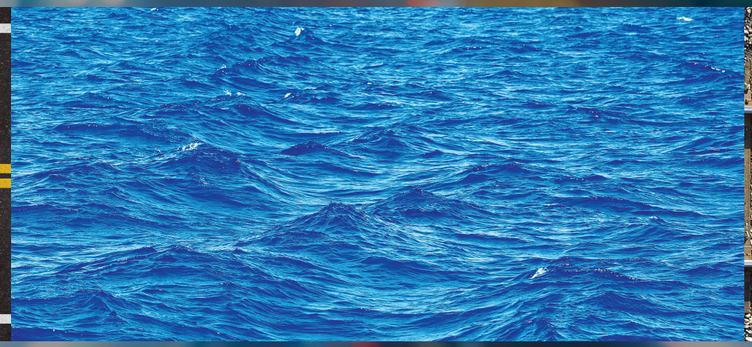
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VOLUME II
MAIN REPORT
PART II

INDIA TRANSPORT REPORT









MAIN REPORT

MOVING INDIA TO 2032

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NATIONAL TRANSPORT DEVELOPMENT POLICY COMMITTEE

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Government of India

VOLUME II
MAIN REPORT
PART II

INDIA TRANSPORT REPORT

MOVING INDIA TO 2032

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LONDON NEW YORK NEW DELHI

NATIONAL
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POLICY
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Rakesh Mohan
Chairman
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January 31, 2014

Dear Hon'ble Prime Minister,

I have great pleasure in submitting to you the Report of the National Transport Development Policy Committee.

I regret very much the great delay in submission of this report. Covering all the transport sectors in detail, while also addressing the various cross cutting issues, entailed a large amount of technical work, which proved to be time consuming. Much of the sectoral work was accomplished through the appointment of corresponding working groups. We also examined international best practice to inform our work; consulted state governments and other stakeholders; and commissioned research studies and papers on specific topics.

Projecting transport requirements and policy over a twenty year horizon is a complex task. This was made more difficult in the current circumstances of an economic slowdown. In our projections we have, however, assumed that the pace of overall economic growth will return to its potential in the coming years and ensuing decades. Transport investment is a response to emerging demand, but it is also an economic growth driver in itself. Transport planning and provision therefore must be seen as central to the growth planning process. That all modes of the country's transport network are under severe pressure is clearly evident. It will be difficult to achieve the kind of growth envisaged if adequate transport investment is not made in an efficient and timely manner.

We find that there has been an accelerating shift of traffic from the railways in favour of roads, partly in response to the stepped up allocation of resources to the roads sector. A massive effort is now required to carry out a similar enhancement of investment in the railways, which will also involve very significant modernization and reorganization, and will also lead to greater environmental sustainability.

The next two decades will witness very significant changes in energy prices, in the discovery and application of new technologies, demographic shifts, and in consumer requirements and tastes in transport. Any projections and policy recommendations made now are almost certain to need modification over time. We have therefore emphasized the importance of institution building for transport governance and of the need for capacity building in the human resources area to raise the level of skills and professional knowledge in the sector, and for research and development. We have also placed special emphasis on institution building and measures for the promotion of safety in all transport modes, and for protection of the environment.

A particular focus of the report is highlighting the need to achieve much greater transportation integration with the South and South East Asia regions. In a world characterized by rapidly increasing economic linkages between countries our region stands out as being among the least integrated. This must be repaired.

Our vision is that a well-developed and competent institutional system for planning, management and execution of transport should be in place as soon as possible, as it blends investment in and delivery of transport services by the public, private and joint sectors alike. The Report abstracts from current methodologies to solve today's problems, while forging a coherent strategy for the transport sector as a whole and for each of the modes of travel.

To meet the needs of India in the 21st century, radical structural change is necessary along with a new strategy for investment.

I would like to acknowledge the generous help and time given by all Members of the NTDPC, the staff of the secretariat, and many other colleagues.

With warm regards,

Yours sincerely,

(Rakesh Mohan)

Dr. Manmohan Singh,
Prime Minister of India
South Block,
New Delhi.

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New Delhi
31 December 2013

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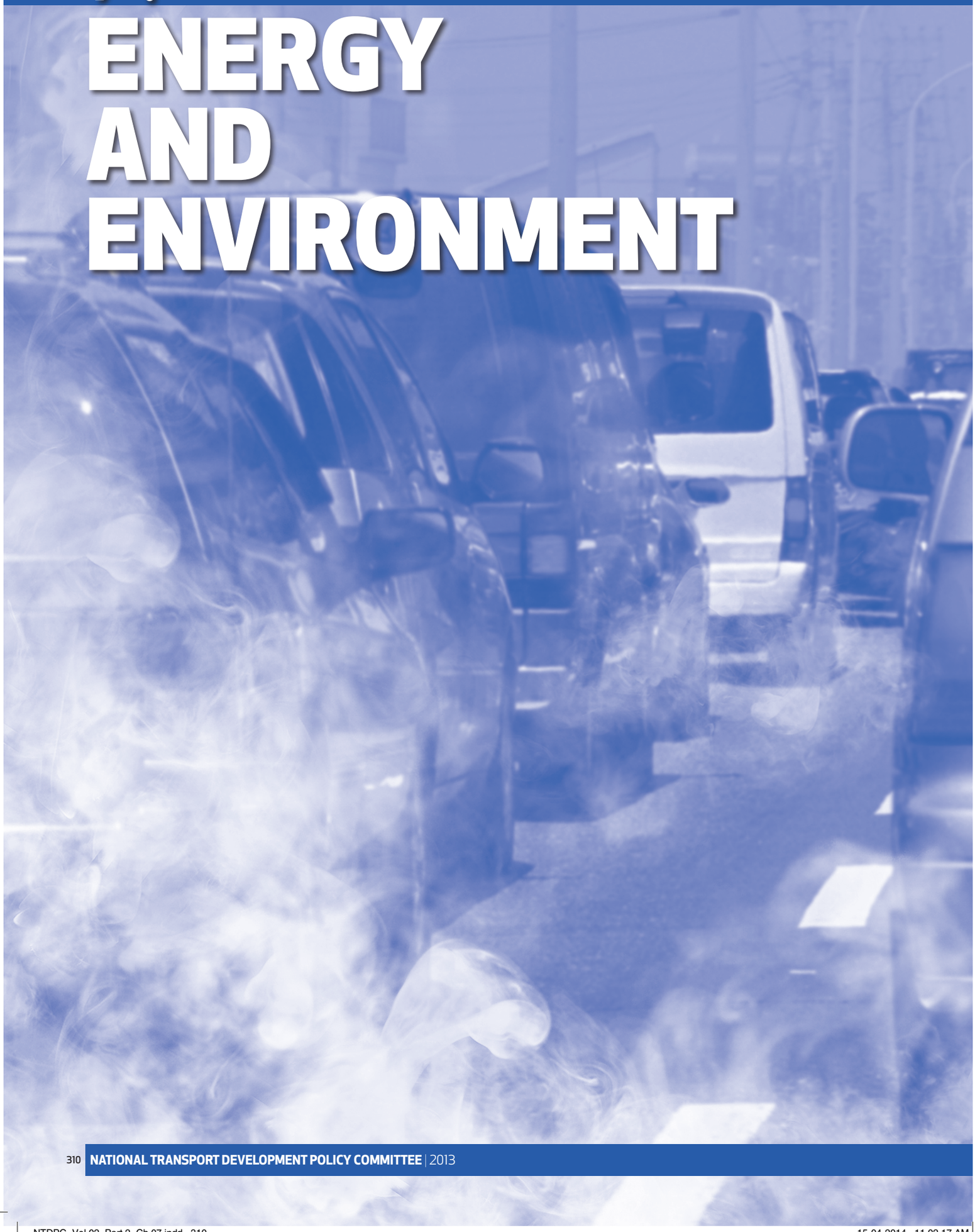
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7. ENERGY AND ENVIRONMENT



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7. ENERGY AND ENVIRONMENT

Vehicle ownership has soared in India over the last two decades. In 1991, according to the Ministry of Road Transport and Highways (MoRTH), the number of vehicles registered in the country was just over 21 million. By 2011, the number had increased to 142 million.

The high growth rate of new vehicle registrations is expected to continue, at least through the remainder of this decade.

The continued growth of the transport sector may be vital for further economic development, but it has exacerbated India's critical air pollution problem: vehicular emissions. Hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_X), particulate matter (PM), and carbon dioxide (CO_2) are a critical issue that has to be tackled on a wartime footing.

In 2011, many Indian cities featured in the World Health Organisation's (WHO) list of the world's 100 most polluted cities. The 2010 Global Burden of Disease (GBD 2010) report listed ambient air pollution as the sixth most important cause of death in South Asia. According to a recent study for six cities—Delhi, Kanpur, Bengaluru, Pune, Chennai, and Mumbai conducted by the Central Pollution Control Board (CPCB), the transport sector is responsible for a majority of NO_X and 30-50 per cent of PM emissions in these cities (Box 7.1).

The problem is widespread. In 2008, the CPCB identified around 70 cities, representing over 80 per cent of cities that were being monitored, that were not complying with the NO_X and PM standards. This was before more stringent air quality standards were brought into effect in 2009. An analysis by the Clean Air Initiative (CAI) Asia of PM concentrations in 130 cities in India also indicated that most of the cities exceeded the national standard, as shown in Figure 7.1. Many of these cities have air pollution levels far above the legal limit, have continuously been in non-compliance for many years, and have no tangible plans to drastically improve air quality in the near future. Increasing vehicular emissions leading to poor air quality have significant negative impacts on public health. Traffic-related air pollution, especially PM and NO_x, has been shown to lead to premature morbidity and mortality. A study supported by the WHO estimated about 154,000 people died in India in 2005 as a result of ambient fine particulate matter ($PM_{2.5}$) alone. This number has most likely increased since.

In 2002, the WHO calculated a respiratory disease mortality rate of 58 persons per 100,000 in India. By 2008, this rate had increased to 101 persons per 100,000. A meta-study by the Health Effects Institute (HEI) looked at the effects of air pollutants on human health by analysing numerous studies from around the world. It found 'suggestive' or 'sufficient' evidence that traffic-related air pollution leads to cardiovascular morbidity, asthma incidence and other respiratory illnesses in children, reduced lung function, and all-cause mortality. Studies conducted in India found much of the same results as the HEI meta-study: air pollution is linked to a variety of morbidity and mortality endpoints.

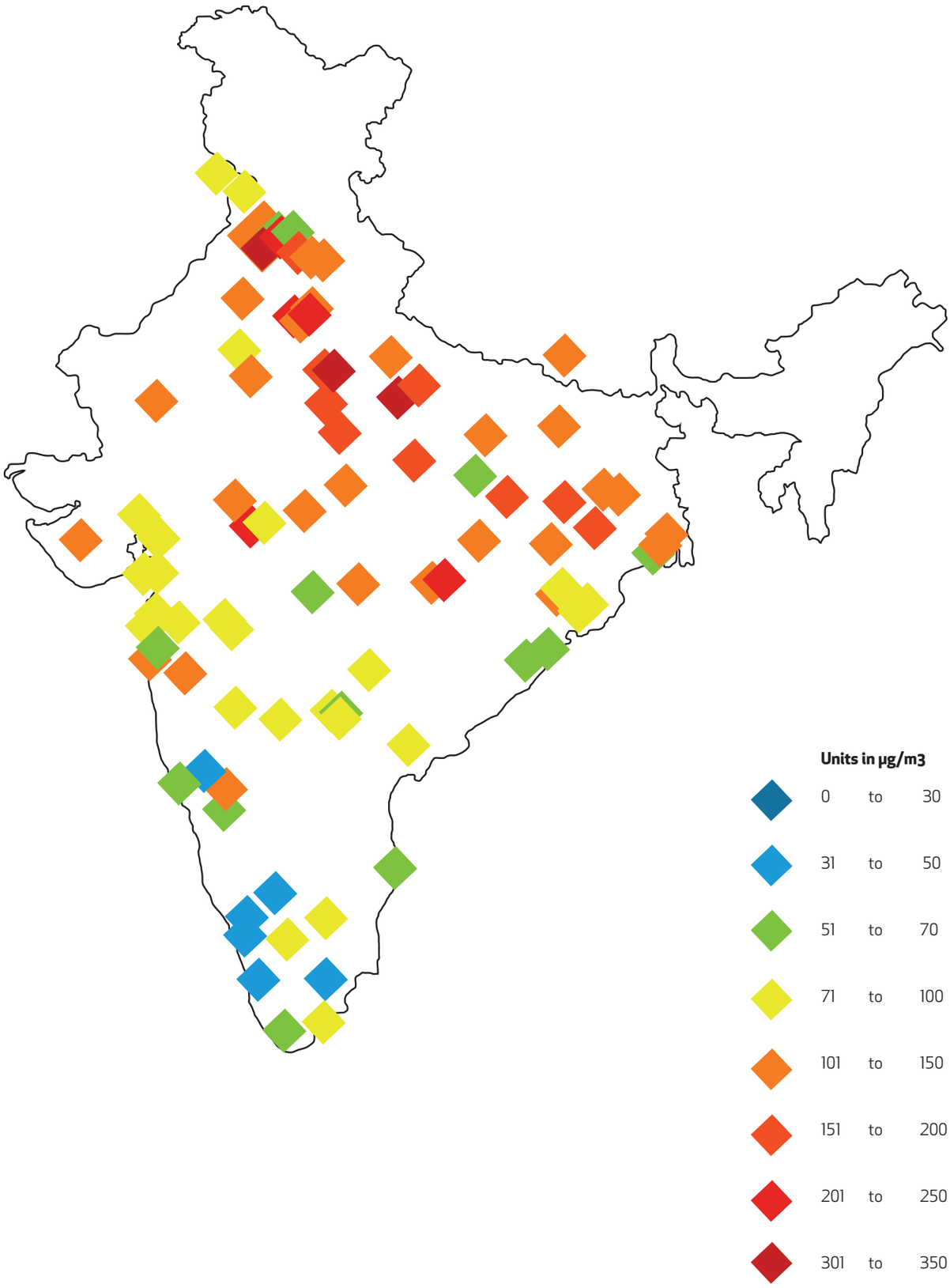
The transport sector accounts for nearly 18 per cent of the total energy consumed in India, second only to the industrial sector. Nearly 98 per cent of the energy needs of transportation are met through petroleum products, and almost half of the total consumption of petroleum products in India occurs on account of transport activities[1]. This demand for energy is expected to grow if no action is taken.

Of the 142 MT CO_2e emissions released by the transport sector in 2007, 87 per cent were on account of road-based vehicular activities[2]. If no action is taken, overall transport CO_2e emissions can come close

1. TERI (2012).
2. Ministry of Environment and Forests (2010).

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Figure 7.1
Annual Average PM Concentrations in 137 Indian Cities in 2008



Source: Clean Air Initiative for Asian Cities (CAI-Asia), 2010. "Clean Air Management Profile (CAMP) India: 2010 Edition". CAI-Asia Centre. Pasig City, Philippines.

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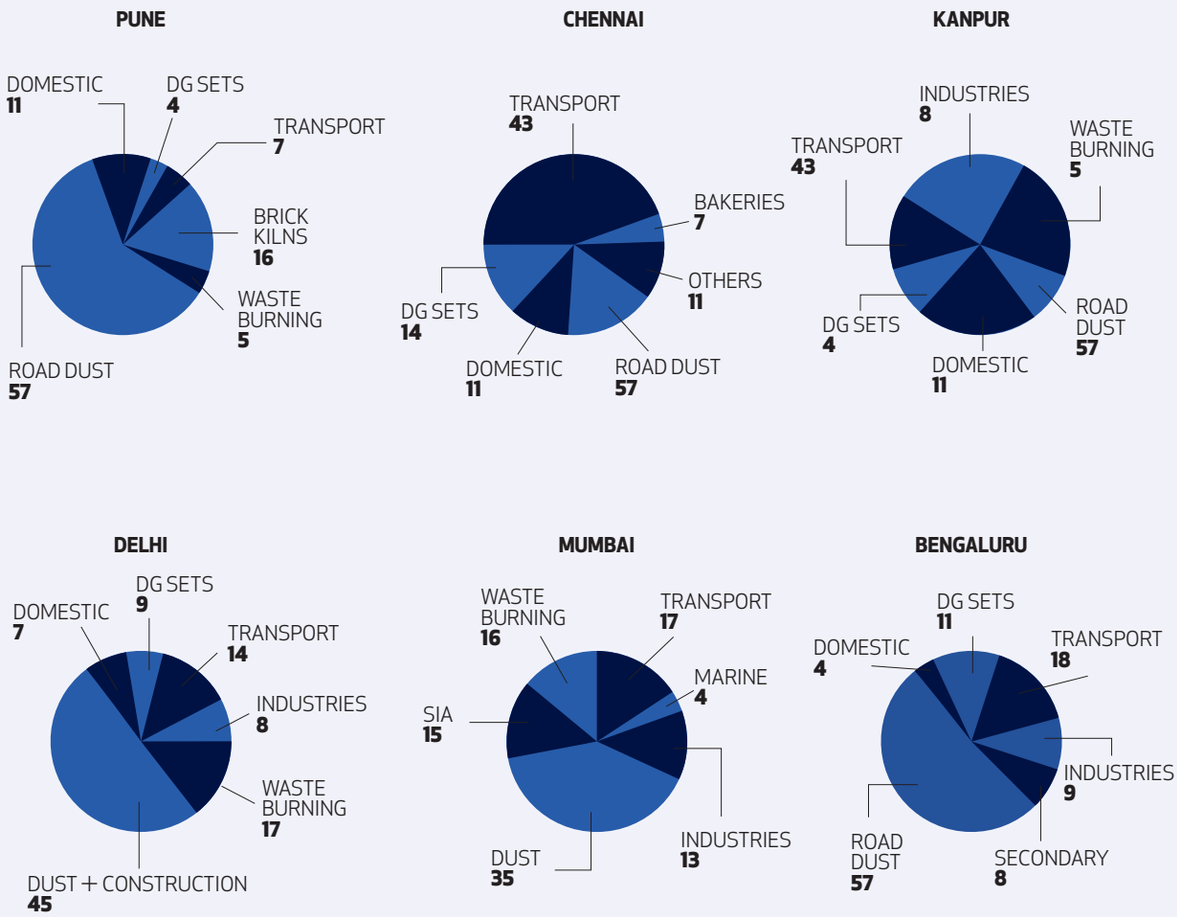
Box 7.1

Transport and Particulate Matter: The CPCB Study

In 2011, the Central Pollution Control Board (CPCB) and the Ministry of Environment and Forests, Government of India, jointly published the results of receptor modelling of particulate pollution in six cities—Pune, Chennai, Kanpur, Delhi, Mumbai, and Bengaluru. The receptor modelling studies are carried out in three steps—collecting samples at representative locations in the city, chemical analysis of the samples to identify the quantities of marker elements for various sources, and statistical mass balance modelling of the results of chemical analysis of the ambient and source samples.

Urban air pollution is a complex issue, fuelled by multiple sources ranging from vehicle exhaust, on-road re-suspended dust due to vehicles, industrial flumes, construction dust, garbage burning, to domestic cooking and heating, and some seasonal sources such as agricultural field residue burning, dust storms and sea salt (for coastal areas). Receptor modelling is one way of apportioning these contributions and this methodology is dependent on the location of the sampling sites. For the six cities, the sampling was carried out at domestic, industrial, and kerbside locations and an average for all samples is presented in the figure below. For total PM emissions (particulate matter with aerodynamic diameter < 10 μm), transport remains an important source—from direct vehicle exhaust emissions and indirect re-suspension of dust due to constant movement of vehicles on the road.

Average Per cent Contributions of Major Sources to Particulate Pollution



Source: CPCB (2011).

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Figure 7.2
Timeline of Implementation of New LDV Standards in Select Countries

LIGHT-DUTY VEHICLE EMISSION STANDARDS SCHEDULE										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
India	Bharat II					Bharat III				
India - 13 Cities*	Bharat III					Bharat IV				
China**	China II			China III			China IV			
Europe	Euro 4					Euro 5				Euro 6
Brazil**	Proconve L3 (Euro 2)		Proconve L4 (Euro 3)		Proconve L5 (Euro 4)				Proconve L6 (Euro 5)	
Thailand	Euro 3							Euro 4		
Argentina	Euro 2		Euro 3		Euro 4					

Source: NTDPC Research.
Note: *Delhi, Mumbai, Kolkata, Chennai, Bangalore, Surat, Agra, Hyderabad, Pune, Ahmedabad, Kanpur, Lucknow, Solapur
**Select cities have more stringent standards

to 1000 MT by 2030, a fourfold increase from 260 MT in 2010[3].

India requires appropriate measures for urban planning, transport infrastructure development, and stringent standards and enforcement to reduce fuel consumption and emissions to curb this extraordinary growth in transport sector energy consumption and pollutant and greenhouse gas (GHG) emissions,. The current approach to urban planning and infrastructure development, that incentivises vehicle use, will have to change. The latest emissions control technologies that are already available will have to be taken advantage of to leapfrog to tighter emission standards and reduce fuel consumption. Additionally, current emission test cycles will need to be replaced by more stringent ones and in-use emissions compliance programmes will have to be solidified to ensure strict enforcement of regulations.

In many cases, these diverse problems overlap. Solutions for one help solve others. For example, measures to reduce vehicle PM emissions also help reduce Black Carbon (BC) emissions, which is a growing concern. This not only improves air quality and public health, it mitigates global warming. Similarly, many vehicle technologies that reduce pollutant emissions also improve vehicle fuel efficiency.

This chapter takes a holistic look at India's road transport sector's growing energy consumption and emissions, and it highlights the negative effects of these and possible ways to mitigate them.

VEHICULAR AIR POLLUTION IN INDIA

The impetus for vehicle emissions regulations in India began in the 1980s, with laws such as the Air Act, 1981, Environment (Protection) Act, 1986, and Motor Vehicles Act, 1988. In 1985, an expert committee was constituted to determine vehicle emission norms for new vehicles, finalise vehicle testing procedures, and approve laboratories. The committee's recommendations were notified in 1990 and India's first-ever new vehicle emission limits and pollution under control (PUC) programme for in-use vehicles were established.

In the early 1990s, a new committee led by retired Justice K. N. Sakia was appointed under the direction of the Supreme Court with the aim of examining measures to further reduce vehicle emissions in the short- and long-term. The Sakia Committee's recommendations focused on Delhi, but it established precedents that were applicable for the rest of the country.

In 1992, a separate committee constituted by the CPCB and led by Prof. H. B. Mathur recommended fuel quality and emission standards for the rest of the decade. As a result, lead in fuels was gradually phased out, fuel sulphur content was reduced, and emission limits for new vehicles were progressively tightened.

At the turn of the century, a committee led by Dr. R. A. Mashelkar was formed at the request of the Prime Minister. The Mashelkar Auto Fuel Policy Committee called for progressively tighter vehicle emission and fuel quality standards, based mostly on European regulations. The committee also recommended two sets of standards: one with more stringent norms for a few targeted cities, and the other for the remainder of the country. The Committee's recommendations were applicable through the year 2010. In January 2013, the Government of India constituted a new Auto Fuel Policy Committee to recommend vehicle emission standards and fuel quality regulations through 2025.

3. TERI (2009).

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Figure 7.3
Timeline of Implementation of New HDV Standards in Select Countries

HEAVY-DUTY VEHICLE EMISSION STANDARDS SCHEDULE										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
India	Bharat II					Bharat III				
India: 13 Cities*	Bharat III					Bharat IV				
China** China IV	China II		China III						China IV	
Europe	Euro IV			Euro V					Euro VI	
Brazil**	Euro II	Proconve P5 (Euro III)						Proconve P7 (Euro V)		
Thailand	Euro 3							Euro 4		
Argentina	Euro II	Euro III			Euro IV					

Source: NTDPC Research.
Note: *Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Surat, Agra, Hyderabad, Pune, Ahmedabad, Kanpur, Lucknow, Solapur
**Select cities have more stringent standards

CURRENT VEHICLE EMISSION STANDARDS

Light-Duty Vehicles (LDV) India follows the European pattern for LDV emission regulations. Thirteen cities are at the Bharat IV (Euro IV equivalent) level, while the rest of India is at Bharat III. Europe is at Euro V, and plans to move to Euro VI by 2014. This means that new Indian vehicles are not fitted with the most advanced emission reduction technologies, despite these technologies being available to Indian automakers.

India also lags behind Brazil and China, both of which are fast developing countries like India and base emission regulations on the European pattern. China implemented China IV standards nationwide in 2011 with Beijing further ahead at China V. Thailand, too, has moved ahead to Euro IV nationwide. Brazilian LDV emission standards were behind Indian standards in 2005, but since then, Brazil has jumped well ahead. Similarly, Argentina moved to Euro IV in 2009. Figure 7.2 shows the timeline of implementation of new LDV standards in select countries.

HEAVY-DUTY VEHICLES (HDV)

For HDV regulations too, India follows the European pattern. The 13 cities with Bharat IV LDV standards also mandate Bharat IV HDV standards while the rest of country follows Bharat III.

India lags behind Europe, China, and Brazil in HDV emission standards. Euro VI emission standards, which require diesel particulate filters, went in to effect in January 2013 for new engines and in January 2014 for all engines sold across Europe. China implemented China IV HDV standards from July 2013, while Beijing implemented China V standards from February 2013 onwards. Thailand implemented Euro IV standards in 2012. Brazil mandated Euro V equivalent standards for HDVs at the beginning of 2012, leapfrogging over Euro IV. Argentina moved to Euro IV in 2009. Figure 7.3 shows the timeline of implementation of new HDV standards in select countries.

TWO- AND THREE-WHEELERS

India does not follow the European regulatory pattern for two- and three-wheelers. Instead, it uses the India Drive Cycle (IDC) to test their emission, and set emission limits accordingly. Currently, Bharat III standards are mandated nationwide for all two- and three-wheelers.

Since India does not follow European regulations for two- and three-wheelers, established Bharat IV and higher regulations do not apply to this class of vehicles. India will have to develop new emission limits to tighten standards under the IDC. Europe, which is currently at Euro III for two- and three-wheelers, has already planned to go to Euro VI by 2020. A recent expert report detailed pathways for similar action in India.

NON-ROAD VEHICLES

India first regulated non-road vehicles in 1999, with the implementation of emission standards for agricultural tractors. These were tightened over the next decade. It then implemented separate standards for construction equipment in 2007. Since then, India has worked to unify emission limits for both categories, although a few differences remain.

TEST CYCLES

India currently uses European test cycles to determine emissions from LDVs and HDVs. For two- and three-wheelers, it uses its own unique test cycle. For non-road vehicles, it follows US test cycles and procedures. In these test cycles, the emissions are often quite different from those under real-world conditions. While it is impossible to create test cycles that represent real-world conditions with perfect accu-

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Figure 7. 4
Timeline of Gasoline Sulphur Content Reduction in Select Countries

GASOLINE SULPHUR CONTENT SCHEDULE (PPM)										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
India	500					150				
India - 2010 Cities**	150					50				
India - 2012 Cities*	500					150		50		
China§	500					150				
Brazil§	1,000									50
Europe	50				10					
Japan	50			10						
Thailand	150							50		

Source: NTDPC Research.
Note: *Puducherry, Mathura, Vapi, Jamnagar, Ankleshwar, Hissar, Bharatpur, Daman, Diu, Silvasa, Unnao, Raebareli, and Aligarh
**Delhi, Mumbai, Kolkata, Chennai, Bangalore, Surat, Agra, Hyderabad, Pune, Ahmedabad, Kanpur, Lucknow, Solapur
§ - Select cities have lower sulphur content

racy, India has been a party to the development of world-s-test cycles, along with other countries. These include a much wider variety of driving conditions than current Indian test cycles. Therefore, they are much more comprehensive in their requirements and make it harder to create a vehicle that 'beats' the test cycle but emits much more in reality.

Europe already has plans to replace its test cycles with world-harmonised test cycles for all vehicle types. India has taken the positive step of allowing the world-harmonised motorcycle test cycle (WMTC) to be used in place of the IDC for two-wheeler testing, but it has yet to do the same for other vehicle types.

EVAPORATIVE EMISSION

As exhaust emissions fall, evaporative emissions become increasingly relevant. Anticipating a move to Bharat VI and beyond in the future, India can begin to establish evaporative emissions now.

Apart from evaporative emissions from vehicles, fumes emitted during refuelling are harmful to human health and the environment. There are a number of vapour recovery systems that can minimise them. India should assess these options.

HISTORY OF FUEL QUALITY STANDARDS

For progressively tighter vehicle emission standards to be implemented, it is important to set fuel quality standards that enable clean vehicle technologies to function optimally.

An important achievement has been the removal of lead from all fuels in the country since the year 2000. After lead, sulphur content is the most important element that affects vehicle emissions. Fuel sulphur inhibits the proper functioning of many emission control systems. India has successfully reduced sulphur content in all its fuels over the last 20 years. Nevertheless, sulphur levels remain higher than what is necessary for the latest clean vehicle technologies to be implemented effectively.

There are other fuel quality parameters too that affect emissions, albeit less significantly. India has made important progress in improving fuel quality on all these parameters.

CURRENT FUEL QUALITY STANDARDS

India's current fuel quality standards took effect in 2010, at the same time as the implementation of the latest vehicle emission standards. Bharat IV fuel quality standards were mandated in 13 cities. Since then, 13 more cities have started receiving Bharat IV fuel. A total of 63 cities should receive Bharat IV fuel by 2015.

The current dual fuel status leads to a situation where Bharat IV vehicles, designed to operate on lower sulphur fuel, refuel in Bharat III areas. This is particularly problematic for commercial vehicles, which often do not operate in just one metropolitan area. Since many emission control technologies require low sulphur fuel to function correctly, Bharat IV vehicles refuelling on Bharat III fuel are likely to emit more than they are designed to.

GASOLINE FUEL QUALITY STANDARDS

India has made important progress in reducing gasoline sulphur content, roughly consistent with fuel sulphur content in China over the last few years. But it yet remains well behind international best practices. Europe and Japan have mandated a maximum sulphur content of 10 ppm in gasoline, and Brazil plans to leapfrog to 50 ppm sulphur gasoline by 2014. Thailand introduced 50 ppm gasoline in 2012. Figure 7.4 shows the timeline of gasoline sulphur content reduction in India and other countries.

DIESEL FUEL QUALITY STANDARDS

As with gasoline, India has significantly reduced the sulphur content in diesel over the last two dec-

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Figure 7.5
Timeline of Diesel Sulphur Content Reduction in Select Countries

DIESEL SULPHUR CONTENT SCHEDULE (PPM)										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
India	500					350				
India - 2010 Cities**	350					50				
India - 2012 Cities*	500					350		50		
China§	2,000							350		
Brazil§	2,000				1,800	1,800-500[1]				500
Europe	50				10					
Japan	50		10							
Thailand	350							50		

Source: NTDPC Research.
Note: *Puducherry, Mathura, Vapi, Jamnagar, Ankleshwar, Hissar, Bharatpur, Daman, Diu, Silvasa, Unnao, Raebareli, and Aligarh
**Delhi, Mumbai, Kolkata, Chennai, Bangalore, Surat, Agra, Hyderabad, Pune, Ahmedabad, Kanpur, Lucknow, Solapur
1 - Transitional: 1800 ppm will gradually be substituted by 500 ppm
§ - Select cities have lower sulphur content (10-50 ppm) to enable Euro V equivalent trucks and buses

ades. Despite this, diesel sulphur content remains higher than gasoline sulphur content in most of the country, and well below international best practices. Europe and Japan have mandated a maximum of 10 ppm sulphur in diesel. Mexico is in the process of implementing 15 ppm sulphur. Thailand implemented 50 ppm diesel nationwide in 2012. Figure 7.5 shows the timeline of diesel sulphur content reduction in India and other countries.

FUTURE VEHICLE EMISSION & FUEL QUALITY STANDARDS

Since 2010, there has been no real initiative in India to move to more stringent standards, or to expand Bharat IV to cover the entire country. This means India will continue to lag behind international best practices, and the gap will only widen as other countries take action while India does not.

The Mashelkar Committee had recommended in 2003 that an Auto Fuel Policy Committee be formed every five years to review progress and keep abreast of international regulatory and technology developments. The Government of India constituted a new Auto Fuel Policy Committee in January 2013 finally to recommend vehicle emission standards and fuel quality regulations through 2025.

CURRENT COMPLIANCE & ENFORCEMENT MECHANISMS

In any country, set standards are only as good as the compliance and enforcement mechanisms. In India, there are many laws and legal precedents that establish mechanisms for the enforcement of vehicle emission and fuel quality standards. A number of government ministries and agencies work on these issues.

MoRTH is the nodal ministry for vehicle emission regulations, collaborating with other ministries and agencies to carry out its duties.

Compliance and enforcement of vehicle emission regulations are separate for new vehicles and in-use vehicles. New vehicles undergo Type Approval (TA) and Conformity Of Production (COP) testing to ensure they meet set standards. These are usually conducted by certified testing agencies. In-use vehicles undergo PUC checks. Vehicle owners are responsible for taking their vehicles to local certified centres for these tests.

But TA and COP are not linked with PUC. The former two are national programmes that rely on new vehicle standards. PUC enforcement is done at the local or state level, and it relies on separate standards uncoupled from the vehicle's original emission standards. India does not have a national in-use testing programme that looks at a vehicle's original emission standards and set deterioration rates.

Another problem is that responsibility for compliance and enforcement is splintered. The MoRTH is ultimately responsible for vehicle compliance issues, but the primary vehicle testing agencies it relies on for this fall under the aegis of the Ministry of Heavy Industries (MoHIPE).

The MoHIPE only partially funds these agencies. They have to rely on automobile companies, the very companies they are regulating, for much of their funding. In 2003, the Mashelkar Committee had recommended the creation of a single, government-funded agency responsible for all vehicle emission and fuel quality issues, including compliance and enforcement. Unfortunately, this recommendation was not adopted by the government.

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Table 7.1
Estimated On-Road Vehicular Population in India in 2030

STUDY	ESTIMATED ON-ROAD VEHICLE POPULATION IN 2030
ICCT (2012)	430 Million
TERI (2009)	315 Million
Guttikunda and Jawahar (2012)	426 Million
ADB (2006)	373 Million*

* For 2035

Officially, fuel quality regulations are handled by the Ministry of Petroleum & Natural Gas (MoPNG). In reality, it is usually managed by oil companies, which test fuel quality at various stages of production and distribution. While representatives from the MoPNG are required by law to be present at refineries and oil depots to sign off on every batch of fuel, there is little evidence that this actually happens. Fuel transporters are required to have permits issued by state governments, up-to-date lists of the retailers they supply, and quantities of fuels supplied to them.

But again, there is little evidence that this is done properly. A 2006 study by the Indian Institute of Management (IIM) Ahmedabad found that the reporting and recordkeeping on the part of fuel transporters was sloppy at best. Little was being done to ensure that trucks were going to their assigned destinations. Tracking each supply truck was not deemed feasible. Exacerbating the situation, corruption among transporters and those responsible for enforcing rules was high, especially among lower level employees.

Lax enforcement, corruption and government subsidies for certain fuels over others gives rise to fuel adulteration, in which cheaper fuels, such as diesel and kerosene, are mixed with more expensive fuels, such as petrol. Both the IIM Ahmedabad study and an earlier study by the Centre for Science and Environment (CSE) found adulteration to be a problem in many parts of India. A special anti-adulteration cell within the MoPNG was set up in 2001 to specifically tackle this issue, but it itself was laden with corruption and shut down in 2004. Another result of inadequate government vigilance of fuel quality compliance is that independent fuel testing laboratories, such as one established in Noida, are not utilised to their full potential. These labs do not have the authority to obtain samples themselves, nor to administer punishment to oil companies, fuel transporters, or retail outlets for violations of standards.

FUTURE OUTLOOK

India has taken a number of positive steps to reduce vehicle emissions over the last two decades. Per vehicle emission of the four regulated pollutants (CO, HC, NO_x, and PM) has fallen. Total vehicle emission of PM have also reduced over the last decade and total NO_x emission growth has slowed. But vehicle ownership in India is expected to continue to rise at a high rate. If no further action is taken to reduce per vehicle emissions, the benefits of past actions will be erased.

VEHICLE EMISSIONS

The Society of Indian Automobile Manufacturers (SIAM) estimates passenger car sales in India will be close to 5 million vehicles by 2020. A study by the University of Michigan had even higher projections of 7.7 million.

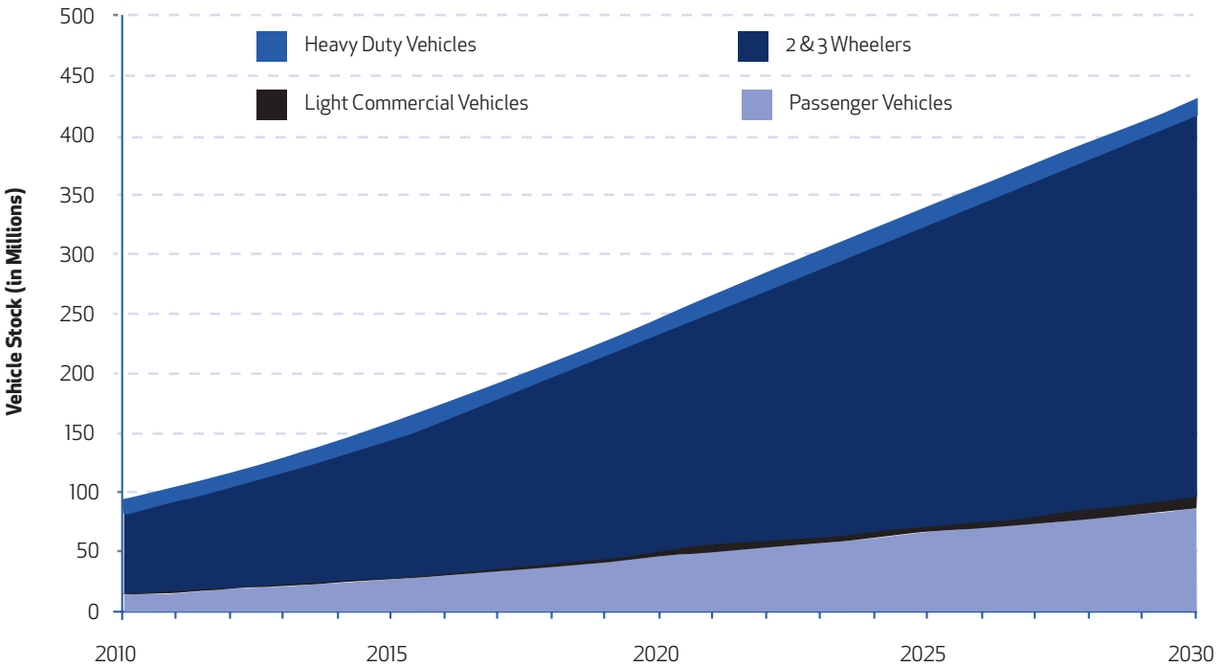
A study by the United Nations (UN) predicted India's total highway vehicle population to be between 206 and 309 million by 2040. Various estimates are presented in Table 7.1. Most of these studies indicate about a five to six times increase in two-wheeler and car population by 2030. Figure 7.6 shows the ICCT's projections of vehicle population breakdown by vehicle type through 2030.

Several estimates show that if no further regulatory action is taken, the trend of declining vehicle PM emission will reverse in the near future. NO_x emission will also increase at a rate faster than they are today. Figures 7.7 and 7.8 show annual PM and NO_x emission, respectively, by vehicle type between 2000 and 2030 under a business-as-usual (BAU) scenario, which assumes current policies and trends will continue. Box 7.2 gives the spatial distribution of emission concentrations in 2010 and 2030, and indicates the regions in the country that are going to be affected the most by vehicular air pollution.

Of the different types of vehicle emissions, NO_x and PM are especially problematic in India. The CPCB recently identified over 70 cities that do not meet national ambient air quality standards (NAAQS) for NO_x and PM. In almost all these cities, vehicles are an important source of pollution. Emission could continue to grow well beyond 2030 if per vehicle emission is not mitigated significantly. The harmful effects of vehicle emission will take a toll on air quality and public health in India, as well as negatively impact global warming. To model what is possible in India, a few studies have developed alternate scenarios which envision tighter vehicle emission and fuel

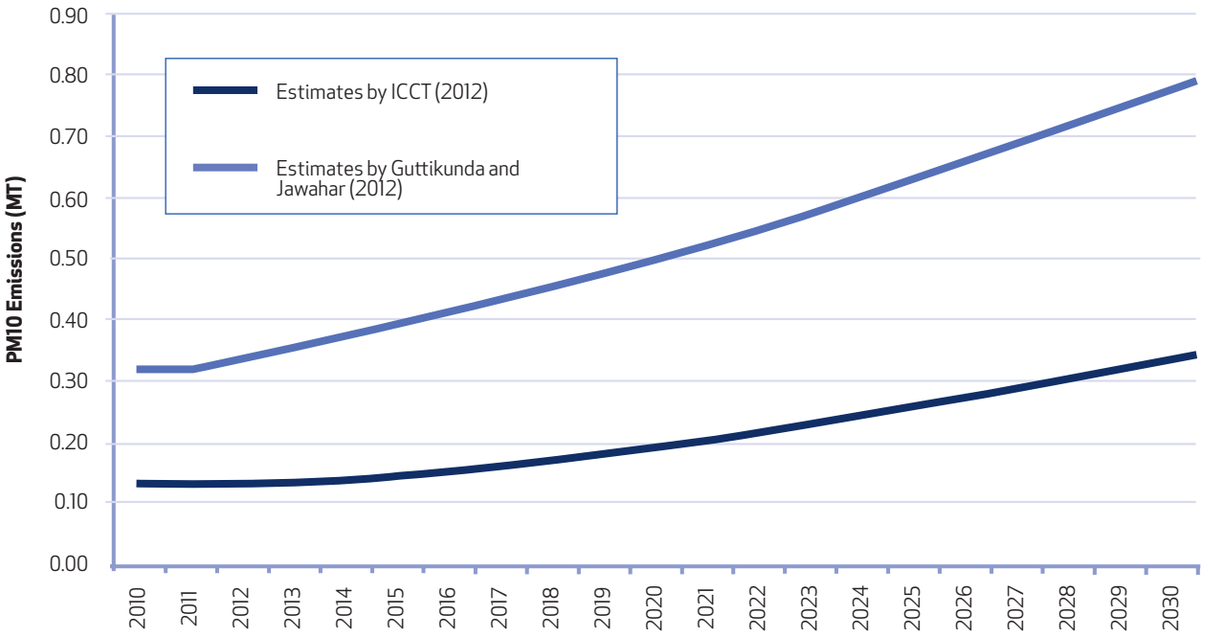
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Figure 7.6
ICCT Projections of Vehicle Population Breakdown by Vehicle Type in India Through 2030



Source: ICCT (2011).

Figure 7.7
Annual PM Emission by Vehicle Type Between 2000 and 2030



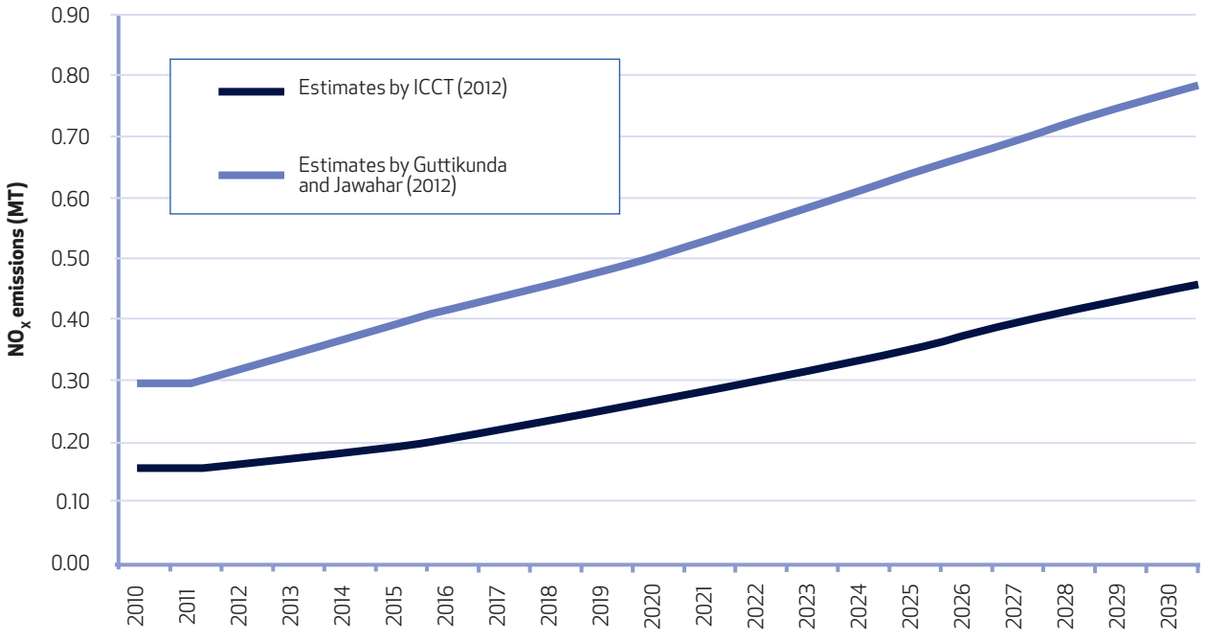
Source: ICCT (2011).

quality standards, better compliance and enforcement, and a shift away from conventional fuels. Table 7.2 shows the assumptions made under the BAU and Alternate Scenario in the study carried out by ICCT in 2012. The changes envisioned in the Alternate Scenario are expected to lead to reductions in all vehicular emission, particularly problematic NO_x and PM. Figures 7.9 and 7.10 show annual vehicle NO_x and PM emission between 2010 and 2030.

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Figure 7.8

Annual NO_x Emission by Vehicle Type Between 2000 and 2030



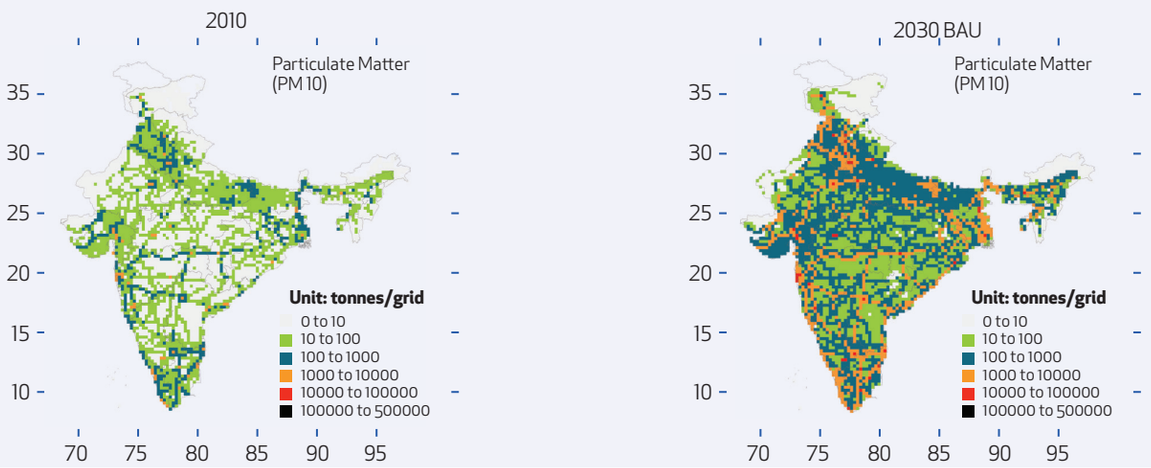
Box 7.2

Gridded Emission Inventory at Spatial Resolution of 0.25° Resolution

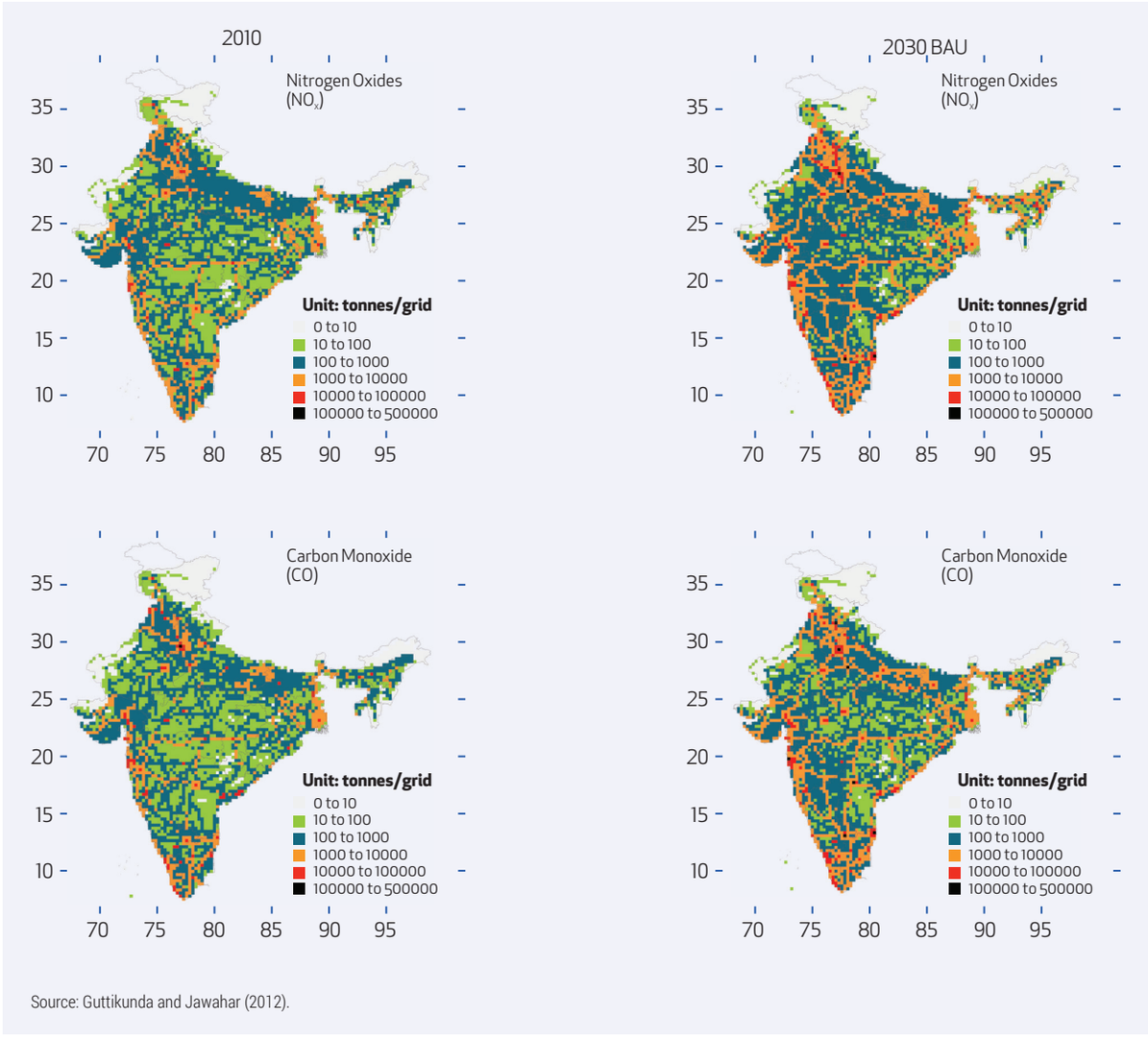
Total emissions by state and by city for 2010 and 2030, under the business-as-usual scenarios are spatially gridded to a resolution of 0.25° (approximately 25 km), covering an area between 67°E and 99°E in longitude and 7°N and 39°N in latitude. While the total emission fields provide information and distinguish between high and low emitting states and cities, a gridded emission field is useful in distinguishing between hotspots such as cities and green spots such as agricultural, forest, and desert areas. The intensity of the emissions in 2030 and beyond is expected to increase around urban centres, due to growing passenger travel demand, and along highways, due to growing freight movement between cities. Compared to PM and SO_2, NO_x and CO are emitted in larger quantities by vehicles.

The layers of information utilised for modelling these emissions include (a) gridded population, (b) gridded road density maps for highways, trunk roads, and arterial roads (inter and intra city), (c) activity maps like ports and airports, which are hot spots of freight movement, (d) urban centre locations, which are hot spots for passenger travel, (e) land use maps to distinguish between populated, agricultural, mining, and forest areas.

Gridded Emission Inventory at Spatial Resolution of 0.25° Resolution



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Source: Guttikunda and Jawahar (2012).

In addition to the regulatory measures envisioned by the Alternate Scenario, reductions in NOx and PM emission can be enhanced by strong urban planning interventions. Aggressive urban public transport and non-motorised transport (NMT) policies can be disincentives for using personal vehicles (Figure 7.11, Guttikunda and Jawahar, 2012).

HEALTH EFFECTS

The reductions in emissions, especially those of PM, will have tangible effects on public health. A study by Guttikunda and Jawahar estimate that premature mortality can be reduced by almost half in the most aggressive scenario that envisages stringent regulations, that takes advantage of improvements in vehicle technology and fuel quality, in addition to promoting sustainable urban public transport policies[4] (Figure 7.12). Annex 1 to this chapter explains the methodology adopted by Guttikunda and Jawahar (2012) to estimate the health impact of vehicular pollution under two scenarios, as illustrated in Figure 7.12.

Another health impact assessment model developed by ICCT (model based on WHO health impact studies) estimates avoided premature deaths in cities from reduced vehicular $PM_{2.5}$ emission in cities, and the resulting economic benefits. Figure 7.13 shows annual avoided premature deaths in India's 337 largest cities from 2010 to 2030, as per ICCT's model. This is based on vehicle $PM_{2.5}$ emission reduction under the Alternate Scenario compared to the BAU scenario. It is estimated that from now through 2030, a total of almost 280,000 premature deaths can be avoided in India from reducing urban vehicle $PM_{2.5}$ emission alone. There would be further benefits of reduced NO_X and HC emission, as well as benefits in extra-urban areas not quantified here.

COSTS & BENEFITS

COSTS

The costs and benefits of implementing clean vehicle and clean fuel policies can be weighed against each other. Costs include investments needed to upgrade refineries to produce cleaner fuel, increased operating costs required to lower fuel sulphur levels, and

4. Gittikunda and Jawahar (2012).

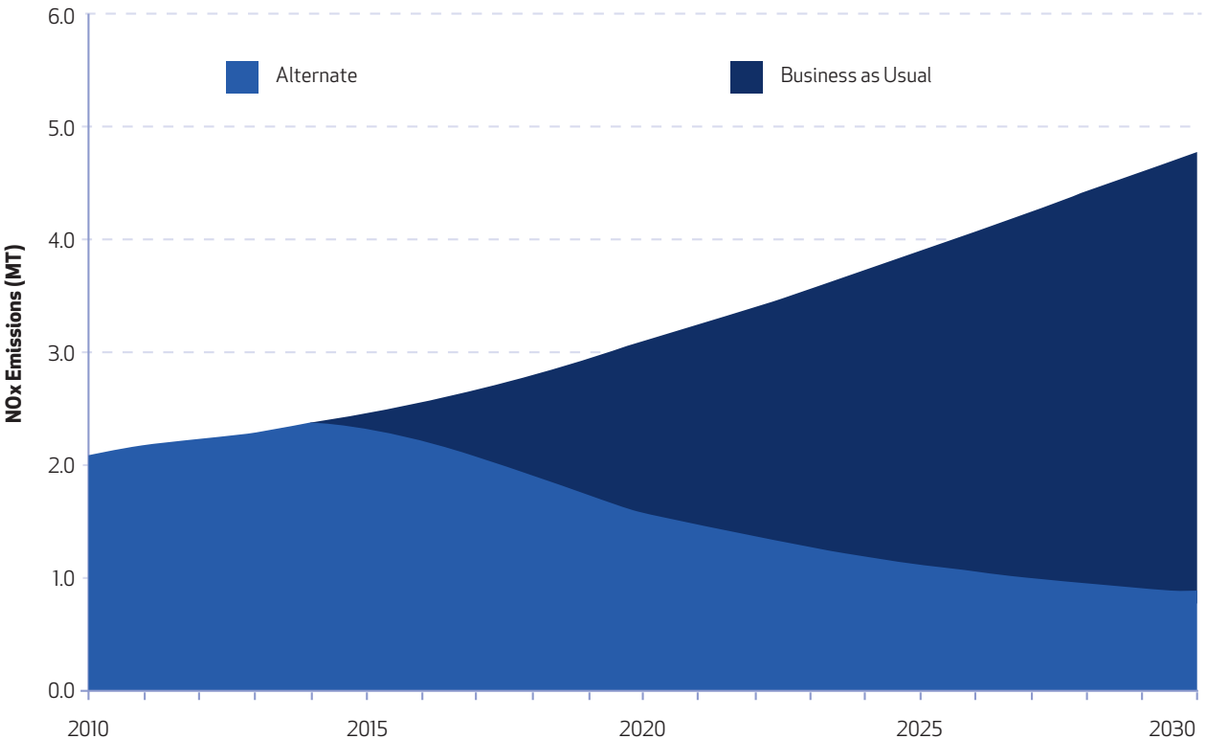
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Table 7.2
Assumptions Under the BAU and Alternate Scenarios in ICCT (2012)

SCENARIO	EMISSION STANDARDS	FUEL STANDARDS	ENFORCEMENT & COMPLIANCE[a]	CHANGE IN FUEL TYPE[b]
BAU	Bharat IV in 13 cities, Bharat III in rest of India	Bharat IV in 26 cities (50 ppm sulfur), Bharat III in rest of India (350 ppm sulfur)	15 per cent of vehicle fleet are gross emitters	50 per cent of new passenger car sales diesel by 2020; 60% by 2030
ALTERNATE	Bharat V by 2015, Bharat VI by 2017, and Tier 3 by 2020 for all vehicles	Low-sulfur fuel (50 ppm) nationwide by 2015; ultra-low sulfur fuel (10 ppm) nationwide by 2017	By 2020, only 3 per cent of vehicle fleet are gross emitters	15 per cent of LDV sales are CNG and 10 per cent LPG by 2030; 75 per cent of bus sales are CNG by 2030; 50per cent of 3-wheeler sales are CNG by 2030

Source: ICCT (2012).
Note: a – Gross polluters are defined as vehicles where emission controls are non-functional
b – CNG and LPG fuel share assumed to come at the expense of diesel
BAU-Business as Usual

Figure 7. 9
Annual NO_x Emission Between 2010 and 2030



Source: ICCT (2012).

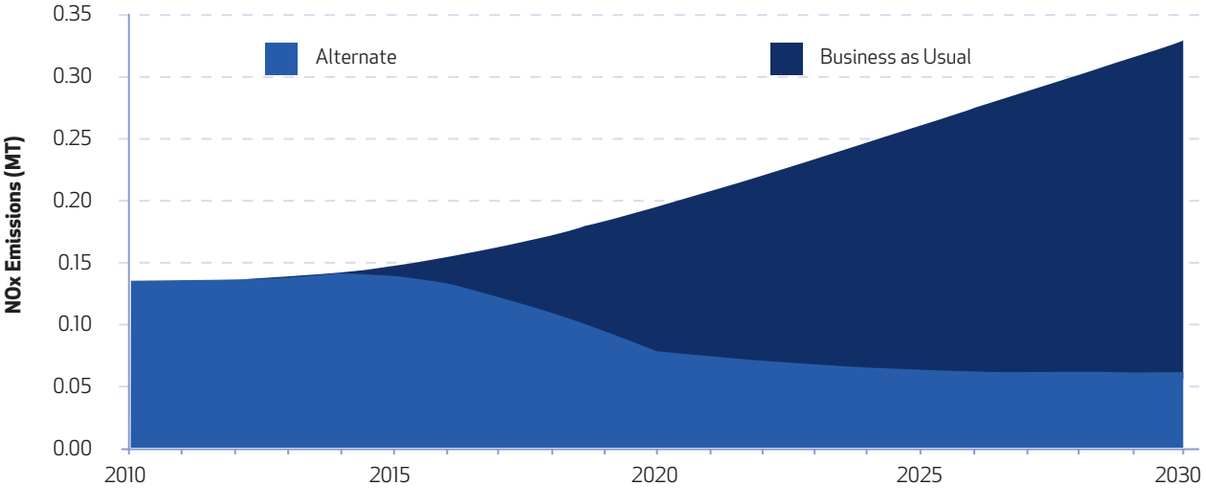
vehicle technology costs needed to reduce emissions from vehicles. Benefits are measured by monetising avoided premature deaths.

The first important study looking at costs to produce ultra-low sulphur fuels (ULSF–fuels with <10 ppm sulphur) in India was carried out by Enstrat International for the Asian Development Bank (ADB). The 2003 study concluded it would take about $445 million (Rs 22,250 million) in capital investments to produce ULSF. The increase in per litre fuel cost was estimated to be 2.80-3.15¢ (Rs 1.40-1.58). This was at a time when gasoline and diesel sulphur content were above 1000 ppm and 2500 ppm, respectively.

A more recent study by Hart Energy and Math Pro looked at what these costs would be today. This study took into account new refineries not accounted for in the Enstrat study, new technologies not well understood a decade ago, and updated estimates of fuel production and consumption in India. Total investments to produce ULSF in India were estimated to be $4.16 billion (Rs 208 Billion, assuming $1=Rs 50). Combining this with increased operating costs and annualising investments, the extra per litre cost of producing ultra-low

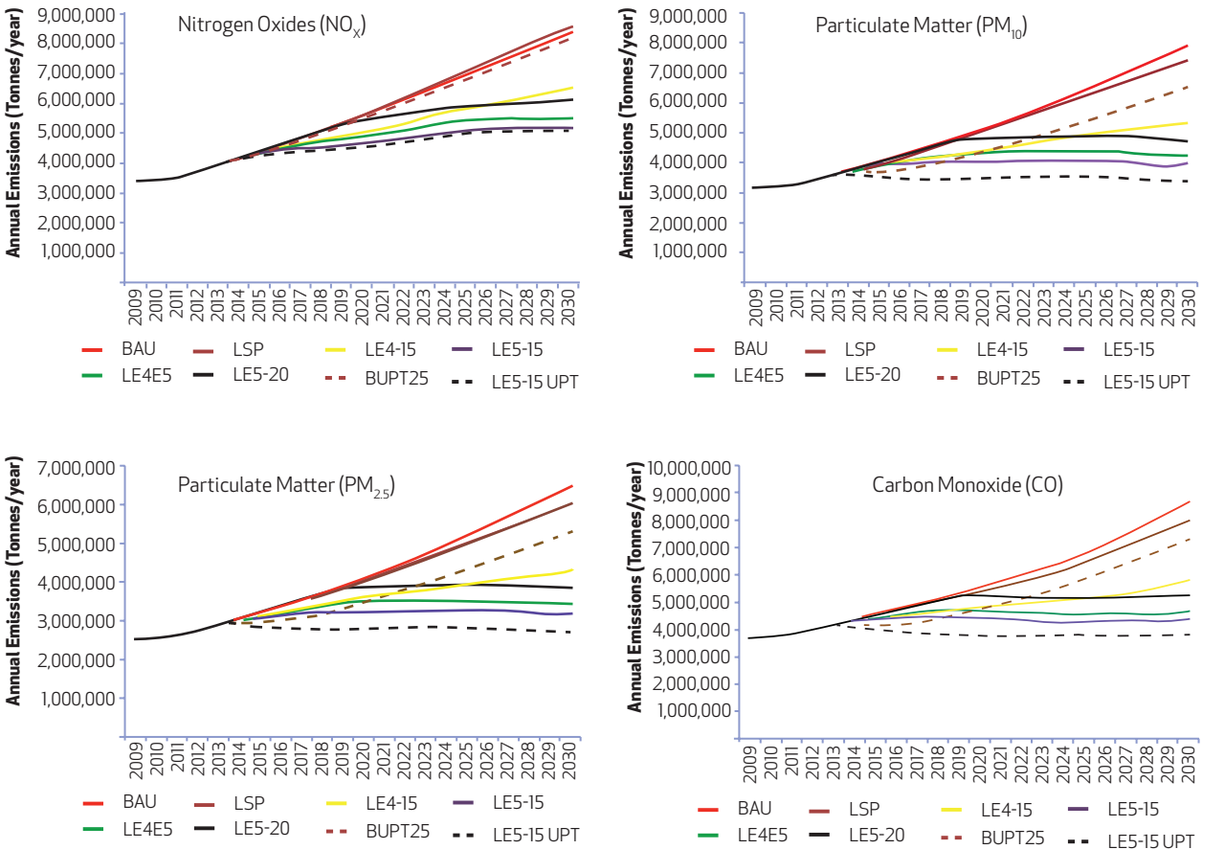
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Figure 7.10
Annual PM Emission Between 2010 and 2030



Source: ICCT (2012).

Figure 7.11
Estimated Energy and Emission Outlook for Road Transport



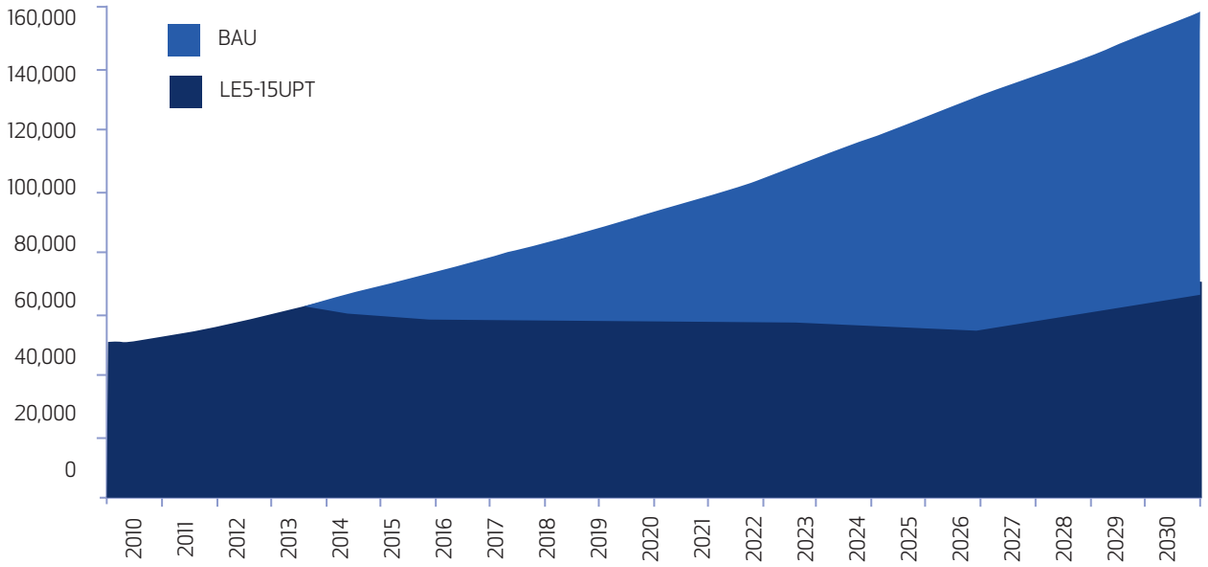
Scenarios in the figure:
BAU = business as usual growth rate and no change in the emission standards
LSP = lower sales projection and no change in the emission standards
LE4-15 = lower sales projection with Bharat IV standards for all vehicles by 2015 for all states
LE5-15 = lower sales projection with Bharat V standards for all vehicles by 2015 for all states
LE5-20 = lower sales projection with Bharat V standards for all vehicles by 2020 for all states (a delayed introduction of the standards)
LE4E5 = lower sales projection with Bharat IV enforced in 2015 and Bharat V standards introduced in 2020 for all vehicles and for all states
BUPT25 = business as usual with no change in emission standards, with an aggressive urban passenger transport policy to promote public transport and NMT, in order to reduce 25 per cent of the vehicle km travelled from passenger vehicles
LE5-15UPT = lower sales projections with introduction of Bharat V standards by 2015 and an aggressive urban passenger transport policy.

Source: Guttikunda and Jawahar (2012).

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Figure 7.12

Premature Mortality per Year Attributable to Road Transport Emissions Under the BAU and LE5-15UPT Scenario



Source: Guttikunda and Jawahar (2012).
Note: BAU: Business as Usual Scenario; LES-15UPT: Scenario with lower sales projections, introduction of Bharat V standards by 2015 and an aggressive urban passenger transport policy

sulphur gasoline and diesel was estimated to be about 0.70-0.87¢ (Rs 0.35-0.44) and 0.64-0.88¢ (Rs 0.30-0.44) respectively.

Costs for clean vehicle technologies have not been studied in India as in the US and Europe. A 2003 study by the German Federal Environmental Agency estimated the cost increase per diesel LDV and HDV for Euro 5 over Euro 4 to be €200-400 (Rs 14,000-28,000) (assuming €1=Rs 70) and €1500-3000 (Rs 0.1.1-0.21 million) respectively. Studies by the European Commission found the cost of upgrading to Euro 6 from Euro 5 to be €200-600 (Rs 14,000-42,000) for LDVs and €825-2000 (Rs 58,000-1,40,000) for HDVs.

ICCT estimated clean vehicle costs in India as well as in Europe, and found costs to be lower than what was reported in European studies.[5] Figures 7.14 and 7.15 show ICCT estimates for per vehicle upgrade costs for various four-wheelers, and two- and three-wheelers, respectively, in India.

The increased costs of cleaner vehicle and fuel production will be passed on to customers. Customers can expect to see an increase in fuel prices of less than Rs 0.50 per litre. With the current programme of adjustment in diesel prices, a half rupee increase that is required for improving the quality of fuel would not be significant for consumers. In fact, public sector refineries can add a few paise to monthly diesel price hikes already being implemented to build capital to invest in ULSF production.

Passenger car customers will see modest increases in gasoline car prices, while diesel cars prices will increase significantly. This will incentivise the production and sale of gasoline cars, which emit less PM and NOx and do not take advantage of government subsidies for diesel fuel. HDV buyers will most likely see the largest cost increase, up to 15 per cent of vehicle cost for diesel HDVs and 10 per cent for CNG HDVs.

BENEFITS

Benefits are often monetised using Value of Statistical Life (VSL) analysis. VSL is multiplied by the number of avoided deaths to arrive at a cost estimate for benefits. Relatively few VSL studies have been conducted in India, but a 2006 study estimated VSL to be about $1.5 million (Rs 75 million).

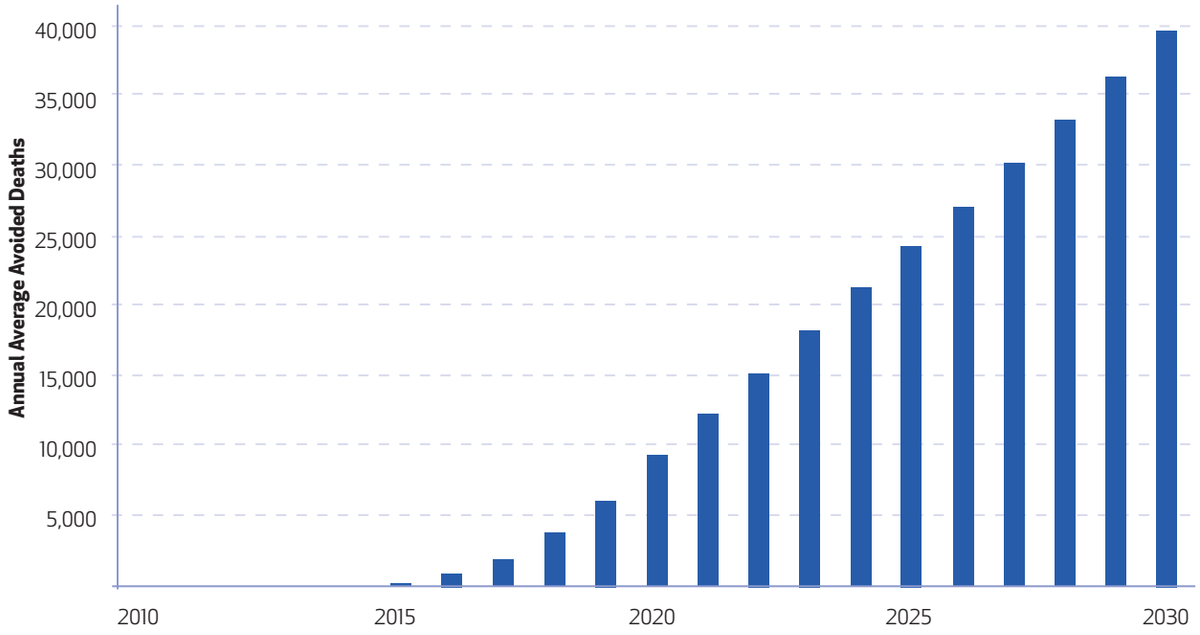
Figure 7.16 shows the ICCT's cost-benefit analysis of the Alternate Scenario versus the BAU Scenario. Through 2030, total monetised benefits of avoided deaths would come out to about $500 billion (Rs 25,000 billion), whereas costs would come out to around $200 billion (Rs 10,000 billion). Annual benefits would undoubtedly continue to rise beyond the year 2030, while annual costs would stabilise, even decrease, as economies of scale and production experience allow the same products to be produced more cheaply. This emphasises that, while there is a cost attached to cleaner fuels and vehicles, the benefits far outweigh the costs in the long term

5. ICCT (2012).

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Figure 7.13

Annual Avoided Premature Deaths as a Result of Lower $PM_{2.5}$ Emission Under the Alternate Scenario



Source: ICCT (2012).

The Alternate Scenario in the ICCT study envisions actions India can feasibly take over the coming decade. Many of the policy changes outlined in the Alternate Scenario have already been put into place in a number of countries. Their experiences provide a starting point for India to move in that direction.

INTERNATIONAL EXPERIENCES

INSTITUTIONAL MECHANISMS

In India, the general process to set new vehicle emission and fuel quality standards is to establish a committee to engage stakeholders and analyse related issues. Working groups within the committee recommend standards and reforms for matters within their purview, for over the next decade or so. The committee's recommendations can then be accepted, modified or rejected by government institutions over time.

Committees that recommend future standards are not permanent. Their composition is not predetermined either, which means they often have to rely on data provided by outside sources, particularly the automobile and oil industries, to make informed decisions. This can lead to a conflict of interest, in which the regulated parties may strongly influence policymaking in their favour rather than in the national interest.

The institutions and mechanisms established in India differ from those in other countries. This section takes a look at institutional mechanisms in the US, Europe, and China.

THE UNITED STATES

In the US, the Clean Air Act (CAA) of 1970 authorises the Environmental Protection Agency (EPA) to establish and enforce vehicle emission and fuel quality standards. Within the EPA, the Office of Transportation and Air Quality (OTAQ) is responsible for these standards. OTAQ consults various stakeholders in the standards development process.

