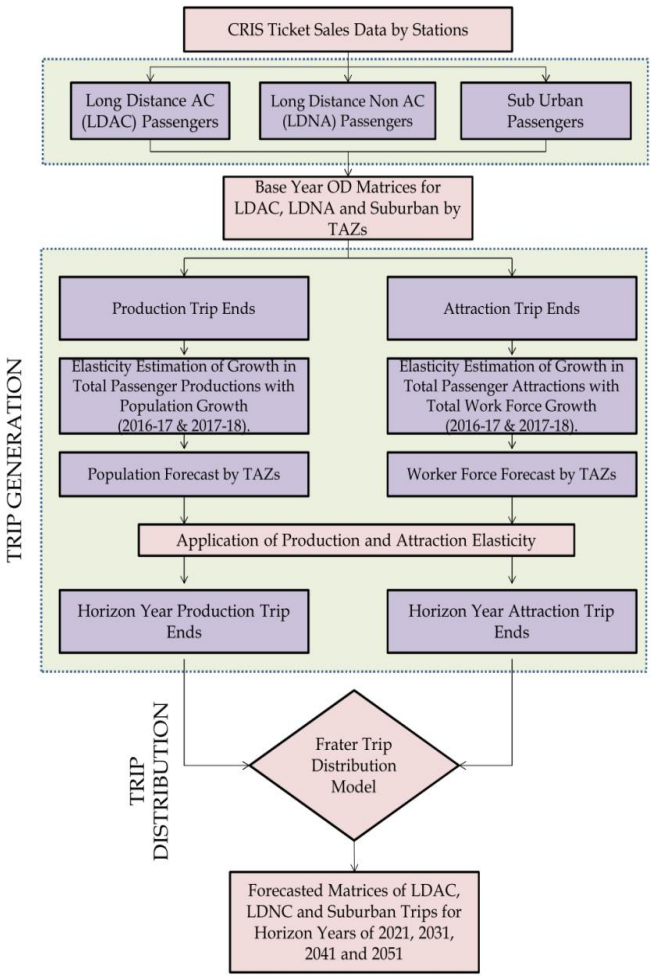


Figure 0-2: – Methodology for Estimating Horizon Year Passenger Demand Matrices

The above stages are described in detail in the following sections

Horizon Year Production & Attraction Trip End (Trip Generation)

The ticket sales data by each station was classified into various Traffic Analysis Zones (TAZs). Diffenent stations falls in different TAZs and one TAZ may have one or more than one station. The ticket sales data collected for each station was converted into Origin-Destination matrices. Different matrices for Long Distance AC, Long Distance Non-AC and Suburban passengers' categories for the years 2016-17 & 2017-18 were developed from the collected data.

CRIS passenger data for years 2016-17 and 2017-18 was given in the following two categories:

- Passenger Reservation System (PRS)
- Unreserved Ticketing System (UTS)

The OD matrices for categories mentioned above were calculated from PRS and UTS data of CRIS in the following manner:

Intercity AC (LDAC): The OD matrices for this category were developed from the PRS data by combining all the AC class passengers which include both the sleeper and car chair categories.

Intercity Non-AC (LDNAC): The OD matrices for this category were developed from the following two data sets:

- OD matrices for all categories of non-AC passengers, from the PRS data; and
- OD matrices for all trips with trip length of more than 80 km, from UTS data;

Suburban (SUB): The OD matrices for this category were developed from the UTS data covering the trips having trip length less than 80 kms

the matrices developed from the data of 2016-17 and 2017-18 was used to estimate growth of passenger for each station i.e. (production and attraction trips ends) respectively. Growth in production trip ends (trips produced from the station) was analysed with respective to zonal population growth and growth rate of attraction trip ends (trips attracted to station) was analysed with growth in workers' quantum for each TAZ. This will be used in estimating the elasticity of production and attraction trip ends.

Forecast of Horizon Year Passenger Trip Matrices (Trip Distribution)

Once the horizon years production and attraction of trip ends are obtained as per the above-mentioned methodology, these forecasted trips shall be distributed for the purpose of obtaining passenger demand matrices. Globally accepted mathematical model namely 'Fratar Trip distribution model' has been used to distribute the forecasted trips. This model distributes the horizon year trip ends (total trips that will be either produced or attracted by a particular zone) into the matrix using the base year calibrated trip distribution model. The mathematical expression of this model is:

$$T_{i-j} = t_{i-j} \times \frac{P_i}{p_i} \times \frac{A_j}{a_j} \times \frac{\sum_1^k t_{i-k}}{\sum_1^k \left[\frac{A_k}{a_k}\right] t_{i-k}}$$

Where,

T_{i-j}	=	Future trips from zone i to zone j
t_{i-j}	=	Present trips from zone i to zone j
P_i	=	Future trips produced at zone i
p_i	=	Present trips attracted at zone i
A_i	=	Future trips attracted to zone j
a_j	=	Present trips attracted to zone j
k	=	Total numbers of zones

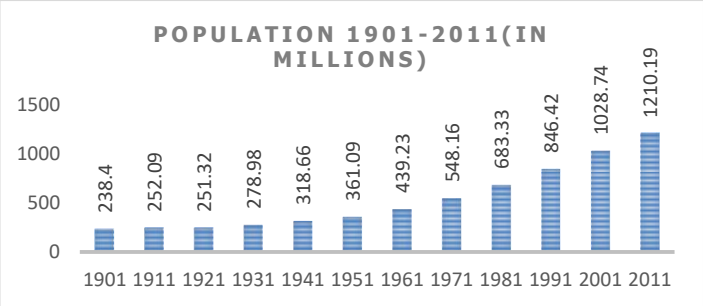
The procedure is laborious and state of the art modelling software 'CUBE Voyager Fratar Module' has been used for this step.

Forecast of Planning Variables

As mentioned in previous stage that variables like population and workers will be used to draw a relationship between trip generated and attracted by a zone. For this purpose, 2011 Census of India data has been used as baseline data and population is projected up to 2051. These projections are undertaken both at the national level, states, districts and Union Territories (UTs).

Past Trend of Population Growth

From 1901-1950, India's population grew by 1.5 times. However, in the next 50 years up to 2000, the population multiplied almost three-fold to reach 102.87 crores.



Population Forecast

District-wise population was estimated up to the year 2051. For this, available Masterplans and City Development plans for all the major cities and metropolitan regions of India were reviewed. The future population projected for these cities/ regions have been envisaged based on the developments planned in the respective regions. Since these cities accommodated substantial population as well as wield considerable influence over the rest of the district, similar growth rates have been adopted for the entire district.

Table 0-3: State-Wise Population Projections (in millions)

States	2021	2031	2041	2051
Andaman and Nicobar Islands	0.43	0.47	0.50	0.53
Andhra Pradesh	52.83	54.54	54.64	54.75
Arunachal Pradesh	1.56	1.70	1.80	1.90
Assam	33.59	36.20	38.01	39.91
Bihar	124.64	142.07	156.28	171.89
Chandigarh	1.19	1.30	1.38	1.46
Chattisgarh	28.69	30.95	32.80	34.77
Dadar and Nagar Haveli	0.39	0.42	0.45	0.48
Daman and Diu	0.27	0.30	0.32	0.34
Delhi	18.54	19.73	20.32	20.93
Goa	1.65	1.79	1.89	2.00
Gujarat	74.13	79.93	83.52	87.27
Haryana	28.30	30.40	31.78	33.21
Himachal Pradesh	7.32	7.74	7.94	8.14
Jammu and Kashmir	13.69	14.85	15.60	16.38
Jharkhand	37.87	41.71	45.25	49.10
Karnataka	66.31	69.24	69.93	70.62

States	2021	2031	2041	2051
Kerala	35.68	37.32	37.99	38.67
Lakshadweep	0.07	0.08	0.08	0.09
Madhya Pradesh	83.22	90.30	95.72	101.46
Maharashtra	124.65	131.02	132.33	133.64
Manipur	3.22	3.51	3.71	3.93
Meghalaya	3.35	3.64	3.85	4.08
Mizoram	1.24	1.35	1.43	1.51
Nagaland	2.23	2.43	2.57	2.72
Odisha	45.55	48.50	50.39	52.35
Puducherry	1.41	1.54	1.63	1.73
Punjab	29.78	31.05	31.39	31.74
Rajasthan	79.65	88.03	94.79	102.06
Sikkim	0.69	0.75	0.79	0.84
Tamil Nadu	76.51	78.69	78.29	77.89
Telangana	44.50	47.13	48.12	49.13
Tripura	4.15	4.51	4.77	5.05
Uttar Pradesh	237.05	259.45	277.61	297.02
Uttarakhand	11.48	12.31	12.92	13.57
West Bengal	102.97	108.51	110.03	111.56
Total	**1380.54**	**1494.18**	**1561.38**	**1632.97**

Forecast of Workforce Quantum

It is projected that around 7.5 million persons would join the Indian workforce per year on average over the next 2 decades[1]. In order to keep the unemployment level low, government needs to add ~8 Million jobs per year. Work Force projections have been made based on past trend of main workers population as per Census data. India is in a stage of "Demographic Dividend" i.e. India's working-age population (people between 15 and 64 years of age) has grown larger than the dependant population — children aged 14 or below as well as people above 65 years of age. This bulge in the working-age population is going to last till 2055-56[2]. With the large population under working age, India would observe an increasing trend of workforce participation rate in next few decades.

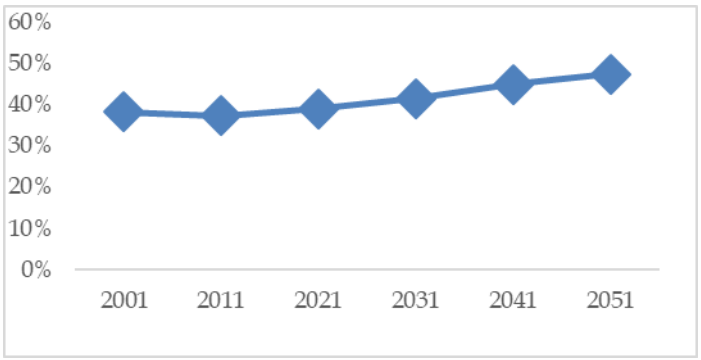


Figure 0-3: – Work Force Projections

[1] Source: IHS Markit
[2] Source: Business Article, Economic Times

Table 0-4: State-wise Work Force Projections (in millions)

States	2011-2021	2021-2031	2031-2041	2041-2051
Andaman and Nicobar Islands	0.19	0.21	0.24	0.27
Andhra Pradesh	28.66	32.82	37.22	41.35
Arunachal Pradesh	0.71	0.82	0.93	1.03
Assam	12.95	14.83	16.82	18.69
Bihar	32.29	36.97	41.93	46.58
Chandigarh	0.58	0.66	0.75	0.83
Chhattisgarh	12.29	14.07	15.95	17.73
Dadar and Nagar Haveli	0.19	0.22	0.25	0.28
Daman and Diu	0.15	0.18	0.20	0.22
Delhi	7.96	9.12	10.34	11.48
Goa	0.71	0.81	0.92	1.02
Gujarat	30.35	34.76	39.42	43.79
Haryana	10.75	12.31	13.96	15.51
Himachal Pradesh	3.09	3.54	4.02	4.46
Jammu and Kashmir	3.94	4.52	5.12	5.69
Jharkhand	10.21	11.69	13.26	14.73
Karnataka	34.87	39.93	45.29	50.31
Kerala	13.90	15.92	18.06	20.06
Lakshadweep	0.02	0.02	0.02	0.02
Madhya Pradesh	33.84	38.75	43.94	48.82
Maharashtra	65.22	74.69	84.70	94.10
Manipur	1.45	1.67	1.89	2.10
Meghalaya	1.37	1.57	1.78	1.98
Mizoram	0.62	0.71	0.80	0.89
Nagaland	1.11	1.27	1.44	1.60
Odisha	15.96	18.28	20.73	23.03
Puducherry	0.59	0.68	0.77	0.86
Punjab	12.59	14.42	16.35	18.17
Rajasthan	31.39	35.94	40.76	45.28
Sikkim	0.34	0.39	0.44	0.49
Tamil Nadu	41.64	47.68	54.07	60.07
Telangana	19.43	22.25	25.23	28.03
Tripura	1.60	1.84	2.08	2.32
Uttar Pradesh	67.28	77.04	87.36	97.06
Uttarakhand	4.39	5.03	5.70	6.34
West Bengal	38.29	43.85	49.72	55.25
Total	**540.92**	**619.46**	**702.46**	**780.44**

It is estimated that the country's work force population will grow to 540 million by 2021, 619 million by 2031, 702 million by 2041 and 780 million by 2051.

2.3. Rail Passenger Growth vs Socio -economic Parameters

In order to understand the rail passenger growth and their respective relationship with socio-economic factors, the regression analysis has been carried out for rail passengers separately for 3 categories namely LDAC, LDNA and Suburban using India GDP and Population separately and described below

Rail Passenger Growth Vs Economic Parameters

The elasticity approach was used for determining growth rates of future rail passengers. In order to estimate passenger growth rates, a regression analysis was carried out with respect to NSDP . Table below, shows transport demand elasticity values for rail passenger quantum considering India's GDP as dependant variable for all the 3 categories for last 10 years.

