

# Green Growth and Transport in India

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# 1. Background

Good transport infrastructure is essential for socio-economic development of a country. India's transport network is vast and diverse comprising an extensive road network of 3,329,105 kilometers and 65,808 route kilometers of rail network geographically connecting the country along its length as well as breadth. India also has an established aviation industry with international and domestic airline services currently being provided through 11 international airports and 89 domestic airports. India's huge coastline of 7,517 km also provides significant opportunities for water based transportation services through a total of 12 major and 200 non major ports<sup>1</sup> and 14,500 km of navigable inland waterways set up along the coastline.

The transport sector in India has grown extensively, especially post-independence, both in terms of physical spread as well as capacity to meet the mobility demands for both passengers as well as freight. Despite its impressive growth, it is seen that the existing transport infrastructure in India is far from meeting the growing mobility needs in terms of coverage, capacity as well as service quality. In fact, the current transport growth trajectory has brought along several negative externalities in terms of increasing congestion, increasing emissions and depleting air quality, rising health related risks, increase in deaths due to road accidents, increasing dependency on fossil fuels and an overall depleting quality of life. The capacity for carrying freight traffic also falls short in view of rising demand and has resulted in increased logistics costs. In a developing country like India, these risks are further exacerbated in light of other development challenges such as rapid population growth, inequality and poverty, high unemployment rate, lack of basic infrastructure facilities, poor access to services, etc. If the business as usual continues, the situation is further expected to worsen raising serious concerns for the country particularly in terms of national energy security (in view of increasing dependence on oil imports). In view of the current transport trajectory that has also brought along significant costs to society, economy as well as environment, a pressing need is felt for a paradigm shift from our present approach to a more sustainable development approach that promotes overall 'green growth' of the transport sector and a green economy in the long run.

UNEP defines a green economy as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive (UNEP, 2011). In our endeavor to develop a future road map for green growth of the transport sector in India, this chapter discusses in detail the key trends of the transport sector in India, the key issues and challenges faced by the sector that limits its growth and also makes recommendations to push the sector on a green development path.

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<sup>1</sup> Major Ports are under the administrative control of Government of India while the Non-major ports are governed by the respective Maritime State Governments.

## 2. Transport sector in India – An overview

The transport sector in India today faces an onerous task of meeting the mobility demands of a population of more than 1.2 billion people spread over an area of 3.3 million square kilometers (Census 2011). For better understanding, the transport sector can be divided into five major sub sectors namely railways, roads, ports and shipping, civil aviation and urban transport. The trajectory in the transport sector suggests the increasing dominance of the road sector in meeting the growing mobility demand with a gradual decline in the railway shares over the years. The next sections would discuss in detail the key trends in each of these sub-sectors and the issues faced by them that act as a hindrance to the overall green growth of the transport sector.

### 2.1 Railways

Indian Railways (IR) is the fourth largest railway network in the world in terms of route kilometers (Twelfth Five Year Plan (2012-17), 2013). With a fleet size of 63,870 passenger service vehicles, 244,731 wagons, and 9956 locomotives, IR carries about 8421million originating passengers and 1014.5MT of originating freight through 7547 stations (TEDDY , 2015).

#### 2.1.1 Rail network

As on 31<sup>st</sup> March 2014, IR had a total network of 65,808 route kilometers<sup>2</sup>. About 32.8% of the total rail network, equivalent to 21,618 route kilometers, is electrified. In terms of route density, Indian Railways stands at 20 route kilometers per 1000 sq. km of area and 5.44 route km per lakh population (MoR 2015a). Considering that only 12,212 km of new lines have been added to the network since independence, the expansion of the rail network in the country has been slow in contrast to the rapidly increasing mobility needs in the country.

As of March 2014, the total track length of the network is 1.16 lakh kilometers<sup>3</sup>, of which 88.4 percent of the total rail network is broad gauge (BG), followed by another 8.1percent metre gauge (MG) and 3.4 percent narrow gauge (NG) (MoR 2015a). However, IR are now increasingly becoming uni-gauge by converting MG and NG to BG. Table 1 below gives the length of traction (in km) by gauge.

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<sup>2</sup> For details, please refer to [http://www.indianrailways.gov.in/railwayboard/view\\_section.jsp?lang=0&id=0,1,304,366,554,1554,1555](http://www.indianrailways.gov.in/railwayboard/view_section.jsp?lang=0&id=0,1,304,366,554,1554,1555)

<sup>3</sup> For details, please refer to [http://www.indianrailways.gov.in/railwayboard/view\\_section.jsp?lang=0&id=0,1,304,366,554,1554,1555](http://www.indianrailways.gov.in/railwayboard/view_section.jsp?lang=0&id=0,1,304,366,554,1554,1555)



**Table 1:** Length of traction (in km) of railways by gauge

Gauge	Route Kms.	Running track Kms.	Total Track Kms.
Broad gauge (1676 mm)	58,177	81,914	1,07,513
Metre gauge (1000 mm)	5,334	5,708	6,688
Narrow gauge (762 mm & 610 mm)	2,297	2,297	2,564
<b>Total</b>	<b>65,808</b>	<b>89,919</b>	<b>1,16,765</b>

**Source:** MoR, 2015a

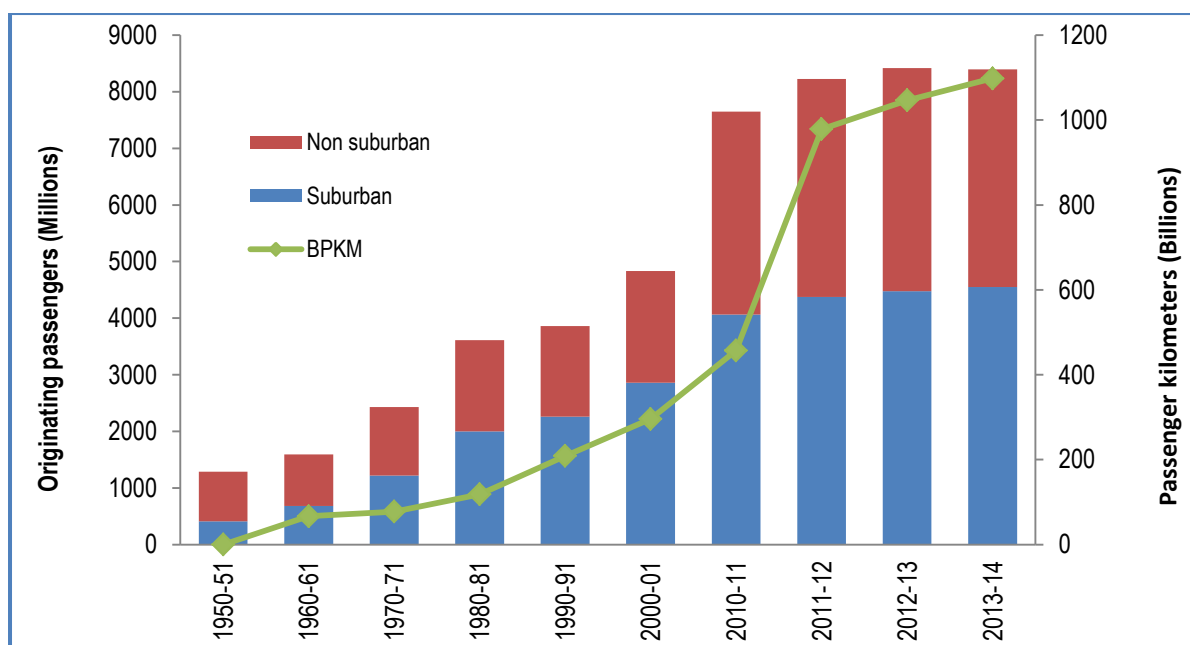
IR is the topmost rail passenger carrier (in terms of passenger km) and the fourth largest rail freight carrier in the world (NTDPC, 2014). However, the traffic flows on the network are uneven and not balanced. As of March 2011, the BG network generated almost 98 percent of the passenger output (PKMs) and 99.9% of the freight output (NTKMs). The Golden Quadrilateral and the diagonals connecting the four major metros, viz., Delhi, Kolkata, Chennai and Mumbai (along with the East-West diagonal extending to Guwahati) constitute less than 16% of the route, but account for more than 50% of the passenger and freight traffic (NTDPC, 2014). Capacity bottlenecks have been one major reason for a steady decline in the railways share in providing passenger and freight mobility over the years.

### 2.1.2 Passenger transport

IR has been the main and preferred mode for long distance travel in the country. With around 12,961 passenger trains running per day<sup>4</sup>, IR plays an important role in providing passenger services to both suburban and non-suburban (intercity/long distance) segments.

*Traffic:* During 2013-14, the railways carried 8,397 million passengers as against 8,421million passengers in 2012-13, registering a slight decrease of about 0.3 percent (MoR, 2015a). Passenger-kilometers grew by 5.5% from 1098.1 billion in 2012-13-12 to 1158.7 billion in 2013-14 (MoR 2015a). Out of the total, suburban traffic constituted nearly 54 % of the total originating passengers in 2013-14. However, in terms of passenger kilometers, suburban traffic accounted for only 14.5 % of the total passenger kilometers in the same year. Figure 1 depicts the increase in passenger traffic output in railways in terms of number of total originating passengers over the years.

<sup>4</sup> For details, please refer to [http://www.indianrailways.gov.in/railwayboard/uploads/directorate/stat\\_econ/IRSP\\_2013-14/pdf/Year\\_Book\\_Eng/2.pdf](http://www.indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/IRSP_2013-14/pdf/Year_Book_Eng/2.pdf)



**Figure 1:** Trend of originating passenger and passenger kilometer growth in railways

**Source:** MoR, 2015b

*Service Quality:* IR services are largely reliable, however the service quality especially in terms of speed, reliability and comfort levels is an area of concern. A host of issues such as inadequate capacity, low average speeds, low level of technology, poor maintenance standards of stations and coaches, and others push away a major potential passenger segment of high income passenger segment. The service quality is also low in comparison to international standards. The maximum permissible speed on IR is only 150 km per hour and the average speed actually achieved is in the range of 60-70 km per hour (NTDPC, 2014). This is much lower than the high speed services (upto 350 km/hr) available in China, Japan, France, Germany and a few other countries.

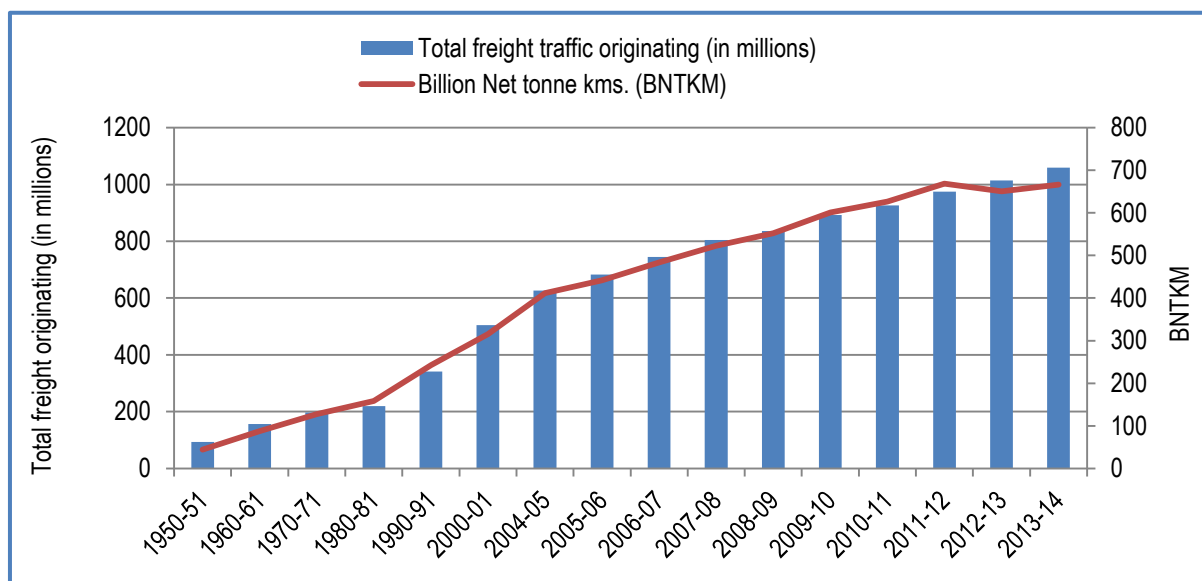
### 2.1.3 Freight transport

Freight trains constitute approximately 40% of the total trains run daily on IR network. As on 31<sup>st</sup> March 2014, IR ran about 8637 goods trains per day carrying about 3 million tonnes per day (MoR 2015a). Bulk cargo dominates the freight basket accounting for over 90 % of the freight traffic on IR. The major freight commodities transported by IR includes coal, cement, fertilizers, steel, iron ore and raw materials for steel plants, foodgrains, petroleum products and container traffic.