Due to historical air quality needs, the US also allows the state of California to set vehicle emission and fuel quality standards stricter than those mandated by the EPA. Other states can choose to adopt California regulations, and so far 13 states have done so.

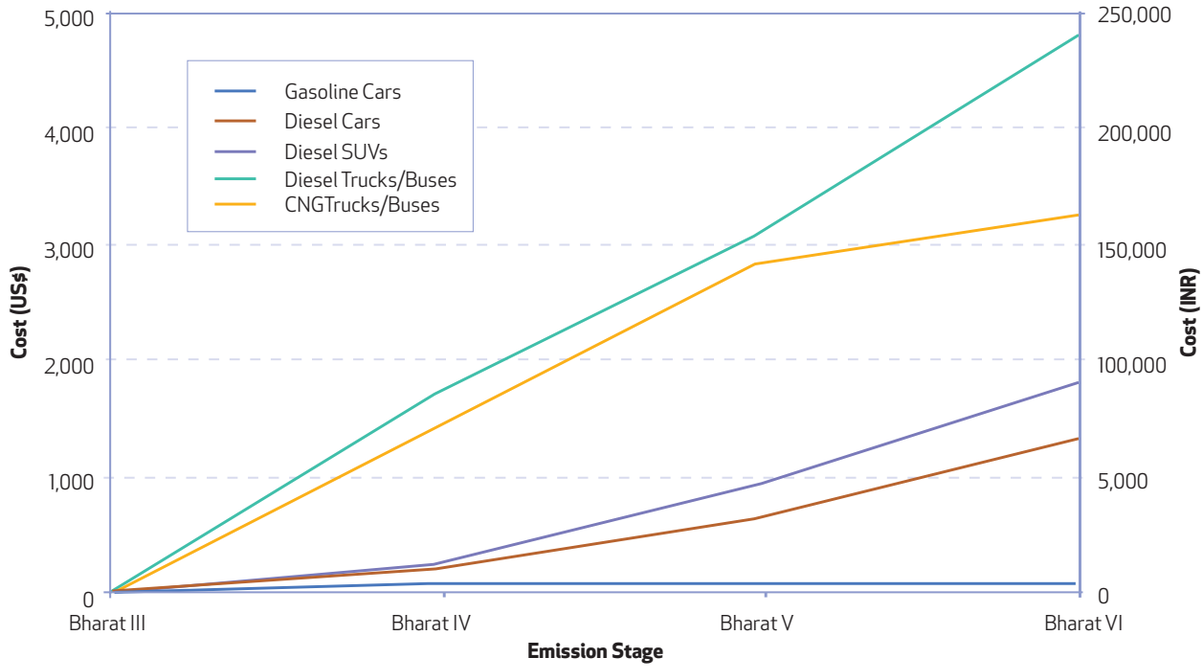
In California, the California Air Resources Board (CARB) establishes and enforces vehicle emission standards, in consultation with various stakeholders. CARB is a department within the California Environmental Protection Agency (Cal/EPA).

Both CARB and EPA are well-equipped and funded to thoroughly study issues before generating new standards. They have numerous laboratories and modelling programmes to test and simulate vehicle emissions. As a result, they do not have to rely on data and claims provided by the automobile and oil industries. This is in stark contrast to India, where committees set up to recommend future standards often lack time, and independent expertise, resources and funding.

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Figure 7.14

Per Vehicle 4-Wheeler Upgrade Costs Progressing to Bharat VI Standards over Bharat III



Source: ICCT (2012).

EUROPE

In the European Union (EU), three institutions jointly establish vehicle emission and fuel quality regulations. The Directorate General (DG) of Enterprise within the European Commission first drafts the next stage of regulations in consultation with stakeholders and other DGs. The draft is then sent to the European Parliament and the European Council where it is further discussed.

In Parliament, the Environment Committee reviews the draft and may discuss it with other committees and stakeholders. Once negotiations are finalised and a compromise is reached, a recommendation is made to Parliament, which then votes on the regulation. A simple majority is needed to approve it. In the Council, ministers from the EU's member countries discuss the draft regulations. A qualified majority (74 per cent) is required for the draft to be approved by the Council.

If there are differences between regulations passed by Parliament and the Council, those two institutions negotiate a compromise. Regulations become law after this process is completed.

CHINA

China's Air Pollution Prevention and Control Law assigns responsibility for establishing and implementing vehicle emission standards to the country's environmental protection authorities. The relevant national-level body is the Ministry of Environmental Protection (MEP). MEP officials oversee the development, finalisation, and notification of environmental standards, though they do not typically engage in the actual drafting of the standards themselves.

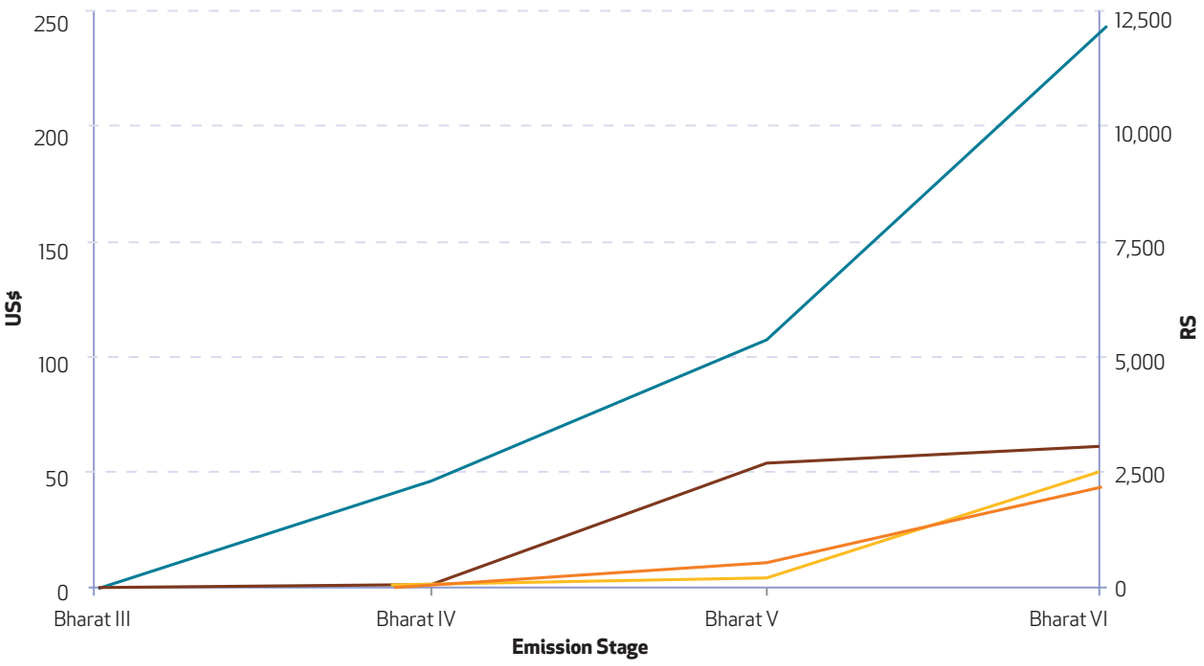
In practice, the MEP assigns a third-party non-governmental institution to research and draft environmental standards. The institution assigned is usually one of several dozen government-affiliated research institutions that play a supporting role to the MEP. These institutions conduct basic research to support environmental policymaking, develop scenario analyses and emission inventories, draft and revise standards, and even participate in environmental policy implementation. Since Chinese law does not mandate that the MEP designate a government-affiliated research institution to draft standards, it is not uncommon for private companies or laboratories to be appointed for this purpose.

China's Air Pollution Prevention and Control Law does not specify clearly which government body should issue fuel quality standards. In practice, the authority to issue the standards lies solely with the Standardisation Administration of China (SAC), which itself has technical committees heavily stacked with oil industry representatives.

Unlike in India, the US and Europe, China does not link fuel quality and vehicle emission standards, which poses a significant problem for the country. China does not set or seek to set long-term vehicle

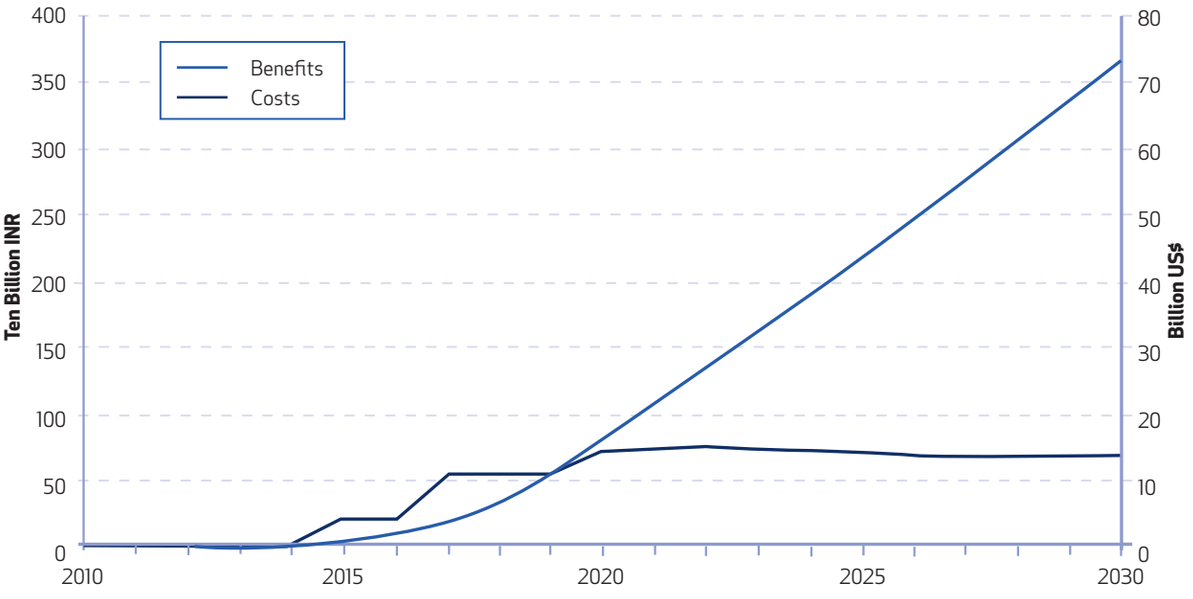
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Figure 7.15
Per Vehicle 2- and 3-Wheeler Upgrade Costs Progressing to Bharat VI Standards over Bharat III



Source: ICCT (2012).

Figure 7.16
A Comparison of Costs and Benefits for the Alternate Scenario from 2010 through 2030



Source: ICCT (2012).

emission and fuel quality standards. This means that regulations are reviewed more frequently. This means new technologies and developments can be taken into account more often.

VEHICLE EMISSIONS AND FUEL QUALITY STANDARDS

The US has been at the forefront of vehicle emission regulations for almost half a century now. The country has some of the most stringent emission stand-

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In India, certain cities have more stringent new vehicle emission standards than the rest of the country, but it has not moved to state- or region-wide implementation of different standards.

ards, as well as well-established compliance and enforcement programmes. The US has also built in much flexibility in its policies, which gives the auto and oil industry wiggle room to comply with regulations. India can learn from the vast experience of the US in setting and enforcing vehicle emission and fuel standards. Apart from the US, Europe and Japan have notable achievements in rapidly cleaning up their fuels and vehicle fleets. Europe has plans to further tighten its standards in the coming years. Both Europe and Japan have some of the cleanest fuels in the world, with the strictest low sulphur compliance. The achievements of China, Brazil, and Mexico also stand out, as all of them are large developing nations like India.

China is in the process of implementing Euro IV equivalent standards nationwide. Brazil began implementing Euro V standards for HDVs in 2012. It also has a ban on diesel powered LDVs. Mexico is one of the few developing countries to have 15 ppm sulphur diesel available in much of the country, with plans to expand the supply of this fuel nationwide in the near future. It also has plans to implement vehicle emission standards roughly equivalent to Euro 5 over the next few years.

The focus of this chapter, however, is on the US, which is the world leader for vehicular air pollution regulations. Japan is also looked at in detail regarding fuel quality compliance, since it has a successful advanced programme that differs considerably from that of the US.

THE UNITED STATES

VEHICLE EMISSIONS

The US emission standards are based on a 'tier' system with multiple 'bins', each with its own emission limits for regulated pollutants. A vehicle manufacturer may certify a vehicle model to any of the bins, provided that the sales-weighted average for all vehicles produced by that manufacturer meets specific fleet-average emission targets. This provides flexibility in meeting standards, while still assuring environmental targets are met. Furthermore, new standards in the US are not implemented at a single point in time. Instead, they are phased in, which allows for more flexibility with compliance.

The US system also establishes much longer durability requirements than Europe and India for HDVs and LDVs. Most LDVs must meet emission requirements for up to 10 years or 120,000 miles (193,200 km), whichever comes first. By contrast, LDVs in India must meet requirements for up to 100,000 km.

US emission standards do not discriminate on the fuel used. This suggests that establishing separate emission standards for diesel and gasoline engines, as is done in Europe, China, and India, is not necessary.

US law also allows states to adopt more stringent emission standards if they choose. A number of states have done so. India has a similar process in that certain cities have more stringent new vehicle emission standards than the rest of the country, but it has not moved to a state- or region-wide implementation of different standards. Nor can cities or states choose to have more stringent standards on their own. Tighter standards across a region are more effective than across a city for a number of reasons, a primary one being that higher-emitting vehicles from outside a city often operate within its limits. In the case of state-wide standards, most vehicles plying the roads of cities within that state would meet the tighter emission standards.

FUEL QUALITY

The US currently has separate sulphur content requirements for gasoline and diesel. Since 2006, diesel has been required to have no more than 15 ppm sulphur content. This level is sufficient for the most advanced after-treatment clean vehicle technologies to function well. Emissions from gasoline-operated vehicles are not as sensitive to fuel sulphur content, though sulphur in gasoline does increase PM and NO_x emissions as well. Sulphur content in gasoline in the US ranges between 30 and 80 ppm.

VEHICLE EMISSION COMPLIANCE AND ENFORCEMENT

Vehicle emission standards are only useful if they are enforced. Countries have various mechanisms to ensure manufacturers produce vehicles that comply with set standards. TA and COP are the most common practices for new vehicles in most countries with vehicle standards. Additionally, countries have differing programmes to test in-use vehicle emissions.

While Europe establishes uniform emission standards for the whole of the EU, compliance and enforcement are the responsibility of individual member states. This splinters this responsibility, and therefore analysing the successes and shortcomings of vehicle emission compliance in Europe is difficult.

China, like India, conducts TA and COP testing for new vehicles in government authorised laboratories. For in-use testing, the national government establishes emission standards and testing procedures, but local governing bodies are responsible for setting up and operating inspection and maintenance (I/M) programmes. This is similar to PUC programmes in

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India. A key new aspect of China's COP programme is the gradual implementation of COP testing without prior notice to manufacturers. While this is still in its early stages, a number of problems have already been identified. This suggests that similar problems in India may come to light if India were to adopt similar procedures.

THE UNITED STATES

Compliance and enforcement in the US is carried out entirely by the Environmental Protection Agency (EPA), as authorised by the Clean Air Act (CAA) of 1970. Many individual states and municipalities have separate in-use emission compliance programmes that may assist the EPA's work. States with more stringent emission limits than federal standards have separate in-state compliance programmes that function parallel to the EPA programme.

The EPA compliance programme looks at emissions throughout the useful life of a vehicle. New vehicles are first tested by at the pre-production stage, and certified by the EPA, if they pass. The EPA then conducts confirmatory testing on certain vehicles. Unlike in India, manufacturers are not given prior notice regarding the timeframe of confirmatory testing, nor are they told from where the test vehicles will be selected.

After confirmatory testing, the EPA relies on a number of in-use compliance programmes to ensure vehicles meet emission standards throughout their useful life. One such programme is the Selective Enforcement Audit (SEA). The SEA came into being in the 1970s, when the EPA found manufacturers were occasionally producing vehicles that did not comply with standards, even though prototypes had been certified. Under the SEA, the EPA can require manufacturers to pull vehicles off the assembly line and test them, at their own expense, in a lab of the EPA's choosing.

As other in-use compliance programmes developed, the SEA programme was phased out for LDVs, though the EPA reserves the right to reinstate it if need be. For HDVs, it is still conducted.

Emissions from in-use vehicles are tested by manufacturers and the EPA. Manufacturers pay vehicle owners to test their vehicles. If vehicles fail an initial test, the manufacturer is required to conduct more rigorous testing. All test data is sent to the EPA. If a vehicle model continues to fail tests, a mandatory recall can be ordered to fix the problem.

The EPA also conducts in-use surveillance testing of its own. Like manufacturer in-use testing, the EPA selects in-use vehicles either at random or because of reasonable belief that further testing is needed. The agency usually pays owners to test their vehicles. In-use surveillance testing verifies manufacturer testing.

The US has the most comprehensive fuel quality compliance programme in the world, which has evolved over time. In Asia, Japan has set up an effective programme, successfully conducting random testing of fuel at all its retail outlets each year.

Much of the US compliance and enforcement approach is based on cooperation between the EPA and vehicle manufacturers. Manufacturers are often invited to see how EPA testing is conducted, and there is considerable communication between the two before important decisions are made. This saves the US government money, as the EPA does not have to test every single vehicle. At the same time, it ensures compliance.

Important aspects of compliance in the US are well-established recall procedures and non-compliance penalties. These incentivise manufacturers to design and test vehicles so they meet emission standards throughout their life. Not doing so means facing stiff fines and expensive recalls or production halts.

Figures 7.17 and 7.18 diagrammatically represent compliance programmes for LDVs and HDVs in the US.

FUEL QUALITY COMPLIANCE & ENFORCEMENT

As with vehicle emission compliance, the US has the most comprehensive fuel quality compliance programme in the world. It also has many years of experience in this area, and its programme has evolved with time. In Asia, Japan has set up an effective fuel quality compliance programme. The country successfully conducts random testing of fuel at all its retail outlets each year.

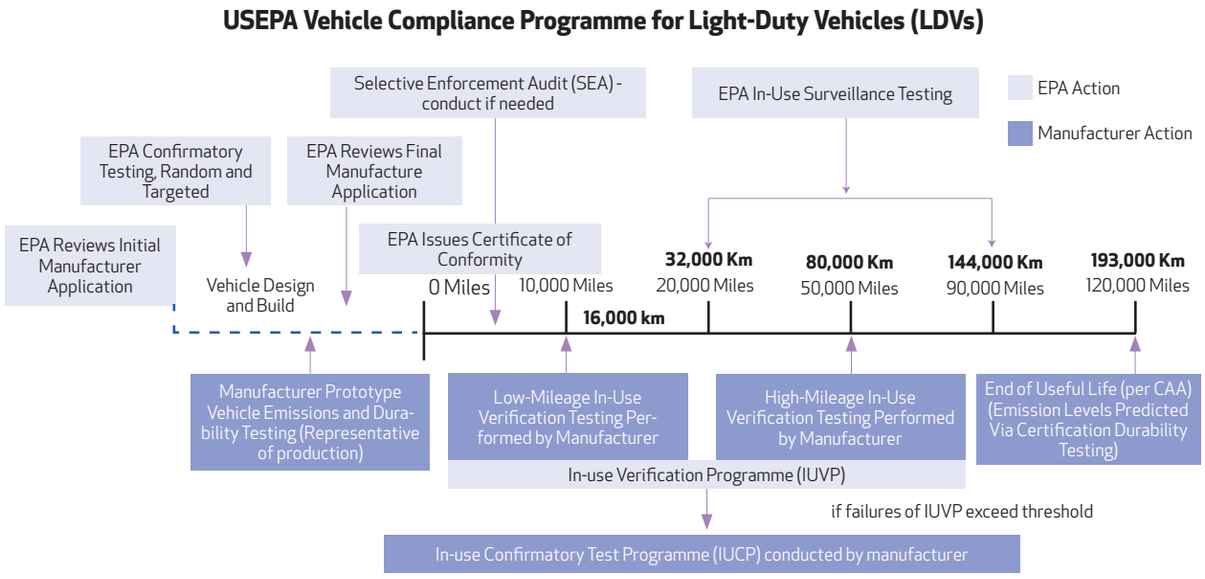
THE UNITED STATES

The CAA of 1970 authorises the EPA to prohibit the manufacture or sale of fuels and fuel additives if there is reason to believe they endanger public health. This is the basis of fuel quality regulations in the country.

The US fuel quality compliance approach seeks to ensure that fuel quality meets set standards throughout the supply chain. At the top of the chain, fuel refiners and importers must first register fuels and fuel additives with the EPA, and conduct tests on their potential evaporative and combustion emission, prior to marketing them. After production, refiners are required to test every batch of fuel four times a year and submit results to the EPA. In addition to this, oil companies are required to hire independent laboratories to conduct fuel testing at refineries and retail outlets. Independent laboratory test

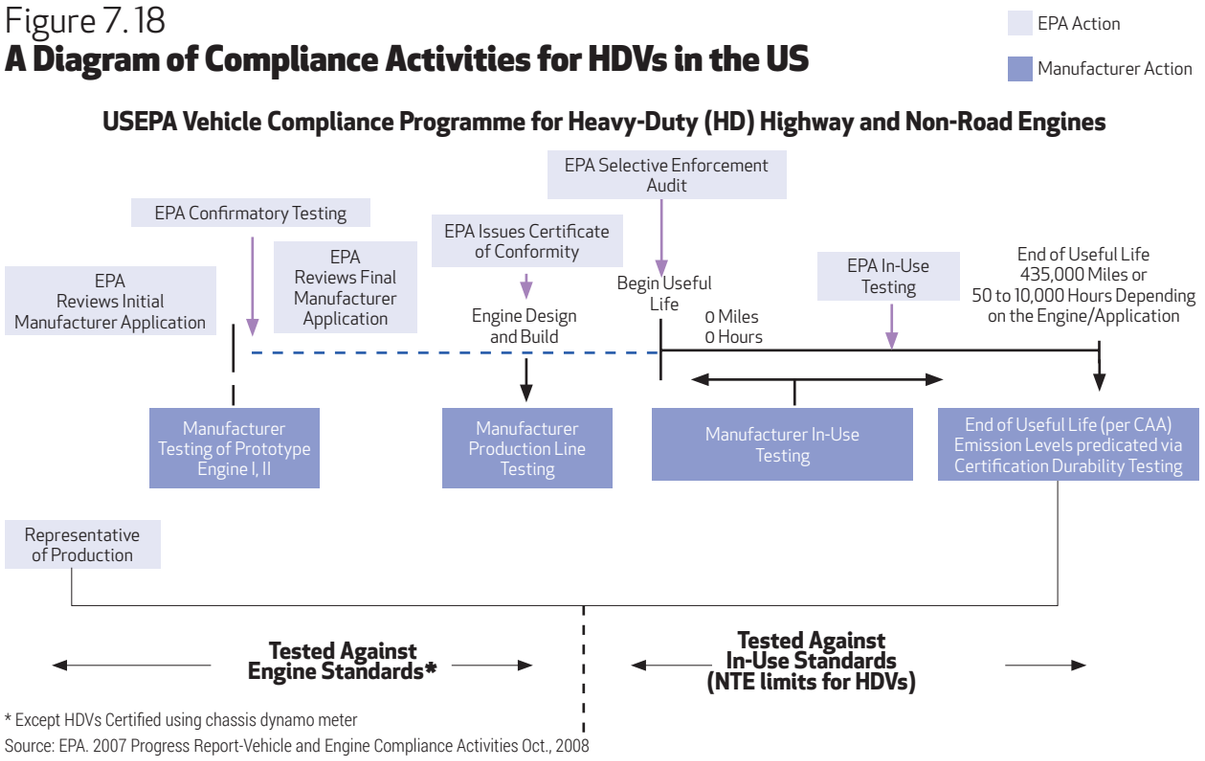
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Figure 7.17
A Diagram of Compliance Activities for LDVs in the US



Source: EPA. 2007 Progress Report-Vehicle and Engine Compliance Activities Oct., 2008

Figure 7.18
A Diagram of Compliance Activities for HDVs in the US



* Except HDVs Certified using chassis dynamo meter

Source: EPA. 2007 Progress Report-Vehicle and Engine Compliance Activities Oct., 2008

results are submitted to the EPA and compared with industry test results.

EPA enforcement officials also conduct their own field tests of fuel quality at various points in the distribution system. They also selectively audit the industry and independent laboratories. If laboratories do not meet standards or if documents are found to be falsified, the EPA can levy fines and shut down facilities.

Because of such comprehensive testing throughout the supply chain, the onus of complying with fuel quality standards falls on all parties in the chain. Costly penalties for non-compliance, such as fines and criminal charges against violators, create a strong incentive for oil companies to meet fuel quality standards at all times.

JAPAN

Japan's current fuel quality compliance programme grew out of the removal of a ban on imported refined fuel in 1996. As more companies started selling fuel

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in Japan, and as fuel came from more diverse places, the country recognised the need to ensure the quality of these products. The Fuel Quality Control Law was then passed, which put the Ministry of Economy, Trade and Industry (METI) in charge of doing this.

Japan's approach to fuel quality compliance is based on testing fuels at the point of sale. All fuel retail outlets must be registered with METI, and fuel samples are selected at random, without prior notice, from each and every outlet. METI contracts the National Petroleum Association (NPA), an independent public corporation, to test samples from every retail outlet at least once a year.

In addition, oil companies are required to conduct their own testing. This must be done prior to distribution and sale, as well as at retail outlets. Industry test results are checked with NPA test results for consistency.

Testing fuel at the point of sale incentivises oil companies to maintain fuel quality throughout the supply chain. Retail outlets selling non-compliant fuels can be shut down and fined heavily, which is costly for the oil companies.

RETROFIT PROGRAMMES

Retrofitting high-emission vehicles, usually older vehicles, can have a strong and positive impact on air quality. Unlike stricter standards for new vehicles, the benefits of which are seen over time as the vehicle fleet turns over, retrofits allow for immediate reduction in emissions since they target vehicles already on the road.

In order to fully harness the benefits of vehicle retrofits and minimise the economic impact, retrofit programmes must be designed and implemented appropriately, and use appropriate technologies. In some instances, retrofitting vehicles may not lead to any reduction in emissions, while costing companies, individuals, and the government large sums of money. For example, studies have found that converting gasoline vehicles to CNG may only have benefits if engines are optimised and after-treatment systems are correctly installed. In some cases, retrofitting vehicles with CNG led to an increase in emissions. This is particularly relevant to India, where there is, and has been, a strong push for CNG vehicles.

At the same time, retrofit programmes that install additional after-treatment technologies on vehicles can significantly reduce emissions, provided that the requisite fuels and supporting infrastructure are available. Two successful retrofit programmes for HDVs, one in the US and one in Japan, are analysed in more detail below. The experiences of each can be a starting point for what is possible in India.

Retrofitting high-emission vehicles, usually older ones, can have a strong and positive impact on air quality. Unlike stricter standards for new vehicles, the benefits of which are seen over time as the fleet turns over, retrofits allow for immediate reduction in emissions since they target vehicles already on the road.

UNITED STATES

In 1993, the EPA developed an Urban Bus Retrofit and Rebuild (UBRR) programme for model year 1993 and earlier urban buses operating in cities with a 1980 population of 750,000 or more. The programme was set to be implemented in 1995.

The programme sought to reduce bus PM emissions by 25 per cent. It allowed cities to choose whichever technologies they felt would be most appropriate, provided that they were certified by the EPA. This allowed flexibility at the local level, while ensuring no cities used technologies that were outdated or unreliable. A later study of the UBRR programme found the cost per tonne of PM reduced to be $31,500 (Rs 1.6 million). The same analysis estimated the cost of new HDV emission standards- that went into effect in 2007- to be $14,200 (Rs 0.7 million) per tonne of PM reduced.

Cost-effectiveness studies for other retrofit programmes in the US found the cost per tonne to be less. An assessment by the Texas Commission on Environmental Quality (TCEQ) found the costs of retrofit programmes in its state to be lower than the costs of new HDV emission standards.

JAPAN

The Tokyo Metropolitan Government (TMG) adopted an ordinance on environmental preservation in December 2000 that included an array of measures targeted at cleaning air, water, soil, and noise pollution. To reduce air pollution, the ordinance included a variety of directives aimed at reducing vehicle emissions, including the retrofitting of diesel-powered HDVs.

The retrofit programme had a two-tier structure, each targeting vehicles of different ages. The programme generally sought more reduction in PM emissions from older vehicles than from newer vehicles.

Emission control equipment manufacturers were required to submit data on the reliability, safety, and durability of retrofit equipment, though there were no specific regulations on minimum standards for these, as there were in US retrofit programmes.

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While India focuses on certifying emissions for new vehicles, the US devotes more resources ensuring in-use vehicles meet emission standards throughout their useful lives.

Once a vehicle was retrofitted, it was issued a TMG sticker, which allowed it to operate within TMG city limits. Vehicles operating within TMG city limits in violation of retrofit requirements were subject to a fine of up to 5,00,000 yen ($5000 or Rs 250,000).

SUMMARY & CONCLUSIONS

The institutional mechanisms to set vehicle emission and fuel quality standards differ in different regions. In India, a committee usually recommends standards for the following decade. Government ministries and agencies then choose whether to implement the recommendations over time or not.

In the US, the EPA alone develops and implements new standards, in consultation with stakeholders, based on its authority under the CAA. In Europe, regulations are developed and have to be passed by the European Commission, the European Parliament, and the European Council. Only then they become law.

In China, vehicle emission and fuel quality regulations are developed separately. The MEP and quasi-government organisations develop vehicle emission standards, while the SAC alone usually sets new fuel quality standards. This separation of regulatory authority has led to problems implementing vehicle emission standards due to poor fuel quality.

A number of countries have implemented stricter vehicle emission controls than India. In recent years, some fast-developing countries at similar economic levels as India, such as China, Thailand, Brazil, and Mexico, have surpassed India in-tightening vehicle emission and fuel quality standards. Their experience is proof that strict vehicle emission standards do not hurt economic development. The US has been at the forefront of vehicle emission control for over forty years. The US EPA has been the sole authority in charge of regulating vehicular pollution and fuel quality parameters. Its vast experience and reforms the US has adopted, provide optimal guidance for what is possible in India.

Whereas India focuses on certifying vehicle emissions for new vehicles, the US devotes more time and resources ensuring in-use vehicles meet emission standards throughout their useful life. Clear and strict punitive measures and recall policies also incentivise manufacturers to test their in-use vehicles regularly. This reduces the resource burden on the EPA.

The same holds true for fuel quality testing. While in India the MoPNG and state governments are officially required to test and certify fuels, there is little evidence that this is done and fuel adulteration persists. In contrast to this, the US EPA contracts independent laboratories to test fuels at various points in the distribution system. The EPA audits these laboratories and conducts some tests itself to verify test results. If any fraud or noncompliant fuels are found, stiff fines are implemented. This places the onus on oil companies and fuel distributers to ensure fuel quality on their own.

Japan also has a successful, comprehensive fuel quality testing programme. Japan's METI and NPA annually test fuel from all retail outlets in the country at random, without prior notice. If any outlet has noncompliant fuels, stiff fines are levied and the outlet may be shut down.

Besides ensuring vehicles and fuels meet set standards at all times, there are other actions that can reduce vehicle emissions. Retrofitting old vehicles is one such action. An urban bus retrofit programme in the US in the 1990s reduced bus PM emissions by 25 per cent in many cities. Another retrofit programme in Tokyo, Japan successfully reduced vehicle emissions there. The cost-effectiveness of retrofits to meet strict emission standards varies. Some studies show retrofits as more expensive while others say they are cheaper.

RECOMMENDATIONS

India has come a long way over the last two decades to establish vehicle emission and fuel quality standards, and to develop compliance mechanisms for them. The country has also caught up with international best practices in certain aspects. Still, there are a number of areas in which it needs to improve. Some require looking more closely at the experiences of other countries and adopting successful programmes for India. Others involve adopting the recommendations of Indian government committees themselves, particularly those of the 2003 Mashelkar Auto Fuel Policy Committee. All these recommendations are discussed here. A new Auto Fuel Policy Committee under Dr. Saumitra Chaudhury of the Planning Commission was formed in January 2013. This new committee has the authority to recommend new standards and reforms through 2025. The recommendations discussed here set an agenda for the new Auto Fuel Policy Committee to consider as they develop specific reforms and targets for India.

RECOMMENDATIONS FOR VEHICLE EMISSION & FUEL QUALITY STANDARDS

TIGHTER FUEL QUALITY STANDARDS

<50 ppm sulphur fuels should be made mandatory nationwide by 2015, and <10 ppm sulphur fuels should

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be available nationwide by 2020. Reforms in diesel pricing currently being implemented should at least partially be used to pay for refinery investments needed to produce these cleaner fuels.

TIGHTER NEW VEHICLE EMISSION STANDARDS

India should implement Bharat VI standards nationwide by 2020 for four-wheelers, thus reaching Europe's fuel quality standards. For two- and three-wheelers, India should develop Bharat IV, V, and VI standards based on Europe's actions and implement them by 2020. The technologies to implement these standards are already available in India. Mandating cleaner vehicles will have positive long-term impact.

EVAPORATIVE EMISSION STANDARDS

By 2015, India should mandate:
Stage I controls for refuelling emissions which capture vapours emitted when tankers supply fuel to retail outlets- and return them to fuel tankers and

Stage II controls- which capture vapours during vehicle refuelling and return them to the storage tanks at retail outlets.

India should also mandate all new vehicles to have onboard refuelling vapour recovery (ORVR) systems at the same time that Stage II controls are implemented. These systems return vapours to a vehicle's fuel tank rather than to retail outlets. ORVR systems are generally cheaper to maintain than Stage II controls. The majority of India's fleet will have them in place about ten years after implementation begins. Once ORVR-fitted vehicles become prevalent, regulations for Stage II controls can be lifted.

WORLD-HARMONISED TEST CYCLES

India has participated in the development of world-harmonised test cycles along with other countries. However, it is yet to adopt any of them. Replacing current test cycles with world-harmonised ones will make it less likely that certain vehicles 'beat' emission testing by passing the test cycle while actually emitting much more under real-world conditions. India should make world-harmonised test cycles optional when Bharat IV regulations come into place nationwide. They should become mandatory when Bharat V regulations come into place.

REVIEW AUTO FUEL POLICY EVERY FIVE YEARS

As new technologies are developed and experiences evaluated, there is a need to review current and future standards accordingly to ensure that the country does not head in the wrong direction or fall behind the world's latest developments. In 2003, the Mashelkar Auto Fuel Policy committee had recommended a review of the auto fuel policy every five years. Yet a new Auto Fuel Policy Committee was not formed until 2013, ten years later, despite the fact that the Mashelkar Committee's mandate was through the year 2010.

India has participated in the development of world-harmonised test cycles, but is yet to adopt any of them. Replacing current test cycles with world-harmonised ones will make it less likely that vehicles 'beat' emission testing.

Even with the formation of the current Auto Fuel Policy Committee to look at regulations through 2025, a new Auto Fuel Policy Committee should be formed five years after the current one completes its task to review progress and to make recommendations in the light of future technologies and international best practices. Provisions for a new Auto Fuel Policy Committee every five years should be made in the MoPNG's five-year plans.

RECOMMENDATIONS FOR COMPLIANCE & ENFORCEMENT

SINGLE AGENCY FOR VEHICLE EMISSION AND FUEL QUALITY REGULATIONS

In 2003, the Mashelkar Auto Fuel Policy Committee had recommended the formation of a National Automobile Pollution and Fuel Authority (NAPFA) responsible for setting and enforcing vehicle emission and fuel quality standards in India. This recommendation was not adopted. Currently there are a number of ministries and agencies responsible for compliance and enforcement in India, which allows blame to be passed onto others if there are problems. Therefore, the government should establish a permanent NAPFA and ensure that it is fully funded.

NATIONAL IN-USE VEHICLE TESTING PROGRAMME

A robust Inspection and Certification (I&C) regime should be established in the country to ensure safety, road worthiness and emission performance of in-use vehicles. All motor vehicle categories should be covered under the I&C regime, which should address both safety and emissions. Presently, only commercial vehicles are required to undergo fitness test for road worthiness. Private vehicles are required to undergo pollution under control checks at periodic intervals as per the Central Motor Vehicle Rules under the Motor Vehicles Act, 1988. The parameters, for which the PUC testing is done, are not related to the parameters for which vehicles are tested for emission during the. Type Approval and Conformity of Production (CoP) tests. On the line of the practice in the United States, India should, in addition to emission standards which should be adhered to by new vehicles, lay down deterioration standards for each year to test in-use vehicles

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Given the history of fuel adulteration in India, it is especially important that the Government develops a national plan to test fuel at retail outlets, along the lines of the US and Japan.

for emissions. There should also be a recall policy to recall models which, on testing, do not adhere to the emission standards derived from the applications of deterioration factors.

A modern I&C regime with minimum manual interference needs to be established in a phased manner. In the beginning, I&C regime should prioritise transport (commercial) vehicles and then move to non-transport (private) vehicles. Phasing the implementation of I&C regime would enhance the probability of success as commercial vehicles are much smaller in number and would be easier to target in the initial phase. Also, the investment requirements will be less and distributed if a phased approach is adopted. The phasing should target bringing older vehicles under the I&C regime earlier, as compared to the newer vehicles. Also, cities with higher vehicular pollution should be targeted first. Periodic fitness tests for commercial vehicles are included under the Motor Vehicles Act and can be initiated under the new I&C regime. I&C of private vehicles will require changes in the Motor Vehicles Act as the law does not currently call for periodic fitness certification; after the initial registration, private vehicles are required to re-register only at the end of 15 years.

A dense network of modern I&C centres should be established with the required capacity for testing commercial and private vehicles. The frequency of testing should be based on the principle that commercial vehicles and older vehicles are tested more frequently, preferably annually. Private vehicles need not require I&C for the first three years, after which they should be subjected to fitness tests biennially till they complete nine years. After nine years, private vehicles should also be subjected to annual tests. In case of two-wheelers, however, the biennial tests should begin after two years till eight years of age, after which they should also have annual fitness tests.

The I&C centres should be established on a public-private partnership (PPP) basis. The central government should lay down the policy and regulatory framework for tests, equipment, manpower requirements based on the advice of an independent agency like a National Accreditation Board (NAB) that could also monitor implementation of I&C by state governments. The state governments should fix the inspection fee after analysing the cost of, each centre and the expected reasonable return on investment from it. State governments could subsidise centres that have lesser volumes of fitness tests. State governments should ensure the implementation of the I&C regime by private testing agencies, independent agencies or empanelled auditors.

CLEAR RECALL POLICIES AND PUNITIVE MEASURES

Indian law clearly authorises the government to fine violators and recall noncompliant vehicles, but there are no well-defined legal procedures for this. Until NAPFA is set up, the MoRTH should establish clear punitive measures and recall processes for noncompliant vehicles and the MoPNG should establish clear punitive measures for noncompliant fuels.

TEST FUEL QUALITY AT RETAIL OUTLETS

Oil companies are responsible for fuel compliance activities while the fuel is in their possession. While they may do this, there is little, if any, verification of their activities by the government, despite legal procedures requiring this. Furthermore, there is hardly any testing of fuels at retail outlets, where consumers ultimately get fuel for their vehicles. Given the history of fuel adulteration in India, it is especially important to test fuel at retail outlets. The MoPNG should develop a national plan to test fuel at retail outlets, along the lines of what is done by the US EPA or Japan's METI and NPA.

ENERGY SECURITY & TRANSPORT ATTRIBUTABLE GREENHOUSE GAS (GHG) EMISSIONS

Increasing energy consumption levels and emission of greenhouse gases (GHG) like CO_2, is another important challenge.

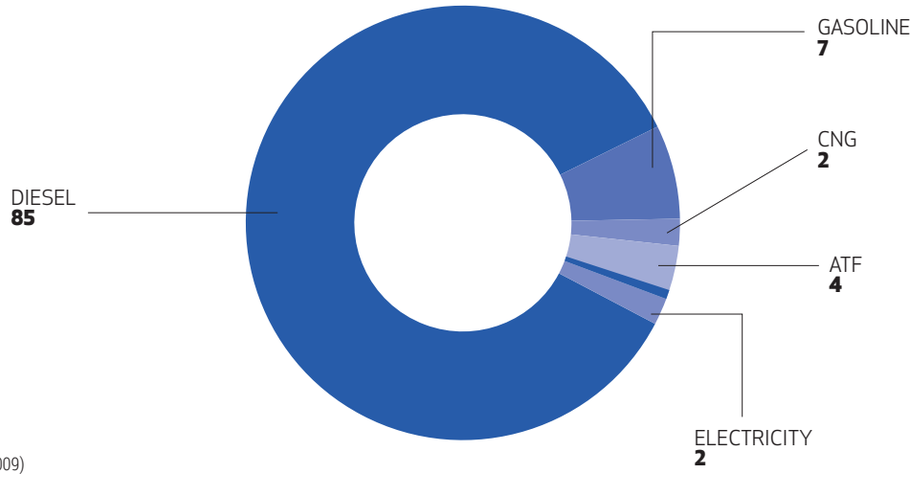
Increasing energy demand by the transport sector raises concerns about energy security and economic growth. GHG emissions from this sector also exacerbate the problem of global warming which can have long-term effects on everyday life and India's economy. Rising temperatures and changing weather patterns for instance will undoubtedly impact agriculture, which employs over half the country. Rising temperatures can also lead to higher sea levels which could inundate coastal areas permanently displacing populations.

According to TERI, in a BAU scenario, the total energy consumption by the transport sector is expected to increase from 81.3 million tonne of oil equivalent (Mtoe) in 2010 to 266.8 Mtoe in 2030, a more than threefold increase[7]. Road transport will be responsible for more than 90 per cent (244.5 Mtoe) of the energy requirements in 2030. Petroleum will continue to be the largest fossil fuel used. Diesel will account for 85 per cent of fuel used. it, as shown in

7. TERI (2009).

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Figure 7.19
Fuel Mix for the Transport Sector in 2030 Under the BAU Scenario (per cent)



Source: TERI (2009)

Figures 7.19 and 7.20. Some estimates predict 2030 requirements to be even higher at 318 Mtoe[8]. The International Energy Agency (IEA) gives a more conservative estimate of 164 Mtoe in 2030 if current policies continue. Petroleum consumption will be 91 per cent of that[9].

THE CHALLENGE OF ENERGY SECURITY

The current trend of growing fossil fuel use is not favourable for India's energy security or economy. Domestic petroleum production has not kept up with growing demand, making the country increasingly dependent on imported crude oil. The uncertainty of crude oil availability in the future poses a problem for India.

This upward trend is not limited to India. World oil demand for transport is estimated to increase from 4,200 Mtoe per annum in 2009 to 5,370 Mtoe per annum in 2035 if current policies continue[10]. (See Box 7.3 for detailed analysis).

The production of crude oil in the country has increased at an average annual growth rate of around 1.6 per cent from 2000-01 to 20010-11, whereas the consumption of petroleum products over this period has increased at a rate of more than 4 per cent annually[11]. The reserves to production (R/P) ratio of crude oil in India indicates enough reserves for 30 years, whereas the R/P ratio[1] worldwide indicates enough crude oil to last in the world for 46 years[12]. India has become, and will continue to be, increasingly dependent on imported crude oil (Figure 7.21) Crude oil imports now account for almost 80 per cent of India's demand[13]. If current trends continue unchecked, this will rise to 90 per cent by 2032[14].

Heavy dependence on imports is bad for India's economic growth. It exposes the domestic economy to the vagaries of international crude oil prices, thereby affecting macroeconomic variables like the country's import bill and trade balance[15]. It also sends billions of rupees abroad to purchase fuel, rather than investing the money at home.

India's transport sector also uses gas and electricity in addition to petroleum products. Together, these two energy sources account for about 2.5 per cent of the energy needs of the sector. Their share is expected to go up to 3.5 per cent in 2030 under a BAU scenario[16]. The government has been making efforts to increase the use of these fuels, not only to reduce dependence on oil, but also to lower air pollutant emission.

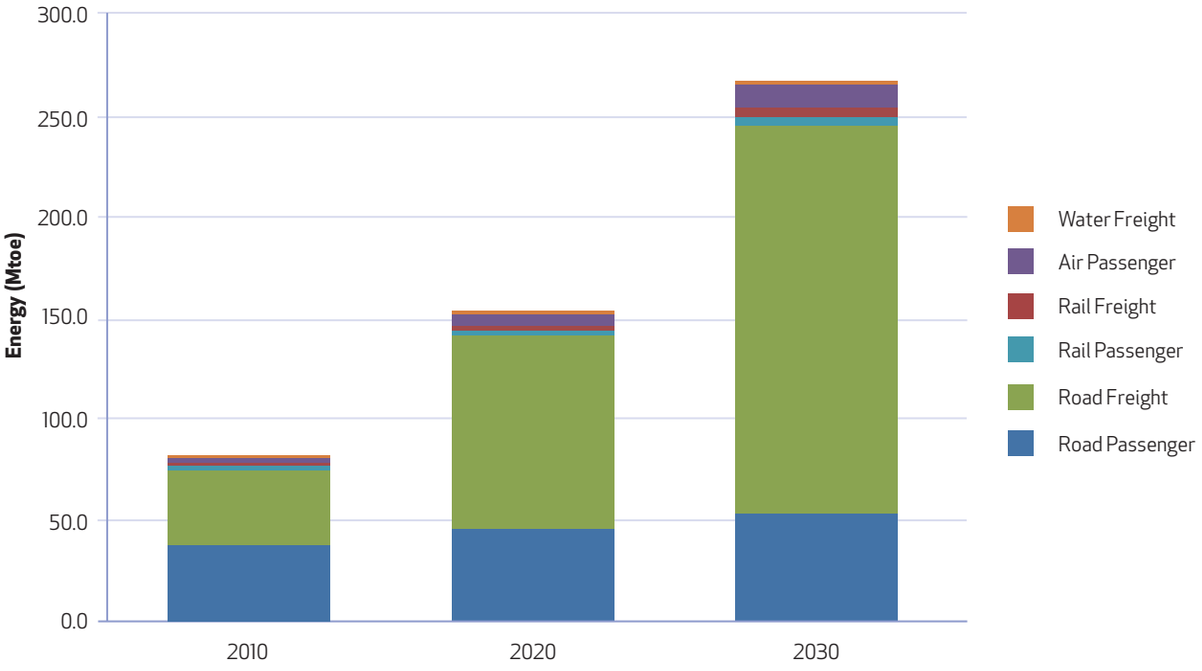
There have especially been fairly strong initiatives to promote natural gas use. The government has a policy of allocating natural gas primarily for the transport sector and secondarily for other sectors. Many first tier cities have shifted their public transport and intermediate public transport systems (such as auto rickshaws and taxis) to CNG and other cities are following suit. According to a proposal by the Petroleum and Natural Gas Regulatory Board (PNGRB), city natural gas distribution networks may be implemented in over 200 cities, which may be used for transportation as well.

But like oil, natural gas is not an infinite resource. The R/P ratio of natural gas in India indicates sufficient domestic production for a maximum of 28.5 years[17]. Currently, the country imports more than 20 per cent of its domestic gas requirements, as shown

8. Guttikunda and Jawahar (2012).
9. IEA (2010).
10. IEA (2010).
11. MoPNG (2012).
12. TERI (2011).
13. MoPNG (2012).
14. TERI (2008).
15. TERI (2011).
16. TERI (2009).
17. TERI (2011).

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Figure 7. 20
Growth in Energy Consumption in Transport Sector in BAU Scenario



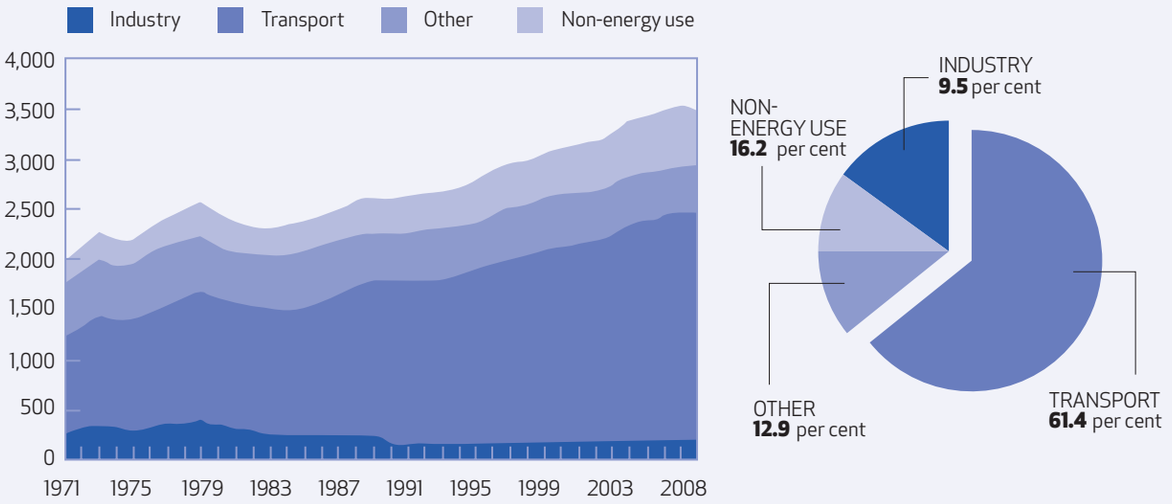
Source: TERI (2009).

Box 7.3
Share of Transportation in Global Petroleum Consumption

Worldwide, transportation accounts for a dominant share of total petroleum consumption annually. In many countries, highway vehicles consume the largest share as in the United States where they account for 61 per cent as per the US Department of Energy 2010 estimates. Clearly, any effort to enhance energy efficiency should pay particular attention to highway vehicles.

Governments worldwide are trying to improve vehicular energy efficiency for many reasons: ensuring greater energy security; enhancing economic development and competitiveness; reducing climate change impact and improving public health.

World Petroleum Consumption by End-Use (in Million Tonne of Oil Equivalent-Mtoe)



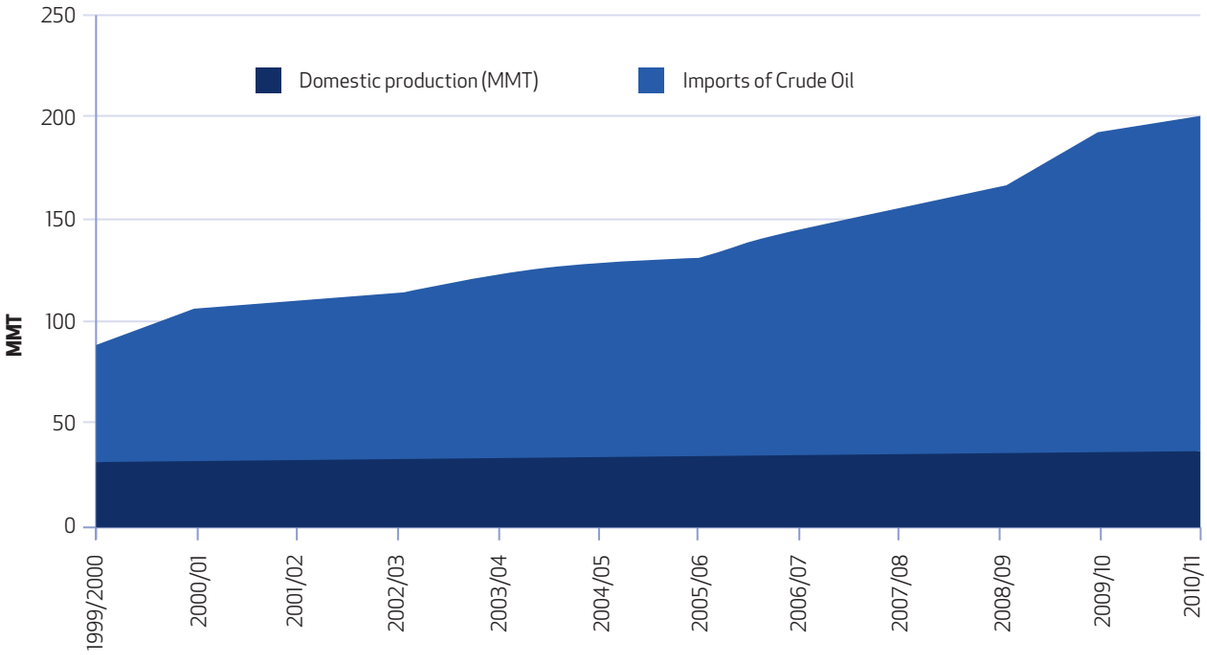
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DRIVERS OF GOVERNMENT ENERGY EFFICIENCY POLICIES	
Energy security	Reduce imported energy Reduce demand increase reliability Control energy demand growth
Economic Development and Competitiveness	Reduce energy intensity Improve industrial competitiveness Reduce production costs More affordable energy customer costs
Public Health	Reduce air pollution that is attributed to vehicle emissions

Adapted from: Energy Efficiency Governance Handbook http://www.iea.org/papers/2010/gov_handbook.pdf (accessed 17 January 2013)

Source: Government Policies to Encourage Energy Efficient Vehicles on Roads, Page 4-5, Kumares C. Sinha, Mohammad H. Arman, Samuel Labi, June 7, 2011.

Figure 7. 21
Domestic Production and Imports of Crude Oil in India, 1999-2000 to 2010-11



Source: TERI (2011).

in Figure 7.22. Increasing demand will further increase dependence on imports.

Electricity use in the transport sector has not been adequately promoted, the primary user being rail transport. Electricity use in road transport is expected to increase in the future as innovation in electric vehicles continues and they become economical to produce and use. The government has announced a National Electricity Mobility Mission Plan 2020 that targets 6-7 million new electric and hybrid electric vehicle sales by 2020. While the implementation of the Mission Plan is expected to yield liquid fuel savings of 2.2-2.5 million tonne by 2020, it will lead to an increased demand for electricity for road transport. About seven million electric vehicles will require additional power generation capacity in the range of 775-865 MW. GHG emissions and energy security concerns will be relevant if this electricity is generated from thermal power plants that depend on imports of coal and gas.

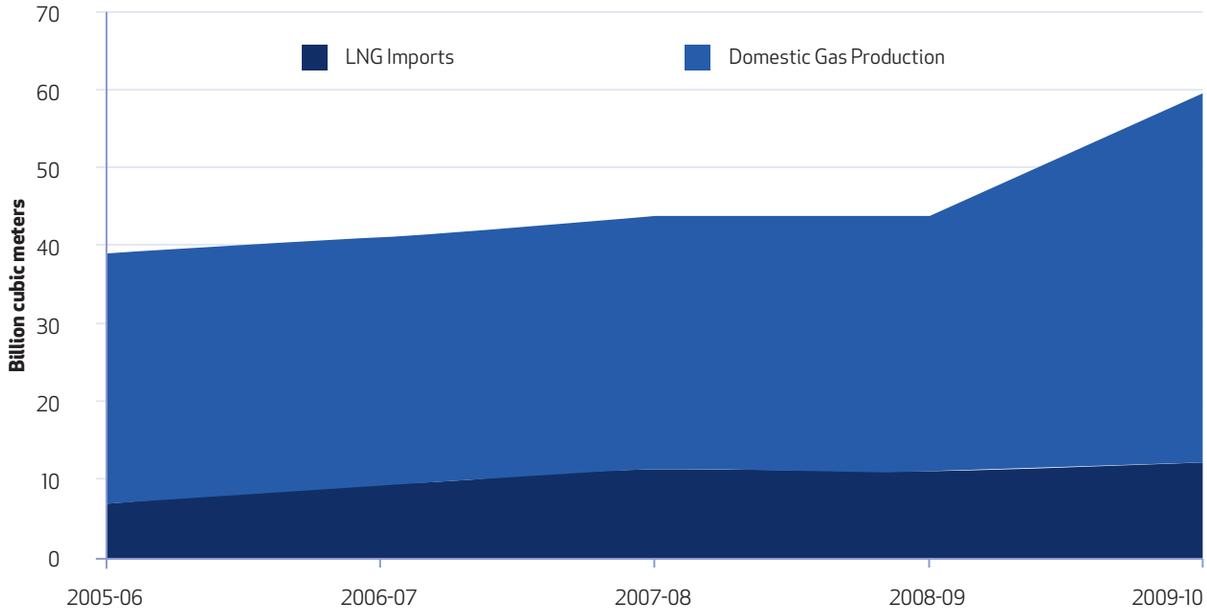
THE CHALLENGE OF INCREASING CO_2 EMISSIONS

The transport sector is a key contributor to CO_2 emission. As per a Ministry of Environment and Forests (MoEF) study[18], the sector was the second largest contributor to CO_2 equivalent emission (CO_2e) in 2007 and generated 142 $MtCO_2e$. Within the transport sector, road transport contributes 87 per cent of the total CO2 equivalent (CO_2e) emissions, as shown in Figure 7.23. As per studies[19] the trend of increasing CO_2 emissions from road transport is expected to continue if no action is taken. In 2030, road transport is expected to have CO2e emission in the range of 850-900 MTas shown in Figure 7.24. Total transport sector CO_2e emissions could go up to 900 million tonne in 2030[20].

18. MoEF (2010).
19. TERI (2009); Guttikunda and Jawahar (2012); ICCT (2012).
20. TERI (2009).

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Figure 7. 22
Domestic Production and Imports of Natural Gas, 2005-06 to 2009-10



Source: TERI (2011).

Appropriate strategies and policies need to be put in place to lower energy consumption and GHG emission from the transport sector. These strategies should include[21]:

- Incentivise use of rail and marine transport for goods movement.
- Incentivise public transport over private vehicles for passenger transport.
- Maintain NMT options, such as biking and walking.
- Implement progressively strict vehicle fuel efficiency standards.

Improving vehicle fuel efficiency can help achieve low-energy, low-carbon growth in the transport sector. Vehicle fuel economy regulations can free up billions of rupees, currently spent on petroleum products, for other needed investments.

In recent years, many advanced countries have established fuel economy or GHG emission standards for vehicles. These regulations are relatively new and continuously changing and expanding as new technologies are developed, and successes and shortcomings are analysed. India, too, is establishing its first-ever vehicle fuel consumption regulations.

TYPES OF VEHICLE GHG EMISSION STANDARDS

Energy consumption and GHG emissions can be reduced by setting fuel economy or fuel consumption standards, by setting vehicle CO_2 and other GHG emission standards or combination of these. Since fuel consumption correlates well with CO_2 emission for a single fuel type, limiting one, in effect, limits the other. But this does not hold true for diverse fuel types. Nor do only fuel economy or fuel consumption standards fully take into account the emission of non-CO_2 greenhouse gases, such as methane (CH_4), hydro fluorocarbons (HFCs), and nitrous oxide (N_2O). CO_2 and CO_2-equivalent GHG emission standards may be needed to regulate total vehicle GHG emissions.

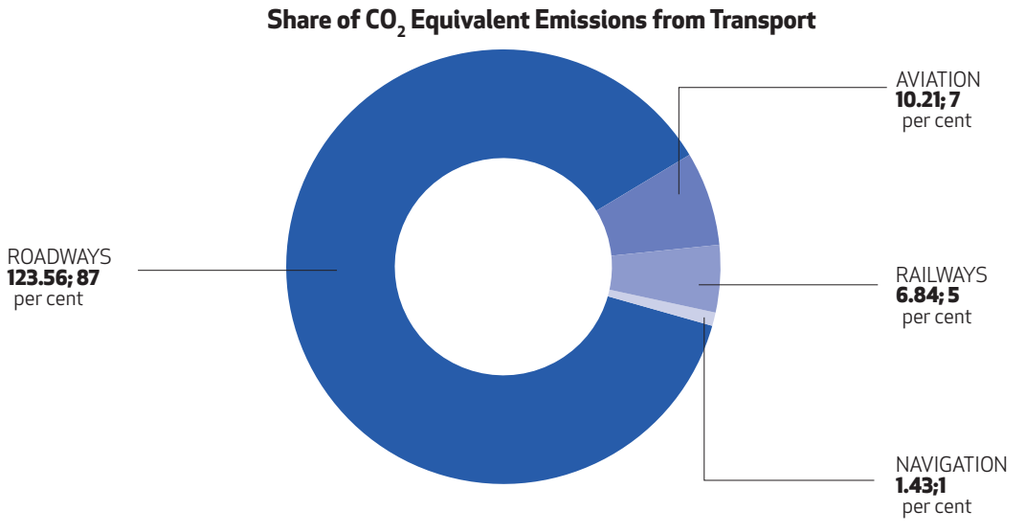
If developed and implemented correctly, GHG emission standards can also provide compliance flexibility by taking into account non-engine technology improvements. For example, operating an air conditioning system places an additional load on the vehicle engine, causing additional fuel to be consumed and therefore increasing CO_2 emission. Extra emission resulting from such loads can be reduced by increasing air conditioning efficiency and using low emission refrigerants.

Standards for fuel efficiency, fuel consumption and GHG emissions can also be established based on vehicle class or weight. But, weight-based standards give manufacturers an incentive to increase vehicle weight to qualify for more lenient standards. This penalises manufacturers who use advanced technologies to reduce vehicle weight to improve fuel efficiency. It should be noted that vehicle GHG emission standards address tank to wheel (TTW) emissions, but they do not take into account well to wheel (WTW) emissions. In certain cases, as in policies promoting the use of biofuels to promote vehicle fuel efficiency, WTW emissions may increase, even with stringent TTW standards.

21. TERI (2011).

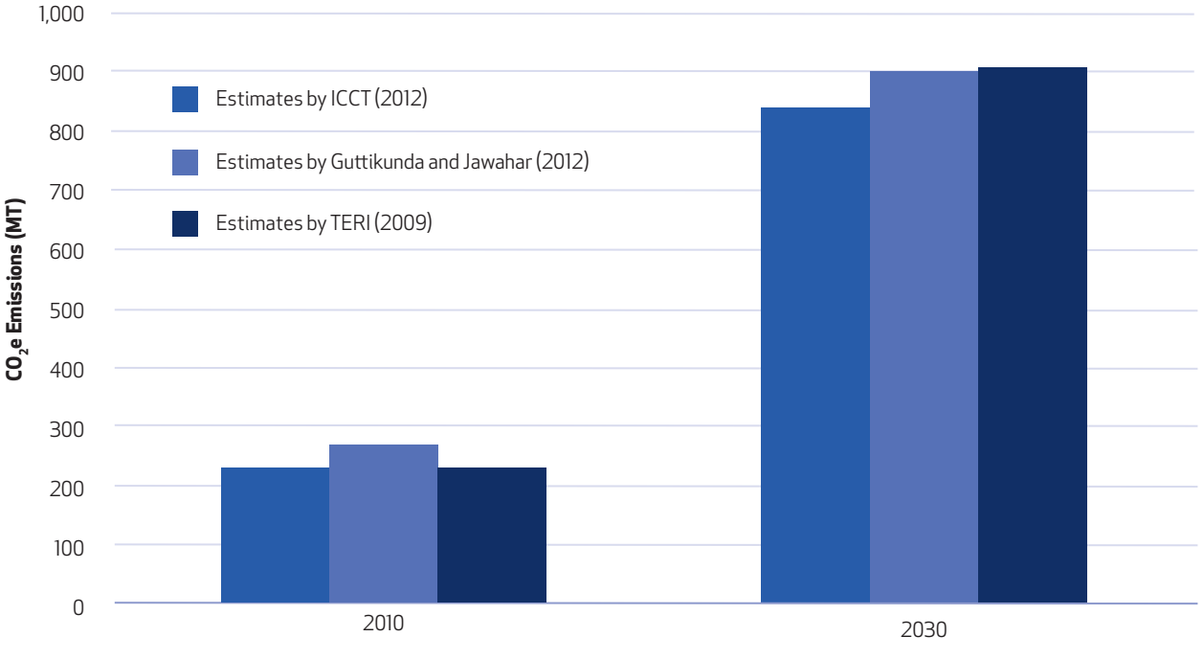
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Figure 7.23
CO_2 Equivalent Emissions from Transport Sector, 2007



Source: MoEF (2010).

Figure 7.24
CO_2 Emission from Transport Sector in BAU Scenario, 2010-30



INTERNATIONAL GHG EMISSION STANDARDS

Standards have generally been established for LDVs first since improvements to reduce emission and increase fuel efficiency are best known for this class of vehicles. Recently, there has been a growing interest in standards for HDVs and two- and three-wheelers too.

LIGHT-DUTY VEHICLE STANDARDS

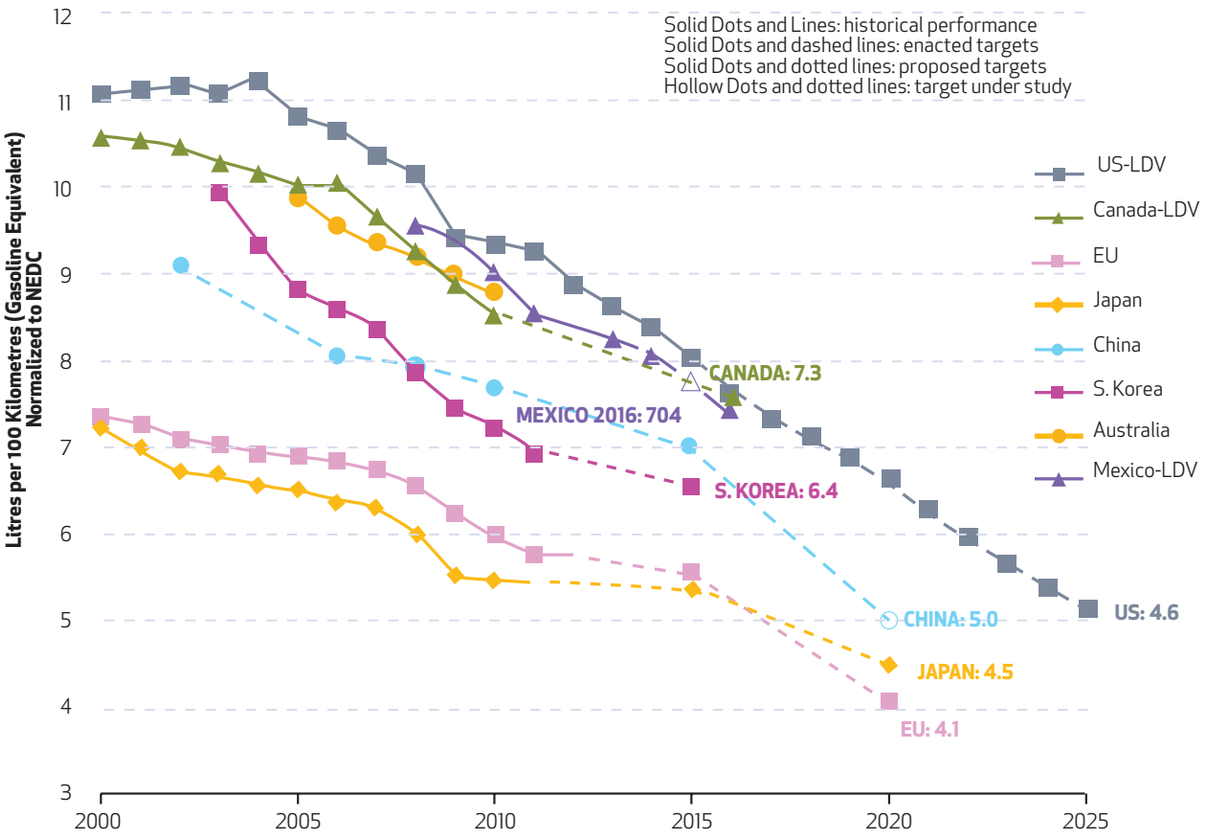
GHG emissions from LDVs have steadily fallen over the last decade, and they are predicted to continue to do so as standards become more stringent. Figure 7.25 shows trends in LDV fuel consumption standards (or equivalents) in litres per 100 kilometres in various countries.

UNITED STATES

For decades, the motivation for the US fuel economy regulations was energy security. In recent years, climate change has become a factor as well. In 2010, the EPA and the US Department of Transportation (DOT) finalised a new joint regulation

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Figure 7.25
Past and Proposed LDV Fuel Consumption Standards in Various Countries



Source: NTDPC Research.
Note: [1] China's target reflects gasoline fleet scenario. If including other fuel types, the target will be higher.
[2] US and Canada light-duty vehicles include light-commercial vehicles.

covering GHG emissions and fuel economy for model years 2012-2016 passenger cars and light trucks.

According to the new standards, the corporate average LDV GHG emission rate will be reduced from an average of 342 gCO_2e/mile in 2008 to 250 gCO_2e/mile in 2016. Fuel economy will increase from an average of 26 miles per gallon (11.05 km/L) to 34.1 miles per gallon (14.5 km/L) during this period.

Additionally, the US is planning to extend LDV CAFE standards to 2025. Passenger cars and light trucks will be required to meet a fleet average fuel economy standard of 54.5 miles per gallon (23.17 km/L) by that year. Some leniency in that standard will be allowed through credits for enhancements in air conditioning technology and other areas that reduce GHG emissions. Box 7.4 discusses some incentives in the US to increase vehicle fuel efficiency.

EUROPE

In 2009, Europe set its first mandatory CO_2 emission target for 2015 at 130 gCO_2e/km for the fleet average for all manufacturers combined. A similar standard for light commercial vehicles (vans) was set in 2011 at 175 gCO_2e/km for the year 2017.

These targets are to be met with vehicle efficiency improvements alone, with additional cuts achieved through measures such as changes in tire pressure, gearshift indicators, air conditioning as well as an increased use of biofuels.

In 2011, a more far-reaching 2020 target of 95 gCO_2e/km was announced for LDVs. The European Commission has until early 2013 to consider the technical and economic analysis to achieve this.
The European standard for CO_2 emissions is a weight-based corporate average, while US fuel efficiency regulations are class-based. This means vehicle manufacturers in Europe do not necessarily have an incentive to decrease vehicle weight in order to increase fuel efficiency.

There are some flexibility and incentives built into the European system. For example, cars emitting less than 35 gCO_2e/km will count as 1.3 cars for up to 20,000 new car registrations per manufacturer. Addi-

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Box 7. 4

Improving Fuel Efficiency for Existing Vehicles: Examples of Rebates and Penalties

The United States government allows tax credits for the purchase of energy efficient vehicles. Tax credit is calculated on the basis of the vehicle's fuel economy and energy savings. After a vehicle meets the eligibility criteria, the automaker applies to the Internal Revenue Service for official certification of the incentive. Above a certain level, the tax credit amount decreases until it eventually phases out (Onoda, 2008).

The state of California developed a 'feebate' system (fee as penalty and rebate as reward). Such a system could be designed to be revenue neutral or to yield a certain pre-specified ratio of total fees to total rebates. For this policy, issues to be considered include (i) the effect of gradual reduction in energy efficiency of vehicles over time. So scheme parameters pivot point(s) and rate- need to be adjusted periodically to maintain overall revenue neutrality. (ii) there can be significant administrative cost, depending on the complexity of the scheme. The purchase of old vehicles which tend to be fuel inefficient and the production of fuel inefficient cars are penalised in certain countries. At the federal level in the US, the Gas Guzzler Tax is a disincentive established by the 1978 Energy Tax Act to discourage the production and purchase of fuel inefficient vehicles (Onoda, 2008).

The Car Allowance Rebate System (CARS), colloquially known as "Cash for Clunkers", a $3 billion U.S. federal programme, established in 2009, provides economic incentives to residents to purchase a new, more fuel-efficient vehicle when trading in a less fuel-efficient vehicle. The programme was promoted as providing stimulus to the economy by boosting auto sales, while putting safer, cleaner and more fuel-efficient vehicles on the roadways (USDOT, 2009).

In Canada, the ecoAUTO programme provides rebates for purchase or long-term lease of efficient cars and light trucks, and Green Levy-an excise tax- penalises those who purchase certain types of energy-inefficient cars (APEC, 2009).

Source: Government Policies to Encourage Energy Efficient Vehicles on Roads, Page 8-9, Kumares C. Sinha, Mohammad H. Arman, Samuel Labi, June 7, 2011.

tionally, manufacturers that develop 'innovative technologies' that are not covered by the test cycle can apply for a maximum credit of 7 gCO^2e/km.

CHINA

China regulates vehicle fuel consumption rather than fuel economy. It introduced its first national fuel consumption standards for new passenger vehicles in 2005 (Phase I). Phase I sets fuel consumption standards on vehicle weight. It was successful in reducing fuel consumption to 8.1 L/100km for model year 2008 vehicles, over an average of 9.1 L/100km for model year 2002 vehicles. Phase I standards were tightened by 10 per cent in 2008 (Phase II) for all model year 2009 vehicles and beyond. In 2009 and even more stringent standards were proposed (Phase III), which aims at a nationwide LDV fleet average fuel consumption rate of 7 L/100km by 2015.

The first two phases of the Chinese standards were per-vehicle certificate standards. Every new vehicle had to meet a maximum fuel consumption set for its weight class before it could enter the market. Such a compliance scheme, though useful in phasing out vehicles with out-dated technologies, does not encourage manufacturers to adopt state-of-the-art fuel efficiency technologies over time.

But the 2015 target may not be met as vehicles are generally getting heavierand hence will have less stringent fuel consumption standards.China is therefore considering a combined per-vehicle certificate standard and corporate average fuel consumption (CAFC) system for Phase III regulations, details of which have yet to be released.

Additionally, China also provides incentives for the production and sale of fuel-efficient vehicles as detailed in Box 7.5.

HEAVY-DUTY VEHICLE STANDARDS

Since the use of HDVs is linked with growth in freight activity, stakeholders in the HDV sector extend beyond vehicle manufacturers and owners to include those who contract services as well.

There are many well-known technical improvements to reduce HDV fuel consumption.

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Box 7.5
Enhancing Highway Vehicle Energy Efficiency: China's Case

Worried about heavy reliance on imported oil and faced with increasing hazy smog conditions in Beijing and other Chinese cities, China is seeking ways to impose greater fuel efficiency. Chinese officials have drafted automotive fuel economy standards that require automakers in China to improve fuel economy by an additional 18 per cent by 2015. The Chinese government has been active in adopting policies and programmes to encourage energy-efficient vehicles on roads:

Economic incentives & disincentives are used to reduce greenhouse gas emissions, and are implemented through subsidies to individuals for purchasing new fuel-efficient or alternative-fuel vehicles or increasing the fuel efficiency of existing vehicles. Some of these economic incentives are:

- A subsidy of $455 to each consumer who buys selected vehicles with engines not exceeding 1.6 liters;
- Subsidies of up to $9,100 for the purchase of an electric car, and up to $7,580 for the purchase of a gasoline-electric hybrid vehicle, in the cities of Shanghai, Hangshou, Changchun, Shenshen and Hefei, under a trial programme, started June 2010.
- Procurement of energy-efficient vehicles for the government
- China is actively supporting research and development of new vehicle technologies. Its largest automobile company, the SAIC group, and other local and foreign auto makers are investing in R&D centres to develop alternative energy and environmentally-friendly technologies. In addition, China enforces mandatory vehicle emission inspection and retirement of old vehicles.