Table 0-5: Estimated Passenger Growth Rates (GDP as Dependant Variable)

Years	Elasticity			GDP Growth Rates	Passenger Growth Rates		
	LDAC	LDNA	Sub		LDAC	LDNA	Sub
2019-2021	1.16	1.36	1.38	6.12	7.1	8.1	8.5
2021-31	1.05	1.2	1.25	7.3	7.6	8.7	9.1
2031-41	1	1.1	1.1	6.5	6.5	7.1	7.1
2041-51	0.9	0.9	0.9	6.5	5.8	5.8	5.8

Based on the analysis above, LDAC is expected to grow at a rate of 7.6% till 2031 and 5.8% till 2051. These rates are in line with the trends observed in the past. However, the growth rates for LDNA and Sub categories have been estimated as 8 and 9% till 2031 and 5.8 % which are substantial high than the observed trends.

Rail Passenger Growth Vs Population Growth

Elasticity approach has been further used in the regression analysis by using population as a dependant variable.

Table 0-6: Estimated Passenger Growth Rates (Population as Dependant Variable)

Years	Elasticity			Population Growth Rates	Growth Rates		
	LDAC	LDNA	Sub Urban		LDAC	LDNA	Sub Urban
2019-2021	0.89	1.05	1.06	1.11	0.99	1.16	1.18
2021-31	0.89	1.05	1.06	0.73	0.65	0.77	0.78
2031-41	0.89	1.05	1.06	0.45	0.40	0.47	0.47
2041-51	0.89	1.05	1.06	0.45	0.40	0.48	0.48

As evident from the table above, elasticity values are near unity or even lesser, therefore the estimated growth rate of rail passengers shall also be somewhere near to the population growth rate which may not be realistic.

2.4. Adopted Passenger Growth Rates

As described in sections above, the growth rates estimated using elasticity method with GDP and Population are not in line with the trends. Therefore, to make the projections realistic, another approach has been adopted.

In this approach first the ratio of population growth rate and passenger growth rate for the base years has been estimated. The ratio was estimated using the passenger gowth CAGR for last 10 years and the population growth since 2011. Table below shows the estimated ratio between the population and passenger growth.

Table 0-7: Ratio between Population CAGR and Observed Passenger Growth Rates

	Passenger CAGR (%, 2008-2018)	Population CAGR (%)	Ratio
LDAC	9.1	1.11	0.12
LDNA	1.44	1.11	0.77
Sub Urban	2.30	1.11	0.48

Future passenger growth rates were then estimated using the ratio mentioned in table above, which was then applied on the horizon year population growth rates for the years 2021, 2031, 2041 and 2051. The adopted passenger growth rates for all the 3 categories are mentioned in table below:

Table 0-8: Adopted Railway Passenger Growth Rates

Years	Projected Population CAGR (%)	Projected CAGR (%) LDAC	Projected CAGR (%) LDNA	Projected CAGR (%) Suburban
2019-21	1.11%	9.65%	4.03%	3.52%
2021-26	0.79%	9.19%	4.01%	3.17%
2026-31	0.80%	9.06%	4.15%	3.07%
2031-41	0.44%	7.85%	3.78%	2.55%
2041-51	0.45%	6.90%	3.57%	2.34%

2.5. Horizon Year Passenger Forecast

Using the above-mentioned growth rates, the passenger forecast has been made and mentioned in table below:

Table 0-9: Rail Passenger Forecast (Millions)

Categories	2018	2021	2031	2041	2051
LDAC	154.03	252.23	586.42	1106.30	1887.78
LDNA	3,466.40	4538.54	6411.58	8687.69	11530.71
Total	3,620.44	4,790.77	6,998.00	9,793.99	13,418.49
Sub-Urban	4,665.34	4456.79	6052.42	7886.82	9927.79
Grand Total	8,285.77	9,247.56	13,050.43	17,680.81	23,346.28

2.6. Horizon Year Passenger Traffic Distribution

The horizon passenger forecast has been done at overall and at zonal level for estimating horizon year productions and attractions. The trips estimated for 3 categories adopted for the study are mentioned in table below:

Table 0-10: Rail Passenger Forecast after Fratar Distribution (in millions)

Categories	2018	2021	2031	2041	2051
LDAC	192.7	252.11	540.98	882.53	1,391.83
LDNA	3,092.42	3,459.89	4,605.40	5,762.60	7,317.70
Total	3,285.12	3,712.00	5,146.38	6,645.13	8,709.53
Sub-Urban	4,049.86	4,434.34	5,941.76	7,831.73	10,388.92
Grand Total	7,334.98	8,146.34	11,088.14	14,476.86	19,098.46

The above-mentioned annual passenger forecast was then converted into daily passenger volume for the purpose of assignment and obtaining section loads. Table below presents the projected daily passengers on Indian Railways.

Table 0-11: Projected Daily Passengers ('000)

Daily	2018	2021	2031	2041	2051
LDAC	422	691	1607	3031	5172
LDNA	9,497	12434	17566	23802	31591
Total	9,919	13,125	19,173	26,833	36,763
Sub-Urban	12,782	12,210	16,582	21,608	27,199
Grand Total	22,701	25,336	35,755	48,441	63,962

3.0. FREIGHT DEMAND FORECAST

For the purpose of freight forecast and estimating the rail share, existing freight movement characteristics both by road and rail has been analysed. The section describes in detail the movement pattern of freight both by road and rail.

3.1. Railway Freight Growth Trends

Freight movement by rail has grown at CAGR of 3.74%. Maximum growth rate (9%) was witnessed in case of Steel, followed by Pig Iron. Finished Steel and Exim Containers both witnessing a CAGR of 7%. Domestic containers and coal both have grown at CAGR 5% and 4.62% respectively.

Table 0-12: 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%**

3.2. Composition of Freight Traffic on IR

From the analysis of the freight data for the year 2017-18, it is observed that a total of 1163 million tonnes of freight was carried by Indian Railways. Of this, Coal and Coke was the dominant commodity, accounting for 48% share, followed by Iron ore (12%), Cement (10%).

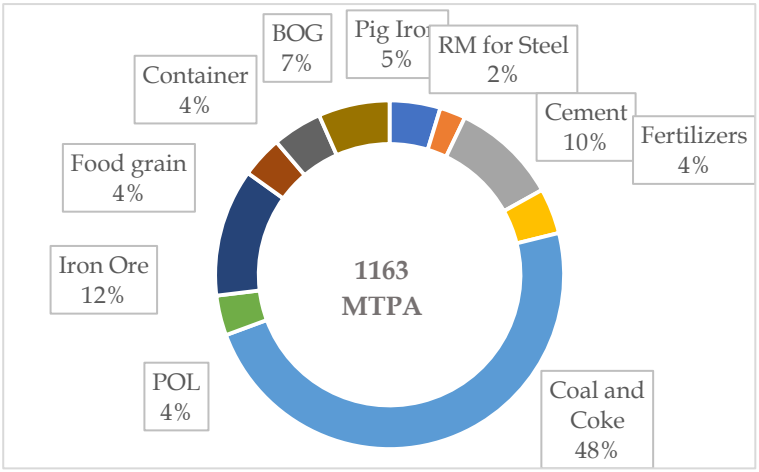


Figure 0-4: Commodity Composition of Rail Freight FY18

3.3. Existing Freight Movement Charateristics

The travel pattern of freight traffic by rail is discussed in the following sections by commodity.

3.3.1. Coal and Coke

India produced about 690 million tons of raw coal in FY 18. Out of this, 645 million tons was non-coking, and the remaining 45 million tons was coking. Further, 208 million tons of coal was imported, 78% of which was non-coking coal used by the power plants. Hence, around 898 MT of non-coking coal was available, in the ecosystem, to be transported.

Figure 0-5: Total Coal in Transportation Ecosystem

Key Production Centers

Currently, coal is mostly produced in eastern parts of India with 75% of throughput coming from four states viz. Odisha, Jharkhand, Chhattisgarh and Madhya Pradesh.

Odisha and Chhattisgarh produce the highest amount of coal in the country with a share of 21% each. In both these states, almost all the coal is non-coking in nature.

Jharkhand produces about 19% of coal, about half of which is coking. Practically, all domestic coking coal comes from Jharkhand.

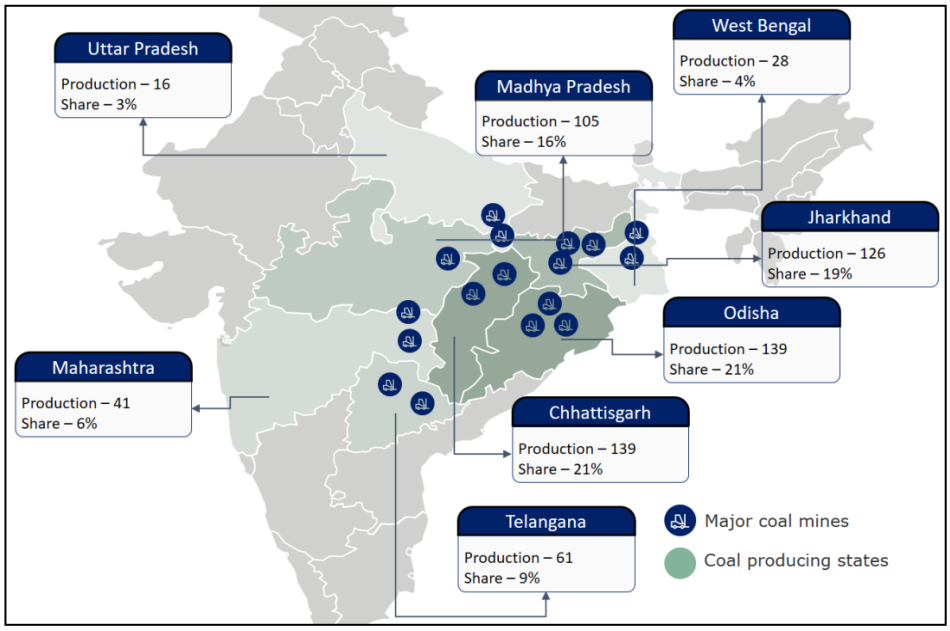


Figure 0-6: Major coal producing States and Coal Mines

Other important coal producing states are Madhya Pradesh (16%), Telangana (9%), Maharashtra (6%), West Bengal (4%) and Uttar Pradesh (2%).

Coal India Ltd, a Government of India entity, produced 84% of India's coal with its eight subsidiaries. The Singareni Collieries Company Limited (SCCL), another government entity, produced 9%. Other public sector entities produced 1%, and the private sector, through captive mines supporting power and steel plants, produced 5%.

Consumption of coal

India consumed 898 MT of non-coking coal in FY18. Exports were negligible at 1.6 million tons, about 0.2% of production. Within the power sector, there were about 142 coal based thermal power stations in FY 2016-17. Out of these, 50 biggest ones consumed about 71% of domestic coal.

Coal Movement Pattern

Coal and coke account for 48% (almost half) of the total freight traffic carried by IR in 2017-18. Maximum movement of Coke and Coal is observed on Angul-Jagatsinghpur route, followed by internal movement within Angul and Bilaspur districts. This can be attributed to the concentration of coal mines in this region. Bilaspur and Angul districts have the maximum share (7% each), followed by Sambalpur, Hazaribagh and Jagatsinghpur at 4% each. The share of the top 10 districts in the rail-based coal traffic is given in figure below.

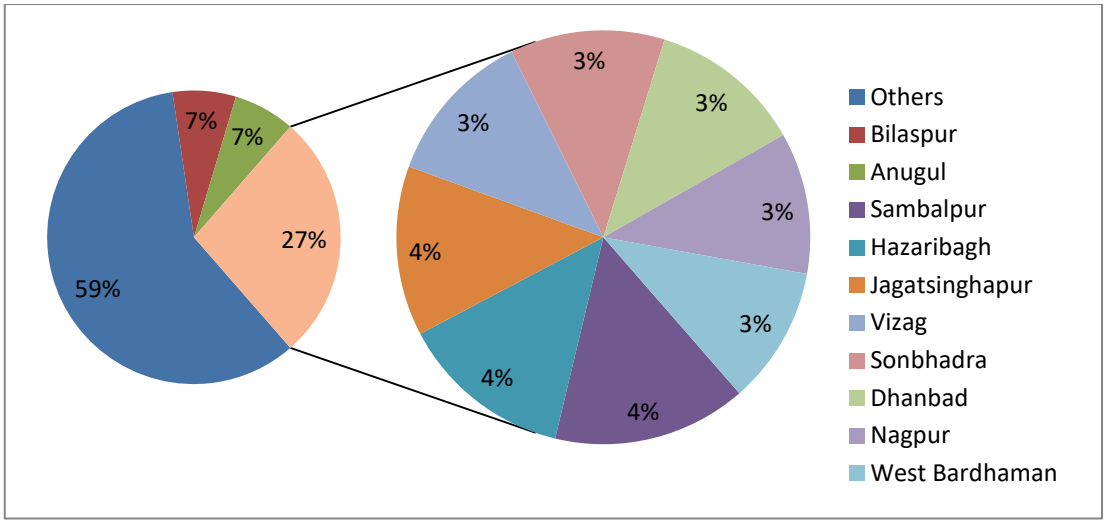


Figure 0-7: District-wise share in coal movement by rail, FY18

Major movement of coal is from Odisha, Jharkhand and Chhattisgarh to power plants nearby as well as in Punjab, Haryana, U.P., M.P. and Maharashtra.

3.3.2. Iron Ore and Steel

Iron ore, along-with pig iron and raw material for steel accounts for 19% of the total freight traffic carried by IR in 2017-18. It generated 16.5% of IR's freight revenues during FY18. The epicentres for steel production are iron-ore mines and steel plants. Typically, production of one ton of steel typically requires around 3 times of raw material. 1 ton of steel results in total 4x volume of freight required to be transported within the industrial ecosystem.

