POLICY PRESCRIPTIONS FOR ENERGY EFFICIENT AND LOW CARBON TRANSPORT MODEL FOR INDIA

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ABSTRACT

India's nominal Gross Domestic Product (GDP) was 1,430,020 million dollars in 2010-11. With a population of 1.2 billion as of 2011, growing towards 1.6 billion in 2050 and with rising income levels, transport infrastructure has to be developed such that it is energy efficient and environment friendly with low carbon footprint that is sustainable in the long run. This paper determines the efficacy of rail, road and air modes of transport in India for various parameters, per unit transport cost, share of transport in GDP, energy consumption (intensity) and equivalent carbon dioxide emissions. Presently, road dominates over the other modes with a modal share of 86% in passenger traffic in 65% in freight traffic. The modal share of rail has been deteriorating steadily. However, various parameters show that rail transport is the most cost effective, energy efficient and eco-friendly mode. Integrated development of transport system, internalising the externalities, introduction of Mass Rapid Transit Systems in cities, large scale of adoption of Public Private Partnership by Indian Railways for construction and operation, seamless multimodal transport system and encouragement for non-motorised transport are some of the policy prescriptions this paper recommends for the development of energy efficient and low carbon transport system.

Keywords: cost effectiveness, energy efficient, seamless multimodal transport, policy prescription, low carbon, passenger traffic, freight traffic, energy intensity, externalities, public private partnership, road, railways, air, passenger kilometre, tonne kilometer

INTRODUCTION

Transportation and communication are cornerstones of the development of an economy. With an average economic growth exceeding 6% between 2000-01 and 2010-11, India is going to be a developed country within two decades. With the population growing towards 1.6 billion in 2050 and with rising income of people coupled with high economic growth, the criticality of development of transport infrastructure for both passenger and freight traffic is underscored. But the prevalent condition is far from satisfactory. On the one hand there is a deficit in the supply of transport infrastructure. On the other hand, logistics costs, of which

transport costs form a major portion (around 60%) is very high in India as compared to international standards, highlighting the poor efficiency of transport facilities. Logistics costs in India were around 13% of the GDP in 2005-06, much higher than the developed economies like Germany (8%), US (9.5%) and Japan (10.5%) (Cygnus, 2007). In addition, transport sector in India is the second most polluting sector emitting 142.04 million tonnes of Carbon dioxide (CO_2) equivalent of greenhouse gases as of 2007 (MoEF, 2010).

In order to achieve sustained growth rate of 8% to 10% with the ever increasing population, it is imperative that development of transport infrastructure takes place rapidly in such a way that the transport systems are able to meet increasing demand, cost effective, energy efficient and environmental friendly.

CURRENT SCENARIO OF INDIAN TRANSPORT SECTOR

This analysis is confined to the development of transport infrastructure in India after 1950 by rail and road modes. Air has been considered only from 2000 since air traffic contributed very little to the overall transport needs till then. Though waterways have been used for freight traffic, since the contribution of inland waterways has been too meagre, it has not been considered, Though the development of pipelines to transport gas and other crude oil products in the last decade forms yet another mode of freight traffic, as its contribution to the total freight volume is very little, this has also not been considered for this study.

In 1950, rail was the most dominant mode of transport with 74% in passenger traffic and 86% in freight traffic (Table 1). Within a decade, railways started losing out to road in passenger traffic and the trend has been continuing unabatedly. Similarly, railways lost its status as the major freight traffic mode to roads by mid nineties and the same trend is continuing (Table 2).

Table 1 – Modal share of passenger traffic in India

Year	Railway Traffic		Road traffic		Air traffic		Total PKM (Million)
	PKM (Million)	Share (%)	PKM (Million)	Share (%)	Available Seat Km (Million)	Share (%)	
1950-51	66,517	74.31	23,000	25.69	NA	0.00	89,517
1960-61	77,665	48.98	80,900	51.02	NA	0.00	158,565
1970-71	118,120	36.00	210,000	64.00	NA	0.00	328,120
1980-81	208,558	27.79	541,800	72.21	NA	0.00	750,358
1990-91	295,644	27.80	767,700	72.20	NA	0.00	1,063,344
1999-00	430,666	19.04	1,831,600	80.96	NA	0.00	2,262,266
2000-01	457,022	17.91	2,075,500	81.32	19,897	0.78	2,552,419
2001-02	490,912	16.78	2,413,100	82.50	20,849	0.71	2,924,861
2002-03	515,044	15.36	2,814,700	83.96	22,833	0.68	3,352,577
2003-04	541,208	14.88	3,070,200	84.43	24,936	0.69	3,636,344
2004-05	575,702	14.14	3,469,300	85.18	27,790	0.68	4,072,792
2005-06	615,614	13.40	3,944,941	85.84	35,077	0.76	4,595,632
2006-07	694,764	13.29	4,485,792	85.78	48,702	0.93	5,229,258
2007-08	769,956	12.98	5,100,795	86.00	60,590	1.02	5,931,341
2008-09	838,032	12.51	5,800,114	86.60	59,160	0.88	6,697,306

2009-10	903,465	11.95	6,595,309	87.24	61,091	0.81	7,559,865

Note: PKM refers to Passenger kilometre. Air traffic is measured in terms of to Seat kilometres (seat Km here)