Hence we see that standards of new vehicles have been controlled through i) Establishment of mandatory fuel-efficiency standards for light duty vehicles. ii) Automotive industry agreements on fuel efficiency and adaptation of efficient and innovative vehicle technology. iii) Mandatory fuel-efficiency standards for passenger cars based on vehicle weight and transmission type (manual or automatic).

The Chinese Government actively promotes public outreach to enhance awareness of the need to reduce energy consumption, how it can be achieved by individual contribution as individuals monitor their energy use. For this purpose, information on vehicle performance is provided to car purchasers and vehicles are labelled with fuel consumption rates at the time of purchase.

Source: Government Policies to Encourage Energy Efficient Vehicles on Roads, Page 22, Kumares C. Sinha, Mohammad H. Arman, Samuel Labi, June 7, 2011.

Setting fuel economy or GHG emission standards for HDVs is a more recent regulatory endeavour than for LDVs. Until the mid-2000s, the focus was on voluntary best practice programmes which connected fleets with resources to improve their in-use efficiency.

Recently, several countries have begun to develop and implement mandatory fuel economy or GHG emission standards for HDVs. Japan implemented the first mandatory HDV fuel economy standards in 2005, followed by the US in 2011. China has implemented a voluntary industry standard on certain vehicle types and is developing a mandatory fuel consumption standard. In Europe, HDV GHG emission standards for the 2013-14 timeframe are under consideration. Table 7.3 shows the development of HDV fuel economy and GHG emission standards in assorted countries and regions.

JAPAN

Japan was the first country to implement mandatory fuel economy standards for HDVs. In 2006, the Japanese government introduced the first fuel economy standards for new HDVs, which were estimated to be responsible for approximately one-third of all CO_2 emission from motor vehicles in 2008. Fleet average fuel economy targets were set to be 7.09 km/L (369.6 gCO_2e/km) for heavy-duty trucks and 6.30 km/L (416 gCO_2e/km) for buses by 2015. Both targets represent a 12 per cent increase in fuel economy over fleet average fuel economy for both vehicle types in 2002.

Japanese standards are corporate average, weight-based standards. Specific targets are set for different types of vehicles and also depend on vehicle weight. Vehicles are tested on a chassis dynamometer over the urban JE 05 test. Fuel economy is then calculated based on a computer simulation that takes into account, testing and various vehicle factors.

THE UNITED STATES

In 2011, the US passed its first GHG emissions and fuel economy requirements for HDVs through model year 2018. The new requirements require up to a 20 per cent decrease in fuel consumption for tractors, a 10 per cent decrease for delivery trucks, garbage trucks, buses, and vocational vehicles, and a 17 per cent

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Table 7.3

The Development of HDV Fuel Economy and GHG Emission Standards in Various Countries

COUNTRY/ REGION	REGULATION TYPE	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Japan	Fuel Economy						Phase 1 Regulation Implemented Starting MY 2015					
				Phase 2 Development								Phase 2
United States	GHG/Fuel Efficiency	Standard proposal	Final rule			Regulation Implemented Starting MY 2014 (mandatory DOT program starts MY 2016)						
					Trailer Rule?		Phase 2 Final Rule					Phase 2
Canada	GHG/Fuel Efficiency			Standard Proposal and Final Rule		Regulation Implemented Starting MY 2014					Phase 2 Implementation?	
Mexico	Fuel Efficiency			Standard Proposal				Regulation Implemented Starting MY 2016			Phase 2 Implementation?	
China	Fuel Consumption	Test Procedure Finalised	Industry Standard Proposal	Standard Proposal	Final Rule		Regulation Implemented Starting MY 2015					
European Union	GHG	Technical Studies			Test procedure Finalised	Mandatory Efficiency Reporting and Policy Development				Policy Implementation?		
California	End-user Purchase Requirements	Requirements for new Tractors and Trailers (MY 2011+)			Additional Requirements for Existing Tractors and Trailers (<MY 2010)				Additional Requirements for Existing Trailers and Reefers (<MY 2010)			

Source: NTDPC Research.

decrease for heavy-duty pickups and vans by 2018 over 2010 year levels.

While the Japanese approach was largely based on engine improvements, the US took a comprehensive look at improving HDV fuel economy. The US programme includes separate engine-only standards as well as also aerodynamics, tires, and weight reduction in its approach.. This gives manufacturers flexibility while complying with regulations.

OTHER COUNTRIES

No other country currently has plans to implement HDV fuel efficiency or GHG emission standards in the near future. Europe and China are currently assessing their capability to set GHG emission standards for HDVs, but neither has yet announced anything definitive.

TWO- AND THREE-WHEELERS

Currently, there are only two countries in the world with two and three-wheeler fuel economy standards: China and Taiwan. China first implemented its two- and three-wheeler fuel consumption standards in 2008. It is expected to implement its second phase of motorcycle fuel consumption standards in the near future.

INDIAN GHG EMISSION STANDARDS

As a part of its low-carbon growth strategy, India has announced it will reduce its GHG emission intensity by 20-25 per cent over 2005 levels, by 2020. An expert group has been set up to develop a strategy to reduce the emission intensity for each of the critical sectors of the economy. After the power generation sector, the transportation sector is currently the second largest contributor of GHG emission in India. Its share is increasing as vehicles on Indian roads increase. Box 7. 6 for the recommendations of the expert group for the transport sector.

In India, the Bureau of Energy Efficiency (BEE) and the MoRTH are responsible for establishing and enforcing fuel economy and GHG emission standards. The BEE will set the standards and MoRTH will be responsible for their enforcement.

LIGHT-DUTY VEHICLES

India is currently developing its first ever fuel economy standards for passenger vehicles. These standards will be applicable to new cars, but will not include light commercial vehicles (LCVs). Including LCVs or establishing separate standards for them would be a good opportunity to reduce diesel consumption, and in turn, lower diesel subsidies the Indian government doles out every year.

New passenger car fuel economy standards were expected to be finalised in 2012, but have been delayed inexplicably. The new standards envision a continuous reduction in fuel consumption over a ten-year period. To give manufacturers adequate lead-time, they are expected to go into effect from 2015-2016. They will be implemented on a CAFC model.

India has developed its first ever fuel economy label for new cars sold in fiscal year 2011-2012. The label is

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Box 7.6

Recommendations on the Transport Sector by the Expert Group on Low Carbon Strategies for Inclusive Growth

As a reflection of its intent to be a responsible member of the community of nations in the efforts to contain climate change, in December 2009, India announced that it would aim to reduce the GHG emission intensity of its GDP by 20-25 per cent by 2020 from its level in 2005. The fulfilment of this commitment requires sector-specific actions. An Expert Group on Low Carbon Strategies for Inclusive Growth was set up to develop recommendations for such actions. The Expert Group submitted an interim report providing a menu of options to reduce GHG emissions intensity in critical sectors of the economy. One of the critical sectors examined by the group was transport.

The strategy for reducing emissions intensity in the transport sector laid out by the Expert Group consists of three elements: avoid; shift; and improve.

1. **Avoid:** This element involves adopting a systems approach and reducing the need for transport through appropriate choices for locating industries and other businesses and through better urban planning to minimise commuting needs.
2. **Shift:** This element focuses on use of more carbon efficient modes of transport.
3. **Improve:** This element emphasises the use of the most carbon efficient technologies for any mode of transport.

The Expert Group focused on three specific interventions that follow from this strategy:

1. Increasing the share of rail in freight transport. This is a "shift" intervention. Chapter I in Volume III of this report which deals with Railways discusses this issue in greater detail.
2. Increasing or retaining the current modal shares of public and non-motorised transport in urban passenger transport. This is an "avoid" and "shift" intervention. It is covered in more detail in Chapter 5 of Volume III of this report on Urban Transport.
3. Improving the efficiency of the vehicle fleet. This is an "improve" intervention and is one of the subjects covered in this chapter.

For improving the fuel efficiency of the vehicle fleet, the Expert Group recommended:

1. Introduce vehicle labelling/rating systems.
2. Introduce minimum efficiency standards.
3. Introduce corporate fleet efficiency standards.

These recommendations are similar to those made on improving fuel efficiency in this chapter.

Source: 'Interim Report of the Expert Group on Low Carbon Strategies for Inclusive Growth,' Planning Commission, Government of India, May 2011.

shown and described in Figure 7.26. Apart from displaying the combined fuel economy of the vehicles, the label ranks fuel efficiency on a five star system. The current rankings are based on fleet average fuel consumption by kerb weight for fiscal year 2009-2010. This means that vehicles with the highest fuel efficiency may not have the highest number of stars. Conversely, vehicles with the lowest fuel efficiency may get more than one or two stars. Despite the BEE label in Figure 7.26 having been finalised, it has not yet been made mandatory.

HEAVY-DUTY VEHICLES

HDV fuel consumption standards have not yet been considered in India, though there is much potential to reduce fuel consumption from HDVs. Probably, they will follow once LDV standards have been put in place.

TWO- AND THREE-WHEELERS

Two and three-wheeler fuel economy or fuel consumption standards may follow after LDV and HDV standards get finalised. Since sales of two- and three-wheelers are high in India, fuel consumption standards for this class of vehicles will be important in curbing overall fuel use and GHG emission. There is also much room for improvement in two- and three-wheeler fuel efficiency in India.

IMPACT OF GHG STANDARDS

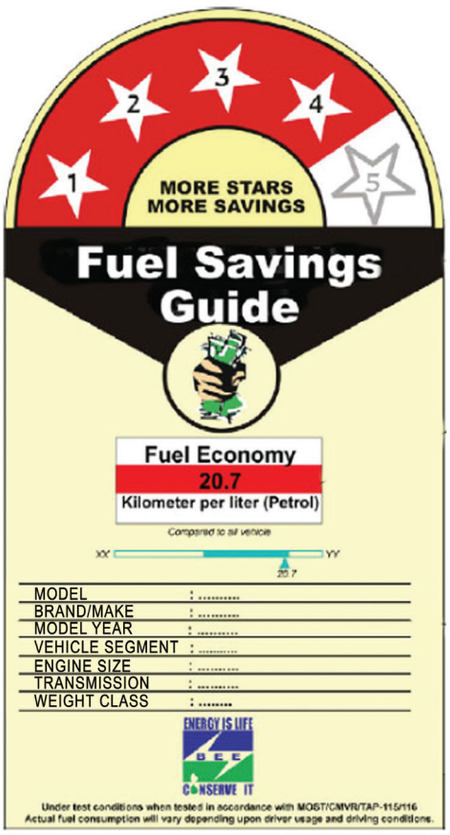
According to analysis by the ICCT, fuel use and CO_2 emission in India will decrease significantly with implementation of vehicle fuel consumption standards. Figure 7.27 shows results of the ICCT's Alternate scenario over the BAU scenario[22]. The Alternate scenario assumes the following annual reduction in GHG emission between 2015 and 2025: 3 per cent for LDVs; 2 per cent for HDVs; 1 per cent for two- and three-wheelers.

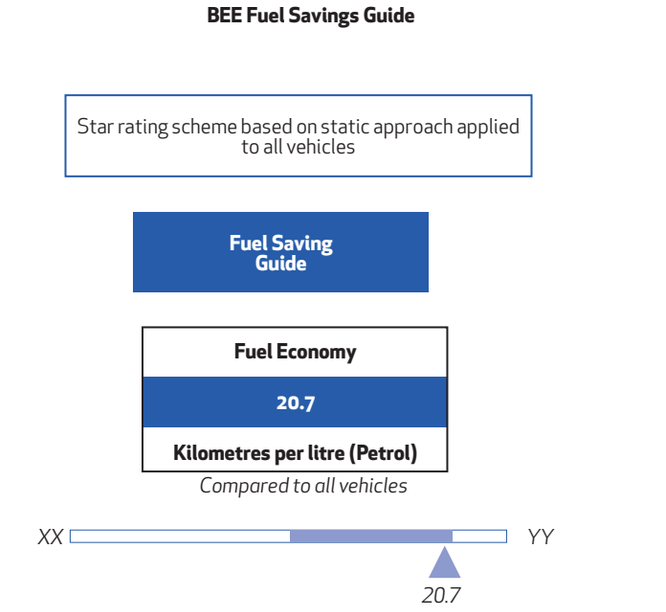
From Figure 7.27, it can be seen that over 1,665 million barrels of oil can be saved and 695 million tonne of CO_2e emissions can be avoided if the

22. ICCT (2012).

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Figure 7.26
India's New Vehicle Fuel Economy Label





Source: NTDPC Research.

2030 Alternate scenario were to become reality. Certainly, reductions in CO_2 emission would continue even without further reductions in new vehicle fuel consumption, as more fuel-efficient vehicles replace old ones.

RECOMMENDATIONS TO REDUCE ENERGY CONSUMPTION AND CO_2e EMISSION

MANDATE FUEL EFFICIENCY LABEL FOR ALL NEW VEHICLES

A BEE label to clearly display a passenger vehicle's fuel efficiency has been developed, but not made mandatory. India should mandate this label for all new model year 2014 and later cars so consumers can make informed decisions when they purchase vehicles.

NOTIFY LDV FUEL CONSUMPTION STANDARDS

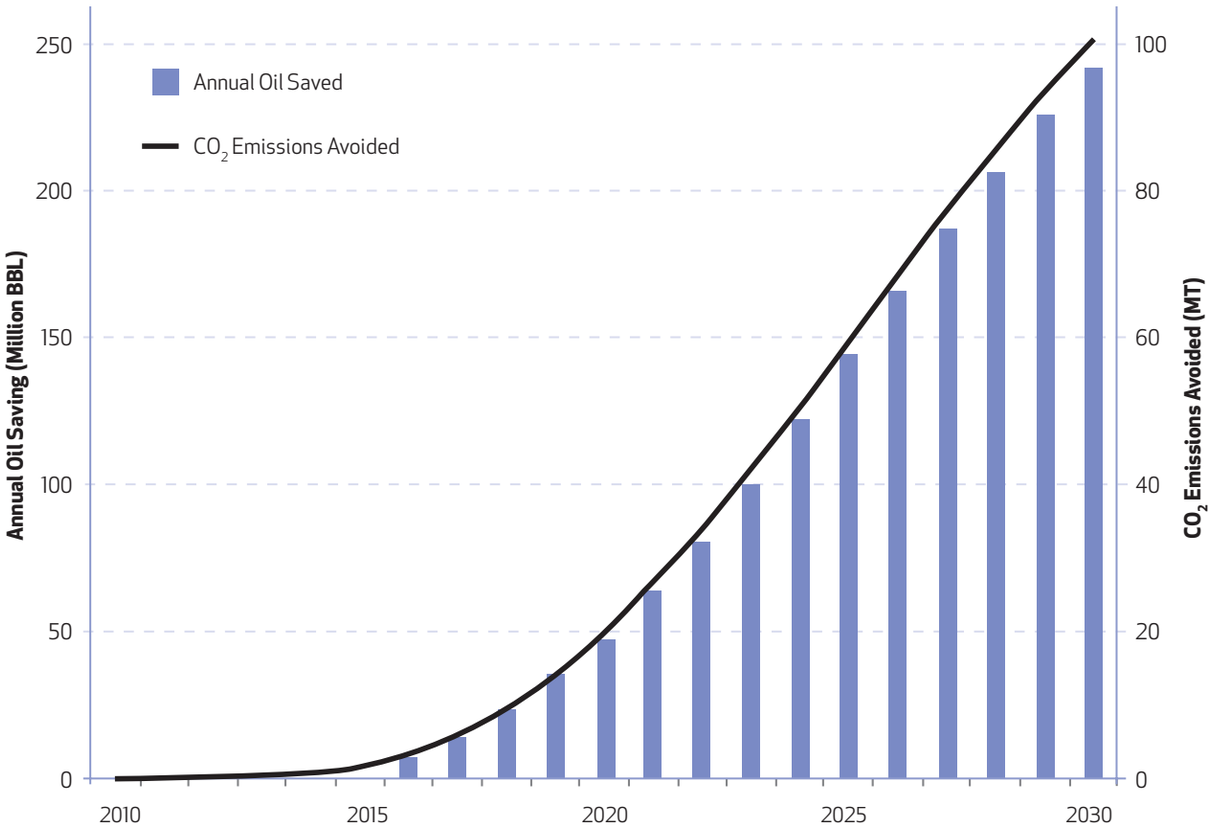
India has already developed LDV fuel consumption standards for the remainder of this decade, but their implementation has been delayed inexplicably. These standards should be notified immediately, and assessment for standards beyond 2020 should be started. Europe is targeting its LDV fleet average GHG emission to be 95 gCO_2e/km by 2020, which is far more stringent than standards proposed in India. Given that India's LDV fleet average GHG emission is roughly equivalent to those in Europe at the moment, India should aim for 95 gCO_2e/km by 2025 at the latest.

DEVELOP HDVs AND TWO- AND THREE-WHEELERS FUEL CONSUMPTION STANDARDS

The government has indicated it would begin this process once LDV standards have been finalised. There is also much that can be done to improve the fuel efficiency of HDVs and two- and three-wheelers. This is especially important in India, where motorcycles dominate new vehicle sales and are expected to do so in the future. The process to develop fuel consumption standards through the remainder of this decade for these vehicles should begin immediately. HDV standards should be in place by 2015 and two- and three-wheeler standards, by 2016. The target for both categories should be to reduce fuel consumption by 20 per cent under current levels by 2020.

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Figure 7.27
Annual CO_2 Emission Under the BAU and Alternate Scenarios



Source: ICCT (2012).

PROMOTE NMT AND PUBLIC TRANSPORT, ESPECIALLY IN URBAN AREAS

Reductions in energy consumption and GHG emissions can also come by promoting public transport and NMT, which would also stem the growth of private vehicles in most Indian cities. Adequate and quality public transport systems should be assured in all cities with populations above 500,000 and safe NMT options should be available everywhere.

SUMMARY & CONCLUSIONS

Energy use and GHG emission by the Indian transport sector are growing dramatically. This will continue unless strong action is taken. Most studies predict energy consumption by the transport sector will increase by factor of 2 to 4 over current levels, by 2030.

Increasing energy use and GHG emission means India will become even more dependent on imported fuels. This can hurt India's energy security and economy, as it sends money abroad rather than investing at home. GHG emission also exacerbates the problem of global warming, which can have dire effects on Indian agriculture and coastal populations.

To mitigate these problems India can:

i) Develop better urban development policies that incentivise public transport and NMT over private vehicle use.

ii) Implement stringent fuel consumption standards for all vehicle types. Indian vehicles are already relatively fuel-efficient, since they are typically smaller. The potential to further improve vehicle fuel efficiency over the next decade or so is also well-recognised.. Still, India risks falling behind other countries that have already implemented LDV fuel efficiency standards and are in the process of implementing HDV and two- and three-wheeler fuel efficiency standards.

India has developed LDV fuel consumption standards for the remainder of this decade, but it has inexplicably not notified them. These standards should be notified immediately, and assessment of the potential to reduce LDV fuel consumption beyond 2020 should begin immediately. India should aim for its LDV fleet average emission to be 95 gCO_2e/km by 2025.

Likewise, the development of fuel consumption standards for HDVs and two- and three-wheelers

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should be started immediately. Standards for HDVs should be in place by 2015, and those for two- and three-wheelers, by 2016. Both should aim to reduce fuel consumption by 20 per cent of current levels by the end of this decade.

LIFE CYCLE ANALYSIS OF TRANSPORT MODES

NEED FOR FACTORING LIFE CYCLE ENERGY AND CO_2 COSTS IN TRANSPORT DECISIONS

Environmental impact assessment exercises carried out to support decision-making in transport sector do not consider the full life cycle energy and CO_2 impact of transport modes and focus on the tail pipe impact only. It is, however, necessary that a holistic approach is adopted while analysing impact.

This is because different transport modes involve varying degrees of construction and maintenance activities; while some modes may be highly material and energy intensive, others may be comparably less energy intensive. Material and energy consumption at various stages of a transport project i.e. construction, operations and maintenance, need to be examined in order to fully understand their impact on environment.

Life cycle analyses (LCA) are typically used to assess such holistic/full-life impact of various products, systems, projects, etc. LCA is considered to be a robust decision-support tool due to the comparative character of its analysis . It helps identify life stages of a product/system having maximum impact and hence enables identification of appropriate mitigation strategies. Full life cycle impact of transport needs to be accounted for and recognised while taking policy decisions related to inter-modal choices and intra-modal greening.

ESTIMATING LIFE CYCLE ENERGY AND CO_2 IMPACTS ON SCOPE OF LCA

All stages in the life cycle of a transport mode like construction of fixed infrastructure and production of materials used in construction, manufacture of rolling stock, movement of rolling stock for transportation of people/goods, maintenance of rolling stock, maintenance of fixed infrastructure, etc require material and energy consumption and lead to CO_2 emission. The LCA should take into account all these life stages. However, certain life stages/ activities can be left out in order to ensure that the LCA exercise is doable. A good LCA exercise should typically include the following life stages.

Life Cycle Analysis helps identify life stages of a product/system having maximum impact and hence enables selection of the right mitigation strategies. Full life cycle impact of transport needs to be recognised when taking decisions on inter-modal choices.

CONSTRUCTION OF THE TRANSPORT CORRIDOR/FIXED INFRASTRUCTURE

PRODUCTION OF CONSTRUCTION MATERIALS

Construction of any transport corridor requires consumption of materials. While on-site consumption of materials may not have any emission, the production of most construction materials is an energy-intensive process that also leads to CO_2 emission. The LCA framework should include this indirect energy consumption component, commonly referred as the 'embodied energy' of materials, and the resultant 'embodied CO_2' of materials.

TRANSPORTATION OF CONSTRUCTION MATERIALS

Once produced, materials are transported to construction sites by motorised modes like trucks. There are two types of energy consumption during this life stage–direct energy consumption by trucks and embodied energy of trucks. While the direct energy consumption component should be included in the LCA framework, the indirect energy consumption i.e. embodied energy of trucks need not be included because these trucks are capital assets,re-used for other construction and non-construction activities too.

ON-SITE IMPACTS: ON-SITE CONSUMPTION OF ENERGY

On-site construction processes require energy to run construction machinery, generate heat, etc. Diesel, electricity and fuel oil are the most common fuels consumed on-site. These processes and their CO_2 impact should be included in the LCA. Indirect energy consumption and CO_2 due to manufacturing of construction machinery and equipment, however, need not be included in the LCA.

ON-SITE IMPACTS: REMOVAL OF VEGETATION

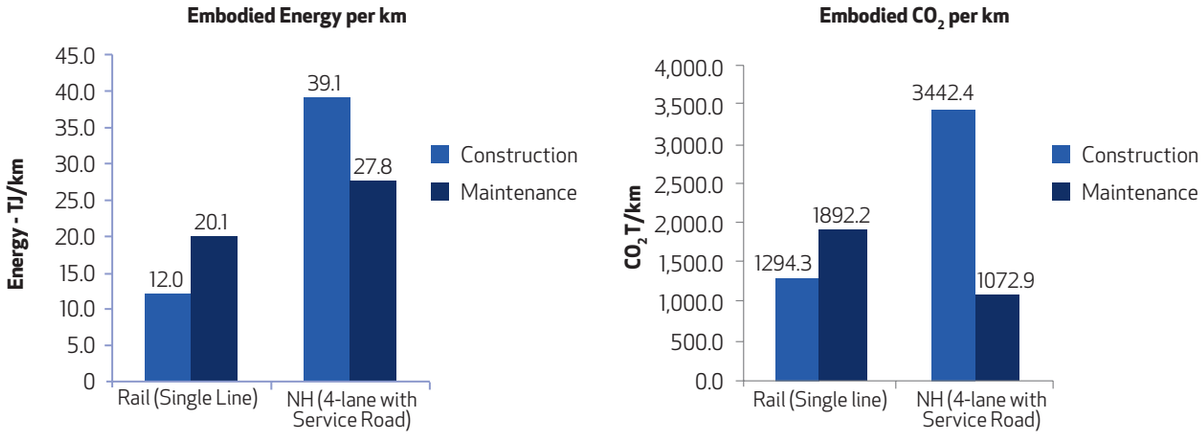
Construction of transport corridors often require removal of vegetation, which leads to loss of the carbon sequestration (CS) potential of vegetation. The LCA should include this CS potential loss.

OPERATIONS ON THE TRANSPORT CORRIDOR

Operations on transport corridors involve movement of the rolling stock. Energy consumption and CO_2 emission due to movement of rolling stock (direct) and manufacture and maintenance of rolling stock (indirect) should be included in the LCA.

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Figure 7. 28
Construction of Rail and National Highways: Embodied Energy and CO_2 Emission



Source: Life cycle analysis study carried out by TERI for NTDPC
Note: It should be noted that the above analysis has been carried out for sample rail and national highways projects.

MAINTENANCE OF THE TRANSPORT CORRIDOR
Energy and CO_2 impact due to annual routine maintenance and periodic maintenance/renewal should be included in LCA as done in the construction stage.

CONSIDERING LCA FOR INTER-MODAL DECISIONS

An understanding of the life cycle energy and emission costs resulting from the above activities in the life cycle of a transport project can help make informed and objective choices of transport modes and technologies in our policies and plans. While financial and technical feasibility analyses are carried out to select the most suitable mode of transport on a corridor/in a city, there is also a need to evaluate life cycle energy and emission costs of the alternate modal options and understand their environmental costs. For e.g. while financial feasibility analysis may indicate construction of national highways as being more cost effective than rail projects, LCA indicates that national highways are more energy and CO_2 intensive during construction, in comparison. (Figure 7.28).

Metro rail projects in urban areas have highest construction costs. LCA comparison indicates that construction of metro has highest environmental costs of all alternatives for urban areas (Figure 7.29).

While cities may choose high-capacity public transport systems like the metro rail as the least carbon emission-generating technology for public transport because it generates no emission at the tail pipe, an LCA evaluation indicates that a metro system generates more CO2 emission per km on a life cycle basis compared to, say, a Bus Rapid Transport system, which can also be high-capacity (Figure 7.30).

But the same metro system, however, is more energy efficient (on a per PKM basis) for its full life period, when compared to a BRT system (Figure 7.30). Introducing life cycle impact considerations can hence bring more detailed understanding of the overall impact of a system/proposed infrastructure project that are not limited to just tailpipe or operations stages and help decision makers make informed choices based on the economic, social and environmental goals set by the national, state or city governments.

It is important to note that LCA results cannot be generalised. While in smaller cities, high-capacity systems like metro rail may not look desirable on a life cycle energy and emission impact basis (per PKM) on account of the low usage, the same systems may be highly desirable in very large cities having very high usage levels. The choice of mode hence needs to be context-specific and an economically and environmentally feasible choice.

CONSIDERING LCA FOR INTRA-MODAL GREENING

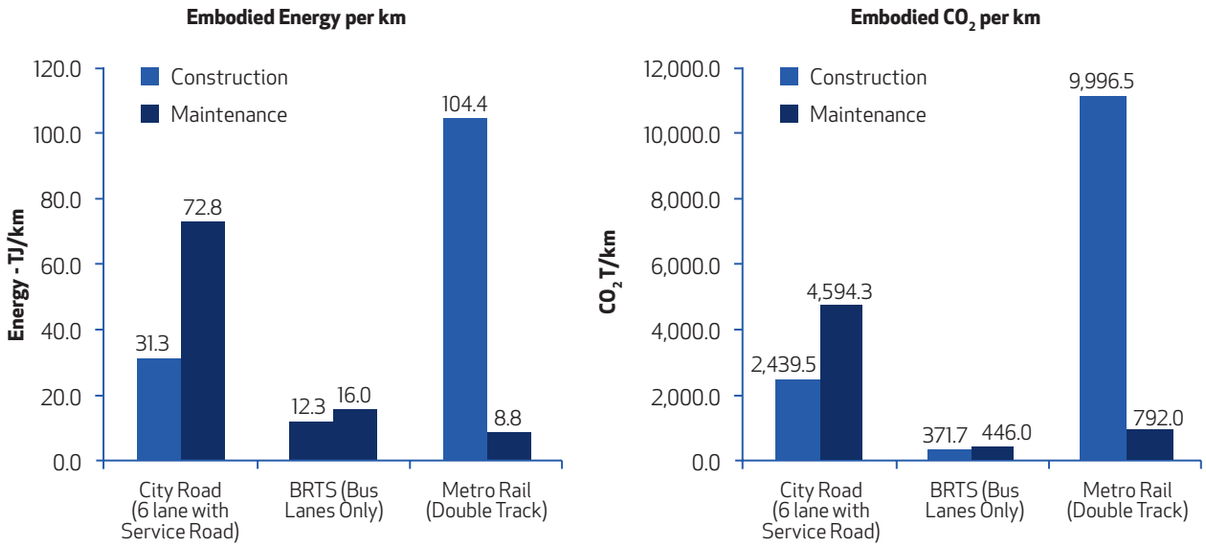
Construction and maintenance of transport infrastructure involves consumption of materials and fuels, some of which are highly energy- and carbon-intensive, significantly contributing to the life cycle energy and CO_2 impact of a particular transport mode.

LCA, if carried out, can indicate the materials and fuels that could be replaced by alternative materials and fuels that are less energy- and carbon-intensive. The LCA can also indicate the positive impact of using locally-available materials in reducing costs. Some possible areas where energy reduction can be achieved during the life of a transportation system are:

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Figure 7. 29

Construction of Urban Transport Projects: Embodied Energy and CO_2 Emission



Source: Life cycle analysis study carried out by TERI for NTDPC.
Note: It should be noted that the above analysis has been carried out for sample urban transport projects.

- Reducing energy and CO_2 intensity of conventional materials used,
- Using alternative materials that are comparatively less energy- and CO_2 -intensive,
- Using locally available materials,
- Using energy-efficient processes and machinery during construction and maintenance,
- Optimising resource utilisation during construction and maintenance, especially for transportation of materials (using locally available materials, reducing idling, using rail for bulk transport of materials, etc.),
- Using alternative fuels for construction processes and for transportation of materials during construction
- Promoting inter-modal shift (towards more energy-efficient modes),
- Improving efficiency of rolling stock, and
- Reducing energy and material intensity during manufacturing and maintenance of rolling stock.

LCA also indicates that if the life of projects is enhanced, then the energy and CO_2 impact due to reconstruction can be reduced/deferred, especially in the case of road-based projects that tend to have a shorter life. Project life can be enhanced by continued maintenance. This will help reduce both monetary and environmental costs on a life cycle basis.

It is recommended that LCA exercises should be carried out at least for all capital-intensive transports projects like metro rail, BRT, national highways, etc. in order to identify intra-modal improvements in terms of material substitution, bringing about operational efficiencies, reducing logistics coss, etc.

BUILDING CAPACITY FOR LCA

Conducting LCA calls for understanding of LCA concepts and analytical skills. These skills do not exist in ministries, government agencies and in most cities including metros. It might also be difficult and not cost-effective to build these skills in all agencies and cities. It is hence recommended that the capacity for conducting LCA should be built in key central agencies like the Planning Commission, state governments and in all metros. State governments can conduct LCA for the other cities.

FINDINGS & RECOMMENDATIONS

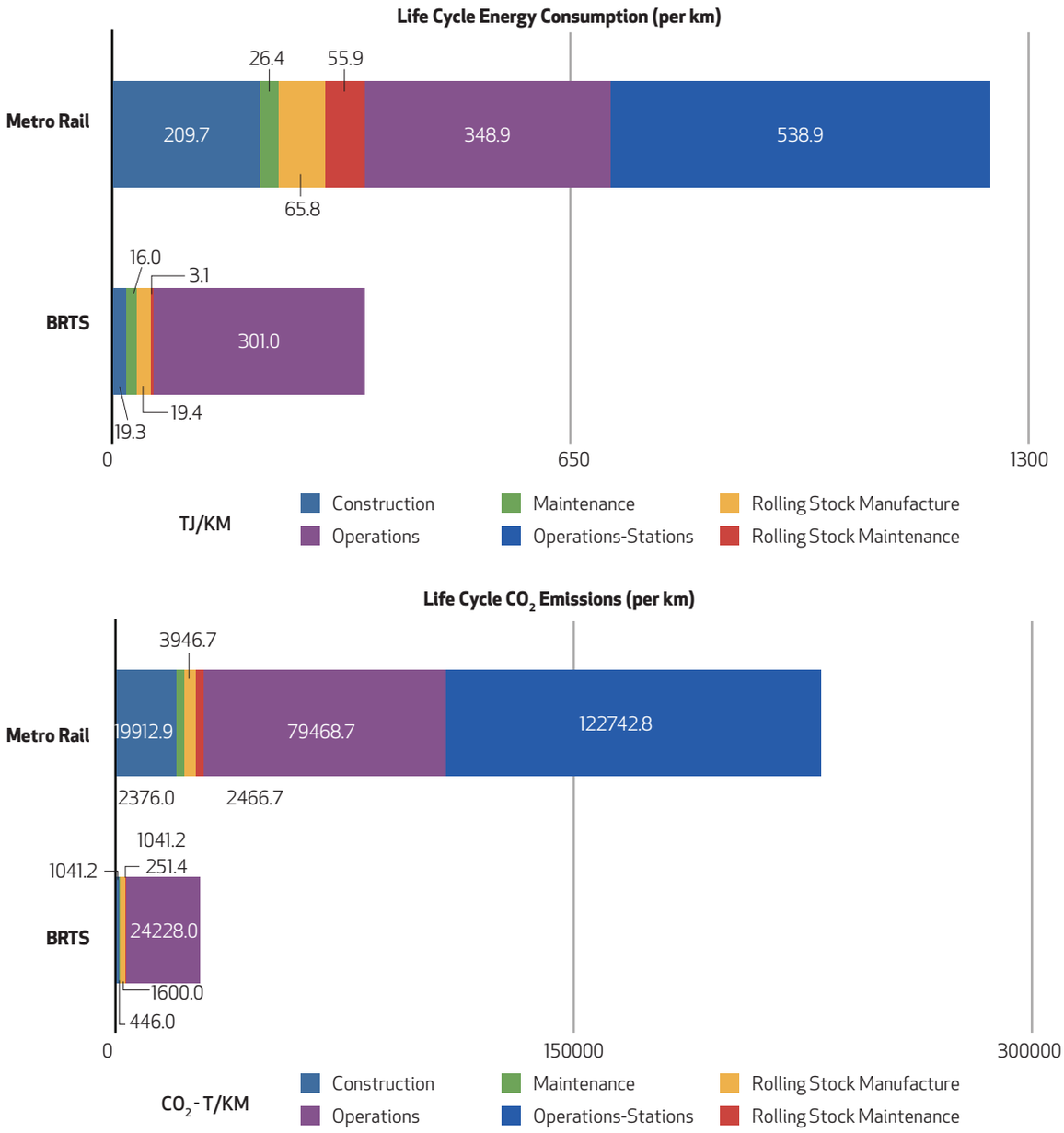
India has come a long way over the last two decades in reducing vehicle emission. Still, associated poor air quality and public health problems drive the need for further emission control. Many Indian cities have been ranked among the most polluted in the world. Vehicles are responsible for the majority of urban NO_x emission and 30-50 per cent of PM emission, in addition to significant HC and CO emission. The problem is exacerbated by the preference for diesel cars in India due to diesel subsidies. Currently, new diesel cars are allowed to emit much more NO_x and PM than gasoline cars.

India also lags behind international best practices in terms of fuel quality and vehicle emission standards. Sulphur levels in fuel remain high, well above the maximum of 10 ppm required for the best clean vehicle technologies to function optimally. Nor does India have any plans of implementing 10 ppm sulphur fuels nationwide any time soon. As a result, vehicle emission standards are not where they can be. Most of

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Figure 7.30

Life Cycle Energy and CO_2 Emission from Metro and Bus Rapid Transit System (BRTS) Projects



Source: Life cycle analysis study carried out by TERI for NTDPC.
Note: It should be noted that the above analysis has been carried out for sample urban transport projects.

India is at Bharat III, with a handful of cities ahead at Bharat IV.

In contrast, the US, Europe, South Korea, and Japan have had 10 ppm sulphur fuels for many years now. Europe is in the process of moving to Euro 6/VI. Countries at similar economic levels as India, such as China, Mexico, and Brazil, are also planning to move ahead on fuel quality and vehicle emission standards shortly.

There is much room for improvement for compliance and enforcement issues in India. Standards are meaningful only if complied with. The US, in particular, has been at the forefront of compliance efforts for over 40 years. By shifting the focus of vehicle emission compliance from new vehicles to in-use testing, over time the onus has been placed on vehicle manufacturers to ensure their products function as designed throughout their useful life. And testing fuel quality at multiple points along the distribution system has incentivised oil companies and fuel handlers to ensure fuel quality is met at all times. Clear, strict recall policies and punitive measures for non-compliant vehicles and fuels compel industry to test its own products. So the US EPA save money as it does not have to allocate resources to test many vehicles or all batches of fuel.

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India can learn from the vast experience of the US and other countries to enhance its own regulatory programmes. Vehicle emission testing is currently limited to new vehicles, meaning there is little data to analyse the effectiveness of emission control technologies throughout their useful life. Weak test cycles mean that while vehicles pass initial emission testing, they may emit much more in real-world situations. While the laws provide for government testing of fuel quality, there is little evidence this is actually done.

Energy use by the transport sector is increasing dramatically, led primarily by private vehicle use. Studies predict that energy use by the transport sector will increase two to fourfold over the next 20 years. Unless strong action is taken, the consequences will be dire for India's energy security, economy, air quality, and global warming.

Enhanced public transport and NMT systems that disincentivise private vehicle use are one step towards combating these problems. These are discussed in more detail in the chapter on urban transport. Establishing vehicle fuel efficiency standards also help mitigate these problems.

India has already developed progressively stricter LDV fuel consumption standards for the remainder of this decade, but they have not yet been notified. They are also significantly weaker than European standards, despite the fact that Indian and European LDV fleets are currently at similar fuel consumption levels. Processes to develop HDV and two- and three-wheeler fuel consumption standards have not even begun, while many other countries are starting to implement these standards already.

It is important to treat vehicle emission and fuel use as a system. Improvements in one often lead to improvements in the other. For example, many technologies that improve vehicle fuel efficiency not only lead to lower GHG emission and fuel consumption, which mitigate global warming and reduce India's dependence on imported fuels, but also reduce air pollutant emission, which improves air quality and public health. Therefore, this chapter looks at all these issues holistically.

With the formation of a new Auto Fuel Policy Committee in January 2013, there is a lot of potential for India to make a headway on all of the points mentioned above. The committee has the authority to recommend reforms through the year 2025. The recommendations below are a starting point for that committee to reduce long-term vehicle emission and fuel consumption in India.

TIGHTER FUEL QUALITY STANDARDS

50 ppm sulphur fuels should be mandated nationwide by the middle of this decade, and 10 ppm sulphur fuels should be mandated nationwide by 2020. Reforms in diesel pricing being implemented currently should be used to pay for refinery investments needed to produce these cleaner fuels.

Energy use by the transport sector is increasing dramatically,led primarily by private vehicle use. Unless strong action is taken, the results will be dire for India's energy security, economy, air quality, and global warming.

TIGHTER NEW VEHICLE EMISSION STANDARDS

Bharat IV fuel quality standard should be implemented nationwide by the middle of this decade, with a target to reach Bharat VI by 2020.

EVAPORATIVE EMISSION STANDARDS

By mid-decade, India should mandate Stage I controls when retail outlets are supplied with fuel, and Stage II controls for vehicle refuelling. India should also mandate all new vehicles to have on-board refuelling vapour recovery (ORVR) systems at the same time. These systems return vapours to a vehicle's fuel tank rather than to retail outlets. Stage II controls can be lifted about ten years after the implementation of ORVR systems because the majority of India's vehicle fleet will then have ORVR systems in place.

WORLD-HARMONISED TEST CYCLES

Replacing current test cycles with world-harmonised test cycles will make it less likely that certain vehicles 'beat' emission testing by passing the test cycle while emitting much more under real-world conditions. India should make world-harmonised test cycles optional when Bharat IV regulations go into force nationwide and mandatory when Bharat V regulations come into force.

REVIEW AUTO FUEL POLICY EVERY FIVE YEARS

In 2003, the Mashelkar Auto Fuel Policy committee had recommended a review of the auto fuel policy every five years. Yet a new Auto Fuel Policy Committee was not formed until 2013, ten years later, despite the fact that the Mashelkar Committee's mandate was through the year 2010. It should be made compulsory that a new Auto Fuel Policy Committee be formed five years after the previous one completes its work. Provisions should be made for this in the MoPNG's five-year plans.

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SINGLE AGENCY FOR VEHICLE EMISSION AND FUEL QUALITY REGULATIONS

In 2003, the Mashelkar Auto Fuel Policy Committee had recommended the formation of a National Automobile Pollution and Fuel Authority (NAPFA) responsible for setting and enforcing vehicle emission and fuel quality standards in India. Currently a number of ministries and agencies are responsible for compliance and enforcement in India. This allows blame to be passed onto others in case of problems. Parliament should establish a permanent NAPFA and ensure that it is fully-funded.

NATIONAL IN-USE VEHICLE TESTING PROGRAMME

India needs to establish a robust Inspection and Certification (I&C) regime to ensure safety, road worthiness and emission performance of in-use vehicles. National-level vehicle testing needs to move beyond type approval (TA) and conformity of production (COP) to include in-use testing. All motor vehicle categories should be covered under the I&C regime. There should also be a recall policy to recall models which on testing do not adhere to the emission standards. Modern I&C centres with minimum manual interference need to be established on a PPP basis in a phased manner. In the beginning, transport (commercial) vehicles could be targeted, followed by non-transport (private) vehicles. Cities with higher vehicular pollution should be targeted first. Commercial and older vehicles should be tested more frequently, preferably annually. The central government should lay down the policy and regulatory framework for tests, equipment and manpower requirements based on the advice of an independent agency like a National Accreditation Board (NAB) that could also monitor implementation of I&C by state governments.

CLEAR RECALL POLICIES AND PUNITIVE MEASURES

Until NAPFA is set up, the MoRTH should establish clear punitive measures and recall processes for non-compliant vehicles and the MoPNG should establish clear punitive measures for non-compliant fuels.

TEST FUEL QUALITY AT RETAIL OUTLETS

There is little, if any, evidence that governmental or independent fuel quality testing is done anywhere along the fuel distribution system in India. Given the history of fuel adulteration, it is especially important to test fuel at retail outlets, where consumers ultimately purchase fuels. Until NAPFA is set up, the MoPNG should develop a national plan to test fuel at retail outlets, along the lines of what is done by the US EPA or Japan's Ministry of Economy Trade and Industry (METI) and National Police Agency (NPA). Mandate fuel efficiency label for all new vehicles A BEE label to clearly display a vehicle's fuel efficiency has been developed but not made mandatory. India should mandate this label for all new model year 2014 and later vehicles so consumers can make informed purchase decisions.

NOTIFY LDV FUEL CONSUMPTION STANDARDS

India has already developed LDV fuel consumption standards for the remainder of this decade, but their implementation has been delayed inexplicably. These standards should be notified immediately and assessment for standards beyond 2020 should be started. The country should target LDV fleet average GHG emission to be 95 gCO2e/km by 2025, Europe's target for 2020.

DEVELOP HDVs AND TWO- AND THREE-WHEELERS FUEL CONSUMPTION STANDARDS

A lot can be done to improve the fuel efficiency of HDVs and two- and three-wheelers. This is especially important in India, where motorcycles dominate new vehicle sales and will continue to do so in the future. India should aim to have HDV standards in place by 2015 and two- and three-wheeler standards by 2016. The target should be to reduce fuel consumption by 20 per cent of current levels by 2020 for both categories.

PROMOTE NMT AND PUBLIC TRANSPORT, ESPECIALLY IN URBAN AREAS

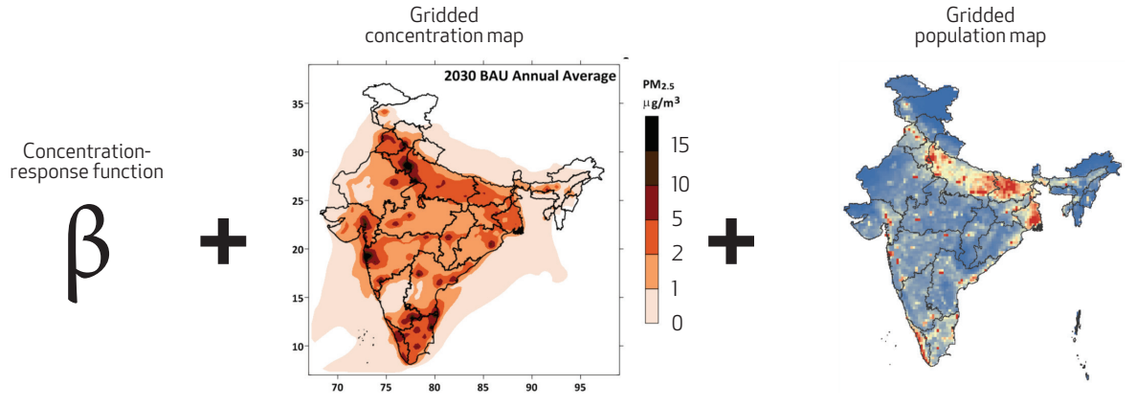
Adequate and quality public transport systems should be assured in all cities with populations above 500,000 and safe NMT options should be available everywhere. Other measures, such as integrated land use planning, enhanced traffic management systems, and integrated transport modes, also help reduce the energy intensity of urban transport systems. The chapter on urban transport details these issues and makes recommendations.

LIFE CYCLE ANALYSIS APPROACH TO BE ADOPTED IN TRANSPORT DECISION MAKING

It is recommended that the capacity to conduct LCA should be built in key central agencies like the Planning Commission, state governments and all metros. State governments can conduct LCA for the other cities. These agencies should carry out LCA analysis to facilitate decisions related to inter-modal choices and intra-modal improvements which reduce environmental costs of transport projects.

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Figure 7.31
Schematics of Health Impacts Assessment



Source: Guttikunda and Jawahar (2012).

ANNEX

METHODOLOGY FOR HEALTH IMPACT ANALYSIS IN GUTTIKUNDA AND JAWAHAR (2012)

Health impact analysis estimates premature mortality and morbidity as a result of outdoor air pollution, using concentration-response functions. However, this is not as easy to calculate and in all likelihood is a gross underestimate that captures only the direct impacts of air pollution (respiratory illness, allergies etc.). The road transport emissions account for 30 per cent of ambient pollution and isolating impacts of transport sources is tricky. The indirect impacts of exposure to pollutants are also many - an increase in inflammation, cardiac conditions, decrease in fertility, cancer, premature birth, among others.

The health impacts (mortality and morbidity) of baseline and future scenarios are estimated using the following methodology-

$$\delta E = \beta * \delta C * \delta P$$

where,

δE= number of estimated health effects (various end points for mortality and morbidity)
β= the concentration-response function; which is defined as the change in number of cases per unit change in concentrations per capita. This is established based on epidemiological studies conducted over a period of time, analysing the trends in hospital records and air pollution monitoring

δC= the change in concentrations

δP= the population exposed to an incremental concentration; defined as the vulnerable population, of age more than 17 years, which spends more time outdoors. This spatial spread of population is obtained from GRUMP (2010) and Census-India (2011).

The concentration-response function (β) (CRF) is defined as the change in the number of cases per unit change in concentrations per capita. Health effects range from minor irritation in eyes and upper respiratory system to chronic respiratory disease, heart disease, lung cancer, and lead up to premature death. In case of mortality, CRF is set to 0.225 per cent per 10 $\mu g/m^3$ increase in the PM_{10} concentrations[22] as the lower bound[23] and 0.6 per cent per 10 $\mu g/m^3$ increase in the PM_{10} concentrations (WHO, 2005) as the higher bound[24]; the total death incidence rate of 241 per 1,000 people was adjusted for the those due to lower and upper respiratory illnesses (including bronchitis and asthma) and cardio vascular diseases. Among the reported number of deaths, these causes account for 15 per cent of the annual death rate[25]. Morbidity in terms of asthma cases, chronic bronchitis, hospital admissions, and work days lost is also estimated.

The population exposed (δP) is defined as the total population exposed to the incremental concentrations (δC) in each grid cell. The grid level population is estimated using GRUMP (2010) and Census-India (2012) and presented in the figure. The population data and the concentrations of PM_{10} are available at 0.25° resolution.

Comprehensive Air Quality Model with Extensions (CAMx) is used; it is an Eulerian photochemical dispersion model that allows for integrated assessments of gaseous and particulate air pollution over many scales ranging from sub-urban to continental.

22. HEI (2010).
23. Public Health and Air Pollution in Asia (PAPA): A Multicity Study of Short-Term Effects of Air Pollution on Mortality. Health Effects Institute (2010) @ http://pubs.healtheffects.org/view.php?id=348 (accessed 27 March 2014).
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This model is designed to unify all of the technical features required of 'state-of-the-science' air quality models into a single open-source system that is computationally efficient, easy to use, and publicly available[26]. For the analysis of the road transport emissions in India, the CAMx model is set up to model the concentrations at 0.25° horizontal grid resolution. The vertical grid resolution extends to 12km stretched over 23 layers. The removal processes in the model include dry deposition varying with the land-use patterns and wet deposition due to predominant meteorological conditions.

The meteorological data (3D wind, temperature, and pressure, as well as surface heat flux and precipitation fields) is derived from the National Centre for Environmental Prediction (NCEP) global reanalysis[27]. The NCEP databases are available for the period of 1948 to 2012. We selected 2010 as the base year and the required data fields are processed for this year. The same meteorology for 2010 is used for all the future scenarios. The NCEP global meteorological fields are processed through the RAMS meteorological model (version 6.0)[28] and the data is available at 2 hour interval for the parameters necessary to run the CAMx dispersion model[29].

Source: Guttikunda and Jawahar (2012).

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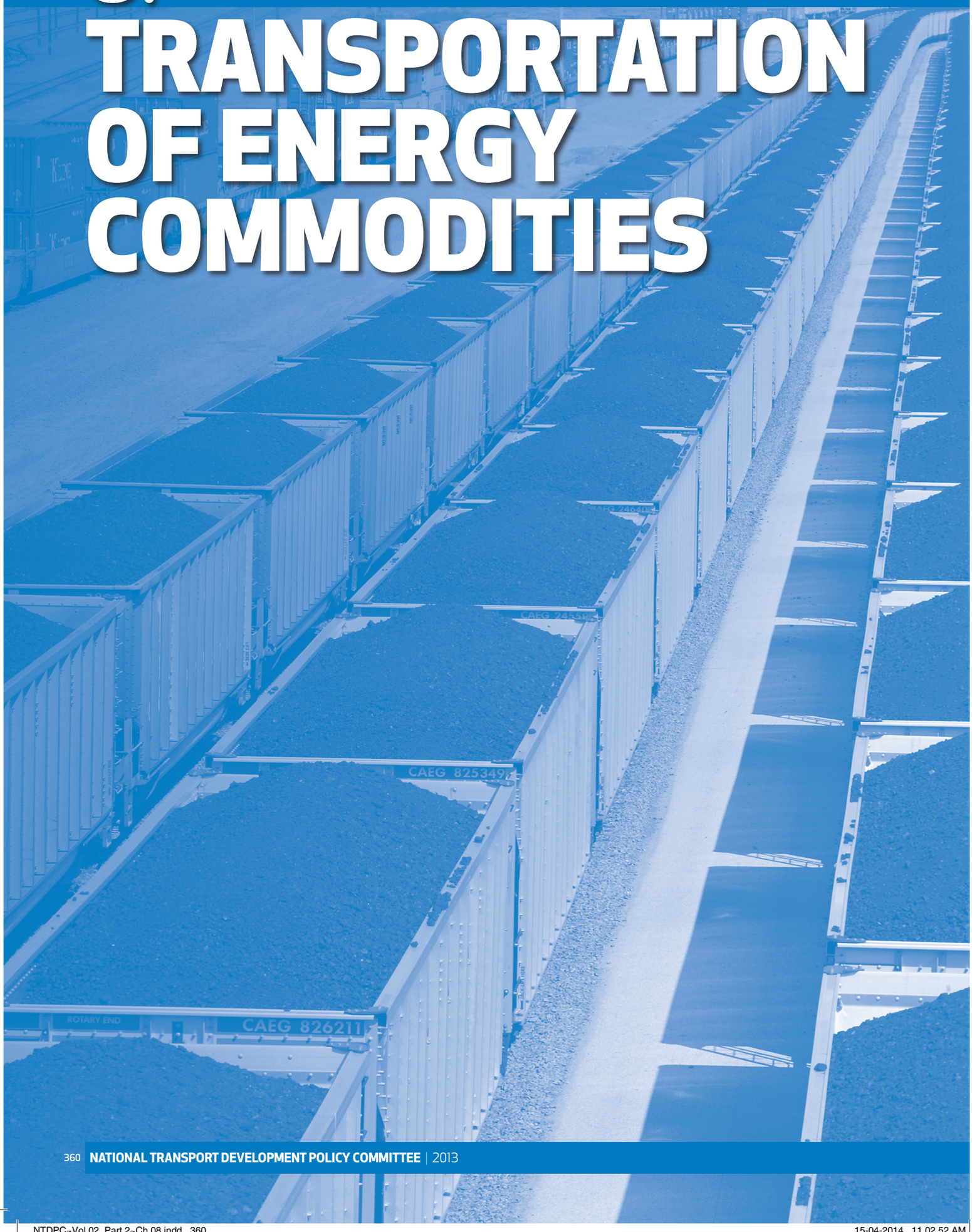
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8. TRANSPORTATION OF ENERGY COMMODITIES



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8. TRANSPORTATION OF ENERGY COMMODITIES

The surge in economic growth, witnessed in recent years in India, has strained the capacity of its transport system as well as the energy supply, particularly electric power.

The government's ambitious development targets and plans, as well as popular discourse, attest to the importance of addressing such infrastructure constraints in a decisive manner over the next two decades, to sustain high levels of economic growth which is also inclusive.

Movement of bulk commodities is a major role of India's transportation system. Coal accounts for almost half the freight volume on Indian Railways, a major supplier of transport services to the electric power and steel industries. Indeed, the congestion caused by inadequate expansion in transport capacity to date, especially on crucial links and corridors, underlies issues such as security of supply chains, inventory of raw materials, port-handling, which affect industry.

The future poses profound challenges. Even if the ambitious aim to improve energy intensity is achieved, sustaining economic growth at 8-10 per cent per annum over the next two decades will require massive increases in power generation and transportation of bulk commodities such as coal, iron and steel.

Development plans from the key ministries of the government as well as initiatives and investment proposals from the private sector seek to address the above issues. The needs are vast and multifaceted while resources are limited. More importantly, the issues are intimately interrelated and the viability of solutions is interdependent, both in terms of the nature of the investment (e.g., transport coal or transmit power) as well as the timing and duration of execution. Hence a piecemeal approach to planning could be severely suboptimal, leading to colossal wastage of resources and time.

LOCATION OF PRODUCTION & SUPPLY

As a first step in assessing the transport requirements for bulk commodities, we identify the origins and destinations of the materials that have to be moved. Raw materials need to be moved from mines to production facilities, and finished products need to be moved from production facilities to the places they are used or consumed. We identify the location of domestic energy and mineral resources, the sources of commodity imports, and the location of production facilities. We also describe the current and projected transfer facilities. For some materials such as coal where domestic demand will outstrip domestic supply, imports will make up the deficit. Therefore, we also describe briefly the geostrategic considerations likely to affect the import of coal.

Coal, oil and natural gas are the three primary commercial energy sources. Being the most abundant fossil fuel in India, coal is by far the largest source of energy and meets about 50 per cent of the country's commercial energy needs. About 35 per cent are met by oil, with more than 80 per cent of that oil being imported. While natural gas accounts for 10 per cent, the consumption of natural gas has risen faster than any other fuel in the recent years.

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Table 8.1
Major Reserves of Coal
[Billion Tonne]

NO.	COAL FIELD	STATE	GRADE OF COAL	GROSS GEOLOGICAL RESERVES (BT)	TYPE OF COAL
1	Talcher	Odisha	F	46.64	Thermal Coal
2	Ib Valley	Odisha	F	22.52	Thermal Coal
3	North Karanpura	Jharkhand	F	13.35	Thermal Coal
4	South Karanpura	Jharkhand	F	6.30	Thermal Coal
5	Rajmahal	Jharkhand	D-E	16.20	Thermal Coal
6	Korba	Chhattisgarh	D-E	11.76	Thermal Coal
7	Hasdeo-Arand	Chhattisgarh	D-E	5.18	Thermal Coal
8	Mand-Raigarh	MP	D-E	23.77	Thermal Coal
9	Singrauli	MP	C-E	12.76	Thermal Coal
10	Wardha Valley	Maharashtra	D-E	6.26	Thermal Coal
11	Godavary Valley	AP	D-E	22.05	Thermal Coal
12	Raniganj	WB	B-E	25.83	Thermal & Semi coking
13	Jharia	Bihar	LVM , C–E	19.43	Coking
	TOTAL			**232.05**	
	AVERAGE ASH CONTENT: 38-40 PER CENT, AVERAGE HEAT RATE 4,000 KCAL/KG				

Source: Working Group Report (2013).

In addition to the bulk transport needs of the energy sector, we also look at the needs of the steel industry. The most important raw materials for the steel industry are iron ore and coking coal. India has very significant amounts of good quality iron ore resource, a significant amount of which was being exported until the recent ban by the Supreme Court. But the steel industry relies heavily on imports of coking coal as much of the national reserves have a high ash content rendering them unsuitable for steel-making.

COAL

About 80 per cent of the potential coal bearing area of 18,000 sq km has been covered by regional exploration. Based on these and more detailed explorations, India's total geological resource has been estimated to be about 286 billion tonne (Bt) of coal. Of this 114 Bt is proven resource, while 137 Bt and 34 Bt are 'indicated' and 'inferred' respectively. Only about 12 per cent of the geological resource contains coking coal; the bulk is non-coking coal. Indian coal is classified into grades, A through G, based on its gross calorific value (GCV) with grade A coal having the highest GCV.

LOCATION OF COAL RESERVES

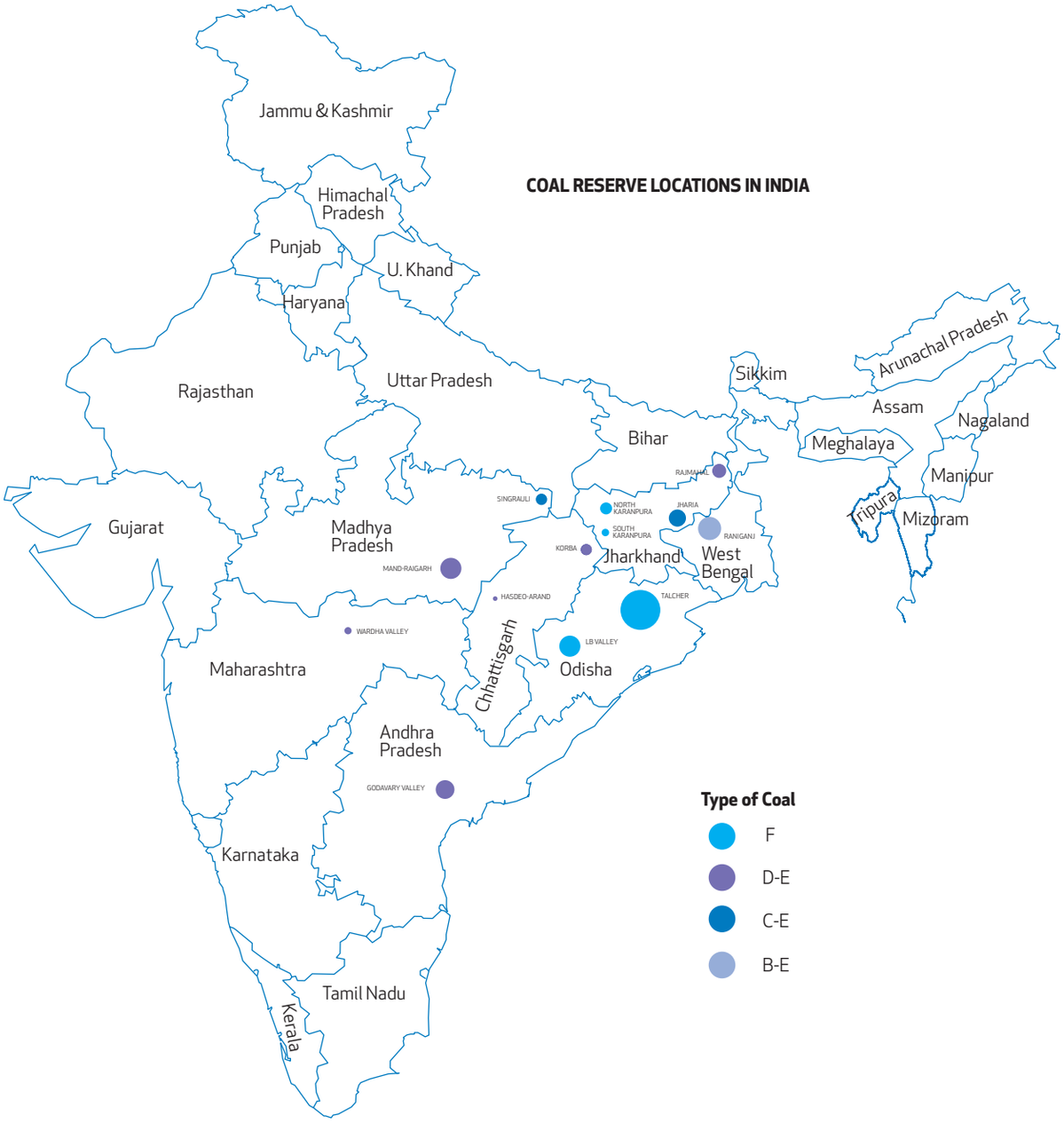
Coal India Limited (CIL) is the major indigenous coal producer and has seven production subsidiaries and an eighth subsidiary (CMPDI) that provides technical support to the other seven. Singareni Colleries Co. Ltd, jointly owned by the Governments of India and Andhra Pradesh, is also into coal production and supply.

Table 8.1 and Figure 8.1 show the major reserves of coal in the country that account for over 80 per cent of the national resource. These coalfields have a geological resource of about 232 Bt and lie mostly in the eastern part of the country.

Figure 8.2 gives the state-wise share of coal reserves. About 70 per cent of the reserves are in

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Figure 8.1
Location of Reserves of Coal



Source: Working Group Report (2013).

three states—Odisha, Jharkhand and Chhattisgarh. However, much of this coal is of the poor quality (mostly grade F, and some D or E).

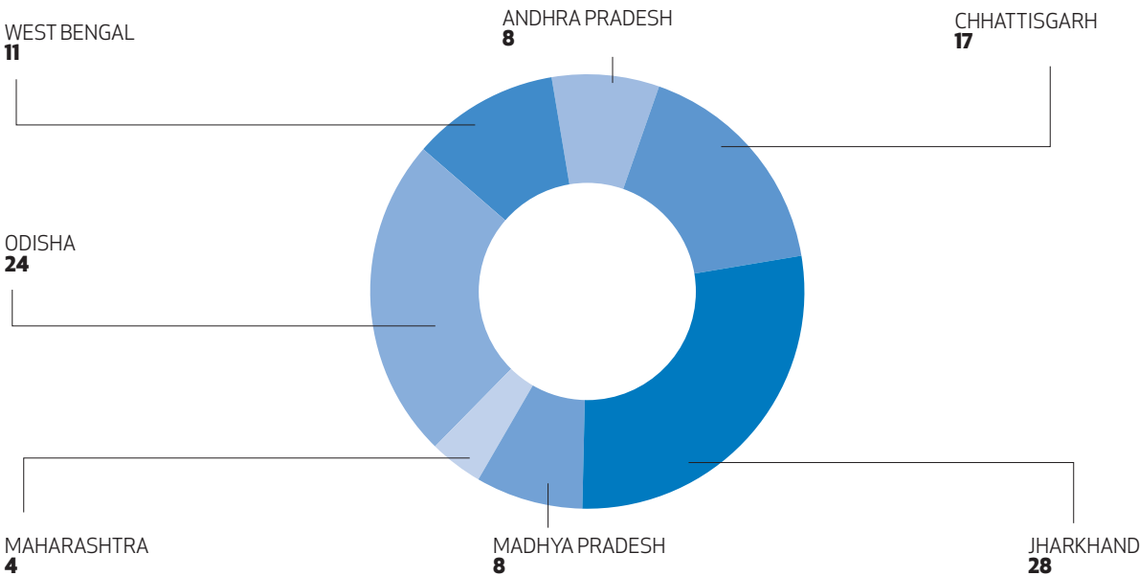
The average growth rate for domestic coal over the next 20 years is 4.33 per cent. The growth is higher (6.5 per cent) during the first decade 2011-22 than the second decade 2022-32 (2.2 per cent). The overall growth rate is considerably lower than the rate at which the demand for coal is expected to grow, necessitating increased imports.

NATURAL GAS

Interest in using natural gas as a fuel is growing because of its lower environmental impact compared to coal and oil. It is increasingly being used in combined-cycle power stations because much higher efficiencies are possible with advanced technology gas turbines. The next largest gas consumer is the fertiliser sector. Gas is also used as a fuel in other industries and in the commercial and domestic sector. Figure 8.3 shows the

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Figure 8. 2
State-Wise Share of Coal Resources
[Per Cent]



Source: Working Group Report (2013).

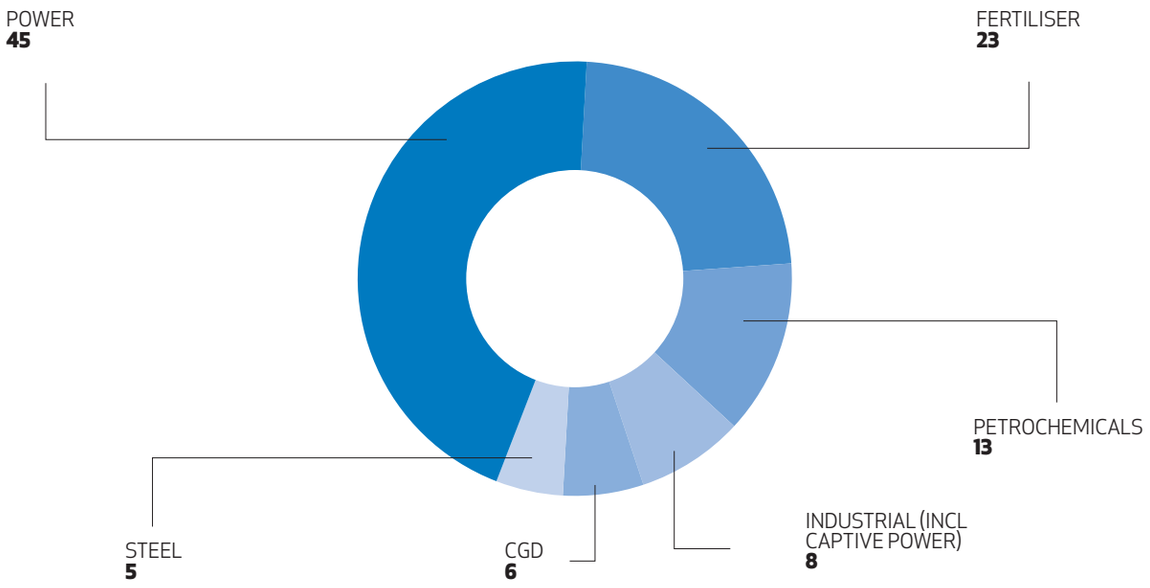
Table 8. 2
Forecast of Production by Coal Companies
[Million Tonne]

COMPANY	2011-12 (EST.)	2016-17	2021-22	2026-27	2031-32	COAL FIELDS
ECL	33	41	51	54	57	Rajmahal, Raniganj
BCCL	30	36	40	42	45	Jharia
CCL	51	83	110	117	124	North & South Karanpura
NCL	69	80	85	90	96	Singrauli
WCL	46	45	45	47	50	Wardha Valley
SECL	112	140	182	193	205	Korba, Mand, Raigarh, Hasdeo Arand
MCL	106	140	195	207	219	Talcher, Ib Valley
NEC	1	1	3	3	3	Assam
Total CIL	447	555	710	753	798	
SCCL	51	57	63	70	77	Godavari Valley
Captive	38	97	245	312	400	
Others	18	18	18	20	20	
All India	**554**	**721**	**1,036**	**1,155**	**1,294**	

Source: Working Group Report (2013).

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Figure 8.3
Sector-Wise Gas Consumption, 2010-11
[Per Cent]



Source: ICRA (2011).

Table 8.3
Production from Existing Gas Fields
[Million Cubic Metre]

REGION	LOCATION	PRODUCTION
Eastern Off-Shore	• Krishna-Godavari Basin (off the coast of Andhra Pradesh) • North East Coast Basin (off the coast of West Bengal) • Cauvery Basin (off the coast of Tamil Nadu)	22,223
Western Off-Shore	• Cambay Basin (off the coast of Gujarat) • Mumbai Offshore Basin (off the coast of Maharashtra)	21,422
On-Shore	Andhra Pradesh	1,384
	Assam	2,729
	Gujarat	2,261
	Tamil Nadu	1,119
	Tripura	610
	West Bengal	41
TOTAL		**51,789**

Source: NTDPC Research.

share of each sector in the total consumption of 177 million standard cubic metre per day (MMSCMD) in 2010-11.

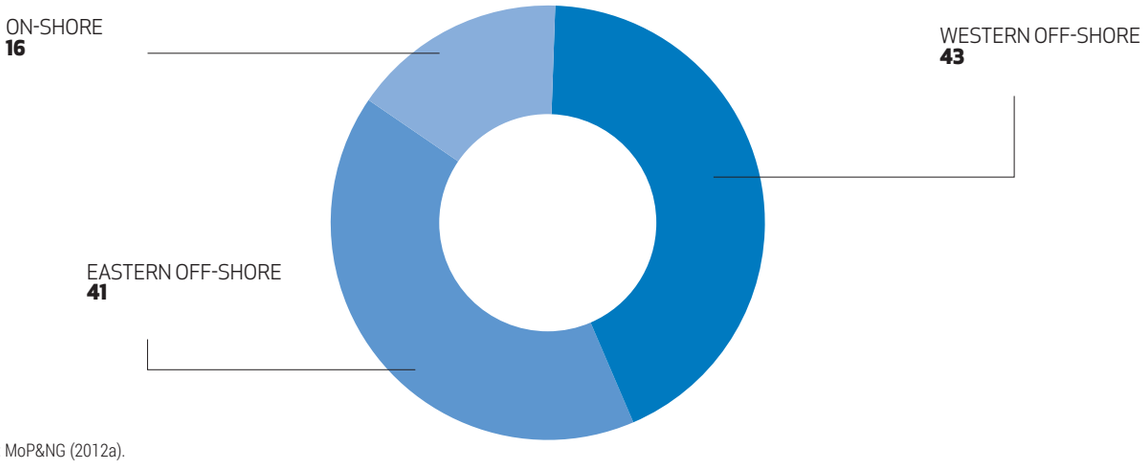
Table 8.3 gives the main gas fields, and the production in 2010-11. As Figure 8.4 shows, the off-shore fields produce most of the domestic gas. With the recent decline in production in some of these fields, such as Reliance KG-D6 block, the contribution of off-shore production has decreased, but it still forms the bulk of domestic production.

Table 8.4 lists the gas fields being proposed for production in the next two decades. No new gas fields are proposed for the 15th Plan.

As Table 8.3 shows, domestic production of natural gas was 52 billion cubic metres (bcm) in 2010-11, corresponding to an average daily supply of about 140 MMSCMD. But consumption was 177 MMSCMD. The gap between consumption and domestic supply was met by imports of LNG. Currently, LNG re-gasification capacity in the country is 13.60 Mtpa (equivalent

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Figure 8. 4
Geographical Share of Gas Production, 2010-11
[Per Cent]



Source: MoP&NG (2012a).

Table 8. 4
Additional Gas Fields Being Proposed

PERIOD	EASTERN OFF-SHORE	WESTERN OFF-SHORE	ON-SHORE
12th Plan	Mahanadi Basin (off Odisha coast)		
13th Plan		Andaman Off-Shore (off coast of Andaman & Nicobar Islands)	• Gujarat (Shale Gas) • West Bengal (Shale Gas) • Tripura
14th Plan			• Andhra Pradesh (Shale Gas) • Tamil Nadu (Shale Gas)

Source: Working Group Report (2013).

Table 8. 5
LNG Terminal and Re-gasification Capacity
[Million Tonne Per Annum]

TERMINAL	CURRENT CAPACITY	12TH PLAN	13TH PLAN
Dahej	10	15	15
HLPL Hazira	3.6	10	10
Dabhol		5	5
Kochi		5	10
Ennore		5	5
Mundra		5	10
East Coast		5	15
TOTAL	13.6	50	70

Source: Working Group Report (2013).

to 49 MMSCMD). Table 8.5 provides details and lists the additional expected LNG terminal capacity. Total gas availability, including domestic production, LNG imports and imports through trans-border pipelines will be about 360 MMSCMD by 2016-17 and 530 MMSCMD by 2021-22.

SHALE GAS

Shale gas is an unconventional source of methane (the major component of natural gas) consisting of gas trapped in rock formations. New technology to extract the gas is transforming the energy outlook in the US. Shale gas now accounts for about a third of its gas supplies and the price of gas has dropped dramatically.