Iron ore

India's iron ore reserves, at 31.32 billion tonnes, are the 5th largest in the world after Australia, Brazil, Russia, and China. 2 states, Karnataka and Orissa together hold 56% of these reserves and contributed 63% of total ore production in FY18. The total iron ore mining production in FY 2018 stood at 210.5 MT with 52% yield coming from Odisha followed by Chhattisgarh (16%), Karnataka (14%), and Jharkhand (11%).

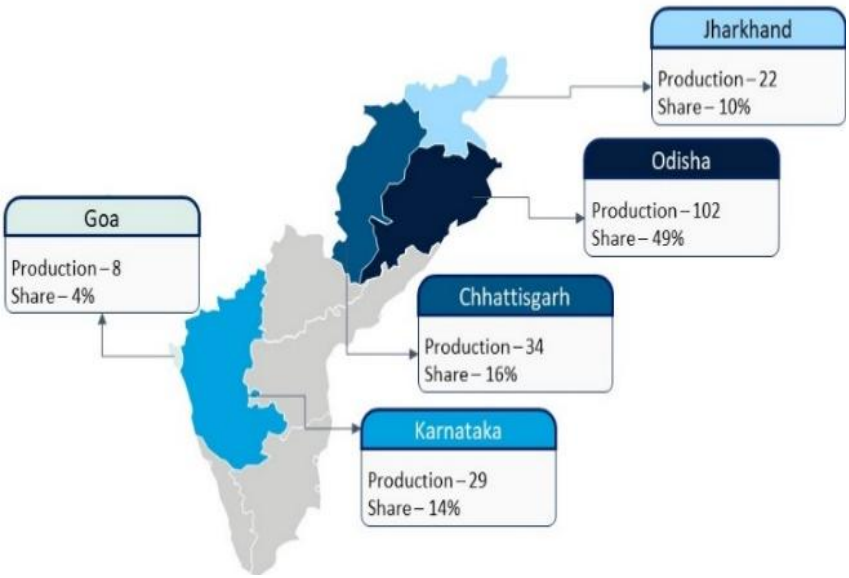


Figure 0-8: Key Iron Ore Producing States

Additionally, 8.6 MT of iron ore was imported from mainly five geographies with JSW steel alone responsible for 60% of these imports. In nutshell, a total of 219 MT of iron ore was available in the country ecosystem to be transported.

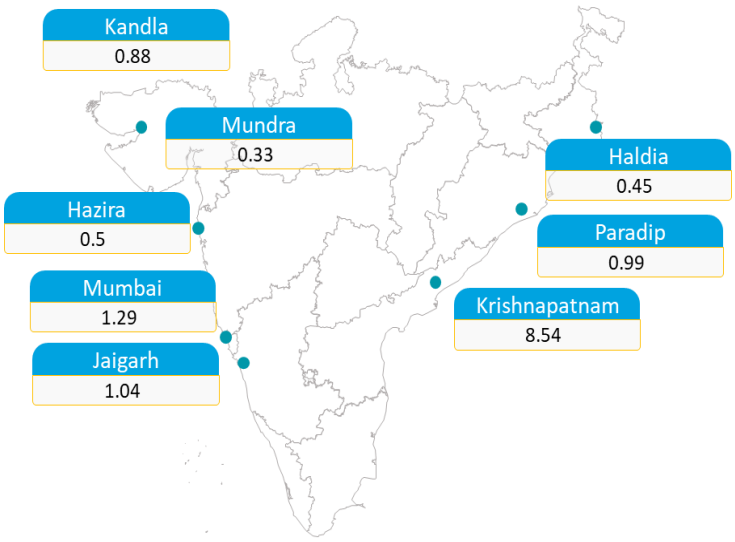


Figure 0-9: Iron Ore Imports by Ports

Maximum movement of iron ore is observed on Dakshin Bastar Dantewada- Visakhapatnam route, followed by internal movement within Purbi Singhbhum and Kendujhar- Paschim Bardhaman. This can be attributed to concentration of iron ore and steel processing plants in these districts of Jharkhand, Chhattisgarh and Orissa, and their movement from/ towards major ports of Haldia and Visakhapatnam.

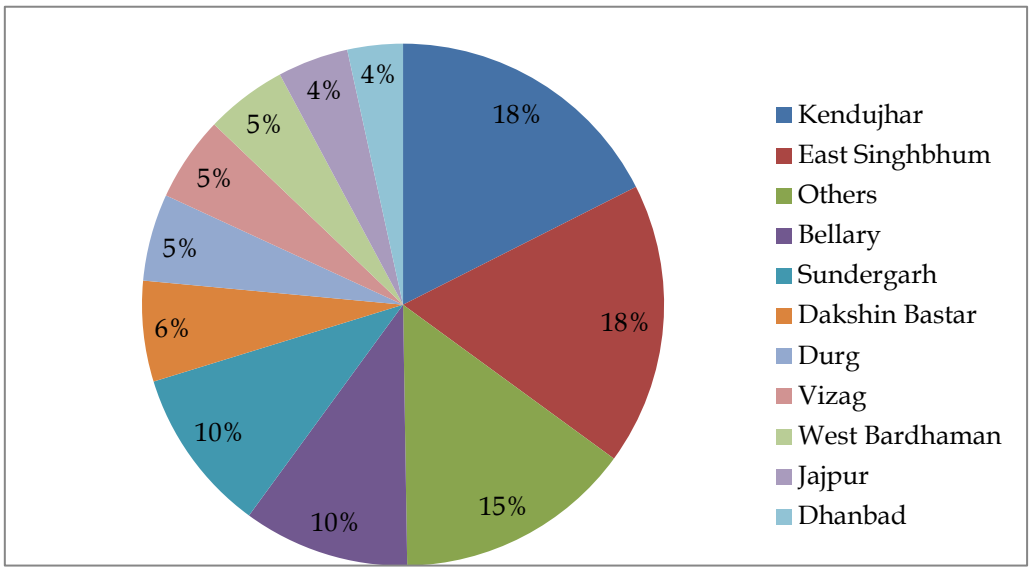


Figure 0-10: District-wise share in Iron-Ore Movement by Rail, FY 18

The share of the top 10 districts in the rail-based iron ore traffic is given in figure above. Kenujhar and East Singhbhum districts have the maximum share (18% each), followed by Bellary and Sundergarh at 10% each.

Iron Ore - Mode Share

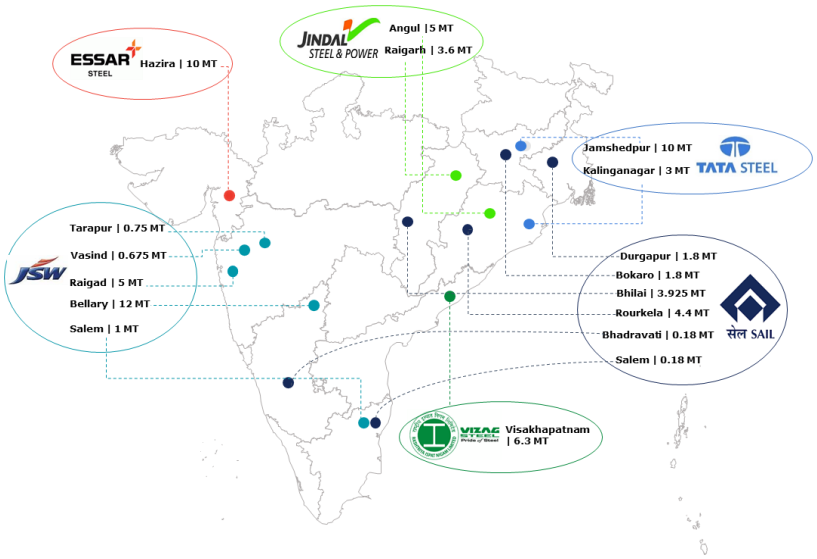
Railways are the most commonly used mode of iron ore transportation. In FY 2018, rail constituted ~70% modal share and moved ~140 MT of Iron Ore to various sectors accounting for an average lead of 305 km. Nearly two-third of

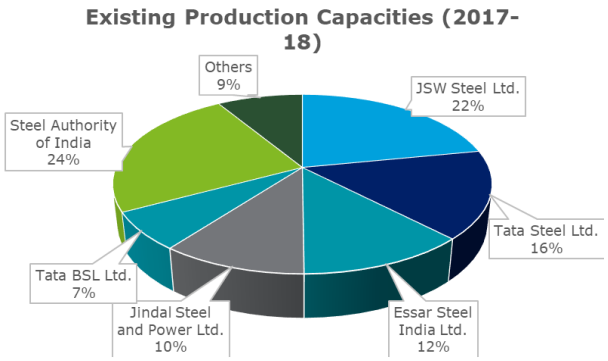
this movement was for steel sector. At the same time, the modal share for road is around 18-20% with coastal and slurry pipelines moving the rest.

3.3.3. Steel

Production and Consumption Areas

India produced ~103 MT of crude steel in FY 2018 The production capacity is concentrated with top 6 players holding ~54% production capacity and ~60% of production. The combined production of top players including SAIL, RINL, TATA Steel, ESSAR, JSWL, and JSPL was 59.39 MT while the rest 43.74 MT produced by Other Producers. The public sector plants (SAIL and RINL) produced 19.75 MT of crude steel, while the rest and dominant contribution (83.38 MT) was that of the private sector, a share of 81% of total crude steel production. The total finished steel production stood at 126.85 MT with another





7.48 MT imported resulting in 134.33 MT of steel in the ecosystem.

Figure 0-11: Production and Reserve Capacities of Steel

The total finished steel consumption in FY 2018 stood at 90.7 MT or 67 Kg per capita against a world average of 215 Kg. Jharkhand, Orissa, Chhattisgarh, and Karnataka are the key major steel-producing states responsible for 58% of steel dispatches for domestic consumption and exports.

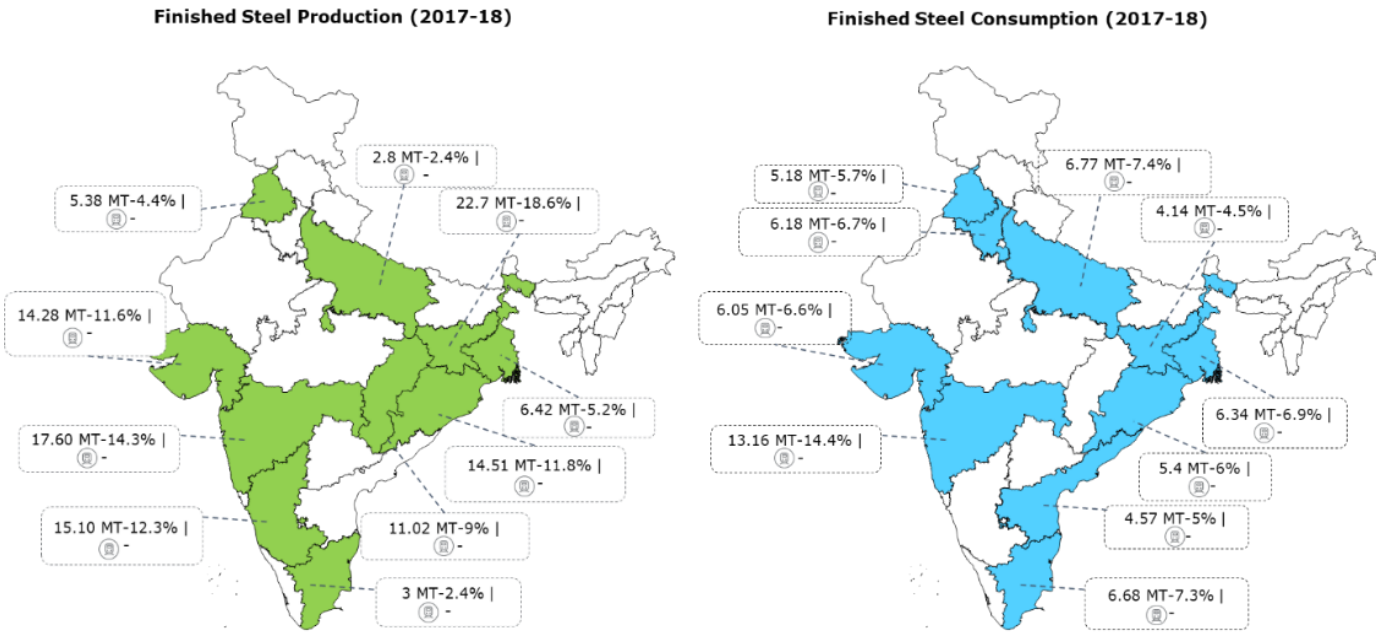


Figure 0-12: Finished Steel Production and Consumption, 2017-18

Indian Railway moved 53.18 MT of finished steel and pig iron, over an average distance of 800+ km, having over ~40% modal share. The main rail users among public sector are SAIL and RINL which use rail for 85% and 70% of outbound steel transportation. Among private sector, Tata Steel and JSW are largest rail users among the private sector with 60% and 40% share respectively.

Steel – Travel Pattern

Maximum movement of pig iron and steel is observed on Bellary- North Goa route, and internal movement within Purbi Singhbhum district. Purbi Singhbhum has the maximum share (10%), followed by Bellary (9%) and Vizag (6%). The desire line diagram of steel movement by rail in FY 18 is given in figure below.