Source: CMIE, 2011 & MoR, 2011

Table 2 - Modal share of freight traffic in India

	Railway Traffic		Road Traffic		Air Traffic		Total Tonne Km (Million)
Year	Tonne Km (Million)	Share (%)	Tonne Km (Million)	Share (%)	Tonne Km (Million)	Share (%)	
1950-51	37,565	86.23	6,000	13.77	NA	0.00	43,565
1960-61	72,333	83.78	14,000	16.22	NA	0.00	86,333
1970-71	110,696	69.89	47,700	30.11	NA	0.00	158,396
1980-81	147,652	61.90	90,900	38.10	NA	0.00	238,552
1990-91	235,785	61.90	145,100	38.10	NA	0.00	380,885
1999-00	305,201	39.52	467,000	60.48	NA	0.00	772,201
2000-01	312,371	38.73	494,000	61.25	171	0.02	806,542
2001-02	333,228	39.28	515,000	60.70	166	0.02	848,394
2002-03	353,194	39.31	545,000	60.66	187	0.02	898,381
2003-04	381,241	39.04	595,000	60.93	210	0.02	976,451
2004-05	407,398	38.67	646,000	61.31	258	0.02	1,053,656
2005-06	439,596	38.88	690,832	61.10	273	0.02	1,130,701
2006-07	480,993	39.42	738,776	60.55	275	0.02	1,220,044
2007-08	521,371	39.75	790,047	60.23	293	0.02	1,311,711
2008-09	551,448	39.49	844,877	60.50	260	0.02	1,396,585
2009-10	600,548	39.92	903,511	60.06	315	0.02	1,504,374

Source: CMIE, 2011 & MoR, 2011

The reasons for the major shift in passenger and freight traffic may be attributed to lack of capacity augmentation in railways. The road, which contributed to only 25% of passenger traffic in 1950, has grown to mammoth proportions to around 87% in 2010. Similarly, its share in freight traffic increased from 14% in 1950 to around 60% in the last ten years. Road transport offered extra benefits to both passenger and freight traffic like door to door delivery, flexibility, etc. Needless to say, roads carry medium value and high value items as much as low valued items unlike railways whose freight mainly consists of low valued bulk items.

Air traffic which initially had a modest share of 0.78% in passenger traffic has steadily increased and peaked at 1.02% in 2007-08, just before global economic meltdown as shown in Table 1. The share of air in freight traffic remained at around 0.02% in the last 10 years as shown in Table 2.

LITERATURE REVIEW

The literature review was done on two themes. The first theme was on the studies that were carried out so far on energy consumption (efficiency), low carbon and environmental aspects of transport systems in India. The second theme was on the policy prescriptions aimed at the development of transport systems which are cost effective, energy efficient and emit less carbon emissions while meeting the demands of transport users.

The energy consumption across various modes of transport was studied in detail by several authors. IEA (2007) predicted that the share of transport in total energy consumption would increase to 20% in 2030 from 10% in 2005. The demand for energy for transport sector would increase from 40 Mtoe (Million Tonnes of Oil Equivalent) in 2005 to 162 Mtoe in 2030. The demand for crude oil, a major source of energy in the transport sector, was expected to go up by five times from 1990 to 2030 (Singh, K. P, 2009). India's dependence on import of oil has been high and was projected to be 80% during 12th five year plan period of 2012-17 (PC, 2011a). India is estimated to import 90% of its oil demand in 2030 (TERI, 2006).

In 2007, although domestic air carried 0.75% of total passenger and 0.02% of total freight traffic, it consumed 7.4% of total energy consumption of transport sector. In comparison, rail carried 13.83% of the total passenger and 40% of the total freight transport but consumed only 4.3% of total energy consumption of transport sector (Singh, A., 2010). Ramanathan (2000) found that road was 63% as efficient as rail transport in 1993-94. Chaudhury (2003) stated that rail consumed 0.18 - 0.19 Mega Joules of energy per Passenger Kilometre (MJ/PKM) whereas for road, it was 0.16-0.64 MJ/PKM, depending upon whether it was bus or private transport in 2000-01. He also included upstream effects of energy generation. Asian Institute of Transport Development's study found that the energy consumption per PKM for rail was between 78.77% and 94.91% of the energy consumed by the road (Bandyopadhyay, 2010). Gupta (2008) studying the vulnerability of 26 net oil importing countries in 2004 assigned Oil Vulnerability Index[1] (OVI) on the basis of various indicators. Higher OVI indicated higher vulnerability. The average value of OVI was 0.64, whereas India scored 0.93 being the third most vulnerable country after Philippines and Korea.

The impact on health resulting from burning of fossil fuel comes from both Green House Gases (GHG) and local air pollution. Air pollution results in localized negative externalities. The impact of transport on environment is much pronounced and detrimental in urban areas. Badami (2005) highlighted a survey conducted in Delhi in mid 1990s that showed on an average, Total Suspended Particulate Matter (TSP) exceeded World Health Organisation guidelines almost daily by 6 to 10 times, mainly due to the concentration of motor vehicular activities. The CO_2 emissions for inter city travel by air was the highest emitter of CO_2 and was almost 80 times that of rail (PC, 2011b). Chaudhury (2003) examining the various emissions of pollutants by rail and road mode found that the range of emissions of pollutants (in grams per PKM) on average was lower for rail over road mode except for TSP. CO_2 and TSP emissions of rail were mainly due to the high carbon content and particulate matter in the coal used in thermal power generating stations.

As seen above, although there were some studies carried out on the energy consumption and carbon emissions of transport systems in India, there was no elaborate analysis carried out so far on the cost, energy consumption, carbon emissions and percent share of GDP in various transport modes.

[1] OVI is a composite index consisting of ratio of value of oil imports to GDP, oil consumption per unit of GDP, GDP per capita and oil share in total energy supply, ratio of domestic reserves to oil consumption, exposure to geopolitical oil market concentration risks as measured by net oil import dependence, diversification of supply sources, political risk in oil-supplying countries and market liquidity

As far as policy prescriptions are concerned, the National Transport Policy of 1980 suggested that the modal share of road should not be more than 60% for passenger transport, whereas it stood at 87% in 2010-11 (MoEF, n.d). TERI advocated 35% share for rail in passenger transport by 2036 (TERI, 2006) to ensure energy efficiency in transport sector. Acknowledging the needs for developing high speed rail (HSR) corridors, the Ministry of Railways selected six corridors for this purpose and decided to setup National High Speed Rail Authority for the implementation of the same. Ministry of Urban Development also decided to support Metro rail systems for cities with a population of 20 lakhs (PIB, 2012).