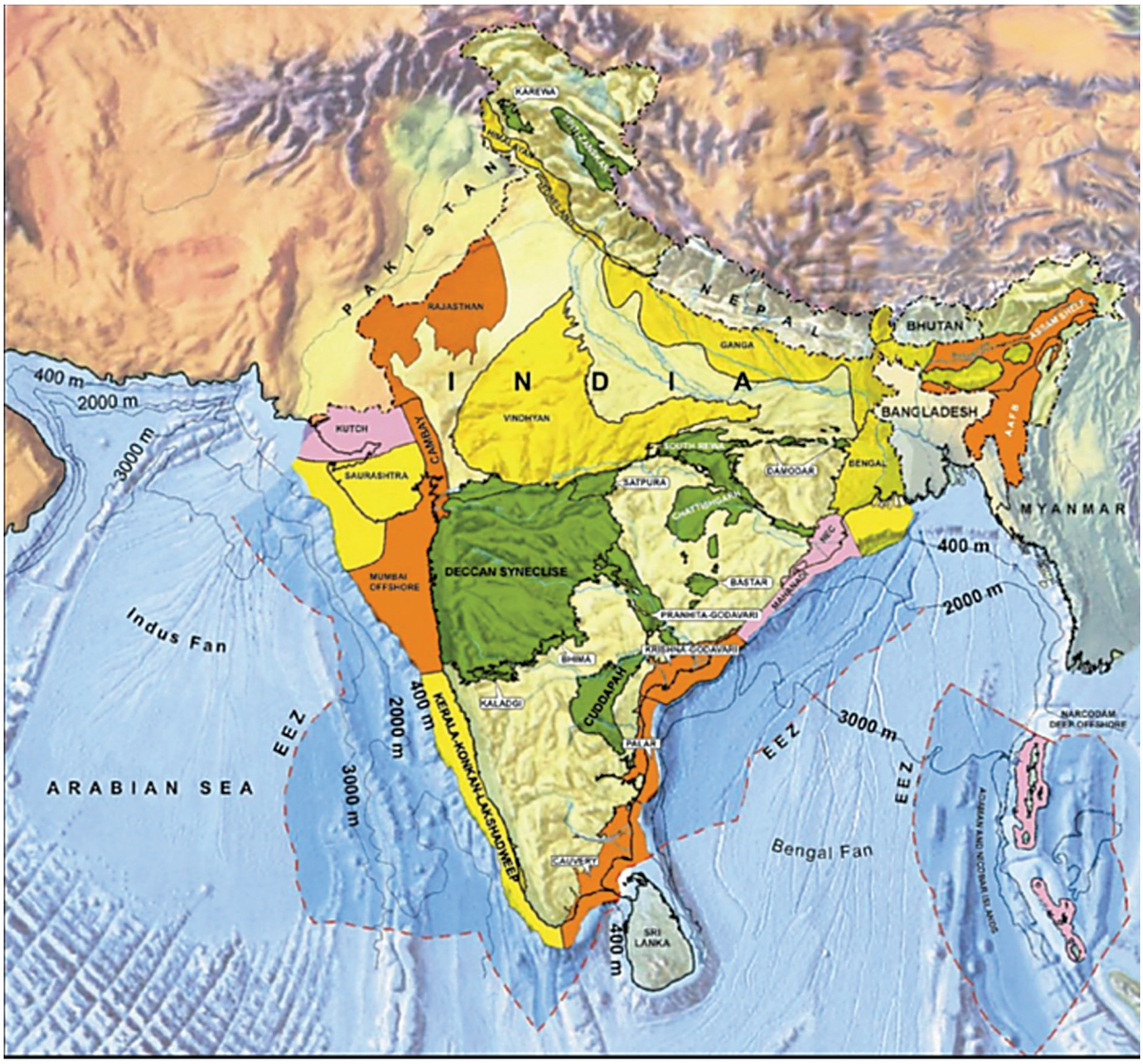
Some of the on-shore sedimentary basins in India are reported to have organically rich shale, and India too has started looking into mapping of shale and generation of prospective sites. Identification of promising basins. DGH has shortlisted the following six sedimentary basins for exploration:

a. Cambay
b. Krishna-Godavari
c. Cauvery
d. Assam
e. Indo-Gangetic
f. Damodar Valley

It should be noted, however, that while prima facie shale gas may seem like a potentially abundant and cheap fuel, it is likely to bring with it its own con-

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Figure 8.5
Map of Sedimentary Basins in India



CATEGORY-I BASIN
(Proven Commercial Productivity)

CATEGORY-II BASIN
(Identified Prospectivity)

CATEGORY-III BASIN
(Prospective Basins)

CATEGORY-IV BASIN
(Potentially Prospective)

PRE-CAMBRIAN BASEMENT/ TECTONISED SEDIMENTS

DEEP VATER AREAS WITHIN EEZ

Note: An exclusive economic zone (EEZ) is a sea zone prescribed by the United Nations Convention on the Law of the Sea over which a coastal state has sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources.
Source: Directorate General of Hydrocarbons (2012).

cerns about use. There are serious environmental concerns associated with the production of shale gas, related to water security, ground water pollution and land subsidence. Therefore, its production and use may be severely restricted unless solutions to these issues are found. If instead of increased gas availability, it is less than projected, then imports of coal would increase.

PETROLEUM, OILS AND LUBRICANTS (POL)

Even at the current low level of per capita consumption of energy, India imports over 70 per cent of its crude oil requirements (mostly from the Middle-East and Iran). As the economy grows and per capita consumption increases, the level of imports will increase. In 2010-11, the country con-

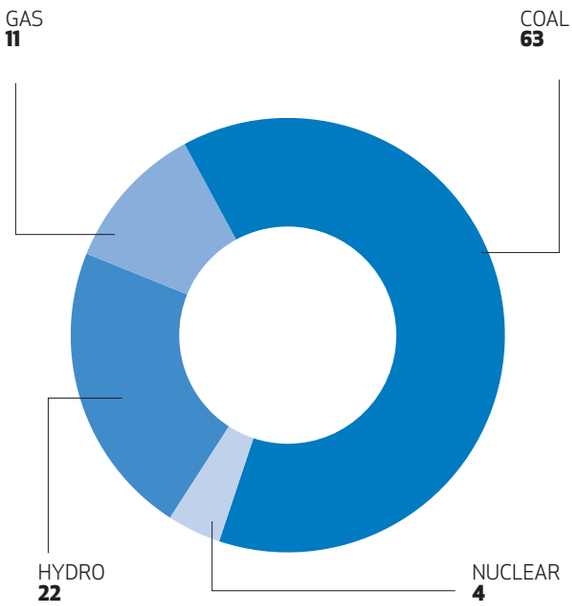
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Table 8. 6
Production of Crude Oil, 2010-11
[Thousand Tonne]

REGION/STATE		PRODUCTION
ON-SHORE	Gujarat	5,905
	Assam/ Nagaland	4,719
	Arunachal Pradesh	116
	Tamil Nadu	234
	Andhra Pradesh	305
	Rajasthan	5,149
	Total On-Shore	**16,428**
OFF-SHORE	ONGC	17,002
	JVC/ Private	4,282
	Total Off-Shore	**21,284**
	Grand Total	**37,712**

Source: MoP&NG (2012a).

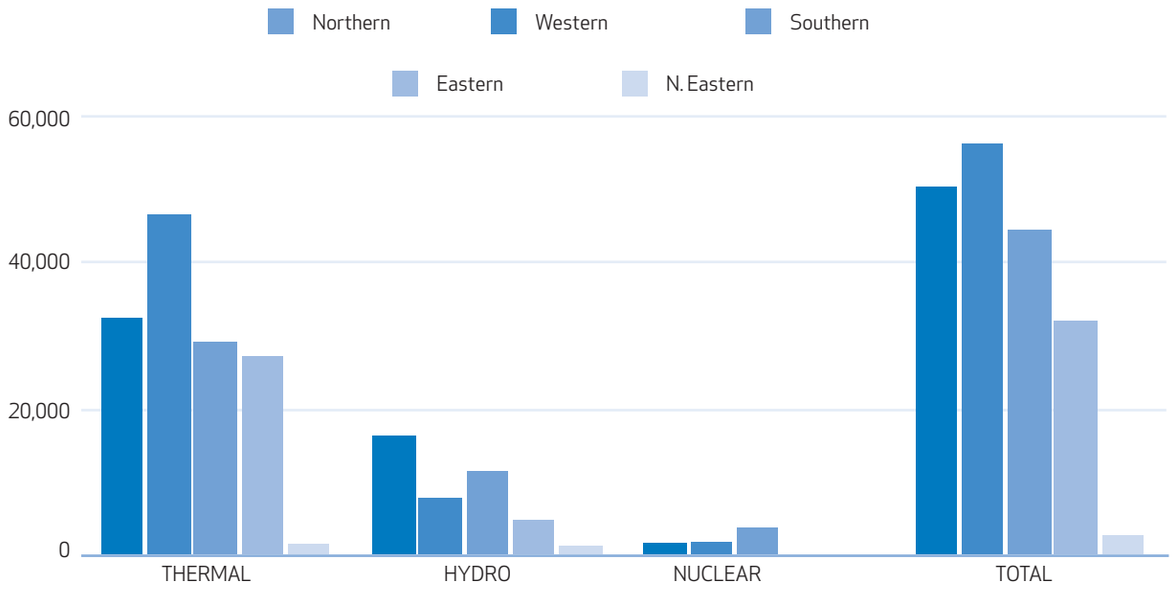
Figure 8. 6
Generating Capacity Mix at End of 11th Plan
[Per Cent]



Source: Working Group Report (2013).

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Figure 8.7
Regional Contribution to Generating Capacity
[Mega Watt]



Source: Working Group Report (2013).

sumed 206 Mt of crude oil, of which 38 Mt was produced domestically and 164 Mt, imported[1]. About 74 per cent of the above domestic production was by government-owned companies (ONGC and OIL) and the rest by private companies or joint ventures.

Hydrocarbons (petroleum and natural gas) are found in sedimentary basins. Figure 8.5 is a map showing the 26 sedimentary basins that have been identified. However, only seven basins—Cambay, Assam Shelf, Mumbai Off-Shore, Krishna-Godavari, Cauvery, Assam, Arakan and Rajasthan—have commercial production. Kutch, Mahanadi and Andaman-Nicobar basins are known to have accumulation of hydrocarbons but there is no commercial production yet.

Table 8.6 gives the amount and location of current crude oil production from the seven sedimentary basins for 2010-11 (provisional). A little over half the production occurs off-shore, and the on-shore production is spread across several states.

REFINERIES

In keeping with the growing demand, the refining capacity of petroleum products has increased either by the expansion of capacity at existing refineries or by setting up new refineries. As of June 2011, there were 21 refineries in the country out of which 17 were in the public sector. Thirteen of them are in the coastal states. The total refining capacity is 193 Mtpa, which is far higher than the domestic requirements, making India a net exporter of petroleum products[2]. In 2010-11, India exported about 42 Mt of petroleum products[3].

1. MoP&NG (2011).
2. MoP&NG (2013).
3. MoP&NG (2011).

POWER PLANTS

LOCATION OF EXISTING CONVENTIONAL GENERATION

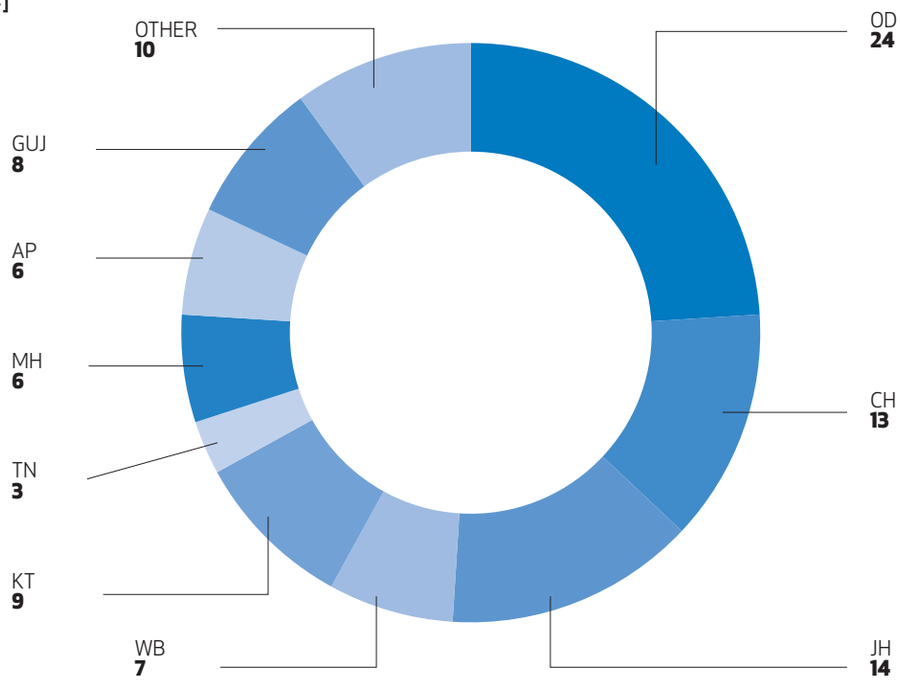
At the end of the 11th Plan, generating capacity was about 175 GW, excluding generation from renewable energy sources. As Figure 8.6 shows, coal is the dominant fuel in electricity generation, firing about two-thirds of the country's capacity. Figure 8.7 shows the regional contribution to generating capacity. Coal fired capacity is distributed across the country except in the Northeastern region, with the Western region being the biggest contributor. Currently, the Northern region, including the hilly regions of HP, J&K, Uttarakhand and Punjab, has the most hydro capacity, followed closely by the Southern region. The contribution of the North-Eastern region is miniscule currently but is expected to grow as more of its very large hydro potential is realised.

There are several factors related to land, environmental impact and public acceptability that constrain the amount of generation capacity that can be added in a particular state. Land acquisition in recent times has become a critical issue for developers of plants for power and other key commodities such as steel. Land is increasingly becoming a scarce resource and its availability is posing a serious challenge for future development of plants.

Power plants can have severe social and environmental impact: air pollution; production of large quantities of ash; water pollution due to ash ponds and deposition of mercury. In addition, thermal power plants require large amounts of water which can severely stress local water resources.

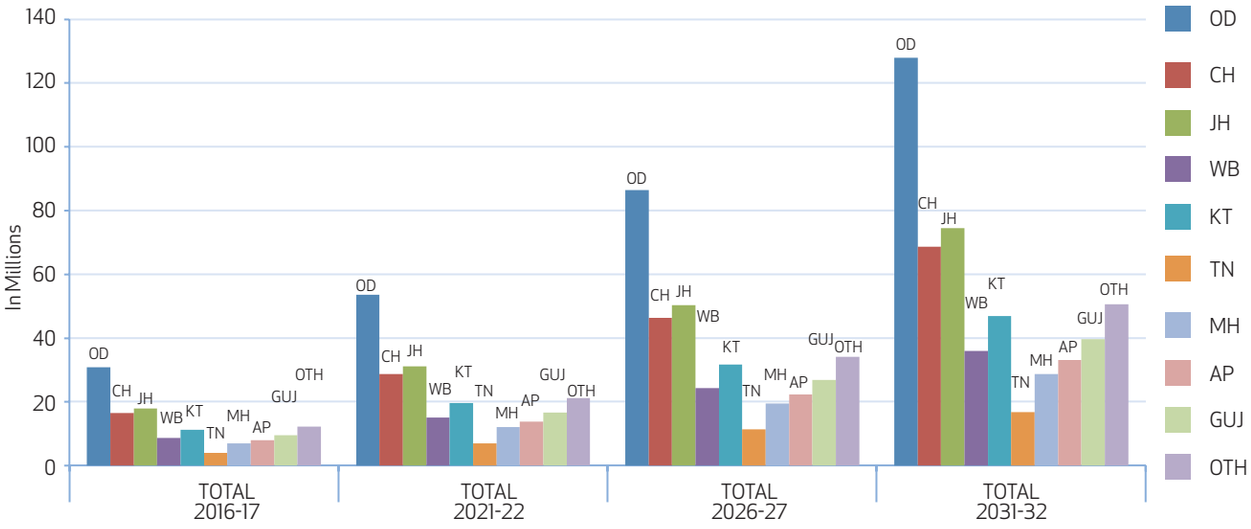
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Figure 8.8
State-Wise Share of Steel Capacity
[Per Cent]



Source: Ministry of Steel (2012a).

Figure 8. 9
Projected Crude Steel Capacity in Major Steel Producing State



Source: Ministry of Steel (2012b).

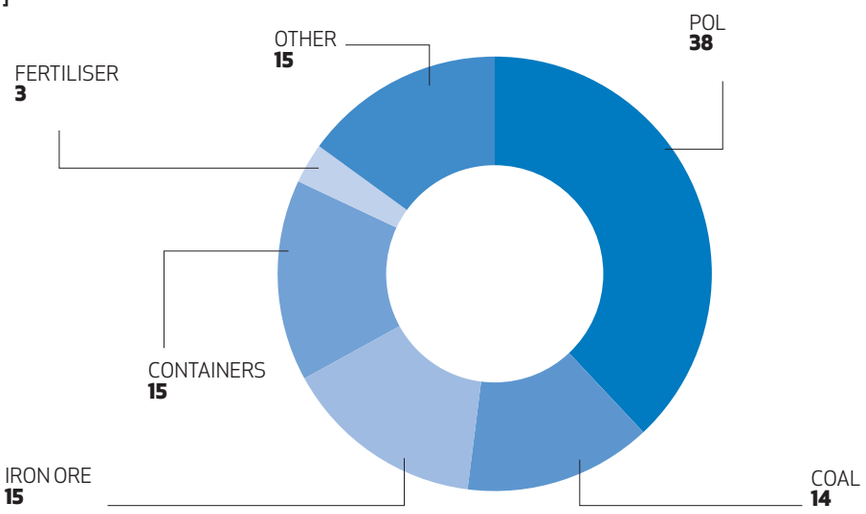
These issues were considered in setting limits on state-wise capacity addition in the modeling exercise to identify locations for new power plants.

IRON & STEEL PLANTS

Steel capacity is located mostly near iron ore mines in the mineral-rich states. As Figures 8.8 and 8.9 show, Odisha, Jharkhand and Chhattisgarh together will have more than 50 per cent of the steel capacity through most of the next two decades. In fact, there is a definite shift in the investors' choices of location towards Odisha. Its share of steel capacity is expected to increase from 12 per cent in 2010-11 to 25 per cent by 2016-17 and remain at that level for the next two decades. In addition, there is a preference for large plants which currently constitute about 65 per cent of the steel capacity. This share is expected to

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Figure 8.10
Commodity-Wise Break-Up of Port Traffic, 2010-11
[Per Cent]



Source: Ministry of Shipping

increase to 76 per cent in 2016-17 and remain at that level for the next two decades. These locational and size preferences are likely to continue because it is expected that Blast Furnace Basic Oxygen Furnace (BF-BOF) technology and other hybrid technologies using hot metal will continue to predominate.

Small and medium units which now use about 70 per cent sponge iron will gradually shift to using scrap as the country accumulates more scrap. When that happens, there could be a shift of steel capacity to the steel-consuming areas. However, that is likely to happen only towards the end of the study period and is expected to be gradual.

PORTS

Ports are an important component of the transport system for the import and export of bulk commodities. They could also play a significant role in the movement of bulk commodities within the country through coastal shipping. However, this potential has been exploited very little.

India's 12 Major Ports are administered by the Union Government, while the 200 notified Non-Major Ports are under the state governments and union territories.

In 2011-12, total cargo handled by Indian ports was 913.9 million tonnes. As Figure 8.10 shows, POL, coal and iron ore make up 67 per cent of the cargo handled by Indian ports, while POL has the biggest share.

MAJOR PORTS

The 12 Major Ports handled 560 million tonnes of cargo traffic during 2011-12, more than 60 per cent of the country's total seaborne cargo. This figure comprises cargo loaded, cargo unloaded and transhipped to the tune of 194 million tonnes, 341 million tonnes and 25 million tonnes respectively. The capacity utilisation—560 million tonnes against 697 million tonnes was approximately 80 per cent.

In 2005, a Committee of Secretaries was set up to establish policies to improve port connectivity. The Committee recommended that each major port should be connected, at a minimum, by a four-lane road and a double-line rail (Chapter 4, Volume III on Ports and Shipping).

NON-MAJOR PORTS

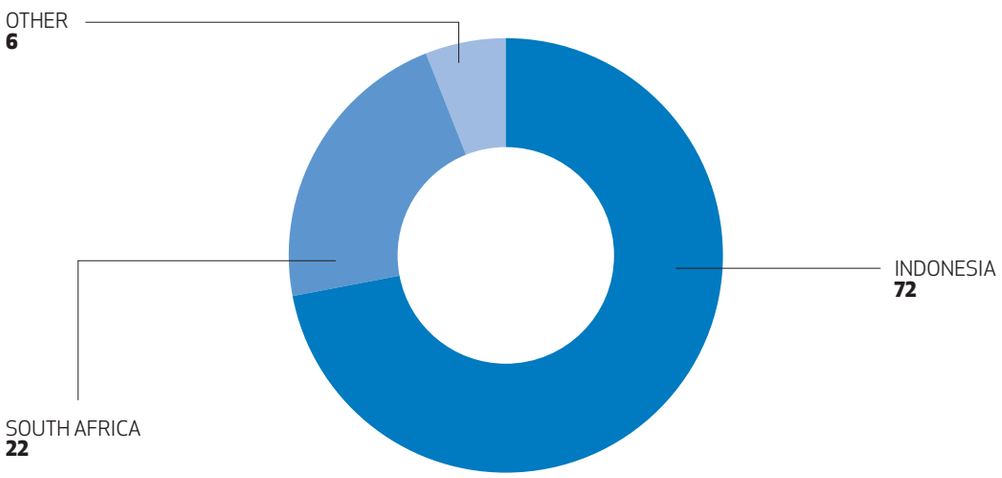
Of the 200 Non-Major Ports, only a few ports are well-developed and provide all-weather berthing facilities. In 2011-12, only 61 ports—including ports at the Andaman and Nicobar Islands—were reported to have handled cargo traffic. Non-Major Ports in India collectively handled 354 million tonnes of traffic in 2011-12; up from 96 million tonnes in 2001-02. The CAGR in traffic during the decade was 14 per cent; double that for Major Ports. POL and its products (44 per cent) was the single largest commodity handled at Non-Major Ports in 2011-12.

IMPORT OF COAL

As discussed earlier, imported coal will bridge the deficit between the demand and domestic supply. In the case of thermal coal, this deficit is likely to increase because production of domestic coal will increase at a slower rate than demand. In the case of coking coal, there is limited availability in India and we are already importing a large part of the country's requirements. As steel production is expected

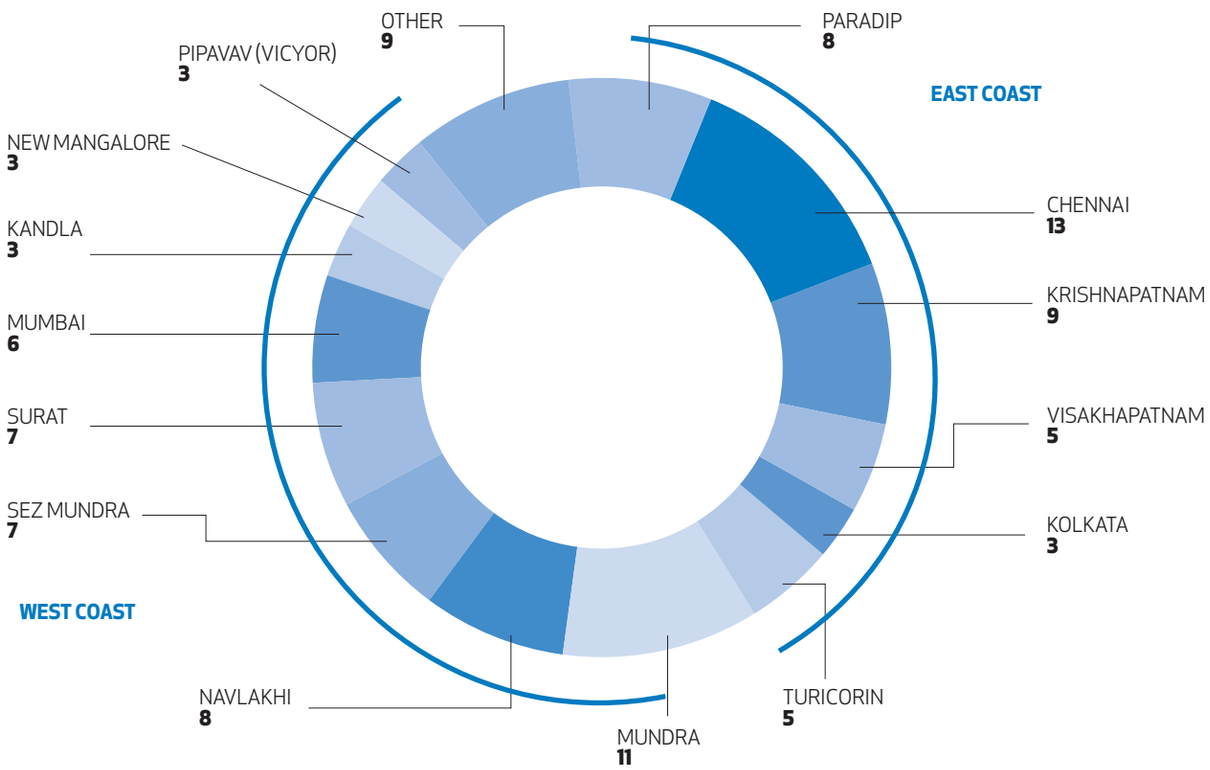
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Figure 8.11
Import of Non-Coking Coal by Country of Origin, 2010-11
[Per Cent]



Source: Coal Controller's Organisation (2012b).

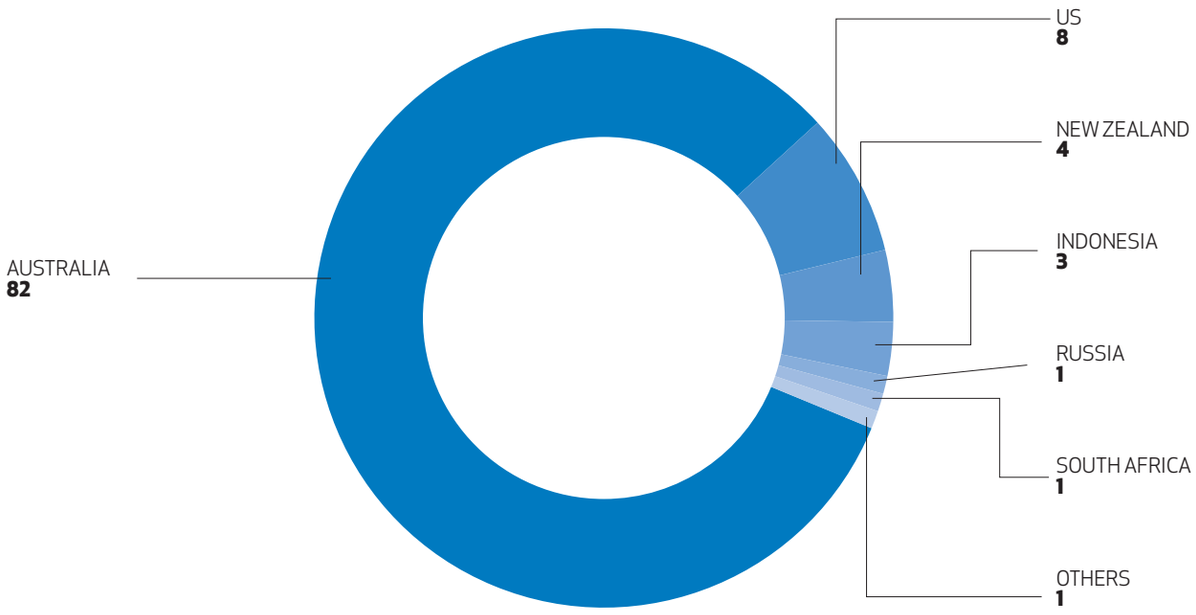
Figure 8.12
Destination Port-Wise Non-Coking Coal Imports, 2010-11
[Per Cent]



Source: Coal Controller's Organisation (2012b).

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Figure 8.13
Import of Coking Coal by Country of Origin, 2010-11
[Per Cent]



Source: Coal Controller's Organisation (2012b).

to increase rapidly, the import of coking coal will also grow similarly. Imported coal is of considerably better quality than domestic coal. While most of the domestic coal has a Gross Calorific Value (GCV) in the range of 3600-4200 kcal/kg, the imported coal has a GCV in the range 5200-6500 kcal/kg. Australian coal is at the higher end of the range, Indonesian coal at the lower end and South African coal in the middle. Therefore, less imported coal is required than domestic coal for producing the same amount of electricity. A reasonable approximation is that one tonne of imported coal is equivalent to 1.5 tonne of domestic coal.

Using the data for FY 2010-11 to illustrate the pattern of India's coal imports, we see from Figure 8.11 that almost all the imported non-coking coal comes from Indonesia and South Africa with Indonesia being by far the biggest supplier (72 per cent). Figure 8.12 shows that these imports are roughly evenly distributed between destination ports on the east and west coasts.

Figures 8.13 and 8.14 show the pattern of coking coal import. Australia is clearly the predominant supplier (80 per cent). Relatively smaller amounts are also sourced from US, New Zealand, Indonesia and South Africa. About the 80 per cent of the coking coal goes to four ports on the east coast—Paradip, Kolkata, Vishakhapatnam and Krishnapatnam which are located close to large steel plants.

INTERNATIONAL COAL MARKET

In 2009, China and India's imports of non-coking coal constituted about 12.5 per cent and 6.4 per cent respectively of the global market of 736 Mt. With imports by other countries remaining relatively steady, China and India are expected to account for about 90 per cent of the growth in the global market[4].

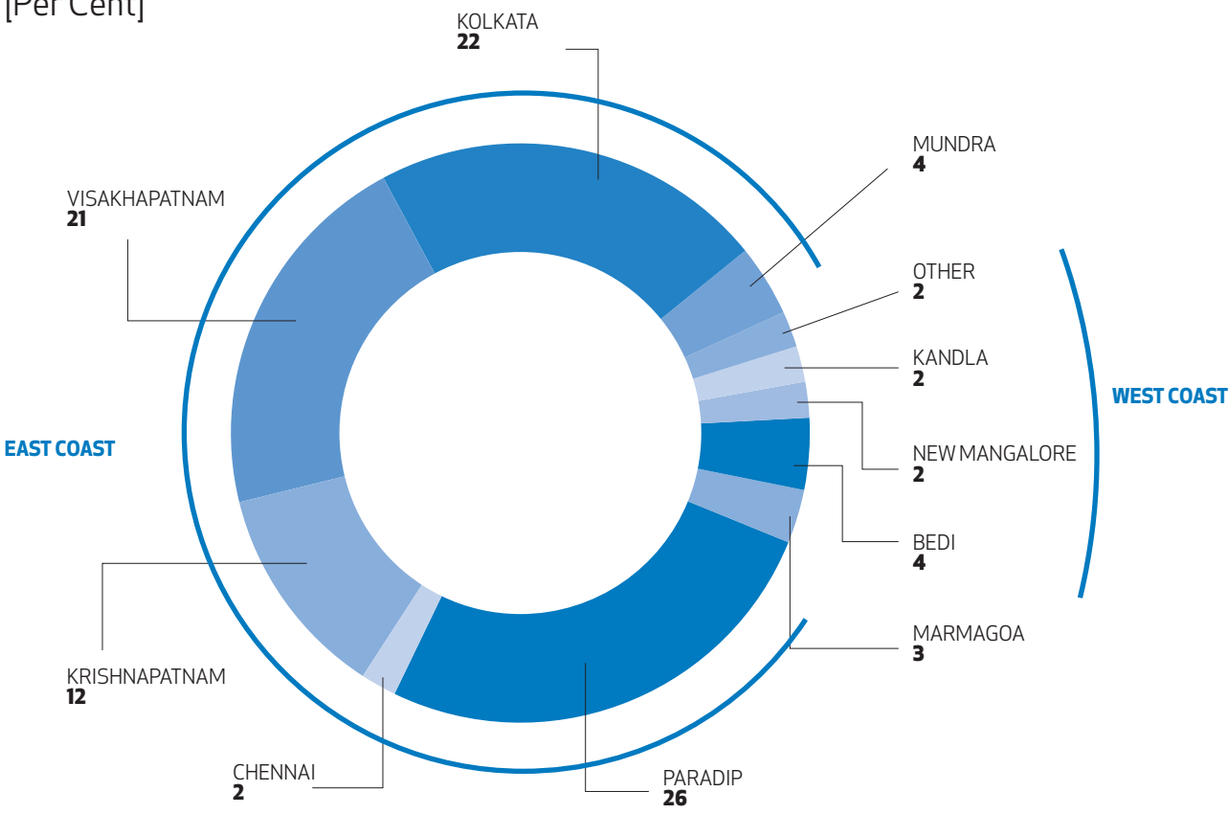
As China's consumption of coal accounts for about half the global consumption, a relatively small mismatch between its domestic supply and demand is likely to have a major effect on global markets[5]. China will be the driver of the global market. There are several uncertainties about whether Chinese domestic production will be able to meet the country's growing demand. One, In addition to boosting production at existing coal mines, new coal mines will need to be developed. Two, some of the new mines are very far from the major industrial cities, posing transportation challenges for infrastructure that is already congested. Three, as China intends to reduce the environmental impact associated with its coal consumption, significant investment will be required to upgrade power plants[6].

Most forecasts expect prices for thermal coal to remain high and hover around $100 per tonne (in current dollars) for the next several years[7].

4. CLSA (2010).
5. IEA (2011).
6. Ibid.
7. CLSA (2010); KPMG (2012); World Bank (2012).

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Figure 8.14
Destination Port-Wise Import of Coking Coal, 2010-11
[Per Cent]



Source: Coal Controller's Organisation (2012b).

FUEL REQUIREMENTS FOR THE POWER SECTOR

India is geographically a vast nation with widely-dispersed population centres and burgeoning economic activity. As the economy modernises and diversifies its production base and living standards rise, reliable and affordable access to electricity in requisite quantities has become a critical imperative for sustainable and inclusive growth.

The primary energy supplies required to generate electricity include fossil fuels (coal, oil and natural gas), hydropower, fissile nuclear materials and renewable (mainly solar and wind) sources that are available in varying degrees domestically but fall chronically short in meeting needs in the aggregate. The current mix (both in terms of installed capacity and actual generation) is dominated by coal with a growing role for natural gas. This is likely to remain so for the next 20-30 years at least. India's coal reserves are concentrated in the eastern states, notably Chhattisgarh, Jharkhand and Odisha, as well as Madhya Pradesh, Bihar, Andhra and Maharashtra.

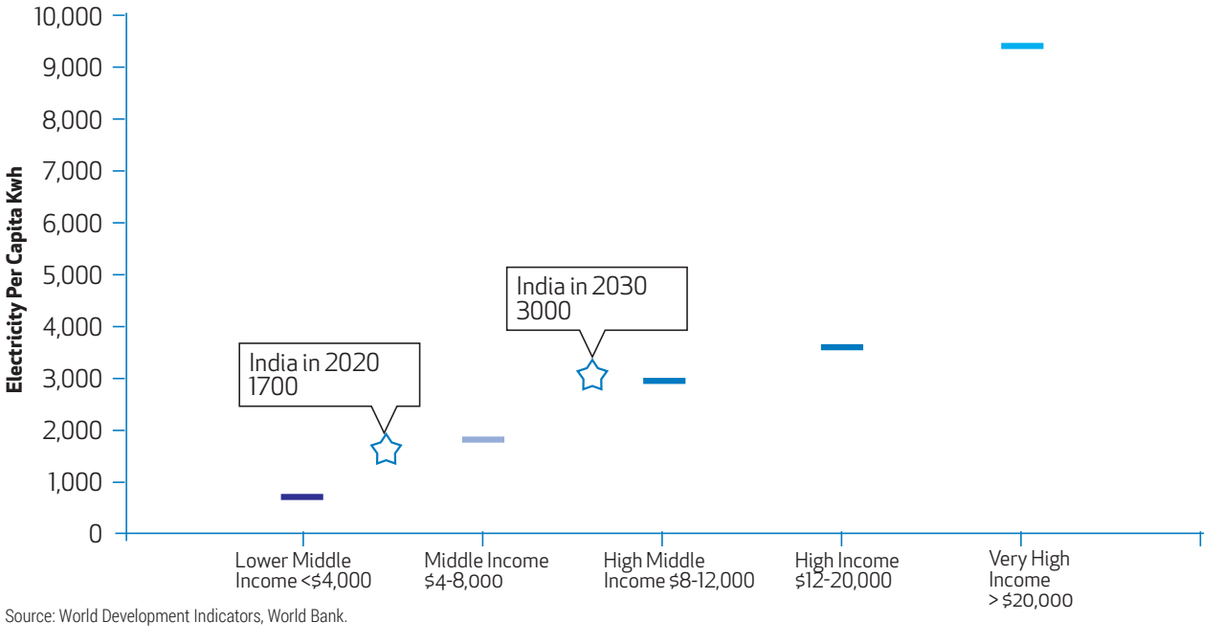
It is evident from the spatial distribution of domestic energy resources that energy needs to be transported over fairly long distances to make it available at the locations of electricity demand. Indeed, transportation of coal for power generation accounts for roughly 50 percent of the rail freight in India, contributing considerably to the increasing congestion in several key corridors of the railway network. Another telling indicator is that the cost of transporting coal to distant power generation facilities is often as much or more than the price of coal at the mine.

Energy imports are the pre-eminent component of our trade imbalance and current account deficits, and a major source of vulnerability to price shocks. Until recently, concern was focused almost exclusively on the hydrocarbon (petroleum) sector. Now attention also needs to be turned to coal availability. Coal imports have grown rapidly in the last few years, making India among the top two importers of steam coal whose entry and anticipated role in the international market is cited as a factor contributing to the rise in prices witnessed a couple of years ago.

There are several implications for the transport system. On the one hand, it is argued that transport bottlenecks have contributed to unreliability of delivering domestic coal to power plants. Others blame the inability to lift coal from mines (and/or nearby

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Figure 8.15
Electricity Use and Per Capita Income



Source: World Development Indicators, World Bank.

railheads) to be a key factor as well for stagnant output of the collieries. The bigger issue, however, is to ensure that the transport system which had hitherto focused exclusively on moving domestic coal rapidly expands the coal handling capacities at ports and provides requisite rail connectivity to the demand locations. The strategic questions that arise naturally are 'which ports?' and 'how much?' in terms of their capacity.

Difficult as the questions may be, their complexity pales before the more profound issue of locating the power plants especially when two-thirds if not three-quarters of the electricity generation capacity that will exist in 2031-32 is yet to be put in place. An obvious question then arises: Would it not be better to transport energy over long distances as electricity over transmission lines instead of moving coal by rail (or gas by pipeline)?

The choice, involving a combination of economic, financial, technical and environmental considerations, is not as straightforward as comparing unit costs of transmission versus rail or pipeline transport. In addition to network effects and geographic constraints, additional complexities arise due to major differences in the properties (calorific value, ash and sulphur content) of domestic and imported coal, choice of technology and fuel type, and patterns of demand (e.g., peaking), to list a few. Yet, given the massive scale of expansion and the high costs involved, combined with the scarcity of financial resources and even more, the limited capacity to execute, it is imperative that the choices made minimise the aggregate cost to the nation of producing and delivering electricity.

Accordingly, a conceptually-simple linear programming model has been employed for the analysis. Annex I outlines this model. As a first approximation, intra-state movement has been ignored and each state constitutes both a demand centre as well as an electricity supply node. The supply options include, in principle, all forms of power generation including nuclear and renewable (solar and wind). These are pre-set at exogenously-determined maximum capacity which even at the most ambitious account for a small, almost negligible proportion. While hydroelectric facilities are also included, the focus is on thermal power generation, using domestic and imported coal as well as natural gas which differ in cost. The current costs of transport options—surface transport of coal, pipeline for gas and transmission line for electricity—once again differ significantly. Average fuel costs also differ. Domestic coal is the cheapest, imported coal and domestic gas (the price of which is regulated) are almost competitive while imported gas, at internationally-traded prices, is the dearest.

PLAUSIBLE DEMAND SCENARIOS FOR ELECTRICITY

The study used a set of three scenarios (base, high and low cases) that provided reasonable estimates of potential upper and lower bounds on demand that would be meaningful for evaluating infrastructure requirements.

BASE CASE

The Central Electricity Authority (CEA) produces electricity demand forecasts every five years under

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the Electric Power Survey of India (EPS). These forecasts are released to coincide with the national Five-Year Plans. EPS is one of the key electricity demand forecasts in the country. It is widely used across the industry and by the states and union territories as one of the most credible reference points. The forecasts are granular and provide details by state/union territory, and by end-use category. The EPS is developed using the partial end-use method, with inputs from the states and a wide range of stakeholders. The initial data feed is subjected to a high level of additional analysis and quality assurance before the EPS is released.

CEA's draft 18th EPS is used as the basis for the base case scenario. The EPS does not typically include captive generation, capturing only utility-level demand. However, for this analysis, the base case uses the draft 18th EPS adjusted to include captive generation. The base case in this scenario, thus, represents total electricity demand. Peak demand is derived by retaining the same energy to peak ratio provided in the draft 18th EPS.

HIGH CASE

The high electricity demand scenario is derived through a normative approach. It is important that this demand scenario is understood in the context and limitation for what it was developed: to provide an approximate upper bound for a high growth scenario.

The high electricity demand reflects aspiration goals for future per capita electricity consumption based on current observed patterns of consumption across countries. It implies that the Indian economy will have to grow in order to realise this demand. But such a normative approach avoids having to make a series of intermediate assumptions on economic growth and the electricity intensity of that growth.

Drawing on the internal and external risks, and to the energy system in particular, it can be inferred that energy delivery may not be able to keep up with the requirements of 8-9 per cent annual economic growth. An iterative process lends credence to consider the possibility of growth grinding down to 6 per cent.

Electricity use within any country represents a wide variety of underlying interrelated factors: income level, the level and composition of economic activity, electricity intensity, availability of energy resources, energy costs and supply infrastructure. One of the most visible relationships with electricity use is income level. A country's per capita electricity consumption exhibits strong correlation with its national income level as illustrated in Figure 8.15.

The relationship between electricity per capita and GDP per capita were econometrically derived using panel data that included a cross sectional of all countries (with available data for all years), covering 28 years between 1980 and 2008.

For the high demand scenario, the following annual per capita electricity assumption is used: 1700 kWh by 2020 and 3,000 kWh by 2030. In contrast, India's per capita electricity consumption for 2011-12 was approximately 880 kWh and is projected to reach approximately 1,500 by 2020-21 according to the draft 18th EPS.

The per capita electricity consumption in the high demand scenario might suggest that by 2020 India would achieve an income level of a middle income country, and by 2030, that of a high middle income country. Both these inferences assume a continued relationship between income and electricity demand.

The high electricity demand scenario is developed at the national level. However, the spatial distribution was modified to describe a future where the variation in the per capita electricity consumption across the states and union territories reduces over time, reflecting our aspiration not only for higher but also more inclusive economic growth. Low levels of per capita electricity consumption reflect a number of factors: lower income levels, low levels of industrialisation, poor access, poor electricity infrastructure and high energy cost.

Although each of these factors may play out differently across states, in totality, low levels of per capita electricity consumption is a strong indicator of low levels on the human development index. This scenario essentially represents a view of the future where government programmes and other targeted investments may move electricity demand to regions with lower level of human development indicators.

Like the base case, this scenario is derived using the regional distribution in the draft 18th EPS. Here, the standard deviation distribution of per capita electricity consumption in the draft 18th EPS is reduced by 25 per cent in 2021-22 and by 50 per cent in 2031-32. This has the effect of bringing the states at either end of the distribution closer to the centre without changing the mean of that distribution. The revised distribution is then used to parse the all-India demand of the high demand scenario to the state/union territory.

LOW CASE

Drawing on the internal and external risks, and to the energy system in particular, it can be inferred that energy delivery may not be able to keep up with the requirements of 8-9 per cent annual economic growth. An iterative process lends credence to consider the possibility of growth grinding down to

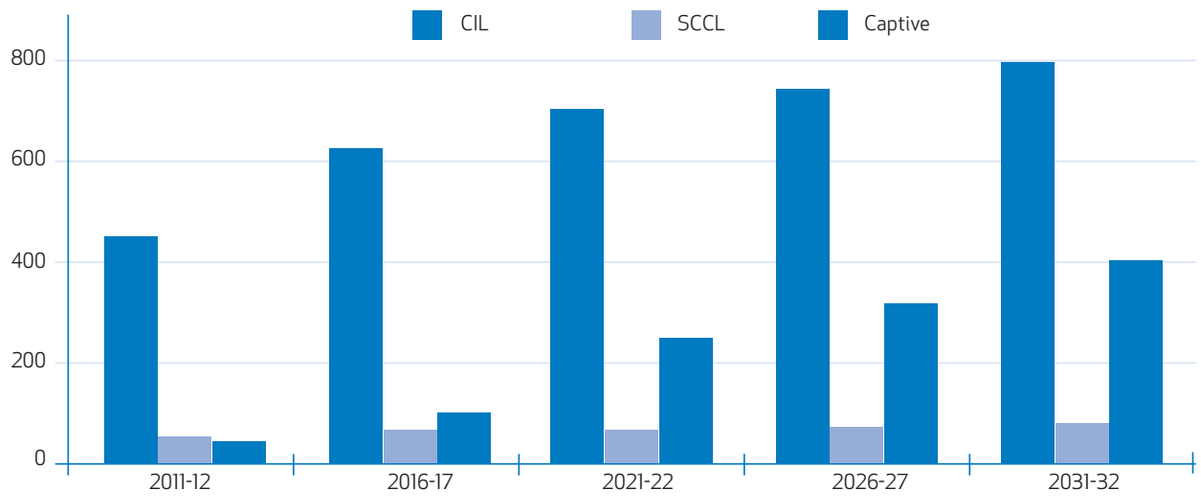
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Table 8.7
National Annual Aggregate Demand by Scenario
[Terra Watt Hour]

CASE	2016-17	2021-22	2026-27	2031-32
Base	1,516	2,118	2,938	3,857
Low	1,329	1,736	2,228	2,808
Aspiration	1,591	2,422	3,334	4,603

Source: Working Group Report (2013).

Figure 8.15
Total Domestic Coal Production
[Million Tonne]



Source: ICF International (Model Runs for Working Group Report 2013).

6 per cent. This is still far from a worst-case economic scenario, but is suitable for illuminating some of the strategic choices that need to be made. Accordingly, a low-case consumption scenario, closely corresponding to the 6 per cent case, was chosen. This is close to the consensus forecasts for Indian GDP growth in the near-term.

Table 8.7 shows the national aggregate electricity demand forecast for the three scenarios.

PARAMETERS AND ASSUMPTIONS

In order to focus on the strategic issues going forward and provide easiest traction for policy making, every effort has been made to ensure consistency with the work done in preparation for the 12th Five Year Plan by the various ministries and departments of the Government of India.

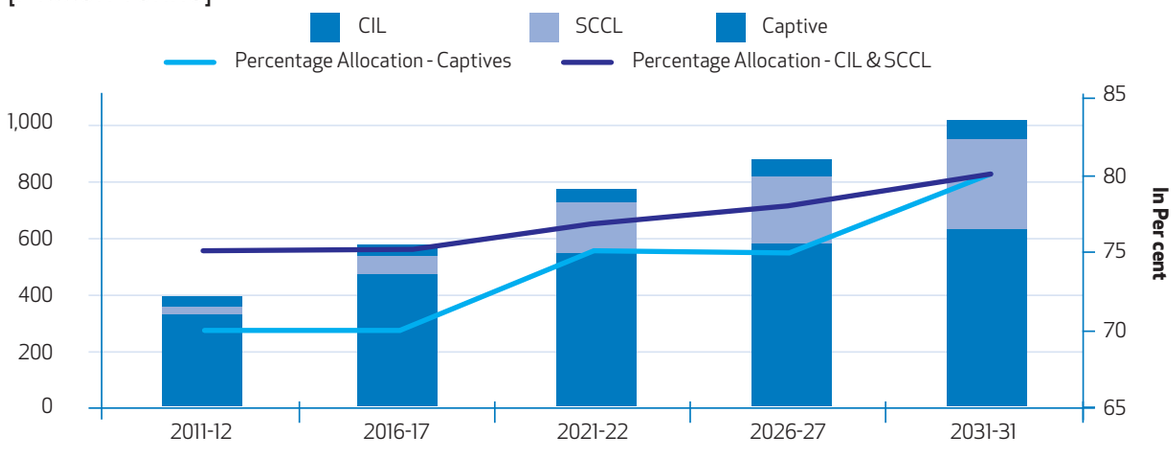
Capacity Additions: For the 12th Five Year Plan, capacity additions have been considered as per the latest CEA and MoP plan. This consists of approximately 66 GW of coal-based plants plus 1.7 GW of nuclear, 4 GW of gas and 11.5 GW of hydro capacity additions. Renewable capacity is over and above the conventional capacity. State level constraints for capacity additions have been modelled as per CEA for the Plans beyond 12th Plan.

Coal Supply: The percentage of coal allocated from CIL and SCCL to the power sector is projected to reach 80 per cent by 2031-32 from the current allocation of 75 per cent of the total coal production. Allocation to the power sector from captive mines is also projected to reach 80 per cent by 2031-32. Lignite is also supplied to the power sector.

Fuel Prices: Coal prices from various subsidiaries are taken as per CIL's notified prices. Imported coal

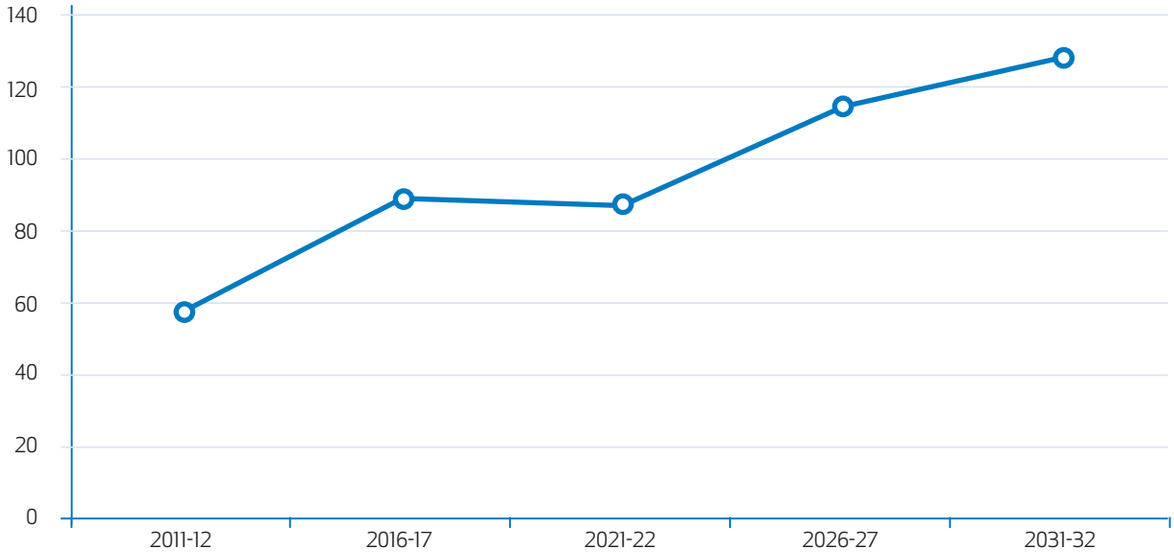
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Figure 8.17
Coal Allocated to Power Sector
[Million Tonne]



Source: ICF International (Model Runs for Working Group Report 2013).

Figure 8.18
Gas Demand by Power Sector
[MMSCMD]



Source: ICF International (Model Runs for Working Group Report 2013).

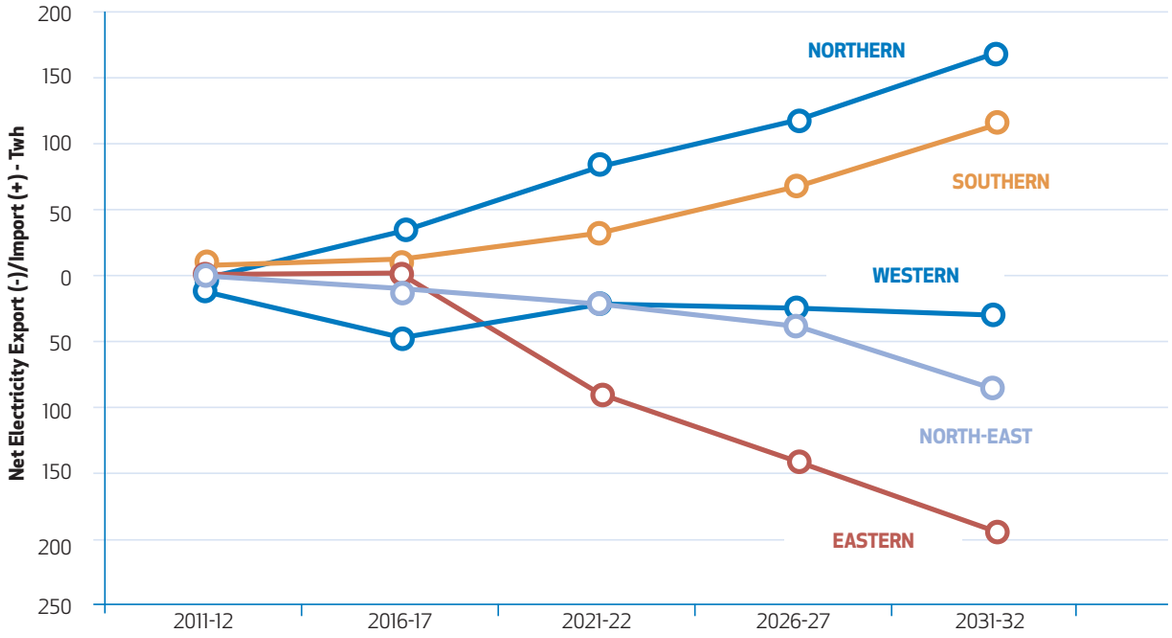
price forecasts are as per the World Energy Outlook 2011 global coal price forecast and analysis shared by ICF International. Domestic gas prices are as per the prevailing market prices from the various sources (APM, NELP, JVs). LNG prices are based on IEA's WEO forecast for Asian deliveries after adjustment, corresponding to the actual contractual arrangements available for Indian buyers.

Gas Supply: The basis for gas production is the DGH-approved gas production plans for various existing and upcoming gas fields. It also reflects analyses commissioned for various stake holders including Petroleum Planning and Analysis Cell (PPAC), Ministry of Petroleum and Natural Gas (MoPNG), DGH, GAIL and others. The longer- term projections for the business as usual (BAU) and other gas supply cases (including conventional and unconventional gas) as well as supply to the power sector is based on international consultants' analysis of gas utilisation policy and expectations around supply in the longer term. More specifically, the gas supply share to the power sector is expected to be in the range of 45-50 per cent of the total production.

Renewable Potential: These assumptions are driven mainly by the requirement as per renewable portfolio obligations (RPOs) and the generation potential for various renewable energy technologies. As per the National Action Plan on

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Figure 8.19
Inter-Regional Electricity Transmission Flows



Source: ICF International (Model Runs for Working Group Report 2013).

Climate Change (NAPCC), 15 per cent of generation should come from renewable energy by 2022. For wind potential, we have taken the latest estimates of 109 GW made by Centre for Wind Energy Technology (CWET) for a hub height of 80 meters. Various foreign institutions such as Lawrence Berkeley National Laboratory (LBNL) in the US provide even higher estimates of 700-1,500 GW for wind potential for India. Solar potential is based on JNNSM targets of 22 GW by 2021-22. For biomass and small hydro, the potential estimated by MNRE has been used.

Cost Parameters: Average, levelised parameters, constant in real terms, have been used for costs of electricity generation, coal mining as well as commodity transport and power transmission.

LIMITS ON CAPACITY ADDITIONS AT STATE LEVEL

There are limits on the amount of capacity that can be added per year, both on the national and state level. These constraints were necessary to prevent excessive concentration of power plants in some states, to reflect limits due to limited land and water availability, and to prevent further environmental degradation in areas that are already critically polluted.

More importantly, political economy considerations suggested that at least half of the incremental power consumption in each state in each Plan period must be supplied by generation capacity within that state. Without such a constraint, it was found, not surprisingly, that imported coal would go to coastal states such as Andhra Pradesh, Gujarat and Maharashtra as this would minimise the cost of imports given the overall levels of availability of domestic coal. The patterns of use of domestic and imported coal that emerged pointed to a likelihood of political wrangling as well as issues of inter-state equity with some fiscal ramifications owing primarily to the large differentials in price of domestic and imported coal. One recent signal of times to come is news reports of protectionist noises from resource-rich states.

FINDINGS AND INSIGHTS FROM THE ANALYSIS

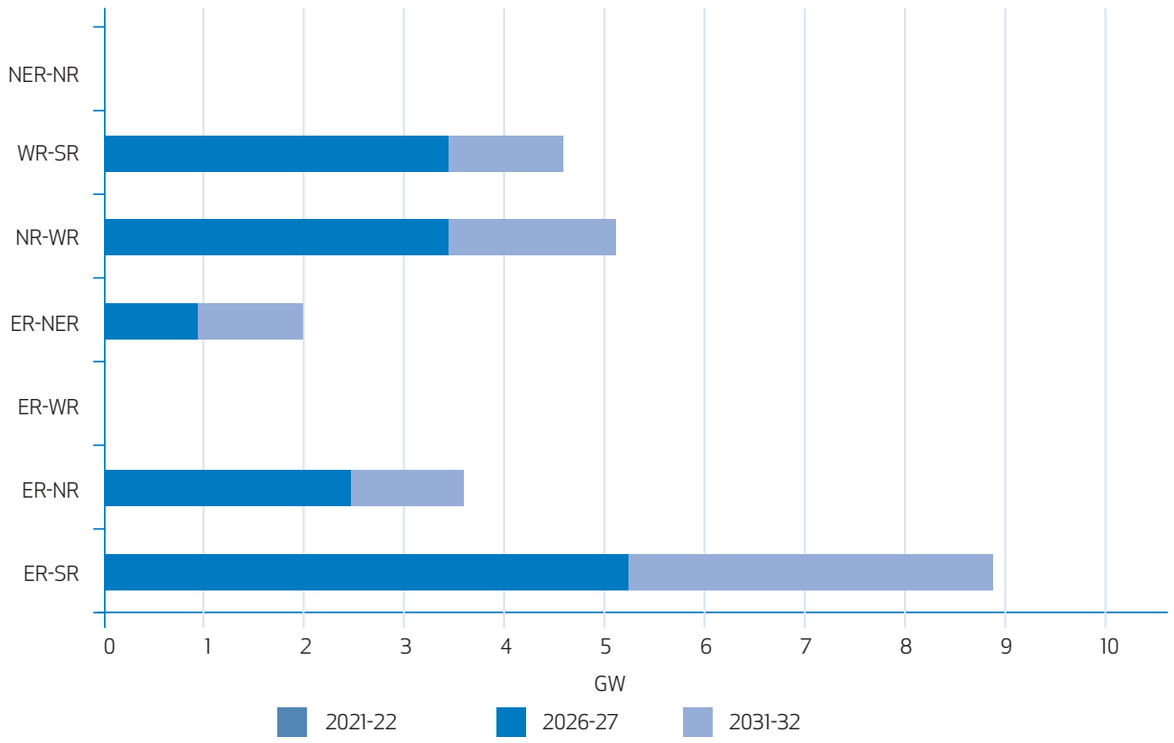
The key outputs from the modeling and analytical effort comprise the state-wise generation of electricity and the associated sources of primary energy. Since our focus is on transportation, particularly of coal, the presentation below is confined to flow of electricity and movement of both domestic and imported coal.

BASE CASE

In this scenario, the Northern and Southern regions, with their burgeoning demand, become major importers of power, while the Eastern region emerges both as a supplier of coal and an exporter of electricity as power generation plants are located

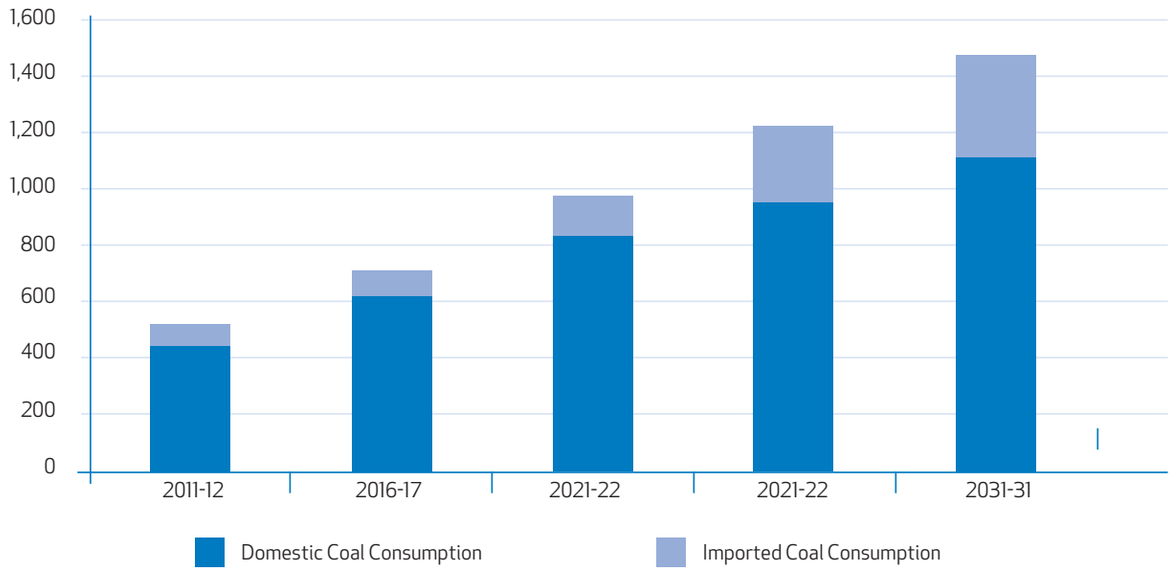
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Figure 8. 20
Transmission Capacity Additions



Source : ICF International (Model Runs for Working Group Report 2013).

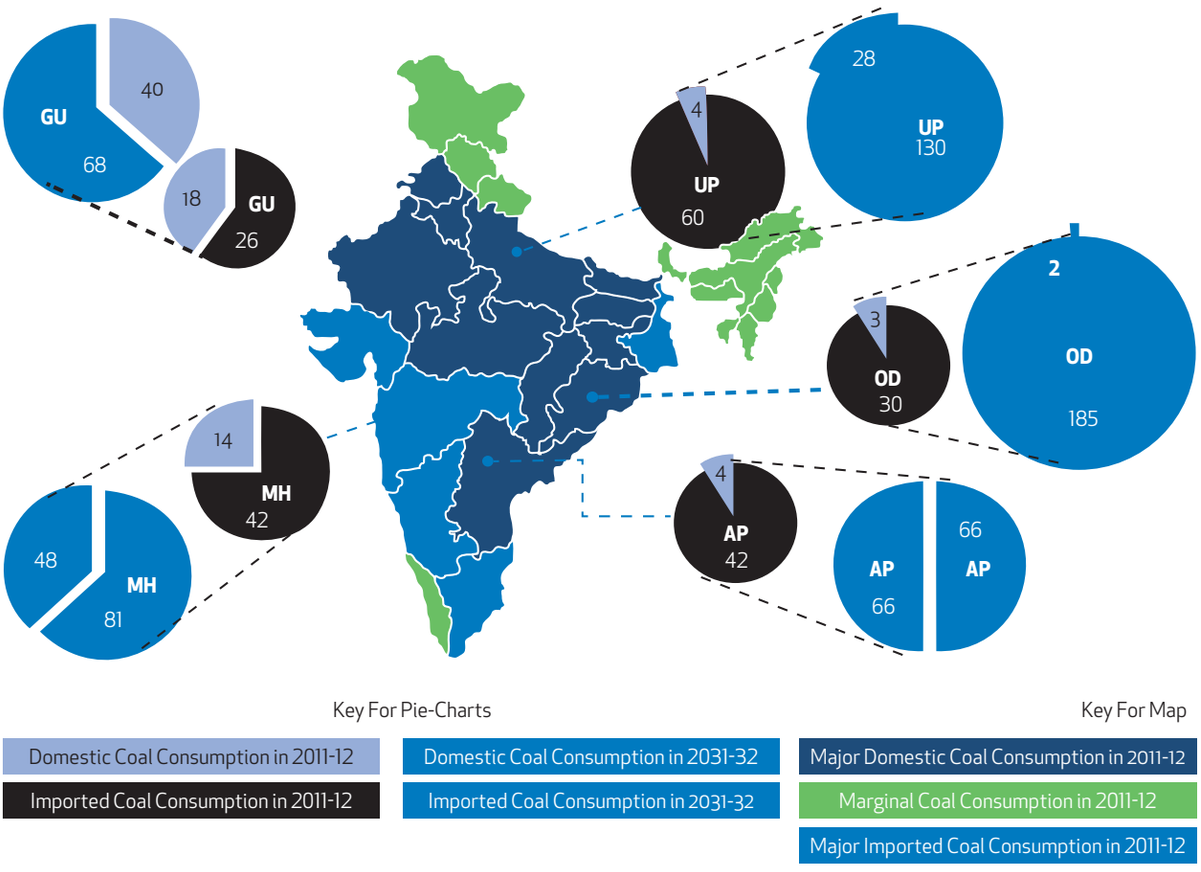
Figure 8. 21
Consumption of Coal
[Million Tonne]



Source: ICF International (Model Runs for Working Group Report 2013).

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Figure 8. 22
Base Case, State-Wise Coal Consumption, 2011-12 and 2031-32
[Million Tonne]



Source: ICF International (Model Runs for Working Group Report 2013).

near the mines. Odisha, for example, is expected to see a massive increase in electricity generation. The North-Eastern (in light of its hydropower potential) and Western regions also export electricity but much less than the major Eastern states.

The expected pattern of electricity flows in the base case scenario point to a major need to expand transmission capacity not only from the Eastern region but also from the Western to the South and North as shown in Figure 8.20. As discussed subsequently, however, the patterns change substantially under the other scenarios. So a robust risk analysis could help prioritise and programme transmission capacity investments, more so, to also maintain grid balance.

INCREASING RELIANCE ON IMPORTED COAL

Domestic coal supply growth (including coal from captive mines and lignite) is not sufficient to meet the increasing demand. Imported coal makes up for the shortages in domestic supply. Demand for imported coal will rise from 74 Mt in 2011-12 to 355 Mt by 2031-32.

The changing mix between imported and domestic coal varies considerably for the states as depicted in Figure 8.22. In addition to Gujarat and Maharashtra, which are already importing coal for power generation, Andhra Pradesh emerges as a major destination of imported coal with for half the total coal consumed in the state being imported. The logic is straightforward: importing coal directly to coastal states minimises transport costs by avoiding land transport over long distances.

States such as UP which are far away from the coast also need imported coal because domestic suppliers are unable to meet the large increase in demand. Thus, not only is there a need to dramatically expand the capacity of ports to handle the massive increases in coal imports but also to ensure rail connectivity to deliver in the hinterland.

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The large volume flow of coal to the Eastern coastal states indicates a need for coastal shipping, which can expand more rapidly than rail links, as the preferred mode of transport.

MOVEMENT OF DOMESTIC COAL BY SURFACE TRANSPORT

The analysis also yields considerable insight in terms of planning priorities. Figure 8.23 for the base case depicts the volumes of coal movement required over the next two decades. It shows the dramatic increase in the volume of coal transported, mainly in the Eastern states. In addition, the volumes for some routes fluctuate. For example, the volume of coal transported to Rajasthan from the East decreases in 2021-22 and then increases by 2031-32. The volume for states like Gujarat and Maharashtra remains fairly constant, their growth being fired by increased imports of coal.

Some salient implications of the transport pattern for coal emerge. One, high priority to address the infrastructure requirements to enable flows depicted in 2021-22. Given the gestation periods in constructing rail links, these projects need to be undertaken now. In particular, the Eastern Freight Corridor and the links to it from the mining areas need urgent action.

Two, the differences between the requirements over the two decadal periods suggest some caution and suitable risk analysis to guard against the possibility of stranded assets due to major shifts in patterns of supply. The coal movement patterns under the other two scenarios discussed later, elucidates this point. Such risks can be hedged through choice of alternative routes.

Three, the large volume flow to the Eastern coastal states indicates a need for coastal shipping, which can expand more rapidly than rail links, as the preferred mode of transport. Moreover, there may be efficiency gains in coordinating the investments with the expansion in capacity of dedicated coal terminals to handle imports. Of course, this may not be possible if separate ports and/or terminals are set up for coastal shipping.

LOW CASE

In this scenario, a preliminary iterative and investigative analysis suggested that if the imports of coal were constrained to the present level, the electricity requirements compatible with a lower rate of economic growth of around 6 per cent, could be met. Here, domestic coal almost meets the overall increase in coal requirement in the country. Southern states will need to rely on domestic, coal-based generation from Eastern and Western states and hence their dependence on other states for electricity will be higher than in the base case.

The dependence of Northern states on other states for supply of electricity is expected to be low compared to the base case. Accordingly, most of the transmission capacity required has to be built towards the Southern region.

A significant and counter-intuitive result emerges from the analysis. Under the low growth scenario the movement of domestic coal actually is larger and puts even more pressure on the rail freight system. Reason: The decrease in coal use is mainly that of imports which would typically land near the demand centres in the coastal states. Domestic coal is utilised in the same volumes as in the other cases but in the low case has to move longer distances to more far-flung locations, thus increasing the surface transport burden. The economic salience of this phenomenon increases further when one considers that the low growth scenario most probably corresponds to constrained public resources and more severe infrastructure bottlenecks.

HIGH CASE

This scenario recognises that the base case itself involves considerable stretch on the supply of infrastructure as well as availability of financial resources. So, to maintain a healthy realism and to also factor in the tremendous and hitherto under-tapped potential of new technologies to increase efficiency and increase the market penetration of renewable energy, certain assumptions on the supply side of the system were also modified. Specifically, the share of renewable energy is projected to rise to 18 per cent in 2031-32. An additional increase of one percentage point in efficiency of power generation every five years is incorporated. Gas supply is also projected to be larger.

Nevertheless, in this scenario, coal imports grow more dramatically and go to coastal states. The Southern region also becomes an exporter of electricity while the Northern region alone remains an importer of electricity. Figure 8.28 depicts the highlights of coal consumption in different states, electricity transmission flows and finally the movement of coal by surface transport. A major implication is the need to expand port capacities even faster, to handle coal imports.

OVERALL OBSERVATIONS

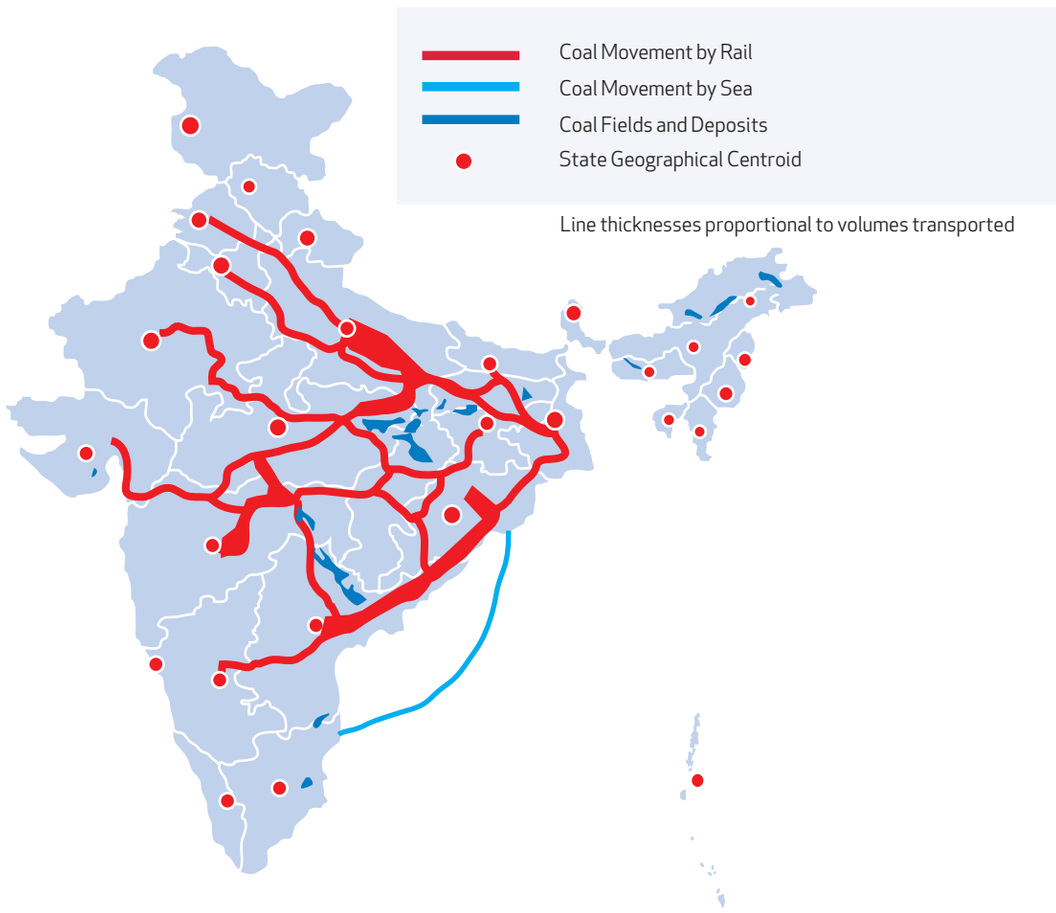
A review of the modeling results in greater detail, yields the following conclusions:

- Coal continues to dominate the energy mix. Its share declines slightly from 68 per cent currently to 65 per cent, 62 per cent and 60 per cent in 2031-32 in the base, low and high cases respectively.
- Coal continues to dominate the capacity mix also. However, its share in the capacity mix declines more rapidly than its share of the generation mix. Currently it is about 55 per cent

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Figure 8.23
Comparison of Coal Movement: Base Case

2011-22



2021-22



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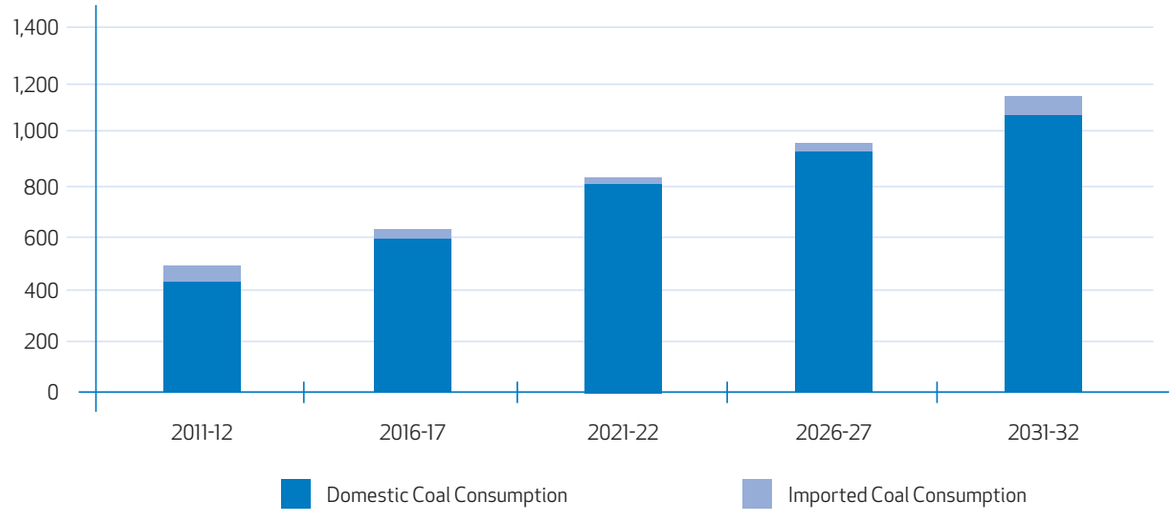
2031-32

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Source: Working Group Report (2013).