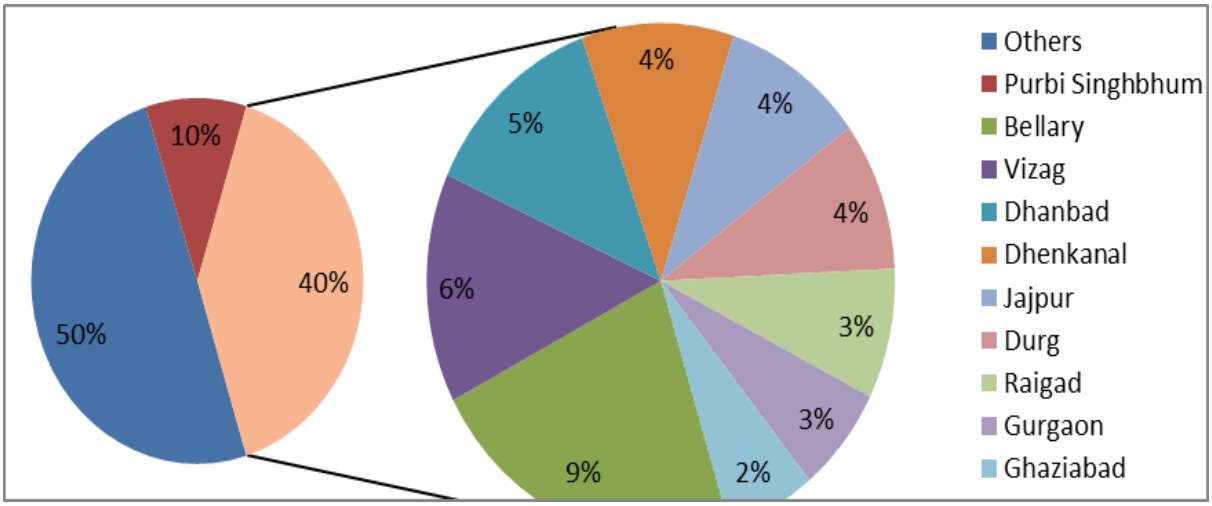


Figure 0-13: District wise share in Steel Movement by Rail, FY 18

Steel – Mode Share

Road remains the predominant mode for the private sector as well as MSME/other segments of the steel industry with more than 58-59% modal share. Out of these, around 20 MT of steel moves within 400-2000Km distance segment where rail remains the most cost competitive mode.

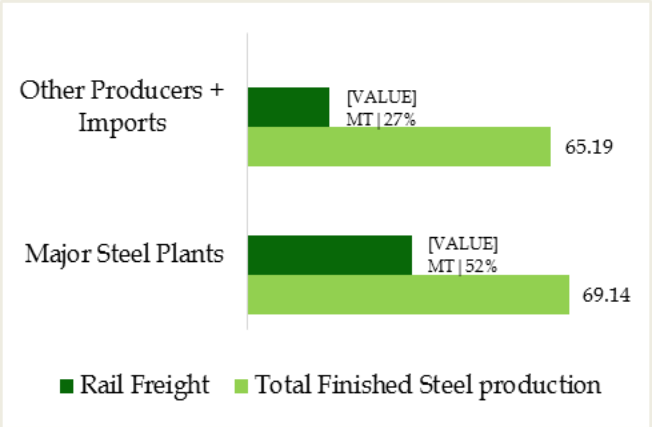


Figure 0-14: Rail Modal Share Steel Industry Segment

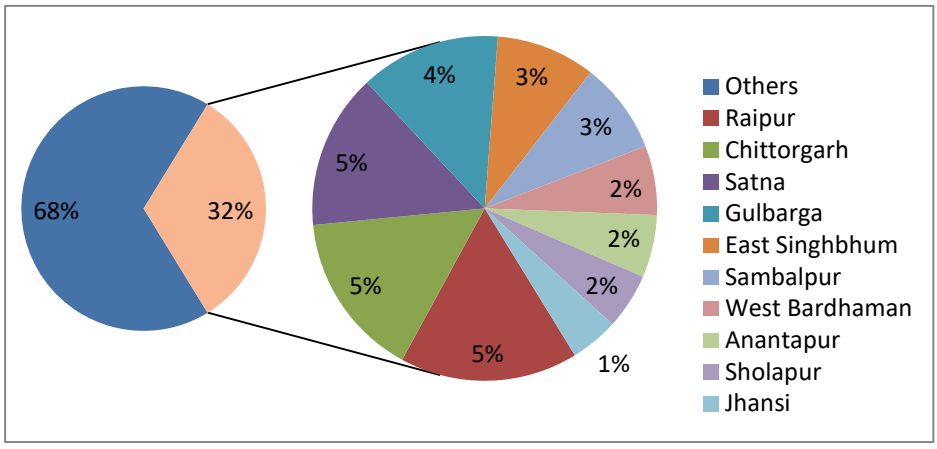
3.3.4. Cement

Cement is the 2nd largest revenue contributor to Indian Railways, and 3rd largest in terms of volumes with a movement of ~114 million tons (MT) during FY 2018. It accounts for around 9-10% of the total rail freight transportation. An additional 2.03 MT of imports meant that total ~300 MT of cement was available to be transported on Pan-India basis during FY 2018.

The cement plants and limestone reserves are at the epicentre of cement production. Cement industry being one of the principle consumers of limestone, accounts for over 95% of total limestone production in India. In fact, about 1.5 tonne of limestone is required to produce one tonne of cement. It has been seen that limestone constituted around ~18 MT of rail movement during FY 2018.

Cement – Travel Pattern

Maximum movement of cement is observed on Gulbarga- Solapur route, followed by Chittorgarh- Mahendragarh and Raipur- Paschim Baradhaman. This can be attributed to presence of limestone, key raw material for production of cement in the districts of Gulbarga, Chittorgarh and Raipur. Raipur, Chittorgarh and Satna districts have the maximum share (~5% each), followed by Gulbarga



and East Singbhum, at 4% and 3% respectively.

Figure 0-15: District-wise share in cement movement by rail, FY 18

Cement - Key Production Centers

The total installed capacity of cement plants in India stood at ~504 MT in FY18 with Rajasthan being the leader constituting ~13% of the total capacity. Major supply centres include Rajasthan, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat, Madhya Pradesh and Maharashtra, having a total of 131 plants.

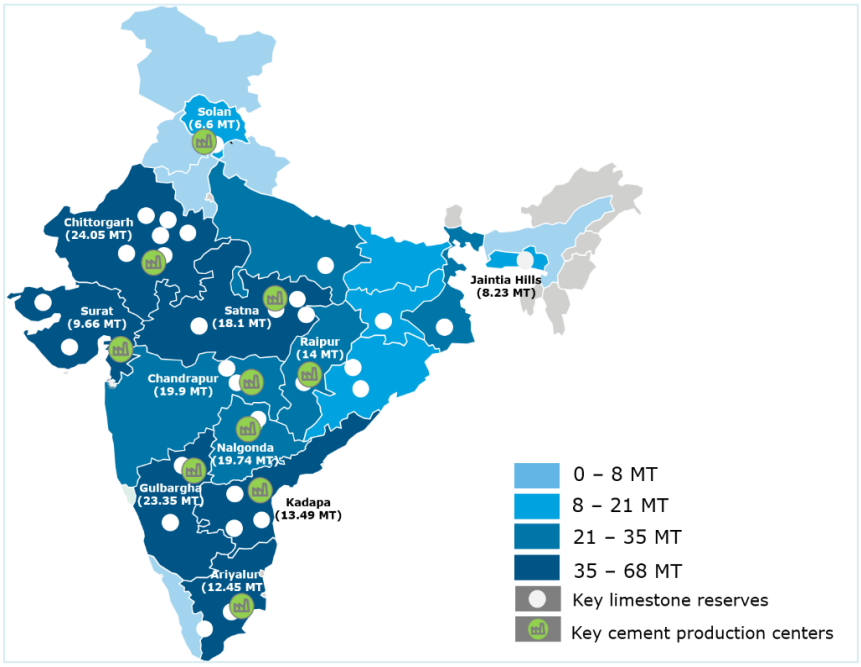


Figure 0-16: Key Cement production Centers

Cement - Consumption Pattern

Top 14 states constituted 90 per cent of the total cement consumption in India with Maharashtra, Uttar Pradesh and Tamil Nadu being the top consuming states together constituting 33 % of the total consumption in FY 2012.

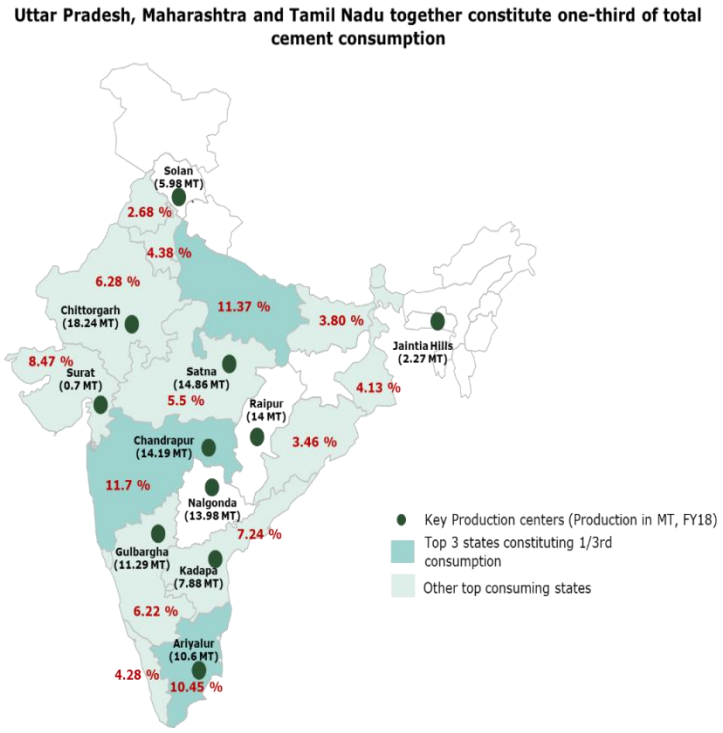


Figure 0-17: State wise Distribution of Cement Production & Consumption

3.3.5. Containers

The total traffic handled at ports in India stood at 1208.5 million tons (MT) during FY 2018 with major and non-major ports witnessing share of 56% and 44% respectively. The share of containers in the total traffic handled at the ports was seen to be around 20% and 14% for the major and non-major ports respectively. In terms of total throughput, 15.07 million TEUs (i.e. 208.23 million tons) of containers were handled at ports (including major and non-major ports) in India during FY 2018. In terms of modal share, road is dominating the EXIM container transportation in India with only 21% of the total container movement (i.e. 208.23 MT) was witnessed through rail during FY 2018.

Containers – Rail Travel Pattern

Maximum movement of container is observed on Kutch-Gurgaon route followed by Alwar-Delhi and Kutch- Ludhiana. Kutch district houses two of India's important ports (together accounting for more than 1/4th of the container traffic at Indian ports) in the western region viz. Kandla and Mundra. Kutch (containing Mundra and Kandla ports) has the maximum share (15%), followed by Raigad in Maharashtra (containing JNPT) at 11%. These 3 ports, together account for more than 60% of India's EXIM container traffic.

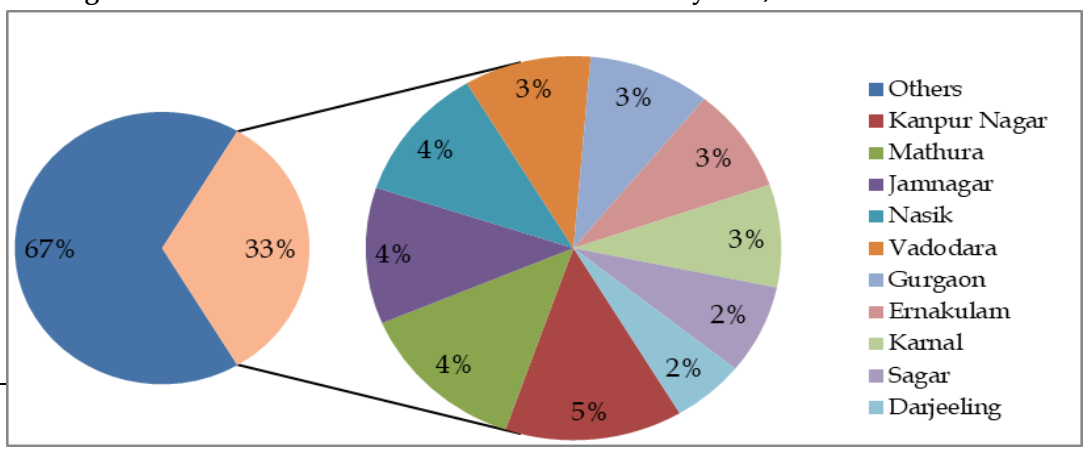
3.3.6. Petroleum, Oil and Lubricants (POL)

POL products witnessed a movement of ~43 million tons (MT) by rail, which accounted for only around 3-4% of the total rail freight transportation. The rail movement mainly accounts for transportation of petroleum products with the average lead of ~650 km from refineries to depots or end customers.

POL – Travel Pattern

Maximum movement of POL is observed on Jamnagar- Gurgaon route, followed by Ernakulam- Kolar and Jamnagar- Kanpur. Jamnagar and Kochi house major oil refineries of RIL and BPCL respectively. Gurgaon, Kolar and Kanpur have major oil terminals, through which further distribution takes place. Kanpur and has the maximum share (~5%), followed by Mathura, Jamnagar and Nashik at ~4% share each.

Figure 0-18: District-wise share in POL Movement by Rail, FY 18



3.3.7. Automobiles: 'As Is Assessment'

Road transportation has traditionally dominated the movement of automobiles in the country. It continues to do so with rail holding a meagre 6.8% share of the total movement of automobiles in FY 2018[3]. However, it is noteworthy that this share has significantly increased from about 1.1% during FY 2014. This reflects potential for rail to make inroads into the automobiles segment.