The policy prescriptions are either at vestige level or on specific issues at modal level. To overcome the above gap, in this paper an attempt has been made to quantitatively measure the performance of each mode of transport for both passenger and freight traffic in India in terms of growth, cost, percent share in GDP, energy consumption (intensity) and carbon emissions. This would give a larger perspective that will enable us to give policy prescriptions for cost effective, energy efficient and environment friendly transport policy for India.

ANALYSIS OF THE TRANSPORT SECTOR DATA IN INDIA

In this section, the collated transport data from different sources have been worked out to determine the value of the following parameters for the three modes of transport, Rail[2], Road and Air.

- Total passenger traffic cost and the percent share of the three modes in terms of both PKM and passenger traffic cost (revenue)
- Total freight traffic cost and the percent share of the three modes in terms of both Tonne Km and freight traffic cost (revenue)
- Each mode's share in GDP for both Passenger and freight transport
- Energy Intensity per PKM and Tonne Km for each mode of transport
- Emission per PKM and Tonne Km for each mode of transport

Passenger Traffic Cost

As shown in Table 3 and 4, the average rate per PKM in rail mode remained almost static between 2002-03 and 2009-10. Passenger fares were not revised during this period and the fares were also cross subsidized from freight transport. On expected lines, the average rate per PKM for air is around 25 times that of the same for rail.

Table 3 – Passenger traffic cost for Rail and Road modes of transport in India

Year	Railway				Road			
	PKM (Million)	Cost per PKM (Rs)	Total Cost (Rs Million)	Share (%)	PKM (Million)	Cost per PKM (Rs)	Total Cost (Rs Million)	Share (%)
1950-51	66,517	0.01	980	64.85	23,000	0.02	530	35.15
1960-61	77,665	0.02	1330	37.98	80,900	0.03	2,170	62.02

[2] Railways in India primarily refers to Indian Railways which enjoys almost a monopoly in providing rail transport services. In this paper the terms Railways and Indian Railway have been used interchangeably.

1970-71	118,120	0.03	2950	26.41	210,000	0.04	8,230	73.59
1980-81	208,558	0.04	8280	19.71	541,800	0.06	33,720	80.29
1990-91	295,644	0.11	31,460	19.72	767,700	0.17	128,050	80.28
1999-00	430,666	0.22	95,560	13.04	1,831,600	0.35	637,120	86.96
2000-01	457,022	0.23	104,840	11.27	2,075,500	0.36	746,370	80.23
2001-02	490,912	0.23	111,040	10.55	2,413,100	0.35	855,660	81.27
2002-03	515,044	0.24	125,410	9.67	2,814,700	0.38	1,074,400	82.85
2003-04	541,208	0.25	132,600	9.32	3,070,200	0.38	1,179,150	82.89
2004-05	575,702	0.24	140,470	8.79	3,469,300	0.38	1,326,990	83.06
2005-06	615,614	0.25	15,083	8.19	3,944,941	0.38	1,515,100	82.29
2006-07	694,764	0.25	17,161	7.93	4,485,792	0.39	1,736,890	80.21
2007-08	769,956	0.26	19,788	7.60	5,100,795	0.40	2,054,970	78.94
2008-09	838,032	0.26	21,864	7.33	5,800,114	0.41	2,372,170	79.49
2009-10	903,465	0.26	23,400	6.98	6,595,309	0.41	2,677,750	79.86

Source: Author's calculations based on MoR, 2011, PC, n.d., IRFCA, n.d., and Highways Department, n.d.

Table 4 – Passenger traffic cost for Air mode of transport and Total Transport passenger transport cost in India

Year	Air				Total Passenger traffic cost (Rs Million)
	Available Seat Km (Million)	Cost per PKM (Rs)	Total Cost (Rs Million)	Share (%)	
2000-01	19,897	3.97	79,080	8.50	930,280
2001-02	20,849	4.13	86,140	8.18	1,052,850
2002-03	22,833	4.25	97,030	7.48	1,296,850
2003-04	24,936	4.45	110,880	7.79	1,422,620
2004-05	27,790	4.68	130,130	8.15	1,597,590
2005-06	35,077	5.00	175,290	9.52	1,841,220
2006-07	48,702	5.27	256,800	11.86	2,165,290
2007-08	60,590	5.78	350,470	13.46	2,603,320
2008-09	59,160	6.65	393,410	13.18	2,984,230
2009-10	61,091	7.22	441,230	13.16	3,352,970

Source: Author's calculations based on DGCA, n.d., and Pandit, n.d.

Freight Traffic Cost

As shown in Table 5 and 6, the average rate per Tonne Km in road in twice that of the same in rail mode, whereas the average rate per tonne in air is 100 times that of the same in rail mode. This clearly shows that even with economic growth, the major chunk of freight traffic will remain with either road or rail.