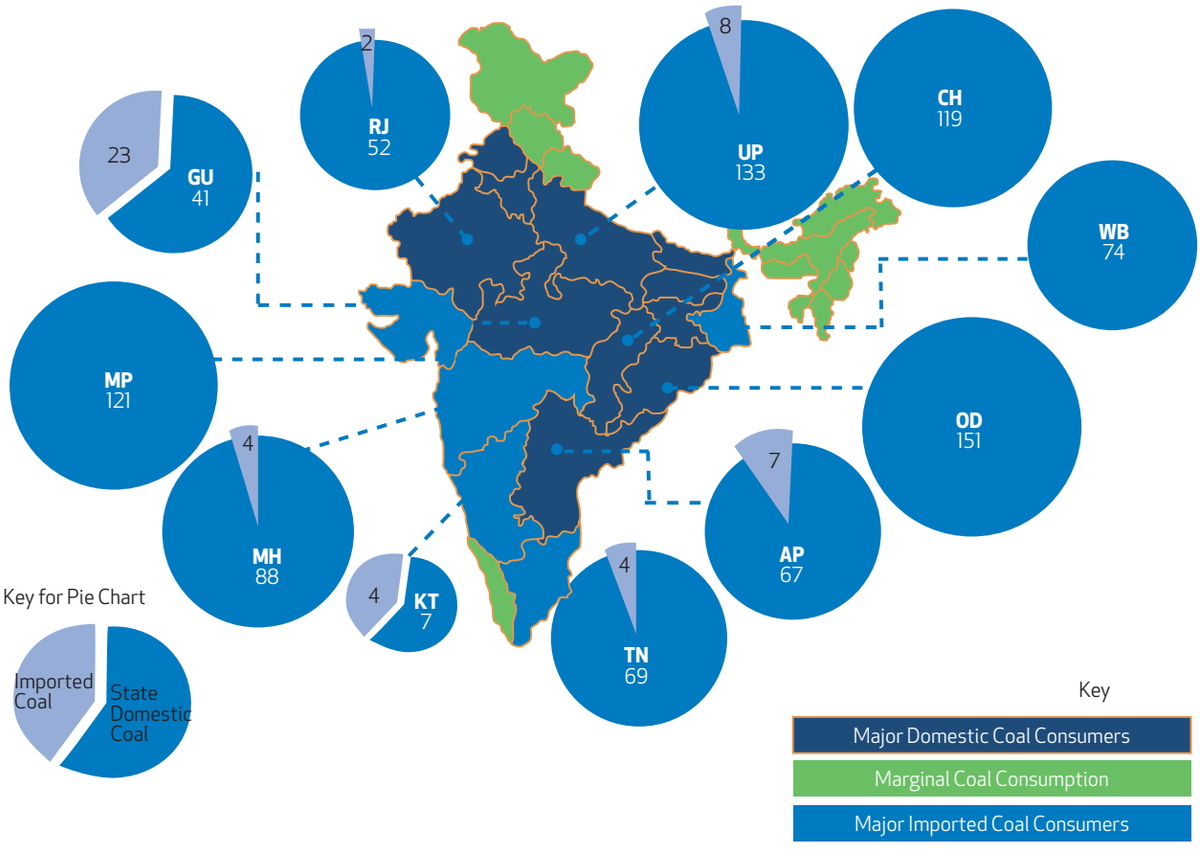
Figure 8.24
Coal Consumption: Low Case



Source: ICF International (Model Runs for Working Group Report 2013).

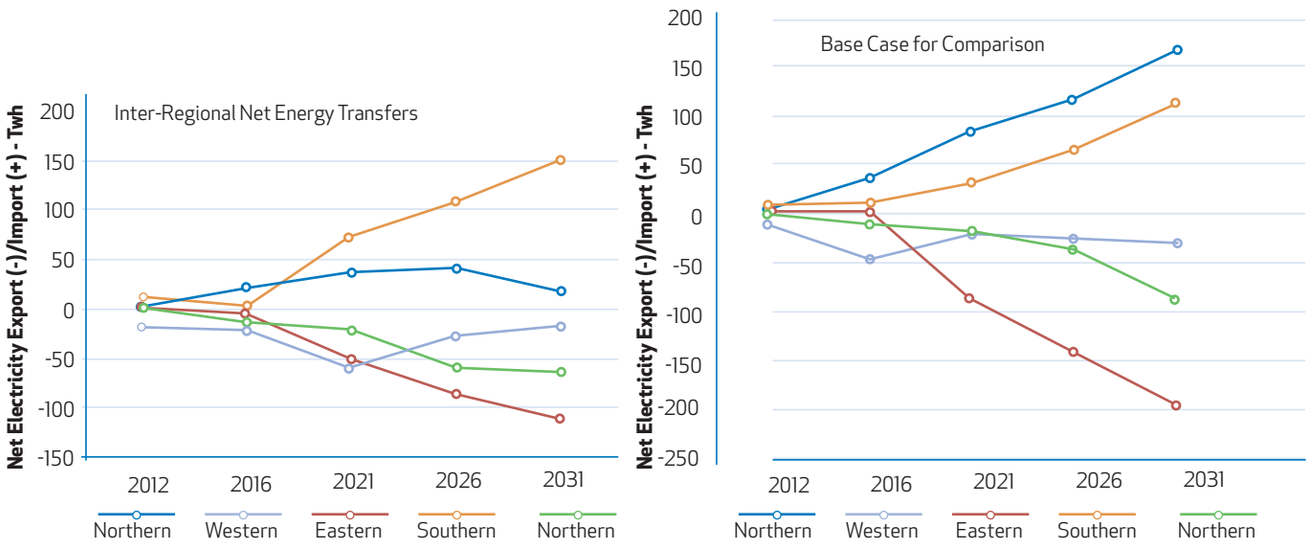
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Figure 8.25
State-wise Coal Consumption, 2031-32: Low Case
[Million Tonne]



Source: ICF International (Model Runs for Working Group Report 2013).

Figure 8.26
Transmission: Low Case

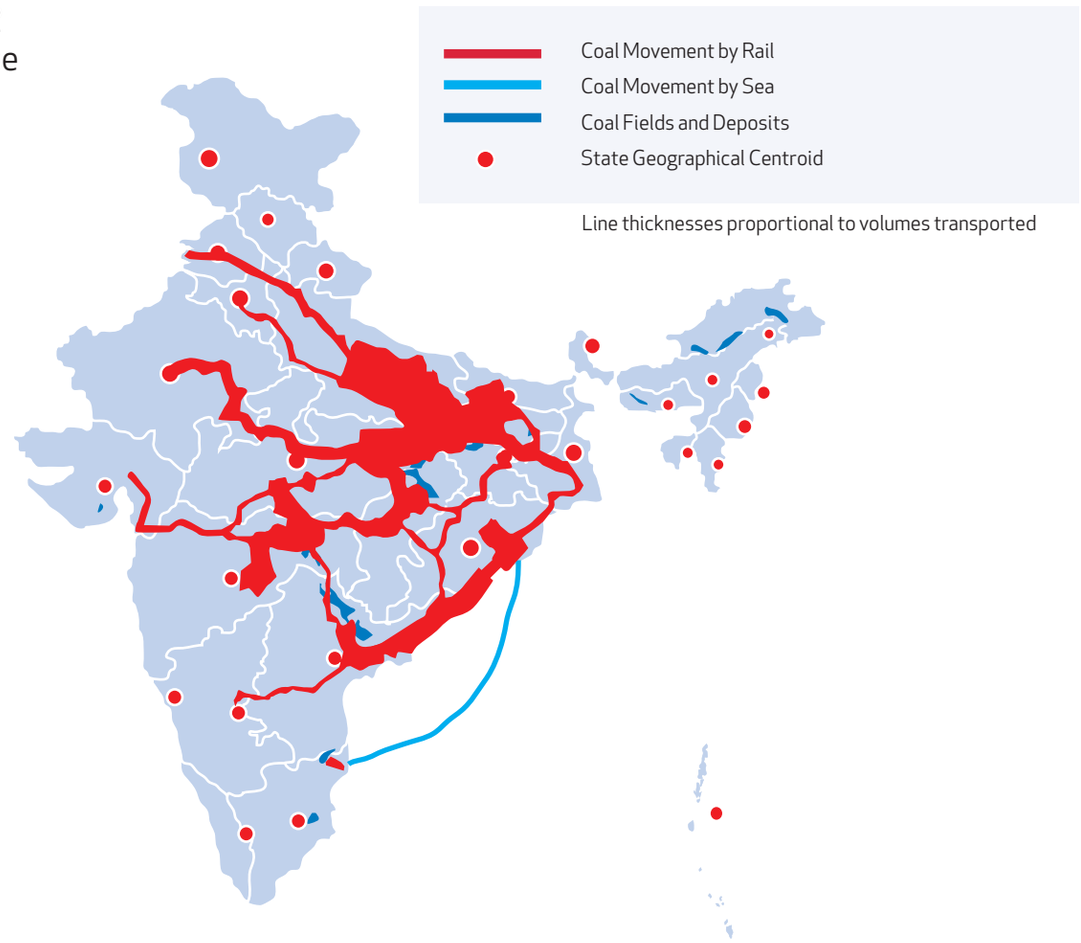


Source: ICF International (Model Runs for Working Group Report 2013).

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Figure 8.27
Comparison of Coal Movement in 2031-32 in the Three Scenarios

2031-32
Low Case



2031-32
Base Case



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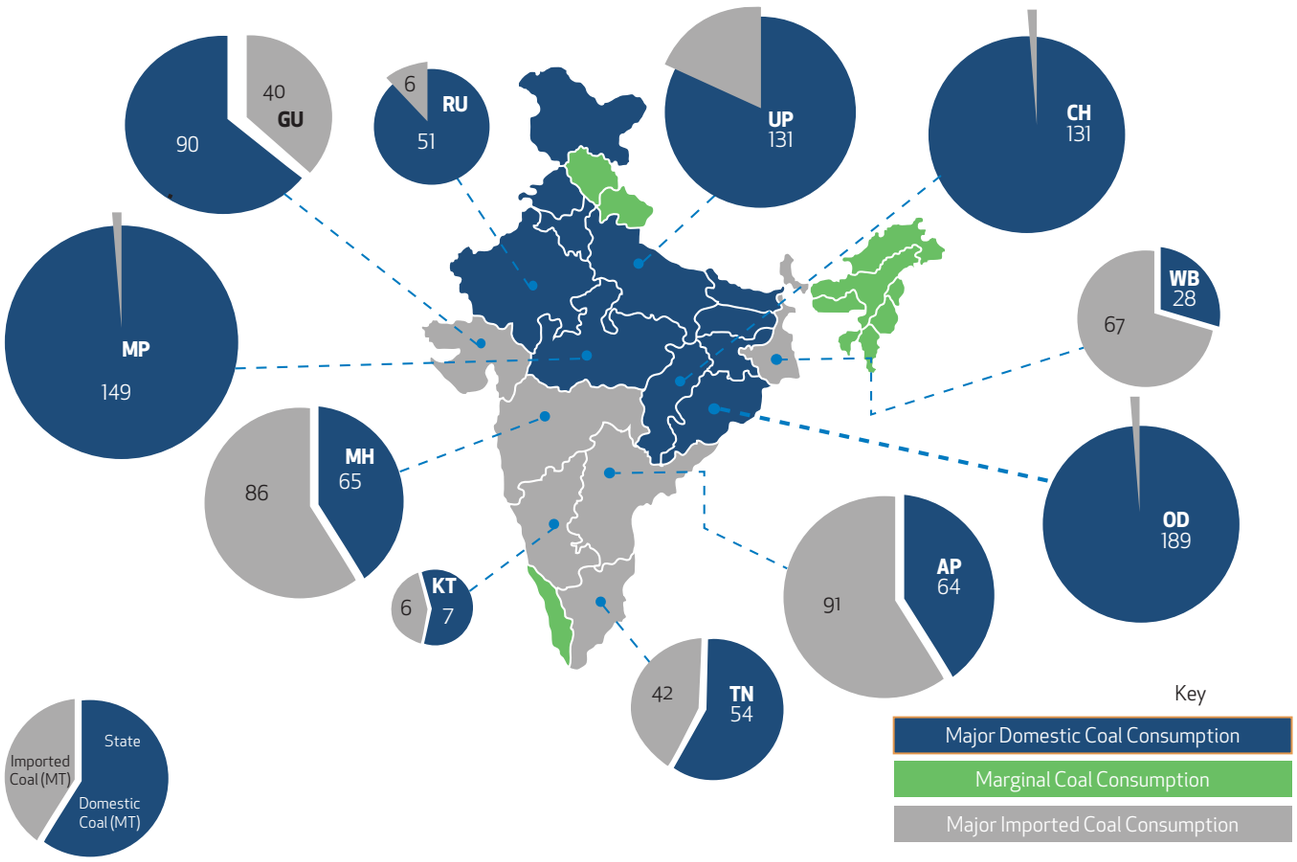
2031-32
High Case

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Source: Working Group Report (2013).

Figure 8.28
State-Wise Coal Consumption, 2031-32: High Case



Source: ICF International (Model Runs for Working Group Report 2013).

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Table 8.8
Consumption of Domestic Coal for the Power Sector
[Million Tonne]

2011-12	2016-17	2021-22	2026-27	2031-32
442	614	828	951	1,112

Source: ICF International (Model Runs for Working Group Report 2013).

Box 8.1
Coal Beneficiation

The intrinsic quality of Indian coal and the way it is mined, results in poor-quality coal. It has high ash content and contains extraneous material such as shale and sandstone. Transport of run-of-mine (ROM) coal is wasteful because the extraneous material and ash are also transported with the coal. Coal Beneficiation (or coal washing) is a process by which the quality of coal can be improved, by either reducing the extraneous material or reducing the ash content or both.

Coal beneficiation is usually done by crushing the coal and putting it in a liquid to separate the lighter coal (low ash content) from the heavier coal (high ash content) and the extraneous material. Because beneficiated coal has a higher calorific value, transport costs are reduced. In addition, there are many benefits for power plants:

- Reduction in the required size of the power plant because less coal is required to produce the same electrical output.
- Better performance because of greater uniformity in the coal that is used.
- Reduction in wear and tear because extraneous material has been removed.
- Reduction in the amount of fly ash that is produced.

The Ministry of Environment and Forests (MoEF) issued a notification that the following power plants use coal with an ash content of 34 per cent or less with effect from June 2001. This was later extended to June 2002:

- Power plants at a distance greater than 1,000 km from the pit head; MoEF has proposed an amendment to reduce the distance to 500 km. CIL has to ensure that there are enough washeries to meet this stipulation[8].
- Power plants located in critically-polluted areas, urban areas and ecologically sensitive areas;
- Power plants using fluidised bed combustion (CFBC, AFBC and PFBC) and integrated gas combined cycle (IGCC) technologies are exempted from this requirement.

Beneficiation results in some loss of coal. The yield decreases as the level of washing is increased. The optimum level of beneficiation depends on several factors: cost of beneficiation; yield; price of unbeneficiated (ROM) coal; economics of the power plant; distance to the power plant and transportation costs. It is difficult to give a single number for the savings in transportation costs. However, for typical Indian coal, the estimated savings in transportation costs for moving coal 1,000 km are about 10-12 per cent[9].

While beneficiation of coal provides many benefits, it also imposes severe stress on the environment. Beneficiation usually uses a lot of water which can be a problem in water-scarce areas. More troubling, the used water gets polluted with coal dust and harms the local environment. The use of dry processes is being explored, and they may provide better performance but at a higher cost. There is not much experience with them yet.

Rejects from beneficiation are often not properly disposed off, and they degrade fertile land and are susceptible to spontaneous combustion. Earlier efforts to burn rejects using fluidised bed combustion

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8. MoP (2012: 45).
9. MoC (2012); Anderson and Nowling (2012).

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(FBC) were not very successful. More recently though, private sector FBC plants are reported to be operating successfully[10].

There is about 44 GW of capacity at a distance of more than 1,000 km and it would require about 175 Mtpa of beneficiated coal to comply with MoEF's notification. If the distance is reduced to 500 km, about 90 GW of capacity would require about 360 Mtpa of washed coal. Existing capacity for coal beneficiation is insufficient. Currently it is 96 Mtpa for non-coking coa[11], although only half is being utilised (based on CCO, Coal Directory, 2010-11). Coal India Ltd (CIL) has plans for adding 20 new washeries with a total capacity of 111 Mtpa, of which 19 Mtpa will be for coking coal and the remaining 92 Mtpa for non-coking coal. Together, this capacity could theoretically be just sufficient to fulfill the requirements of MoEF.

Beneficiated coal is not being used by power plants due to both supply and demand factors. Suppliers of washed coal see very little incentive in producing washed coal. There have been conflicts between CIL and its customers over who should bear the costs of washing. On the other hand power plants do not demand washed coal because there is no penalty for not complying with MoEF's directive.

and declines in 2031-32 to 45 per cent for the base and low case and 37 per cent in the high case scenario.

- The share of natural gas in the energy mix declines for all three scenarios because it is increasingly used as an intermediate resource in the dispatch order instead of as a base load resource as done currently.

Annexes of the WG report give state-wise and region-wise details for the terminal years for each of the next four Five-Year Plans for consumption of domestic coal; consumption of imported coal; consumption of natural gas; conventional generation capacity; renewable energy capacity; and net transmission.

DOMESTIC COAL USAGE

Table 8.8 shows domestic coal usage. It remains the same in all three scenarios because domestic coal is the least expensive fuel for electricity generation and is used first to meet the nation's electricity requirements. After the domestic coal available in a particular year is exhausted, other fuels are considered by the model.

The amount of coal needed for the power sector even today is large and it will grow about threefold by 2031-32. Moving it will require increasing rail infrastructure for transportation which poses great challenges for the already-strained Railways. Coal beneficiation (also known as coal washing) is one way to reduce transportation requirements. However, this comes at a cost. Box 8.1 on coal beneficiation describes the benefits and some of the environmental costs of coal beneficiation.

IMPORTS OF COAL

Table 8.9 shows consumption of imported coal for states that consume more than 3 Mt in any year and under any of the three scenarios. The amount for the entire country is also shown in the last row. Total imports are expected to grow dramatically; almost five-fold over the next two decades in the base case, and six-fold in the high case. As can be seen from Table 8.9, most of the imported coal is expected to be used in the coastal states: AP, Gujarat, Maharashtra, Karnataka, Tamil Nadu and West Bengal. However, there are other states such as Haryana, Punjab, Rajasthan and UP that are also likely to be significant consumers of imported coal.

CLIMATE CHANGE AND USE OF COAL

No study of the power sector can ignore concerns about climate change and the detrimental effects on the global environment from power generation, particularly from the burning of coal. India must do what is reasonably possible to limit emissions of green-house gases (GHGs).

The scenarios were therefore modeled to reflect significant efforts to make the energy mix cleaner through the use of increasing amounts of renewable resources and gas. In particular, renewable resources have been pushed aggressively. In the base case, the capacity from renewable resources increases almost nine times over the two decades. In the high case, the introduction of renewable is even more aggressive, increasing by about twice that amount (18 times). Gas use also increases by a factor of two over the two decades, but gas use is constrained by the limited supply of gas over the next two decades.

These large increases in the use of renewable energy and natural gas were incorporated in the scenarios in spite of the very large cost advantage with coal based generation. Currently, natural gas based generation costs about 1.5 times domestic coal based generation on a per kWh basis. In the case of renewable energy,

10. MoC (2012).
11. SG-2 (2011).

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Table 8.9
Consumption of Imported Coal for Select States
[Million Tonne]

	BASE CASE					LOW CASE					HIGH CASE				
STATES	2011-12	2016-17	2021-22	2026-27	2031-32	2011-12	2016-17	2021-22	2026-27	2031-32	2011-12	2016-17	2021-22	2026-27	2031-32
AP	4	11	27	49	66	4	5	5	5	7	4	12	28	54	91
BI	1	3	1	1	1	0	0	0	1	1	1	3	1	9	15
CH	2	0	0	0	0	0	0	0	0	0	3	11	0	0	0
GU	18	22	43	59	68	18	16	14	16	23	19	31	47	60	90
HY	4	2	6	13	17	4	0	0	0	5	04	2	9	12	18
KT	7	7	6	6	15	7	3	2	2	4	7	7	5	5	6
MH	14	20	17	35	48	12	2	3	3	4	14	20	17	43	86
PB	0	2	2	7	9	0	0	0	0	3	0	2	3	7	8
RJ	2	4	6	15	5	2	1	1	1	2	2	4	6	6	6
TN	4	5	24	37	47	4	0	1	1	4	4	8	15	35	42
UP	4	0	4	28	28	2	0	0	0	8	4	0	7	32	28
WB	6	1	1	14	48	6	0	0	0	0	6	2	18	29	67
INDIA	**73**	**88**	**138**	**266**	**355**	**61**	**28**	**27**	**28**	**61**	**76**	**106**	**158**	**295**	**460**

Note: Only states that consume more than 3 Mt in any year under any of the three scenarios are shown in this table. Therefore, the total of these states will be less than the amount shown for the entire country in the last row.
Source: ICF International (Model Runs for Working Group Report 2013).

the cost penalty is even higher with wind energy costing about twice as much and solar PV three times as much as domestic coal based generation.

Further as discussed earlier, the high case recognises that the higher growth that is postulated will also allow a greater focus on greener but more expensive options. That is why almost twice the amount of renewable resources as the base case are added. In addition, generation efficiency is assumed to increase by one percentage point every five years, and a greater availability of natural gas was assumed.

However, in spite of these initiatives, coal continues to dominate the energy mix, although its share drops to some extent to 65 per cent in the base case from its current level of 68 per cent. The decrease is greater for both the low case (62 per cent) and the high case (60 per cent). One reason for the continued dominance of coal is that there is a large increase in the projected requirement for electricity. While the contribution from renewable energy increases dramatically, in absolute numbers there is still a large gap in electricity requirements which must be filled by coal.

HANDLING UNCERTAINTIES

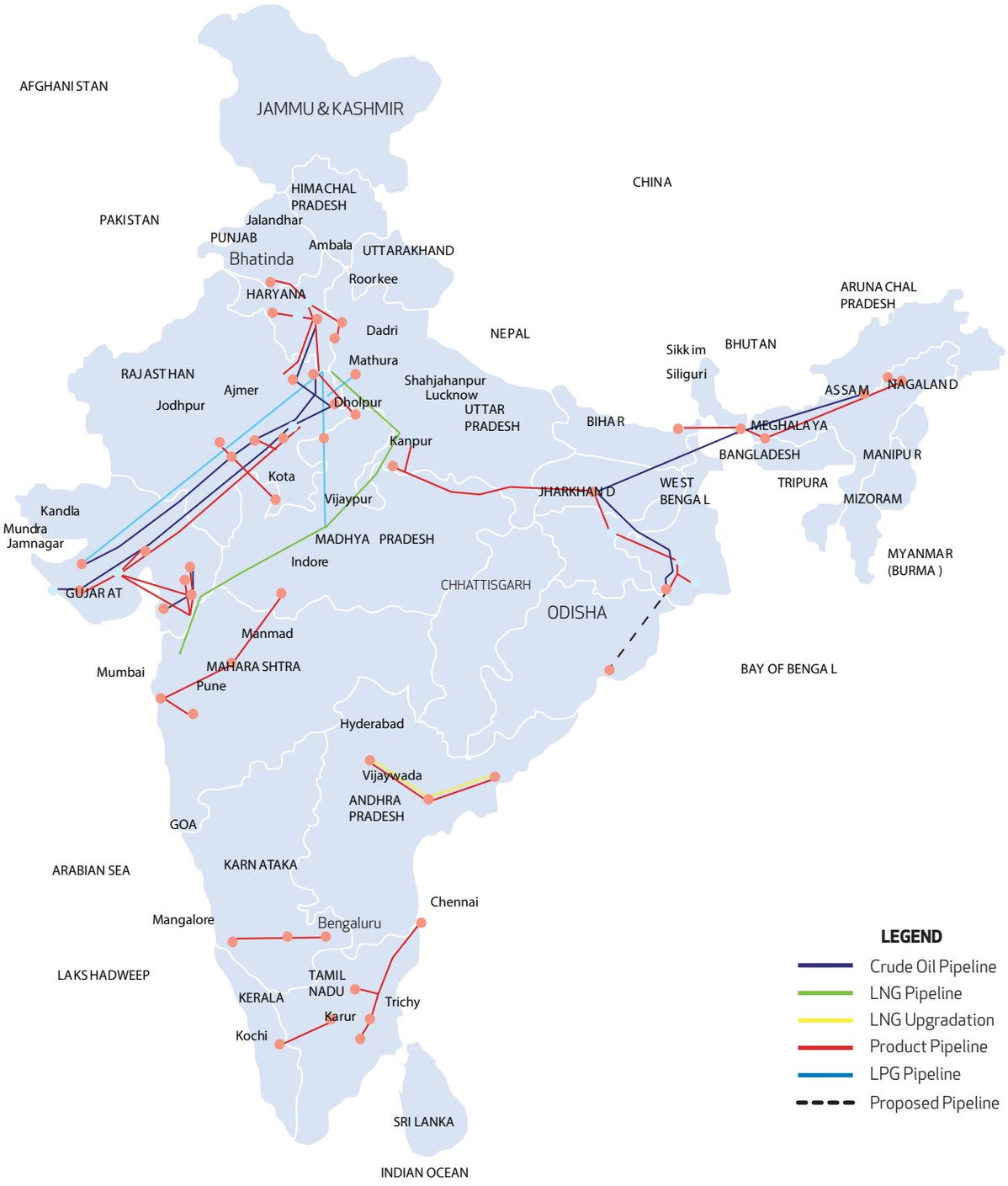
As we have seen in the three scenarios, there can be great variation in both the amount of coal to be transported and the pattern of the movement. This could be triggered by changes in the rate at which the economy is growing, greater use of renewables, increased availability of gas or higher energy efficiency.

Given this uncertainty, it is important that planning for bulk transport of energy commodities be adaptive. A strategic bulk transport planning group that monitors developments and potential developments in coal and other fuel markets, renewable energy technologies, and domestic fuel supply, should be established. In response to changing conditions, it should periodically, say every five years, direct changes in the plans for transport of fuels so that adequate fuel supplies are available to power plants without delay and at low cost. The group should include all major stakeholders and representatives from power, railways and natural gas sectors.

Chapter 5, Volume II on Institutions for Transport System Governance, proposes an Office of Transport Strategy (OTS) that would integrate transport planning across modes and coordinate between the ministries and other levels of government. The strategic bulk transport planning group could be established under the OTS, and the OTS could extend coordination to non-transport ministries such as power, petroleum and natural gas, and steel, on issues related to transport of bulk commodities.

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Figure 8. 29
Oil and Gas Pipelines in India



Source: NTDPC Research.

TRANSPORT REQUIREMENTS FOR PETROLEUM AND NATURAL GAS

In India, all the natural gas and a major part of the petroleum and petroleum products are transported by pipelines. Even though a fraction of petroleum products is transported by rail, the amounts are insignificant compared to the amount of coal that needs to be moved, and therefore do not have much of an impact on the railway infrastructure required for movement of bulk commodities. The main intention of looking at the transport requirements for the petroleum and gas industry is to check the adequacy of the infrastructure, particularly for gas, to ensure that sufficient transport capacity is available for the power sector. Transportation for the petroleum industry covers

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Table 8.10
Modes of Transport for Crude Oil
[Million Tonne]

	PSUS			PRIVATE COMPANIES		
YEAR	PIPELINES	COASTAL SHIPPING	TOTAL	PIPELINES	COASTAL SHIPPING	TOTAL
2011-12	70.2(52)	64.8(48)	135	8.25(11)	66.75(89)	75
2016-17	84.6(45)	103.4(55)	188	8.82(9)	89.18(91)	98
2021-22	97.99(41)	141.01(59)	239	10.26(9)	103.74(91)	114
2026-27	116.66(38)	190.34(62)	307	12.24(9)	123.76(91)	136
2030-31	146.68(38)	239.32(62)	386	15.3(9)	154.7(91)	170

Note: The figures in parentheses are percentage shares.
Source: MoP&NG (2012a).

the movement of crude oil from oil wells or ports to refineries, and the movement of petroleum products from refineries to the retail outlets.

CRUDE OIL

Crude oil is moved either by pipeline or coastal shipping to the refinery. Crude from onshore oil fields is mainly transported through pipelines, while coastal ships primarily move crude oil from offshore oil fields. Road and rail are not used. At present, there are 16 crude oil pipelines in the country, with a length of 8,560 km and capacity of 107 Mtpa (Figure 8.29). The pipelines are in the North-West and East, mostly carrying PSU crude. The PSUs transport roughly half their crude through pipelines while private companies use coastal shipping (Table 8.10).

The demand for crude oil is expected to increase from 210 Mt in 2011-12 to 286 Mt at the end of the 12th Plan and 353 Mt at the end of the 13th Plan (2021-22) with new refineries at Gujarat, Maharashtra and Tamil Nadu in the next decade, and expansion of 55 Mtpa at existing refineries proposed during the 13th Plan. In order to optimise the crude mix and product pattern to ensure adequate profitability of the companies, crude oil will be sourced from various producing nations in addition to domestic fields.

The year-wise estimate for movement of crude oil through coastal and pipelines, both by PSUs and private companies, is shown in Table 8.10.

With a number of refineries coming up at ports, the share of movement of crude oil by coastal shipping is expected to increase from 65 per cent in 2010-11 to 73 per cent by 2031-32.

PETROLEUM PRODUCTS

Petroleum products include petrol, diesel, ATF, naphtha, fuel oil, bitumen, LPG, lubricants, paraffin wax, petroleum coke, etc. The movement of these products from the refineries to the retail outlets is carried out using the least cost mix of rail, coastal shipping, roads and pipelines. The primary movement of petroleum products, from refineries to depots is through pipelines, rail or coastal shipping. The secondary movement of petroleum products, i.e., from the depot to the retail outlet, viz. last mile, is necessarily by road.

In comparison with rail and road, pipelines are considered much more economical. IOCL estimates for 2010-11 that the cost of movement was Rs 0.34 per Mt-km for movement through pipelines, Rs 1.39 per Mt-km by rail and Rs 2.86 per Mt-km by road. In addition to their safety and environmental-friendly approach, the per-unit cost advantage explains the economic importance of investment in pipelines for movement of oil and gas. Consequently, since 2008-09, there has been substantial investment in pipeline infrastructure. At present, there are 31 product pipelines, 11,274 km long and with a capacity of about 70 Mt. In addition, there are LPG pipelines of 2,313 km with a capacity of about 4 Mt. Table 8.11 gives the inter-modal mix of transport, for only primary movement of petroleum products in 2010-11 and the next two decades. As shown, the share of the pipelines is about 30 per cent. This is considerably less than in countries like the USA and China. In the US,

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Table 8.11
Movement of Petroleum Products
[Million Tonne]

YEAR	PSUs					PRIVATE COMPANIES				
	PIPELINE	COASTAL	RAIL	ROAD	TOTAL	PIPELINE	COASTAL	RAIL	ROAD	TOTAL
2011-12	56.76(46)	18.51(15)	40.72(33)	7.40(6)	123.39	2.86(4)	60.87(85)	3.58(5)	3.58(5)	71.61
2016-17	90.14(53)	23.81(14)	45.92(27)	10.20(6)	170.08	2.88(3)	81.53(85)	5.76(6)	5.76(6)	95.92
2021-22	118.56(54)	30.74(14)	57.08(26)	13.17(6)	219.55	3.25(3)	87.84(81)	7.59(7)	9.76(9)	108.45
2026-27	157.64(54)	46.71(16)	75.90(26)	14.60(5)	291.92	4.80(4)	88.86(74)	12.01(10)	15.61(13)	120.08
2030-31	203.92(55)	55.61(15)	88.98(24)	18.54(5)	370.76	5.85(4)	103.83(71)	16.09(11)	20.47(14)	146.24

Note: The figures in parentheses are percentage shares.
Source: MoP&NG (2012a).

59 per cent of petroleum products were transported through pipelines, followed by coastal shipping (33 per cent), road (5 per cent) and railways (3 per cent).

Broad industry projections suggest that movement of POL products by PSUs through pipelines would be around 55 per cent, coastal shipping 15 per cent, rail 24 per cent and road 5 per cent by 2031-32.

The share of pipelines used by PSUs would increase substantially during this period, whereas the product movement by private companies would remain stable at 4 per cent. It may be inferred that, on the whole, pipelines would continue as the most preferred mode. Although railways at present transport a major share of products, their percentage contribution is expected to decline primarily due to the expansion of the pipeline network. This would ensure a balance between the ability of transport to serve economic development and to conserve energy, promote safety and sustain quality of future life.

As Table 8.11 shows, about 20 per cent (~105 Mt) of petroleum products will be transported by rail. This is small compared with movement of coal for power (~1460 Mt). Therefore, POL movement has little effect on planning for railways.

IMPORTS AND EXPORTS OF POL

Rapid growth in domestic consumption of petroleum products and refining capacity has increased the country's dependence on imports of crude oil. On the other hand, India has not only become a net exporter of petroleum products, but is now the largest exporter of petroleum products in Asia[12]. This section gives an estimate of the imports and exports of crude oil and petroleum products and the resulting liquid bulk traffic at ports.

Table 8.12 provides the details of the calculation. We first estimate the requirements for crude oil which is based on the sum of domestic demand and the net exports of petroleum products. Domestic demand has been estimated for the 12th and 13th Plan by the MoP&NG[13]. We extrapolated the results until 2031-32 using the CAGR for the 13th Plan. While in its report for the 12th Plan, the MoP&NG did estimate the exports of petroleum products for the 12th Plan, we could not find any projections for exports beyond 2016-17. As the level of exports is linked to the global requirements for petroleum products, we have assumed that India's share of exports as a percentage of global requirements would remain at the level projected for 2016-17. Global requirements were obtained from the International Energy Outlook by the Energy Information Administration (EIA) of the US. Imports of petroleum products, which consist mostly of LPG, have remained stable at about 11 Mtpa. We have assumed that imports remain at this level throughout the study period.

The total amount of petroleum products that need to be produced in the country is equal to the domestic demand plus net exports. In Table 8.12, this amount is shown as 'Total to be Produced'. The 12th Plan data indicates that a tonne of crude oil yields about 0.93 tonne of petroleum products[14]. We use this estimate to calculate the requirements for crude oil in the country.

12. MoP&NG (2011).
13. Ibid.: 49-50.
14. Ibid.: 163.

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Table 8.12
Estimation of POL Traffic at Ports
[Million Tonne]

	PIPELINE	2011-12	2016-17	2021-22	2026-27	2031-32
1	Domestic Demand for Petroleum Products	147	186	245	322	424
2	Gross Exports of Petroleum Products	58	91	94	100	104
3	Gross Imports of Petroleum Products	10	11	11	11	11
4	Net Exports of Petroleum Products (2-3)	48	80	83	89	93
5	Petroleum Products to be Produced in India (1+4)	195	266	328	412	517
6	Requirements for Crude Oil (5/0.93)	210	286	353	443	556
7	Domestic Production of Crude Oil	38	41	41	41	41
8	Required Imports of Crude Oil (6-7)	172	245	312	401	515
9	Total Imports and Exports of POL (2+3+8)	240	347	417	513	631
10	**TOTAL POL TRAFFIC AT PORTS (9 X 1.37)**	**329**	**475**	**572**	**702**	**864**

Source: Working Group Report (2013).

By 2031-32, it is estimated to reach 556 Mt. Some of it will be met by domestic production. Recent projections for the 12th Plan period show a small decline in production[15]. Therefore, we have assumed that domestic production will remain at current levels. Subtracting domestic production from total requirements for crude oil give us the amount of crude oil that needs to be imported. It is expected to reach 515 Mt by 2031-32. The sum of POL imports (crude oil and petroleum products) and exports (petroleum products) is shown in Table 8.12 and is expected to reach 631 Mt by 2031-32.

Port traffic includes not just this amount but also some domestic crude that is produced off-shore and crude oil and petroleum products moved by coastal ships. Estimating this amount directly is very difficult. Instead, we looked at POL port traffic for the last several years and compared it with the total imports and exports of POL. We found that the ratio of POL port traffic to POL imports and exports over the last several years has varied between 1.25 to 1.53,with an average of 1.37. We have used the average of 1.37 to arrive at POL port traffic which is shown in the last line of Table 8.12.

NATURAL GAS

Natural gas constitutes 24 per cent of the total energy mix in the world. Its share in the Indian energy basket was around 11 per cent in 2010. It is projected that the growth of natural gas demand in India in the next two decades will alter the primary energy mix of India, by way of substitution from oil to gas, and reach up to 20 per cent. MoP&NG estimates that demand for gas will increase to 473 MMSCMD by 2016-17 and 606 MMSCMD by 2021-22, and would be about 790 MMSCMD by 2031-32[16].

The production of natural gas has increased from 89 MMSCMD to 143 MMSCMD at an annual growth rate of 17 per cent in the period 2007-08 to 2010-11. More discoveries of natural gas are expected in the coming years. Demand for natural gas has increased by 24 per cent during this period. Demand for natural gas up to 2031-32 is estimated based on the domestic production estimates as provided by the Directorate General of Hydrocarbons (DGH) and expected demand for natural gas by various sectors—power, fertiliser, city gas, industry, petrochemicals/refinery/internal consumption and sponge iron/steel. It is assumed that from 2017-18 onwards, additional gas would be available domestically from CBM Blocks and other future discoveries. Accordingly, a growth rate of 6 per cent is assumed from 2017-18 onwards and the availability is expected to stabilise thereafter at an annual growth rate of 3 per cent till 2031-32.

The remaining gap in demand is expected to be met through imports using existing facilities at Dahej, Kochi, Dabhol, Hazira and other LNG terminals

15. PetStats (2011: 12:42).
16. MoP&NG (2011a); MoP&NG (2011b).

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Table 8.13
Estimates of Demand for Gas
[MMSCMD]

YEAR	GAS DEMAND
2010-11	170
2011-12	193
2016-17	473
2021-22	606
2026-27	703
2031-32	791

Note: Figures are based on the expectations that IPI/TAPI will be operational from 2018-19 onwards.
Source: MoP&NG (2012a).

proposed at places like Mangalore, Ennore, Mundra, Paradip, etc. Besides, certain Floating Storage Regassification Units (FSRUs) are being planned at port locations like Dighi, Mumbai, Paradip, Vizag, Mangalore, Cuddalore, etc.

The availability of transport infrastructure for gas needs to keep pace with availability of gas and commissioning of user industries. Gas transportation needs have been accordingly estimated until 2031-32 (including regional and trunk pipelines) as shown in Table 8.13.

Gas transportation estimates are related to the demand projections for gas, expected to increase substantially with the increase in demand projected by sectors like power and fertiliser. Given the present domestic availability, demand from other sectors like city gas, industrial, petrochemicals, refineries, internal consumption and sponge iron would be met mostly through imported LNG. However, the estimates have not considered the role of price elasticity in relatively price-elastic sectors like power and fertiliser. In this scenario, the actual demand could be much lower than the projected demand.

Pipelines are practically the only mode of inland gas transportation from producing regions to various consumption centres. India presently has approximately 13,000 km of gas pipelines with a total design capacity of 334 MMSCMD. As shown in Figure 8.30, this comprises around 8,400 km owned and operated by GAIL, around 1,469 km of east-west pipeline operated by RGTIL and the remaining operated by regional players like GSPC, IOCL, etc. The growing gas demand and new gas fields along the East coast, emphasise the need for faster development for gas transportation infrastructure. In 2007, MoP&NG had authorised around 5,771 km of pipelines to GAIL and 2,628 km to Reliance Logistics. Besides, GAIL is also upgrading the GREP/DVPL for 1,280 km for a capacity of 54 MSMCMD.

The PNGRB has authorised 4,325 km of pipeline through a transparent bidding process. In addition, another 2,675 km of pipeline is under various stages of bidding.

Table 8.14 summarises the composition of the gas pipeline grid. The total capacity of 1,176 MMSCMD will meet the requirements given in Table 8.13.

As the table shows, additional pipelines of about 32,000 km will be needed. It is difficult to estimate the cost because the cost per km varies by a factor of four to five depending on the diameter of the pipeline and by a factor of more than two depending on the region. It should be noted that some of these new pipelines are already under construction.

TRANSPORT REQUIREMENTS OF THE IRON AND STEEL INDUSTRY

Production of a tonne of steel requires three to four tonne of raw materials. So, to estimate the transport requirements for the steel industry, we first estimate the raw material requirements.

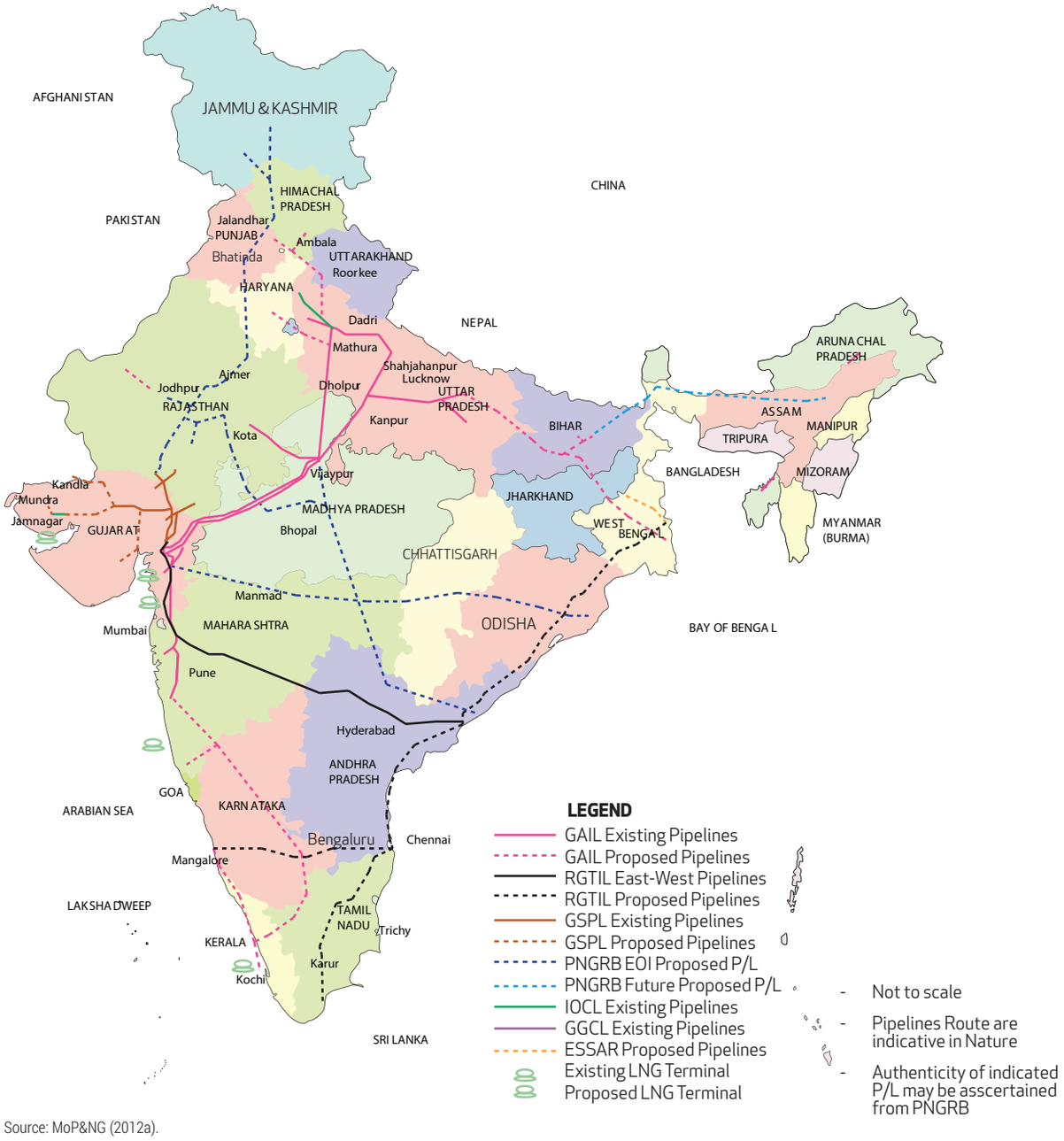
The calculations of raw material requirements have been projected on the basis of the following current norms of consumption and expected improvements in efficiency of operation[17]:

- Iron consumption is 1.6 tonne per tonne of crude steel (CS), based on BF/BOF technology.
- Coking coal use to decrease from 0.8 tonne per tonne of crude steel to 0.75 tonne, with increasing use of pulverised coal injection (PCI) and scrap in electric furnaces. (Use of

17. Ministry of Steel (2012a).

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Figure 8.30
Existing and Proposed Natural Gas Pipelines



Source: MoP&NG (2012a).

scrap expected to increase from 15 per cent in 2016-17 to 25 per cent in 2031-32.)

Input materials required to produce one tonne of crude steel will decrease from the present four tonne to three, with these efficiency improvements. This will reduce the need for transportation of raw materials.

Based on these requirements, the amount of raw material to be transported for the terminal year for each of the next four Plans has been estimated in the Table 8.15.

These transport requirements do not include those for exporting iron ore. While these exports are, and have been, quite large (~50 per cent of mined iron ore), they have declined recently because of the ban on export of iron ore. These exports will continue to decrease and will not be significant after 2016-17 as the iron ore resource needs to be conserved to ensure availability of adequate amount of steel for the country's development.

Steel production in 2011-12 was 73 Mt (provisional estimate)[18]. Assuming the same ratio of material to be moved to finished steel produc-

18. MoS (2013).

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Table 8.14
Expected Composition of Gas Grid at End of 13th Plan (2021-22)

PIPELINE TYPE	LENGTH (KM)	CAPACITY (MMSCMD)	COMMENTS
Existing	13,508	334	Existing
Under Execution by GAIL/RGTIL	9,679	263	12th Plan
Under Upgradation by GSPL	1,220	30	12th Plan
PNGRB Bidding Rounds	7,000	243	12th Plan
AGCL/ OIL	350	6	12th Plan
New Greenfield Pipelines	4,000	150	13th Plan
Additional Pipelines through Augmentation	5,000	150	13th Plan
Additional Pipelines through Spurlines	4,500	0	13th Plan
TOTAL	**45,257**	**1,176**	

Source: MoP&NG (2012a).

Table 8.15
Estimates of Amounts of Raw Material and Steel to be Transported
[Million Tonne]

	MATERIAL	2016-17	2021-22	2026-27	2031-32
1.	Iron Ore	217	346	526	736
2.	Coking Coal	86	135	203	280
3.	PCI	11	17	41	56
4.	Non-coking Coal	39	67	82	122
5.	Scrap	15	36	78	145
6.	Others	118	188	284	398
7.	**TOTAL STEEL MAKING RAW MATERIAL (1+2+3+4+5+6)**	**486**	**790**	**1,213**	**1,737**
8.	Total Finished Steel	113	199	325	495
9.	**TOTAL RAW MATERIAL AND FINISHED STEEL (7+8)**	**599**	**989**	**1,538**	**2,232**

Source: Ministry of Steel (2012a).

Table 8.16
Modal Distribution of Raw Material Traffic between Road and Rail
[Per cent]

	RAIL		ROAD	
	RAW MATERIALS	FINISHED STEEL	RAW MATERIALS	FINISHED STEEL
Mega/Large Projects	90	70	10	30
Small & Medium Units	30	30	70	70

Source: Ministry of Steel (2012a).

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Table 8.17
Average Lead Distances for Steel and Raw Material
[Km]

IRON ORE	COAL	OTHER RAW MATERIALS	PIG IRON AND FINISHED STEEL
325	405	763	988

Source: Ministry of Steel (2012a).

Table 8.18
Estimated Railway Traffic Due to the Steel Sector

TOTAL (INDIA)	2016-17		2021-22		2026-27		2031-32	
	MT	MT-KM	MT	MT-KM	MT	MT-KM	MT	MT-KM
Iron Ore	164	53,320	262	85,142	398	129,354	557	180,978
Coking Coal	65	26,330	102	41,260	154	62,168	212	85,721
PCI	8	3,291	13	5,517	31	12,434	42	17,144
Non-coking Coal	30	12,062	51	20,633	62	24,998	92	37,323
Scrap	11	10,804	27	26,965	59	58,080	110	108,392
Others	89	68,102	143	108,736	213	162,476	301	229,663
TOTAL STEEL MAKING RAW MATERIALS (1+2+3+4+5+6)	**367**	**173,908**	**597**	**287,895**	**916**	**449,509**	**1,314**	**659,222**
TOTAL FINISHED STEEL	**68**	**67,463**	**120**	**118,806**	**196**	**194,030**	**299**	**295,522**

Source: Ministry of Steel (2012a).
Note: MT = Million Tonne; MT-KM = Million Tonne Km.

Table 8.19
Estimated Road Traffic Due to the Steel Sector
[Million Tonne]

TOTAL INDIA	2016-17	2021-22	2026-27	2031-32
Iron Ore	53	84	128	179
Coking Coal	21	33	49	68
PCI	3	4	10	14
Non-coking Coal	10	16	20	30
Scrap	4	9	19	35
Others	29	46	69	97
TOTAL STEEL MAKING RAW MATERIALS (1+2+3+4+5+6)	**118**	**192**	**295**	**423**
Total Finished Steel	45	79	128	196
TOTAL RAW MATERIALS AND STEEL (7+8)	**163**	**271**	**424**	**619**

Source: Ministry of Steel (2012a).

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Table 8. 20
Imports of Coking Coal for Steel Industry by State
[Million Tonne]

STATE	2011-12	2016-17	2021-22	2026-27	2031-32
Odisha	7.8	15.8	26.4	42.2	58.2
Chhattisgarh	4.2	8.5	14.1	22.6	31.2
Jharkhand	4.5	9.2	15.3	24.6	33.9
West Bengal	2.2	4.4	7.4	11.9	16.4
Karnataka	2.9	5.8	9.7	15.5	21.4
Tamil Nadu	1.0	2.1	3.5	5.5	7.6
Maharashtra	1.7	3.5	5.9	9.5	13.1
Andhra Pradesh	2.0	4.1	6.8	10.9	15.0
Gujarat	2.4	4.9	8.2	13.1	18.1
Other Locations	3.1	6.2	10.4	16.7	23.0
Total India	**31.8**	**64.5**	**107.7**	**172.5**	**237.8**

Source: Ministry of Steel (2012a).

tion as for 2016-17, the total raw material and steel that was moved in 2011-12 was about 390 Mt. This amount is projected to increase to 2232 Mt in 2031-32; almost a six-fold increase over the next 20 years (Table 8.15).

Currently, most of the material for large steel plants is moved by rail, and for small and medium units, by road. We have assumed this pattern holds throughout the study period (Table 8.16).

Current lead distances for raw materials and finished steel are shown in Table 8.17. While lead distances for iron ore are short, reflecting the proximity of steel plants to mines, the lead distances for finished steel are large (~1000 km) because finished steel is transported across the country. Consequently the transport requirements for finished steel in tonne-km are much higher than for raw materials. Using these numbers for lead distances, projected rail traffic for the steel industry is shown in the Table 8.18.

We have also estimated the road traffic for the steel sector in Table 8.19. As expected, road traffic is much less than rail.

IMPORTS OF COKING COAL

Much of the coking coal reserves in the country have high ash content, rendering them unsuitable for steel-making. Consequently, about 70 per cent of the coking coal required by the steel industry is currently imported. As the domestic production of coking coal is expected to remain stagnant or even decline, the share of imported coal is expected to increase to 75, 80 and 85 per cent in 2016-17, 2021-22 and 2026-27 respectively, and remain at that level for the rest of the study period[19]. Using these assumptions, the imports of coking coal have been estimated in Table 8.20.

INFRASTRUCTURE REQUIREMENTS AND INVESTMENT PLANNING FOR RAILWAYS

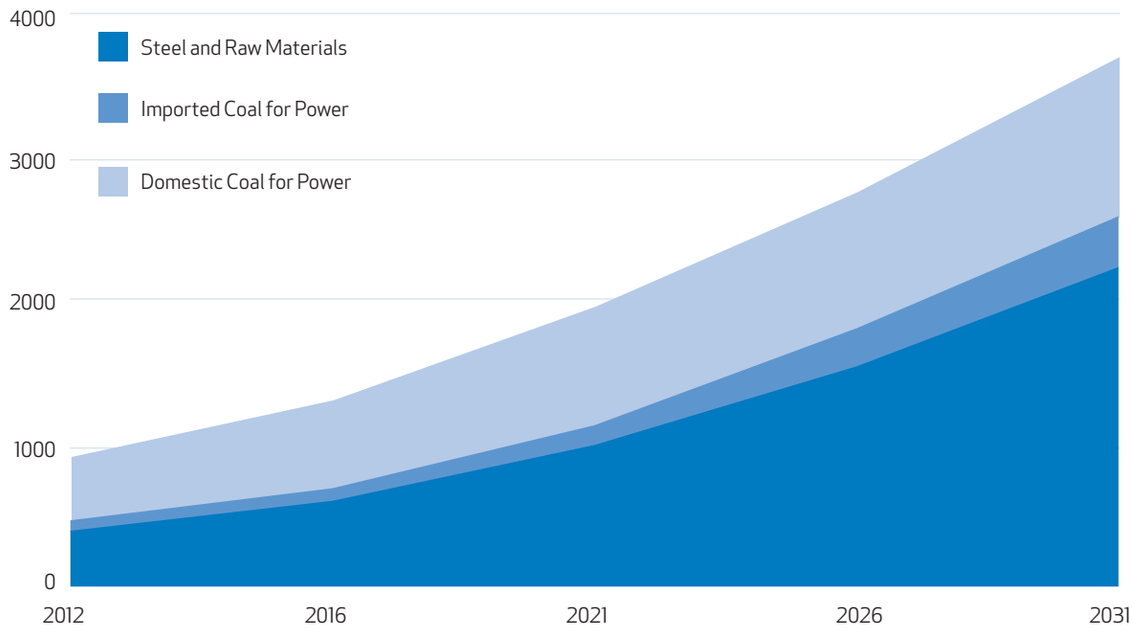
India's requirements for bulk commodities are expected to grow rapidly over the next two decades. For the power sector, coal will remain the dominant fuel even though its share is expected to decrease marginally. The use of domestic coal for the power industry will be limited by the amount that will be produced and is expected to grow by about 2.5 times. Imports of coal for the power sector however, will grow much faster; by almost five times by 2031-32.

As the intensity of steel in the economy is expected to increase, steel requirements will grow faster than the economy. By current projections, requirements for steel will grow by almost seven times. As a tonne of finished steel requires three to four tonne of raw materials, the transport requirements for steel industry will be huge. The transport requirements for the power and steel industry are expected to grow from about 900 Mt now to 3,700 Mt in 2031-32 (Figure 8.31).

19. MoS (2012).

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Figure 8. 31
Amount of Bulk Material to be Transported for Power and Steel Industries
[Million tonne]



Source: Working Group Report (2013).

Railways is one of the main modes of transport for dry bulk commodities. The rail network is already stretched to capacity with almost all the major trunk routes bearing traffic well above their designed capacity. This section assesses the additional requirements for transport of bulk commodities that will be imposed on the rail network and the upgradation required.

Transport of coal and iron ore by rail can be broadly broken up into five segments:

1. **First Mile Connectivity** where coal/iron ore is transported from the mine to the rail siding
2. **Feeder Routes at the Source End** which carry the coal/iron ore from the rail siding to the trunk route
3. **Trunk Routes** which carry the material long distances, usually between states
4. **Feeder Routes at the Destination** which move the material from the trunk route connection point to the rail siding at the destination power or steel plant
5. **Last Mile Connectivity** where the material is moved from the rail siding to the power or steel plant

It is important to ensure that each link in the transport chain from mine to power/steel plant functions effectively because the overall transport chain will be only as effective as its weakest link. Hence, we consider here all segments of the rail transport chain.

Of course, not all coal or iron ore shipments will traverse all five segments. For example, coal for power plants within a coal-producing state may be carried by a single feeder route that connects the rail siding at the mine to the power plant. First and last-mile connectivity are not usually provided by rail but are included because they are important in ensuring that coal or iron ore moves in an efficient and effective way. Poor first and last-mile connectivity can be a bottleneck in the transport of bulk material.

PATTERN OF MOVEMENT OF BULK COMMODITIES FOR THE POWER AND STEEL INDUSTRY

MOVEMENT OF COAL FOR THE POWER INDUSTRY

As transport requirements can be quite different, depending on the types of rail segments traversed, it will be useful to divide transport of domestic coal for the power sector into three categories:

1. Transport within the coal-producing states which relies mostly on road transport, MGR, conveyor belts/ropes and short rail routes
2. Transport to states neighbouring coal-producing states which takes place either on non-DFC routes or on short sections of high-density trunk routes that will later be covered by dedicated freight corridors (DFCs)
3. Transport to distant states which makes extensive use of high density trunk routes that will later be covered by DFCs

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Table 8. 21
Movement of Domestic Coal

YEAR	CONSUMPTION WITHIN SUPPLY STATES (MILLION TONNE)	CONSUMPTION IN NEIGHBOURING STATES (MILLION TONNE)	LONG-DISTANCE TRANSPORT—(EXTENSIVE USE OF DFCs) (MILLION TONNE)	TOTAL (MILLION TONNE)	SHARE OF IN-STATE CONSUMPTION (PER CENT)	IN-STATE CONSUMPTION AND NEIGHBOURING STATES (PER CENT SHARE)
Base Case						
2011-12	194	64	156	442	44	58
2021-22	429	152	212	828	52	70
2031-32	664	110	260	1112	60	70
Low Case						
2011-12	194	64	156	442	44	58
2021-22	396	140	222	828	48	65
2031-32	602	114	288	1,112	54	64
High Case						
2011-12	194	64	156	442	44	58
2021-22	443	150	184	828	54	72
2031-32	693	117	222	1,112	62	73

Source: Working Group Report (2013).
Note: For transport to neighbouring states and for long-distance transport, only the major coal-consuming states were considered. Therefore, the total in column 5 will be slightly higher than the sum of columns 2, 3 and 4.

Using the outputs of the model described earlier, Table 8.21 shows the amount of domestic coal likely to be transported in each of these categories for the three scenarios[20]. The share of in-state consumption, already at 44 per cent, could increase to 60 per cent by 2031-32 in the base case. In the low case in 2031-32, it is slightly lower at 54 per cent and in the high case it is at 62 per cent.

If we include transport to neighbouring states to get an estimate of the share of transport within the coal-producing regions, we find that the share of these categories grows to 64-73 per cent by 2031-32. These trends are consistent with our earlier finding that as the economy grows, domestic coal is used 'closer to home'. While in some cases, the regional or in-state movement may be on a short part of a dedicated freight corridor (DFC)[21], a very large portion of domestic coal will not make extensive use of DFCs.

This finding is reinforced by an analysis of how much coal is transported by the various modes. A report by PriceWaterhouse Coopers states that the share of rail is about 49 per cent, MGR is 19 per cent and road is about 26 per cent (Figure 8.32).

A similar pattern emerges when we examine the movement of imported coal. As Table 8.22 shows, the share of consumption by the coastal states reaches over 80 per cent in 2031-32 for the base and high case. It is slightly lower at 71 per cent for the low case. In such a scenario, where most of the imported coal is expected to be used close to the coast, short rail routes or conveyor belts are likely to be important.

Thus we see that a progressively greater share of coal will be used within the source and coastal states, and hence the share of shorter rail routes, road, MGR and belts/ropes will grow.

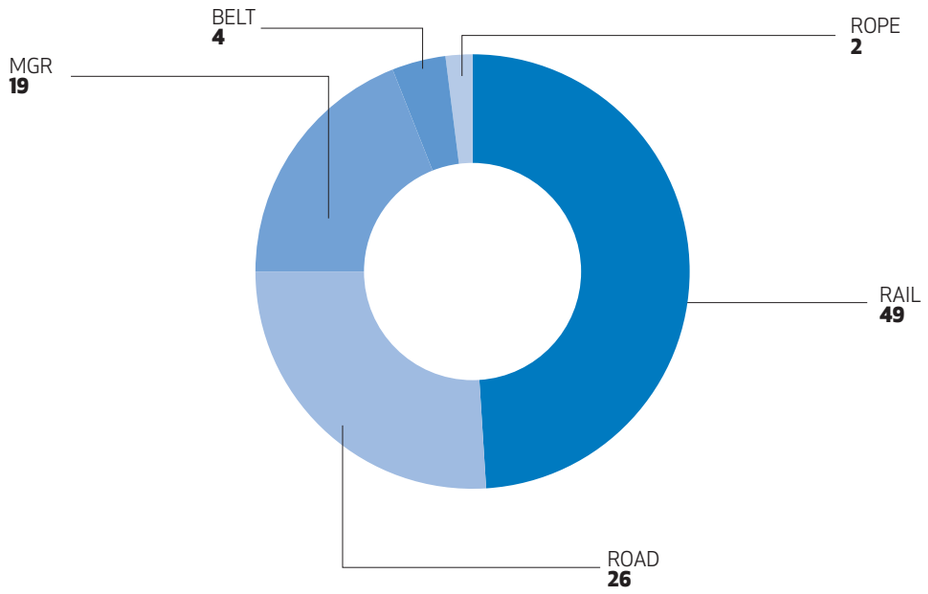
MOVEMENT OF BULK MATERIALS FOR THE STEEL INDUSTRY

The steel industry requires transport of iron ore, coking coal, non-coking coal, other raw materials such as limestone, and finished steel. Lead distances for non-coking coal and iron ore are short because of proximity of steel plants to iron ore and coal mines. Consequently, much of the movement of iron ore and non-coking coal is on short rail routes for large steel plants and by road for the smaller plants. Similarly, because of the proximity

20. These estimates are indicative. Specifying an exact route for transport of coal would require a precise origin and destination. Because the modeling exercise treated an entire state as a node, such precise identification of origins and destinations was not possible in this study. A much more detailed modeling exercise with a much higher resolution for locating power plants would be required.
21. Indian Railways has proposed the construction of six DFCs. These are discussed in more detail later in the sub-section, 'Indian Railways Plans High Density Corridors'.
22. PwC (2009).

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Figure 8.32
Share of Different Modes for Transport of Domestic Coal
[Per Cent]



Source: PwC (2009).

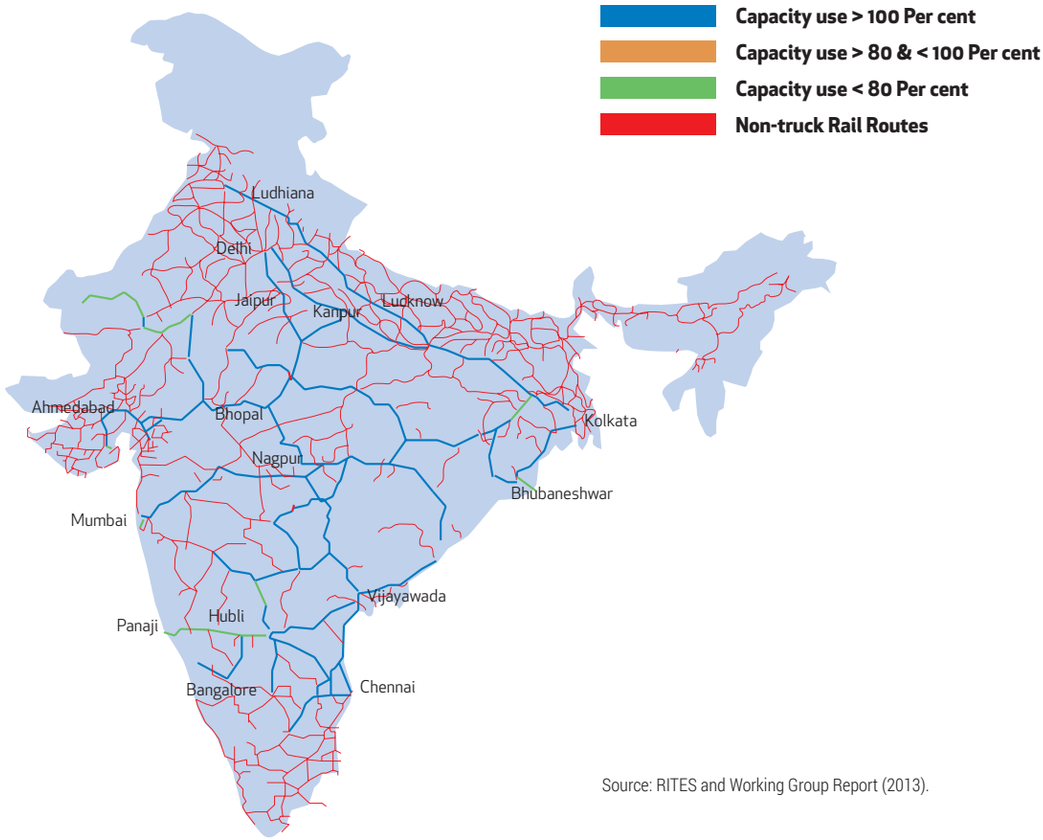
Table 8.22
Movement of Imported Coal

YEAR	CONSUMPTION WITHIN COASTAL STATES (MILLION TONNE)	ON NON-DFC ROUTES (MILLION TONNE)	LONG-DISTANCE TRANSPORT—EXTENSIVE USE OF DFCS (MILLION TONNE)	TOTAL (MILLION TONNE)	COASTAL STATES CONSUMPTION (PER CENT SHARE)
BASE CASE					
2011-12	53	0	14	73	73
2021-22	119	0	19	138	86
2031-32	293	0	59	355	82
Low Case					
2011-12	50	0	8	61	83
2021-22	26	0	1	27	96
2031-32	43	0	18	61	71
High Case					
2011-12	54	0	15	76	72
2021-22	131	0	25	158	83
2031-32	382	0	75	460	83

Source: Working Group Report (2013).
Note: For the routes covered by DFCs and non-DFC routes, only states which consumed more than 3 Mtpa of imported coal were considered. Therefore, the total in column 5 will be slightly higher than the sum of columns 2, 3 and 4.

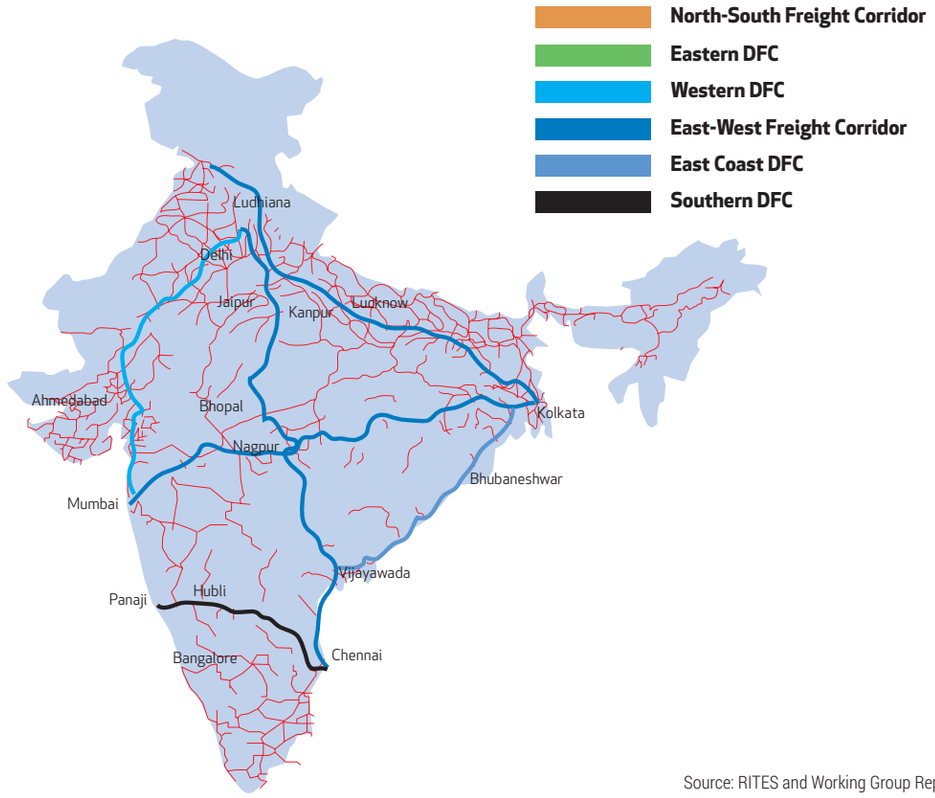
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Figure 8.33
Major Rail Routes for Transport of Bulk Commodities



Source: RITES and Working Group Report (2013).

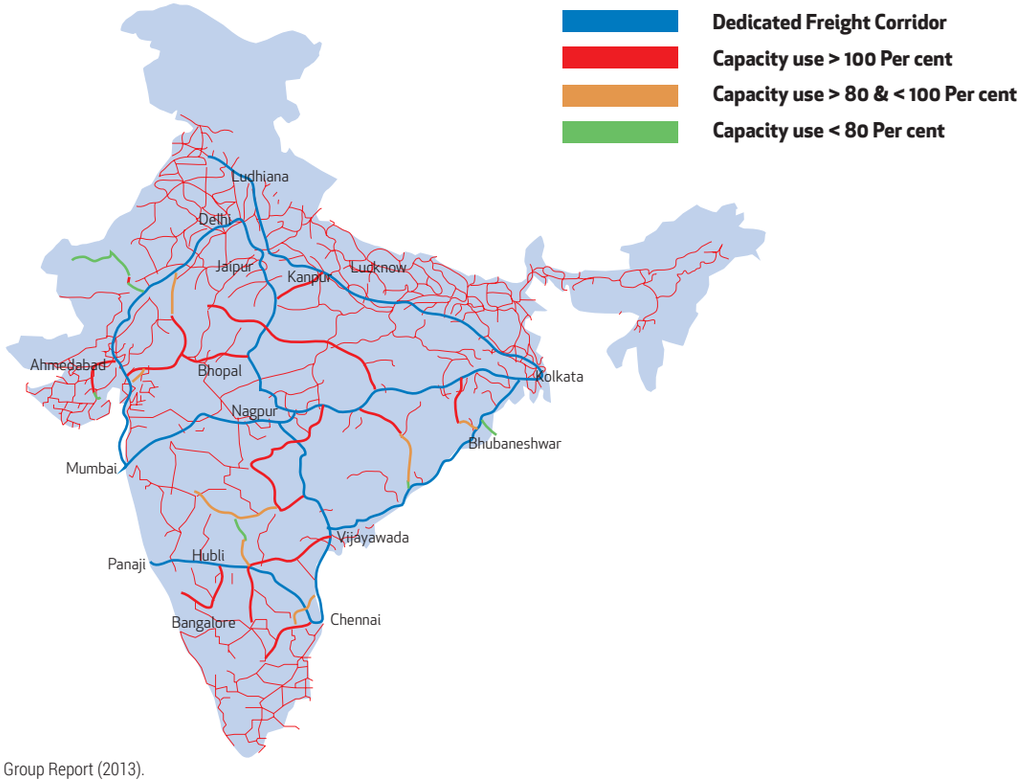
Figure 8.34
DFC Routes



Source: RITES and Working Group Report (2013).

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Figure 8.35
Impact of DFCs on Trunk Routes



Source: RITES and Working Group Report (2013).

of the ports which receive coking coal imports, the lead distances for imported coking coal are short and transport is on short rail routes for large steel plants and by road for smaller steel plants. Finished steel is transported across the country and its effect is diffused throughout the network. So, its effect on specific routes may not be so significant, and hence is not covered here.

TRUNK RAILWAY ROUTES

STATUS OF RAIL ROUTES

Figure 8.33 shows the main rail routes that transport over 80 per cent of coal, iron ore, iron, steel, limestone and dolomite. We also examined the level of capacity utilisation for the sections of the routes. A section reaches 'saturation' if the capacity utilisation is greater than 80 per cent. Therefore, we have divided the sections that comprise these routes into three categories: where the capacity utilisation is (1) less than 80 per cent (green); (2) between 80 per cent and 100 per cent (yellow); and (3) greater than 100 per cent (red).

Almost all the sections on the map in Figure 8.33 are blue, implying that almost all sections on the major routes are operating at capacity utilisation greater than 100 per cent. So, almost all bulk commodity routes face major delays due to congestion. This is particularly relevant for transport of coal over long distances which makes extensive use of the high density network, and for transport within coal-bearing states and to neighbouring states, as some of this transport may occur over short sections of these trunk routes.

INDIAN RAILWAYS PLANS HIGH DENSITY CORRIDORS

Indian Railways recognised the problem several years back and has proposed construction of dedicated freight corridors (DFCs), shown in Figure 8.34. Six DFCs totaling 9,538 km have been proposed:

(a) Western DFC (Delhi-Mumbai) 1,534 km.
(b) Eastern DFC (Ludhiana-Kolkata) 1,839 km.
(c) East West DFC (Howrah-Mumbai) 1,976 km.
(d) East-Coast DFC (Kharagpur-Vijaywada) 1,097 km.
(e) South DFC (Chennai-Goa) 902km.
(f) North South DFC (Delhi-Chennai) 2,190 km.

Of these, the first two are already under construction and pre-feasibility studies have been carried out for the others. Figure 8.35 shows the impact of the DFCs on the trunk routes for the transport of bulk commodities. While many of the sections will no longer be congested (blue), there will still be some, shown in red and yellow, that will be congested and will require capacity augmentation.

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Table 8. 23

Expected Long Distance Movement of Domestic and Imported Coal on DFCs for the Power Sector

[Million Tonne]

YEAR	EASTERN	WESTERN	EAST-WEST	NORTH-SOUTH	EAST COAST	SOUTHERN	TOTAL—ON ROUTES COVERED BY DFCs
Base Case							
2012	88	6	23	30	22	0	170
2021	124	14	57	23	13	0	231
2031	211	30	30	33	15	0	319
Low Case							
2012	88	6	23	30	22	0	170
2021	99	1	62	36	25	0	223
2031	207	9	78	0	12	0	306
High Case							
2012	88	6	24	30	22	0	171
2021	105	18	60	23	3	0	209
2031	212	31	37	8	8	0	297

Source: Working Group Report (2013).

SCHEDULE FOR DFCs

The Western DFC and Eastern DFC are under construction and scheduled to be completed by 2017. The other four DFCs have been proposed. Not yet approved, they could be completed earliest by 2023.

Table 8.23 shows the approximate volumes of domestic and imported coal likely to be transported over long distances on DFCs. Movement of coking coal is not included because most of it occurs within iron ore-rich states.