The total revenue earning freight tonnage carried by the Indian railways has increased by fourteen times from 73 MT in 1950-51 to 1,051.6 MT<sup>5</sup> in 2013-14 (MoR 2015a). Net tonne kilometers (NTKM) earned in 2013-14 were 665.8 billion. The freight earnings amounted to INR 915.71 billion in the same year (MoR 2015a).

<sup>5</sup> For details, please refer to [http://www.indianrailways.gov.in/railwayboard/uploads/directorate/stat\\_econ/IRSP\\_2013-14/pdf/Year\\_Book\\_Eng/2.pdf](http://www.indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/IRSP_2013-14/pdf/Year_Book_Eng/2.pdf)

Though the traffic has increased over time, the market share of railways has been decreasing gradually. The freight trains use the same tracks and infrastructure as passenger trains, but get lower priority in operations which has adversely affected the service quality of freight operations. The freight rates are also kept high with the idea of cross subsidising the passenger services, making freight services by rail extremely uncompetitive.



**Figure 2:** Trends in total originating freight traffic and net freight tonne kilometers growth in Railways

**Source:** (MoR, 2015b)

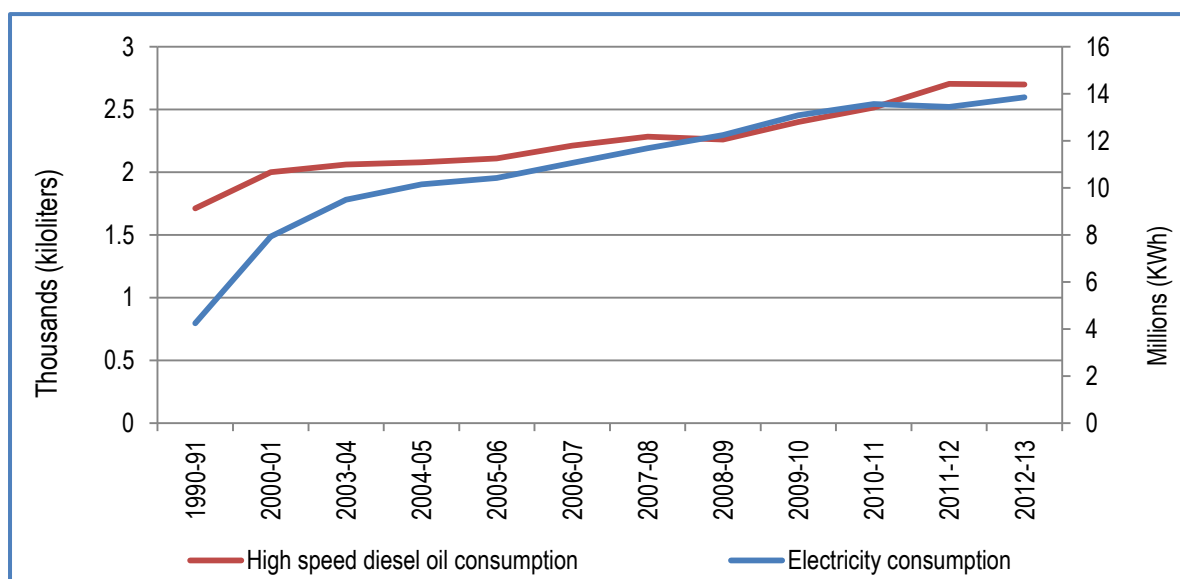
During the Twelfth Five Year Plan (FYP), the rail share in freight is targeted to go up by atleast 2%. However, if the business as usual scenario continues, the share of railways in freight transport is expected to reduce to 25% by 2020 (NTDPC, 2014). Therefore, to facilitate a shift from road to rail would require a major increase in investments and a focused strategy. Lack of adequate investments and intermixing of social and commercial objectives of the railway business have been a major reason for slow growth and declining market shares. The total investment in the railways for the 11<sup>th</sup> FYP stood at INR 2,033 billion, which was INR 299 billion less than the planned outlay at the beginning of the plan. The 12th FYP has projected an investment of INR 5,192 billion in railways between 2012 and 2017.

#### 2.1.4 Fuel consumption and emissions

Rail transport is undeniably much more energy efficient and environment friendly when compared to other modes of transport. As per a study conducted by Asian Institute of Transport Development (AITD) titled Environmental and Social Sustainability of Transport-Comparative Study of Rail and Road (2000), rail consumes 75% to 90% less energy for freight traffic; and 5% to 21% less energy for passenger traffic when compared to road. The social cost therefore, in terms of environmental damage or degradation is significantly lower in rail transportation.

At present, railways are mostly dependent on electricity and high speed diesel (HSD). The consumption of HSD on locomotive services in 2013-14 was 2780.90 million litres, a slight

increase from 2699.62 million litres in 2012-13. The consumption of electricity on locomotive services increased from 13,853 million KWH in 2012-13 to 14411 million KWH in 2013-14. Direct consumption of coal by the railways is almost negligible on account of the phasing out of steam locomotives (MoR 2015a).

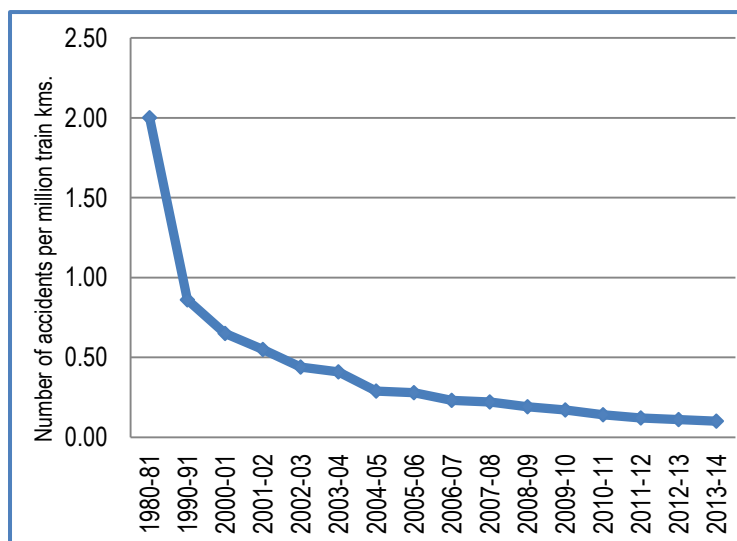


**Figure 2:** Growth in consumption of electricity and HSD by railways for locomotive services  
**Source:** (MoR 2015a)

In terms of emissions, rail transport emits 17 gram CO<sub>2</sub> equivalent per PKM as compared to 84 gram per PKM in case of road transport. Similarly, rail transport emits 28 gram CO<sub>2</sub> equivalent per NTKM as compared to 64 gram per NTKM in case of road transport (NTDPC, 2014). Given the above, it is realized that any shift of traffic from road to rail would lead to substantial savings in terms of energy consumption as well as overall social costs.

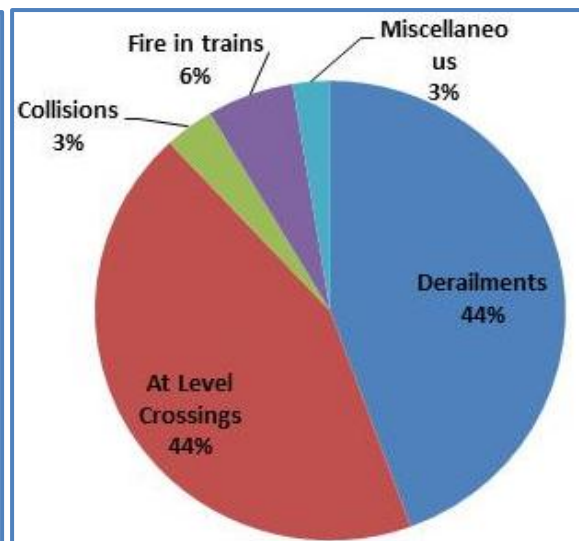
### 2.1.5 Safety performance

Despite increase in traffic volumes for both passenger as well as freight traffic, statistics indicate a gradual decline in the number of train accidents per year. In 2013-14, there were 117 consequential train accidents as compared to 120 in 2012-13. Train accidents per million train kilometres show a decline from 0.11 in 2012-13 to 0.10 in 2013-14 (Figure 4).



**Figure 4:** Trend in incidence of accidents per million train kms

**Source:** MoR (various years)



**Figure 3:** Causes of train accidents in 2013-14

**Source:** MoR, 2015

Roughly 85% of accidents on IR are alleged to be on account of human error or failure (NTDPC, 2014). Statistics indicate that derailments and accidents at level crossings constitute for roughly 90% of the total accidents. Figure 5 shows the causes of accidents in railways in 2013-14. It is important to note that the data maintained in the Railway Board office pertains to only those train accidents with apparent consequences. The casualties due to trespassing of railway track, or for other reasons connected with railway infrastructure and casualties of IR's own staff while on duty, though quite substantial, are not included in the statistics of train accident related casualties (NTDPC, 2014).

The high rate of railway accidents in India can be attributed to multiple discrepancies in the current safety practices caused by poor maintenance of equipment and installations, lack of trained staff, and inability to adapt to new technologies. Lack of adequate infrastructure and paucity of resources further exacerbates the safety performance of IR.

### 2.1.6 Key issues

The current share of railway is neither optimal nor sustainable in the long run. The key issues associated to IR operations that have resulted in low and declining shares of railways in the overall mobility scenario in India are as listed below:

- **Slow expansion of rail network:** In view of the country's size and requirements of a growing economy, the growth in railways has been extremely slow and inadequate (Twelfth Five Year Plan (2012-17)). There is also little presence of railways in hilly regions and North Eastern (NE) states in India, making access to railways a major concern in these areas.
- **Capacity constraints:** There is a huge imbalance in the pattern of train operations with infrastructural and capacity constraints faced by the core network. Though gauge

conversion of the existing lines (from meter and narrow gauges to broad gauge) has helped in adding capacity to the system, however, there is still a need to address the infrastructural and carrying capacity needs of the IR network that have surfaced in the recent years.

- **Inadequate and unplanned investments:** The slow progress and declining shares of railways in the overall transport system in India is largely a result of poor unplanned investments in the sector, especially in the last decade wherein, huge investments were directed to the road sector. Focussed investments in the sector therefore needs to be prioritised especially targeting towards capacity creation.
- **Social versus commercial objectives:** IR has a very thin and limied pool of available funds. Intermingling and imbalance in social and commercial objectives of the business have resulted in uncertainty in terms of creating capacity to enhance business or meeting travel demand. For long term sustainability of IR, striking a balance between the two is important.
- **Poor quality of services:** Presently the service quality of IR is low. With increasing incomes, passenger traffic is expected to increase and so will the demand for better quality services (Twelfth Five Year Plan (2012-17), 2013). A need is felt to enhance the speed of the railway services and introduce tailored services to cater to the needs of different sectors and passenger classes wherever required.
- **Inefficiencies in operations:** Not much attention has been paid to the last mile linkages or connectivity to other modes which has implications in terms of increased cost especially in case of frieght business. Significant improvements are required in improving the operational efficiency of the railways which would require measures like extensive modernisation, increase in service speeds, use of information technology, etc.
- **Distortions in tariff structure:** Despite the monopolistic operations, IR faces significant financial losses. Being a public good, the passenger fares in railways are kept low and freight fares are comparatively much higher so as to cross-subsidise the low passenger tariffs. High cost of freight mobility is a major issue for the declining shares of freight in the sector.
- **Safety concerns:** The present safety environment on IR is largely inadequate. As discussed earlier, though the number of train accidents per year have shown a gradual decline over the years but the total number of casualties in railways is still high.

## 2.2 Roads

Roads and road transport forms the backbone of the transport sector in India for both passenger as well as freight mobility. In 2011-12, road transport alone accounted for 4.8% share in India's GDP (Singh, 2014).

### 2.2.1 Road network

India has the second largest road network of 3.33 million kilometers in the world, comprising national highways, expressways, state highways, major district roads, other district roads and village roads. The share of the road sector in total transport by road and

rail has been estimated to be 64.5% of freight and 85.9% of passenger movement in 2011-12, as compared to 13.8% freight and 15.4% of passenger movement in 1950-51 (TERI, 2015).