Table 5 – Freight traffic cost for Rail and Road modes of transport in India

Year	Railway				Road			
	Tonne Km (Million)	Cost per Tonne Km (in Rs)	Total Cost (Rs Million)	Share (%)	Tonne Km (Million)	Cost per Tonne Km (in Rs)	Total Cost (Rs Million)	Share (%)
1950-51	37,565	0.03	1,190	--	6,000	NA	NA	--
1960-61	72,333	0.04	2,800	--	14,000	NA	NA	--
1970-71	110,696	0.05	6,010	--	47,700	NA	NA	--

1980-81	147,652	0.11	15,500	--	90,900	NA	NA	--
1990-91	235,785	0.35	82,520	--	145,100	NA	NA	--
1999-00	305,201	0.71	217,550	--	467,000	NA	NA	--
2000-01	312,371	0.74	230,470	29.40	494,000	1.10	544,670	69.47
2001-02	333,228	0.74	245,860	28.85	515,000	1.16	597,400	70.10
2002-03	353,194	0.74	262,320	28.21	545,000	1.21	657,240	70.68
2003-04	381,241	0.72	274,040	26.75	595,000	1.24	738,030	72.06
2004-05	407,398	0.75	304,900	26.31	646,000	1.30	838,390	72.33
2005-06	439,596	0.81	355,330	26.97	690,832	1.37	944,180	71.68
2006-07	480,993	0.85	410,720	27.25	738,776	1.46	1,077,590	71.50
2007-08	521,371	0.89	464,230	27.27	790,047	1.54	1,215,900	71.43
2008-09	551,448	0.94	517,480	26.32	844,877	1.69	1,426,420	72.54
2009-10	600,548	0.95	569,140	24.19	903,511	1.94	1,753,710	74.55

Source: Author's calculations based on MoR, 2011, PC, n.d., IRFCA, n.d.

Table 6 – Freight traffic cost for Air mode of transport and Total freight transport cost in India

Year	Air				Total Freight Transport cost (Rs Million)
	Tonne Km (Million)	Cost per Tonne Km (Rs)	Total Cost (Rs Million)	Share (%)	
2000-01	171	51.83	8,860	1.13	784,000
2001-02	166	53.89	8,950	1.05	852,200
2002-03	187	55.43	10,360	1.11	929,920
2003-04	210	57.99	12,180	1.19	1,024,250
2004-05	258	61.07	15,760	1.36	1,159,040
2005-06	273	65.18	17,790	1.35	1,317,300
2006-07	275	68.77	18,910	1.25	1,507,220
2007-08	293	75.44	22,100	1.30	1,702,230
2008-09	260	86.73	22,550	1.15	1,966,450
2009-10	315	94.20	29,670	1.26	2,352,520

Note: The cost of Available Seat Mile in India in 2009 was found to be 22.5 cents (Pandit, n.d.). For air freight traffic, the average rate per Tonne Km was calculated for 2007-08 to be INR 68.77 and was adjusted for other years on the basis of inflation.

Source: Author's calculations based on DGCA, n.d., and Pandit, n.d.

Share of modes of Transport in GDP

Table 7 shows the share of transport in GDP as determined by the author. The share of passenger traffic (around 5%) is a little higher than that of freight traffic (around 3%). The transport sector as a whole contributes to around 8% of GDP. On expected lines, the road transport shares a little more than 6% of GDP, followed by rail with a little more than 1% and air with about 0.7%. With sustained higher economic growth, freight traffic may surpass passenger transport in future. But, passenger traffic will also go up with increased economic activities and increased income levels. Till India's growth and population saturates, the growth in both passenger traffic and freight traffic will continue.

Table 7 – Share of transport in GDP

Year	Passenger transport	Freight transport	Modes		
			Rail	Road	Air
2000-01	4.01	3.38	1.45	5.57	0.38
2001-02	4.21	3.41	1.43	5.81	0.38
2002-03	4.68	3.35	1.40	6.24	0.39
2003-04	4.55	3.28	1.30	6.13	0.39
2004-05	4.47	3.25	1.25	6.06	0.41
2005-06	4.48	3.20	1.23	5.98	0.47
2006-07	4.55	3.16	1.22	5.91	0.58
2007-08	4.74	3.10	1.21	5.96	0.68
2008-09	5.01	3.30	1.24	6.38	0.70
2009-10	4.73	3.32	1.13	6.26	0.66

Source: Author's calculations based on Economy Watch, n.d. and data from Table 3. 4, 5 and 6

Energy Consumption of various transport modes

This calculation of energy consumption for all the three modes of transport was done as given in Table 8 to determine the energy intensity of all the three modes of transport for both passenger and freight traffic as shown in Table 9.

Table 8 – Energy consumption for traffic in various modes of transport
(in Trillion BTU)

	Passenger traffic			Freight traffic		
Year	Rail	Road	Air	Rail	Road	Air
2000-01	24.71	730.38	69.56	54.32	533.01	7.80
2001-02	24.52	772.97	76.78	54.29	539.66	7.97
2002-03	25.42	846.17	83.90	53.17	517.62	8.96
2003-04	25.56	871.48	91.67	52.82	545.46	10.07
2004-05	24.65	902.18	99.42	53.51	570.00	12.04
2005-06	23.23	942.32	110.86	54.73	587.24	11.25
2006-07	22.91	980.72	124.61	54.83	608.46	9.18
2007-08	23.17	1,037.34	137.88	54.36	613.78	8.70
2008-09	22.96	1,071.30	151.88	54.35	644.19	8.71
2009-10	22.47	1,077.00	164.85	54.64	705.35	11.09

Note: The cost of transport is not fully free from economic distortions (especially in case of rail). Since the energy consumption calculations are essentially based on cost of transport, they are prone to some inaccuracies.

Source: Author's calculations based on Singh, A., 2010 and tables 3, 4, 5 and 6

As shown in Table 9, it was estimated that energy intensity for rail mode is about 25 BTU per PKM for passenger traffic and about 90 BTU per Tonne Km for freight traffic. For road, it is about 163 BTU per PKM and 780 BTU per Tonne Km and for air, the values are about 2700 BTU per PKM and 35000 BTU per Tonne Km. However, the values clearly substantiate the viewpoint that Rail is the energy efficient mode of transport. The energy efficiency of Rail is

almost 6 times better than that of road in passenger traffic and 8 times that of road in freight traffic. Similarly, the energy efficiency of rail is more than 100 times that of air in passenger traffic and about 400 times that of air in freight traffic.