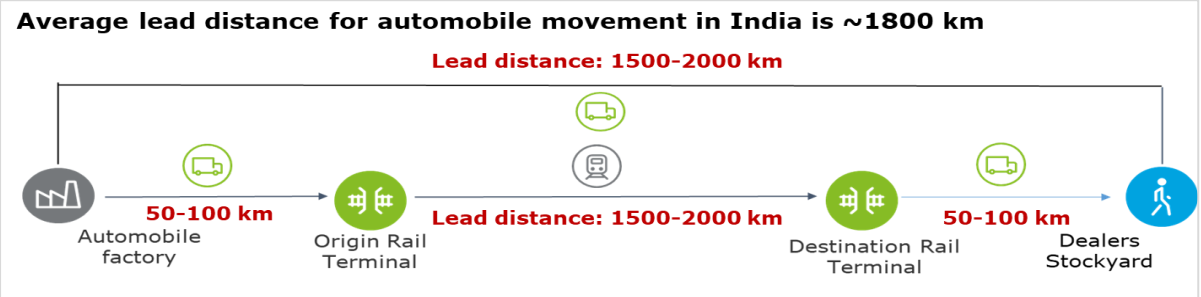


Figure 0-19: Automobile Value Chain

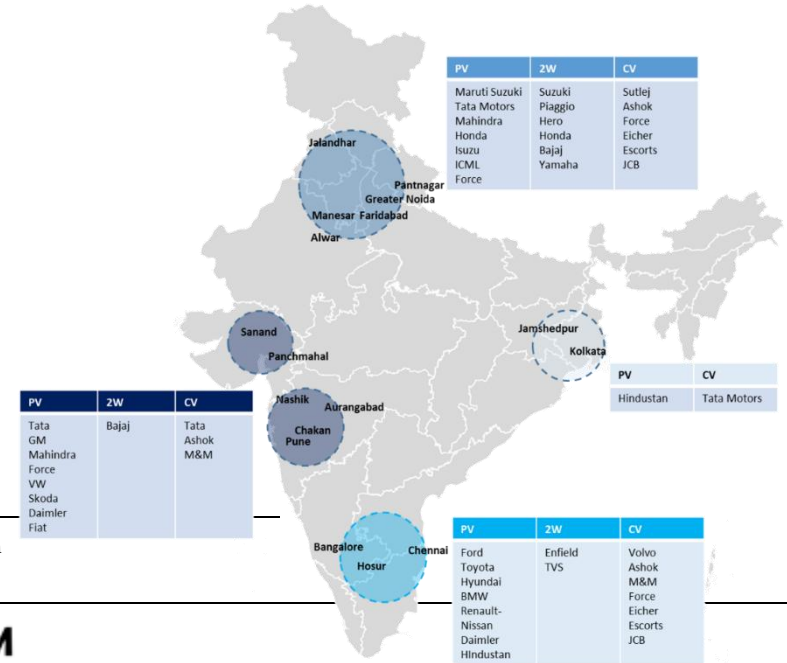
In fact, the average lead distance for automobile movement in India is ~1800 km further making rail transportation an economical mode, as per industry estimates.

Key Supply Centers

There are three key automobiles production clusters in India with Manesar, Pune and Chennai being the major production hubs within the clusters located in northern, western, and southern part of the country respectively.

Consumption patterns

Manesar, Pune and Chennai accounts for the major automobile production units



[3] CRIS data

Source: Secondary Research, Industry Consultations, Deloitte Analysis

Figure 0-20: Key Automobile Production Clusters

UP, Maharashtra and Tamil Nadu have the maximum number of registered motor vehicles

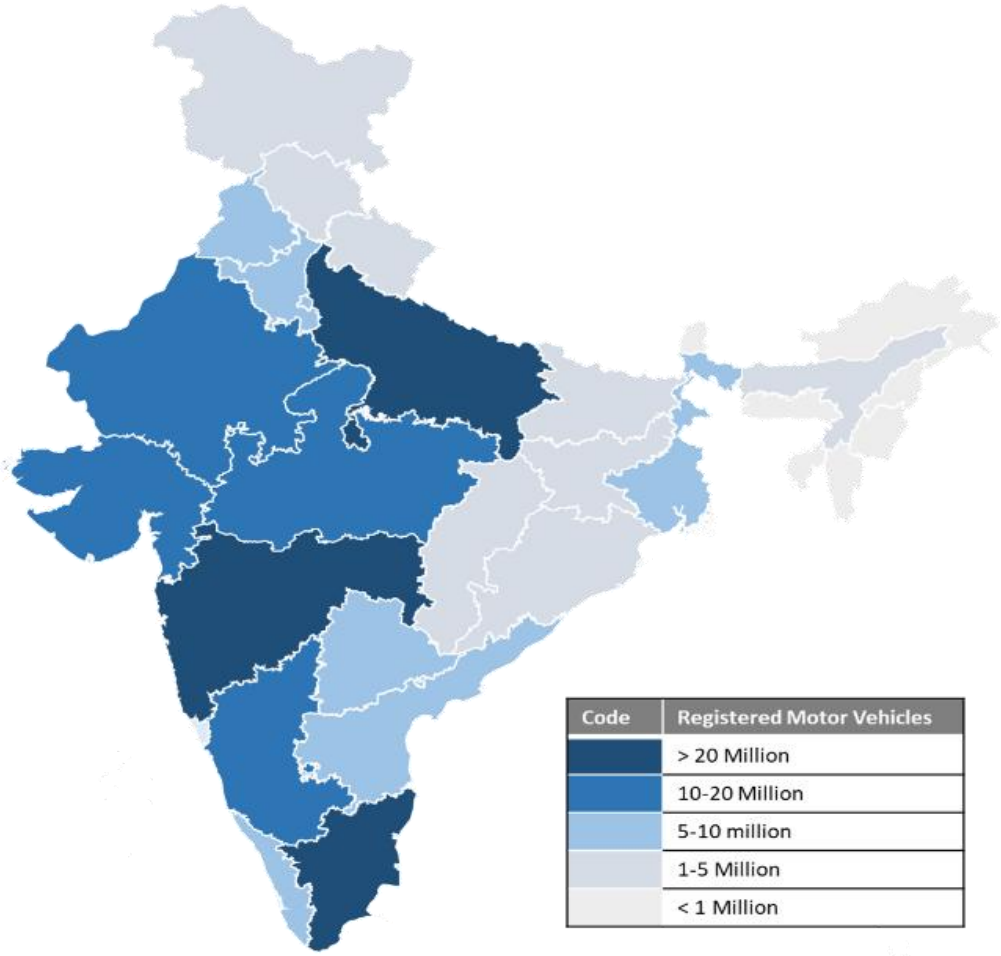


Figure 0-21: Number of motor vehicles registered across the country

Modal share and Logistics Competitiveness

Indian Railways Modal Share: As mentioned earlier, railways have always maintained a small share of the automobile segment, with less than 7% share in FY 2018. The share has however increased steadily over the years, providing scope for expansion of rail's modal share in this fast-growing segment.

3.3.8. AS-IS Freight Movement - Findings

- From 2016-17 to 2017-18, the overall rail freight traffic has grown by 11.4% from 1,044 to 1,163 million tonnes. Of this, coal is the fastest growing commodity, with annual growth rate of 21.2%
- Railways registered 0.65 Billion freight ton kilometres in the year 2017-18.
- Coal has the majority share in freight traffic on IR (48%).
- Maximum movement of Coke and Coal is observed on Angul- Jagatsinghpur route, followed by internal movement within Angul and Bilaspur districts.

- Maximum movement of iron ore is observed on Dakshin Bastar Dantewada- Visakhapatnam route, followed by internal movement within Purbi Singhbhum and Kendujhar- Paschim Bardhaman.
- Maximum movement of pig iron and steel is observed on Bellary- North Goa route, and internal movement within Purbi Singhbhum district.
- Maximum movement of cement is observed on Gulbarga- Solapur route, followed by Chittorgarh- Mahendragarh and Raipur- Paschim Baradhaman.
- Maximum movement of container is observed on Kutch-Gurgaon route followed by Alwar-Delhi and Kutch- Ludhiana.

4.0. Freight Demand Forecast

Indian Railways identifies 346 freight commodities that can be classified under certain segments. Further, any freight commodity that has any movement by rail gets identified/ finds mention in the freight movement data of the Indian Railways. Based on stakeholder consultations with respect to relevance of considering distinct commodities[4]/ commodity groups for such a study, a benchmark of two (02) million-tonnes annual throughput on the rail system was considered and Freight Operations Information System (FOIS) database was accordingly analyzed to identify such commodities.

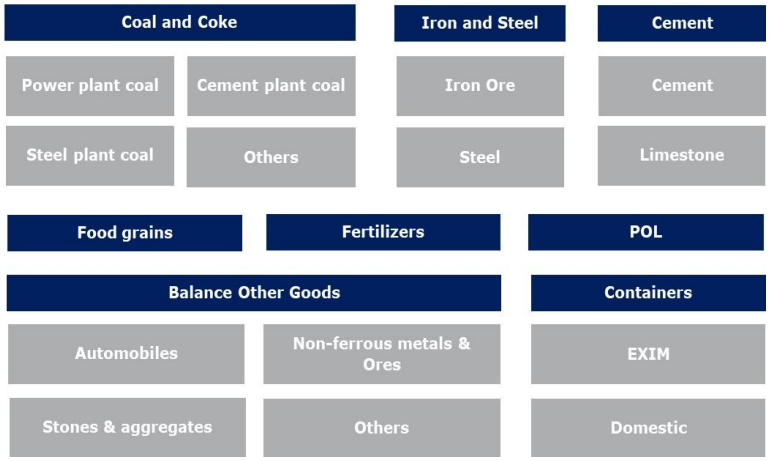


Figure 0-22: – Freight Commodity Groups

To ensure that the set of freight commodities/ commodity groups identified is representative of all major commodities within the national freight eco-system, broader reference was also made to industrial output and commodities that underpin/ drive the same.

The commodities were grouped as illustrated below and further study/ projections undertaken for the identified commodities/ commodity groups. This provided the basis for use of Indian Railways' FOIS data representing rail freight flows, as well as road surveys for mapping commodity flows in the rest of the national freight ecosystem.

[4] Non-Commercial or internal traffic like Ballast, though above benchmark, were not included

4.1. Forecast Methodology

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

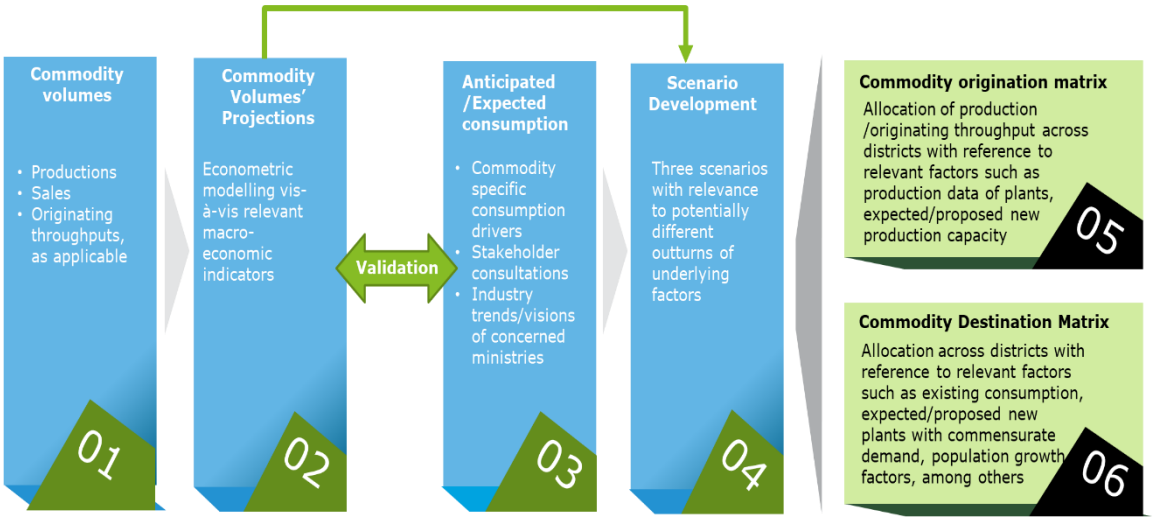
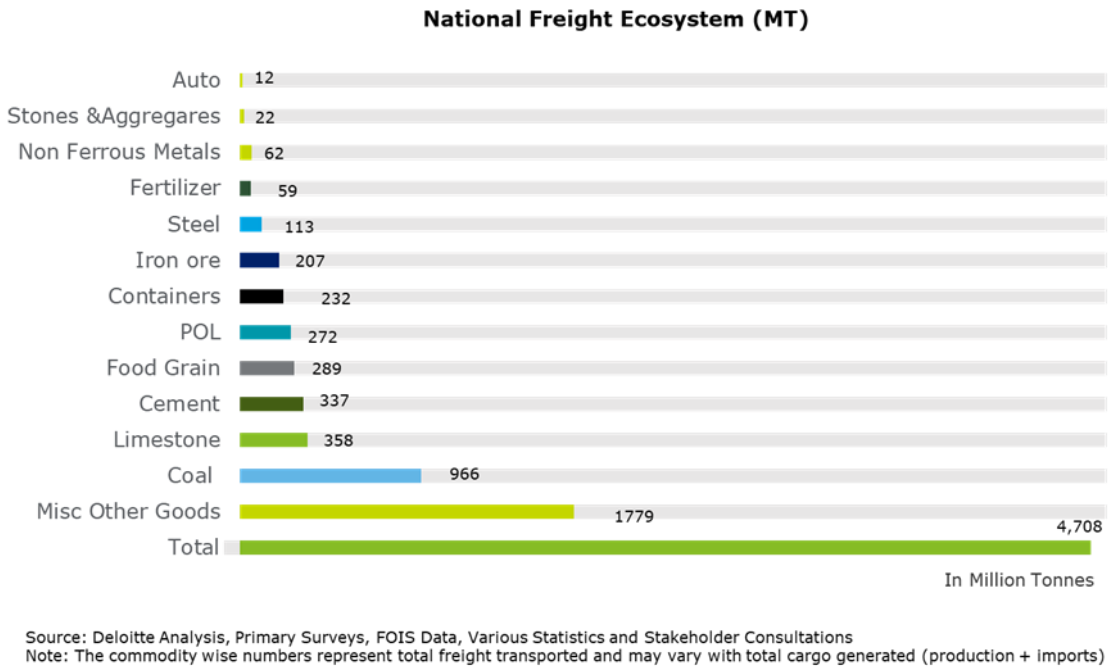


Figure 0-23: – Methodology for Freight Volume & Transportation Requirement Projections

4.2. 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:



Source: Deloitte Analysis, Primary Surveys, FOIS Data, Various Statistics and Stakeholder Consultations
Note: The commodity wise numbers represent total freight transported and may vary with total cargo generated (production + imports)

Figure 0-24: – National Freight Ecosystem

A summary snapshot of the consolidated Projections is presented in figure below.