**Table 2:** Type and length of different road categories in India (2014)

Road type	Length of road (km)
National Highways (including Expressways)	79,443
State Highways	131,899
Major District Roads	467,763
Rural and Other roads	2,650,000
<b>Total</b>	<b>3,329,105</b>

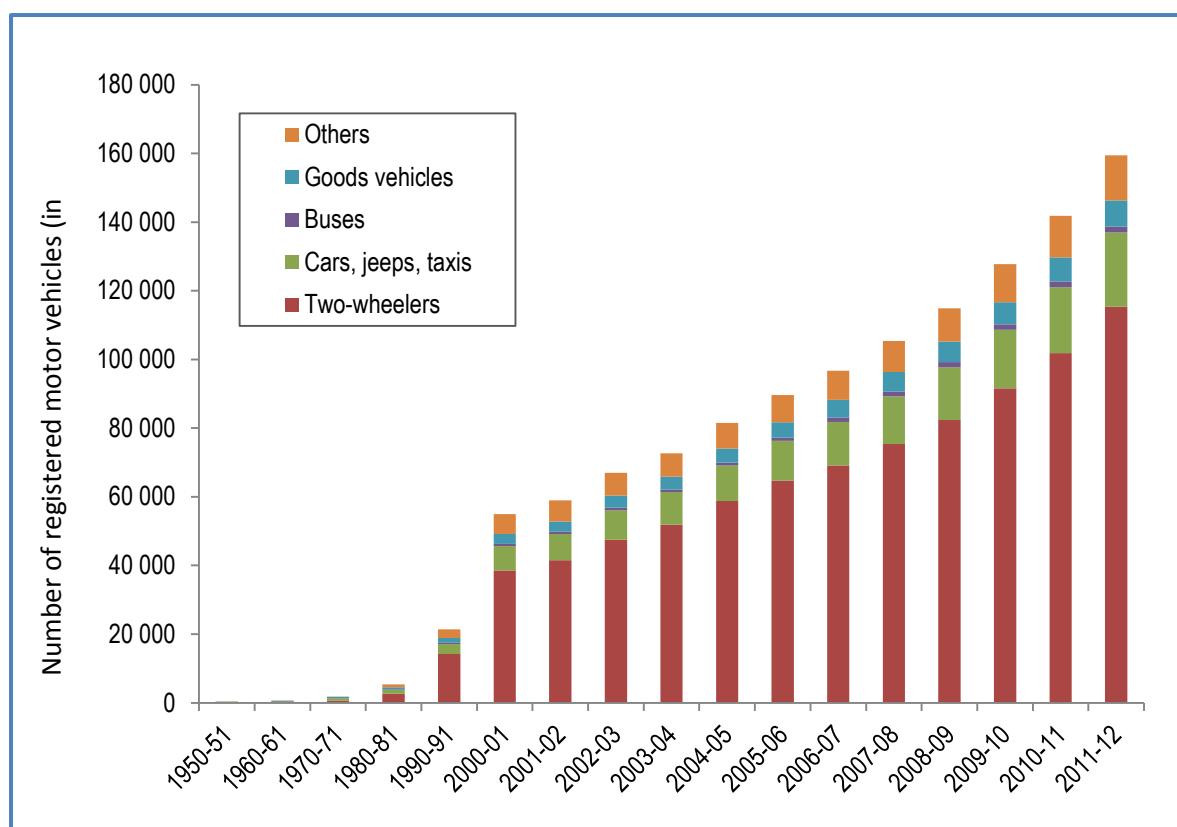
Source: NHAI, 2014

National highways and expressways together constitute only about 2.8% of the total road network in the country but carry about 40% of the total road traffic (NHAI, 2014). During the 11th FYP, a total of 9,044 km of national highways was completed under the National Highway Development Plan (NHDP). The National Highways Authority of India (NHAI) aims to reach a total national highway network length of 85,000 km by end of the 12th FYP period. This includes planned development of 1,000 km of expressways under NHDP Phase IV and another 500 km of expressways (with 200 km through budgetary allotments and 300 km through PPP mode) (MoRTH 2013a). The Government of India launched the Pradhan Mantri Gram Sadak Yojana (PMGSY) on 25 December 2000 as a 100% centrally sponsored scheme, with the objective of strengthening the rural road network. In 2011-12, more than 4,500 habitations were connected and nearly 9,150 kms of road length upgraded/renewed (TERI, 2015).

### 2.2.2 Vehicle growth and composition

The total number of registered motor vehicles in India has increased from 0.3 million as on 31st March, 1951 to about 159.5 million as on 31st March, 2012 (Figure 6). The total registered vehicles in the country grew at a Compound Annual Growth Rate (CAGR) of 9.9% between 2001 and 2011 (MoRTH 2013a). In the business as usual scenario, the total fleet size is further expected to increase to about 400 million by 2030 (ICAMP, 2014). This growth will further worsen the traffic situation in the country and aggravate the related problems of increasing pollution levels, traffic jams, and vehicular emissions; having impact on the health and quality of life.





**Figure 4:** Growth in the total registered motor vehicles in India (1951-2012)

**Source:** MoRTH, 2013a

The vehicle composition is primarily dominated by personalized modes (mainly two wheelers and cars) which account for nearly 86 percent of the total number of motor vehicles in the country. Two-wheelers alone accounted for 72 percent in the total vehicle population, followed by passenger cars at 13.5%, buses at 1.05%, goods vehicles at 4.8% and other vehicles (a heterogeneous category that includes three-wheelers, trailers, and tractors) at about 8.25%, as on 31st March 2012. Number of registered vehicles in five metropolitan cities, namely, Delhi, Bengaluru, Chennai, Hyderabad and Pune accounted for 49.3% of the total registered vehicles among the 35 million plus cities (MoRTH 2013a).

### 2.2.3 Passenger transport

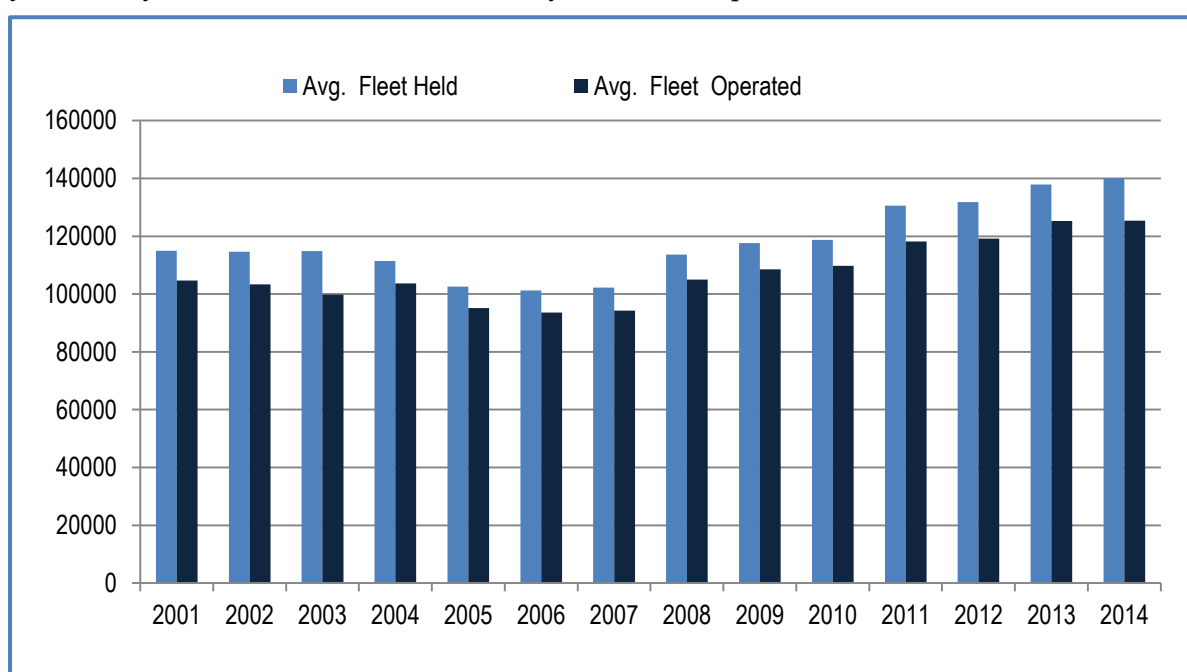
#### Interstate and intercity Public Transport (PT) services

At present, State Transport Undertaking (STU's) are primarily responsible for provision of interstate and intercity public transport services, in the form of bus services. Apart from the government run public buses, private run services also play a significant role in meeting the mobility needs in urban as rural India. These include various modes like buses, minibuses, low capacity vehicles like auto rickshaws, tempos, jeeps, etc.

While personal vehicles have shown a phenomenal increase, the percent share of buses in the total number of registered vehicles has declined from 11.1 percent in 1951 to 1.1% in 2011-12, indicating slow growth (MoRTH 2013a).



*Government run buses:* In India, the share of buses held by STU's in terms of total registered vehicles has decreased over years. The number of buses both held and operated by STU's have however shown an increase post the launch of Jawaharlal Nehru National Urban Renewal Mission (JnNURM) in December 2005, a Government of India scheme providing financial assistance for infrastructure development in cities. As per MoRTH statistics, the total bus fleet held by STU's in India was reported at 1.40 lakh as on 31<sup>st</sup> March 2014 as against 1.02 lakh in 2006, registering an increase of more than 38 % over a period of eight years. Only 89.5 % of the total fleet held by STU's was operated in 2015.



**Figure 5:** Growth in average bus fleet held and operated by STU's per year

**Source:** MoRTH (various years)

Though the number of buses has increased post 2006, a gradual decline in the total number of passengers carried has been observed by the STU's. The total number of passengers carried by the STU's in 2013-14 was 2,51,111 lakh passengers which was 1.6% lower than the number of passengers carried during 2012-13 (MoRTH, 2015).

**Table 3:** A comparison of performance indicators of the STU's in 2013-14 and 2012-13

Performance Indicators	2013-14	2012-13
Fleet Utilisation (%)	89.5	90.8
Average age of fleet (years)	27.56	27.09
Number of accidents	19658	19896
Number of fatal accidents	3793	3891
Revenue earning kilometers (lakhs)	155472	160001
Vehicle productivity (Kms/ staff/ day)	304.1	317.8
Average fuel efficiency (Km/ lite of HSD)	4.25	4.28

Most of the STU's face extreme financial losses further leading to operational inefficiencies and poor service quality. In 2013-14, the STU's earned a total revenue of INR 45,21,539 lakhs and incurred a total cost of INR 54,94,750 lakhs which resulted in a net loss of INR 9,73,211 lakhs. The net loss increased by 27% during 2013-14, over last year i.e. 2012-13 (MoRTH, 2015). Increasing passenger fares is not seen as a viable solution as PT is mostly looked upon as a social obligation by the government.

#### 2.2.4 Freight transport

As of 2011-12, road transport holds 69% share of the total freight traffic in the country. In the BAU scenario, it is estimated that the share of road in total freight traffic would decline to 65% in 2016-17 and then further to 55 % in 2021-22 and 50% in 2031-32 (NTDPC, 2014).

Road based freight mobility in India is mainly driven by the agricultural and industrial sector of the economy. Light and Heavy commercial road vehicles enjoy an advantage over the railways in providing easy last mile connectivity often resulting in cheaper end to end costs. While HCVs are more common for transporting goods for longer distances, LCVs are finding more popularity as a carriage mode for navigating through the compact urban centers and also rural areas.

With growing penetration levels and numbers of LCV's in the Indian market, the total freight moved on LCVs is expected to increase from 112 to 3038 btkm between 2010 and 2050 (TERI, 2010). On the other hand, the freight moved by HCV's is expected to increase from 1189 btkm in 2010 to 3763 btkm by 2020, a growth of over 215 percent in just under a decade (TERI, 2010). Further, it is estimated that by 2050 the total freight moved by HCVs would be 67% of all the freight moved across both road and rail carrying both bulk and non-bulk commodities (TERI, 2010).

#### 2.2.5 Fuel consumption

Road sector is highly energy intensive in comparison to railways. It is also the largest consumer of energy within the transport sector from petroleum products. The road transport sector, comprising both passenger and freight transport, accounts for nearly 72 percent of High Speed Diesel (HSD) consumption in India (MoPNG, 2012). While the consumption of HSD in the road transport sector increased by 7.4 percent from 33.74 MT in 2009-10 to 36.24 MT in 2010-11, the consumption of motor spirit increased at a higher rate of nearly 11 percent from 12.82 MT in 2009-10 to 14.2 MT in 2010-11 (MoPNG, 2012).