Table 9 - Energy intensity for various modes of transport

	BTU / PKM			BTU / Tonne Km		
Year	Rail	Road	Air	Rail	Road	Air
2000-01	54.07	351.90	3,496.22	173.89	1,078.96	45,599.12
2001-02	49.95	320.32	3,682.83	162.93	1,047.89	48,032.96
2002-03	49.36	300.63	3,674.39	150.55	949.76	47,922.79
2003-04	47.23	283.85	3,676.08	138.56	916.75	47,944.92
2004-05	42.83	260.05	3,577.61	131.35	882.35	46,660.58
2005-06	37.73	238.87	3,160.52	124.49	850.05	41,220.71
2006-07	32.97	218.63	2,558.64	114.00	823.60	33,370.76
2007-08	30.09	203.37	2,275.63	104.26	776.89	29,679.66
2008-09	27.40	184.70	2,567.31	98.56	762.46	33,483.88
2009-10	24.87	163.30	2,698.47	90.98	780.67	35,194.53

Source: Author's calculations based on Singh, A., 2010 and tables 3, 4, 5, 6 and 8

Emissions from various transport modes

The emissions follow the pattern of energy consumption. Table 10 shows the calculations of Green House Gases (GHG) emission in CO_2 equivalent for every PKM and Tonne Km for all the three modes of transport. From the calculations, it is found that the Equivalent CO_2 emission is the lowest for rail mode, distantly followed by road and very high for air. The CO_2 equivalent emission per PKM for road is at least four times that of rail and the same for air is almost 60 times that of rail. The CO_2 equivalent emission per Tonne Km for air is at least 60 times that of rail and the same for air is almost 240 times that of rail.

Table 10 – GHG Emissions in CO_2 equivalent for various modes of transport

	Total Emissions in thousand tonnes			Emissions in kg per PKM			Emissions in Kg per Tonne Km		
Year	Rail	Road	Air	Rail	Road	Air	Rail	Road	Air
2000-01	5,991.28	95,778.48	5,864.88	0.004	0.027	0.265	0.013	0.087	3.457
2001-02	6,010.53	100,105.26	6,463.83	0.004	0.024	0.281	0.012	0.083	3.663
2002-03	6,029.85	104,627.49	7,123.95	0.004	0.023	0.282	0.012	0.077	3.677
2003-04	6,049.23	109,354.02	7,851.48	0.004	0.022	0.284	0.011	0.077	3.700
2004-05	6,068.68	114,294.07	8,653.32	0.003	0.020	0.278	0.010	0.074	3.623
2005-06	6,088.18	119,457.29	9,537.04	0.003	0.019	0.247	0.010	0.071	3.219
2006-07	6,844.64	123,554.00	10,210.90	0.003	0.017	0.195	0.010	0.068	2.547
2007-08	7,151.96	129,101.57	10,669.37	0.003	0.016	0.166	0.010	0.065	2.160
2008-09	7,473.09	134,898.24	11,148.42	0.003	0.015	0.178	0.010	0.064	2.325
2009-10	7,808.63	140,955.17	11,648.99	0.003	0.013	0.179	0.009	0.066	2.330

Source: Author's calculations based on MoEF, 2010 and tables 3, 4, 5 and 6

REASONS FOR DECLINING SHARE OF RAIL

The analysis of transport data in India between 2000 and 2010 confirmed the well established fact that Rail is the cost effective, energy efficient and environmental friendly transport system. Railways can carry large volumes of both passenger and freight traffic than road and air and given the ever increasing population, railways should be the most preferred mode of transport in future. But the performance of Indian Railways in terms of retaining market share has been very poor compared to road and air.

The share of rail in carrying freight did not decrease much in the last 10 years as much as it declined in the previous decades. It remained at about 39%. However, this is not a testimony to state that railways managed to stop its decline in freight traffic. This is because, the contribution of railways has been confined mainly to low priced bulk items like coal, ore to steel plants, etc. (Railway Board, 2006). Of the railways freight traffic in 2008-09, 88% was accounted for by eight bulk commodities. The share of non-bulk traffic was a meagre 12% of the total traffic. This clearly shows that railways failed to capture the increase in freight traffic in medium value and high value goods, arising out of an impressive economic growth in the last ten years.

The unabated decline in Railways' share in passenger traffic from 1950 onwards has not been arrested even once by Indian Railways. This anomaly has been happening in spite of subsidized fares for about 90% of the commuters. As a result, the share of railways in passenger traffic has reduced from 74% in 1950-51 to 12% in 2009-10. The reasons for the trend described above may be attributed as follows:

No capacity augmentation of railway infrastructure

Railways did not augment its capacity in the last 60 years to cater to the increasing passenger and freight traffic. In the last 60 years, the route length of railways increased by 6.57% and its running track length increased by 18.73%.

Monopolistic business pattern of Railways

In a competitive environment, there would be a natural incentive to improve business practices. Indian Railways being a monopolistic organization does not have that initiative. The facade of a Government organization following socialistic objectives has also hindered railways from competing with road and air modes head on. Although Indian Railways introduced good number of schemes for private participation, still it is too little to change its monopolistic character. Initiatives like Roll-On Roll-Off (RORO) of Konkan Railways Corporation (a part of Indian Railways) that capitalises on synergic effect of multimodal transport system are far and few.

Poor Private participation

India's success story in some infrastructure sectors like Telecom, Ports and Airports may be mainly attributed to the private participation. The private investment in railways is abysmally low at 4% as shown in Table 11 (Haldea, 2011). With little or no private participation unlike other infrastructure sectors like telecom, roads, airports and air services, railways failed to incorporate efficiency, best business practices and technological inputs of private players by adopting some form of Public Private Partnership, except for some schemes like Own Your Wagon. The barriers for private entry in the development of railways remain high. Railways is yet to develop a strong and robust framework for Public Private Partnership (PPP) for its various core functions. Even, the concept of involving private players in the maintenance of railway stations has not taken off so far in a big way.