S.No.	Commodity	Sub-commodity	Cases	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040	2045	2050
1	Cement (MT)		Optimistic			377	420	465	512	562	614	670	729	792	858	928	1337	1850	2480	3240
			Realistic	298	337	361	373	423	487	539	568	582	601	637	688	743	799	1007	1253	1544
			Pessimistic			359	371	386	410	444	478	508	533	558	587	620	718	881	1069	1291
2	Steel (MT)	Iron Ore	Optimistic			210	225	242	260	279	299	321	345	370	398	427	594	796	1038	1321
			Realistic	201	207	209	219	237	247	263	276	292	308	325	340	356	444	541	647	762
			Pessimistic			206	215	230	238	250	261	274	286	300	311	323	385	447	510	573
		Finished Steel	Optimistic			121	130	140	150	161	173	185	199	214	229	246	342	459	598	761
			Realistic	105	113	120	126	137	143	151	159	169	177	187	196	205	256	312	373	439
			Pessimistic			118	124	133	137	144	150	158	165	173	179	186	222	258	294	330
3	Limestone (MT)		Optimistic			423	471	521	574	629	689	751	818	888	962	1041	1499	2074	2780	3632
			Realistic	339	358	403	430	457	485	513	542	571	602	633	666	699	736	855	974	1093
			Pessimistic			396	418	439	461	483	505	527	550	572	595	618	878	1077	1298	1538
4	Fertilizers (MT)	Fertilizer Products (Urea, DAP, MOP, Complex fertilizer, SSP)	Optimistic			66	72	79	85	92	99	106	114	122	130	138	189	250	325	416
			Realistic	57	59	64	69	73	78	83	88	93	99	104	110	116	145	179	217	260
			Pessimistic			61	65	69	73	77	81	86	90	94	99	104	118	147	180	216
5	Foodgrains (MT)		Optimistic			302	313	325	338	350	364	377	392	406	422	438	533	648	789	960
			Realistic	285	289	298	307	316	325	334	344	353	363	374	384	395	450	513	585	666
			Pessimistic			293	301	308	315	323	331	339	347	355	364	373	413	470	533	604
6	POL (MT)		Optimistic			292	312	334	357	382	409	438	468	501	536	574	805	1129	1583	2220
			Realistic	254	272	291	310	330	350	370	391	412	434	457	480	504	669	821	989	1173
			Pessimistic			285	301	317	333	348	364	380	396	413	429	446	561	652	743	833
7	Coal (MT)		Optimistic			1021	1047	1058	1115	1173	1232	1293	1355	1418	1484	1547	2071	2691	3419	4265
			Realistic	885	966	1003	1020	1022	1069	1115	1162	1209	1256	1305	1354	1400	1798	2242	2731	3267
			Pessimistic			984	991	983	1018	1052	1086	1119	1152	1185	1218	1248	1531	1824	2124	2430
8	Automobiles (in Million Tonnes)	Passenger Vehicles, Commercial Vehicles, Three Wheelers, Two Wheelers	Optimistic			12	13	14	15	17	18	19	21	22	24	26	37	53	72	97
			Realistic	10.4	11.6	11	12	12	13	13	14	14	15	16	16	17	21	25	30	36
			Pessimistic			11	11	11	11	11	12	12	13	13	14	14	17	20	23	26
9	Metals & Ores (MMT)	Aluminium, Bauxite Ore, Copper, Copper Ore, Lead and Zinc, Lead and Zinc Ore	Optimistic			71	77	83	90	97	105	113	122	132	142	153	216	293	386	497
			Realistic	44.2	62.4	68	74	80	86	92	99	105	112	119	126	133	173	217	266	319
			Pessimistic			66	71	76	81	85	90	95	100	105	110	115	140	166	193	218
10	Stones & aggregates	Marble, Laterite	Optimistic			25	27	29	32	34	37	39	42	45	48	51	67	87	110	136
			Realistic	21	22	24	26	28	30	33	35	37	39	42	44	46	60	75	91	109
			Pessimistic			24	25	27	29	30	32	34	35	37	39	40	49	58	67	76
11	Containers (MMT)	`	Optimistic			254	275	297	320	346	374	404	436	471	509	549	785	1080	1440	1871
			Realistic	218	232	253	274	295	317	339	362	385	409	434	459	485	625	781	953	1140
			Pessimistic			247	265	282	300	317	335	352	370	388	406	424	517	614	710	804
12	Miscellaneous Other Goods		Optimistic			1800	1926	2061	2206	2360	2525	2702	2891	3093	3310	3542	4213	5011	5960	7090
			Realistic		1779	1792	1908	2033	2165	2305	2455	2615	2785	2966	3159	3364	3857	4422	5070	5814
			Pessimistic			1771	1864	1962	2065	2173	2287	2407	2534	2667	2807	2954	3264	3607	3985	4403
13	**Total National freight Volumes (MT)**		Optimistic			**4974**	**5308**	**5647**	**6053**	**6482**	**6938**	**7419**	**7932**	**8474**	**9052**	**9660**	**12687**	**16422**	**20981**	**26506**
			Realistic		**4709**	**4898**	**5150**	**5443**	**5794**	**6151**	**6493**	**6837**	**7200**	**7597**	**8021**	**8464**	**10032**	**11990**	**14180**	**16621**
			Pessimistic			**4821**	**5022**	**5223**	**5471**	**5739**	**6012**	**6292**	**6571**	**6859**	**7157**	**7465**	**8814**	**10220**	**11728**	**13344**

Figure 0-25: – National Freight Ecosystem Detail Breakup

4.3. Freight Projections by Commodity Type

In order to arrive at horizon year forecasts for each of the commodity, projections in terms of quantum of generation by each commodity have been done. Subsequent sections explain the projections by commodity type.

4.3.1. Coal Volume Projections (2020-2030)

Coal continues to remain a key source of electricity generation in India with power generation accounting for ~85% of total coal requirements/ consumption. Remaining coal volumes are used in Steel, Cement and other sectors as a metallurgical input for production. The cumulative volumes projected are presented below:

Table 0-13: Coal Volume Projections (Million Tons)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	1,021	1,047	1,058	1,115	1,173	1,232	1,293	1,355	1,418	1,484	1,547
Realistic	1,003	1,020	1,022	1,069	1,115	1,162	1,209	1,256	1,305	1,354	1,400
Pessimistic	984	991	983	1,018	1,052	1,086	1,119	1,152	1,185	1,218	1,248

4.3.2. Limestone and Cement Volume Projections (2020-2030)

Cement

The growth plans for housing, infrastructure & other sectors along with investments planned by government agencies, in these sectors, were analyzed to compare and calibrate above projected volumes against potential cement requirements for various horizon years. Lastly, projected volumes were also validated through discussions with Cement Manufacturers' Association and other manufacturers.

Limestone is a key input in cement production with latter consuming 95% of the limestone volumes in the country. Accordingly, Limestone demand was projected on basis of similar macro-economic factors as considered for cement production forecasts. The projected volumes for cement and limestone are presented below:

Table 0-14: Cement Volume Projections (Million Tons)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	377	420	465	512	562	614	670	729	792	858	928
Realistic	361	373	423	487	539	568	582	601	637	688	743
Pessimistic	359	371	386	410	444	478	508	533	558	587	620

Table 0-15: Limestone Volume Projections (Million Tons)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	423	471	521	574	629	689	751	818	888	962	1,041
Realistic	403	430	457	485	513	542	571	602	633	666	699
Pessimistic	396	418	439	461	483	505	527	550	572	595	618

4.3.3. Iron Ore & Steel Volume Projections (2020-2030)

The key consuming sectors were construction & infrastructure (consuming 40% of total steel volumes), machinery (43%), automobiles (3%), power (4%), and

railways (2%). These sectors collectively accounted for 92%[5] of total steel requirement in India.

Steel

The demand for steel was projected with reference to various macro-economic factors like real Gross Domestic Product (GDP), Iron & Steel Price Index, Coke Price Index, among others and corresponding correlations & elasticities were assessed.

Iron Ore

Steel is the main consuming industry for Iron ore. Past iron ore consumption trends by the steel sector were reference basis assumption that these trends will continue in future. The projected volumes for steel and Iron ore are presented below:

Table 0-16: Finished Steel Volume Projections (Million Tons)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	121	130	140	150	161	173	185	199	214	229	246
Realistic	120	126	137	143	151	159	169	177	187	196	205
Pessimistic	118	124	133	137	144	150	158	165	173	179	186

Table 0-17: Iron Ore Volume Projections (Million Tons)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	210	225	242	260	279	299	321	345	370	398	427
Realistic	209	219	237	247	263	276	292	308	325	340	356
Pessimistic	206	215	230	238	250	261	274	286	300	311	323

4.3.4. Exim Containers Volume Projections (2020-2030)

During FY 2018, 15.07 million TEUs (i.e. 208.23 million tonnes) of EXIM containers were handled at Indian ports including major and non-major ports. The industry has witnessed a growth rate or CAGR of around 7% since 2011[6].

For Exim container traffic, multiple macro-economic factors like real Gross Domestic Product (GDP), Merchandise Trade as a percentage of GDP, Exchange Rate, Population, World Output, Index of Industrial Output, impacting containerized EXIM traffic were analysed. Corresponding correlations and elasticities were established in order to ascertain preferred indicators impacting EXIM traffic growth. Lastly, past trends for imports and exports were referenced to assess the import export mix of projected traffic. The scenario wise volume Projections for EXIM Container volumes are presented below:

Table 0-18: Exim Container Projections (Million TEUs)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	17.58	18.99	20.51	22.15	23.92	25.83	27.90	30.13	32.54	35.14	37.96
Realistic	17.48	18.94	20.42	21.92	23.46	25.03	26.64	28.29	29.98	31.72	33.51
Pessimistic	17.07	18.29	19.50	20.70	21.91	23.12	24.34	25.56	26.80	28.04	29.30

[5] National Steel Policy, 2017
[6] Source: Indian Port Association Statistics

4.3.5. POL Products (2020-2030)

POL production growth was projected based on real GDP growth and corresponding correlation and elasticity were also assessed. Study team also gathered feedback from stakeholder consultations to validate these projections.

Table 0-19: POL Projections (Million Tonnes)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	292	312	334	357	382	409	438	468	501	536	574
Realistic	291	310	330	350	370	391	412	434	457	480	504
Pessimistic	285	301	317	333	348	364	380	396	413	429	446

4.3.6. Automobiles (2020-2030)

Automobile demand was projected with reference to correlation/elasticities with various macro-economic indicators like real Gross Domestic Product (GDP), real interest rate, index of industrial production, investments in infrastructure, private final consumption expenditure, and total final consumption expenditure etc. The projected volumes for each of the four auto categories are presented below:

Table 0-20: Passenger Vehicles Projections (Million Units)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	4.33	4.52	4.72	4.91	5.10	5.30	5.51	5.73	5.95	6.19	6.44
Realistic	3.85	3.74	3.72	3.77	3.84	3.94	4.06	4.18	4.31	4.45	4.60
Pessimistic	3.36	2.90	2.65	2.52	2.46	2.46	2.50	2.55	2.62	2.71	2.80

Table 0-21: Commercial Vehicles Projections (Million Units)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	1.25	1.38	1.52	1.68	1.86	2.05	2.25	2.49	2.75	3.04	3.36
Realistic	1.03	1.10	1.16	1.24	1.32	1.39	1.45	1.52	1.59	1.67	1.75
Pessimistic	1.01	1.07	1.13	1.19	1.26	1.31	1.35	1.41	1.47	1.52	1.58

Table 0-22: Three-Wheeler Vehicles Projections (Million Units)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	1.25	1.34	1.43	1.52	1.61	1.71	1.81	1.93	2.07	2.21	2.36
Realistic	1.19	1.26	1.33	1.39	1.45	1.52	1.58	1.65	1.74	1.81	1.90
Pessimistic	1.18	1.24	1.30	1.36	1.40	1.46	1.51	1.57	1.64	1.70	1.77

Table 0-23: Two-Wheeler Vehicles Projections (Million Units)

Scenarios	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimistic	25.78	27.38	29.06	30.82	32.67	34.49	36.47	38.58	40.86	43.23	45.73
Realistic	25.96	27.41	28.91	30.47	32.09	33.63	35.31	37.07	38.94	40.88	42.88
Pessimistic	25.38	26.50	27.65	28.83	30.05	31.15	32.37	33.63	34.98	36.34	37.74

4.3.7. Commodity Volume Projection – Beyond 2030

A commodity wise snapshot of such volume projections for 2031 - 2050 is presented below.