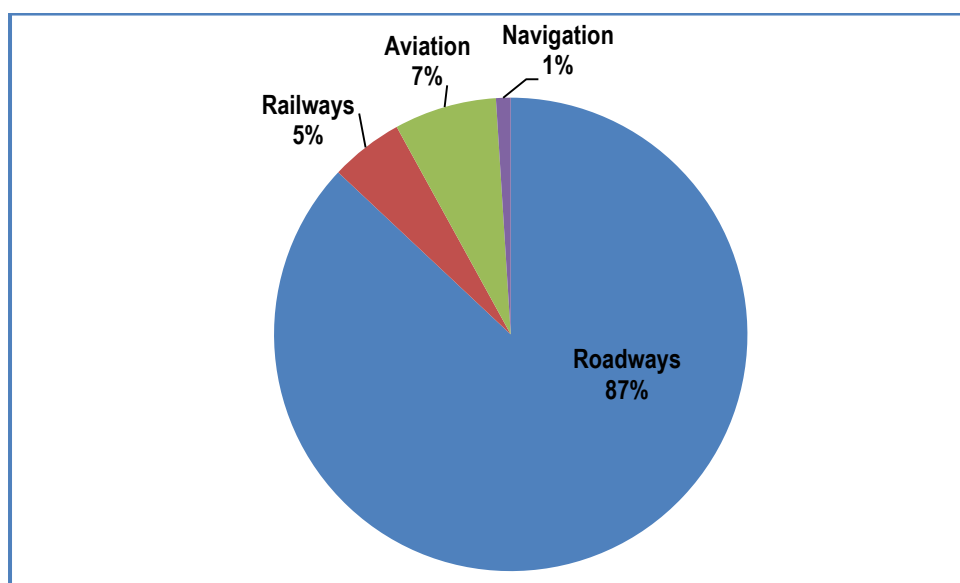
Several efforts/initiatives have been taken up to promote cleaner fuels like Compressed Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) in public buses and other modes like auto rickshaws in certain cities. The consumption of LPG by the transport sector during 2010-11 was 0.225 million tonnes, a small share of 1.7% of overall LPG consumption in the country (MoPNG, 2011-12). Not much success has been achieved and a lot needs to be done to increase the penetration of these fuels in our cities, especially in terms of creating adequate and appropriate infrastructure (like pumping station, pipelines, etc), bringing in right technology and creating a demand by way of incentives.

Studies predict that the energy use by the transport sector will increase two to fourfold over the next 20 years (NTDPC, 2014). Unless strong action is taken, the consequences will be dire for India's energy security as well as economy.

### 2.2.6 Pollution

Rapid increase in vehicle fleet has brought along the concern of increasing emissions, imposing huge costs to public health and general well-being. Vehicle emissions contribute to particulate matter (PM) smaller than 2.5 micrometers (PM<sub>2.5</sub>) and to nitrogen oxides (NO<sub>x</sub>). While NO<sub>x</sub> leads to production of ozone, PM<sub>2.5</sub> is a major contributor to premature deaths and numerous other illnesses. In 2007, road sector accounted for nearly 87 percent of the total emissions from the transport sector (Figure 8). In the BAU scenario, this number is expected to increase four times by 2030 (CPCB, 2011). Apart from the increase in vehicle fleet, preference of diesel cars in India, mainly driven by large diesel subsidies also worsens the air pollution problem as diesel cars are allowed to emit much more NO<sub>x</sub> and PM than gasoline cars (NTDPC, 2014).

The situation in cities in India is further discussed under the urban transport section.



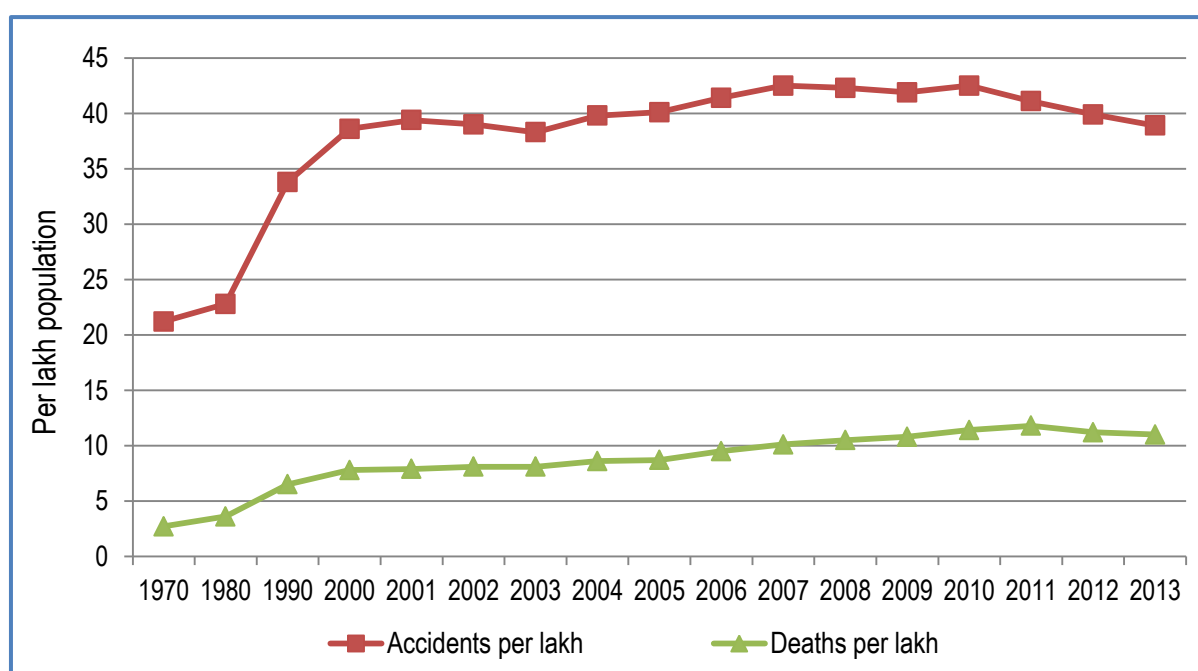
**Figure 6:** Share of CO<sub>2</sub> equivalent emissions from transport sector in 2007

Source: (NTDPC, 2014)

### 2.2.7 Road accidents and fatalities

India ranks number one in terms of road deaths globally (WHO 2013). With rapidly increasing vehicles on road, road accidents are becoming one of the leading causes of deaths and hospitalizations in India. As per the MORTH statistics, India has witnessed a 4.3 times increase in the total number of accidents between 1970 and 2013; the total number of fatalities and injuries have also increased by 9.5 times and 7.1 times respectively over the same period. High accident and fatality rates also bring along severe costs and impacts on economy and public health. In economic terms, India loses 3% of the national Gross Domestic Product (GDP) each year from road traffic injuries and fatalities.

The number of accident as well as deaths has increased steadily both in terms of absolute numbers and per lakh population. However, a slight decline has been reported in the numbers consecutively over the last two years i.e. 2012 and 2013. In 2013, the total number of road accidents was 486,476 as compared to the number of 490,383 in 2012. The total number of persons killed in India has also reported a slight decrease from 138,258 in 2012 to 137,572 in 2013 (MoRTH 2013b). The total number of road accidents per lakh population in India has shown an increase from 21.2 in 1970 to 38.9 in 2013. The total number of persons killed per lakh of population has shown an alarming increase from 2.7 in 1970 to 11.8 in 2011 and declined thereafter to 11.0 in 2013 (Figure 9). As per the MoRTH statistics, there is one road accident happening every minute in India and one person getting killed in a road accident every four minutes.

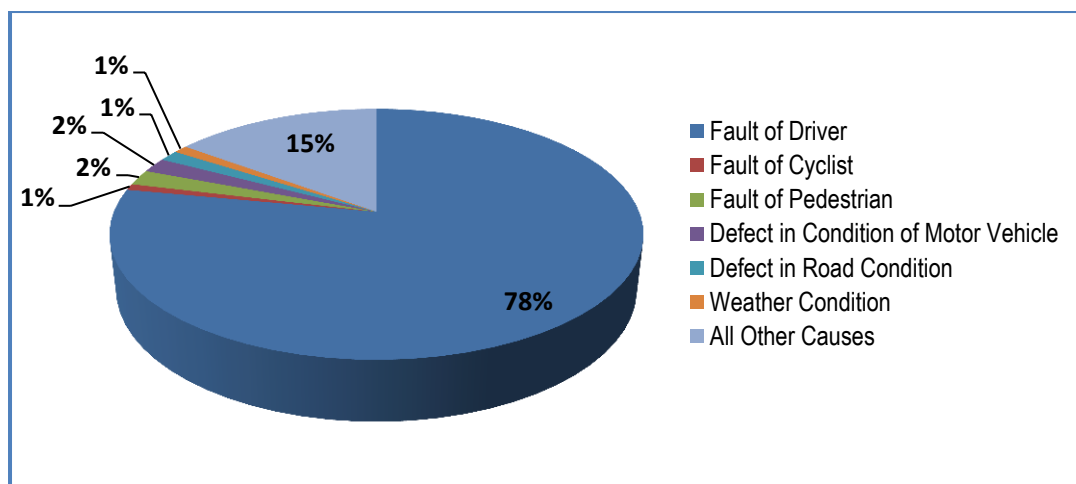


**Figure 7 :** Trends in total number of accidents and deaths in India (1970-2013)

**Source:** MORTH 2013

Nearly 22.7% of the total road accidents in India in 2013 were reported in million plus cities in India (MoRTH 2013b); and accounted for nearly 13.1% of the total persons killed in the same year<sup>6</sup>. Acute under-reporting, poor accident recording and limitations with regards to the data that gets collected, makes it difficult to identify the exact causes and severity of accidents in India (NTDPC, 2014). However, statistics reveal that drivers' fault accounted for nearly 78% of the total road accidents and 73.1% of the total fatalities in India (Figure 10). While a significant share (52.3 percent) of the total road accidents occurs on the highways in India, there is a serious lack of information on road accidents and their causes at the city level.

<sup>6</sup>Census of India 2011 has reported 54 million plus cities. Out of these 54 cities, 50 million plus cities reported road accident data for 2013. The shares indicate the 50 million cities in India (MoRTH 2013b)



**Figure 8:** Causes of road accidents in India in 2013

**Source:** MoRTH, 2013b

### 2.2.8 Key issues

Despite India's vast road network, the demands of passenger and also freight mobility are left unmet or partially met. The road transport sector witnesses a critical shortage of adequate transport infrastructure. The existing systems are unable to meet the growing demands and face several issues which are as discussed below.

#### Roads

- Though the roads sector has experienced extensive investments and growth particularly in the last decade, the demand for mobility has clearly surpassed the rate of supply of infrastructure in India. As a result, the road network faces capacity issues leading to severe congestion and other issues such as rise in travel times, increasing pollution levels, etc.
- With poor maintenance practices, quality of roads is also increasingly becoming a pressing issue in the road sector.

#### Road transport

- Vehicles in India are witnessing an exponential growth. The highest growth is observed in personalized modes accompanied by declining shares of more sustainable modes like public transport and non-motorized transport shares.
- The current ways of transportation in India dominated by private modes have led us on the path of increased dependency on petroleum products and hence reduced national energy security.
- With increasing levels of fuel consumption, the overall emissions of pollutants and green house gas (GHG) emissions have also increased considerably.
- Poor penetration of planned and adequate public transport systems in Indian cities has resulted in an increasing dependency on personalized modes of transport and unplanned privately operated informal public transport systems.
- Freight mobility by road in India is highly inefficient with extremely high costs of transportation and high turnaround times

- Increasing number of road fatalities and injuries with an increasing share of pedestrians and cyclists explains the vulnerable condition of the low income sections on road.

## 2.3 Civil aviation

India has become the ninth largest civil aviation market in the world (Twelfth Five Year Plan (2012-17), 2013). The sector has witnessed significant growth particularly in the last decade. The liberal policies of the government promoting privatization have significantly helped the sector to thrive in the recent years. With increasing urbanization, fast growing middle class population, increasing affordability levels and augmentation of right infrastructure, the demand for air travel has grown and is further expected to grow in the country. The sector had registered a growth<sup>7</sup> of more than 16% during the period 2004-05 to 2011-12. The key trends in the sector are discussed in the following section:

### 2.3.1 Airport infrastructure and airlines

India, at present, has a total of 132 airports<sup>8</sup>. Out of which, Airports Authority of India (AAI) manages 125 airports, including 68 operational airports (11 international, 8 customs and 49 domestic), 26 Civil Enclaves in Defence airports or Customs airports (3 international, 4 customs and 19 domestic), and 31 non-operational domestic airports (TEDDY, 2015). Six of these airports – Delhi, Mumbai, Bengaluru, Nagpur, Hyderabad and Cochin – are run on Public Private Partnership (PPP) basis and currently handle approximately 60% of India's total air traffic (NTDPC, 2014). Additionally, there are airports that are either completely privately owned or owned by their respective state governments.

### 2.3.2 Traffic

Though a decline was seen in traffic in 2008 due to increase in fuel costs and global economic recession, the sector however recovered once again in mid-2009. The traffic is further expected to rise exponentially in the coming decades.