Table 11 - Share of private investment in different sectors in 11th five year plan

Sector	Electricity	Telecom	Roads	Railways	Ports	Airports
Share of private investment	44%	82%	16%	4%	80%	64%

Source: Haldea, 2011

Cross subsidization

High pricing of freight transport and subsidy for passenger transport has been a major economic distortion in Indian Railways. Railways has even admitted to the same in the white paper they published in 2009. The data for 2008-09 indicates that the average earnings per PKM was 26.09 paise; whereas the average earnings per Tonne Km was 93.84 paise (MoR, 2011). On a larger note, one third of Indian Railways revenues come from passenger trains, which form two thirds of its operations and vice versa. Railways also have cross subsidization within the passenger services segment. For instance, the average earning per PKM for non-suburban upper segment services (primarily air-conditioned) was 106.25 paise, while the corresponding data for second class (mail and express services including sleeper) was 27.09 paise. Highly subsidised suburban transport is another concern. 90% of non-suburban passengers are low-fare paying second class unreserved travellers where even the basic costs are not recovered (MoR, 2009).

Lack of aggression in business development

Both Indian Railways and Chinese Railways (CR) carried almost the same volume of Passenger Traffic both in 1992 as well as 2002. However, in freight traffic, the volume carried by CR is four and a half times that of India. They achieved these results through efficient exploitation of track, locomotives and wagons, and by assigning lower priority to passenger services. China has a larger proportion of double lines and has adopted automatic signalling more aggressively than India. As a result, CR operates roughly twice the number of trains on electrified double line tracks than the Indian Railways. Chinese Railways have planned for an investment of US $ 200 billion from 2004 to 2020, basically aimed at network expansion, doubling and creation of dedicated Passenger and Freight Corridors (Ram & Singh, n.d.) whereas Indian Railways does not have any such ambitious programmes.

Competition from the road sector

70,548 Km of National Highways carry almost 40% of the total traffic, although this constituted 2% of total road network. To strengthen and expand national highways, Government of India has announced seven phases of NHDP programme. The first two phases were aimed at strengthening Golden Quadrilateral (GQ) and North- South and East – West corridors. So, far, more than 13000 Km of national highways have been four laned and most of them belong to GQ and NS-EW corridor. The private participation has become a norm rather exception in roads development. The fact that 150 projects were given on PPP in the last three years is a testimony to this. These developments coupled with the other benefits that the road transport offers shifted the focus towards roads.

The number of registered vehicles has increased from 1,865,315 in 1970-71 to 89,618,267 in 2005-06, a 48 fold increase. The CAGR of all the registered vehicles has been at about 11.70%. The increase has been stupendous across all types of vehicles that are used for passenger traffic and freight traffic especially personal transport vehicles and trucks.

Competition from low cost airlines

With the onset of low cost airlines with rates comparable to that of rail fares of AC coaches for the corresponding routes. Taking into account the time lost, the air fare actually works out to be cheaper for people who are in the higher income group. This had hit railways hard as shown in Table 12. The growth of air traffic in the last decade is mainly due to entry of with many low cost private players in airline operations and development of both Greenfield airports and expansion of existing airports in major cities.

Table 12 - Segment wise analysis of Passenger Traffic

	Passengers 2001-02 (Million)	Passengers 2005-06 (Million)	Difference in Passengers	% change	PKM 2001-02	PKM 2005-06	Difference in PKM	% Change
Suburban								
1st Class	177.0	195.9	18.9	10.7	5,320	6,460	1,140	21.4
2nd Class	2,821.9	3,133.3	311.4	11.0	87,548	99,959	12,411	14.2
Non suburban								
1 AC	0.8	1.1	0.3	37.5	750	568	182(-)	24.3(-)
AC 2T	12.7	12.0	0.7(-)	5.5(-)	9,908	8,135	1,770(-)	17.9(-)
AC 3T	12.9	20.6	7.7	59.7	11,022	12,704	1,682	15.3
1st Class	6.6	6.2	0.4(-)	6.1(-)	1,950	1,905	45(-)	2.3(-)
AC Chair car	7.8	9.4	1.6	20.5	4,208	4,199	9(-)	0.2(-)
Sleeper								
Mail/Express	156.1	177.2	21.1	13.5	117,304	120,092	2,788	2.4
Ordinary	4.5	5.8	1.3	28.9	1,739	1,854	115	6.6
2ndClass								
Mail/Express	335.1	485.0	149.9	44.7	117,137	170,556	53,419	45.6
Ordinary	1,557.3	1,678.0	120.7	7.8	136,602	189,112	52,510	38.4
Grand Total	5,092.7	5,724.5	631.8	12.4	493,488	615,544	122,056	24.7

Source: CMIE, 2011

Failure to assess and act on commuters' need

In suburban rail systems, there was a substantial increase of 21% in first class and 14% in second class in passenger traffic between 2001-02 and 2005-06. On the other hand, there was a reduction in PKM for non suburban trains (long distance express trains), especially in first AC and two tier AC. This indicates that high class long distance passengers deserted trains in favour of flights. Again there was a substantial increase in second class (unreserved) PKM, which may have been due to subsidised passenger fares. The substantial increase in PKM for sub urban rail system, especially in first class, indicates that in spite of preference for personalised transport, if comfortable and speedy sub urban rail services are provided, passengers would be more than willing to shift to rail mode.

Lack of Synergy between transport modes

Road is the last mile for most of the freight traffic. The share of railways in freight traffic has reduced since freight cannot be switched easily from one mode to another mode. Unlike goods movement by truck, railways has not ensured quality of service in terms of reduced transit time, efficient handling at terminals, scheduled services, reliability, safety and security of goods and facility for storage and easy switch to road transport, etc.