In the next decade, about half the long-distance transport of coal will take place on the Eastern DFC. By 2031-32, it will account for two-thirds. The Western DFC will carry imported coal mostly from Gujarat to the Northern and North-Western states. The East-West, East Coast and North-South DFCs will carry about the same amount of coal as one another but much less than the Eastern DFC. The Southern DFC is expected to carry almost no coal.

Therefore, for long distance transport of coal the Eastern DFC is far more important than the others and it should be given the highest priority. The traffic on the Eastern DFC will be highest closest to the coal-fields and will decrease as coal is unloaded at successive states on the route to the farthest state. This would also apply to the other DFCs. Another reason for focusing on the Eastern end of the DFCs is that transport of coal within coal-producing states and to neighbouring states is likely to use sections of DFCs that are short but the volume of traffic can be high. Almost all the use of short sections of DFCs will occur in the eastern part of the country.

Given the size of the DFC projects and the associated challenges, delays are possible, particularly in the remaining four which await approval. Given the time it will take to make the DFCs operational, even if there are no delays, the traffic will grow and some short-term augmentation will be required. Otherwise, the existing infrastructure will be strained to breaking point. This situation doubles the challenge because short-term measures are needed along with long-term. Given the limited resources, creative solutions will need to be found to ensure that there is no unnecessary duplication of efforts and expenditure. It could be that the augmentation will support increase in passenger traffic on these corridors once freight shifts to the DFCs.

RAIL FEEDER ROUTES AT MINES AND PLANTS

Feeder routes are critically important for the effectiveness of the bulk transport system, particularly at the source end, because they bring the material (coal or iron ore) up to the trunk route that then carries it to its destination. Inadequate transport capacity on these routes will have wide repercussions for the power and steel industry.

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Table 8. 24
Critical Feeder Routes for Coal

RAIL LINK	DISTANCE (KM)	COST (MILLION RS)	START YEAR	INITIAL PROJECTED END-DATE
North Karanpura Coalfield – JH, Tori-Shivpur-Hazaribagh, New BG line	92	6,210	2000	31 DECEMBER 2012
North Karanpura Coalfield – JH, McCluski-ganj-Piparwar New BG line	30.5	1,420	1990	SEPTEMBER 2011
Mand-Raigarh Coalfields – CH, Bhupde-opur-Baroud-Durgapur	91	31,,00	Approved	MARCH 2018
Ib Valley Coalfield – Odisha, Barpali-Jhar-suguda-Gopalpur- Manoharpur Tract	52.4	4700	2006	31 MARCH 2012
Talcher Coalfield – Odisha, Jarpada-Angul - Talcher Rail Corridor	87	To be estimated	To be approved	NA
Talcher Coalfield – Odisha, Radhikapur West Block – Angul Rail Corridor	50	To be estimated	To be approved	NA
Talcher Coalfield – Odisha, Talcher – Dhamra Port via Bhadrak[23]	150	To be estimated	To be approved	NA
Singareni Coalfield – AP, Bhadrachalan Rd – Sattupalli	52	3,600	To be done on PPP basis	NA
TOTAL	**605**	**35,100**		

Note: For the purpose of calculating total costs for routes where costs are yet to be estimated, it was assumed that the cost would be the average cost of the other routes in Rs million/km.
Source: Ministry of Coal (2012).

Feeder routes at the destination end bring the material from the trunk route to the destination plant. They are not much of a problem because the transportation capacity required for a single plant is comparatively low. However, power plants in coal-producing states are likely to come up in clusters of about 4000 MW at locations not yet known, and are likely to require new rail lines directly from mines.

FEEDER ROUTES AT MINES

Most of the increase in coal production is expected to come from three regions: (1) Talcher and Ib Valley coalfields in Odisha with a potential increase of 110 Mtpa by 2031-32; (2) North Karanpura coalfields in Jharkhand with a potential increase of 75 Mtpa; and (3) Mand-Raigad coalfields in Chhattisgarh with a potential increase of 90 Mtpa. Table 8.24 gives a list of the critical routes in these areas. Early implementation and completion of these rail connectivity projects is important if the need for domestic coal for power is to be met in the coming two decades. As the table shows, some action has been taken by the Railways on several of these projects but much more needs to be done.

For example, the project to construct a new broad gauge line for the North Karanpura coalfield from McCluskiganj to Piparwar was started way back in 1990. IRCON was awarded the contract but it left the job in 2002. Another five years went by before RITES was hired to complete the work. The new completion date was September 2011 but the work is still on. The Tori-Shivpur-Hazaribagh line, also in North Karanpura coalfield, was started in 2000 and had a scheduled completion date of end of 2012 but only 410 million of the Rs 1,500 million payment made to the Railways has been utilised. The 40-km single line rail corridor between Angul and Talcher is mostly complete but has been held up because of land acquisition issues for a 4-km stretch.

On the other hand, there are several projects such as the extension of the Bhupdeopur-Baroud-Bijari-Durgapur double line which have not even been started. For some of them, even cost estimates have yet to be made.

As Table 8.24 shows, the combined length of these links is about 600 km, estimated to cost Rs 35 billion.

23. The new line, Angul-Sukinde, has been sanctioned. The Sukinde-Bhadrak line exists but if a new line is required, then approval will be needed.

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Table 8. 25
Critical Feeder Routes for the Iron and Steel Industry

STATE	NAME OF THE PROJECT	DISTANCE (KM)	COST IN RS MILLION (2011-12)
	NEW LINE		
Odisha	Angul-Sukinda Road (Suppl.)	99	6,390
Jharkhand	Hansdiha-Godda	30	2,670
Andhra Pradesh	Bhadrachalam Road-Sattupalli	56	3,380
Chhattisgarh	Dallirajahara-Jagdalpur	235	11,050
Tamil Nadu	Attipattu-Puttur	88	4,470
Karnataka	Kottur-Harihar via Harpanhalli	65	3,540
Karnataka	Hubli-Ankola (Suppl.)	167	3,380
	DOUBLING		
Odisha	Sambalpur-Titlagarh	182	9,510
Odisha	Sambalpur-Talcher	174	6,790
Odisha	Banspani-Daitari-Tomka-Jakhapura (Suppl.)	180	9,430
Odisha	Barbil- Barajamda	10	525
Odisha	Bimalgarh- Dumitra	18.3	1,157
Odisha	Banspani-Jaruri	09	910
Odisha	Champajharan- Bimalgarh	21	1,511
Odisha	Brundamal-Jharsuguda flyover connection to join DN Line (Suppl.)	-	880
Andhra Pradesh	Vizianagram-Kottavalasa 3rd line	35	1,950
Chhattisgarh	Sailari-Urkura	25	730
Chhattisgarh	Kirandul-Jagdalpur	150	8,270
	Raipur-Titlagarh incl. NL Mandi Hasaud-Naya Raipur (20 km) and new MM for conversion of Raipur (Kendri)- Dhamtari & Abhnapur-Rajim branch line(67.20 km)	270	6,920
Maharashtra	Chandrapura-Rajabera-Chandrapura-Bhandaridah	11	350
Bihar	Kajra-Kiul (Suppl.)	16	480
Jharkhand	Barharwa-Tinpahar	17	750
Jharkhand	Rajkharsawan- Sini- 3rd line	15	916

(Contd...)

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STATE	NAME OF THE PROJECT	DISTANCE (KM)	COST IN RS MILLION (2011-12)
Jharkhand	Sini- Adityapur 3rd line	22.5	953
Jharkhand	Bhojudih- Mohuda	23	1,342
Jharkhand	Goelkera- Manoharpur 3rd line (Chakradhpur- Bondamunda Section)	40	2,717
Jharkhand	Dongaposi- Rajkharsawan 3rd line (Suppl.)	75	3,094
Jharkhand	Tinpahar-Sahibganj as PH-I of doubling of Tinpahar-Bhagalpur	38	1,680
Jharkhand	Sahibganj-Pirpaniti	11	1,300
Jharkhand	Padapahar- Banspani	32	1,553
West Bengal	Rajgoda-Tamluk-Phase-II of Panskura-Haldia Doubling	13.5	869
West Bengal	Panskura-Kharagpur 3rd line (44.7km) with new MM Panskura - Ghatal(32.8 km) NL 11-12	77.5	5,292
West Bengal	Chinpai-Sainthia, Prantik-Siuri	32	5,960
West Bengal	Gokulpur- Midnapur New Bridge on diversion alignment with substructure & steel super structure on Bridge No,143	2	521
Chhattisgarh	Salkar Road-Khongsara Patch Doubling	26	1,439
Chhattisgarh	Khodri- Anuppur with flyover at Bilaspur	61.6	3,855
Chhattisgarh	Bypass at Champa	14	376
TOTAL		**2,341.4**	**117,413**

Source: Ministry of Coal (2012).
Note: For the purpose of calculating total costs for routes where costs are yet to be estimated, it was assumed that the cost would be the average cost of the other routes in Rs million/km.

The Railway Plan in the 12th Plan has been estimated at Rs 5,200 billion[24]. The amount required for these critical feeder routes for coal is about 0.7 per cent of the total Railway Plan. Given that these links are essential for the transport of the most of the additional coal that is going to be produced in the coming two decades and the relatively low investment required, these links must be given top priority and be completed within this Plan.

Listed in Table 8.25 are rail connectivity or capacity augmentation projects for the iron and steel industry that are awaiting completion.

The combined length of these links is about 2,340 km and the total cost is estimated at Rs 117 billion, about 1.7 per cent of the total Railway Plan for the 12th Plan. As with the critical feeder routes for coal, these links are essential for the transport of iron ore. They must be given top priority and be completed within this Plan for the unhindered growth of the iron and steel industry. They should be designed to handle 25-30-tonne axle load so that the capacity of the lines is effectively increased.

The major reasons for the delays in providing these links are[25]:

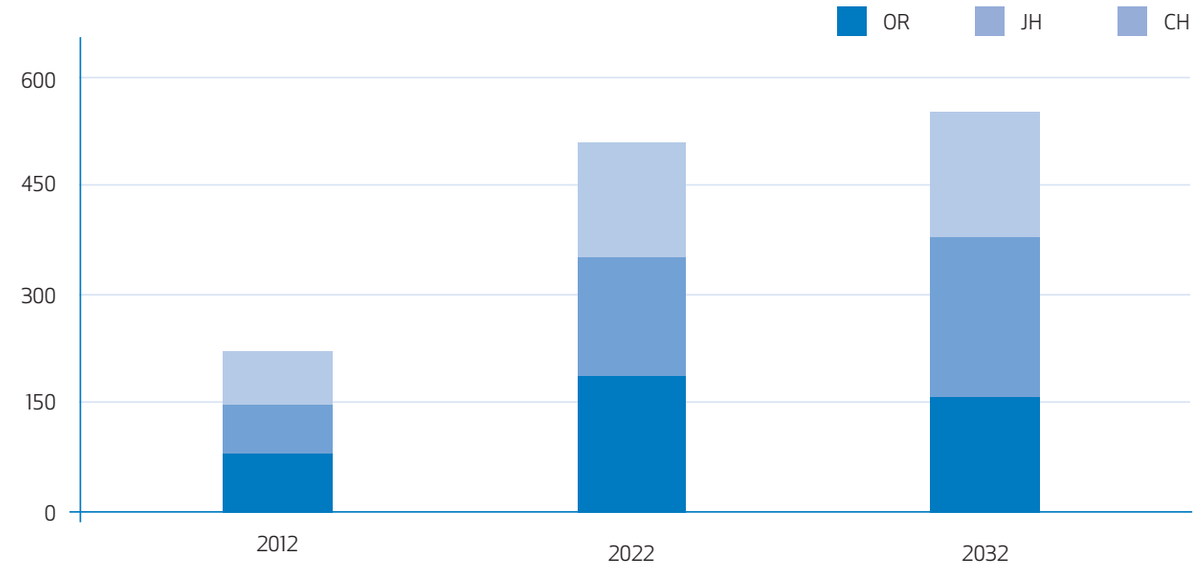
- Difficulties in acquiring land and delays in clearances
- Projects are initiated only if they meet stringent requirements of guaranteed minimum traffic to enable Railways to earn a minimum return on its investments. Private participation by steel plant owners may be one way to solve this problem.
- Rail projects have a long gestation period and more advance planning needs to be done so that railway infrastructure grows as there is economic growth in the region.

These critical feeder routes should be completed as soon as possible.

24. Bansal (2013).
25. MoS (2012: 15).

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Figure 8.36
Coal Production from Tri-State Region
[Million Tonne]



Source: Working Group Report (2013).

FEEDER ROUTES TO POWER PLANTS

In-state consumption of coal for power is likely to increase and much of this new capacity will come up in clusters of about 3000-4000 MW each. Such power plants will need to be located not only near coal mines but also near sources of water. It is difficult to predict where these clusters of power plants will come up. In any case, feeder routes from the mines to the power plants will need to be provided. These links will be 70-100 km long and will be required to carry about 20 Mtpa[26]. They should be designed for heavy-haul technology where a rake per day carries 4 Mtpa. Some of these feeder routes may overlap, to some extent, with each other or the feeder routes that bring coal from the mine to the trunk route.

Consumption of domestic coal within coal-producing states is expected to grow at about 24 Mt per year. Assuming that half of this will be used in power plant clusters and the other half in pit-head plants, roughly one such feeder route to a cluster of power plants will be required every other year. Given that most of the increase in production of coal is expected to occur in the tri-state region of Odisha, Jharkhand and Chhattisgarh, about one such feeder route will be required in each of the three states every six years.

NEED TO FOCUS ON TRI-STATE REGION OF ODISHA, JHARKHAND AND CHHATTISGARH

As Tables 8.24 and 8.25 show, most of the critical feeder routes lie in Odisha, Jharkhand and Chhattisgarh as steel plants and mineral resources, particularly coal and iron ore, are concentrated in these states. In spite of the importance of these states, the development of the rail network has been inadequate.

These states produce more than half of the domestic coal used in the country and are expected to produce about two-thirds of it by 2032 (Figures 8.36 and 8.37). In addition, a quarter of the country's steel production is going to be located in Odisha by 2016-17, a share that will remain constant for the next two decades. Together, these states will have more than half the steel capacity of the country.

PRIVATE PARTICIPATION IN RAIL CONNECTIVITY PROJECTS

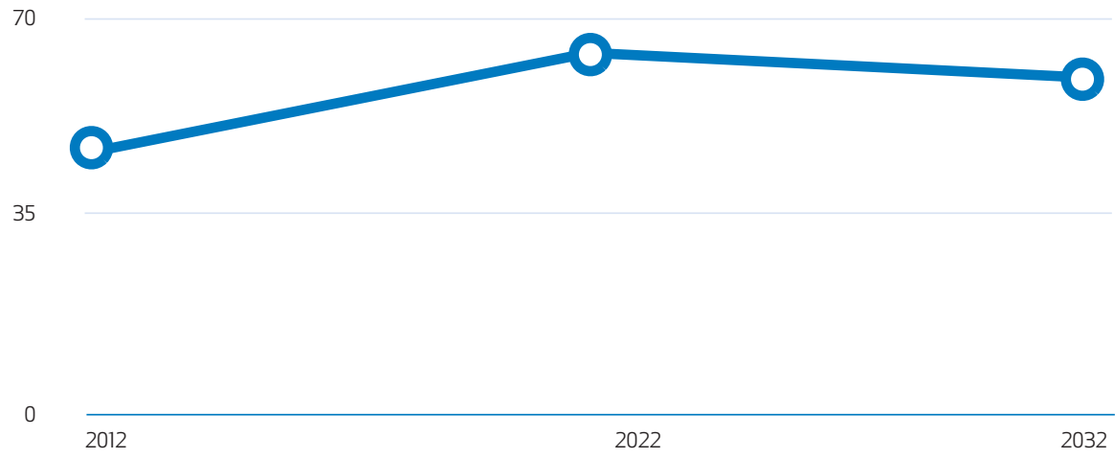
While the need for rail connectivity for previously unconnected areas is growing, Railways faces resource constraints to fulfill these demands. Therefore, Indian Railways has been working on ways to attract participation of the private sector, to provide an alternative source of funding. The first policy was Railways' Infrastructure for Industry Initiative (R3i) issued in July 2010, but it was not applicable to lines from coal and iron ore mines. In February 2011, Railways introduced a second policy, Rail Connectivity to Coal and Iron Ore Mines (R2CI). More recently, on 10 December 2012, the Cabinet Committee on Infrastructure approved a new policy on participative models for rail connectivity and capacity augmentation. This supersedes R3i and R2CI.

IR has formulated five participative investment models for its existing shelf of projects and for new projects[27]:

26. A 1000 MW power plant requires about 5 Mtpa of domestic coal.
27. MoR (2012).

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Figure 8.37
Contribution of Tri-State Region to National Coal Production
[Per Cent]



Source: Working Group Report (2013).

1. **Non-Government Railway Model** is designed for developing feeder routes at source and destination. The project developer is responsible for land acquisition, project development and construction with no financial input by IR. The project developer will be paid 95 per cent of the net income from the project.
2. **JV Model** for operationally necessary/bankable sanctioned/to be sanctioned railway projects. This model is for bankable new line or gauge conversion projects that have clearly identifiable stakeholders such as users of the line or ports, mines, exporters, plants or state governments. The JV will include the Railways and these stakeholders. The JV will get a portion of the freight revenue.
3. **Railway Projects on BOT** awarded through competitive bidding, where the viability gap funding required would be the bidding parameter. This model is designed for cases where it may not be possible to identify stakeholders who will take the lead in making investments. An example is a long rail corridor where revenue is generated from multiple streams. Here the concessionaire will provide the funding and will be paid a user fee based on 50 per cent of the apportioned freight.
4. **Capacity Augmentation with Funding Provided by Customers.** This model is for those cases where some potential beneficiaries of a capacity augmentation project (doubling, multiple lines, etc.) are willing to fund the project in order to expedite it. The funds with associated interest will be returned to the customers through rebate on freight charges.
5. **Capacity Augmentation with Annuity.** This model is for cases where it is not possible to get funding from a specific user. Here, the concessionaire would be paid through an annuity.

State governments can participate in any of these models. If they participate through the first and second models, they can bid out the projects.

The five cases cover most of the circumstances under which private investment could accelerate the development of rail infrastructure. IR will remain a key player even with private participation, carrying out the following functions. Success of the new PPP policy will depend on how well IR is able to execute these functions.

- Certification of the lines in all cases, and in some cases even supervision of the construction.
- Supervision and certification of the maintenance of the lines.
- Operation of the rail network with its rolling stock.
- Collection of freight charges and disbursal of payments to the private parites as per the terms of the specific agreement.

Large integrated producers of steel or large mining companies can enter into these PPP arrangements, but smaller parties may find it difficult to do so. Institutional mechanisms will need to be developed to facilitate coordination among SMEs and large firms in the same area to pool their resources to create common infrastructure[28].

28. MoS (2012).

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FIRST MILE CONNECTIVITY

ROAD CONNECTIVITY FROM MINE TO RAIL SIDING

Coal and iron ore are generally transported from mines to the nearest rail siding by road. In many cases the evacuation of material is hampered by the following factors: (1) lack of adequate and appropriate material handling infrastructure at the mine and at the rail siding; (2) inadequate road capacity from the mine head to the railway siding; (3) occasional shortage of railway rakes.

Evacuation of coal and iron ore is hampered by lack of adequate and appropriate material handling infrastructure at the mine and at the rail siding; inadequate road capacity from the mine head to the railway siding; occasional shortage of railway rakes.

Efforts are being made to augment material loading and unloading facilities and increase road transportation capacity. The shortage of rail rolling stock is often a seasonal issue which is exacerbated by congestion on the lines. As capacity constraints are removed, it will also mitigate the shortage of rolling stock to some extent. Creation of road infrastructure takes time. Advance planning, though rarely done, is essential to develop the required roads for movement of coal from mine-heads to rail-heads. It has also been suggested that the existing fair-weather roads in high-growth coal fields, particularly where captive coal blocks are expected to become operative, be converted into all-weather express coal corridors[29].

Due to the poor quality of road transportation, the loading at rail sidings shows an annual pattern: it peaks during winter and declines during summer and monsoon. The mine company is unable to utilise the rail capacity optimally, and the unused capacity is lost. Railways estimates that the drop in loading results in a loss of about 50 rakes per day for a substantial part of the year[30].

Further, because the coal from the mines in the traditional coal fields has to be moved through heavily-populated villages, and is vulnerable to blockage and other disturbances due to socio-political events, the following suggestions have been made about transportation from mine-heads to rail-heads[31].

1. Wherever possible, long-distance conveyor belt systems should be used. This will reduce the environmental impact of road transport.
2. Siding rationalisation plans should be developed.
3. Coal mining companies should consider developing a hub-based system for transporting coal from existing mines wherever feasible.

MERRY-GO-ROUND (MGR) SYSTEMS

Most pithead plants, particularly the large ones, get their coal using merry-go-round (MGR) systems. Almost 20 per cent of the country's domestic coal is transported by MGR. As a greater percentage of coal will be used within the producing state, the share of movement by MGR will grow. Therefore, it is important that this mode of transport is also efficient.

Sometimes there is a delay in the development of the mining and the MGR system, and the power plant is completed before one of the two is functional. In such cases, as a stop-gap measure, coal is brought from another location in case of delay in the mine. Or Indian Railways is asked to transport coal from the mine in case of delay in the MGR system. Such stop-gap arrangements become difficult to get out of due to socio-political reasons. Therefore, synchronisation between the development of the pithead power plant and the mine and transport system is critical[32].

In addition, Indian Railways states that often pithead plants with MGR require augmentation of their coal supplies by Indian Railways. But often the MGR systems are not designed for handling rakes from outside[33]. This results in delays. When pithead plants are proposed in the future, the MGR systems should be designed to handle rakes from the Indian Railways. Indian Railways can operate the MGR systems at lower cost because of its expertise on rail systems[34]. Therefore, it is suggested that Indian Railways be involved as a partner in the running of MGR systems.

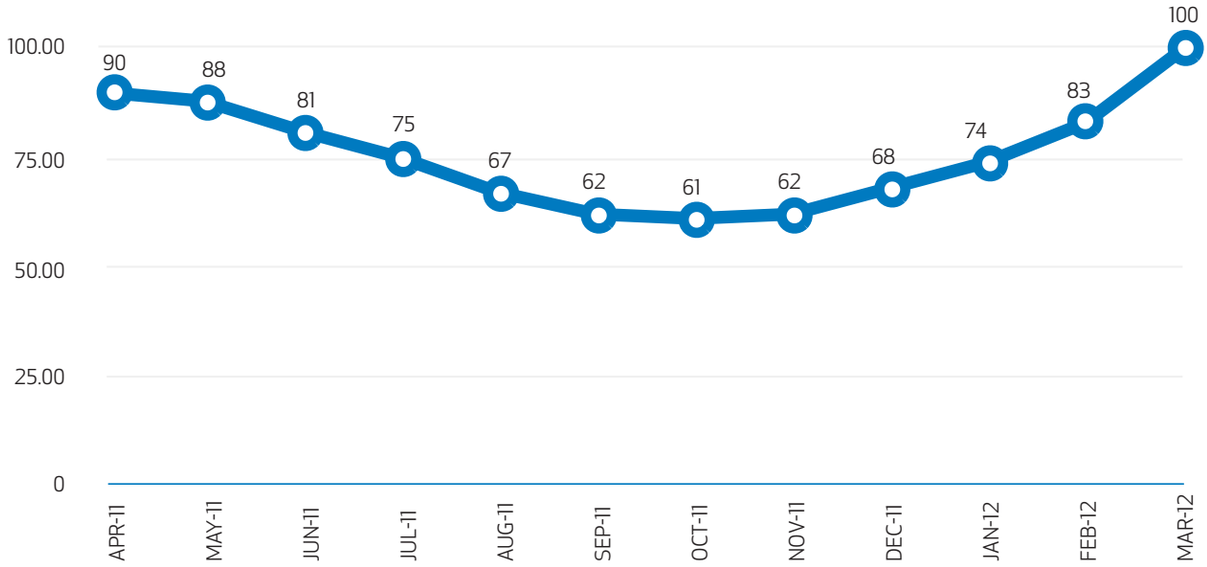
LAST MILE CONNECTIVITY

Transport of unsized coal sometimes results in delays in unloading, especially of bottom discharge wagons, because large pieces get stuck. Sizing of coal before dispatch would avoid this problem and ensure faster unloading of rakes. It would also increase the carrying capacity of wagons through better compaction. Sometimes there are delays in unloading because the material handling system at the receiving power plant cannot handle all types of wagons. Either a power plant should be designed to handle a particular type of wagon and only that type of wagon should be sent to that power plant, or all power plants should be capable of handling all types of wagons—bottom discharge, tippler, etc. While the first option may be more economical from the perspective of the power plant, it may not be feasible, given the limited rolling stock available with the Railways. In either case, the turnaround time of rakes at power plants would be greatly improved.

29. MoC (2011).
30. Roy (2012).
31. MoC (2011).
32. Ibid.
33. Roy (2012).
34. Ibid.

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Figure 8.38
Month-Wise Pit-Head Closing Stock of Coal in 2011-12
[Per Cent]



Source: Coal Controller's Organisation (2012a).

There is also a need to improve the bunker, conveyor belt and stacking capacities at power plants. As the tonnage per train discharged at the power plant increases, bunkers will need to be emptied and their content stored at the power plant site. Otherwise, overfull bunkers will become a bottleneck slowing down the unloading of trains. Therefore, additional stacking capacity will be required.

BUILD-UP OF COAL STOCKS AT PITHEADS

There has been concern about the build-up of coal stocks at the pitheads of mines awaiting transportation while, ironically, there is a shortage of coal at many power plants[35].

Coal production and road transportation to rail sidings follow a pattern over the year where they peak during the winter months and decline during the summer and monsoon season. Railways is unable to meet this wide variation in demand and consequently pithead stocks peak in the winter months and decline in the summer and monsoon months (Figure 8.38).

Pithead stocks are the cumulative effect of a mismatch between production and the amount transported by Railways.

About 45[36] Mt of coal is lying at pitheads[37]. Such an annual build-up indicates that there is no spare capacity in the rail transport system. It is an early warning that the rail network or the amount of rolling stock or both are operating at their full capacity.

Currently we are at a low-level equilibrium where production of coal is not increasing or is increasing very slowly and the transport system is almost able to keep up. But if the amount of coal produced at the mines increases, as would be desirable, then there may not be sufficient capacity in the transport system to move that coal to power and steel plants. The transportation system will become a bottleneck, blocking the value of increased production from benefitting the economy.

RAIL EFFICIENCY AND TECHNOLOGY IMPROVEMENTS

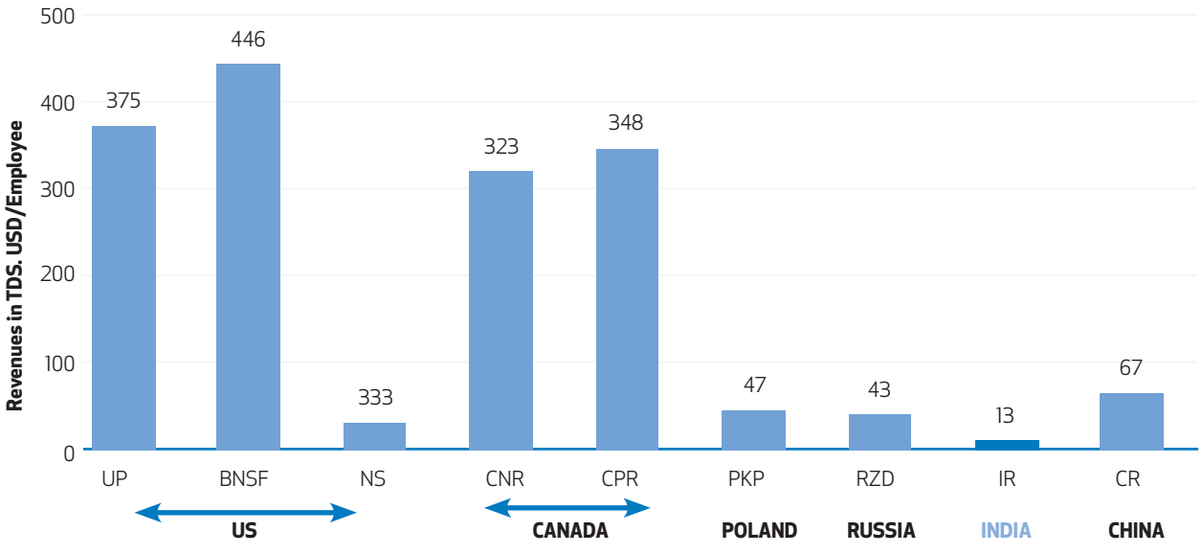
Freight transportation in India is far less efficient than in other countries. Figures 8.39 and 8.40 compare two indicators of efficiency of India with a peer group of countries. India's staff efficiency, measured in revenues per employee, is the lowest. It is only $13,000 per employee compared with the best of $446,000 per employee. Wagons in India provide transportation of 2.4 Mt-km per year, much lower than the best of about 12.4 Mt-km.

Transportation cost is a large fraction of the price that the customer pays. For states that are far from coal mines, rail transportation can often be more than the price of coal at the mine-mouth, effectively more than doubling the cost of fuel for power plants.

35. Business Today (2012).
36. This number is the minimum stock and is about 60 per cent of the maximum pithead stocks reported for 2011-12. For a year-by-year comparison of pithead stocks, we think that the minimum stock for the year is a more appropriate measure of the annual mismatch between transportation requirement and capacity.
37. Working Group Report (2013).

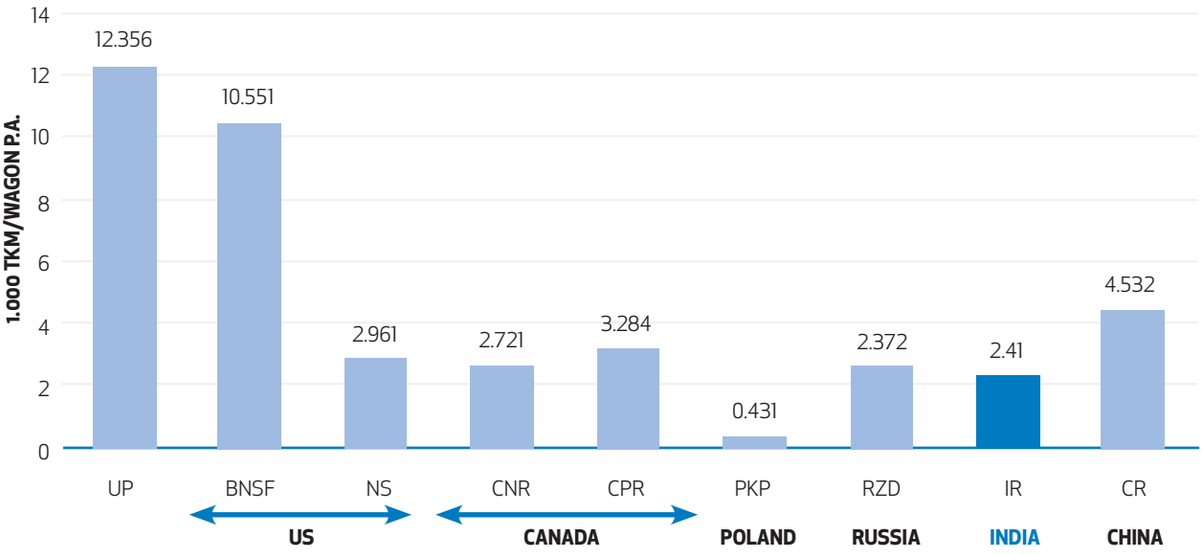
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Figure 8.39
Comparison of Staff Efficiency of Railways in Select Countries



Source: Jahncke (2012).

Figure 8.40
Comparison of Wagon Efficiency in Select Countries



Source: Jahncke (2012).

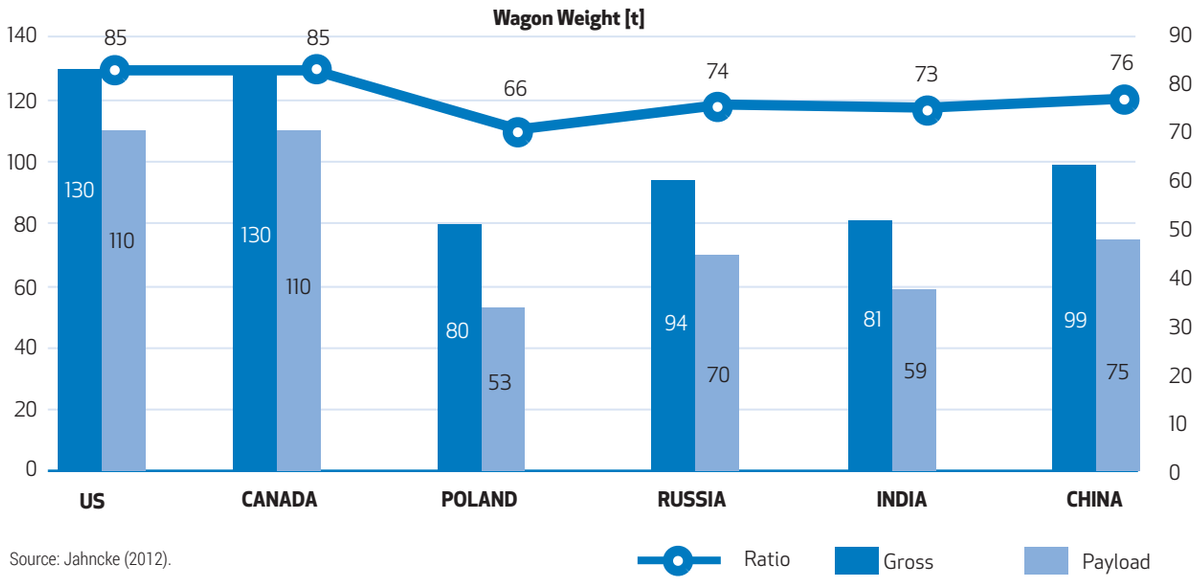
Therefore, it is important that the transport cost be kept low. Furthermore, the Railways' main competitive advantage is its lower cost. It must keep costs low or its market share will erode even faster than it already is.

Transportation costs per tonne can be lowered by using well-loaded trains with a high net weight to gross weight ratio. Indian trains are comparable on most loading parameters with trains in Poland, Russia and China but not with trains in US and Canada. For example, Figure 8.41 shows that Indian wagons have a net to gross ratio of 73 per cent which is significantly lower than the world's best of about 85 per cent. This means that Indian wagons are spending a larger fraction of fuel to carry the weight of the wagon itself. Further, the Indian trains, with a maximum length of 680 metre, are much shorter than trains in the US and Canada which can be as long as 2.5 to 3 km (Figure 8.42). The problem is compounded by the

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Figure 8. 41

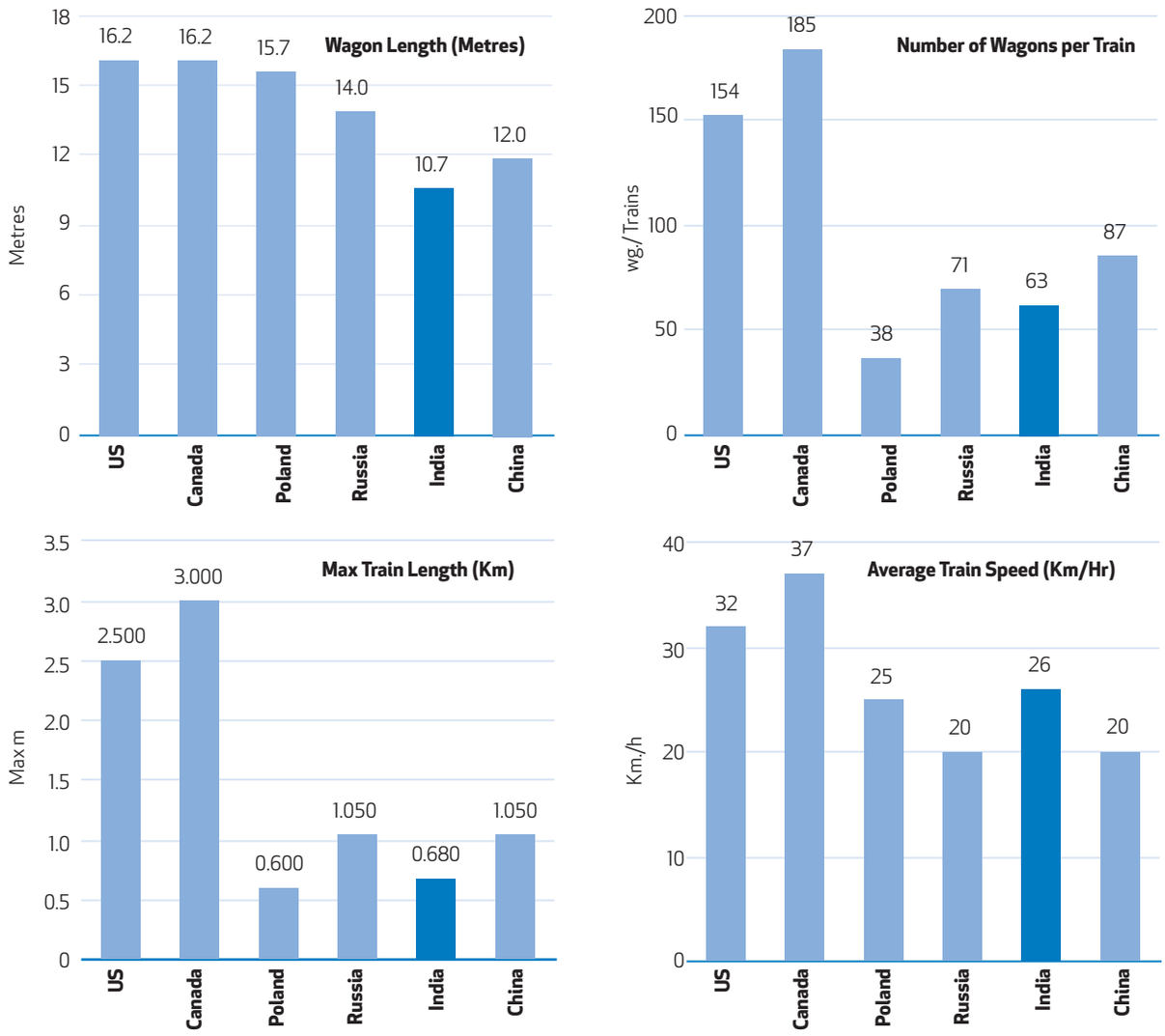
Comparison of Wagon Weight and Payload to Gross Weight for Select Countries



Source: Jahncke (2012).

Figure 8. 42

Country-Wise Comparison of Components of Loading Level of Trains



Source: Jahncke (2012).

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Table 8. 26

Required Investment in Rolling Stock and Terminals to Carry Additional Bulk Materials

CATEGORY OF INVESTMENT	12TH PLAN	13TH PLAN	14TH PLAN	15TH PLAN
Increase in thermal coal transported by end of each FYP (Million tonne)	187	264	251	250
Increase in iron ore transported by end of each FYP (Million tonne)	77	129	180	210
Increase in coking coal transported by end of each FYP(Million tonne)	30	49	68	77
Total increase in bulk material transported by end of each FYP (Million tonne)	294	442	499	537
Required investment in rolling stock and terminals (Rs Billion)	441	663	749	806

Note: It is assumed that each additional Mtpa to be carried will require investment of Rs 1500 million (For details see Annex III. 6.2 of the Working Group Report 2013).

lower average speed of Indian trains (26 kmph) compared to the speeds in US and Canada (32-37 kmph)[38].

Indian Railways is planning to address these issues. The report of the Working Group on Railways for the 12th Plan discusses a strategy of 'heavier, longer, faster' which includes the following measures[39]:

- Use of 25-tonne axle load wagons for iron ore, and planning for 30-tonne axle load
- Moving overall regime from 22.8 tonne to 23.5 tonne axle load.
- Greater use of long haul trains. As an interim measure, on some sections, Indian Railways is running two trains in tandem, effectively as one train to reduce the impact of capacity constraints[40].
- New rolling stock and infrastructure is being designed so that trains will run at 100 kmph empty and 75 kmph when loaded. Efforts are ongoing to make fully-loaded trains run at 100 kmph.

However, in order to carry the much higher volumes of bulk commodities over the next two decades, Indian Railways will have to take big strides in improvements of transport infrastructure. The focus should be on:

- Infrastructure enabling higher axle loads;
- Specialised wagon and loading technology;
- Longer trains.

INVESTMENT REQUIRED

PRIORITISATION OF INVESTMENTS IN RAIL NETWORK

Given the limited resources available for further development of the railway network, prioritising should be on two principles: (1) route developments that have the highest impact; and (2) urgently-required route developments over those where the requirement is expected sometime later.

Based on these two principles, we suggest the following priorities:

1. **Critical Feeder Routes for Coal and Iron & Steel.** All the additional coal or iron ore that is to be transported by rail will make use of these feeder routes. A delay in providing these routes will affect availability of coal and iron ore for the entire country.
2. **Construction of DFCs Starting from Eastern End.** Construction of DFCs must start at the end located in the coal-bearing region because (1) coal-bearing traffic will be the highest nearest to the coal region and (2) transport of coal within coal-bearing states or to neighbouring states is likely to use short sections of the DFCs.
3. **Highest Priority to the Eastern DFC.** The Eastern DFC must get very high priority because it is likely to carry 50-70 per cent of the coal traffic to distant states from the coal-source states. Therefore we suggest that the Eastern DFC be built within the 12th Plan. The Western DFC is required for container traffic (not discussed here) and is already slated for completion by the end of the 12th Plan. However, because it is not as important for movement of bulk materials, we suggest that about 80 per cent of the investment be done in the 12th Plan and the remaining 20 per cent in the 13th Plan. The E-W, East Coast and N-S DFCs, are scheduled to be operational by the end of the 13th Plan. To keep the investment in the

38. Jahncke (2012).
39. MoR (2012).
40. Roy (2012).

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Table 8. 27
Suggested Plan-Wise Investment for Railways
[Rs Million]

CATEGORY OF INVESTMENT	12TH PLAN	13TH PLAN	14TH PLAN	15TH PLAN
Critical Feeder Routes-Coal	31,500			
Critical Feeder Routes-Iron and Steel	117,400			
Feeder Routes for Power Plant Clusters	25,000	25,000	25,000	25,000
Eastern DFC	459,750			
Western DFC	268,450	115,050		
E-W DFC	164,667	329,333		
East Coast DFC	91,417	182,833		
N-S DFC	182,500	365,000		
Southern DFC			112,750	112,750
Additional Augmentation		1,157,173	1,157,173	1,157,173
Rolling Stock and Terminals	441,385	663,000	748,500	805,500
TOTAL	**1,782,068**	**2,837,390**	**2,043,423**	**2,100,423**

Note: The required investment for rolling stock and terminals is for coal and iron ore only. However, the investments for DFCs and the additional augmentation are for all commodities because it is difficult to separate the investment by commodity.
Source: Working Group Report (2013).

12th Plan from becoming burdensome, we suggest that only a third of the investment be made in the 12th Plan and the remaining investment and construction take place in the 13th Plan. As the Southern DFC is not important for movement of bulk commodity, we suggest that it be shifted to the 14th and 15th Plans.

4. **Additional Augmentation.** We have removed the critical feeder routes from this list because the critical feeder routes will be covered in the 12th Plan. We suggest the remaining augmentation be spread out evenly over the 13th-15th Plans, with augmentation to routes closest to the coal and iron-ore regions getting priority.

INVESTMENT IN RAILWAYS FOR BULK TRANSPORT

Investment in the railways includes: (1) investment in rolling stock and (2) investment in the rail network. First we estimate the required investment in rolling stock and terminals. As the amount of bulk material that needs to be transported increases, the number of wagons, locomotives and terminals will have to increase. We estimate an investment of about Rs 1500 million in rolling stock and terminals for each additional Mtpa to be carried. We estimate the increase in the bulk material to be transported in the terminal years of the next four Five Year Plans as shown in Table 8.26.

Next we look at the total investment required for transporting bulk materials by rail. Based on the principles of prioritising investments described in the previous section, we suggest the Plan-wise investment for the Railways given in Table 8.27.

INFRASTRUCTURE REQUIREMENTS AND INVESTMENT PLANNING FOR PORTS

As shown in Table 8.28, the traffic at ports for thermal and coking coal and POL will grow dramatically in the next two decades. Will our ports be able to handle the traffic given that many are already stretched to capacity? Efforts are being made to improve the performance of Indian ports. However, in addition to port-wise development plans, a comprehensive strategy needs to be evolved for the port sector.

There are also issues of how poorly our ports compare with international benchmarks of performance. Perhaps, most importantly, the level of connectivity of the ports to the hinterland needs to be

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Table 8. 28
Projected Port Traffic for Coal and POL[41]
[Million Tonne]

COMMODITY	2011-12	2016-17	2021-22	2026-27	2031-32
Thermal Coal	97	142	224	340	423
Coking Coal	32	65	108	173	238
POL	329	475	572	702	864
Total	**458**	**682**	**904**	**1,215**	**1,525**

Note: Port traffic includes movement by coastal shipping. Because coastal shipping adds to the traffic at both the origin and destination port, the additional traffic due to coastal shipping is twice the volume of material transported.
Source: Earlier tables in this chapter.

considered because even the most modern and best-performing port would be useless if it lacked sufficient connectivity to the destination of materials to be imported.

Before the ban by the Supreme Court, exports of iron ore were increasing dramatically. Over the nine-year period from 2000-01 to 2009-10, they increased over threefold. In 2009-10, about 53 per cent of the iron ore produced was exported. There was a decline in 2010-11 because of the Supreme Court ban. According to the Ministry of Steel, because the iron ore resources are ultimately limited, the resources should be conserved for the domestic steel industry. Therefore, development of additional mining capacity should be undertaken in a 'well-calibrated' way so that excess capacity does not result in an incentive to export, while ensuring that iron ore is available for the domestic steel industry as it expands. Keeping this in mind, we have not focused here on transportation requirements for export of iron ore.

PORT CAPACITY

India's ports are stretched to their capacity. As Figure 8.43 shows, the capacity utilisation of the major ports averages around 85 per cent, with at least four operating at a utilisation of 100 per cent or more. International norms recommend that capacity utilisation be below 70 per cent to avoid delays.

Commodity-wise capacity utilisation for coal and POL which is of greater interest here is shown in Figures 8.44 and 8.45. Unfortunately, capacity utilisation for coal is available for only four major ports, but for POL we have more complete data. These commodity-wise capacity utilisation figures reaffirm the same picture of ports stretched to capacity. For coal, three out of four ports have capacity utilisation above 80 per cent while the international norm is 70 per cent. For POL, about half the major ports have capacity utilisation above 70 per cent.

PORT PERFORMANCE

The lack of capacity at the ports and consequent congestion and delays are reflected in the poor performance of the major ports. Table 8.29 provides some measures of performance of Indian ports.

In spite of a lot of effort, we have not been able to get international benchmarks for these performance metrics that would provide a fair 'apples to apples' comparison with Indian ports. However, one indicator of the penalty that is imposed on ships at Indian ports due to lack of adequate capacity is the following observation by the Ministry of Shipping that

> *there is no concept of 'pre-berthing detention' as in world-class ports. The capacity is much more than the actual traffic and the planning is also done on those lines. Hence there is no question of any ship waiting at anchorage*[42].

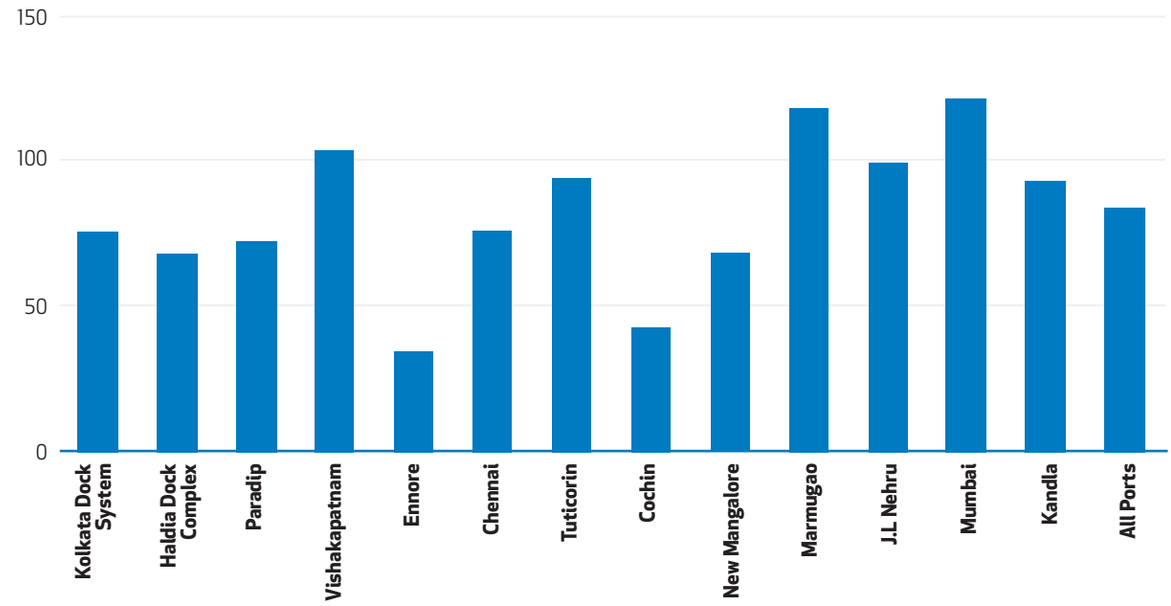
In contrast, on average, ships have to wait for more than two days to berth at an Indian port.

While data on port performance is not available for bulk commodities, the Maritime Agenda does have a comparison of major Indian ports with Singapore for handling of container ships. The turnaround time for container vessels at major Indian ports is 1.77 days compared to just 0.50 days at Singapore port. The cargo dwell time for containers at major Indian ports is 3.78 days while it is just 0.60 days for Singapore. Even though the performance of a port on handling of bulk cargo can be different from containers, these numbers do give an idea of the gap between the performance of Indian and world-class ports.

41. The traffic in this table, particularly for coal is a little lower than given in Chapter IV 4, Volume IIIon Pports and Shipping in Volume III. The projections given here are based on expected level of imports and coastal shipping with data on 2011-12 from the Directorate-General of Commercial Intelligence and Statistics (DGCIS). The projections in the chapter on ports areis based on direct projections of traffic, with data for 2011-12 from the Ministry of Shipping.
42. Ministry of Shipping (2011).

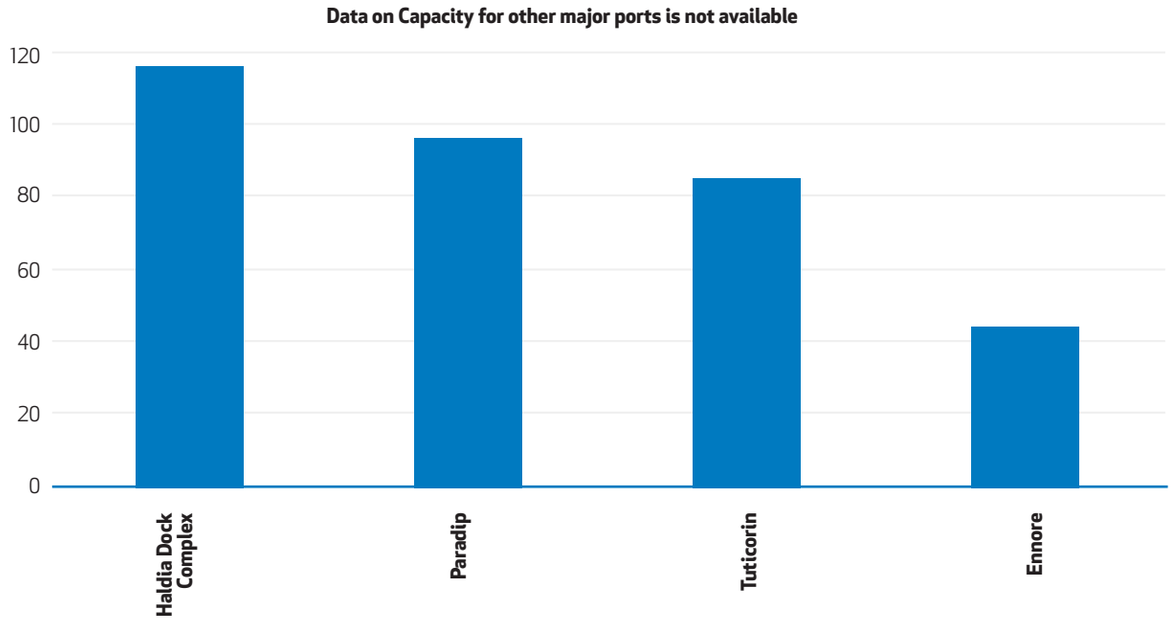
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Figure 8. 43
Capacity Utilisation Percentage of Major Ports



Source: Ministry of Shipping (2012).

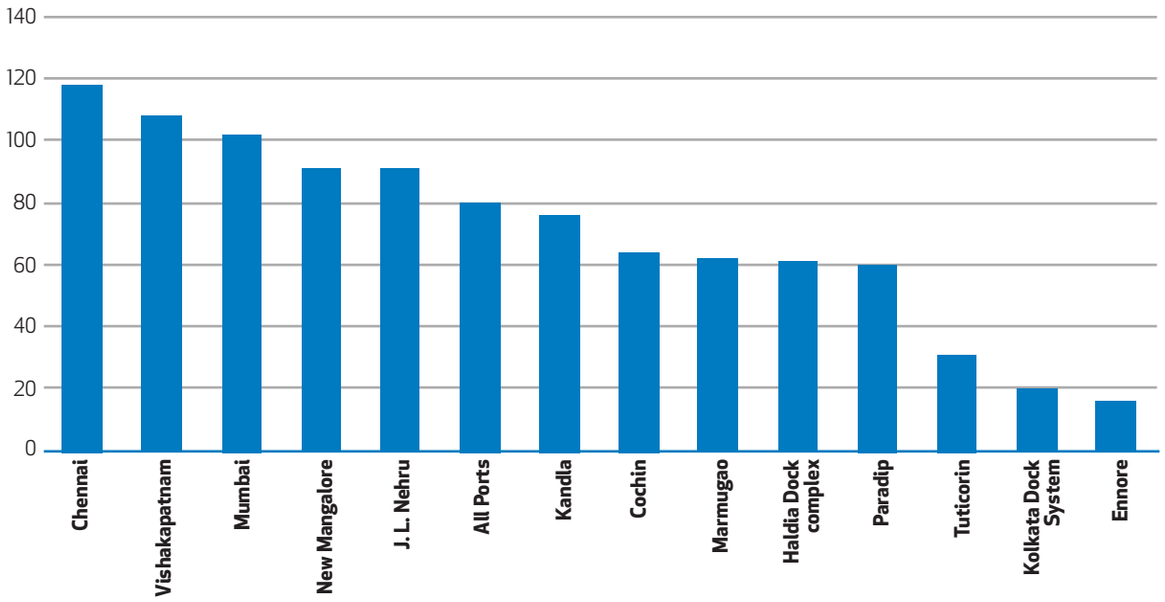
Figure 8. 44
Capacity Utilisation Percentage for Coal at Major Ports



Source: Ministry of Shipping (2012).

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Figure 8. 45
Capacity Utilisation Percentage for POL at Major Ports



Source: Ministry of Shipping (2012).

Table 8. 29
Performance of Major Ports

PERFORMANCE METRIC	AVERAGE FOR MAJOR PORTS
Pre-Berthing Dwell Time	2.1 days
Turn-Around Time	4.5 days
Output Per Ship-berth-Day	11,112 Tonne

Source: Indian Ports Association (2012).

Some of the reasons for the poor performance at ports are listed below[43]:

- **Low Level of Mechanisation.** Indian ports lack modern technology to handle coal and other bulk cargo. There are a limited number of berths available for handling bulk cargo with mechanised ore-handling capability. (Paradip Port is the only one with a dedicated berth for coal handling.) The low level of mechanisation, in combination with other factors leads to low productivity.
- **Inadequate Cargo-Handling Equipment.** Even the equipment that exists in the ports is old and breaks down frequently and takes long to be repaired. This results in long down-times, exacerbating the problem of low productivity.
- **Inadequate Navigational Aids and Facilities.** Most of the ports are not equipped with a vessel traffic management system (VTMS). Furthermore, the number of tug-boats and launches are likely to be insufficient for the increased traffic that is expected.
- **Insufficient Use of Information Technology.** Resources and equipment at the ports are spread out and without good ERP systems, are underutilised.
- **Insufficient Drafts.** The drafts at Indian ports have been very low and not in keeping with the increase in ship sizes that is occurring around the world. The older ports have drafts as low as 7 metres while a few of the new ports go up to 16 metres. For shipping of bulk materials such as coal and iron ore, the larger the ship the better because of the economies of scale. As Table 8.30 shows, *transport costs for bulk shipping can come down by more than 40 per cent by increasing the size of the ship from Handy Size to Cape Size.*

43. PwC (2009).

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Table 8.30
Effect of Vessel Size on Transport Costs

SHIP SIZE	DEAD WEIGHT (TONNE)	DRAFT REQUIRED (METRES)	TRANSPORT COSTS (INDEXED TO HANDY SIZE AS 100)
Handy Size	35,000	10	100
Panamax	80,000	12	76
Cape Size	180,000	18	58

Source: Ecorys (2012).

However, the required draft also increases from 10 metres for a Handy Size vessel to 18 metres for a Cape Size vessel.

- **Insufficient Storage Space.** Lack of adequate stacking space results in less clear space at the port which in turn leads to higher vessel turnaround time.

COASTAL SHIPPING[44]

Coastal shipping is an important mode of transport for bulk commodities that has several advantages and can reduce the burden on other modes. Coastal shipping uses less fuel (~5 g/tonne-km) compared to road (~ 31 g/tonne-km) and rail (~ 9 g/tonne-km). Consequently, it is less expensive and has a lower environmental impact. Currently, coastal shipping carries only about 7 per cent of the freight traffic, well below its potential, given India's long coastline. In comparison, the share of coastal shipping is 15 per cent in the US and 43 per cent in the EU. Even at the current low level of penetration, about two-thirds of the total traffic carried by coastal shipping is for POL, coal and iron ore. Therefore, it can play a significant role in the bulk transport of these commodities.

COMPARISON OF TRANSPORTATION COSTS USING COASTAL SHIPPING

Table 8.31 compares the costs for transporting coal from Mahanadi Coalfields Ltd (MCL) in Odisha to the coastal states namely, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Gujarat by coastal shipping with the costs of rail transport. For coastal shipping, it is assumed that coal is transported from the mine by rail to Paradip from where it is shipped to the destination ports in the states. One destination port has been selected for each state. For estimating the costs of rail transport, it is assumed that coal is transported by rail from the mine to the geographical center of the state. For both rail and coastal shipping, we have used tariffs as proxies for the costs. Ideally, costs should be compared but it was not possible to get actual costs for transportation and handling.

In spite of the much longer distance ships would have to travel, the freight charge in all cases are lower for coastal shipping even for Kandla port where the distance travelled by a coastal ship is much greater than the distance travelled by rail which cuts across the country. For Vizag, Ennore and New Mangalore, shipping freight charges are 25-50 per cent of the rail freight charges.

But on comparing total costs, it is cost-effective to use coastal shipping only for transporting coal to Ennore. For all other destination ports in the table, the customer would pay more in total for coastal shipping, because of the other charges.

Handling charges to be paid at Paradip to load the ship and at the destination port to unload the ship, and freight charges would have to be paid to bring the coal from the mine to the port of origin (Paradip in this example) and to take the coal from the port to the power plant. Together, the additional charges are almost as much or even more than the shipping freight charges. Thus, the cost advantage of coastal shipping is not realised because of high handling charges and first and last mile connectivity.

REASONS FOR SLOW ADOPTION OF COASTAL SHIPPING

There are several factors which contribute to the high handling charge for coastal shipping and the lack of interest in it:

- Major Ports do not have separate berthing and material-handling facilties for coastal vessels which are smaller. This results in higher costs and longer turnaround times.
- Minor Ports do not have adequate material-handling facilities and the equipment is often not working.
- Lack of consolidation and the resulting large number of small players hampers economies of scale.

44. This section, except the table and analysis of costs is based on information in the report by Ernst & Young (2011).

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Table 8. 31
Comparison of Rail and Coastal Shipping Costs
[in Rs/Tonne]

(COAL FROM MAHANADI COALFIELDS, ODISHA TO DESTINATION PORT VIA PARADIP FOR COASTAL SHIPPING)						
DESTINATION PORT	RAIL	COASTAL SHIPPING				
	FREIGHT	FREIGHT	HANDLING	RAIL - MINE TO ORIGIN PORT	RAIL - DEST. PORT TO POWER PLANT	TOTAL
Vizag	867	173	368	327	91	959
Ennore	1,164	243	368	327	91	1,029
New Mangalore	1,248	646	368	327	91	1,432
Mumbai	994	820	368	327	91	1,606
Kandla	1,445	1,173	368	327	91	1,959

Note: Freight charges for coastal shipping (Rs 0.23/tonne-km), and handling charges are based on TANGEDCO costs for transporting coal from Paradip to Ennore.
Source: Working Group Research and TANGEDCO (2012).

- The other modes of transport such as roads, railways and aviation enjoy subsidies and credit facilities butnot coastal shipping. Effectively, this increases costs.
- Connectivity between ports and the hinterland is inadequate.
- Qualified personnel are not available because most prefer to move to overseas ships that have better perquisites and tax benefits.
- Lack of an integrated transport policy which encourages and promotes inter-sectoral coordination

RECOMMENDATIONS FOR PROMOTING COASTAL SHIPPING

Over the years, the government has taken several initiatives to remove some of the disadvantages suffered by the coastal shipping industry. In 2004, a special cell was established for development of coastal shipping. As a result, in 2008, the manning scales for coastal ships were relaxed so that they were more consistent with the smaller size of the vessels, and did not impose an onerous staff requirement. In recognition of the fact that the vessels engaged in coastal shipping were smaller and did not require the same construction, equipment and safety requirements as ocean-going vessels, there was an exemption for coastal ships from these requirements of the Merchant Shipping Act. Now coastal ships are subject to requirements that are more appropriate for the kind of service they do. In addition, policies have been proposed for dedicated facilities for coastal shipping and to develop minor ports for this.

In spite of these initiatives, growth in coastal shipping has been sluggish relative to its potential. While appropriate policies have been formulated, there has been a lack of framework for implementation. Such a framework should include inputs from all stakeholders on barriers to effective implementation and suggestions for overcoming them; and assign responsibility and timelines for various tasks.

STRATEGIC CONSIDERATIONS FOR FURTHER DEVELOPMENT OF PORTS

As we have seen, currently Indian ports have severe limitations of capacity to handle bulk cargo traffic. Clearly considerable efforts and investment will be required to upgrade the ports to not only service the fourfold increase in traffic but also meet the performance benchmarks based on international standards. Efforts are being made to improve the performance of individual ports. However, a broader and coherent strategy needs to be developed for the overall ports sector based on a vision for the sector.

Some of the issues that need to be addressed, as the country develops its port strategy:

- Mega Ports provide very significant economies of scale and most of the world's major economies have a few Mega Ports. How many Mega Ports should there be in the country and where should they be located?
- Should ports for bulk commodities be separate from those for other cargo?
- Should ports for coastal shipping be separate from ports for international traffic?

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Except for Paradip, no major port in India has dedicated berths for unloading coal. Traditionally, this was how it was in other countries too. However, now the worldwide trend is towards development of facilities dedicated to handling bulk cargo.

Consideration of these issues, particularly regarding the number and location of mega ports are discussed in the chapter on Ports and Shipping.

EXPECTED PORT TRAFFIC FOR BULK COMMODITIES

We looked at the current level of coal imports in the coastal states to determine how much was for consumption within that state and how much was destined for other states. For each landlocked state, we were also able to make an educated guess about which coastal state was importing coal for it. This allowed us to develop a picture of the approximate route taken by the imported coal. As consumption by state for POL was not known, we simply assumed that the current pattern of imports would continue. Thus as the nationwide POL port traffic is projected to increase, the relative proportion of traffic in each state is assumed to remain the same.

THERMAL COAL

Figure 8.46-52 show port traffic by state for thermal coal. It is mainly imported by Gujarat, Andhra Pradesh, Tamil Nadu and Odisha. For the coming two decades, we assume that Gujarat will import thermal coal for itself and mainly for Rajasthan, Haryana and Punjab and a small amount for Madhya Pradesh. Andhra Pradesh is expected to import for itself and Eastern Maharashtra; Tamil Nadu for itself and Karnataka. Odisha is not expected to use any imported coal but will import for Uttar Pradesh, Bihar and West Bengal. Three ports on the eastern coast—one each in Andhra Pradesh Odisha and Tamil Nadu—could serve their own needs and those of Bihar, West Bengal, Uttar Pradesh and Eastern Maharashtra. On the western coast, Gujarat will need a mega port. In addition, it seems appropriate to have a mega port near the southern part of the coast of Maharashtra. This would serve western Maharashtra and Karnataka.

COKING COAL

Figures 8.53-55 show port traffic by state for coking coal. Odisha and Andhra Pradesh are expected to be the main ports. Odisha will import for the steel plants in the state and for those in Jharkhand. Andhra will import mainly for itself and for Chhattisgarh. Gujarat is also expected to import a significant amount. Karnataka and Goa are also likely to import some. Mega ports in Andhra Pradesh and Odisha would be able to serve the needs of the east coast while those in Gujarat and the northern part of the Karnataka coast should be able to serve the needs of the west coast.

POL

Figures 8.56-58 show port traffic by state for POL. Gujarat is by far the dominant state for port traffic for POL. By 2031-32, the port traffic in Gujarat for POL is expected to reach 500 Mt. Clearly a mega port will be required in Gujarat. The other coastal states have POL traffic that is roughly equal to one another but much less than Gujarat.

COMPOSITE PORT TRAFFIC BY STATE

Figures 8.59-61 show the composite port traffic by state due to POL, thermal coal and coking coal. Gujarat is by far the state that has the most port traffic for all three commodities, and would clearly be a prime location for a mega port. On the east coast, three states have a large amount of traffic—Odisha, Andhra and Tamil Nadu, and are potential candidates for mega ports. On the west coast, in addition to Gujarat, one or two more mega ports will be required. Maharashtra has the largest amount of port traffic on the west coast after Gujarat, and it may be appropriate to have a port on the southern end of the Maharashtra coast that could also be used to serve Gujarat and Karnataka.

SUGGESTIONS FOR LOCATING MEGA PORTS

Selection of sites for locating mega ports requires extensive modeling and analysis. First and foremost, the port traffic from all commodities will need to be taken into account. In this study, we have looked at port traffic from coal and POL only. Second, detailed data are required on the cost of further development of ports at potential sites. Third, detailed modeling will be required to examine the costs and benefits of various alternative selections from a short list of potential sites.

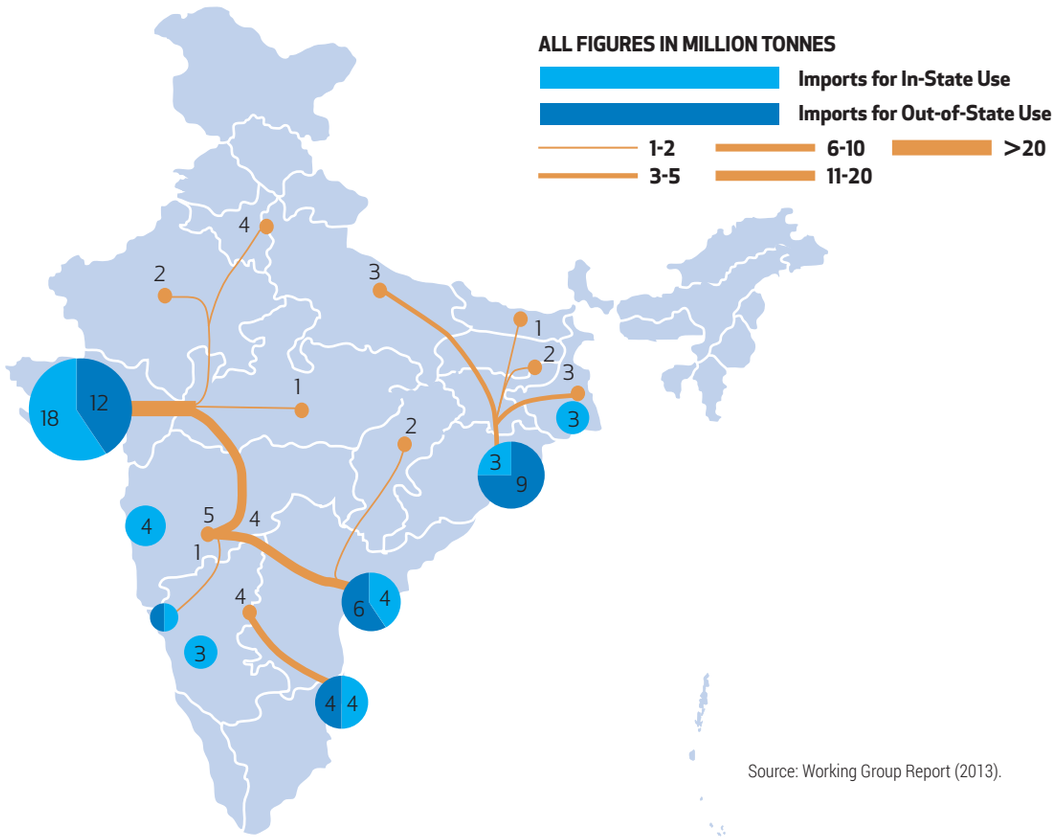
Lack of adequate draft at the port entrance is one of the main issues that need to be addressed at a macro-level for the port sector. Except for some ports such as Mundra, Kakinada, Dhamra and Gangavaram which have a natural deep draft, most other ports have shallow natural drafts and therefore require that the depth of the approach channel be artificially created and maintained[45]. Dredging is a highly capital intensive activity where the costs are very sensitive to the type of seabed that needs to be dredged. Loose sand beds are relatively cheaper to dredge but hard rock beds can be very expensive to dredge[46]. These issues need to be kept in mind in strategising about the number and location of mega ports.

The investment in breakwaters also needs to be considered. Breakwaters break the force of sea waves and thus create tranquil water conditions so that ships can be loaded and unloaded smoothly. However, they involve large investment. They also have

45. imaritime (2003); DPCL (2013).
46. imaritime (2003).

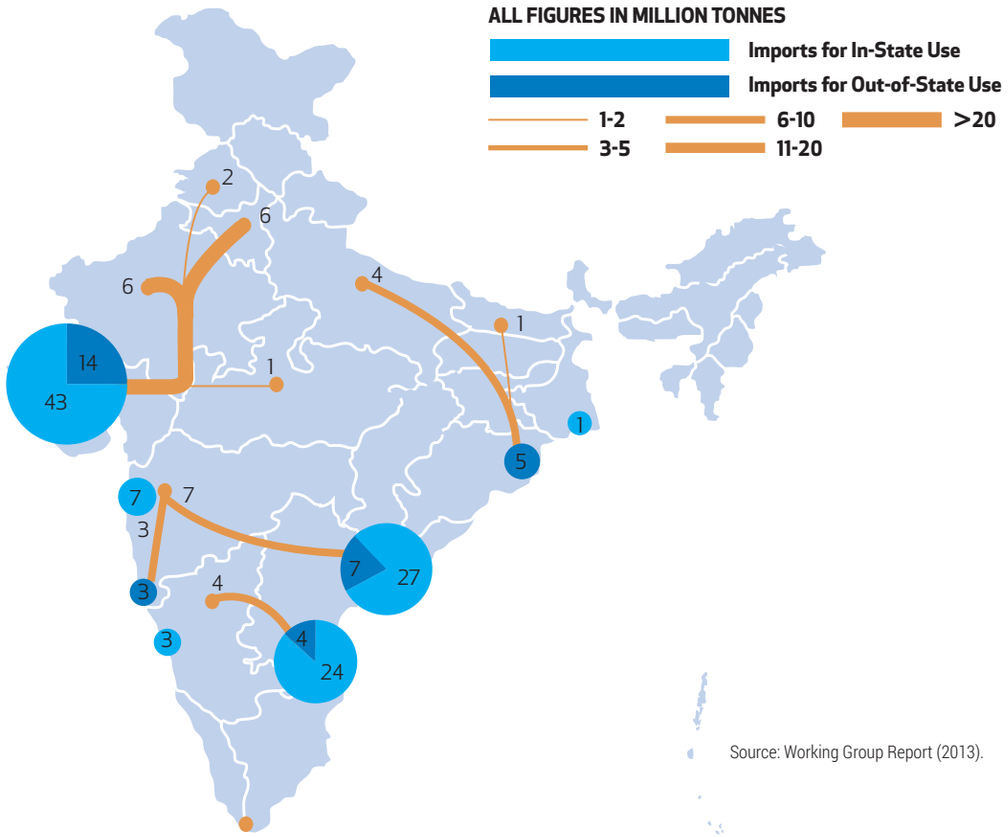
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Figure 8. 46
Port Traffic for Import of Thermal Coal 2011-12: Base Case



Source: Working Group Report (2013).

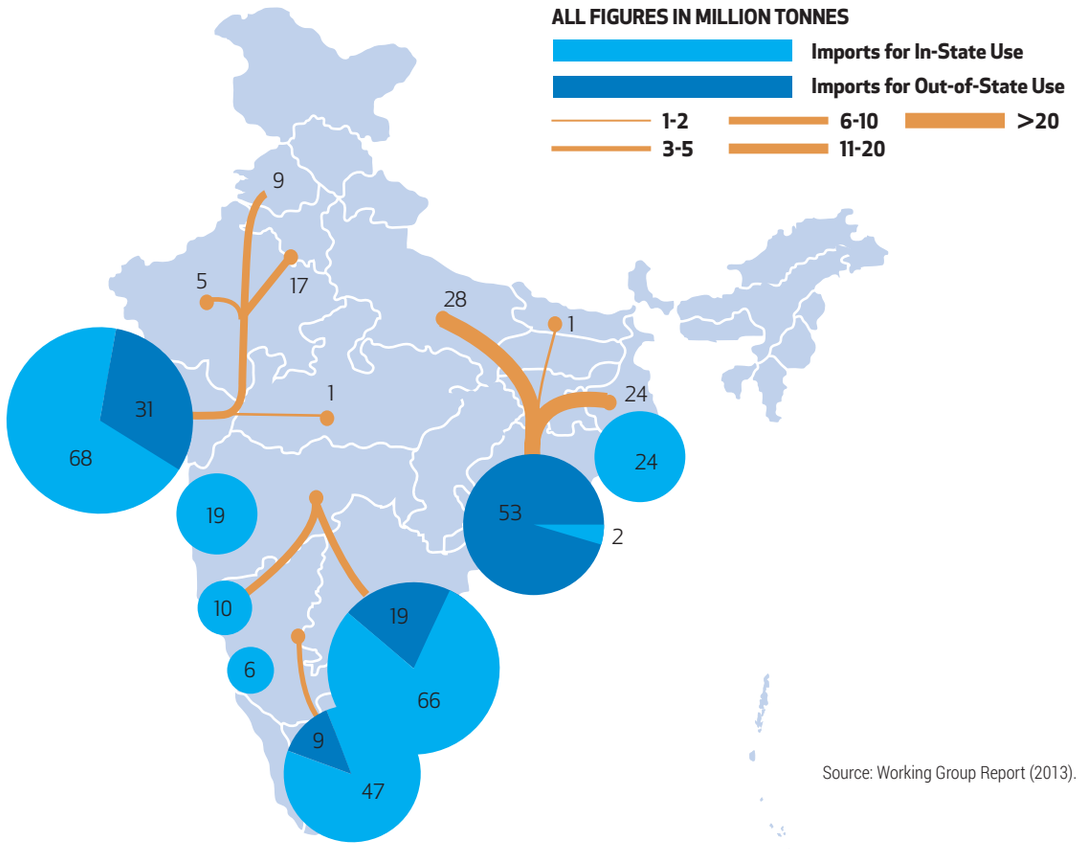
Figure 8.47
Port Traffic for Import of Thermal Coal 2021-22: Base Case



Source: Working Group Report (2013).