**Passenger traffic:** In 2010-11, domestic air traffic in India carried by scheduled carriers was 54 million and is expected to increase by more than 8 times reaching 438 million passengers in 2030-31. International traffic at the Indian airports moving to and from India by 2030-31 is also expected to grow by 5.7 times from 38 million in 2010-11 to about 217 million in 2030-31 (NTDPC, 2014).

**Freight traffic:** As per the Report by the Working Group on Civil Aviation for the NTDPC, India's domestic and international cargo traffic (carried) from and to India is projected to reach a level of 3.6 and 8.2 million metric tonnes (MMT) per annum by 2030-31 respectively from the level of 0.5 and 1.2 MMT per annum in 2010-11.

The Indian aviation sector is constrained in terms of capacity. Given the expected increase in traffic in future, the sector would need to develop adequate infrastructure and undergo extensive capacity augmentation to meet the rising demands. As per the Twelfth Five Year

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<sup>7</sup> For details, please refer to [http://civilaviation.gov.in/cs/groups/public/documents/newsandupdates/moca\\_003368.pdf](http://civilaviation.gov.in/cs/groups/public/documents/newsandupdates/moca_003368.pdf)

<sup>8</sup> For details, please refer to [http://civilaviation.gov.in/cs/groups/public/documents/newsandupdates/moca\\_003368.pdf](http://civilaviation.gov.in/cs/groups/public/documents/newsandupdates/moca_003368.pdf)

Plan (2012-17), it is estimated that there is an additional requirement of 30 functional airports by 2017 and about 180 functional airports in all over the next 10 years. In terms of investments, a total investment worth of INR 3, 77,275 crores has been estimated for airport infrastructure development work by 2031-32 (NTDPC, 2014).

### 2.3.3 Fuel consumption

With increasing air traffic, the fuel needs in the sector have also increased over the years particularly post 2000-01. The overall consumption of aviation turbine fuel (ATF) by the aviation sector grew from 3.3 MT in 2005/06 to 5.54 MT in 2011-12. During the Eleventh Plan period (2007-12), the average compound annual growth rate (CAGR) of ATF consumption was 6.8% (TERI, 2015)

Fuel is perhaps the largest input in aviation, accounting for around 50% of operating costs (NTDPC, 2014). The high cost of aviation turbine fuel (ATF) is therefore one of the major challenges for the financial health and competitiveness of the aviation sector.

### 2.3.4 Key issues

The aviation sector in India is witnessing several challenges constraining its future growth. The committee set up for developing the National Transport Development Policy Committee report analyses the sector in detail and highlights the key issues faced by the sector which include poor connectivity to NE states, oversaturation of existing facilities leading to congestion and capacity bottlenecks especially at the terminals, inefficiencies in modal transfers, high fuel costs affecting the financial performance of airlines and lack of availability of trained/skilled labor.

## 2.4 Ports and Shipping

India has a long coastline of nearly 7,517 kilometers, offering significant opportunities for development of maritime transport sector. As per TERI estimates (TERI, 2015), almost 90% by volume and 70% by value of India's global merchandise trade is carried through the sea route.

### 2.4.1 Infrastructure and traffic

#### Ports

India has a total of 12 major ports and over 200 minor/intermediate ports along the coastline and sea islands. While 11 major ports are administered by their respective Port trusts; Ennore Port is a corporatized major port.

The major ports handled a total traffic of 555.50 MT in 2013-14 as compared to 545.79 MT in 2012-13, recording an increase of about 1.8%. The non-major ports handled about 420.20 MT in 2013-14, as against 387.9 MT in 2012-13 (TERI, 2015). While traffic handled increased at a slow pace of 1.8% at major ports; the traffic at non-major ports increased at a much higher rate of more than 11%.



In 2013-14, major and non-major ports together handled cargo of 980.49 MT. Out of which about 43% of the country's total maritime freight traffic was handled by the non-major ports. The Indian ports handled a total of 13.88 million passengers during 2010-11 as compared to 13.98 million passengers in 2009-10. In 2010-11, the major ports handled about 344 000 passengers and the minor ports handled about 13.53 million passengers (TERI, 2015).

Railways and road transport largely carry the traffic from ports to the hinterland within India, with pipelines carrying crude oil and petroleum products. Railways are presently carrying considerably less than their optimal share of port traffic and road transport has made up the deficit partly with many negative externalities (Twelfth Five Year Plan (2012-17)).

### Coastal Shipping

India had a fleet strength of 1213 vessels with gross tonnage (GT) of 10.49 million in 2014. Of the total fleet, 367 ships with 9.31 million GT cater to India's overseas trade and the rest to coastal trade. There has been a consistent decline in the share of Indian ships in the carriage of India's overseas trade from 31.5% in 1999–2000 to 13.7% in 2004–05 and further to 7.95% in 2010–11 (Twelfth Five Year Plan (2012-17)).

The gross registered tonnage (GRT) under the Indian flag (including coastal and overseas) has been increasing in the last decade. It increased from 6.95 million GRT in 2000 to 8.24 million GRT in 2005 and further to 10.16 million GRT in 2010 (TERI, 2015). In 2012-13, India's overseas seaborne trade was about 754.9 million and the share of Indian ships in this trade was 10.9% (TERI, 2015).

### Inland waterways

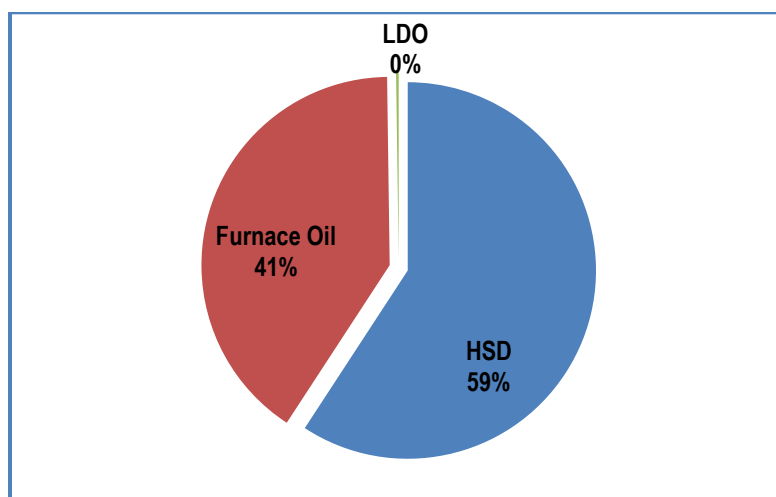
India at present has about 14,500 km of navigable waterways comprising rivers, canals, backwaters and creeks (TERI, 2015). The modal share of freight transported through inland water transport in total freight traffic is as low as 0.28% (TERI, 2015) and is hence a under developed mode of transport in India.

Despite its environmental advantages over other modes, the penetration level of water inland transport in the market for freight transport is extremely low, limited largely to movement of iron ore in Goa and fertilizer raw material in the West Coast region (NTDPC, 2014). The total cargo movement on India's waterways (comprising the three national waterways and waterways in Goa and Maharashtra) increased from 23.684 MT in 2012-13 to 24.751 MT in 2013-14 (TERI, 2015).

#### 2.4.2 Fuel consumption

Water transport is one of the most environment friendly, cost-effective, and efficient modes of transportation. During 2011-12, the shipping sector consumed 0.54 MT of High Sulphur Diesel (HSD), 0.002 MT of Light Diesel Oil (LDO), and 0.37 MT of furnace oil (Figure 12). (TERI, 2015)





**Figure 9:** Consumption of petroleum products in shipping in 2011-12

Source: TERI, 2015

### 2.4.3 Key issues

Slow expansion and growth in the water transport sector is a result of lack of adequate investments and lack of incentives for the private sector to invest in the sector. The key issues faced by the sector are as discussed below:

- **Capacity issues:** The existing ports are already facing congestion and saturation. Considering the rapidly increasing traffic and trade requirements of growing Indian economy, it is realized that significant investments are required in the sector to be able to cater to the growing needs. This would include either upgradation of the existing major ports into mega ports or development of new ports.
- **Inadequate drafts:** India's ports are highly constrained for capacity and are expected to remain so in the near future (NTDPC, 2014). The key limitation of the sector is in terms of inadequate drafts, both in the channel and at berths. Limited dredging capabilities are also a pressing issue and needs attention.
- **Inefficiencies in operation:** Inefficiencies in port operations have resulted in high dwell time and high turnaround times. This is a result of a multitude of issues such as inadequate port side infrastructure, lengthy custom clearance procedures, and time consuming and inefficient modal transfers.
- **Poor hinterland connectivity:** Poor connectivity and inefficient modal transfers lead to problems of slow evacuation of cargo.
- **Lack of funds:** Development of port infrastructure has traditionally been driven largely by public investment. The little private investment that has been attracted in the port sector has been mostly in developing terminal facilities. Development of basic infrastructure such as sea locks, breakwaters, port basins, common areas, and main hinterland connectivity also entails large fixed costs and is typically funded through public investment (NTDPC, 2014)

## 2.5 Urban transport

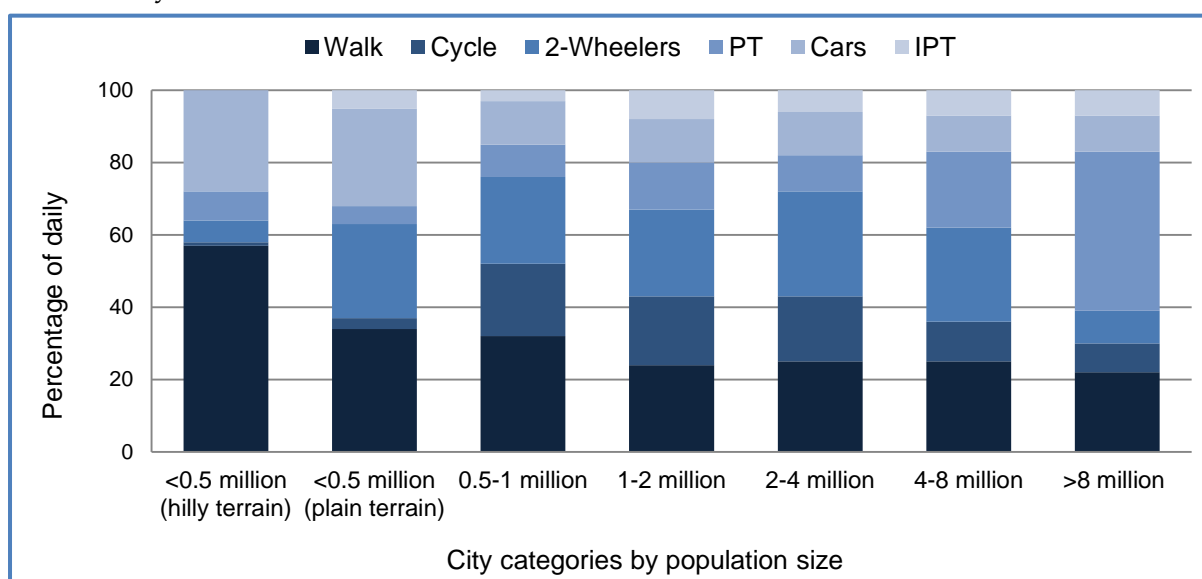
If cities are the engines of growth, transport are its wheels. The contribution of cities in India is nearly about 60% to the country's gross domestic product (GDP), and is further expected to rise to 70% by 2030 (NTDPC, 2014).

In 2011, 377 million accounting for about 31.2% of the total population in India lived in cities (Census 2011). The number is further expected to rise to about 600 million by 2030 (HPEC Report, 2011). Rapid urbanization and urban sprawl have brought along a phenomenal increase in the need to travel for work, recreation, education and other socio economic needs. Unlike other sectors, urban transport is guided and is often a reflection of urbanization patterns. If not planned and managed well, the costs of urban transport on economy and environment can be huge.

### 2.5.1 Modal shares

Presently, urban transport needs in our cities (for both passenger and freight mobility) are met by a mix of motorized and non-motorized modes. Depending on city characteristics and variable needs, this mix varies from one city to another. At present, there is inadequate understanding of, and inconclusive data on, the modal share distribution between these various transport modes, across city types and sizes in India. The figure 12 below gives the modal shares of transport in Indian cities based on their city population sizes.

Given the mixed land use and high dense development of Indian cities, the trip lengths are generally short irrespective of the city size. The average trip length in medium and small size cities is less than 5 km. In bigger cities like Mumbai and Hyderabad 80% of the trips are less than 10 km in length and 70% of the trips are less than 5 km. In cities like Pune 97% of the trips is less than 10 km and 80% of the trips are shorter than 5 km (Tiwari, 2011). Despite the short trip lengths, the travel distances and travel times in our cities have increased considerably.