Development of one particular mode of transport cannot happen in isolation. There is a need to integrate this with other modes for the transport sector to flourish. This also shows there is an urgent need to redraft the national transport policy and revamp the existing transport setup.

POLICY PRESCRIPTIONS

A study conducted in Stanford University revealed that when per capita GDP in the U.S. hit $37,000 passenger travel stopped growing. In other developed countries like Canada, Sweden, France, Germany, UK, Japan and Australia also, passenger travel levelled out at a per capita GDP of $ 25,000 to $ 30000 (Burns, 2011). But, India is in the growth phase of the trajectory of per capita mobility (travel) unlike the developed countries which have already reached the saturation phase of the S curve of per capita mobility. Some estimates show that the road based per capita passenger mobility will enter the saturation phase by 2040-41 (Singh, S. K., 2006). As India is expected to grow till 2060-61 as indicated by various reports like the corresponding development of transport infrastructure would have to happen in the same period. Hence, there exists scope for change in transport pattern since the behaviour lock-in of commuters has not set in substantially.

The policy prescriptions for energy efficient and low carbon transport model are to be seen first at the macro level and then at the sectoral level because if policy prescriptions for every sector emanate from the macro level policy prescriptions it would provide better synergy.

Macro level policy prescriptions

Transport System as a monolith

There should be a larger transport policy that includes both freight and passenger transport for long, medium and short distance transport needs. For this to happen, the policy makers should view the transport system as a monolith. All the modes of transport and other aspects of public goods should work in tandem. For example, if a city adopts a mass rapid transit system, to get enough patronage, other factors like urban land use pattern, accessibility, feeder networks, law and order, etc., would also have to be considered holistically. Such synergy would provide a level playing field for all players to maximise the benefits they offer to the society.

Integrated Group of Transport Ministries

An integrated group of transport ministries can be constituted under the chairmanship of the Prime minister or a high ranked Cabinet minister or Deputy Chairman of Planning Commission to chart out the national transport policy and make necessary changes whenever required and follow up on the progress of the policy. The ministers and secretaries of all the transport ministries and representatives from some other key ministries like Ministry of Finance should be members in the Group. In addition to devising the integrated transport policy the group can also meet at regular intervals to take stock of the situation and make necessary policy changes so that the development of transport infrastructure goes unhindered and projects are executed on time.

Internalise the externalities

The externalities, both positive and negative, are to be internalised in the cost of transport. This would enable users and polluters to pay for the externalities they create for the society. Apart from environmental concern, the externalities arising from the safety of the transport mode should also be incorporated in the internalisation of the transport costs. The Rail mode has been doing far better than roads in terms of safety. The number of people who die on roads for every PKM and Tonne KM of transport is much higher for road than for rail. Internalising the cost of externalities in the transport charges would give a level playing field for all the transport modes and allow the transport users to choose the modes that provide less negative externalities

Large scale adoption of Public Private Partnership (PPP)

By theory, transport systems are public goods, characterised by non rivalry and non excludability. For the government, investing huge sums in transport infrastructure means heavy taxation across the board, which results in severe economic distortion. Allowing private players to invest in transport infrastructure, entities and systems and collect toll from the users of the service would reduce the distortion greatly. Moreover, PPP would bring in

some of the best practices of the industry as there will be competition among private players for providing better services to the customers. Although PPP projects have been awarded in the last decade for a large number of road projects (around 150) and four big airports, it has to be adopted by railways also. Like the government policy on roads, where the projects are first tried out in PPP BOT[3] model first, the integrated transport policy should prescribe PPP BOT as the first model to be tried out for any developmental project.

Sector specific reforms

Railways

In spite of the fact that rail is the cost effective, energy efficient, safe and friendly to environment, the trend of railways playing second fiddle to roads for more than three decades in both passenger and freight traffic has come out very clearly in our analysis. The transport policy should aim at a modal shift towards rail from road. The cost of freight transport by road increases substantially, when the distance exceed 1000 Km (Mc Kinsey & Company, n.d.) whereas rail is cost effective. The transport policy should fix a time frame for the change in modal shift with a blue print aiming at 60 to 70% modal share for railways, in both passenger traffic and freight traffic.

Railways has witnessed continuous loss in its share of transport for more than three decades. The decay that is already set in railways cannot be reversed unless there is a paradigm shift in the approach towards development. Even the latest White paper published by Railway Board in December 2009 did not think on the lines of paradigm shift.

To set it right, the first and foremost task before railways is large scale capacity augmentation supplemented by improved operational efficiency. This can be achieved by unbundling various functions and bringing in private players except on few key segments. Railways have enough models to emulate in this regard. Ministry of Civil Aviation (MOCA) has successfully demarcated the areas of operation between private players and government bodies. For instance, MOCA retained some specific and crucial functions under the control of government agencies and opened up all other operations to private players. Air Traffic control and Security are the major functions that are now under the fold of government agencies. Ministry of Road Transport and Highways along with NHAI and Planning Commission have developed strong framework for PPP. The four laning of GQ which started in the late nineties is nearly complete now and poised for six laning through Build Own and Operate (BOT) mode. Taking cue from these success stories, railways should develop well balanced and investor friendly framework for its PPP.

The next task is to stop cross subsidising. Like the power and telecom sectors where there is a regulatory authority, there should also be an independent Regulatory Authority for Railways not only to fix the tariff rates in proportion to the cost of service, but also for dispute resolution issues that may arise after the introducing private players. Stopping cross subsidization

[3] Build Operate Transfer

would also boost the financial health of railways and make it competitive in the transport sector. The fourth task is to withdraw from doing allied activities like running hospitals and schools and remain focussed on core activities of passenger and freight traffic.