Table 0-24: Freight Demand Forecast by Commodity (2031-2051)

S.No.	Commodity	Sub-commodity	2035	2040	2045	2050
1	Cement (MT)		799	1007	1253	1544
2	Steel (MT)	Iron Ore	444	541	647	762
		Finished Steel	256	312	373	439
3	Limestone (MT)		736	855	974	1093
4	Fertilizers (MT)	Fertilizer Products (Urea, DAP, MOP, Complex fertilizer, SSP)	145	179	217	260
5	Food grains (MT)		450	513	585	666
6	POL (MT)		669	821	989	1173
7	Coal (MT)		1798	2242	2731	3267
8	Automobiles (in Million Tonnes)	Passenger Vehicles	5	6	6	7
		Commercial vehicles	9	10	12	14
		Three wheelers	1	1	1	1
		Two Wheelers	7	8	10	13
9	Metals & Ores (MT)	Aluminium (MT)	10	12	15	18
		Bauxite Ore (MT)	68	86	105	126
		Copper (MT)	3	4	5	6
		Copper Ore (MT)	13	17	21	25
		Lead (MT)	1	1	1	1
		Zinc (MT)	2	2	3	4
		Lead & Zinc Ore (MT)	75	95	116	139
10	Stone & Aggregates	Marble Production (MT)	31	38	45	53
		Laterite Production (MT)	29	37	46	57
11	Containers (MT)		625	781	953	1140
12	Miscellaneous Other Goods		3857	4422	5070	5814
13	**Total National Freight throughput (MT)**		**10,032**	**11,990**	**14,180**	**16,621**

5.0. Optimum Modal Mix – Estimation of Rail Freight Share

One of the objectives of the National Rail Plan is to ascertain the share of Rail in transporting freight for each of the commodity type and to provide strategies for enhancing the rail share. The section discusses in detail the share of rail in the bases year and what shall be the future rail share with respect to various ongoing and proposed railway projects.

5.1. Base Year Railway Share in Freight Movement

A total freight movement of 4,464 Million Tonnes occurred across the country. Of which 1,162 million tonnes were moved by rail whereas 2,911 million tonnes were moved by road. on the overall railways registered a market share of 26% in the total freight movement. Refer Table below.

Table 0-25: 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%**

5.2. Freight Distribution Trends

Analysis related to total freight generation and the modal share has been analysed in historical perspective by comparing the data collected as part of present study with that of the data collected as part of Total Transport Study Report. Total freight movement having leads up to 300 Km have increased from 840 MT in 2007-08 to 1829.16 in 2018-19. Total freight movement having leads beyond 300 Km has increased from 1486 MT in 2007-08 to 2245 MT in 2018-19. It is pertinent to note that share of Rail in freight movement having leads beyond 300 Km has fallen from 51.5% (765 MT) in 2007-08 to 32.4% (727 MT) in 2018-19. However, quantum of freight movement has remained same, but share has fallen due to overall increase in the freight generation clearly stating the issue related to stagnation of supply of railway freight wagons.

Table 0-26: Total Freight Distribution (Million Tonnes)

Total Traffic	**2017-18**	**2007-08#**
a) Traffic carried by Road Transport	2911.76	1558.87
b) Traffic Carried by Rail	1162.72	768.72
c) Traffic Rail & Road (a+b)	4074.48	2327.59
d) Traffic Road Leads up to 300 km	1393.14	837.89
e) Traffic Rail leads up to 300 km	436.03	2.90
f) Total Traffic leads up to 300 km (d+e)	1829.16	840.79
g) Total Potential Traffic Moving Beyond 300 km		
- Rail	726.69	765.82
- Road	1518.62	720.98
Total	**2245.31**	**1486.80**
Rail Share in Potential Traffic*	**32.4%**	**51.5%**
* % of Rail traffic (726.7MT) to total (2245.3MT)		

Source: # Total Transport Study Report, RITES

5.3. Share of Railways in Various Commodity Movement

As described above, the total freight moved by both road and rail combined in the the year 2018-19 is 4,074.5 Million Tonnes, of which 1162 MT (29%) was carried by Rail and 2911 MT (71%) were carried by road. Of the all main commodities, maximum quantum is of Coal both in Road and Rail. A total of 860 MT of coal was carried in total, of which 560 MT (65%) was carried by Rail and 298.5 MT (35%) was carried by road.

Table 0-27: Commodities by Volume moved by Rail and Comparative Road Share (2017-18)

S. No	Commodity	Total	Modal Share			
			Rail		Road	
		MT	MT	Share (%)	MT	Share (%)
1	Fertilizer	56.8	49.2	87%	7.7	13%
2	Pig iron	81.0	54.8	68%	26.2	32%
3	Coal	859.3	560.7	65%	298.5	35%
4	Iron Ore	210.8	137.5	65%	73.4	35%
5	RM for Steel	49.8	27.9	56%	21.9	44%
6	Cement	305.2	114.1	37%	191.2	63%
7	Container	219.0	53.6	24%	165.4	76%
8	POL	241.2	43.1	18%	198.1	82%
9	Food grain	284.0	44.8	16%	239.2	84%
10	BOG	1767.3	77.0	4%	1690.3	96%
	Total	**4074.5**	**1162.7**	**29%**	**2911.8**	**71%**

5.4. Average Trip Length by Commodity Type (Rail and Road)

The maximum average lead in case of Rail is for Food Grains (1316 Km), followed by Containers (885 Km), Pig Iron (804 Km) and Fertilisers (776 Km). in case of Road, the maximum average lead is for POL (844 Km), followed by Fertilisers (763 Km) and Coal (634 Km). on the overall, the average leads for Rail is 530 Km and for Road is 522 Km.

Table 0-28: Mode wise Average Leads by Commodity Type (2017-18)

S. No	Commodity	Rail	Road	All Modes (Km)
1	Pig Iron	804.5	609.7	741.4
2	RM for Steel	528.8	548.4	537.4
3	Cement	503.7	483.8	491.2
4	Fertilizer	776.4	763.3	774.7
5	Coal	443.3	634.7	509.8
6	POL	624.3	844.0	804.8
7	Iron Ore	246.8	477.0	326.9
8	Food grain	1316.2	427.7	568.0
9	Container	885.0	539.6	624.2
10	BOG	597.3	480.1	485.2
Overall		**530.1**	**522.4**	**524.6**

5.5. Estimation of Railway Mode Share

Out of 4,059 million tons of commodities, transferred cumulatively by Road and rail, 28.40% commodities by weight is carried by the Indian Railway. 1,162.6 Million tons of commodities are handled by the Rail every year i.e. 3,157,802.5 tons per day.

Table 0-29: Present Condition of Commodity Movement (2017-18)

Commodity	Total Commodities in Million Tonnes/ year (Road and rail)	Tonnes/ Day by Rail
BOG	1,767.3	211,040.0
Cement	305.2	211,040.0
Coal	843.8	312,464.6

Container	219.0	1,508,561.1
Fertilizer	56.8	146,927.5
Food grains	284.0	134,751.3
Iron Ore	210.8	122,842.6
Pig Iron	81.0	376,592.7
POL	241.2	150,077.6
Steel RM	49.8	118,111.0
Total	**4,059.0**	**76,434.2**

Table 0-30: Phase wise CAGR of Commodities

Commodity wise CAGR	2019-2021	2021-2026	2026-2031	2031-2041	2041-2051
BOG	4.29%	6.54%	5.81%	3.15%	2.83%
Cement	14.30%	8.55%	6.24%	5.24%	4.55%
Coal	2.64%	3.63%	4.08%	4.71%	3.80%
Container	20.06%	5.44%	5.80%	4.77%	3.81%
Fertilizer	14.48%	6.07%	5.03%	4.35%	3.79%
Food grains	5.34%	2.83%	2.81%	2.66%	2.63%
Iron Ore	2.48%	5.87%	5.08%	4.18%	3.45%
Pig Iron	22.23%	6.26%	5.54%	4.14%	3.45%
POL	1;6.84%	7.99%	5.40%	3.98%	3.59%
Steel RM	5.87%	5.93%	4.94%	4.18%	3.45%
Total	**6.95%**	**5.93%**	**5.30%**	**3.90%**	**3.41%**

Table 0-31: Projected Commodity Demand in Million Tonnes

Commodity (Demand) Million Tonnes	2019	2021	2026	2031	2041	2051
Balance other Goods	1,767.3	1,922.1	2,638.1	3,499.4	4,774.0	6,308.6
Cement	305.2	398.7	600.8	813.2	1,355.3	2,114.0
Coal	843.8	888.9	1,062.5	1,297.4	2,055.4	2,984.2
Container	219.0	315.7	411.5	545.6	869.6	1,263.6
Fertilizer	56.8	74.5	100.0	127.8	195.7	284.0
Food grains	284.0	315.1	362.3	416.2	540.9	701.5
Iron Ore	210.8	221.4	294.5	377.3	568.5	798.3
Pig Iron	81.0	121.0	163.9	214.7	322.2	452.4
POL	241.2	329.3	483.7	629.3	929.9	1,323.3
Steel RM	49.8	55.8	74.4	94.7	142.8	200.4
Total	**4,059.0**	**4,642.6**	**6,191.8**	**8,015.5**	**11,754.4**	**16,430.4**

5.5.1. Mode Choice Model

Mode choice model has been developed based on the most evident factors of any goods 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).

Utility Equation is derived in the form of, $y = \alpha + \beta \times \delta TT + \gamma \times \delta TC$

Where,

α = Constant

β = Coefficient of Difference of Travel Time

γ = Coefficient of Difference of Travel Cost

δTT = of Difference of Travel Time

δTC = of Difference of Travel Cost

and the probability equation for Binary Logit of using rail as a mode to transfer a commodity is derived as, $P(Rail) = \frac{e^{\lambda y}}{1+e^{\lambda y}}$

Where,

y = Utility Equation.

λ = Calibration factor

5.5.2. Scenario Building

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

1. Business as Usual (BAU): Rail Infrastructure Remain same whereas in case of Roads, Project Bharat Mala is considered implemented.
2. Enhancement of Wagon Utilisation to 800 Km/ Day: Implementation of Dedicated Freight Sub-Network along with operations of loanger and heavier trains will bring Major Railway Network at par with DFC Standards that will help in achieving a speed of 800 km/ Day with Cost remaining same.
3. Wagon Utilisation as 800 Km/ Day with 30% less Cost: Implementation of Railway projects that will bring Major Railway Network at par with DFC that will help in achieving Wagon Run of 800 km/ Day and reducing the cost being charged by 30%.
4. Business as Usual (BAU) with reduction in Cost by 30%: Rail Infrastructure Remain same whereas, the cost being charged is reduced by 30%.

In the Scenarios 2&3, the improvement in the speed has been considered since majority of the network shall be tripled or quadrupled by the addition of 3rd and 4th line. The Speed of Road and Rail and the Cost of Commodities considered are mentioned in table below.

Table 0-32: Comparison of Scenarios

Parameters	Scenario 1: BAU	Scenario 2: 800 Km/ day, with BAU Cost	Scenario 3: 800 Km/ day, with 30% less Cost	Scenario 4: BAU Speed with 30% less Cost
Rail Speed (Km/ day)	250	800	800	250
Road Speed (Km/ day)	550	550	550	550
Rail Cost	BAU	BAU	30% lesser than BAU	30% lesser than BAU
Road Cost	BAU	BAU	BAU	BAU
Terminal Time	BAU	BAU	BAU	BAU

5.5.3. Estimation of Rail Share under Scenario 1: Business as Usual (BAU) with Bharat Mala Incorporated

Modal share of both Road to Rail for each of the scenario has been estimated using Binary Logit Model. In Scenario 1, Rail speed has been considered as 10.4 kmph and Road speed will increase from 16.6 kmph to 23 kmph due to Bharatmala and cost of Transportation remaining same.

Table 0-33: Estimated Rail share of Commodities for Scenario 1

Commodity	2051	2041	2031	2026	2021	2019	Existing
BOG	1.46%	1.46%	1.45%	1.45%	1.46%	1.46%	4.36%
Cement	38.28%	38.28%	38.28%	37.85%	37.06%	37.29%	37.37%
Coal	61.88%	61.88%	61.88%	61.90%	61.94%	61.93%	65.26%
Container	15.96%	15.96%	15.96%	15.75%	15.60%	17.94%	24.49%
Fertilizer	85.27%	85.27%	85.27%	85.34%	85.41%	85.22%	86.53%
Food grains	16.63%	16.63%	16.63%	16.32%	16.37%	14.64%	15.79%
Iron Ore	59.52%	59.52%	59.52%	59.52%	59.53%	59.57%	65.20%
Pig Iron	49.11%	49.02%	49.26%	48.98%	48.01%	47.71%	49.00%
POL	9.41%	9.61%	9.99%	10.61%	10.54%	10.54%	17.87%
Steel RM	54.76%	54.76%	54.76%	54.76%	54.76%	54.76%	56.02%
Total Percentage	**25.81%**	**24.84%**	**23.40%**	**23.91%**	**24.68%**	**24.84%**	**28.02%**
Point Percent Change	**-2.22%**	**-3.18%**	**-4.63%**	**-4.11%**	**-3.34%**	**-3.18%**	
Tonnes/ day, Scenario1	11,616,293	7,999,604	5,138,283	4,056,158	3,139,703	2,762,661	
Tonnes/ day in Existing Situation	13,066,358	9,036,474	5,834,786	4,596,847	3,556,573	3,116,458	
Commodity Diversion (Tonnes/ Day)	**-1,450,065**	**-1,036,870**	**-696,504**	**-540,689**	**-416,870**	**-353,797**	

5.5.4. Estimation of Rail Share under Scenario 2: Enhancement of Wagon Run to 800 km/ Day with BAU Cost

Rail Speed has been considered as 33.3 Kmph due to implementation of Dedicated Freight sub-network with heavier and longer trains. Enhancement in Road speed has also been considered due to implementation of Bharatmala Project. Cost of Transportation for both road and rail remains same.