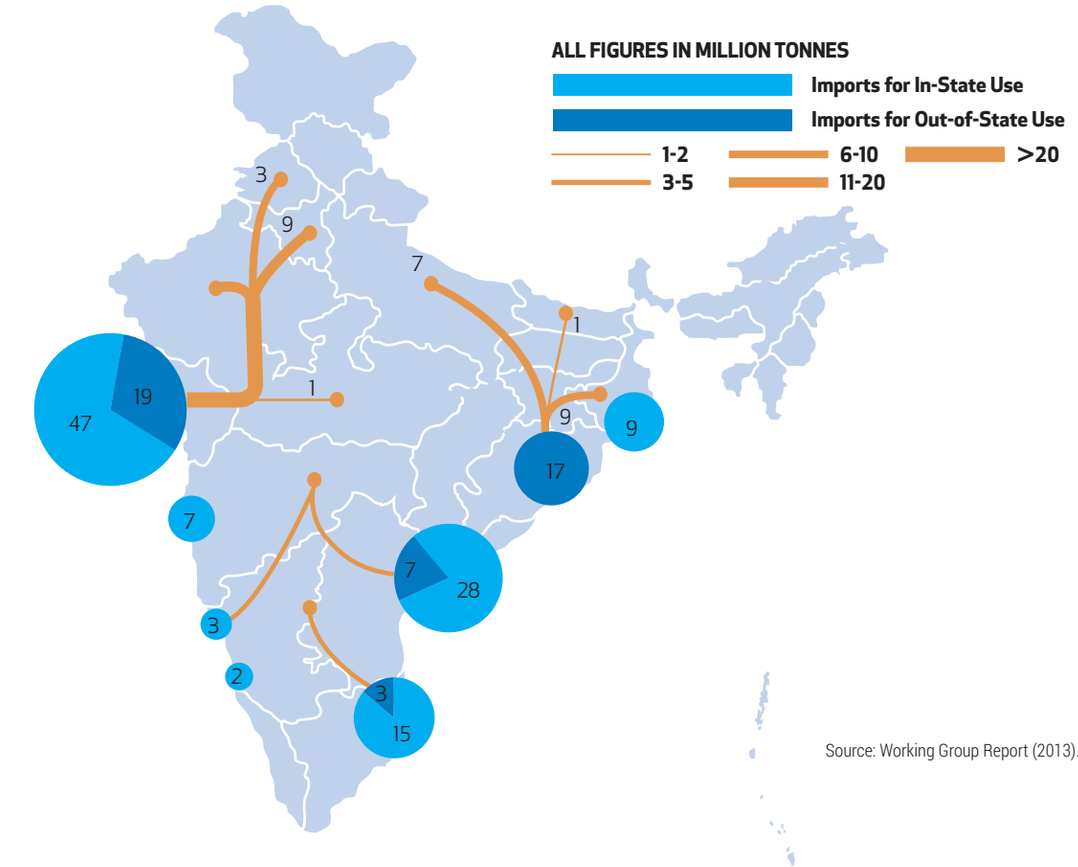
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Figure 8.48
Port Traffic for Import of Thermal Coal 2031-32: Base Case



Source: Working Group Report (2013).

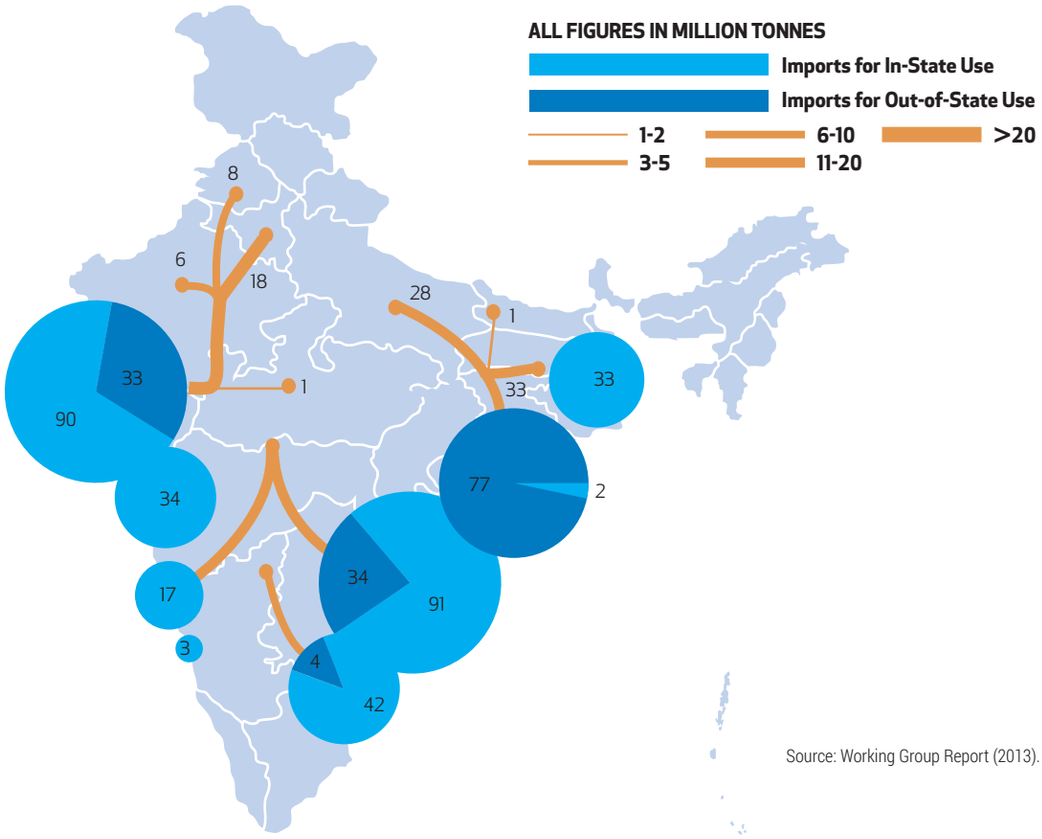
Figure 8. 49
Port Traffic for Import of Thermal Coal 2021-22: High Case



Source: Working Group Report (2013).

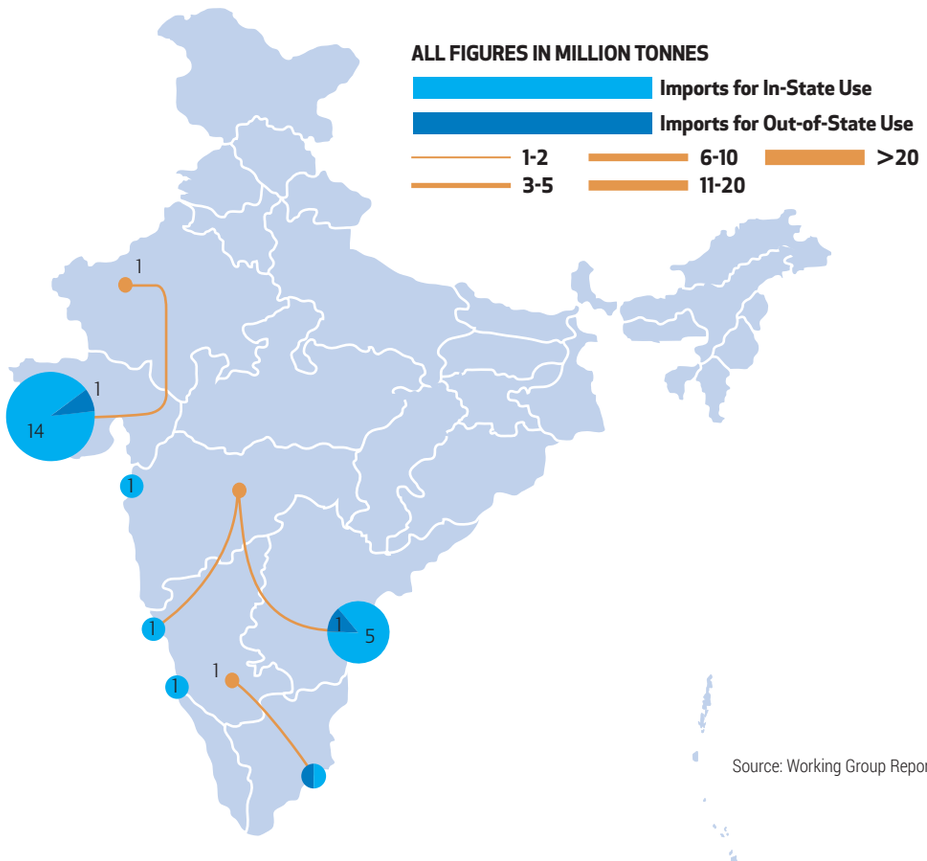
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Figure 8. 50
Port Traffic for Import of Thermal Coal 2031-32: High Case



Source: Working Group Report (2013).

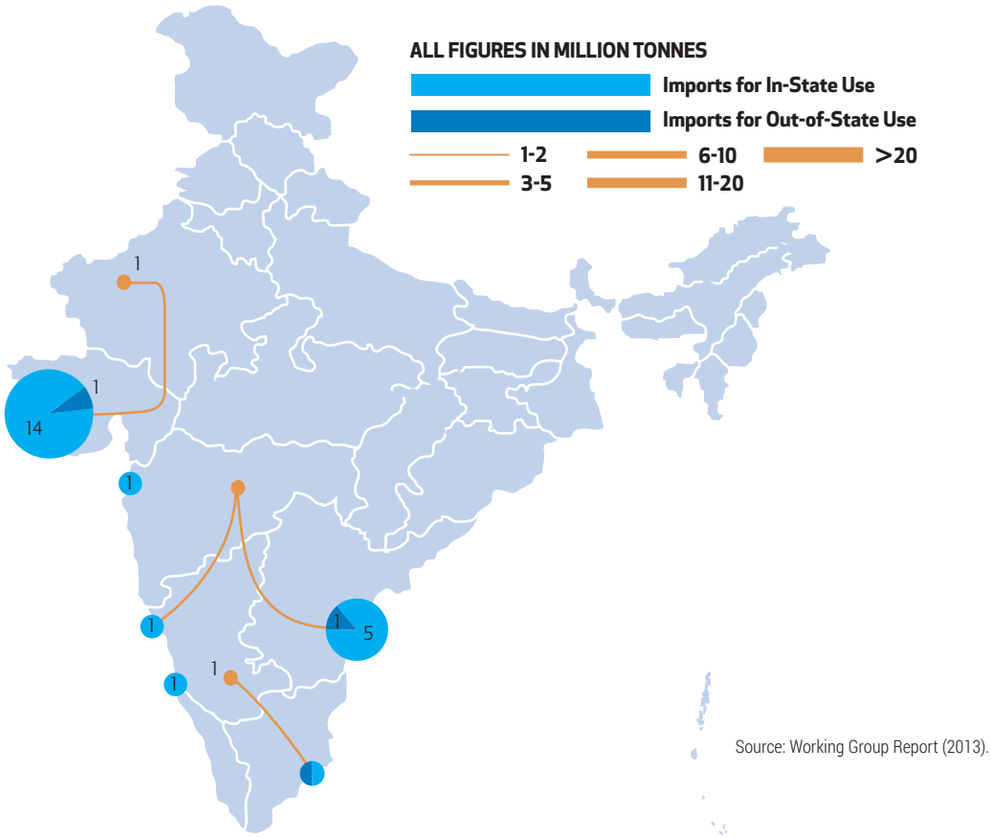
Figure 8. 51
Port Traffic for Import of Thermal Coal 2021-22: Low Case



Source: Working Group Report (2013).

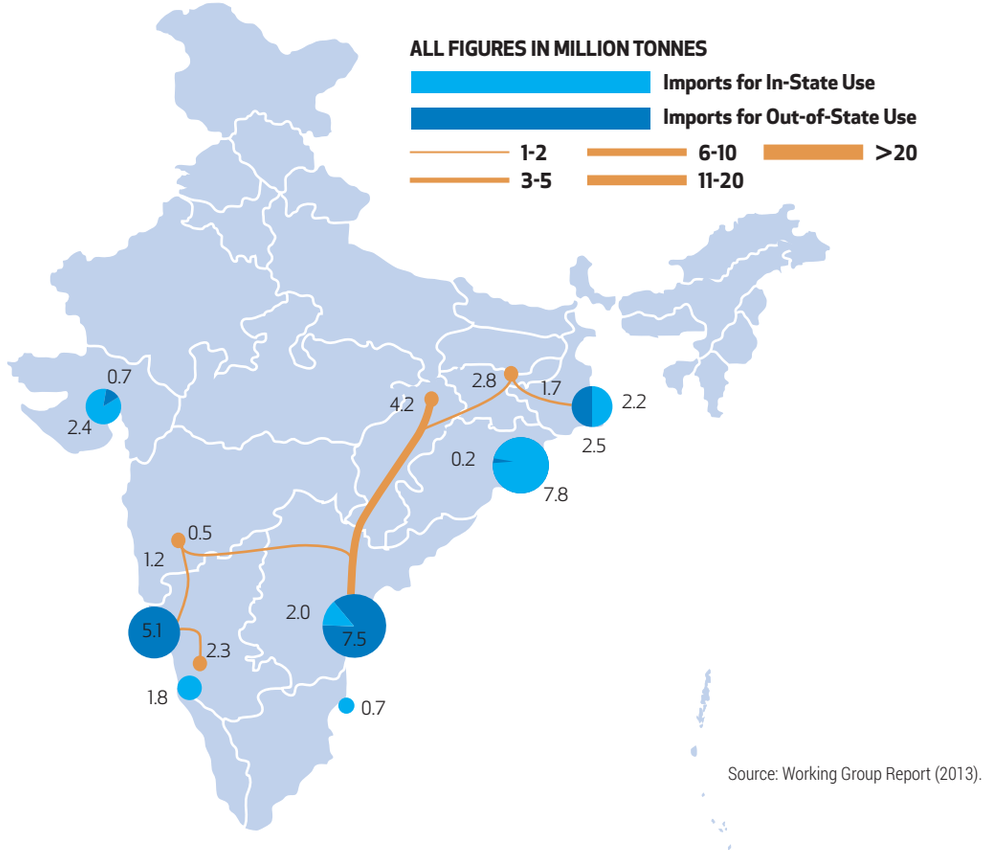
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Figure 8.52
Port Traffic for Import of Thermal Coal 2031-32: Low Case



Source: Working Group Report (2013).

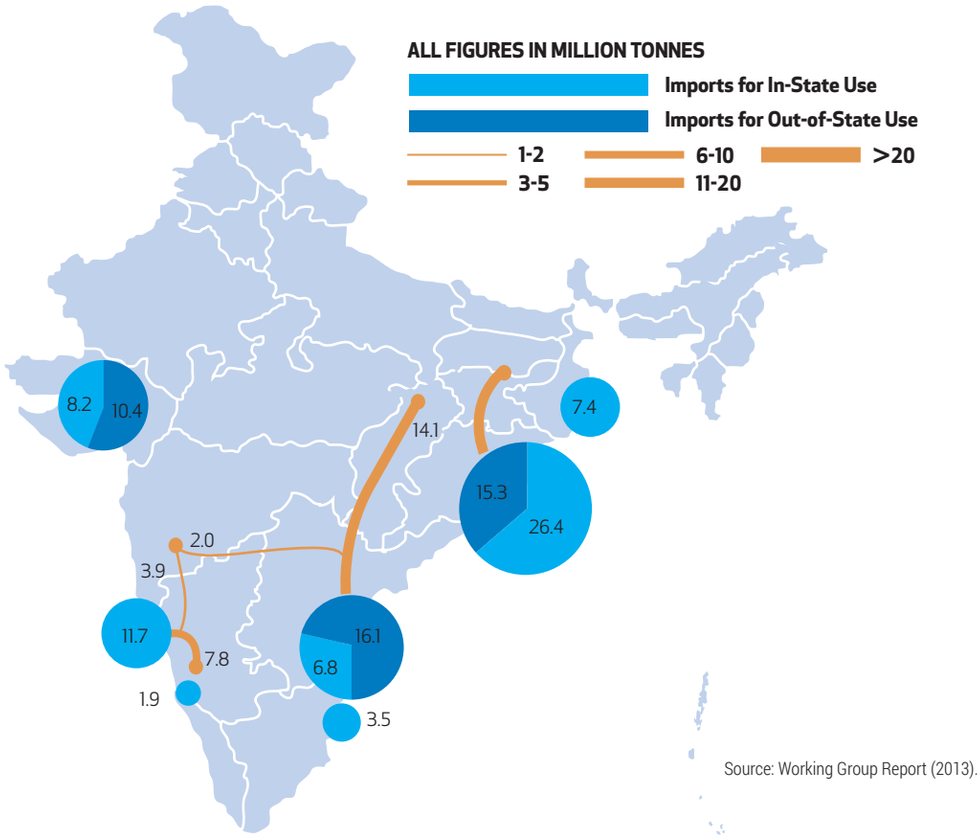
Figure 8.53
Port Traffic for Imported Coking Coal 2011-12



Source: Working Group Report (2013).

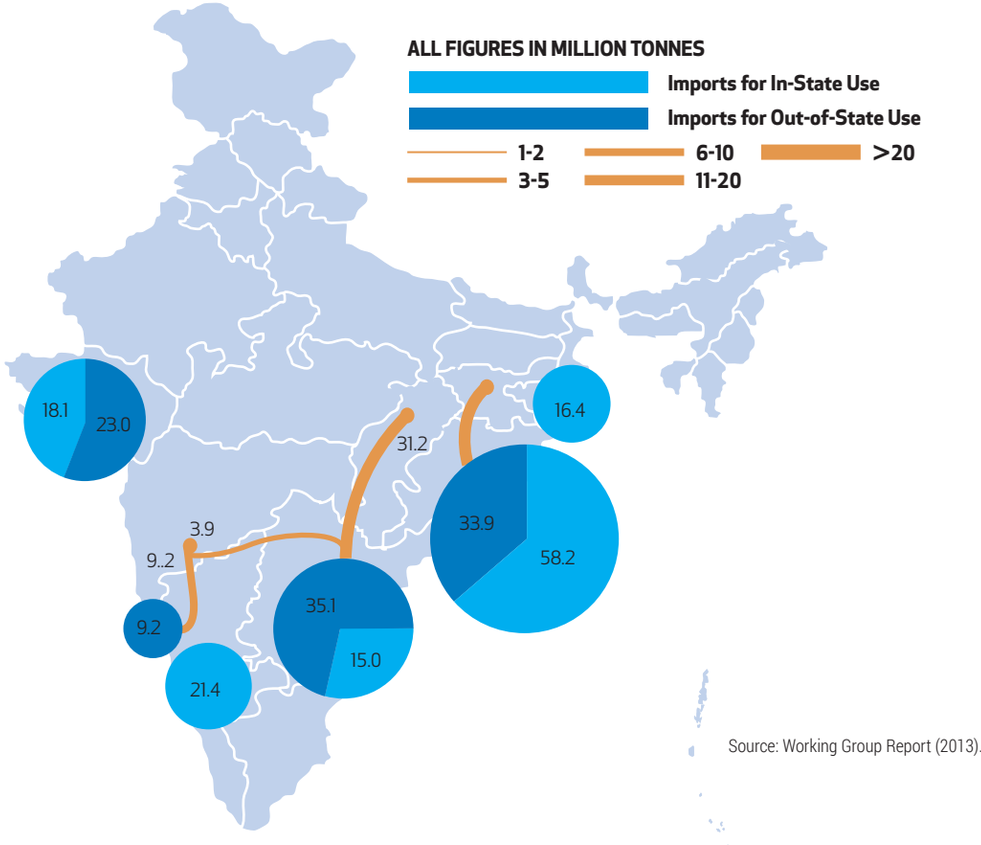
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Figure 8.54
Port Traffic for Imported Coking Coal 2021-22



Source: Working Group Report (2013).

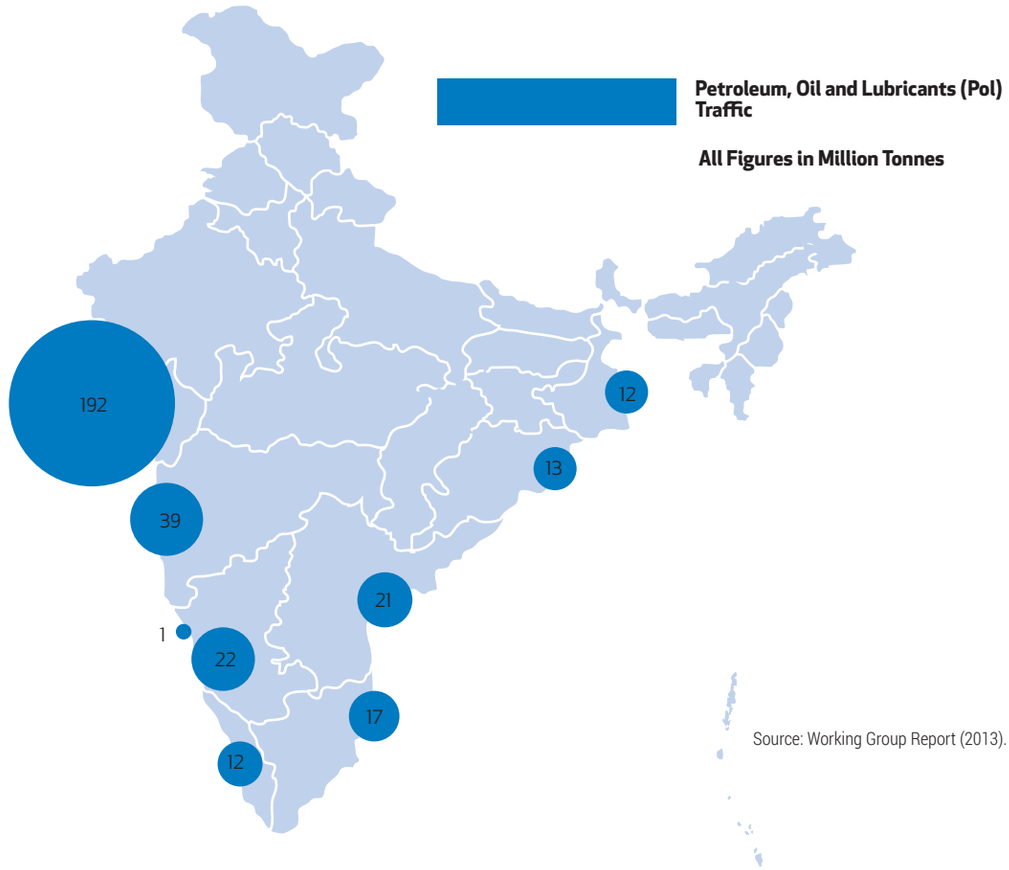
Figure 8.55
Port Traffic for Imported Coking Coal 2031-32



Source: Working Group Report (2013).

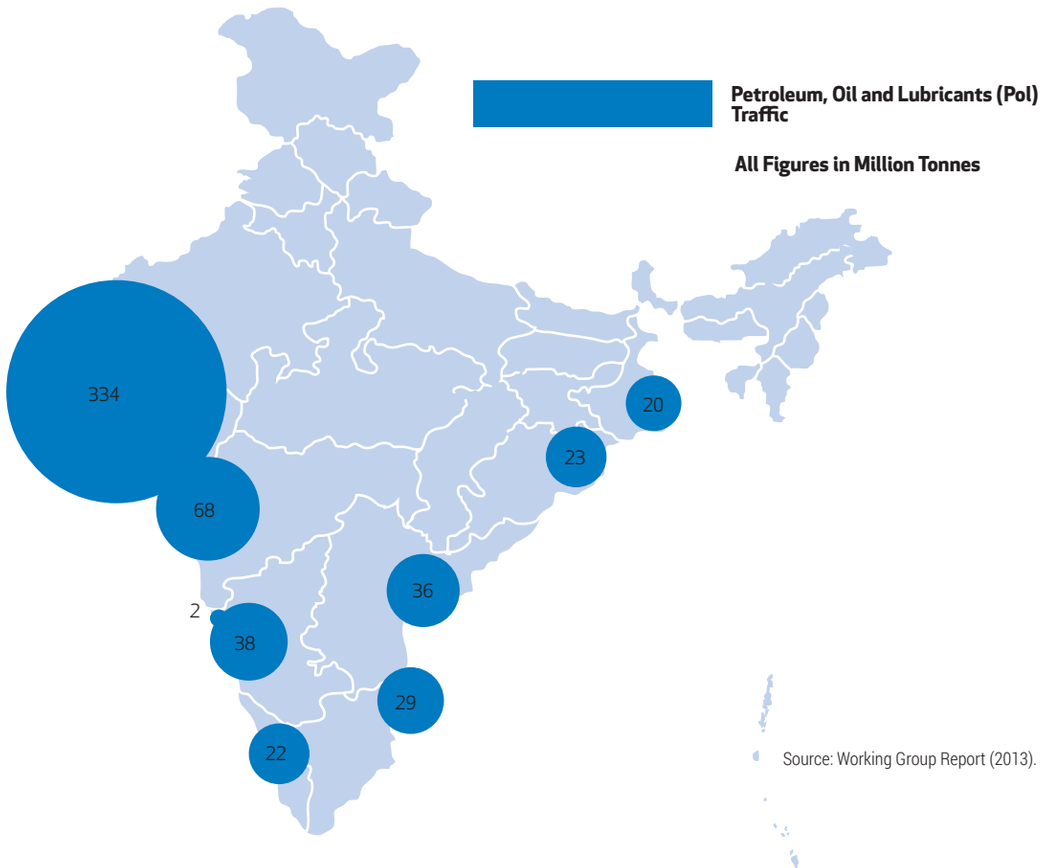
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Figure 8. 56
Port Traffic for POL 2011-12



Source: Working Group Report (2013).

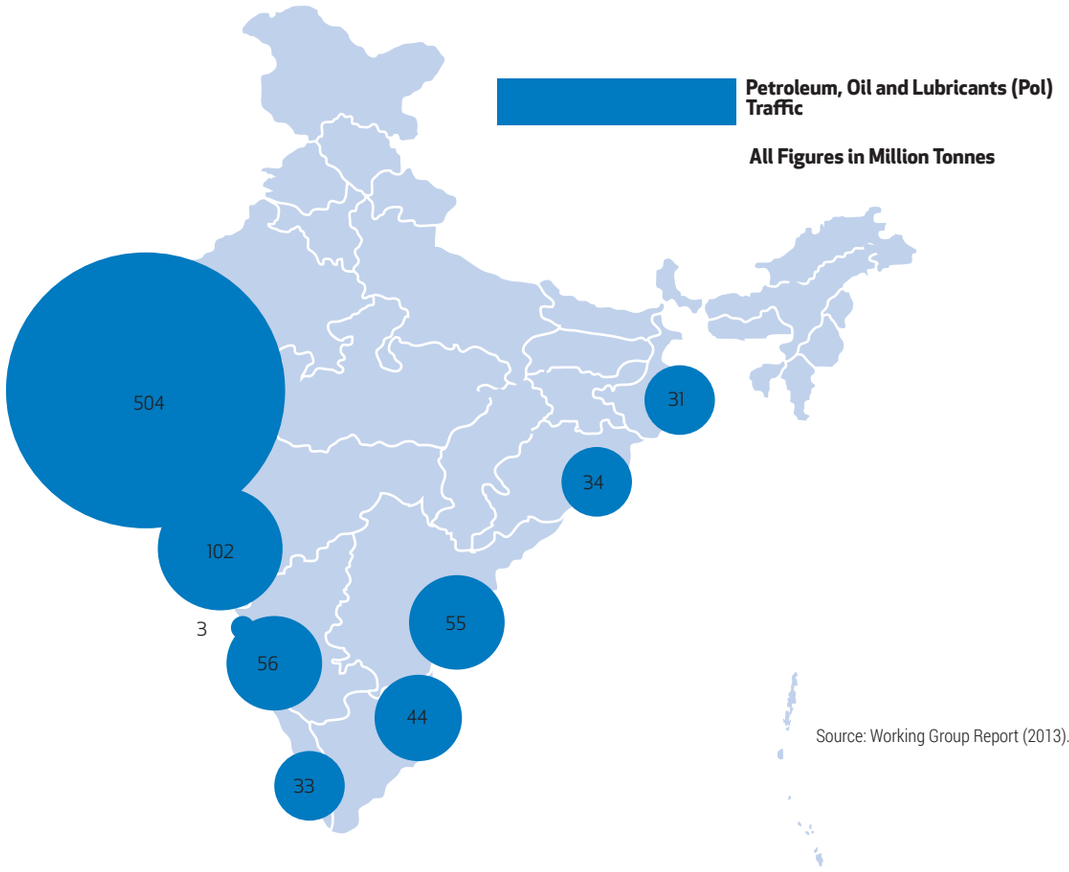
Figure 8. 57
Port Traffic for POL 2021-22



Source: Working Group Report (2013).

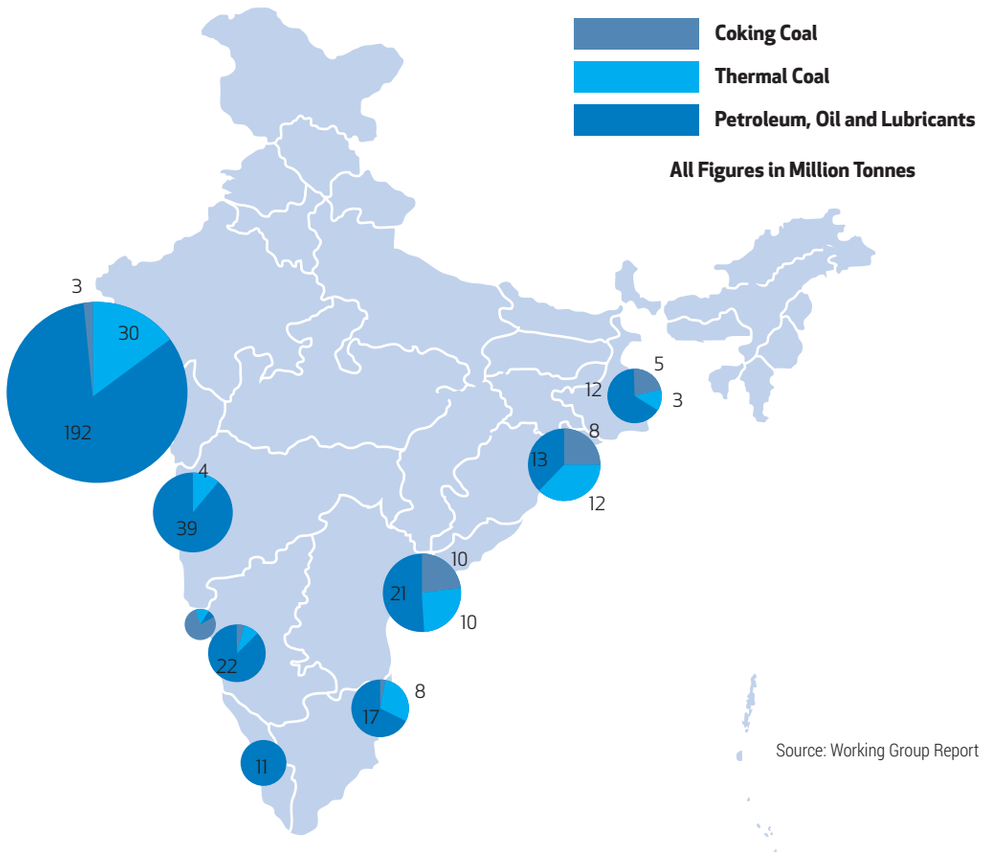
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Figure 8. 58
Port Traffic for POL 2031-32



Source: Working Group Report (2013).

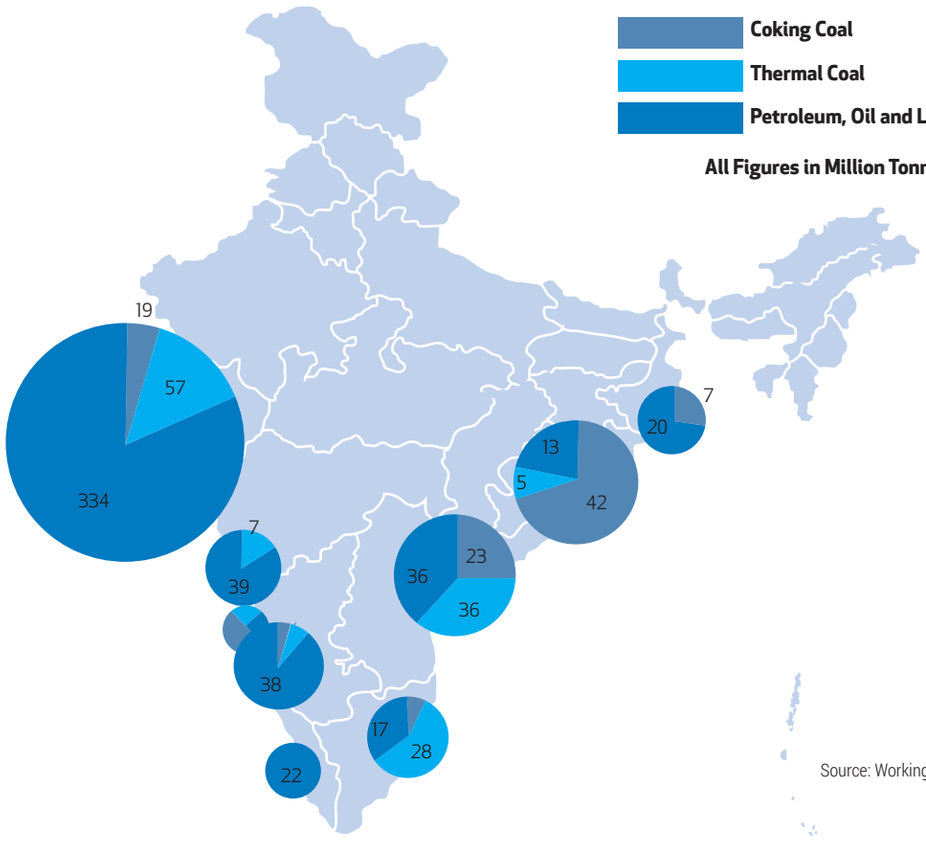
Figure 8. 59
Composite Port Traffic 2011-12



Source: Working Group Report (2013).

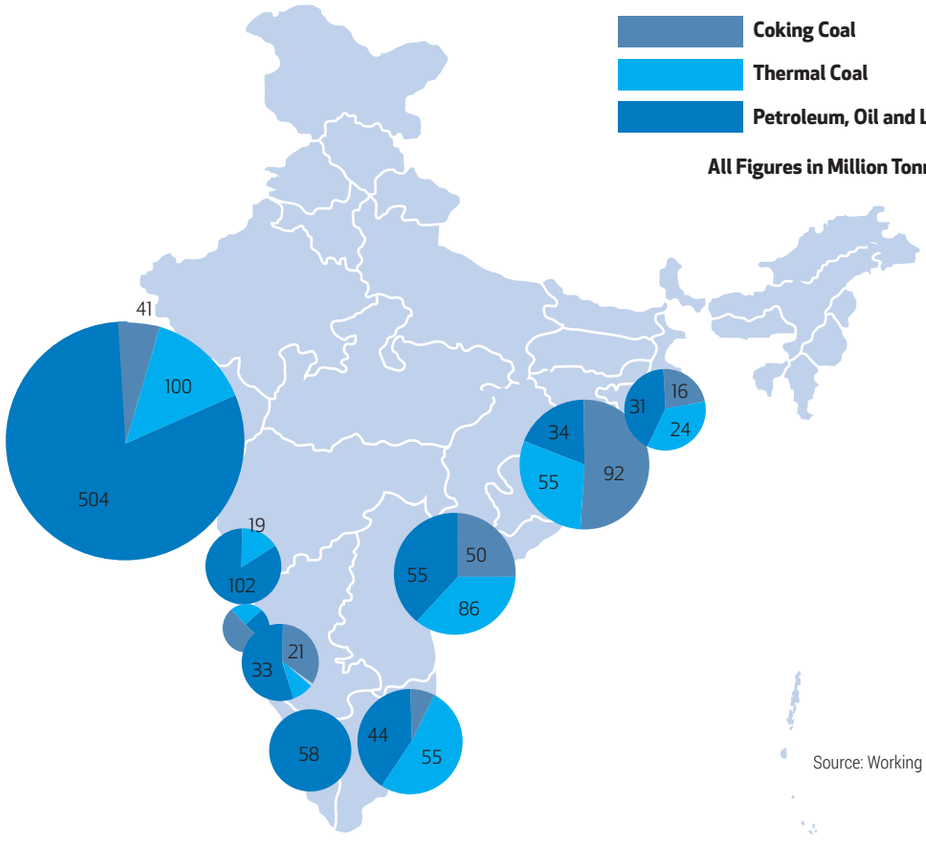
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Figure 8. 60
Composite Port Traffic 2021-22



Source: Working Group Report (2013).

Figure 8. 61
Composite Port Traffic 2031-32



Source: Working Group Report (2013).

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Table 8.32
Ports with Dedicated Facilities for Dry Bulk Commodities

COUNTRY	PORT	COMMODITY
Canada	Port Cartier	Iron Ore
	Seven Islands	Iron Ore and other minerals
	CSL Transshipment	Iron Ore, Coal
Brazil	Tubarao Terminal	Iron Ore
South Africa	Richards Bay	Coal
	Saldanha	Iron Ore and Steel
Australia	Port of Hay Point	Coal
	Dalrymple Bay Coal Terminal	Coal
	Port of Abbot Point	Coal

Source: Ecorys (2012).

long-term effects on the sediment transport near the shore and need to be constructed only after intensive and comprehensive geo-technical studies on ocean currents in order to avoid damage to the coastline[47].

DEDICATED BULK-HANDLING FACILITIES

Except for Paradip, no major port in India has dedicated berths for unloading coal. Traditionally, this was how it was in other countries too, with bulk cargo being handled along with general cargo in multipurpose ports. However, now there is a worldwide trend towards development of facilities dedicated to handling bulk cargo. Some of the reasons for this development are[48]:

- The scale of shipments and size of ships for bulk commodities have increased. Bulk cargo technologies have advanced. Larger ships require more storage space and deeper water.
- Rail connectivity up to the terminal and unit train operations have become prerequisites for bulk transport.
- In an attempt to gain control over the entire supply-chain including dedicated port facilities, shippers are looking for vertical integration.
- Urban society is becoming more conscious of environmental issues and does not want 'dirty' coal and coal-dust in its neighbourhoods. Furthermore, there are safety and security issues associated with commodities such as coal and POL.

The tendency towards vertical integration will need to be monitored for monopolistic practices. If a private player sets up a terminal in a port for its exclusive use and restricts entry of others or charges monopoly rents for its use, then it may distort the market for the commodity. Appropriate regulatory measures will be required to monitor and prevent such practices.

Table 8.32 gives some examples of dedicated facilities[49].

DEDICATED PORTS/TERMINALS FOR COASTAL SHIPPING

Ships used for coastal shipping are smaller and require appropriate berths. Major ports do not have separate berthing facilities for coastal ships. At the same time, minor ports lack adequate infrastructure and much of the equipment does not work. Consequently, turnaround times for coastal ships are high. About 70 per cent of a coastal ship's time is spent in ports and only about 30 per cent on voyages, inflicting huge losses on the coastal shipping companies[50]. It is suggested that several minor ports be developed along the coast every 100-200 km with the following capacity[51]:

- Ability to handle vessels with a requirement of draft up to 5 metres.
- Material handling and other infrastructure to turn around a vessel in 12-18 hours.
- Sufficient first and last mile connectivity to road/rail network.

47. imaritime (2003).
48. Ecorys (2012).
49. See Ecorys (2012) for details.
50. E&Y (2011).
51. Ibid.

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Connectivity to the non-major ports is very poor. Of the 200 non-major ports, only 60-65 ports are active, handling import and export of cargo. Of these, only six have complete rail connectivity.

This will reduce congestion at major ports and enhance the efficiency of coastal shipping.

CONNECTIVITY TO PORTS

Ports should be seen as nodes in the transport network and not a goal in themselves. Port connectivity is essential for the import of both thermal and coking coal. In 2005, a Committee of Secretaries was set up to establish policies to improve port connectivity. The Committee recommended that each major port should be connected by minimum a four-lane road and a double-line rail. As imported coal is most likely to be transported by rail, we focus only on rail connectivity here.

While Kolkata, Haldia, Vizag, Ennore, Chennai, Tuticorin, have the required double-line connectivity, for the following ports the provision of double-line connectivity is in progress:

- Paradip port is connected by a double-line section with Cuttack to the Howrah-Chennai trunk line. The Daitari-Banspani and Haridaspur-Paradip lines are under construction.
- Cochin port has single-line connectivity and is in the process of getting double-line connectivity
- New Mangalore port has limited rail connectivity and additional connectivity needs to be provided.
- Mumbai Port has double-line connectivity but the trains have to pass through a busy suburban section. Work on a third line is in progress.
- Kandla port has connectivity to Mumbai and Delhi via Ahmedabad. Doubling of the Gandhidham-Kandla is in progress.

Connectivity to the non-major ports is very poor. Of the 200 non-major ports, only 60-65 ports are active, handling import and export of cargo. Of these, only six have complete rail connectivity. Another 8-10 have a railway station nearby but still need last-mile connectivity. Provision of rail connectivity to the non-major ports needs to be improved urgently.

INVESTMENT FOR UPGRADING PORTS

The estimates of investment required in ports for bulk commodities are based on the volume of import/export traffic for coal and POL. We have considered coal and POL only so that we can estimate how much investment can be attributed to these bulk commodities. However, we recognise that actual planning and investment would consider all commodities and would take into account synergies between the various commodities. Further, these estimates are only indicative and are not based on detailed planning. Such detailed planning can only follow a detailed strategy for ports that takes into account some of the considerations outlined earlier.

The calculation of the investment required is shown in Table 8.33. It starts with estimates of traffic for import of thermal coal; import of coking coal; and POL import of crude oil and import and export of petroleum products. In order to minimise delays, international practice requires that cargo-handling capacity at ports be 30 per cent more than the anticipated traffic[52]. In order to calculate the cost of creating capacity, estimates of Rs 550 million/Mt of additional capacity for coal and Rs 520 million/Mt for POL have been used. These estimates have been suggested in the WG report and are based on calculations by TAMP of the cost of adding capacity. Lastly, 100 per cent has been added to these costs for additional facilities and activities such as deepening and maintenance of channels and other infrastructure. These calculations indicate that about Rs 1,485 billion would be required over the next two decades to support the required import/export of coal and POL.

CONCLUSIONS AND RECOMMENDATIONS

Economic growth is critically dependent on adequate amounts of electric power and steel. Almost all economic activity requires electricity and steel is an important input for many industries. In order to sustain a GDP growth rate of 8 to 9 per cent over the next two decades, it is estimated the production of electrical energy will need to increase by 3.5 times from 1,105 BU now to 3,860 BU by 2031-32. As coal is expected to remain the dominant fuel for the power sector, the requirement for coal is expected to grow correspondingly. Domestic coal is expected to grow by about 2.5 times; from about 440 Mt in 2011-12 to 1,110 Mt in 2031-32. Its use in the power industry will be limited by the amount produced and imports will bridge the deficit and grow much faster; by almost five times; from 73 Mt in 2011-12 to 355 Mt by 2031-32.

The intensity of steel use in the economy is expected to increase. So requirements for steel will grow faster than the growth of the economy from 73 Mt in 2011-12 to 495 Mt in 2031-32; almost an eightfold increase. Keeping in mind that a tonne of finished steel requires three to four tonne of raw material, the transport requirements for the steel industry will be huge; growing from 600 Mt in 2011-12 to about 2230 Mt in 2031-32.

52. Ministry of Shipping (2012).

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Table 8. 33
Investment Required in Ports for Coal and POL

	2011-12	2016-17	2021-22	2026-27	2031-32
Traffic (Mt)					
Thermal Coal	97	142	224	340	423
Coking Coal	32	65	108	173	238
POL	329	475	572	702	864
Capacity (Mt)					
Thermal Coal	126	185	291	442	550
Coking Coal	42	85	140	225	309
POL	428	618	744	913	1,123
Incremental Capacity Reqd (Mt)					
Thermal Coal		59	107	151	108
Coking Coal		43	56	85	85
POL		190	126	169	211
Cost of Creating Capacity (Rs Million)					
Thermal Coal		32,175	58,630	82,940	59,345
Coking Coal		23,595	30,745	46,475	46,475
POL		98,696	65,572	87,880	109,512
Total		154,466	154,947	217,295	215,332
Cost of Other Facilities		154,466	154,947	217,295	215,332
TOTAL INVESTMENT REQUIRED		**308,932**	**309,894**	**434,590**	**430,664**
TOTAL CUMULATIVE INVESTMENT 2012-2032 (Rs Million)					**1,484,080**

Source: Ministry of Shipping and Working Group Report (2012).

The transport requirements for the power and steel industry are expected to grow from about 900 Mt now to 3,700 Mt in 2031-32. While POL and natural gas will also grow, most of the transport for these commodities will be carried out through pipelines. Some POL will be transported by rail but the volumes will be very small and are not expected to impact the rail network much. However, it will have a huge impact on cargo traffic at ports. It already has the largest share (38 per cent) of port traffic, that will increase by over 2.5 times from about 330 Mt in 2011-12 to 865 Mt in 2031-32.

These very large increases in the transport requirements for bulk commodities will be a great challenge because our transport systems are barely able to cope with the traffic today. The trunk railway network is heavily congested. Generally, a rail route is considered congested when the capacity utilisation increases beyond 80 per cent. Almost all the major rail routes[53] over which coal and iron ore will be transported are operating above 100 per cent capacity. Build-up of coal stocks at pitheads is an early warning of the lack of capacity.

Similarly, the capacity utilisation for ports averages 85 per cent with at least four operating at 100 per cent or more. International norms recommend a capacity utilisation below 70 per cent to avoid delays.

Unless well-planned steps to rapidly improve the bulk transport system are successfully implemented,

53. Overall in the country, about 40 per cent of the sections are operating at 100 per cent or higher of capacity. Another 20 per cent are operating between 80 and 100 per cent capacity. The sections making up the high-density routes fall predominantly in the first category. Therefore, high-density routes on which coal and iron ore are transported are almost all congested.

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Odisha, Jharkhand and Chhattisgarh are expected to produce about two-thirds of all domestic coal by 2031-32. Together, they will also have more than half the country's steel capacity. Clearly this tri-state region will be critical for meeting the demand for domestic coal and steel for the next two decades. Ensuring adequate transportation infrastructure in this region, which also services adjoining states, is critical for the country's growth.

the transport system will become a stranglehold on the economy, starving it of energy materials and other key commodities essential for economic growth.

RAIL NETWORK

Coal and iron ore are brought mostly by road from mines to the rail sidings. Feeder routes then carry the coal or iron ore from the rail sidings to the trunk routes. The trunk routes carry the minerals long distances, usually between distant states. Close to the destination, feeder routes move the materials from the trunk route to the rail siding at the power or steel plant.

Not all shipments of coal or iron ore traverse all these segments. For example, thermal coal destined for a power plant within the coal-producing state is likely to be moved over a single feeder route between the mine and the power plant. The transport requirements can be quite different depending on the types of rail segments traversed. Coal transported to plants within the coal-producing region will rely mostly on MGR, conveyor belts/ropes and short rail routes. Such routes may use only a short part of a DFC. On the other hand, transport to distant states is likely to make extensive use of routes covered by DFCs.

As the economy grows, domestic coal will be used 'closer to home' and therefore, the importance of shorter rail routes will increase. The rate of growth of the economy will affect the relative importance of short rail routes versus DFCs, highlighting the importance of adaptability of plans for bulk transport.

CRITICAL FEEDER ROUTES AT MINES

Most of the increase in coal production is expected to come from three regions: (1) Talcher and Ib Valley coalfields in Odisha with a potential increase of 110 Mtpa by 2031-32; (2) North Karanpura coalfields in Jharkhand with an increase of 75 Mtpa; and (3) Mand-Raigad coalfields in Chhattisgarh with an increase of 90 Mtpa. Feeder routes that will carry coal from the mine to the trunk routes are critical to bring the coal to power and steel plants. But eight critical feeder routes in these regions are awaiting completion. Shortages of coal, which are already slowing down the economy, will become even more acute in the future if these feeder routes are not completed. Similarly, critical feeder routes for moving iron ore must be completed to ensure steel production keeps up with the economy's requirements.

The total cost of these routes will be about Rs 35 billion for coal and Rs 117 billion for steel; just 2.4 per cent of the Railways budget for the 12th Five Year Plan, but with large benefits for the economy. These critical routes must be completed on the highest priority within the 12th Five Year Plan.

IMPORTANCE OF SHORT DISTANCE TRANSPORT OF COAL

As the economy grows, domestic coal will be used closer to home. Consumption of coal within coal-producing states is expected to increase from 44 per cent currently to 60 per cent by 2031-32. If we include transport of coal to neighbouring states, we find that about 70 per cent of domestic coal in 2031-32 will be used within coal-producing regions. As a result, a very large portion of domestic coal will make limited use of DFCs over short sections. Similarly, more than 80 per cent of the imported coal will be used by importing coastal states. *The share of short-rail routes, road, MGR and conveyor belts or ropes will thus grow and these modes should get attention to ensure that the power sector does not suffer from an insufficient supply of coal.*

FEEDER ROUTES TO POWER PLANTS WITHIN COAL PRODUCING STATES

As in-state consumption of coal for power is likely to increase, much of this new capacity will come up in clusters of about 3,000-4,000 MW each. Such power plants need to be located near coal mines and also near sources of water. It is difficult to predict where these clusters will be located but feeder routes from the mines will be needed.

We estimate that such links will be about 70-100 km long and will be required to carry about 20 Mtpa each. Therefore, roughly one such feeder route to a cluster of power plants will be required every other year in the tri-state region of Odisha, Jharkhand and Chhattisgarh. These links should be designed for heavy-haul technology where a rake per day carries 4 Mtpa. It is likely that some of these feeder routes may overlap to some extent, with each other or the feeder routes that bring coal from the mine to the trunk route. As each such feeder route will take a minimum of six years to complete, planning for these routes must be coordinated with investments being planned in the power sector. Decisions for the corresponding transport investment should be taken simultaneously.

PRIVATE PARTICIPATION IN RAIL CONNECTIVITY PROJECTS

The urgent need for such feeder routes highlights the growing need for rail connectivity to previously

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unconnected areas. Indian Railways (IR) faces resource constraints to fulfill these demands. Therefore, it has launched a new policy to attract private participation in rail connectivity and capacity augmentation. The five models in the policy cover most of the circumstances under which private investment could accelerate the development of rail infrastructure. IR will remain a key player even with private participation and will be responsible for many functions: certification of lines; supervision of the maintenance of lines; operation of the rail network with IR rolling stock; and collection of freight charges. Therefore, success of the new PPP policy will depend on how well IR is able to execute these functions. Large integrated producers of steel or large mining companies are likely to enter into these PPP arrangements but smaller parties may find it difficult to do so. Institutional mechanisms will need to be developed to facilitate coordination among SMEs and large firms in the same area to pool their resources to create common infrastructure.

NEED TO FOCUS ON THE TRI-STATE REGION OF ODISHA, JHARKHAND AND CHHATTISGARH

Most of the critical feeder routes for coal and iron ore lie in Odisha, Jharkhand and Chhattisgarh. This is no coincidence because steel plants and mineral resources, particularly coal and iron ore, are concentrated in these states. These states produce more than half of the total domestic coal and are expected to produce about two-thirds by 2031-32. Together, they will also have more than half the country's steel capacity. Clearly this tri-state region will be critical for meeting the demand for domestic coal and steel for the next two decades. Ensuring adequate transportation infrastructure in this region, which also services adjoining states, is critical for the country's growth.

CONSTRUCTION OF DFCS

Even though domestic coal will be used closer to home, transport to distant states will also increase. Some DFCs may be more important than others for this long-distance transport. The Eastern DFC is likely to carry an overwhelming share of the long-distance coal traffic, with its share increasing from about half currently to about two-thirds by 2031-32. Excluding the Southern DFC which is not expected to carry much coal, the other DFCs have a much smaller and about equal share of the long-distance coal traffic. Therefore, the eastern DFC must be given the highest priority among the DFCs, and should be completed within the 12th Five Year Plan. The Western, East-West, North-South and East Coast DFCs should be completed by the end of the 13th Plan, and the Southern DFC can be completed by the end of the 15th Plan. For the DFCs that have one termination point in the eastern resource-rich part of the country, construction must start from there because bulk traffic is the highest in those areas. This will also facilitate transport within coal-producing states using short sections of DFCs.

A strategic bulk transport planning group, that monitors developments and potential developments in coal and other fuel markets, renewable energy technologies and domestic fuel supply, should be established. The group should include all major stakeholders and representatives from power, railways, and natural gas sectors.

ADAPTIVE PLANNING AND COORDINATION BETWEEN MINISTRIES

A counter-intuitive result from the model of the power sector is that under the low-growth scenario, the movement of domestic coal is larger, putting even more pressure on the rail freight system. This is because as growth slows, domestic coal will not be required to the same extent closer to the producing area and will be available to be sent to areas further away, thus reducing imports of coal. This will increase the burden on the rail transport system, unfortunately, right when public resources are likely to be more constrained. The results from the modeling exercise also show that there can be great variation in both the amount of coal to be transported and the pattern of the movement, triggered by changes in the rate at which the economy is growing, greater use of renewables, increased availability of gas or higher energy efficiency.

Given this uncertainty, it is important that planning for bulk transport of energy commodities be adaptive. A strategic bulk transport planning group, that monitors developments and potential developments in coal and other fuel markets, renewable energy technologies and domestic fuel supply, should be established. In response to changing conditions, it should periodically (say every five years) direct changes in the plans for transport of fuels so that adequate fuel supplies are available to power plants without delay and at low cost. The group should include all major stakeholders and representatives from power, railways and natural gas sectors.

Chapter 5, Volume II on Institutions for Transport System Governance proposes an Office of Transport Strategy (OTS) that would integrate transport planning across modes and coordinate between the ministries and other levels of government. The strategic bulk transport planning group could be established under the OTS. The OTS could extend coordination to non-transport ministries such as power, petroleum and natural gas, and steel on issues related to transport of bulk commodities.

MODERNISATION OF EQUIPMENT

Freight transport in India is far less efficient than rail in other countries. There is a great need for upgrading and modernising equipment, rolling stock and rail lines. As the Railways recognises, trains must be heavier, longer and faster in order to maximise the use of existing infrastructure. Heavy-haul technology

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should be used wherever possible and new lines should be designed for it. This increases the capacity of trains about fourfold so that a train per day would result in transport of four Mtpa from about one Mtpa using current technology.

IMPROVEMENTS IN FIRST-MILE CONNECTIVITY BETWEEN MINE AND RAIL SIDING

Coal and iron ore are generally transported from coal mines to the nearest rail siding by road. Often, the evacuation of material is hampered by inadequate road capacity from the mine head to the railway siding. Creation of road infrastructure takes time. Therefore, advance planning is essential to develop the required roads but such planning is rarely done.

Conversion of existing fair-weather roads in high-growth coal fields, particularly where captive coal blocks are expected to become operative, into all-weather express coal corridors should be seriously considered. Coal mining companies should also consider developing a hub-based system for transporting coal from existing mines, wherever feasible.

Coal from the mines in the traditional coal fields has to be moved through heavily-populated villages and is vulnerable to blockage and other disturbances due to socio-political events. Hence, wherever possible, long-distance conveyor belt systems should be used for movement. This will also reduce the environmental impact of road transport.

BULK TRANSPORT-RELATED INVESTMENT REQUIRED IN THE RAIL NETWORK

Suggested Plan-wise investments have been prioritised on level of impact of the investment; and urgency of the route development. A total investment of about Rs 8,700 billion over the 20-year period will be required. The investment is relatively higher in the 12th and 13th Plan when most of the major investments will be made.

PORTS AND SHIPPING

As discussed earlier, by 2031-32, Indian ports will have to handle five times more thermal coal than today, 7.5 times more coking coal, and about 3.5 times more POL. Indian ports are barely able to handle current levels of imports so these large increases in the future will be a big challenge.

NEED FOR A VISION FOR THE PORTS SECTOR

Efforts are being made to improve the performance of ports; however, they are focused on improving the performance of individual ports while improvements are neededon a systemwide basis. A vision needs to be developed for the ports sector and a national strategy based on it. One issue is the establishment of mega ports. Most of the world's major economies have a few. India has none. Mega ports can accomodate larger ships resulting in a reduction of up to 40 per cent of transport costs. In addition, mega ports provide very signficant economies of scale for advanced handling equipment which can dramatically reduce turnaround times for vessels. A vision for the ports sector should consider issues such as: How many mega ports should there be in the country and where should they be located? What will be the roles of mega ports, major ports and non-major ports in such a framework? What role should coastal shipping play in the framework?

SELECTION OF SITES FOR MEGA PORTS

An analysis of the expected port traffic from POL and coal over the next two decades reveals that Gujarat is by far the state that has the most port traffic for all three commodities, and would clearly be a prime location for a mega port. On the East coast, Odisha, Andhra and Tamil Nadu have a large amount of traffic and are potential candidates for mega ports. On the west coast, in addition to Gujarat, one or two more mega ports will be required. Maharashtra has the largest amount of port traffic on the west coast after Gujarat, and it may be appropriate to have a port on the southern end of the Maharashtra coast that could also be used to serve Goa and Karnataka. Some of the existing ports that have a deep draft and could be developed to become mega ports are: Mundra (Gujarat); Gangavaram (AP); Dhamra (Odisha); and Ennore (TN).

However, selection of sites for locating mega ports will require extensive modeling and analysis. First, all types of port traffic including containers and other commodities needs to be included in the analysis. Second, detailed data are required on the cost of development of candidate ports, and then detailed modeling is required to examine the costs and benefits of the potential sites.

PROMOTION OF COASTAL SHIPPING

Coastal shipping is an important mode of transport for bulk commodities that uses only about one-sixth the fuel per tonne-km as that used by road transport and about half of that used by rail. Hence, it is less expensive and has a lower environmental impact. However, coastal shipping carries about only about 7 per cent of the freight traffic, well below its potential given India's long coastline. The cost advantage of coastal shipping is not realised because of high handling charges and poor first and last mile connectivity. Handling charges can be reduced by creating dedicated ports or terminals for coastal shipping. Terminals dedicated to service coastal ships should be set up at the major ports. In addition, five or six non-major ports on the east and west coasts should be selected to be ports for coastal shipping and developed and equipped for that purpose. Adequate road and rail connectivity to these coastal shipping terminals and ports should be provided.

INVESTMENTS IN THE PORT SECTOR

Investment of about Rs 1,485 billion will be required over the 20-year period.

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ANNEX I. OVERVIEW OF INTEGRATED PLANNING MODEL® (IPM®)

The modelling of the power sector was done using the India-Integrated Planning Model® (I-IPM®) developed by ICF International. It uses linear programming to select investment options and to dispatch generating units to meet overall electric demand over the chosen planning horizon.

I-IPM® is backed by an extensive database capturing all the parameters of the Indian power sector. The key data include:

- Data on all power plants, their costs, operation parameters and fuel capability. All new power plants currently under construction, along with the characteristics of new, unplanned units
- Demand represented at the state level along with the demand profiles for each state.
- Fuel supply, extensively treated with distinct supply regions and transport infrastructure and costs.
- Transmission capability between states, including proposed new builds.

As a forward-looking model, I-IPM® determines the most efficient, capacity addition path. As the model solves for all years simultaneously, it selects the most appropriate solution to meet the demand for electricity by considering options such as building new base load or peaking units; retrofitting or repowering existing units; selecting units that should be retired or mothballed. It also identifies the timing of such events.

Outputs from the model include optimal generation capacity expansions including mothballing, retrofits, retirements and new builds, optimal transmission expansion builds, optimal fuel transportation and optimal compliance plans for individual generation units.

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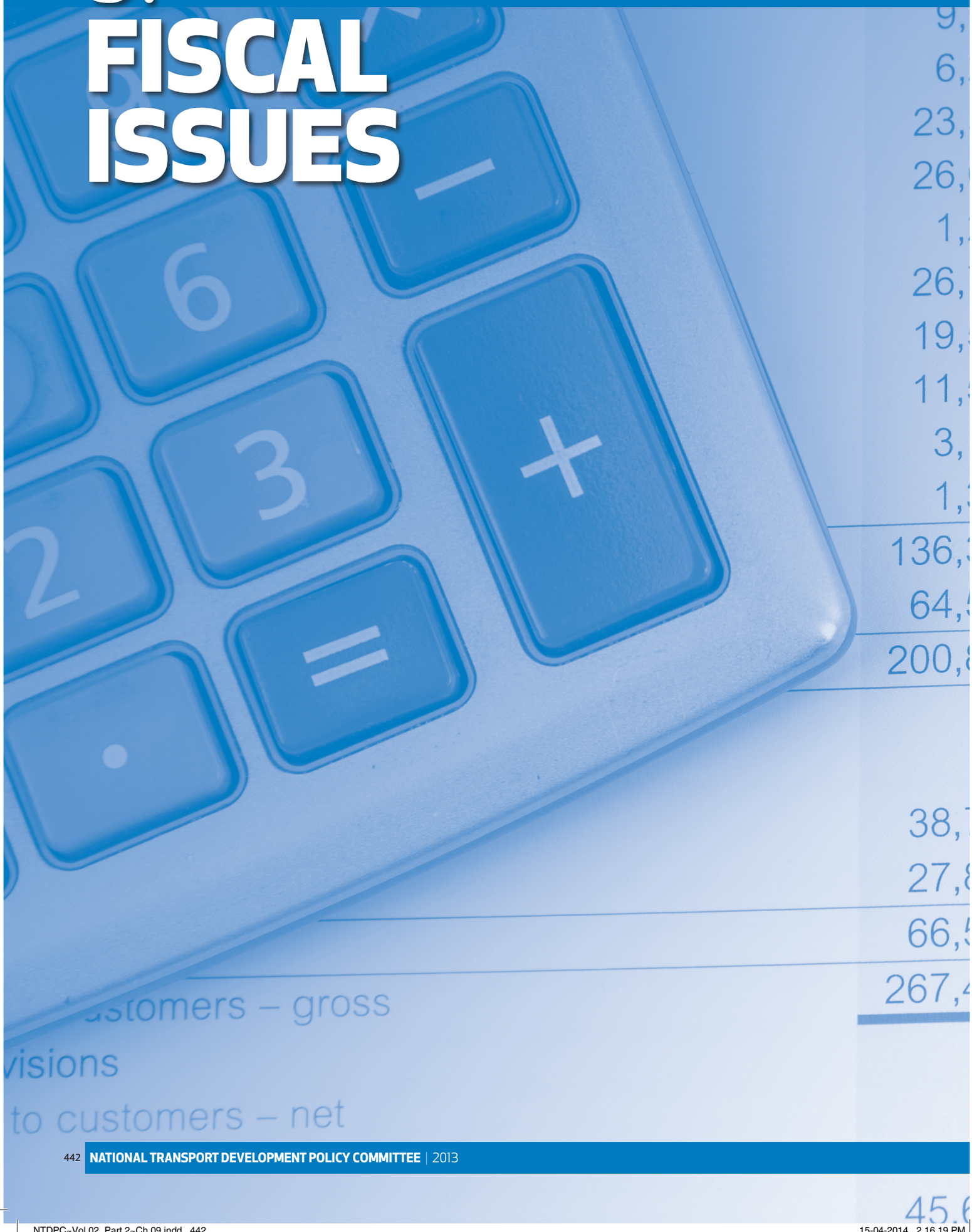
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9. FISCAL ISSUES



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9. FISCAL ISSUES

The objective of this chapter is to look into the current system of transport taxes and user charges as a part of transport pricing strategy in India. Transport pricing is a method of resource allocation through a collection of tools that affect the final price of transport services and thus influences the behaviour of users and transport service providers. It is commonly assumed that there is no such thing as the 'right' price; there are only optimal pricing strategies aimed at achieving specific objectives.

One of the major problems in setting optimal transport pricing is to decide on the right objective. For example, the optimal price for profit maximisation may differ from that required for maximising social welfare or facilitating sustainable development. Moreover, effectiveness of other public policies towards transport depends on transport pricing. This chapter aims to define rational transport pricing policies and address a range of issues related to taxation structure in Indian transport sectors.

Transport taxes and user charges are two major components of transport pricing policy. We distinguish tax from user charges in this context. However, in practice, this distinction is often blurred. Taxes are government-mandated payments which go to the public exchequer. User charges explicitly relate to the benefits derived from consuming the services provided by the transport infrastructure. For example, Road Tax (or Motor Vehicle Tax) is intended to generate revenue for the purpose of road infrastructure development and maintenance. It is more like a payment for using infrastructure and therefore, could be considered as a user charge. However, road tax is collected irrespective of whether a car owner is actually using the infrastructure. The revenue from road tax is added to the total tax pool of a state and not necessarily earmarked entirely for maintenance and development of road. Usually, the final price of transport service (fare/ freight rate) includes 1) cost of provision of the service including input taxes (tax on fuels, rolling stocks, etc) and user charges levied on transport service provider, 2) profit margin, 3) output/ service taxes (less subsidy). Conceptually, if we go by the definition of user charge, fare and freight charge may be implicitly considered as a user charge. However, following the literature, we assume that the fare or the final price of transport service is different from user charges for using other types of transport infrastructure.

To provide firms and individuals with pricing signals that guide their behaviour in a more rational economic manner, taxes and user charges need to be rationalised. Without this, interventions to manage the transport sector efficiently will be less than fully successful. Without better pricing, many investments and subsidies may be wasted and confidence in the outcomes of a wide range of policies undermined.

Broadly there are five objectives of taxes and user charges:

GENERATION OF RESOURCES

Generation of internal resources for development and maintenance of transport infrastructure could be considered to be the main objective of transport taxes. Tax revenues have more fiscal flexibility as they can be spent on anything, whereas user charges are levied closer to the point of use of transport infrastructure and can be spent on maintenance of the infrastructure. In an economy with broader social objectives, it is difficult to tightly link revenues with user charges in each transport sector for the expenditure incurred on it. Tax revenue gives this flexibility. Inter-modal, inter-regional, and inter-group distribution of resources is the main consideration while preferring taxation over user charges in a particular mode.

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Theoretically, pricing should internalise the whole spectrum of externalities. However, this may lead to a very complicated tax system. There is a trade-off between improving efficiency through an array of taxes and better compliance through a simplified tax structure.

Investment priorities are determined on larger socio-economic considerations. The economic viability of large-scale investment projects should be assessed by taking into account all the costs and benefits. The total cost of investment is not only the direct cost of capital but it also involves opportunity cost of capital. Taxes and user charges in transport sector should be set in such a way that the price of the services covers at least its marginal cost in short-run and recovers the opportunity cost in the long-run. While the need for cross-subsidisation is well recognised, there should not be any justification for general subsidy for transport.

It is well established in the literature that more inelastic the demand, the greater is the opportunity to impose taxes. However, in so doing, the government should ensure that the economically vulnerable sections of the society are not denied the service. Given this general consideration, taxation policies should be conducive to maximum generation of resources if huge investment demand in transport sector is to be financed. Otherwise, the fiscal authority has to compromise with other socially important spending like health and education.

ECONOMIC EFFICIENCY

The concept of economic efficiency is derived from the theory of welfare economics and it is related to efficiency in the allocation of resources. Inefficient resource allocation can be changed to better allocation such that someone is made better off without hurting others. An efficient allocation is one where no such reallocation is possible. Economic efficiency also implies minimum technological cost of providing the service. Many governments follow economic or allocative efficiency principles in transport pricing policy. Welfare economics postulates that social benefit is maximised and as a result economic efficiency achieved when prices are equated with marginal social cost. When price is set at marginal cost, the sum of producers' surplus and consumers' surplus are at their maxima. Traditional theory tells that such a condition exists in the long run under perfect competition when individual producers set their profit maximising price. However, any degree of monopoly power permits a firm to charge a price higher than marginal cost so that it can realise additional profit at the expense of reduced output. This, in turn, may lead to unfortunate circumstances where some consumers are denied the use of the service. Indeed, it is the fear of monopolistic exploitation that has led to price regulation in transport sectors in many countries.

There is another source of inefficiency in transport pricing. If marginal private cost is different from marginal social cost due to negative externalities or marginal private benefit is different from marginal social benefit due to positive externalities, transport service providers may set prices at levels different from the 'first best' solution for society as a whole. Corrective fiscal measures may change the behaviour of service providers and consumers so that economic efficiency is achieved. Under this regime, full cost including social and environmental cost is accounted for in the price of transport services through proper taxation. For example, if there is negative externality in the transport sector and marginal private cost is lower than marginal social cost, government may impose a tax on output to equate private and social costs. Similarly, if the social benefit is higher than the private benefit, government may induce higher output through subsidies.

Theoretically, pricing should completely internalise the whole spectrum of externalities. However, this may lead to a very complicated tax system. As the tax structure becomes complex, the cost per unit of revenue collection increases. It also induces higher transaction cost. There is a trade-off between improving economic efficiency through an array of taxes and reduction in cost of revenue collection and better tax compliance through a simplified tax structure.

The conditions for the 'first-best' world are rarely found in reality. There are some other crucial conditions where fiscal policies play a welfare-improving role. Problems also arise when applying marginal cost pricing principle in transport because capacity is indivisible and can be increased only in large chunks. There are obvious economies of scale. Cyclicality in utilisation of infrastructure makes marginal cost pricing complicated. We summarise below the main reasons for fiscal intervention to achieve economic efficiency.

a) Externalities (both positive and negative)
b) Degree of monopoly
c) Indivisibilities of supply and short-term fixed capacity constraints
d) Indivisibilities of demand and short-term peak load problem

For some scarce resources, taxes play a role of shadow prices. For example, India follows the principle of import parity pricing of petroleum products. In this case, the taxes and margins added on top of the production cost ensures socially efficient use of this scarce resource.

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Table 9.1
Transport Pricing Policy Objectives and Conflict

PRICING POLICY OBJECTIVES	CONFLICTS
Economic Efficiency vs Profitability	Pricing to promote the efficient use of transport capacity may lead to financial losses.
Environmental Sustainability vs Income Distribution	Pollution taxes may adversely affect poorer income groups and lead to unemployment
Profitability vs Macroeconomic Policy	Pricing for profitability may lead to higher transport prices thereby creating inflationary pressures
Profitability vs Income Distribution	Pricing for profitability may lead to higher transport prices with adverse effects on poor communities
Economic Efficiency vs Macroeconomic Policy	Macroeconomic price restraint policies may conflict with the need to increase transport prices during periods of congestion and excess demand

Source: Sustainable Transport Pricing and Charges: Principles and Issues, Asian Institute of Transport Development and UNESCAP, 2001

To sum up, it is important to recognise the importance of marginal cost pricing and internalisation of externalities in transport sector–correcting the price signals through taxes and user charges so that individuals (including transport service users, service providers and investors) guide their behaviour in a more rational economic manner.

INCOME DISTRIBUTION

The third rationale for taxation and user charges is the consideration of income distribution. Policy makers are usually concerned about the distribution of income. It is indeed true that optimal pricing strategy must look into the options of equity while keeping marginal conditions unchanged. Government should attempt to move towards a more progressive tax system in transport where tax incidence for people with lower ability-to-pay is lower. However, policies promoting redistribution are often coupled with ad-hoc interventions such as excessive price controls in the transport sector and consequent perpetuation of loss-making services. Cross-subsidisation involves charging some users above the marginal cost to offset the losses made on services where prices are fixed below the relevant marginal cost.

However, cross-subsidisation often violates the principle of progressive tax since it may not target the appropriate income groups effectively. The supply of the transport service is then often curtailed adversely, affecting the very people the policy is supposed to benefit. In general, cross-subsidisation should be eliminated in the interest of economic efficiency. If subsidy is socially desirable, it should be distributed through other general transfer mechanisms without distorting price signals. It is also argued that the efficiency gain from removing cross-subsidisation may generate enough resources to compensate those who suffer from the undue burden. Therefore, it is important to identify the distributional implication of particular pricing policies and to modify them appropriately to achieve economic efficiency within the constraints of equity requirements.

ENVIRONMENTAL SUSTAINABILITY

Environmental protection has increasingly become an important policy objective in the transport sector. Transport, in general, and road transport in particular, contribute a large proportion of greenhouse gases which threaten environmental sustainability. Consequently, governments are increasingly introducing measures, including pricing tools such as pollution and congestion taxes, to control environmental pollution. Do such measures distort the pricing system? We have already emphasised the role of taxes in correcting price signals in the presence of negative externalities. Promoting environmental sustainability is consistent with the aim of welfare maximisation through economic efficiency where social welfare incorporates social environmental cost and benefit.