In order to increase freight operations, along with the existing schemes for private participation, the private players may be allowed in day to day operations of railways. With no competition in place, railways lack the vibrancy that is needed for a transport operator. The private players may be permitted to ply trains and construct and operate freight terminals with storage facilities that will act like intermodal transport hubs. Railways lost an opportunity to try out PPP, when the Western Dedicated Freight Corridor that was initially planned as a PPP project, was later converted as the project for a subsidiary of Indian Railways. To bring about a paradigm shift in the functioning of railways, the Railway Board has to be constituted with people who are expert in business reforms, transport operations, PPP, etc. At present, the members comprise just senior Indian Railways officers. Unless fresh lease of air is allowed, new thoughts and new ideas cannot emerge and evolve.

Introduction of Mass Rapid Transport (MRT)

Mass Rapid Transport either by rail or road is cost effective, energy efficient, safe and friendly to environment. Fast, comfortable, safe and commuter friendly mass transport system will go a long way in inducing passengers to move from private transport to public transport both for long distance travel and every day local trips. The cities which have more than 5 million population should have more than one MRT system. The transport policy should prescribe development of MRT (by road or rail or both) for the cities of than having one million population.

Seamless Multi modal transport system

The value of every mode has to be based on its effectiveness in its interoperability with other modes of transport. For instance, the commuter should be able to pay the travel fare for MRT and other modes as well as parking charges with a single card. When Metro is introduced in a city, the metro stations have to be well connected by other modes of transport. The AC Volvo bus facility from Bangalore International Airport to different places of Bangalore by Bangalore Metropolitan Transport Corporation and the metro rail connectivity between New Delhi and T3 terminal of New Delhi Indira Gandhi International Airport are good examples of seamless multimodal transport system. This should be made mandatory at the approval stage itself.

Non motorised transport

It has been found that walk trips form a significant portion of local travel trips. There were many instances of people using cycles in large scale for their daily trips. Commuters in Ahmedabad and Coimbatore used cycles extensively for their daily activities even a decade back. The ‘Right To Walk’ and ‘Right to Cycle’ are not just slogans but play a vital role in the

development of cost effective, safe, energy efficient, environment friendly transport systems. Although, the successive road policies of government have been insisting on allocation of specific resources (25%) for creating facilities for non motorised transport, it is not implemented in letter and spirit in all the projects. The needs of the people opting for non motorized transport have to be accommodated while devising transport projects.

Road transport

Roads are and will remain the last mile of any transport system. Hence the development of roads complements and synergises other modes of transport. In spite of the fact that road transport is less energy efficient than rail, as a whole, for distances less than 1000 Km, road transport is little more economical than rail, if all functions of transportations are factored in (Mc Kinsey & Company, n.d.). So, the road sector is never going to lose its status as a preferred mode of transport for short distances and as the last mile connectivity.

The Result Framework Document (RFD) of Ministry of Road Transport and Highways for the year 2010-11 has mentioned their vision as “Enabling India to have sustainable, efficient, safe and internationally comparable quality of road infrastructure to achieve enhanced connectivity and mobility to a level which accelerates socio-economic development” (MoRTH, n.d.). With success in developing physical infrastructure, the focus should be on improving the soft aspects of road transport that will improve the average speed of vehicle and reduce accidents. The average speed of trucks on Indian roads is about 20 Km/ hour. So, a truck in India can cover only 250-300 Km a day compared to 700-800 Km in developed countries such as the US and Europe. Owing to poor road conditions and check-post delays, trucks in India travel for 20 days a month on an average compared to 25 days in developing countries (TCI–IIMC report, 2007). With improved physical infrastructure, the attention has to be shifted for free flow of traffic by introducing electronic tolling at toll booths and IT supported verifications of documents.

The other major concern of road transport is accidents. There are no palpable actions to reduce accidents and improve road discipline. India has become the capital of road accidents and deaths. Around 1.20 lakhs people die on roads each year. Mortality rate per 10,000 vehicles is 14 in India (2004) and 16 (2007) compared with less than two for developed countries (MoF, 2010). Invariably, the fault of driver is the cause of accident in 75% of the cases (PC, 2011c) and bad road constitutes only 1% to 2%. Actions to reduce road accidents and ameliorate the conditions under which drivers and crews operate on Indian roads have to be introduced. The objective should be to provide develop strong and water-tight measures for licensing, legal framework for monitoring and punishing violation of traffic rules, vehicle overloading, and automated check for drunken and reckless driving, facilities like paid rest rooms for drivers and safe parking space for vehicles.

The Regional transport Offices have to be computerised and linked so that data on vehicles are available at every check post and tolling booth. This would not only improve the efficiency or road usage but also help the police personnel to check crimes.

Air transport

For distances more than 800 kms, air travel would be preferred as the time difference between air and train travel would be substantial. India is still in the nascent stage of air traffic and hence it should be allowed to grow till it peaks and stabilizes. The PPP initiative in airport development has worked really well. The measures that could augment air traffic in the coming decades are as follows:

- Private players have been allowed to construct and maintain airports only in some cities. They should be involved in the development in small airports also.
- Customer friendly policies have to be devised to protect the customers from unscrupulous practices of private airlines
- With so many private operators functioning more efficiently, it is unnecessary to have a national carrier which is more of a liability with mounting losses. Air India can therefore be disinvested.

CONCLUSION

Railways have been found to be the most cost effective, energy efficient and sustainable mode of transport. But improvements in the rail sector have been sporadic and ineffective so far given the increased transport requirements of a growing India. India has a wonderful opportunity to develop energy efficient, environment friendly and sustainable transport systems because Indian transport systems have not been developed fully. A transport policy that looks at the demand and supply of various transport modes holistically is the need of the hour. The policy prescriptions mentioned herein aid in developing such an integrated transport policy.

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