**Figure 10:** Modal shares in Indian cities (percentage of daily trips) in 2007

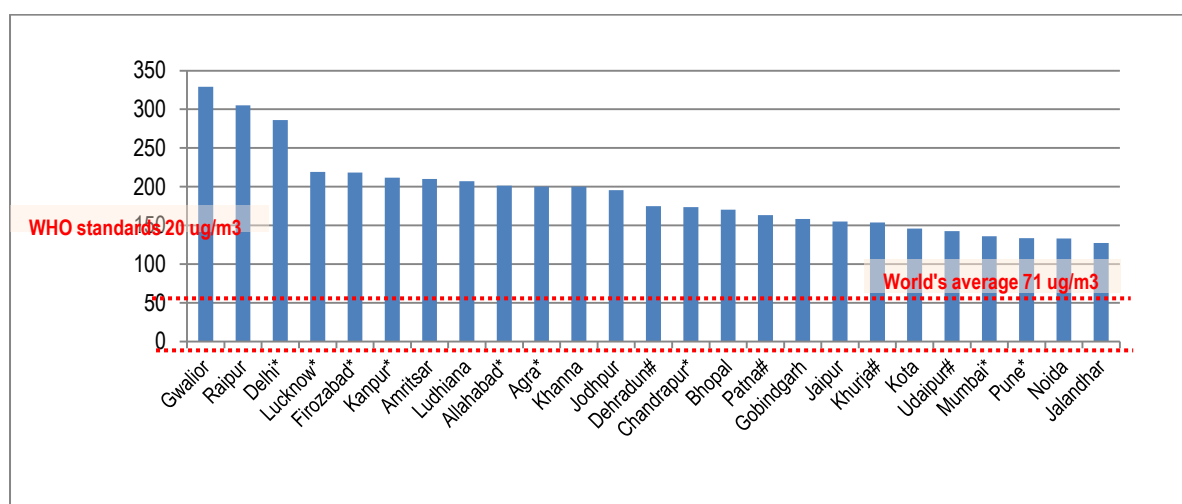
**Source:** WSA, 2008

There is a phenomenal growth of private vehicles in urban areas. Private vehicles (including both two wheelers and cars) have increased at a rate of almost 12% in the country in the last decade. With growing incomes and aspirations, this number is further expected to increase exponentially in the BAU scenario. This in combination with declining shares of PT and NMT further raises concern regarding the increasing problems of congestion, pollution, etc. The travel trends of the past three decades show a sharp decline in bicycle trips and a rise in motorized two-wheeler and car trips (Tiwari, 2011).

Very few cities in India have organized, planned and regulated public transport systems. In absence of adequate PT services, private run public transport modes such as Tata magics, auto rickshaws, etc. have emerged in the cities. The significant popularity gained by these modes can be attributed to their flexible operations, easy availability of modes at all times and affordable and comfortable services provided by them. In small and medium towns where formal PT services are completely absent, these private run modes have extended themselves as public transport modes serving the mobility needs of the population. These trends have brought along problems of increased journey times, increasing congestion and poor air quality.

### 2.5.2 Fuel consumption and emissions

The current patterns and trends of transportation in our cities are extremely energy intensive and highly unsustainable which are further expected to worsen with expected increase in vehicle fleet. In 2014, thirty seven cities in India featured on the World Health Organisation's (WHO) list of the world's 100 most polluted cities in terms of PM 10 concentration levels. The graph below shows the top 25 cities in India as per the WHO ranking (Figure 13). According to a 2011 study conducted by the Central Pollution Control Board (CPCB) for six cities— Delhi, Kanpur, Bengaluru, Pune, Chennai, and Mumbai, the road transport sector is responsible for a majority of NO<sub>x</sub> and 30% to 50% of PM emissions in these cities. Another study by TERI brings forward that the road transport sector contributes about 15% to 50% of the PM<sub>2.5</sub> emissions in cities and is a dominant contributor to NO<sub>x</sub> emissions (ICAMP, 2014).



**Figure 11:** Top 25 polluted cities in India in terms of PM10 concentration levels (2012)

(Cities\* - 2011 data; Cities# - 2010 data)

**Source:** WHO 2014 database

### 2.5.3 Safety

With increasing vehicle fleet, traffic fatalities in cities are also increasing at a high rate. In 2013, fifty million plus cities accounted for a share of 22.7% in total road accidents in the country, 12.4% in total persons killed in road accidents and 16.2% in total persons injured (MoRTH 2013b). Studies suggest that pedestrians, bicyclists and two wheeler riders comprise of 60-90% of the total fatalities. Motorcyclists also represent a large portion of urban fatalities (about 25%) (Tiwari, 2011).

Due to limited data available specifically in context to accidents in urban areas, the exact causes of accidents are not known. Also, there are discrepancies in the way data is stored at the urban level and hence reliability is an issue.

### 2.5.4 Key issues

At present, cities in India face huge deficit in terms of urban transport services and infrastructure both in terms of quantity as well as quality (Working Group on Urban Transport, National Transport Development Policy Committee, 2012). With increasing personal vehicles and declining Public Transport (PT) and Non-motorized Transport (NMT) shares, cities in India are progressing in the wrong direction. As a result, the cities in India are experiencing problems of congestion, increasing travel times, increasing travel costs, depleting air quality and others.

Given a large section of population in India cannot afford personalized modes or even the subsidized public transport modes, the issues of disparity in availability of public transport services, reduced access to mobility and affordability of available modes remains a major concern area. The lop-sided investments into building road infrastructure for moving cars (i.e. roads/flyovers/ parking lots) and lack of investments in non-motorized transport infrastructure (walking/cycling) or public transport further exacerbates the condition of the under privileged or low income sections who are dependent on these modes to meet their daily needs.

## 3. Government structure and initiatives

### 3.1 Institutional Framework

Inadequate transport infrastructure and poor quality services are seen as a major constraint for economic development in India. Several initiatives and efforts have been made by government to deal with the above issues across the different modes. This section discusses in detail the initiatives taken up by the government to deal with the challenges of the transport sector and improve the overall transport situation in the country. Here, it is important to understand the institutional setting of the sector.

The transport sector in India is highly fragmented institutionally not only among the three levels of governance but also across institutions. Broadly, the central government is responsible for national highways, railways, civil aviation, major ports and international shipping, and national inland waterways. State governments are responsible for state and rural roads, non-major ports and coastal shipping, inland water transport, urban transport,

and trucking and intercity bus services. The rest of the responsibility of provision of infrastructure like bus stands, footpaths, street lighting, and others lies with the respective city governments. It is to be noted that the division of responsibilities is not absolute and there are overlapping roles and responsibilities. For instance, the central government also plays a role in urban transport, motor vehicle transport and coastal shipping, in the form of policy making, regulations and funding assistance.

At the central level, there are six dedicated ministries that look after different modes of the transport sector and control the different decisions related to the independent growth of each of these modes. The six ministries include Ministry of Road Transport and Highways (MoRTH) mainly looking into the development of National Highway through the National Highways Authority of India (NHAI), Ministry of Urban Development (MoUD) looking into matters related to urban transport, Ministry of Rural Development (MoRD) responsible for development of rural roads, Ministry of Railways (MoR) handling the railway operations through the Indian Railways, Ministry of Civil Aviation (MoCA) for civil aviation and airports through Airports Authority of India and Ministry of Shipping (MoS) looking after Ports, shipping related matters and national water inland waterways. Their development plans and agenda are further overseen by the NITI Aayog (or National Institution for Transforming India Aayog), a policy think tank of the Government of India which works out sectoral targets and provides promotional stimulus to the economy to grow in the desired direction. Apart from this, there is limited interaction and coordination among these mode specific ministries and works in an isolated manner in their own area without adequate know how about the impact of their sectoral decisions on the other modes.

The division of functions and responsibilities at the lower levels i.e. State and local government is more complicated in nature. The table 4 below lists the multiple institutions responsible for development, control and management of the transport sector at the three levels of governance in India and their key roles. At the state level, once again there is no single authority looking into the entire transport sector but multiple organizations serving different functions related to provision and management of transport infrastructure and services.

The table above clearly suggests the multiplicity of organizations in the transport sector. Lack of coordination among the institutions along with ambiguity in roles and responsibilities is a major challenge that needs adequate attention if the sector has to grow in an integrated manner on a 'green' development path.

**Table 4:** Institutions involved in planning and management of transport services at different levels of governance in India

No.	Name of the Ministry/ Institution	Key functions
<b>Central level</b>		
1.	<i>Core Ministries</i>	
	<ul style="list-style-type: none"> <li>Ministry of Road Transport and Highways (MoRTH) – <i>National Highways</i></li> </ul>	Formulate policies, sponsor and support programmes, provide funding assistance to state and city

No.	Name of the Ministry/ Institution	Key functions
	<ul style="list-style-type: none"> <li>Ministry of Urban Development (MoUD) – <i>Urban Transport</i></li> <li>Ministry of Rural Development (MoRD) – <i>Rural roads</i></li> <li>Ministry of Railways (MoR) – <i>Railways</i></li> <li>Ministry of Civil Aviation (MoCA) – <i>Civil Aviation/Airports</i></li> <li>Ministry of Shipping (MoS) – <i>Ports, Water inland waterways</i></li> </ul> <p><i>Other ministries - indirect involvement in making decisions related to transport sector</i></p> <ul style="list-style-type: none"> <li>Ministry of Finance (MoF)</li> <li>Ministry of Environment and Forests (MoEF)</li> <li>Ministry of Petroleum and Natural Gas (MOP&amp;NG)</li> </ul> <p><i>Special Institutions</i></p> <ul style="list-style-type: none"> <li>National Highways Authority of India (NHAI)</li> <li>National Rural Roads Development agency (NRRDA)</li> <li>Major Port Trusts</li> <li>Indian Railways (IR)</li> <li>Airports Authority of India (AAI)</li> <li>Inland Waterways Authority of India</li> <li>Central Pollution Control Board</li> </ul>	governments, set up standards and guidelines, ensure coordination between relevant stakeholders including lower levels of government, appraise progress of programmes and ensure successful implementation through timely monitoring
2.	Niti Aayog (erstwhile Planning Commission)	Assess country's needs and resources and prepare of five year plans for effective and balanced utilization of country's resources, appraise progress and ensure successful implementation of the plans
<b>State level</b>		
3.	State Maritime/ Ports Development Board	Non major Ports
4.	State Transport Department/ Regional Transport Office	Vehicle licensing and registration; road tax collection; emission norms
5.	State Transport Undertakings (STU's)	Provision of inter and intra city Public transport (bus) services
6.	State Development Authorities/ Town & Country Planning Organization (TCPO)	City and town planning; preparation of master plans or regional plans
7.	Public Works Department (PWD)	Construction and maintenance of road and bridges
8.	Pollution Control Board	Enforcement of emission norms

No.	Name of the Ministry/ Institution	Key functions
9.	Finance department	Budgetary allocation of funds, tax collection
10	Traffic Police*	Enforcement of traffic rules
<b>City level</b>		
11	Municipal government (Municipal Corporations/ Municipalities/ City public Works Department)	Construction and maintenance of roads and other infrastructure (e.g. bus stands, footpaths, street lightning)
12	City development authority	City/ town planning functions
13	Traffic Police*	Enforcement of traffic rules, safety
14	City Bus Corporations/ Special Purpose vehicles (SPVs)	Plans and manages operations of concerned service

(\* present in some states or cities only)

## 3.2 Policies/ Programmes/ Plans

Given the fragmented institutional structure of the transport sector, it is not surprising that the initiatives taken up over the years to deal with the growing problems have been in isolation mostly specific to a mode. This is also the major reason for the limited success of these initiatives. This section gives an overview of the various initiatives in terms of policies and programmes taken up by the government to deal with the various challenges faced by the sector.

### Roads

#### *National Highways*

Realizing the need and importance of a well-connected road network for national integration and socio economic development of the country, the Government of India launched the National Highways Development Programme (NHDP) in 1998 with the overall idea of improving more than 49,260 km of arterial routes of national highway network to international standards in a phased manner. The 5,846 km Golden Quadrilateral project (connecting Delhi, Kolkata, Chennai and Mumbai) and the 7,300 km North-South (NS) & East-West (EW) Corridors (wherein NS corridor connects Srinagar to Kanyakumari and East-West corridor connects Porbandar to Silchar) are the two major components of the programme.

#### *Rural Roads*

The Prime Minister's rural roads development programme or the Pradhan Mantri Gram Sadak Yojana (PMGSY) launched in 2000 aimed at providing all weather connectivity to the unconnected communities in rural India. The project aimed to cover habitations with a population of 500 persons and above in the plain areas and 250 persons and above in hill states until 2007. However, the project faced slow implementation and delays. By the end of 2006, only 30 percent of the targets were met. In 2005, rural roads were also identified as one



of the major components under Bharat Nirman Program, Government of India's flagship programme for rebuilding rural infrastructure in India<sup>9</sup>.