Table 0-34: Rail share for Scenario 2

Commodity	2051	2041	2031	2026	2021	2019	Existing
BOG	17.93%	17.93%	17.92%	17.92%	17.92%	17.92%	4.36%
Cement	42.24%	42.24%	42.24%	41.67%	40.62%	40.92%	37.37%
Coal	73.66%	73.66%	73.66%	73.65%	73.64%	73.64%	65.26%
Container	44.32%	44.32%	44.32%	43.90%	43.46%	47.22%	24.49%
Fertilizer	90.16%	90.16%	90.17%	90.02%	89.92%	90.22%	86.53%
Food grains	21.47%	21.47%	21.47%	21.05%	21.08%	19.39%	15.79%
Iron Ore	81.62%	81.62%	81.62%	81.62%	81.61%	81.61%	65.20%
Pig Iron	57.17%	57.01%	57.47%	57.02%	55.52%	54.90%	49.00%
POL	44.09%	43.83%	43.34%	42.63%	42.95%	42.42%	17.87%
Steel RM	59.88%	59.88%	59.88%	59.88%	59.88%	59.88%	56.02%
Total Percentage	**41.40%**	**40.50%**	**39.09%**	**39.36%**	**39.94%**	**39.94%**	**28.02%**
Point Percent Change	**+13.38%**	**+12.48%**	**+11.07%**	**+11.34%**	**+11.92%**	**+11.92%**	
Tonnes/ day, Scenario 2	18,636,839	13,043,998	8,584,999	6,677,108	5,080,368	4,442,019	
Tonnes/ day in Existing Situation	13,066,358	9,036,474	5,834,786	4,596,847	3,556,573	3,116,458	
Commodity Diversion (Tonnes/ Day)	**+5,570,481**	**+4,007,524**	**+2,750,213**	**+2,080,261**	**+1,523,795**	**+1,325,561**	

5.5.5. Estimation of Rail Share under Scenario 3: Enhancement of daily Wagon Run to 800 km/ Day alongwith 30% Reduction in Cost

This scenario is similar to that of Scenario 2, only difference is that a cost reduction of 30% has been considered in charges for transporting the freight across all commodities.

Table 0-35: Rail share for Scenario 3

Commodity	2051	2041	2031	2026	2021	2019	Existing
BOG	22.49%	22.49%	22.48%	22.48%	22.47%	22.47%	4.36%
Cement	51.03%	51.03%	51.03%	50.32%	48.96%	49.38%	37.37%
Coal	75.65%	75.65%	75.66%	75.65%	75.63%	75.63%	65.26%
Container	48.31%	48.31%	48.31%	47.92%	47.49%	51.51%	24.49%
Fertilizer	91.25%	91.25%	91.25%	91.09%	90.96%	91.31%	86.53%
Food grains	32.06%	32.06%	32.06%	31.36%	31.21%	29.51%	15.79%
Iron Ore	83.96%	83.96%	83.96%	83.96%	83.95%	83.95%	65.20%
Pig Iron	70.18%	69.96%	70.57%	70.01%	68.25%	67.14%	49.00%
POL	47.59%	47.29%	46.72%	45.85%	46.23%	45.65%	17.87%
Steel RM	61.43%	61.43%	61.43%	61.43%	61.43%	61.43%	56.02%
Total Percentage	**46.20%**	**45.28%**	**43.88%**	**44.10%**	**44.60%**	**44.51%**	**28.02%**
Point Percent Change	**+18.17%**	**+17.26%**	**+15.86%**	**+16.07%**	**+16.57%**	**+16.49%**	
Tonnes/ day, Scenario 3	20,795,572	14,582,103	9,636,505	7,480,675	5,672,624	4,949,795	
Tonnes/ day in Existing Situation	13,066,358	9,036,474	5,834,786	4,596,847	3,556,573	3,116,458	
Commodity Diversion (Tonnes/ Day)	**+7,729,214**	**+5,545,629**	**+3,801,719**	**+2,883,828**	**+2,116,051**	**+1,833,337**	

5.5.6. Estimation of Rail Share under Scenario 4: BAU Speed along with Cost Reduction of 30%

This scenario is similar to that of Scenario 1, however cost reduction of 30% has also been considered.

Table 0-36: Rail share for Scenario 4

Commodity	2051	2041	2031	2026	2021	2019	Existing
BOG	9.10%	9.10%	9.10%	9.09%	9.10%	9.10%	4.36%
Cement	48.54%	48.54%	48.54%	47.88%	46.64%	47.00%	37.37%
Coal	68.23%	68.23%	68.23%	68.23%	68.25%	68.25%	65.26%
Container	31.68%	31.68%	31.68%	31.23%	31.00%	34.81%	24.49%
Fertilizer	88.18%	88.18%	88.18%	88.13%	88.10%	88.18%	86.53%
Food grains	28.64%	28.64%	28.64%	28.04%	27.95%	26.26%	15.79%
Iron Ore	71.87%	71.87%	71.87%	71.87%	71.87%	71.89%	65.20%
Pig Iron	65.95%	65.77%	66.29%	65.79%	64.17%	63.28%	49.00%
POL	15.90%	16.12%	16.54%	17.19%	17.21%	17.05%	17.87%
Steel RM	57.95%	57.95%	57.95%	57.95%	57.95%	57.95%	56.02%
Total Percentage	**34.61%**	**33.61%**	**32.13%**	**32.57%**	**33.28%**	**33.35%**	**28.02%**
Point Percent Change	**+6.58%**	**+5.59%**	**+4.11%**	**+4.54%**	**+5.25%**	**+5.33%**	
Tonnes/ day, Scenario 3	15,579,058	10,823,697	7,055,846	5,524,854	4,232,609	3,709,069	
Tonnes/ day in Existing Situation	13,066,358	9,036,474	5,834,786	4,596,847	3,556,573	3,116,458	
Commodity Diversion (Tonnes/ Day)	**+2,512,700**	**+1,787,223**	**+1,221,060**	**+928,007**	**+676,037**	**+592,611**	

5.6. Comparison of Scenarios

If there is no augmentation in Rail Infrastrcutre and Bharatmala Project is implemented, the rail share will reduce to 25.81%. Further, Dedicated freight sub-network with heavier longer trains is implemented with and without better pricing, the rail share will be 41.40% & 46.20% respectively. If no upgradation in rail infrastcrutre is carried out and cost is reduced by 30%, the rail share shall be 34.61% in case of Scenario 4.

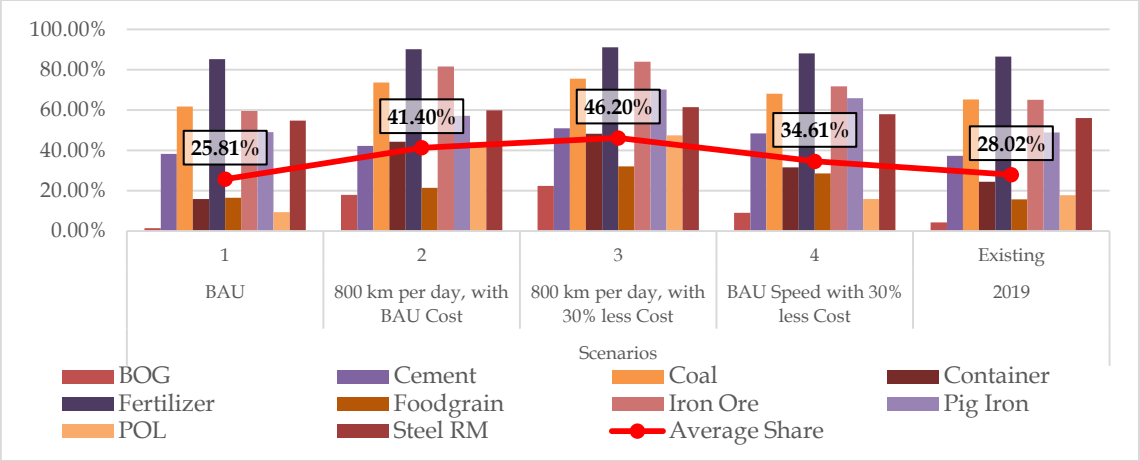


Figure 0-26: Forecast Rail Share by Scenarios

At present, Indian Railways handle 3.12 Million tonnes of commodity everyday. Whereas, in Horizon year, 2051 the rail share in Scenario 3 it is estimated to be 20.80 Million tonnes/day.

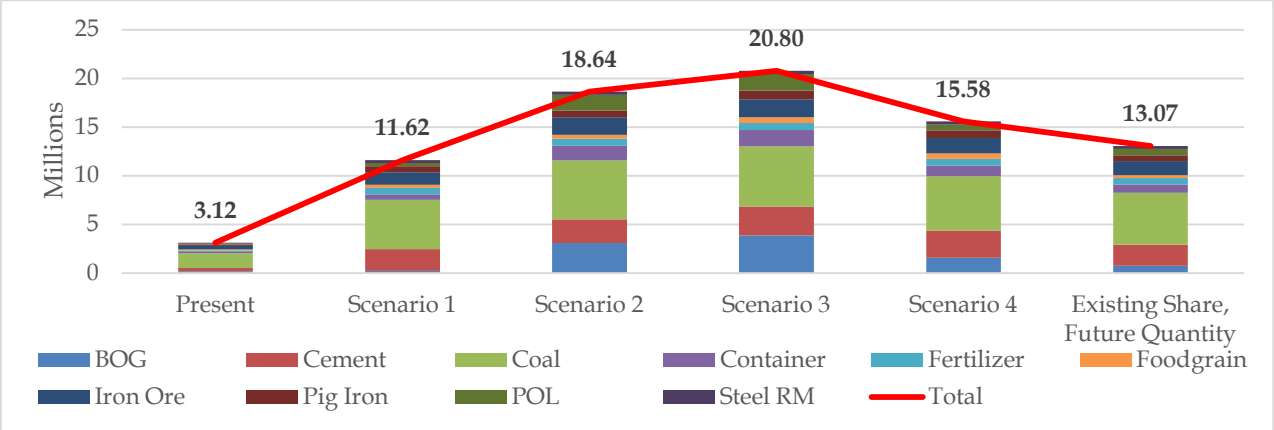


Figure 0-27: Forecast Freight Movement by Rail, By Scenarios (Million Tonnes/ day)

Table 0-37 Commodities Carried by Rail (Tonnes/ Day)

Commodity	Total Freight Forecast (Million Tonnes/ Annum) 2051	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Existing Share
BOG	6,308.6	251,663.7	3,098,738.6	3,887,106.0	1,572,792.5	753,337.5
Cement	2,114.0	2,217,270.7	2,446,502.0	2,955,650.2	2,811,024.6	2,164,256.3
Coal	2,984.2	5,059,504.4	6,022,135.2	6,185,432.7	5,578,147.2	5,335,504.0
Container	1,263.6	552,566.8	1,534,263.9	1,672,403.5	1,096,726.3	847,778.6
Fertilizer	284.0	663,399.7	701,425.3	709,855.6	685,985.6	673,190.0
Foodgrain	701.5	319,517.5	412,619.7	616,104.8	550,354.1	303,411.8
Iron Ore	798.3	1,301,872.8	1,785,216.9	1,836,281.6	1,571,922.4	1,425,938.8
Pig Iron	452.4	608,708.0	708,713.2	869,903.1	817,496.7	607,389.8
POL	1,323.3	341,072.0	1,598,349.3	1,725,466.7	576,366.7	647,896.6
Steel RM	200.4	300,716.9	328,874.4	337,367.9	318,242.0	307,654.5
Total	**16,430.4**	**11,616,292.5**	**18,636,838.6**	**20,795,571.9**	**15,579,058.1**	**13,066,357.9**

5.7. Consclusions and Recommendations

As per the comparison of the scenarios described in sections above, it is evident that the maximum enhancement of rail share in total freight movement shall be in case of Scenario 3. This means that development of dedicated freight sub-network, usage of longer and heavier trains along with reduction in freight charges by 30% shall result in maximum rail share. Different Scenarios will perform differently as the shift towards Rail will be different. In this case, Scenario 3 will be able to divert an additional +18.17% from road to rail, so therefore it is the recommended scenario for rail.

6.0. Way Forward

With Traffic Survey Data and Railway PRS and Freight data being analysed, and Passenger and Freight Demand being forecasted as part of Demand Forecast Report, the most important task ahead is the analysis of rail Network Constarints and identification of Railway Network Improvement Proposals. Following tasks are required to be organised:

- Forecast Rail Matrices to be assigned on Rail network.
- Identification of Railway Network bottlenecks.
- Identify Rail Network Improvement proposals based on rail traffic forecasts.
- Prioritise/ Phasing of railway Projects.
- Financing Strategies.