## **Urban transport**

The first ever policy in urban transportation, National Urban Transport Policy (NUTP) was launched in 2005 by the Ministry of Urban Development (MoUD), Government of India. The policy gives priority to mobility of 'people' over 'vehicles' and aims to develop equitable and sustainable urban transport systems. The policy provides direction to the state governments and also provides financial assistance through Jawaharlal Nehru National Urban Renewal Mission (JnNURM). JnNURM, a reform based programme launched in 2005 to fast track planned infrastructure development in the "mission cities" in India. The mission aimed at creation of economically productive, efficient, equitable and responsive cities and providing financial assistance to the mission cities for planning and implementation of projects related to urban infrastructure including urban transport. To avail funding under JnNURM, the cities were required to develop Comprehensive Mobility Plans (CMPs) in line with objectives set under the NUTP.

In 2009, the Government of India released the first-ever national plan on climate change - the 'National Action Plan on Climate Change (NAPCC)' - with an aim to reduce India's carbon emissions. The plan has eight missions that define the broad policy directions for reducing India's emission intensity. The National Mission on Sustainable Habitat in the NAPCC outlines the measures to reduce emissions from the transport sector. The mission proposes 'better urban planning and modal shift to public transportation' in order to move towards low carbon transport systems.

Under the ambit of NUTP, MoUD launched the Sustainable Urban Transport Project (SUTP) in 2010. The project aimed to promote environmentally sustainable urban transport in India (for example public transport and non-motorized transport modes) and also encourage the use of environmentally sustainable transport modes through demonstration projects in selected cities.

## **Fuel**

In India, vehicle emission norms were first introduced in 1991 and then further strengthened in 1996 wherein vehicle manufacturers were made to incorporate technology upgradation measures to reduce exhaust emissions from vehicles. With this, use of lead free and low sulphur fuels was made compulsory in major Indian cities and then subsequently across the country. Further in 1999, Ministry of Surface Transport (MoST) notified introduction of Bharat Stage-I (BIS 2000) and Bharat Stage-II vehicle emission norms broadly equivalent to Euro I and Euro II in entire India and National Capital Region (NCR) respectively.

With the coming of the first Auto Fuel Policy in 2003, fuel conforming to BS III norms was introduced in 13 major cities, while BS II fuel was made available elsewhere in the country and BS I quality fuel phased out starting from April 2005. From April 2010, BS IV fuel was implemented in 13 major cities and BS III fuel made available in the rest of the country from

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<sup>9</sup> For more details, please refer to <[http://pmgsy.nic.in/Intr\\_E.pdf](http://pmgsy.nic.in/Intr_E.pdf)>



September 2010. Compliance with these increasingly stringent auto fuel specifications required significant investments by the oil companies in technology upgradation and other changes required in the manufacture of gasoline and diesel and their transportation from time to time. The Auto Fuel Policy of 2003 provided a roadmap for 2010 suggesting required actions across various areas including vehicular emission norms, fuel quality and standard of CNG/LPG kits, measures to reduce emissions from in-use vehicles, vehicle technology, air quality data and Research & Development. It also covered air quality data and health effects of air pollution (Ref)<sup>10</sup>. In year 2014, the auto fuel policy was further revised. The policy sets up a clear roadmap for auto fuel quality till 2025. The policy aims to make available and ensure rollout of BS IV emission norms as fast as possible at the national level and then the earliest possible rollout of BS V emission norms. Apart from the above, fuel consumption standards have already been setup for LDV's in the country but are yet to be operationalized. The government is also in the process of setting standards for HDV's.

In 2013, the Government of India also launched the National Electric Mobility Mission Plan (NEMMP) 2020 with an aim to address the issue of rising vehicular pollution, and increasing concerns over the energy security of the country. The plan aims to promote electric vehicle technologies in India and achieve a target of penetration of electric vehicles to the extent of atleast 14-16 percent of the total vehicle fleet in India by 2020. Under this mission, the Department of Heavy Industries, Government of India in association with the Society of Indian Automobile Manufacturers (SIAM), recently launched the Scheme for Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) in India. The scheme is planned to be implemented over a period of 6 years, till 2020, and intends to achieve net sales of 6-7 million electric and hybrid vehicles per year in the country. A total investment of INR 795 crores has been approved for the initial 2 year Phase I of the scheme and Rs 75 crores has been sanctioned in the budget for FY 2015-16. The scheme covers interventions across four major areas of demand and supply creation, technology development, charging infrastructure and pilot projects.

## **Railways**

To deal with challenges faced by the rail sector, India railways came up with first ever vision document and White Paper in 2009 outlining the needs and future plans of the Indian railways. The document highlights the need to increase the shares of rail sector in passenger and freight mobility both and also enhance the environment friendliness and energy efficiency of the sector. To do so, several initiatives have been taken up or are planned to be taken up across a range of issues including improving connectivity of the network, capacity enhancement of the existing lines, technology upgradation, improving energy efficiency, improving revenues, increase use of renewable energy and others. Box 1 discusses the recent initiatives taken up or being taken up under each of these areas in the railway sector. IR vision 2030 is under preparation.

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<sup>10</sup>For more details, please refer to [http:// petroleum.nic.in/ docs/ autopol.pdf](http://petroleum.nic.in/docs/autopol.pdf)

## Civil aviation

A national policy for the Civil Aviation is under preparation. The draft policy emphasizes on the need to develop airports as integrated multi-modal hubs rather than in isolation for better service levels as well as potential for growth, provision of air connectivity to isolated and unserved areas with special focus on north-eastern states, rationalization of fuel costs and service efficiency improvements (MoCA, 2014). The Twelfth FYP also aims to propel India among the top five civil aviation markets in the world by providing access to safe, secure and affordable air services to everyone through an appropriate regulatory framework and by developing world class infrastructure facilities (Twelfth Five Year Plan (2012-17))

While the Eleventh FYP saw a total investment target of INR 49,267 crore, the anticipated expenditure during the Plan period was INR 44,124 crore. The projected investment during Twelfth Five Year Plan from Central sector is expected to be INR 33,198 crore. Besides, an investment of INR 50,000 crore comprising INR 40,000 crore from private investment and Rs10,000 crore by others including concessioners, third party and so on have been projected to be made in airport projects during the Twelfth Five Year Plan.

Apart from the above isolated initiatives of the ministries, several expert committees have been set up by the government of India to deal with the challenges faced by the transport sector in India as a whole. An expert committee, National Transport Policy Development Committee (NTDPC) was set up in 2009 by the Government of India to develop a long term integrated policy for the transport sector taking inputs from all the transport related mode specific ministries. The final report by the Committee was released in 2014.

Another committee on Low Carbon Strategies for Inclusive Growth was set up by the Planning Commission to recommend low carbon strategies for the Indian economy. The final report of the Committee was released in 2014. The specific strategies recommended by the committee include planning for a modal shift from road and air to railways and water, improving the efficiency of existing transport systems, provide for and improve the shares of public transport and non-motorized transport modes within road transport along with disincentivising the use of private modes.

## 4. Way forward

To sum up, India's transport system is undeniably vast comprising of multiple sub sectors and is further expected to expand at an alarming rate in the coming decades. The current imbalance in modalities with dominance of road transport sector (particularly personalized modes), accompanied by declining shares of more energy efficient and environment friendly modes (like railways, public transport and non-motorized transport in urban areas) pose significant costs to society, economy and environment. The existing transport systems in India have clearly not been able to keep pace with the growing mobility needs and face issues of inadequate infrastructure, capacity saturation, low efficiency levels, paucity of resources and hence slow growth. As a result, India faces serious concerns relating to national energy security, increasing congestion, rising pollution and associated health problems, poor safety levels and an overall depleting quality of life, particularly in urban areas. In the BAU scenario, the problems are further expected to worsen. Responding to the

above challenges would therefore require a paradigm shift in the way transport sector grows in the coming decades.

For a developing country like India, it is important that the drivers of mobility are not only green but also ensure more sustainable and equitable growth in the long run. The greatest challenge for India lies in meeting the current and future demands for mobility (passenger and freight both) by developing and providing right and adequate transport infrastructure. Planning and investing in green transport and infrastructure can help in shaping the future patterns of transportation. Existing literature suggests that redirecting investment to green transport options can provide the same mobility needs but with significant reduced societal and environment impacts and in some cases even for less money (UNEP, 2011).

Greening of the overall transport sector in India would seek a holistic strategy that involves planned interventions that promotes low carbon growth, resource efficiency and inclusive development in the long run. This would require a combination of interventions promoting integrated green growth of the overall sector along with specific measures promoting green growth in each of the subsectors. To make a decisive shift to green transport, interventions and massive investments are required in the coming decades in the form of modal shifts actions, specific infrastructure development and upgradation works, fuel and system efficiency improvements and mobility management.

#### 4.1 Develop integrated multi modal transport systems

The present approach wherein each of the transport sub sectors i.e. roads, railways, aviation, ports and others are developing in silos have resulted in extensive costs to the economy, society as well as environment. Lack of adequate horizontal and vertical integration among them further exacerbates the situation. Therefore, there is a need to adopt a more integrated approach of the entire transport sector as a whole, keeping in mind the larger agenda for socio economic development of the country.

As also recommended by the Twelfth Five Year Plan and the NTDP Report, the integrated approach must look at achieving a more balanced modal mix which leads to a safe, reliable, efficient, sustainable, economical and environment friendly transportation systems. There is a huge potential to reduce the energy intensity of the transport sector by incentivizing and promoting the use of more efficient and sustainable modes of transport i.e. railways (especially for long distance travel), water transport, public transport systems and non-motorized transport systems. To move towards integrated multi modal systems,

- A strategic plan must be developed that clearly identifies and assesses the existing gaps, development priorities and investments required to achieve integrated multi modal systems. The roadmap should essentially be backed by a multi-level investment plan with required investments over time and the potential sources of finance.
- As also recommended by the NTDP report, the strategic plan should aim to achieve a desirable modal mix taking into consideration the lifecycle energy costs of different modes. It should also reflect the full resource costs of each transport mode for each type of commodity transported over various distances and terrains.

- It is essential that adequate attention is paid to developing missing infrastructure stretches/links within one mode as well as between modes, followed by addressing the capacity issues, both infrastructural and carrying capacity issues.
- Adequate institutional capacities and systems must be ensured to facilitate the development of integrated multi modal systems:
  - Set up a unified Ministry of Transport that overlooks all the transport subsectors and makes collective decisions for the entire transport sector.
  - Set up an integrated data management system and centre for regular monitoring of transport data.

To arrest the current trends and promote green growth in the sector, interventions along the following lines are recommended:

## 4.2 Promote shift to more energy efficient and environment friendly modes

### 4.2.1 Shift from road transport to railways and water transport

In view of the need to reduce energy demand, the current modal mix in India is largely unsustainable. Necessary measures must be taken to not only arrest but reverse the continuously declining shares of energy efficient sustainable modes like railways and water transport in India. Any shift in traffic from road to these modes would result in substantial savings in energy consumption as well as reduced social costs.

#### **Shift to Railways**

Studies by Asian Institute of Transport Development (AITD) and Rail India Technical and Economic Service (RITES) assessed the environmental and social costs of various modes of transport and recommended an increase in railway shares from the current 36% to 50% by 2030. Several issues plague the sector at present and hence limiting its growth. Dealing with these issues would require massive planning and investments focusing on capacity creation and improvement in operations. The key strategies required to address the key issues in the sector and enhance its shares are as discussed below:

- **Capacity augmentation:** Uneven and imbalance in traffic flows have resulted in severe capacity issues on certain sections of the IR network. Immediate attention should be given to the infrastructural and carrying capacity constraints that have already surfaced. Infact, railway planning must aim to ensure creation of capacity ahead of demand.
- **Electrification of network:** Railways should progressively head towards electrification of its network. Targets must be set and reviewed from time to time.
- **Commercialization of operations:** For long term sustainability of railways, there is a need to strike a balance between the two aspects in respect of investment planning and introduction of services. To do so, IR must look at separation of funding of the projects and services on the social account, and can consider funding the social projects through stakeholder and beneficiary contribution. The funding patterns of these projects should be done on similar lines as other social sector programmes.

- **Rationalization of tariffs:** Passenger tariff setting in railways should be rationalized in tune with the business growth environment of the railways. The current passenger fares needs to be reviewed and rationally linked to input costs. Freight tariff needs to be based on differentiation linked to type and quality of service offered (NTDPC Final Working Group Report on Railways, 2012). It is essential that both freight rates and fares takes into account competition from other modes, level of cross subsidization feasible and need to generate decent surpluses for reinvestment.
  - A Tariff Regulatory Authority may be set up that draws out the tariff structure for both for passenger and freight.
- **Improve efficiency in freight movement:** To promote movement of freight by railways, efficiency improvements must be sought.
  - Running of premium freight services with guaranteed transit times and assured deliveries.
  - Introduction of new technologies aimed at improving axle load of wagons, expansion of long haul, use of Global Positioning System (GPS) and Radio-frequency identification (RFID) technology for tracking purposes and technological innovations to improve efficiency of operations.
  - Creation of multimodal logistics parks that allow efficient transshipment between modes and lead to reduction in costs of intermodal transfer and overall production.
  - Promote containerization with the objective of diversification and expansion of freight market.
  - Operationalization of Dedicated Freight Corridors (DFC's) would lead to segregation of freight and passenger traffic. This will further result in larger number of passenger services, faster passenger services, quicker freight movement, and help in decongesting major terminals (Twelfth Five Year Plan (2012-17)).
- **Upgrade quality of passenger services:** To meet the rising passenger demands and expectations in terms of service quality, the following interventions are recommended:
  - Enhancing speed on the passenger lines to 160-200 kmph on select corridors initially and then further increments can be planned in a phased manner
  - Introduction of tailored services to meet requirements of various sectors and various classes of passengers
  - Decongest major passenger terminals by developing alternative terminals in suburban areas of major cities
  - Redevelopment of stations for smooth flow and comfortable experience of passengers
  - Ensure proper maintenance so as to ensure clean and hygienic environment. Run a cleanliness drive at the stations and in the trains under the Swachh Bharat campaign

- Introduction of High Speed Rail (HSR) services on selected corridors after carrying out proper pre-feasibilities
- **Improve safety performance:** To target better safety levels in railways, the following recommendations are made in line with the Twelfth FYP:
  - Improved safety systems and required technologies needs to be put in place. These should include provision of audio visual warning to road users in advance of approaching trains, computerized real time monitoring of assets and use of condition based in predictive maintenance systems, development of Train protection and Warning System (TPWS) and Anti Collision Device (ACD)/Train Collision Avoidance systems (TCAS).
  - Railways should also develop 'crashworthy' structural design capable of absorbing high impact loads in unfortunate case of collision/accidents.
  - All the furnishing materials in the coaches to have superior fire retardant properties in line with international norms.

### **Shift to Water Transport**

Given the higher economic and environmental benefits related to water transportation in comparison to other modes, India must look at enhancing the sector and increasing the shares of coastal shipping and inland waterways in the coming decades. To do so, the following interventions are recommended:

- A strategic roadmap must be developed to promote coastal shipping and inland water ways in the country. The plan must clearly set targets to increase national tonnage over the years in a phased manner and identify strategies to do so.
- *Increase in drafts:* Inadequate drafts are a major issue limiting the growth of water transport in the sector. It is recommended that drafts at both in channel and at berths at major ports must be increased (at least 14 to 17 meters) by 2017 with the objective of building capacity to accommodate bigger vessels.
- *Upgradation/Development of infrastructure:*
  - Set up coastal terminals at major ports
  - Upgrade existing port/ develop mega ports
  - Develop more cargo handling facilities
- **Efficiency improvements:** To improve operational efficiencies, it is essential that adequate measures are taken to reduce dwell time and turnaround time at the ports. This would include measures such as technology improvements, capacity increase, measures for more efficient cargo evacuation from terminals, etc.
- Improve hinterland connectivity



## Civil Aviation

Civil aviation though energy intensive plays a crucial role in economic growth and promotes international trade. Greening of the aviation sector is essential given the high overall costs of the sector and the associated externalities. To deal with the present challenges faced by the sector, the following interventions have been suggested:

- Develop airports as inter modal hubs for easy and smooth transfers and increased efficiency
- Removal of capacity bottlenecks and upgradation of existing infrastructure to increase handling capacity
- Develop new airports for improved connectivity especially to north-eastern states
- Rationalization of ATF prices to improve financial performance and make the industry more competitive
- Encouraging emergence of regional airlines to cater to air transport needs of Tier II and Tier III towns and promoting low cost carriers for this purpose.
- Setting up of National Aviation University to meet critical skill development needs of the aviation sector
- Ensure adequate safety measures are taken from time to time with increase in operations over years.

### 4.2.2 Shift from personalized modes to public transport and non-motorized transport

In view of the need to reduce energy demand for cities, increased attention must be given to promoting and incentivizing a shift from personalized modes to more sustainable modes i.e. Public transport and non-motorized modes. Share of public transport on the average should be aimed at 60% of motorized trips and 35% of total trips including walk (Working Group on Urban Transport, National Transport Development Policy Committee, 2012).

- a. **Provision of adequate PT services:** Public transport to be integrated, multimodal and citywide with efficient interchanges and should provide a high level of service. It is recommended that all cities with a population of one lakh plus to have organized public transport (Working Group on Urban Transport, National Transport Development Policy Committee, 2012). Appropriate systems and technologies must be selected based on the needs and structure of the city. The Working group on urban transport for the NTDPC Report suggests the following systems for cities with different population sizes:
  - o Organized city bus service as per Urban bus specifications in all 1 lakh+ cities and state capitals;
  - o Add BRTS in cities with pop. > 1 Mn;
  - o Cities with population >2 Mn to start planning rail transit projects, with 3 Mn to start construction. Estimated requirement 10 km per Mn;
  - o In existing mega cities, Metro rail to be expanded @ minimum 10 km per/year
  - o Suburban rail to be provided in urban agglomeration with population > 4 Mn
- b. **Organize and integrate informal modes:** Better organization and integration of private run informal public transport modes must be looked into as these modes

already serve mobility needs of a large section of population in urban as well as rural India.

- c. *Improve quality of service of the existing PT systems to attract higher shares*
- d. *Provide safe and adequate NMT infrastructure:* In view of short trip lengths and mixed landuse structure of Indian cities, promoting NMT can prove to be very beneficial in reducing the energy demand and also emissions in the urban transport scenario in India. Adequate measures should be taken to retain the current modal shares and also further promote NMT as a mode of choice.
  - Develop dedicated NMT infrastructure: Walk and cycle lanes to be provided in all 2 lakh+ cities and state capitals. Facilities for walk and bicycling should be developed at the city level and not in isolation or parts. Cycle rickshaw to be a part of the public transport network
  - NMT plans should be made a mandatory component of CMP
  - Priority should be given to NMT projects in funding.

#### 4.3 Improve energy efficiency of the existing vehicle fleet

Vehicle fleet in India has increased dramatically and is further expected to rise; and so are the resulting emissions. It is critical that more energy efficient fuels and vehicle fleet/technologies are introduced to reduce the emission load and achieve better air quality levels. This would include interventions such as

- a. *Upgradation of fuel quality:* Promoting cleaner fuel by reducing sulphur content can lead to significant reduction in emissions. The government should mandate BS-IV or low sulphur fuel (50 ppm) in the country without any further delay. BS-V fuel or the ultra-low sulphur fuels (10 ppm) should be mandated in the country by 2020. This would seek substantial investments for technology upgradation of the refineries for production of cleaner fuels.
- b. *Tighten vehicle emission standards:* Given the expected rapid increase in vehicle fleet in the coming decades, it is important that appropriate interventions are adopted to reduce the emission of pollutants from vehicle engines. As suggested by Auto Fuel Policy 2025, the whole country should move to BS-IV norms by 2017 and target to reach BS-VI by 2020. *3.3 Introduce fuel consumption standards for improved fuel efficiency:* The fuel consumption standards for LDVs have already been set but are yet to be operationalized. These standards should be notified immediately. Standards should also be developed for HDVs and two and three wheelers on priority basis so as to improve their fuel efficiency.
- c. *Encourage fleet modernization:* Government of India should run a programme to incentivize the elimination of older vehicles from road transportation.



- Retrofitting of after-treatment devices (such as exhaust gas recirculation (EGR), diesel particulate filters (DPF), selective catalytic reduction (SCR) into diesel vehicles should be done for significant reductions in PM emissions.
- d. *Upgrade in house testing (Inspection and maintenance (I&M) regime)*: Vehicle testing needs should move beyond type approval and conformity of production to include in-use testing (NTDPC, 2014). The government should look at replacement of existing Pollution under Control (PUC) centers with a smaller number of modernized and automated centers that can be effectively monitored by the state governments. Provisions should also be made to allow fuel testing at retail outlets. Apart from the above, stricter enforcement must be ensured.

#### 4.4 Plan a transition to cleaner fuels

Energy use in the transport sector will rise in the coming decades with increase in vehicle fleet. In view of the rising emissions from the current fuels, feasibility of more cleaner and greener fuels should be explored. The use of electric and hybrid vehicles is a cleaner transport alternative with zero emissions (provided electricity is produced by renewables or natural gas) and can reduce dependency on petroleum products (ICAMP, 2014). A proper roadmap should be developed highlighting the costs and benefits of switching to a particular fuel and pre requisites to enable and facilitate that shift. Adequate research and funding should be made available to explore the feasibility of different fuels followed by adequate regulations and incentives to facilitate penetration of newer fuel and technologies. The recently launched FAME scheme of the Government of India is in line with the objective of promoting electric and hybrid vehicles sales in the phased manner over a time period of six months.

#### 4.5 Integrated land use and transport planning

The spatial arrangement of the various land uses or activities across the city is a very important factor in determining the intra city travel demand. Therefore, any efforts towards integrated land-use and transport planning can significantly help in reducing the need to travel and lead to reduction in associated costs. For more integrated development of cities,

- City officials should be encouraged to develop integrated land use transportation plans in a way that serves the entire population as well as considerably reduces the need to travel.
- Promote high densities and mixed land use development for compact cities
- Unified transport and urban development agency should be setup that acts as an umbrella organisation overlooking and coordinating the multiple agencies working on the different dimensions and aspects of city and transport planning.

#### 4.6 Travel demand management (TDM)

TDM would include interventions (excluding provision of major infrastructure) to modify travel decisions so that more desirable transport objectives of social, economic and/or environmental sustainability can be achieved, and the negative externalities of travel can be reduced (MoUD, 2013)

**a. Use of new Information and Communications Technology (ICT) systems to reduce travel demand**

Information and Communications Technology (ICT) is increasingly seen as a possible means to complement and/or improve the efficiency of physical mobility.

- Measures like promoting e- governance programs, promoting telecommuting/e-work and e-trade can significantly in reduction of the number of trips.
- Encourage use of Intelligent Transport Systems (ITS)

**b. Discourage use of personal vehicle ownership and use**

Several measures like high fuel prices, vehicle related taxes, vehicle quota scheme, registration tax, annual vehicle license fees and linking vehicle purchase with parking availability can help in discouraging vehicle ownership to a great extent.

Controlling vehicle usage becomes important as vehicle ownership controls do not help once the vehicles are on road. Measures to control usage of private vehicles on road include increasing the cost of usage of private modes, road pricing/ congestion pricing, parking management etc.

**c. Encourage ride sharing/ carpooling to reduce number of trips.**

## 4.7 Improve safety conditions

Poor safety conditions particularly in the road sector needs immediate attention. Improvements in road safety conditions should assume priority.

- Revisit and update road design standards to ensure that the needs of all user categories are looked into;
- Develop a roadmap to achieve targeted reduction in road accidents and fatalities;
- Adequate provisions should be made to include adequate safety features in vehicle design;
- Stricter enforcement of traffic rules;
- Setup a dedicated body for road safety with clear goals and functions;
- Organize road safety awareness programs for drivers', children and others.

It is to be noted that to assist and facilitate the implementation of the green interventions discussed above, appropriate enabling conditions must be ensured. These conditions would include a wide range of policies like setting up appropriate planning and regulatory frameworks, data/information systems, setting up the right economic incentives, ensuring availability of adequate funds, strengthening of the current institutional setting, training and capacity building and also generating mass awareness among the citizens to promote behavioral changes in the form of modal choices.

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## **About TERI**

A unique developing country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. TERI has grown to establish a presence in not only different corners and regions of India, but is perhaps the only developing country institution to have established a presence in North America and Europe and on the Asian continent in Japan, Malaysia, and the Gulf.

TERI possesses rich and varied experience in the electricity/energy sector in India and abroad, and has been providing assistance on a range of activities to public, private, and international clients. It offers invaluable expertise in the fields of power, coal and hydrocarbons and has extensive experience on regulatory and tariff issues, policy and institutional issues. TERI has been at the forefront in providing expertise and professional services to national and international clients. TERI has been closely working with utilities, regulatory commissions, government, bilateral and multilateral organizations (The World Bank, ADB, JBIC, DFID, and USAID, among many others) in the past. This has been possible since TERI has multidisciplinary expertise comprising of economist, technical, social, environmental, and management.



The Energy and Resources Institute

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