RELATIONSHIP WITH MACROECONOMIC POLICIES

Macroeconomic policies mainly target five interdependent variables: a) rate of growth of national output; b) level of employment; c) price or inflation; d) interest rate; and e) balance of payments (and therefore the exchange rate and capital flows). The level of investment in transport infrastructure and the transport pricing are interlinked with other macroeconomic policies. Investment in the transport sec-

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Table 9. 2
Important Taxes in Transport Sectors

NAME OF TAX	LEVYING AUTHORITY	IMPORTANT COMPONENTS	MODE
Taxes on Vehicles	State Governments	Receipts under the Indian Motor Vehicles Act, Receipts Under the State Motor Vehicles Taxation Act, Receipts Under State Toll Tax, Services and Service Fees, etc.	Roads
Taxes on Goods and Passengers	State Governments	Passenger Tax, Goods Tax, Tax on Entry of Goods into Local Areas, Tolls on Roads, etc. (nomenclature depends on state specific act)	Roads and Inland Water Ways
Other Taxes and duties on Commodities and Services	State Governments	Foreign Travel Tax (Tax on travel by Air, Tax on travel by Sea), Inland Air Travel Tax	Air, Water
Taxes on Sales, Trade, etc.	State Governments	State Sales Tax Act, Central Sales Tax Act, Tax on Sale of Motor Spirits and Lubricants	All modes, Fuels
Service Tax on Transport Services	Central Government	Air Travel Agent Services Tour Operator Services Goods Transport Operator Services Port Services Service on Repair Provided by Authorised Service Station for Motor Car and Two Wheeled Vehicles Cargo Handling Services Rail Travel Agent Services Airport Services Transports of Goods by Road Ship Management Services Transports of Coastal Goods and Goods through National Waterways	All modes
Excise	Central Government	Excise duty and cess on transport goods	All modes, Fuels
Customs	Central Government	Custom duty and cess on transport goods	All modes, Fuels

Source: NTDPC Research.

tor affects aggregate output through the multiplier effect. It also generates employment and improves export competitiveness. Tax revenue collected from this sector is contributed to the consolidated pool and therefore gives greater fiscal flexibility. The prices of all other sectors are strongly linked with transport prices. Consequently, aggregate inflation may be contained through some of the fiscal instruments used in the transport sector. Macroeconomic policies, therefore, can impinge on transport pricing policies.

The set of objectives discussed above are often complex and conflicting. There is always a need for reconciling multiple objectives. For example, internalising diverse social costs associated with externalities through appropriate taxes and user charges may actually lead to an array of taxes. Similarly, reducing the complexity of tax structure through unified tax may fail to internalise diverse social costs associated with externalities but can have a significant impact on efficiency of tax collection. We may draw an analogy with tariff reforms in India during the early 1990s. A simpler tax system, especially in the road sector, may be beneficial for growth and efficiency of road transport. While there are many transport pricing policy objectives, economists usually argue that the pursuance of economic efficiency should take precedence over other objectives. A summary of pricing policy objectives and conflicts arising therefrom are given in Table 9.1.

How does the current tax structure in transport meet the objectives discussed above? Does it fulfill the principle of marginal cost pricing and achieve economic efficiency? Lack of data restrains us from in-depth analysis of fiscal inefficiencies arising from the current tax structure. However, an attempt has been made to discuss some of the important issues related to the current tax system, especially in the road transport sector. Taxes and user charges on transport modes, and the way in which they are levied, have a profound effect on traffic flows and on the development of transport infrastructure. Before discussing the sources of fiscal inefficiencies, there is a need to review the prevailing tax structure. The following section gives a bird's eye view of all indirect taxes levied on transport sectors by mode (rail, road, aviation, ports and shipping) and levying authority (centre and state).

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Table 9.3
Taxes Levied on Rail Transport

A. CENTRAL TAX:	
1) Excise Duty:	Excise duty is imposed on 1) Rolling stock, 2) Other equipments, and 3) Fuel (High Speed Diesel and Coal)
2) Custom Tariff:	Basic duty, CVD, Special CVD, education cess is imposed on rolling stock, other equipments and Fuel
3) Service Tax:	Rail travel agent services, Transport of goods by rail service are subject to service tax and education cess (education cess and higher/secondary education cess)
B. STATE TAX:	
1) Sales Tax/ Value Added Tax (VAT):	The state governments collect VAT/Sales tax on rolling stock, other equipments and diesel (HSD). The tax rate widely varies across states. Some states also charge entry tax on HSD (Karnataka, Oddisa), cess (Gujarat, Chandigarh, West Bengal), additional tax on VAT (Punjab, Haryana), Air Ambience Charge (Delhi), Social Security Cess (Kerala), etc. Electricity: State Electricity Duty (varies across states)

Source: NTDPC Research.

THE SYSTEM OF TAXES AND USER CHARGES IN THE TRANSPORT SECTOR

The power of regulation and imposition of taxes on transport modes have been specified under the three lists vide the Seventh schedule (Article 246) of the Indian Constitution, viz. Union List, State List and Concurrent List.

Union List: Railways; National Highways; shipping and navigation on inland waterways; maritime shipping and navigation; lighthouses; major ports; airways, aircraft, and air navigation; provision of aerodromes; petroleum and petroleum products; customs; excise; and inter-state trade and commerce.

State List: Roads; bridges; ferries; other means of communication not specified in Union List; municipal tramways; inland waterways not specified in the Union or Concurrent Lists; taxes on entry of goods into a local area for consumption, use or sale therein; taxes on goods and passengers carried by roads or on inland waterways; taxes on vehicles; taxes on boats; and tolls.

Concurrent List: Non-major ports and parts of shipping and navigation on inland waterways subject to the provisions of the Union List with respect to national waterways.

The taxes are broadly classified as 'Central taxes' and 'State taxes'. The indirect taxes levied by the central government are excise, customs, and service taxes. The state governments mainly collect sales tax/VAT, Motor Vehicle Tax (MVT) from road, and Passenger & Goods Tax (P&GT) from road and inland water transport. Table 9.2 summarises important taxes in the transport sector, levying authority and modes.

Though the central government is the levying authority for excise, customs and service taxes, a share of the tax revenues collected by the Union Government is distributed among states based on recommendations of the Finance Commission. Till the Ninth Finance Commission, only income tax and excise revenues were considered for sharing with states. After the Tenth Finance Commission (1995–2000), all taxes (except surcharges and cess) are now considered for devolution. The divisible pool includes other revenues including customs duty and service tax.

It is evident from Table 9.2 that the road sector is subject to multiple taxes at the state level. All other modes are mainly subject to the central taxes. Any variation in fuel price across regions is mainly due to the diverse state-level sales tax. We discuss the tax structure by mode below.

RAIL

The central government collects excise and customs on railway rolling stock, other equipment and fuels. Several services related to rail transport are also under the service tax net. The state governments levy VAT/sales tax on sales of rolling stock and other equipment. Electricity and fuel are also

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Table 9. 4
Taxes Levied on Road Transport

A. CENTRAL TAX:	
1) Excise Duty:	Excise duty is imposed on vehicles and parts. Motor vehicles for the transport of persons and goods are subject to varying rate on the basis of cylinder capacity, engine type, capacity, chassis, etc. Excise duty is a mixture of ad valorem and unit specific tax rates. Petrol/MS and HSD are subject to basic excise duty, Special Additional Duty, and Additional Excise duty.
2) Custom Tariff:	Motor vehicles for the transport of persons and goods are subject to varying basic duty (based on cylinder capacity, engine type, capacity, chassis, etc). CVD is also charged at the rate of excise duty. Education cess and secondary education cess are also collected.
3) Service Tax:	The following services in road transport sector are subject to service tax and education cess: Rent-a-Cab Scheme Operator Services, Tour Operator Services, Goods Transport Operator Services, Service on Repair Provided by Authorised Service Station for Motor Car and Two Wheeled Vehicles, Transports of Goods by Road, Travel Agents (other than Air Travel Agents)
B. STATE TAX:	
1) Taxes on Vehicles:	This tax is popularly known as Motor Vehicle Tax (MVT) or Road Tax. State governments generate revenue under Motor Vehicles Act, 1988 (regulation purpose), State Motor Vehicles Taxation Act (tax revenue purpose), state toll tax act, and different services and service fees. Some states have combined all these taxes and fees in a single tax scheme. This tax system varies across states and vehicle type. Some states collect onetime tax while several other states levy annual or quarterly tax.
2) Taxes on Goods and Passengers:	This tax is levied on goods and passengers carried by road or inland water way. Major components of this tax are tax on goods, passengers, entry of goods into local areas for consumption or final sale (popularly known as entry tax). Some states also collects tolls on roads under this nomenclature.
3) Taxes on Sales, Trade, etc.:	This tax group includes receipt under Central Sales Tax Act (states collect this tax), receipt under State Sales Tax Act (also known as VAT), Tax on Sale of Motor Spirits and Lubricants, and Surcharge on Sales Tax. The sales tax rate or VAT schedules vary across states.

Source: NTDPC Research.

Table 9. 5
Taxes Levied on Civil Aviation

A. CENTRAL TAX:	
1) Excise Duty:	Helicopters, aeroplanes, Aircraft launching gear; deck arrestors or similar gear; ground flying trainers; parts thereof are subject to central excise duty. Basic excise duty on Aviation Turbine Fuel (ATF) is 8 per cent. There is no additional excise duty.
2) Custom Tariff:	Helicopters, aeroplanes, propellers, air combat simulator, etc. are subject to custom duty and other trade restrictions are applied to these goods. CVD and Special CVD are applicable to private aircrafts. Basic custom duty on ATF is nil (ATF is domestically produced). However, CVD is levied on ATF (at the rate of excise).
3) Service Tax:	Air Travel Agent Services[1], Tour Operator Services, Cargo Handling Services, Airport Services , etc are taxed. The service tax on international air travel for passengers embarking in India and travelling in higher (other than economy) classes was imposed with effect from 1 May 2006. Vide Finance Act, 2010 the service tax on air travel was expanded to cover international and domestic travel in economy class[2].
B. STATE TAX:	
1) VAT/Sales Tax:	Fuel: State governments collect sales tax on Aviation Turbine Fuel (ATF). The rates vary across states substantially. VAT rate on ATF is as high as 28.75 per cent in Madhya Pradesh and lowest 0 per cent in Karnataka. Haryana imposes surcharge on ATF at 5 per cent. The average VAT rate is close to 20 per cent across states

Source: NTDPC Research.

1. Route Navigation Facility, Landing and Parking, Terminal Navigational Landing, etc are important airport services. Airport Authority of India or private operators collect user charges for providing these servises to airlines. These services are under service tax net.
2. Generally the break-up of the total air fare is the following. 1) base fare, 2) passenger service fee (marked as WO in ticket, collected by AAI or private operators), 3) airline fuel charge (collected by airlines), 4) service tax (marked as JN in ticket), and 5) development fee (marked as IN or YM in ticket, levied by airports). In addition to these, there may be transaction fee (marked as OC, collected by ticketing agent) and fuel surcharge (marked as YQ, collected by airlines).

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Table 9.6
Taxes Levied on Shipping

A. CENTRAL TAX:	
1) Excise Duty:	Ferry-boats, cargo ships, barges and similar vessels for the transport of persons or goods are taxed at 5 per cent, vessels for fishery are not taxed. Fuel: as given in section on Road and Rail
2) Custom Tariff:	Cruise ships, excursion boats, ferryboats, cargo ships, barges and similar vessels for the transport of persons or goods are taxed. CVD (other than fishing vessels) and special CVD are applicable on top of the basic rate.
3) Service Tax:	Steamer Agent Services, Port Services, Cargo Handling Services, Dredging Services of River, Port, Harbour, Backwater or Estuary, Ship Management Services, Transport of Persons by Cruise Ship, Transports of Coastal Goods, etc are taxed
B. STATE TAX:	
1) VAT/Sales Tax:	Ships and other vessels are taxed Fuel oil is subject to sales tax as described in sections on Rail and Road.

Source: NTDPC Research.

subject to state-level taxes. Table 9.3 summarises important taxes in rail transport by the levying authority.

ROAD

In addition to excise, customs and service tax levied by the central government and sales tax/ VAT levied by the state governments, there are several other taxes imposed on road transport at the state level. Taxes on Vehicles and Taxes on Goods and Passengers are two important categories of state-level taxes. There are several components of Taxes on Vehicles and Passenger and Goods Tax (P&GT). Motor Vehicle Tax (MVT–popularly known as Road Tax) is a major component of taxes on vehicle. Goods Tax, Passenger Tax, and Entry Tax are three important components of Taxes on Goods and Passengers. The road tax rates are diverse and complex in nature. The complexity of these taxes is discussed in greater detail in the next section. The VAT on fuels, levied by state governments, varies widely across states. Some states impose an additional tax on VAT, employment cess, air ambience charges, entry tax, and social security cess on fuel. Customs duty and excise tax are imposed by the central government and are, therefore, uniform across states. The taxes in road transport sector are summarised by levying authority in Table 9.4.

CIVIL AVIATION

The main tax levies on this sector come from sales tax or VAT levied on aviation turbine fuel (ATF). The sales tax rate varies across states. Domestic airlines spend around 35 to 40 per cent of operating costs on ATF while foreign airlines pay lower price for ATF due to exemption from some tariffs. ATF is also subject to central excise. Although import of ATF is not allowed, import parity price of domestically produced ATF includes CVD. International flights (domestic and foreign operators) are exempted from state sales tax on ATF. A summary of taxes imposed on this sector is given in Table 9.5.

PORTS AND SHIPPING

Water transport comprises shipping services (coastal and ocean), inland waterways, and port services (major, intermediate, and minor ports). Other subsidiary services, viz. ship building and repairing, cargo handling, freight forwarding, lighthouse facilities, and other port services are also important inputs to this sector. Tariffs in the major ports are governed by the Tariff Authorit of Major Ports (TAMP), whereas minor ports are under the state ambit. The Inland Waterways Authority of India regulates national waterways (there are five inland waterways). Indirect taxes in this sector are very similar to those in the civil aviation sector. The central government collects excise and customs tariffs from ships, boats and fuel. Service tax is also applicable to several services related to this sector. The state governments levy sales tax/ VAT on vessels and fuels. A summary of tax and user charges is given in Table 9.6.

USER CHARGES

In addition to taxes, user charges also constitute an important component of transport pricing. User charges, by definition, include a diverse range of payments for usage of transport services and infrastructure. Fare or freight charges may be seen as

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Table 9.7
Important User Charges in Transport Sectors

NAME OF CHARGE	LEVYING/COLLECTION AUTHORITY	IMPORTANT COMPONENTS	MODE
Toll on National Highways	National Highway Authority of India, Private Operators (Public Private Partnership projects)	Toll charges on National Highways, Fees for use of permanent bridges, bypass or tunnel	Roads
User Charges in Major Ports	Major Ports (Port Trusts)	Port Dues Berth Hire Pilotage & Towage Wharfage Charges Demurrage Charges Anchorage Salvage & Divers Fees Dry Docking Water Supply to Vessels Licence Fee for Space	Water
User Charges in Airports	Airport Authority of India, Private Operators	Route Navigation Facility Charges Landing and Parking Charges Terminal Navigational Landing Charges	Air

Source: NTDPC Research.

direct charges levied on the user. The fares are distinct from the user charges paid by transport service provider or passengers to the owner or operator of transport infrastructure.

Several explicit user charges on roads (toll), aviation (airport-related charges) and shipping services (port-related charges) are collected either from transport service providers or directly from traveller/transporter. Unlike port and airport services, there is no explicit user charge levied on usage of rail infrastructure by Indian Railways. However, private rail container operators do pay user charges to the railways. The way infrastructure is maintained and the tariff rates are regulated in railways is quite different from that in other modes. One important distinction is that there are separate authorities for operation of the infrastructure and regulation of the tariff structure in shipping and aviation sectors. For example, either the Airport Authority of India (AAI) or private entities operate the airport infrastructure whereas the Airports Economic Regulatory Authority (AERA) regulates the tariff structure. Similarly, port trusts operate shipping infrastructure whereas the Tariff Authority of Major Ports (TAMP) regulates the tariff structure in major ports.

In contrast, the Indian Railways is the sole owner and operator of the huge railway infrastructure and at the same time it also regulates the tariff structure. Freight and passenger tariff rates in rail transport do not explicitly mention any user charge levied on usage of railway infrastructure. However, tariff rates, in principle, may implicitly internalise the cost of depreciation of infrastructure. Indian Railways does not have a proper system of internalising the cost of depreciation of own infrastructure through user charges. Though there is a Depreciation Reserve Fund of Indian Railways, the current reserve in this fund is very low and there is no clear revenue generation practice through user charges. As long as there is no internal system of payment for user charges, railways may not fully internalise the cost of depreciation of its own infrastructure. (Chapter on Railways for recommendations on reforms in Railways accounting).

Table 9.7 gives a summary of important user charges levied on transport modes.

Subsidy is an integral part of the transport pricing mechanism. Only a part of government subsidies is clearly visible in the central government's budget documents. Such explicit subsidies are mainly on food, fertiliser and petroleum. There is no explicit subsidy to transport sectors mentioned in the central government budget documents. However, Indian Railways receives subsidy towards dividend reliefs and other concessions, and reimbursement of losses to railways on operating strategic railway Lines. Under the 'Separation of Convention' the Railways are required to pay dividend at a fixed rate on capital advance by the central government. The rate of dividend is periodically revised by the Railway Convention Committee of Parliament. Railway receives, in principle, subsidy equivalent to the amount of dividend paid on investment in strategic lines, non-strategic portions of lines in north-eastern states, etc.

There are several forms of implicit subsidies in transport. According to the annual reports published by Indian Railways, there is cross-subsidisation from freight earning to passenger and other coaching earnings. Similarly, earnings of the state

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Table 9.8

Complexity of Motor Vehicle Tax Structure

STATE	GOODS TRANSPORT			PASSENGER TRANSPORT			PERSONALISED TRANSPORT		
	Types of Vehicle	Number of Lines	Parameter	Types of Vehicle	Number of Lines	Parameter	Types of Vehicle	Number of Lines	Parameter
Andhra Pradesh	4	8	C,W,Q/L	.3	8	R,E,C,K,Q,S	4	5	C,Q/L,O
Arunachal Pradesh	3	3	A	1	1	L	4	4	L
Assam	3	11	C,Q	1	4	C,Q/A,S	4	12	P,C,R,Q/L
Bihar	3	9	C,W,A	1	3	C,A	4	7	P,W,A/L
Chhattisgarh	4	9	C,W,Q/L,U	1	4	C,M,S,K	4	6	C,P,Q/L
Goa	1	17	C,W,A	1	5	C,M,A	4	11	C,W,P,A/L,S
Gujarat	2	5	C,W,P,A	2	10	C,A	4	6	C,P,L
Haryana	1	5	C,W,A	2	4	C,A,R,I	4	7	C,W,A/L,I
Himachal Pradesh	3	5	A	1	2	C,A,R	5	7	L,H
Jammu and Kashmir	2	2	Q,U	1	1	C,Q	4	7	H,Q/L
Jharkhand	4	7	C,W,A	1	4	C,A	5	5	C,A/L
Karnataka	3	4	C,W,Q/L	1	8	C,Q,E,S,R	4	7	C,W,P,Q/L
Madhya Pradesh	1	10	C,W,Q/L	1	6	C,M,S	4	4	P,C,Q/L
Maharashtra	2	5	C,W,A/L	8	10	C,A,R,E	4	18	C,P,Q/L,S
Manipur	4	7	F,A	1	1	C,A	4	7	W,F,A
Meghalaya	5	10	C,W,A/L	2	3	C,A	4	4	L
Mizoram	4	6	C,A	1	1	C,A	4	4	A
Nagaland	4	8	C,A,U	1	5	C,R,A	4	11	W,H,R,L
Odisha	2	11	C,W,A,P	2	11	C,A,K,S	4	10	C,W,O,PA
Punjab	3	6	C,W,A,U	2	18	S,R,D/A,K	4	12	C,A/L,S

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STATE	GOODS TRANSPORT			PASSENGER TRANSPORT			PERSONALISED TRANSPORT		
	Types of Vehicle	Number of Lines	Parameter	Types of Vehicle	Number of Lines	Parameter	Types of Vehicle	Number of Lines	Parameter
Rajasthan	3	16	P,L,U	2	35	C,D,P,B,T	2	9	C,H,P,L
Sikkim	3	3	C,W,A/L	1	2	A	3	9	C,H,A/L
Tamil Nadu	4	23	C,W,Q/L	3	8	C,R,Q,S	4	5	P,S,A/L
Tripura	4	8	C,W,A	3	7	C,A	4	5	A
Uttar Pradesh	4	6	C,W,Q	1	1	C,Q	4	8	C,H,P,F,Q/L
Uttarakhand	4	8	C,Q,R	1	2	C,Q/M	4	5	H,P,C,Q/L
West Bengal	4	59	C,W,Q	1	1	C,Q	4	11	C,H,L
Andaman Nicobar	3	3	A	1	1	A	4	4	A
Chandigarh	3	7	C,A	1	2	A	4	13	C,A/L
Dadra and Nagar Haveli	3	3	C,W,A	1	1	C,A	4	8	C,W,A
Daman and Diu	2	3	C,W,F,A	1	3	C,A,K	4	13	C,W,H,A
Delhi	2	10	C,A	1	5	C,A	3	8	P,L
Puducherry	2	9	W,Q	2	8	C,Q,R,S	4	13	C,W,H,S,Q,A

Source: NCAER report (NCAER 2012). Detailed tax rates are given in NCAER report.

Legends:
C: capacity
W: weight
P: price
A: annual
Q: quarterly
L: lifetime/ lumpsum
F: fuel type
R: regional
K: distance (km)
S: service
E: Earnings
M: monthly
I: institution
D: daily
B: body form i.e. whether chassis or vehicle
T: number of wheels/ tyres
O: ownership of second vehicle, age of vehicle,
H: cc (engine capacity)

owned transport corporations fall short of operating cost and receive some form of subsidies from state governments. Sometimes, they receive subsidised fuel as well. In the aviation sector, some economically unprofitable regional routes receive cross-subsidisation. In recent past, the ship-building industry has also received subsidies.

The above discussion on the current system of taxes brings forth an important finding: the tax system in road transport is much more complex compared to rail, civil aviation and shipping. While there are hardly any taxes imposed by the state governments on rail transport, the other two modes, aviation and shipping, face less tax complexity due to uniformity in tax structure. Except fuel, these three transport modes are almost exempted from state-level taxes. On the other hand, the Road Tax and P&GT rates are very diverse and complex. In fact, one of the important sources of inefficiencies in the transport sector is the multiplicity and complexity of this tax structure resulting in several barriers to free movement of goods across state borders. Since road is the dominant mode of transport, any inefficiency in this sector gets multiplied through strong sectoral linkages. Why is the tax system in road transport so complex? Does MVT and P&GT comply with the objectives we discussed in the first section? These are the questions we try to address in the next section.

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COMPLEXITY OF TAXES IN ROAD TRANSPORT

In addition to usual central taxes, Motor Vehicle Tax (MVT) and Passenger and Goods Tax (P&GT) are levied by the state governments in road transport. Broadly, there are two objectives of MVT. First, it can be justified as the approximate user charge for use of the road network. Second, MVT is used as a fast-growing base of tax revenue for states. Over time, it became an important revenue source of state governments. However, the complexity of this tax system has caused several impediments to smooth functioning of inter-state trade and commerce.

TAX COMPLEXITY

There are different bases for computation of tax rates across states. While the access charges vary according to vehicle type, they do not discriminate according to usage type. The current structure of MVT is only indirectly linked to usage of the road network. Moreover, the revenue generated from MVT is not necessarily earmarked entirely for road network development and maintenance. Therefore, it is not a perfect user charge. The MVT structure depends on the use of vehicle, i.e. whether it is a goods carrier, used in passenger transport, or as a personalised vehicle. Further, each of these three vehicle types includes a specified category of vehicles that are taxed differently. MVT, in its current form, is a form of registration charge on access to road network. In fact, the more distance a vehicle has travelled, the less the vehicle charge per kilometre.

The tax parameters are mainly capacity/ weight of the vehicle, fuel type, body type, engine capacity, distance travelled, ownership, cost of vehicle, etc. Tax could be paid quarterly, annually, or for life depending on state-specific rules. Some states also charge differentiated tax within regional limit. Each state has multiple lines of tax rates based on a combination of parameters for each broader group, i.e. passenger vehicle, goods vehicle and personalised vehicle. It is evident that as the tax lines increase, the tax structure gets complicated. Moreover, a varied combination of these parameters complicates and prevents formulation of a common benchmark for state-level comparison. Nevertheless, an effort has been made to summarise the extent of complexity of MVT across states based on number of tax lines, number of parameters, and types of vehicles. Wide variations in the MVT rates, not only across states, but also across vehicle types and further within are summarised in Table 9.8.

For any vehicle type, a low number of lines and parameters would indicate a simplified tax procedure whereas complexity is evident for states with higher number of lines and parameters. The tax procedures appear to be the simplest in Delhi and Chandigarh (apart from smaller states and UTs) after taking into account the variety of decisive parameters in case of goods carrier. West Bengal appears to be executing an extremely complex structure as the state has got the maximum number of lines. With regard to passenger transport, Andhra Pradesh, West Bengal and Uttar Pradesh have the simplest structures whereas Punjab and Rajasthan implement a considerably varied tax structure across vehicles transporting passengers. Tax structure on personalised vehicles is most simple in Andhra Pradesh, whereas Maharashtra exhibits huge complexity due to high number of lines as well as parameters.

The Motor Vehicle Tax can be justified as the approximate user charge for use of the road network. It is also used as a fast-growing base of tax revenue for states. However, the complexity of this tax system has hampered smooth functioning of inter-state commerce.

MVT, levied by states under their own motor vehicle taxation acts, is mainly for revenue purpose, whereas licence fees, registration fees, permit fees, etc. collected under Indian Motor Vehicles Act are for regulatory purpose of road transport. The revenue collected from registering motor vehicles, obtaining driving licences, transfer of ownership of motor vehicles, permit for transport vehicles, and certificate of fitness for transport constitute a significant portion of states' total tax revenue.

Thus, there are four main characteristics of the current Motor Vehicle Taxation System.

a) Different classification principles of vehicles for the purpose of taxation across states
b) Variation in duration of tax cycle across states- life time vs periodic
c) Use of ad valorem vs specific rates
d) Multiplicity of tax rates

All the above features result in serious problems of cross-classification and unintended economic effects.

Some states also impose tax on entry of goods into local areas for final consumption or sale; tolls on roads; passenger tax; and goods tax. All these taxes are classified as Taxes on Goods and Passengers in state budget documents. Some states also impose surcharge on tax on goods and passengers carried by road and inland waterways. At present, all the states do not levy entry tax. Also, it is not levied on all goods. Entry tax is levied through a separate statute in each state. There may be separate statutes for the levy of entry tax on motor vehicles and other speci-

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Table 9. 9
Multiplicity of Laws and Taxes that Regulate Road Transport Sector

TYPE OF LAWS AND TAXES	IMPORTANT LAWS/TAXES
Laws governing access control to National Highways	i) National Highways Act, 1956 (ii) National Highways Rules, 1957 (iii) The National Highways Authority of India Act, 1988 (iv) National Highways (Land and Traffic) Act, 2002 (v) Highways Administration Rules, 2003.
Laws governing inter-state movement of goods	(i) Central Sales Tax Act, 1956 (ii) Various State Sales Acts / State VAT (iii) Various Local / Municipal Acts Governing Octroi and Entry Tax (iv) The Carriers Act, 1865 (regulating the liability of carriers)
Laws governing inter-state movement of vehicles	(i) The Motor Vehicle Act (MVA), 1988 (Amended in 1994, 2000, and 2001) (ii) The Central Motor Vehicle Rules (CMVR), 1989 (Amended in 1994, 2000, 2002, 2004, and 2005) (iii) Various State Motor Vehicles Acts.
Taxes	Road Tax, also known as Motor Vehicle Tax State VAT/Sales Tax Passengers and Goods Tax (P&GT) which includes Entry Tax State Toll Taxes Service Tax on output of this sector as well as secondary activities.
User Charges/Fees	Registration of motor vehicles Obtaining of driving licenses Transfer of ownership of motor vehicles Permit for transport vehicles Certificate of fitness for transport Tolls on roads and bridges

Source: NTDPC Research.

fied goods. Local area, for this purpose, means an area falling within the jurisdiction of any municipal corporation, municipality, municipal body, cantonment board, gram panchayat, or any other local authority constituted under the statutes referred to in the law for levying entry tax. This tax is generally payable only at the point of first entry in the state, except in specific situations. In certain states, entry tax may be payable on movement from one local area to another.

Vehicles and their parts attract central excise, customs duty, and state sales tax. Basic customs duty on vehicles is around 10 per cent. CVD rate varies from 10.3 per cent to 22.6 per cent. A Special CVD of 4 per cent is also imposed on some vehicles and parts thereof. Central government collects excise duty at 22 per cent for passenger transport vehicles. There is additional specific tax of Rs 20,000 per unit for some types of vehicles. Excise duty varies from 10 per cent to 22 per cent for goods carrier. Sales tax / VAT for motor car vary from 12.5 per cent (Punjab, Maharashtra, Kerala, West Bengal, etc.) to 14.5 per cent (Andhra Pradesh). Inter-state transactions are subject to central sales tax of 2 per cent.

The Union Government also collects revenue from service tax on transport of goods by road, cargo handling service, tour operator's service and rent-a-cab service. The standard service tax rate is 12.36 per cent including education cess.

TOLL AND CESS

There are two important other components of road pricing that need to be discussed: toll on National Highways and cess on petrol and diesel. Toll is an instrument used to control access to road. The toll, or user fee, on National Highways is levied and collected in accordance with the provisions of the National Highways Act, 1956 and rules made thereunder. User fee is charged on all sections of the National Highways having four or more lanes, bridges, and newly constructed bypasses. A ceiling for fee rate per kilometre for different types of vehicles has been prescribed for public-funded projects. Toll is charged in India under an 'open system' that imposes a fixed payable amount independent of the facility availed. This is in contrast to the 'closed system' approach in many other countries that charge tolls on the basis of the distance travelled. In the case of private investment projects, the collection of fee levied under the rule is made in accordance with the terms of the agreement entered into by the concessionaire.

The Government of India introduced a cess on both petrol and diesel through the Central Road Fund (CRF) Act, 2000. Currently, Rs 2 per litre is levied as cess or additional duty of excise and customs on

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Table 9.10
State Tax Revenue From Road Transport
[Rs Billion]

YEAR (MARCH ENDING)	MOTOR VEHICLE TAXES AND FEES	SALES TAX ON MOTOR SPIRITS AND LUBRICANTS	SALES TAX ON PASSENGER AND GOODS TRAFFIC	TOTAL STATE TAX FROM ROAD TRANSPORT (A)	TOTAL STATES' OWN TAX REVENUE
2003	84	51	36	171 (12.0)	1,421
2004	101	50	42	193 (12.1)	1,599
2005	108	67	52	227 (12.0)	1,891
2006	120	30	65	214 (10.1)	2,123
2007	132	13	68	214 (8.5)	2,525
2008	151	16	68	236 (8.2)	2,865
2009	164	9	85	259 (8.0)	3,219
2010	191	10	99	300 (8.3)	3,631
2011	244	7	113	364 (7.9)	4,607
Growth Rate (per cent)*	14.2	-21.9	15.5	9.9	15.8

Source: NTDPC Research.

both petrol and high speed diesel (HSD) oil as per the provisions of the Act amended by the Finance Act in 2005. Parliament decided that the fund so collected should be put aside in a Central Road Fund (CRF) for exclusive utilisation towards the development of a modern road network.

To sum up, the tax structure is exceedingly complex in road transport, and has wide variations across states. It is difficult to compare tax rates among states due to the differential taxation structures and different classification principles for taxation of vehicles. Moreover, some states levy specific amount as tax on motor vehicles, whereas some others collect ad valorem tax. In some states, road tax is collected in lump sum as lifetime tax, whereas in other states, it is collected periodically.

Regulation and taxation of motor vehicles are two distinct powers under the Indian Constitution. While regulation is under the concurrent list, taxation of road transport is under the state list. Except for National Highways, state governments have the responsibility of construction and maintenance of roads. Both central and state governments impose taxes at different stages–on purchase, ownership, and use of vehicles as well as 'services' related to this sector. A summary of the multiplicity of laws and taxes in the road sector is given in Table 9.9.

While the multitude of taxes and user charges lead to severe complexities, it is difficult to ignore their increasing contribution to the public exchequer. Is it possible to rationalise the tax structure in the road sector in a revenue-neutral way? What is the significance of these taxes in states' finances?

REVENUES FROM TAXES ON ROAD TRANSPORT

Revenue from MVT is one of the increasing sources of state's own tax revenue. Though it was originally envisaged to be levied as a regulatory measure, over time it became an important revenue source. According to a report sponsored by the Planning Commission[3], the revenue from MVT has increased at an annual rate of 14.6 per cent and exhibited a tax buoyancy of 1.05 during the period 1980-81 to 2007-08. Table 9.10 gives state tax revenue from road transport from 2002-03 to 2010-11. During the same period, revenue from MVT grew at a CAGR of 14.2 per cent, whereas revenue from Passenger and Goods Tax (P&GT) grew at 15.5 per cent. However, revenue from sales tax on motor spirit and lubricants declined annually at 21.9 per cent. The fall is particularly sharp between 2005 and 2006, with almost a consistent decline from thereon.

3. Purohit and Purohit (2010).

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Table 9.11
Central Tax Revenues from Road Transport
[Rs Billion]

YEAR (MARCH ENDING)	MOTOR VEHICLES AND ACCESSORIES		TYRES AND TUBES		HSD		MS		TOTAL CENTRAL TRANSPORT REVENUES (B)	STATE AND CENTRAL REVENUES C= B+(A) OF TABLE 10	TOTAL INDIRECT TAX OF CENTRAL GOVT
	Import Duty	Excise Duty	Import Duty	Excise Duty	Import Duty	Excise Duty	Import Duty	Excise Duty			
2003	12	53	..	14	46	58	..	116	300 (30.9	471	969
2004	14	56	..	11	53	73	..	126	333 (30.2)	526	1,104
2005	19	68	..	14	67	79	..	138	385 (29.9)	612	1,289
2006	21	70	..	11	57	112	..	176	447 (29.9)	660	1,496
2007	32	68	..	12	71	126	..	183	492 (27.1)	706	1,814
2008	44	67	..	14	97	129	..	201	553 (26.6)	789	2,080
2009	49	44	..	9	67	130	..	211	509 (26.1)	768	1,952
2010	41	93	15	11	47	140	34	288	669 (36.2)	969	1,849
2011	65	87	26	9	159	185	87	268	886 (34.1)	1,250	2,594

Source: State Finances: A Study of Budgets (RBI), several years.
* Annual growth rate between 2000-01 and 2010-11.
† Shares in states' own tax revenues are given in parenthesis.

It is also important to emphasise that growth rates varies across states, especially between special and non-special category states. The share of revenue from road transport in total states' own tax revenue was 12.0 percent in 2002-03. The aggregate revenue from states' own taxes has increased annually at 15.8 per cent, whereas total revenue from road transport-related taxes has increased annually at 9.9 per cent during 2003-2011. As a consequence of sudden drop in sales tax revenue from motor spirit and lubricants since 2005-06, the share of revenue from road transport in total states' own tax revenue has dropped to 7.9 per cent in 2011 from 12.0 per cent in 2003.

The Central Government generates revenue from import duty and excise duty on motor vehicle and parts, tyre, tubes, and fuels. The figures are given in Table 9.11. Total revenue from excise and customs on road transport-related goods and fuel has increased annually at 14.5 per cent during 2002-03 to 2010-11. During the same period, the share of this revenue in total net indirect tax revenue of the Central Government hovered in the range of 26 to 36 per cent, with the average being 31 per cent. Total revenue of states and central government from taxes on road transport were around Rs 470 billion in 2002-03 which have increased to about more than Rs 1200 billion by 2010-11 growing at a CAGR of 13.0 per cent.

REVENUE FROM SERVICE TAX

There are several services related to the road sector that are taxed. Some services like tour operator services, goods transport operator services (discontinued from 2005-06) and cargo handling services, do not necessarily fall under the classification of road transport. Therefore, considering aggregated revenue figures from service tax might not be useful. Table 9.12 gives the disaggregated figures of service tax revenue

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Table 9.12
Service Tax Revenues from Road Transport
[Rs Million]

SERVICE	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Rent A Cab Scheme Operator Services	110	150	290	530	680	1,260	2,180	2,610	2,370	2,890	3,580
Tour Operator Services	110	130	310	430	950	1,520	1,510	1,710	1,480	1,750	2,400
Goods Transport Operator Services		50	370	50							
Service or repair produce by authorized service station for motor car & two wheeled motor vehicle	170	510	790	1,480	1,570	2,200	2,420	2,820	2,650	3,170	4,510
Cargo handling (only inland cargo)	-	100	390	950	1,690	3,290	3,790	4,450	4,840	5,340	6,290
Transport of goods by road	-	-	-	1,910 [4]	14,090	24,820	28,340	32,080	26,280	30,280	33,860
Travel agent	-	-	-	30	60	100	120	120	110	190	200
Total	**390**	**940**	**2,150**	**5,380**	**19,040**	**33,190**	**38,360**	**43,790**	**37,730**	**43,620**	**50,840**

Source: Finance Accounts, Union Government, Controller General of Accounts, Ministry of Finance.

from road transport-related services from 2001-02 to 2011-12. Over time, new services were introduced under the service tax net. As a result, tax revenue from the road sector has increased rapidly between 2001-02 and 2011-12. The largest share comes from transport of goods by road (around 66 per cent[4]).

REVENUE FROM TOLL AND CESS

In addition to taxes, toll and cess contribute significantly to the public exchequer. However, as mentioned earlier, these instruments have less fiscal flexibility to meet the resource mobilisation objective. Total toll revenue from National Highways was Rs 44 billion in 2009-10 and that increased to Rs 80 billion in 2011-12 (Table 9.13)[5]. There is increasing emphasis on PPP projects in the road sector. The construction and expansion of projects under National Highways Development Project (NHDP) Phase III and onwards is undertaken on PPP basis with build, operate and transfer (BOT) as the preferred mode to mobilise resources for infrastructure development. Share of toll revenues from publicly funded projects (including operate, maintain and transfer projects) was 37 per cent in 2009-10. The share was down to 25 per cent in 2011-12.

The fuel cess is collected by the Ministry of Finance. The revenue from cess on HSD and Petrol has increased from Rs 113 billion in 2005-06 to Rs 184 billion in 2011-12 (more than 60 per cent increase in six years). Total collection from the cess is given in Table 9.14.

The collection on this account is credited to the Consolidated Fund of India and thereafter Parliament, by appropriation, credits such proceeds after adjusting the cost of collection to the Central Road Fund (CRF). The CRF is distributed by the Planning Commission amongst the three Ministries of Rural Development, Railways, and Road Transport and Highways in the manner prescribed under Section

4. The percentage figure is based on aggregation of all the services listed in the table. As already mentioned, there are several services that span across modes.
5. The service tax on transport of goods by road was introduced on 01.01.2005. This is the reason for this low figure.

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Table 9.13
Toll Revenue from National Highways
[Rs Billion]

CATEGORY	2009-10	2010-11	2011-12
Public Funded Stretches +OMT	16	19	20
BOT Stretches (revenue share to NHAI/premium)	3	5	9
BOT Stretches (Concession accrues to the Concessionaire)	25	35	51
Total	**44**	**59**	**80**

Source: National Transport Development Policy Committee, Planning Commission
Note: OMT: Operate, Maintain & Transfer; BOT: Build, Operate & Transfer

10 (viii) of the Central Road Fund Act, 2000. The central government is responsible for development and maintenance of the National Highways. The Ministry of Road Transport and Highways takes care of the development and maintenance work of National Highways through three agencies, viz. National Highways Authority of India (NHAI), state public works departments (PWDs) and Border Road Organisation (BRO). The state roads and major district and rural roads fall under the responsibility of the respective state governments. These are developed and maintained by various state agencies. However, as already mentioned, some funds are also being provided by the Union Government from CRF for the development of state roads. There are two important schemes under which the state governments receive funds from CRF: (a) to develop state roads (other than rural roads, and (b) to develop interstate connectivity. These schemes are called Improvement of State Roads from the CRF and Economic Importance and Interstate Connectivity Scheme, respectively. To illustrate, an allocation of Rs 167 billion was made under CRF in 2009-10, the break-up of which is given in Table 9.15.

TOTAL RESOURCES GENERATED FROM ROAD TRANSPORT

The total resources generated from indirect taxes, cess and toll from road transport sector is around Rs 1,523 billion in 2010-11 which is around 1.95 per cent of GDP (Table 9.16). It was Rs 1,216 billion in the previous year.

Generation of economic resources is one of the important rationales for taxes in the transport sector. The above discussion has highlighted the importance of the revenue-generating role of vehicle tax, passenger and goods tax and user charges in states' finances. However, most of the state-level taxes are ad-hoc in nature and do not necessarily follow the principle of economic efficiency. There are two main explanations for that. First, there is no comprehensive study to assess and fix the tax rates on the marginal cost-benefit principle of transport pricing. Second, the multiplicity and complexity of taxes impose transaction costs and several other hurdles for inter-state movement of cargo. In the next section, we discuss the sources of fiscal inefficiencies in road transport sector.

SOURCES OF FISCAL INEFFICIENCIES

Fiscal inefficiencies in transport sectors may arise due to several reasons. First, in a federal structure, the lack of coordination between tax-levying authorities may lead to huge transaction costs. For example, lack of state-level coordination in granting permits causes difficulties for private operators. The interstate movement of cargo and passengers is delayed due to long waiting times for paper work at state borders. Second, taxes on motor vehicles, goods and passengers vary across states substantially. Not only that, the way that tax is being collected has a significant impact on overall efficiency. Some states use simplified tax slabs and less complicated parameters for tax rates. In other states, the rate not only differs across types of vehicle, it also differs by capacity, axle type, and fuel type. Some states simplified the tax collection by imposing one-time tax. Third, tax rates are not necessarily set at optimal levels that fully reflect social costs due to negative externalities. Generally, externalities depend on type of fuel, carrying capacity, engine type, usage of infrastructure, time of traffic movement, etc. However, multiple tax lines create complications and cost of tax collection increases. It may also increase probability of tax eva-

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Table 9.14
Funds Collected from Cess on High Speed Diesel and Petrol in India
[Rs Billion]

YEAR	AMOUNT COLLECTED
2005-06	113
2006-07	122
2007-08	133
2008-09	152
2009-10	166
2010-11	170
2011-12	184

Source: Lok Sabha Unstarred Question No. 1707, dated 10 December 2008. Rajya Sabha Unstarred Question No. 1810, dated on 8 December 2011 and Rajya Sabha Unstarred Question No. 4458, dated 7 May 2013

Table 9.15
Allocation of Central Road Fund in 2009-10
[Rs Billion]

ALLOTTEE	AMOUNT
National Highways	86
Rural Roads	48
Railways	10
Grant to State Governments and UTs for State roads	21
Grant to States & UTs for Roads of Inter-State Connectivity and Economic Importance	2
Total	167

Source: NCAER Report (NCAER, 2012).

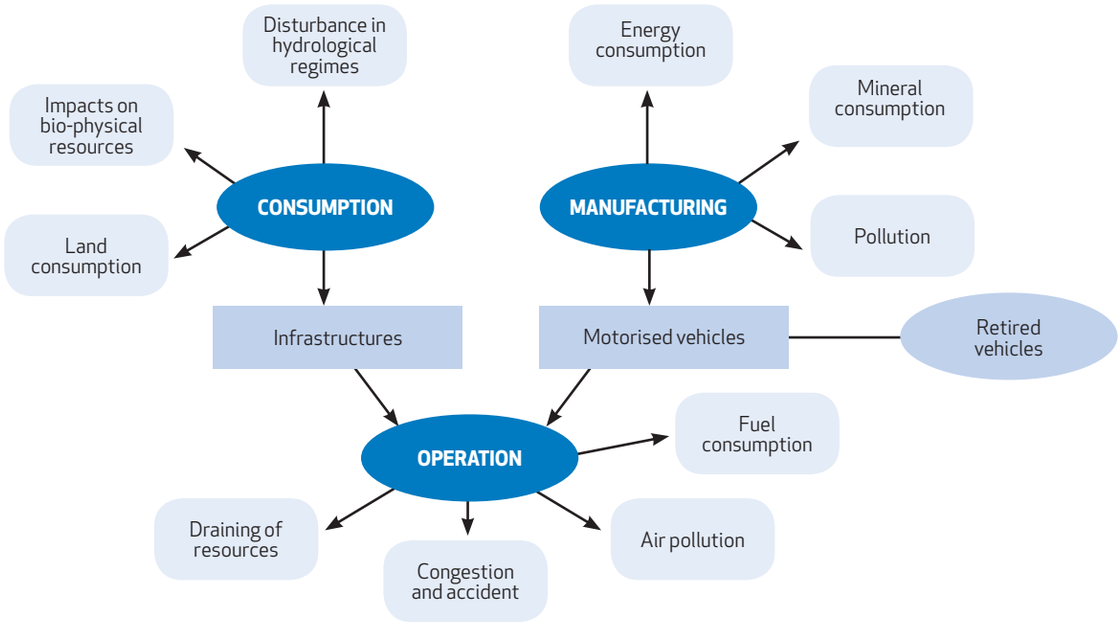
Table 9.16
Total Revenue Generation from Road Sector
[Rs Billion]

PARTICULARS	2010	2011
Total State and Central Road Tax Revenues	969	1,250
Service Tax Revenue from Road Transport	38	44
Toll Revenue from National Highways	44	60
Revenue from Cess on High Speed Diesel and Petrol	166	170
Total Revenue Generation from Road	1,216	1,523
GDP at Current Market Price	64,778	77,953
As a Per cent of GDP	1.88	1.95

Source: Planning Commission.

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Figure 9.1
Environmental Impacts of the Transportation System



Source: Environmental and Social Sustainability of Transport: Comparative Study of Rail and Road, Asian Institute of Transport Development, 2002

Table 9.17
Important Environmental Effects of Transport Modes

MODES	AIR	WATER RESOURCES	LAND RESOURCES	SOLID WASTE	NOISE	RISK OF ACCIDENT	OTHER IMPACTS
Road	Air pollution (CO, HC, NOx, particulates such as lead), global pollution (CO_2, CFCs)	Modification of water systems by road building; pollution of surface and ground water by surface run-off	Land taken for infrastructure; extraction of road building materials	Abandoned facilities and rubble from road works; road vehicles withdrawn from service; waste oil	Noise around highways	Deaths, injuries & property damage due to road accidents; risk from transport of hazardous goods	Partition or destruction of neighbourhoods, farmland and wildlife habitats; congestion
Air	Air pollution, greenhouse & ozone depletion effects at higher altitudes due to NOx emissions	Modification of water tables, river courses and field drainage in airport construction	Land taken for infrastructure; dereliction of obsolete facilities	Abandoned facilities and aircraft withdrawn from service	Noise around airports	Deaths, injuries & property damage due to aircraft accidents	
Water Transport	Discharge of ballast water, oil spills, etc.; modifications of water systems during port construction & canal cutting and dredging	Land taken for infrastructure; dereliction of obsolete port facilities & canals	Abandoned and laid-up vessels and craft	Bulk transport of fuels and hazardous substances			
Rail	Air pollution in populated areas; global pollution from thermal generating stations for electric traction		Land taken for right-of-way and terminals; dereliction of obsolete facilities	Abandoned lines, equipment and rolling stock	Noise and vibration around terminals and railway lines	Derailment or collision of trains carrying hazardous substances	Partition or destruction of neighbourhoods, farmland and wildlife habitats

Source: Sustainable Transport Pricing and Charges: Principles and Issues, Asian Institute of Transport Development and UNESCAP, 2001

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sion. Major obstacles to interstate movement arise from transaction costs which reduce and sometimes may completely eliminate the benefit of differentiated taxing systems across states. It is observed that vehicle owners often change the address of vehicle registration to other states where tax rates are lower. Similarly, Indian ship owners are increasingly registering their ships in other tax-friendly countries.

We, however, are not in a position to quantify the loss due to obstacles at state borders (systemic obstruction that may cause slower movement of freight in India). There is a need to undertake a study to identify and quantify transaction costs caused by multiplicity of tax systems and non-harmonised regulations.

A typical carrier has to face a number of regulatory agencies when moving goods across regions: sales tax authorities, regional transport offices (RTOs), excise, forest department, regulated market committee, civil supplies (check on the movement of essential commodities, black marketing, weights and measures, food adulteration), and mining department. Clearly, all issues are not fiscal. Transporters have to face multiple detentions resulting in lower speed, loss of time, higher transaction costs, more fuel consumption, etc. All these lead to underutilisation of vehicle capacity and adversely affect operational viability. It is often argued that the road transport sector, due to these reasons, faces unequal competition from freight/cargo transport by rail, despite the fact that it has been gaining traffic share from the railways for a long time. Moreover, it causes wider economic costs which are difficult to assess.

The consequences of distortionary pricing policy are revenue loss due to tax evasion, higher expenditure on regulation and tax collection, transaction costs due to complicated tax systems, environmental damage, etc. As a result, insufficient revenue is generated for infrastructure development and maintenance. In recent years, government increasingly depends on private partnership in infrastructure projects. However, the private players may not necessarily maximise net social benefit and consequently a conflict arises.

The key questions concerning tax efficiency in the transport sector are the following:

- whether transport charges internalise marginal social costs
- whether transport sectors are subject to the same level of taxes on factors - labour and capital - in comparison with other sectors (direct taxes are beyond the purview of our analysis)
- whether transport charges on different modes are levied on the same basis
- whether subsidies in transport sector are justified under increasing returns to scale and if net charges cover fixed cost and part of marginal cost
- whether redistribution through cross-subsidisation serves its purpose by properly targeting intended recipients
- whether domestic and foreign operators pay same level of transport taxes across states

We are not in a position to investigate these sources of inefficiencies due to data limitations. Later in the chapter, in order to gauge the wedge of inefficiency, we have attempted to capture some elements of differences in the delivery of transport services across a group of countries. The countries selected for such comparison are a mix of some developed and some developing countries.

The inefficiency due to complexity in tax structure is one of the reasons behind the tariff reforms in India. Instead of multiple tariff lines and product-specific rates, India gradually moved to simplified tariff lines. Similarly, recent sales tax reform has introduced uniform three to four schedules of VAT rates. A transparent and uniform tax system across states is one step forward towards a common market in India.

Thus, while the current tax structure in the road transport sector may achieve the revenue-generating goal for the states, it creates a big challenge to policy makers for moving towards a common market in India. The objective of environmental sustainability through a proper pricing mechanism is also an important challenge. How does the Indian transport sector cause negative externalities in terms of immediate health hazards, and long-term environmental damage through greenhouse gases? Is there any role of fiscal instruments to correct pricing signals?

ENVIRONMENTAL COST OF TRANSPORT AND CORRECTIVE FISCAL MEASURES

As has been discussed earlier, if pricing does not internalise the social cost due to negative externalities, there are serious problems in allocation of resources and overall economic welfare of the society. There are several external costs relating to the damage to human health on account of transport, especially road transport. It may be caused by noxious pollution, noise pollution, congestion, climate change, etc. Some effects are immediate, while others may be observed in the longer term. Figure 9.1 and Table 9.17 give a summary of negative externalities of transport modes both at systems and modal levels.

Though there is a high degree of uncertainty in estimating the correct monetary value of environmental cost in the transport sector, all studies indicate substantially high cost of damage to health. An early study 'Environmental and Social Sustainability of

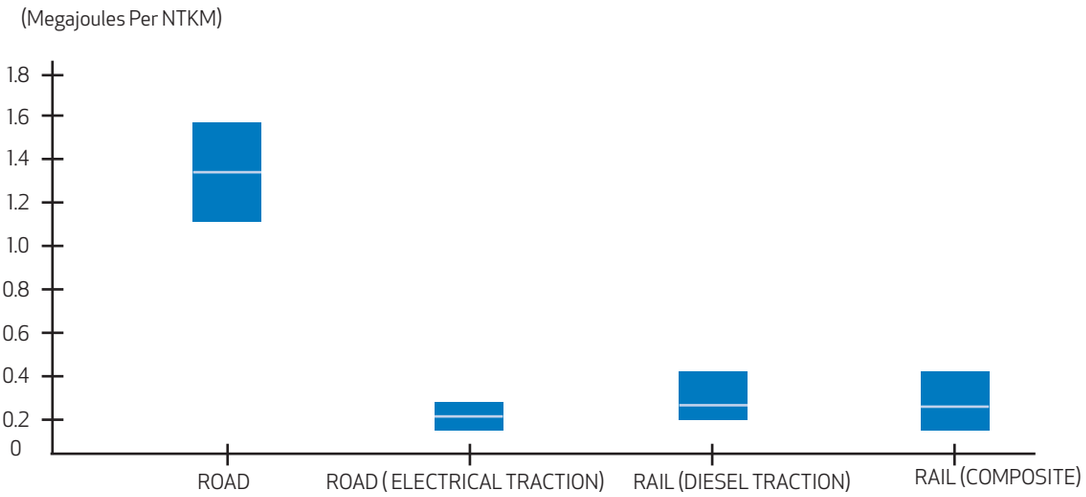
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Table 9.18
Environment Cost Per Tonne-Km for Road and Rail
[Rs]

MODE	COST
Road (Freight)	0.202
Rail (Diesel Traction)	0.051
Rail (Electric Traction)	0.015
Airways	0.690
Coastal Shipping	0.030

Source: Total Transport System Study by RITES (2007-08).

Figure 9.2
Energy Consumption Ranges in Freight Transport



Source: Environmental and Social Sustainability of Transport; Comparative Study of Rail and Road, Asian Institute of Transport Development, 2002.

Transport' conducted by Asian Institute of Transport Development (AITD) in 2002 indicates that health damage cost of rail is generally lower than that of road. In urban areas for freight traffic, it is lower by as much as 76 paise per NTKM, while for passengers, it is lower by 10 paise per PKM. Moreover, substitution of passenger traffic on road by rail with diesel traction would result in substantial savings in health damage cost per day.

A study entitled Total Transport System Study (TTSS) by RITES made an assessment of the environment cost based on another previous study, 'Estimating Cost of Air Pollution Abatement for Road Transport in India: Case Studies of Andhra Pradesh and Himachal Pradesh' conducted by Institute of Economic Growth in 2005. The cost to the environment was treated as the cost of abatement, comprising cost of upgrading vehicle technology to meet higher emission norms and cost of improving fuel quality. The study drew on the data and findings from various studies such as emission level by different modes from Central Pollution Control Board (CPCB), social cost from Environmental and Social Sustainability

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Table 9.19
Comparison of Co_2 Emission Between Rail and Road

		RAIL (SINGLE LINE)	ROAD (4 LANES WITH SERVICE ROAD)
Embodied energy (TJ/km)	Construction	12	39
	Maintenance	20	28
Embodied CO_2 emission (T/km)	Construction	1,294	3,442
	Maintenance	1,892	1,073

Source: Total Transport System Study by RITES (2007-08).

Study of Transport by AITD, cost of improvement of fuel quality from the Mashelkar Committee, 2002. On the basis of analysis, the environment cost per tonne-km for road freight sector was determined as Rs 0.202. The cost for rail, airways and coastal sector was arrived at in proportion to fuel consumption under each of these sectors. A fuel consumption norm of 2.54 litres/'000 GTKM under rail, 0.00216 litres/tkm under coastal sector and 4.8 litre/100 kms for Airways was adopted. The environment cost adopted in the study under different modes is shown in Table 9.18.

The environment cost is assessed as Rs 0.051 per tonne-km for diesel rail traction while it is Rs 0.015 per tonne-km for electric-powered rail traction. The cost for coastal shipping has been determined as Rs 0.030 per tonne-km while for Airways it is found much higher at Rs 0.690 per tonne-km. Clearly, rail and coastal shipping have greater social cost advantage in freight movement. If the objective is to minimise the environmental cost and enhance sustainability, there is a clear case for shifting towards rail while also encouraging coastal shipping. With significant variation of external cost across modes and comparative cost advantage in some modes, the overall social cost of transport depends on an optimal mix of modes. A survey carried out among transporters in India suggests that the quality of service matters most in determining choice of transport mode[6].

A comparative study of relative energy consumption for equivalent volumes of traffic on rail and road modes for both passenger and freight traffic, conducted by AITD in the year 2002 revealed that rail consumes much less energy than road transport and has maximum advantage in respect of freight traffic. Figure 9.2 illustrates energy consumption (MJ/NTKM) between road and rail freight transport.

A study[7] on life cycle energy and CO_2 emissions impacts of transport mode in India by TERI (2012) suggests that understanding of the full-life cycle energy and CO_2 impacts of transport modes can help choose better inter-modal shifts that are least energy and carbon-intensive throughout their lives. It also helps promote intra-modal shift towards more 'greening' by changing share of various components that contribute to energy consumption and CO_2 emissions. Rail (single line) has around 12 TJ/km of embodied energy for construction and 20 TJ/km for maintenance (Table 9.19). Whereas, highways (four-lane with service road) has 39 TJ/km and 28 TJ/km of embodied energy in construction and maintenance respectively. When we compare same modes for their embodied CO_2 emissions, rail releases around 1,294 T/km and highway releases 3,442 T/km during construction phase. The corresponding figures for maintenance phase are 1,892 T/km and 1,073 T/km respectively. Apart from applying different scientific mitigating measures, fiscal instruments may play a vital complementary role.

Transport policy directed towards internalisation of externalities in each mode can effectively improve the sustainability. As a quasi-public good, transport network should be priced for the use of its services for both passenger and freight traffic. We have already explained the rationale behind taxation and user charges for equity and efficiency considerations. We described the major taxes – taxes on vehicle, taxes on goods and passengers and taxes on fuels

6. Dey Chaudhury (2005).
7. Life cycle analysis of transport modes, prepared for National Transport Development Policy Committee (NTDPC) by The Energy Resources Institute (2012).

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Box 9.1
Sustainable Pricing in Transport Sector

- Sustainable development should be promoted to the extent possible through transport prices that are equated with marginal social cost. The scarcity value of the natural resources used in the provision of transport infrastructure and services and the external costs due to pollution and degradation of the environment (that is, the social cost of transport), should be built into the price of providing or using transport facilities and services. Optimal pricing must balance economic efficiency, equity and transaction costs.

- The internalization of externalities is a fundamental requirement in devising transport pricing policies to promote sustainable development. Transport generates many negative externalities or external costs, including noise, accidents, pollution and congestion. If the externality costs are not borne by those who generate them, then the market mechanism fails to allocate resources efficiently. The 'polluter pays' principle suggests that users should be made aware of the external costs they generate by imposing on them pollution tax equal to the marginal environmental cost. This would also reduce the volume of transport activity to the socially optimal level.

- A sustainable transport policy will require intervention in the market system to ensure that:
  - the direct or indirect use of natural resources is such that they can at least be replaced by (a) their natural regeneration (e.g. hydroelectric energy for electric traction), or (b) discovery of new deposits of the currently used exhaustible resource (e.g. oil or natural gas reserves), or (c) the use of a new renewable resource (e.g. wind or solar power), or (d) conserving the use of resources per unit of transport output, or (e) a combination of these; and
  - the damage to the environment is within such limits that the productivity of other economic activities and the quality of life, in terms of health and security against accidents, do not deteriorate over time.

Source: Sustainable Transport Pricing and Charges: Principles and Issues, Asian Institute of Transport Development and UNESCAP, 2001.

and lubricants. None of these three types of taxes can be considered as representing charges related to the extent of usage of physical infrastructure and environmental damage. Gradually, highways are brought under the toll network which helps to internalise depreciation cost of infrastructure. It is a user cost in its true sense. However, India needs to develop an effective transport pricing policy, especially in urban transport, for environmental sustainability. We should also keep in mind that unnecessary complication in the tax system due to multiple environmental taxes may once again induce efficiency loss for reasons mentioned above.

It is an enormous task to assess the current tax system in terms of its effectiveness of achieving economic efficiency, environmental sustainability and resource generation – the three important rationales discussed in the first section. What is the extent of welfare loss due to economic inefficiencies under the current tax regime? The biggest hurdle we face in addressing these issues is limited data. As a result, it is almost impossible to disentangle the effect of fiscal inefficiency from all other inefficiencies in the sector. However, as a confidence-building exercise, we use a general equilibrium framework to answer whether welfare-improving reform in transport tax structure is possible given strong sectoral linkages in the economy.

MODELLING RESULTS

The differential multiple tax regime across sectors of production leads to distortions in allocation of resources, thus introducing inefficiencies in the sectors of domestic production. The Thirteenth Finance Commission Report has recommended moving over from a complex tax structure at central and state levels to a comprehensive and simplified Goods and Services Tax (GST) regime that would facilitate efficiency in transport sectors. A recent NCAER study has analysed the impact of introducing GST on economic growth and international trade; changes in rewards to the factors of production; and the impact on output, prices, capital, employment, efficiency and international trade at the sectoral level[8]. GST would lead to efficient allocation of factors of production. The overall price level would go down. It is expected that the real returns to the factors of production would go up. The present study looks at distortions in the tax structure with regard to trans-

8. NCAER (2009).

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Table 9. 20
Cross-Country Comparison of Transport Efficiency

COUNTRY	TAX INTENSITY OF TPT OUTPUT	TPT INTENSITY OF OVERALL OUTPUT	ENERGY INTENSITY OF TPT OUTPUT		
			PETROLEUM	ELECTRICITY	TOTAL
Brazil	2.7	2.9	14.8	1.4	16.2
Canada	-0.4	2.4	9.5	0.6	10.1
China	-	3.5	17.3	1.5	18.8
France	2.9	2.9	4.9	0.7	5.6
Germany	2.9	3.4	4.7	0.9	5.6
India	**4.7**	**4.0**	**20.1**	**1.6**	**21.6**
Japan	-	2.3	6.6	1.7	8.2
Korea	-	2.3	18.8	0.6	19.4
South Africa	3.3	3.6	11.3	1.4	12.7
Thailand	0.9	1.9	25.1	1.1	26.2
USA	-	2.0	8.7	0.3	9.0

Source: NTDPC Research.
Note: TPT: Transport and Storage
Petroleum: Coke, refined petroleum products and nuclear fuel
Electricity: Electricity, gas and water supply

port sectors. Given that the taxation regime in transport sectors is complex, there is an urgent need to introduce fiscal reforms in this sector.

There may be many reasons for the transport sectors to be relatively less efficient compared with international standards. While we attempt to mimic overall reforms in sectors of transport, we also narrow down our focus on the efficiency introduced in these sectors just because of GST reforms in India's taxation structure. This is conceptualised through assuming a wedge to be narrowed down by reforms of various types.

Tax policies play an important role in the economy through their impact on both efficiency and equity. A good tax system should keep in view issues of income distribution. It should also endeavour to generate tax revenues to support government expenditure on public services and infrastructure development. Cascading tax revenues have differential impacts on firms in the economy with relatively high burden on those not getting full offsets. This analysis can be extended to international competitiveness of the adversely affected sectors of production in the economy. Such domestic and international factors lead to inefficient allocation of productive resources in the economy. This results in loss of income and welfare of the affected economy.

For a developing economy like India, it is desirable to become more competitive and efficient in its resource usage. Apart from various other policy instruments, India must pursue taxation policies that would maximise its economic efficiency and minimise distortions and impediments to efficient allocation of resources, specialisation, capital formation and international trade. With regard to the issue of equity, it is desirable to rely on horizontal equity rather than vertical equity. While vertical equity is based on high marginal rates of taxation, both in direct and indirect taxes, horizontal equity relies on simple and transparent broad-based taxes with low variance across the tax rates.

In sum, implementation of a comprehensive GST in India is expected to lead to efficient allocation of factors of production, thus leading to gains in GDP and exports. This would translate into enhanced economic welfare and returns to the factors of production, viz. land, labour and capital.

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Table 9. 21
Percentage Change in Macro Variables, Implicit Import Tariff Simulations

ECONOMIC INDICATOR	SIM 1	SIM 2	SIM 3	SIM 4
GDP	0.0423	0.0326	0.0213	0.0148
Export	0.7361	0.5679	0.3703	0.2581
Import	0.5238	0.4041	0.2635	0.1837
Output	0.0247	0.0191	0.0124	0.0087
Real Return to Land	0.0427	0.0329	0.0215	0.0150
Real Return to Labor	0.0789	0.0609	0.0397	0.0277
Real Return to Capital	0.0678	0.0523	0.0341	0.0238

Source: Our simulation results.

We use a general equilibrium model to analyse the impact of tax rationalisation in transport services. Based on the economy-wide transactions, India is modelled to produce, consume and trade in 130 sectors of the economy. These sectors include 26 agriculture and allied services, 11 mining, 68 manufacturing, and 25 service sectors. There are five transport service sectors, viz. rail, land, water, air, and transport auxiliary services. The final demand equations for various sectors are obtained assuming a single representative consumer who maximises utility subject to a budget constraint. It is assumed that the revenue from tariffs and indirect taxes gets redistributed to consumers and then spent. Intermediate demands are derived from the profit-maximising decisions of the representative firms in each sector. The manufactured products' markets are assumed to depict monopolistic competition behaviour and those in rest of the sectors (agriculture, mining, and services) operate under perfect competition. In addition to the sectoral effects that are the primary focus of our analysis, the model also yields results for changes in exports, imports, the overall level of welfare (measured through GDP) in the economy, and the economy-wide changes in real wages and returns to land and capital. Because both labour and capital are assumed to be homogeneous and mobile across sectors in these scenarios, we cannot distinguish effects on factor prices by sector.

The wedge between the efficiency levels of transport services in India in comparison with some international standard is not easy to quantify. We are not aware of any benchmarks in this regard. However, we have attempted to capture some elements of differences in the efficient delivery of transport services across a group of countries. The information on input–output flow matrices of these countries has been used for this purpose. The source of this information is OECD. The countries selected for such comparison are a mix of some developed and some developing countries. The set of countries in our sample include Brazil, Canada, China, France, Germany, India, Japan, South Africa, South Korea, Thailand and the United States. Transport intensity of total output, ratio of net indirect taxes to the output of transport services, and energy usage (petroleum products and electricity) per unit of output of transport services have been computed for all 11 countries. One of the major observations refers to the overall usage of transport services as intermediate input used by the economy as a whole. This refers to the cost incurred on the purchase of transport services for producing one unit of output of the economy. India uses 4 paise worth of transport services to produce one rupee worth of total output, i.e. a usage of 4 per cent (Table 9.20). This may be referred to as transport intensity. This is the highest value within the group of 11 selected countries. The corresponding value is 3.6 per cent for South Africa, 3.5 per cent for China and 2.9 per cent for Brazil. Thus the share of transport services used in each unit of total output in India is 11 per cent higher than that of South Africa, 14 per cent higher than that of China and 38 per cent higher than that of Brazil. The gap

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is much higher with respect to developed countries. This implies relatively less efficient usage of transport services. Such an inefficiency wedge may arise due to tax complexity in transport sectors along with various other reasons including financing, maintenance, pricing, governance, etc. We have used a conservative estimate of 35 per cent for this wedge.

Another important observation addresses the issue of tax intensity of transport sectors. It is observed that the ratio of net indirect tax to the output of this sector is 4.7 per cent in India. This is much higher than the corresponding value of 3.3 per cent in South Africa, 2.9 per cent in France and Germany, 2.7 per cent in Brazil, and 0.9 per cent in Thailand. While it may not be easy to quantify the impact of tax intensity and complexity within the overall inefficiency wedge of 35 per cent, we have assumed this to be less than half and hypothesised it as 15 per cent.

India's transport services do not make efficient use of fuels consumed. The energy use for transport services in India is higher than most countries except for Thailand. This is a matter of concern with regard to the environmental pollution issues. The share of energy usage in India's transport sectors is 21.6 per cent which incorporates 20.1 per cent for petroleum products and 1.5 per cent for electricity. The total energy use intensity of transport sectors is 12.7 per cent in South Africa, 16.2 per cent in Brazil and 18.8 per cent in China. The developed countries have much lower values: France and Germany at 5.6 per cent, Japan at 8.2 per cent and the United States at 9 per cent.

In our experimental design, we attempt to simulate the impact of introducing efficiency in transport services through comprehensive reforms, inclusive of tax reform in these sectors as well as the subcomponent of rationalisation of tax structure. In the absence of any benchmarks study of this nature, we undertake some hypothetical exercises for demonstration purposes. Various scenarios have been discussed to incorporate the impact of improved efficiency realised through overall reform as well as reducing tax-related complexities and introducing a uniform GST.

In the first scenario, we assume a wedge of 35 per cent between the efficiency of India's transport sectors vis-à-vis some international standard benchmark. This implies that we guesstimate an implicit import tariff of 35 per cent on all the sectors of transport. However, as mentioned earlier, we acknowledge this efficiency wedge could be due to a combination of factors including financing, ownership (public, private, or PPP), maintenance, pricing, governance, and taxation among others. We consider an alternative scenario where such wedge is assumed to be lower at 25 per cent. The third scenario assumes that the purely tax-related inefficiency wedge

The energy use of transport services in India is higher than most countries: 21.6 per cent, compared with 12.7 per cent in South Africa, 16.2 per cent in Brazil, and 18.8 in China.

may be even lower at 15 per cent. Fourthly, we also take into account the fact that all transport sectors may not be equally inefficient. We, therefore, attempt to simulate the inefficiencies in a non-uniform pattern, based on the respective transport intensity of each of the five transport sectors. All such wedges are assumed to be represented through equivalent import tariffs.

Simulation 1: Elimination of implicit import tariff of 35 per cent on all the transport service sectors
Simulation 2: Elimination of implicit import tariff of 25 per cent on all the transport service sectors
Simulation 3: Elimination of implicit import tariff of 15 per cent on all the transport service sectors
Simulation 4: Elimination of implicit import tariff of 10 per cent on land transport services; 15 per cent on rail, air and water transport services; and 25 per cent on support and auxiliary transport services

Results: Our results show that the economy gains under each of the four simulations. This implies that improved efficiency of transport sectors under all the four scenarios would have a welfare-enhancing impact for the economy. However, the extent of gains varies across experiments.

We observe that welfare gains for the economy vary between 0.042 per cent under Simulation-1 to 0.015 per cent under Simulation 4, depending upon the wedge that has been knocked off (Table 9.21). There are corresponding gains in trade and output.

As the economy adjusts to the new equilibrium, resources will be allocated more efficiently as compared to the base equilibrium. The real returns to all factors of production, land, labour and capital, increase.

Scale effect, an important indicator of efficient production, is measured as output per firm. Firms in the manufacturing sector have been modelled to operate under monopolistic competition. Under the assumption of free entry and exit, as the total output in a sector expands in a country, new firms may join in and vice versa. The positive scale effect refers to an increase in output per firm and may be considered as an indicator of enhanced scale and reduced costs in the situation of monopolistic competition in the relevant manufacturing sector. A negative scale effect refers to a decline in output per firm.

As suggested by the design of our simulations, efficiency reforms in the transport service sectors would

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The issue of incorporating externalities, including congestion and pollution, in marginal cost pricing has not been addressed adequately while formulating tax rates.

lead to lower costs of service delivery for the end consumer. Access to relatively low-priced transport services would reduce the costs for firms with sectors under monopolistic competition in the medium-to-long run. While the firms are permitted to move in and out of the industry, only the efficient ones would stay in business. Competitive pressures leading to increasing returns of scale would show up as efficiency improvements in sectors. This would result in higher values of output per firm as the firms strive to achieve more efficient plant size and lower per unit costs. Thus, the gains in economic welfare are expected to come from improved allocation of resources, lower prices to consumers and business firms, and availability of more varieties to consumers. The realisation of economies of scale in manufacturing reinforces these welfare-enhancing effects.

The results of our demonstrative experiments bring out positive scale effects for all sectors of manufacturing. Even though the magnitude of scale effects varies across simulations, the pattern remains promising for the economy in each simulated scenario.

Economic development is becoming increasingly sensitive with regard to environmental implications. Any current policy is assessed for its environmental impact. In this section, we present and discuss the results of our simulations with special focus on energy sectors. Any changes in the energy sectors, in terms of consumption, are likely to have direct effects on the greening of Indian economy.

Based on the 130 sectors in the India input–output transaction table for the year 2003–04, we identify five core sectors that can be collectively referred to as the energy sector. These include natural gas, crude petroleum, petroleum products, coal tar products and electricity.

Various sectors of the economy have different energy requirements. We have computed energy intensities, defined as proportions of energy inputs in total inputs, across various sectors. Further, the composition of energy usage also varies across sectors with some sectors depending on a particular type of fuel. Our results show that two of the five transport services studied have high energy intensities.

The results of simulations indicate that enhanced efficiency of transport services will move the economy towards a new equilibrium with lower demand in each of the constituting sub-sectors of the composite energy sector. Thus, making transport sectors more efficient than their current performance levels would not only be welfare-enhancing but also environment-friendly.

Long-run scenario: The provision of more efficient transport services would boost the efficiency of other sectors of production. The efficiency boost would depend on the proportional amounts of transport services consumed by these sectors. This would get reflected in sectoral export gains. We assume that the existing inefficiencies in the provision of transport services impact the export prices through implicit export taxes. These export taxes are computed as proportional shares of the use of transport services across all sectors of production. The taxes are normalised to a maximum of 15 per cent. We experiment with four other simulations assuming that the implicit export taxes in agricultural, mining and manufacturing sectors are now eliminated. Each of the four earlier simulations is now run superimposed with implicit export tax elimination. The gains in GDP, trade and returns to the factors of production are much higher than those reported in previous simulations.

CONCLUSION

The current transport pricing system is an accumulation of multiple taxes and user charges implemented at different points of time at varying levels of governance. In addition, fuel tax is an integral part of transport pricing. The taxation structure is quite different across modes and states. This is partly due to the existing constitutional provisions. The central government levies indirect taxes in the forms of union excise, import duty and service tax whereas the state governments levy sales tax/VAT, MVT, and P&GT. Taxes are imposed on inputs as well as outputs of transport services, thus affecting the cost and price structure in these sectors. The tax differentiation in this sector is determined by a number of parameters that vary across states, uses and types. Apart from taxes, governments also raise revenues through user charges. The toll charges are used mainly for the development and maintenance of road infrastructure. Similarly, route navigation facility charges; landing, parking and housing charges; terminal navigation landing charges; etc. are some of the user charges in the aviation sector. Ports also collect several user charges for port services.

Our documentation of taxes and user charges in various sectors of transport indicates that the prevailing regime is extremely complex. There are wide variations in tax regimes across states. The road transport sector has suffered on account of entry barriers through taxes imposed on interstate movement. Cities located across the state borders should share a common taxation mechanism so that unnecessary wastage of time and harassment at borders

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are avoided. Intra-modal tax structures are also complex within each state. Taxes on various categories of fuel vary within and across states. The issue of incorporating externalities including congestion and pollution (social costs) in marginal cost pricing does not seem to have been addressed adequately while formulating the tax rates. Whereas revenue objective of pricing policy has been achieved partially, ad-hoc and complex nature of some of the taxes, especially at the state level, has resulted in less-than-efficient delivery of transport services which would, in turn, affect the efficiency of other sectors.

Inefficiencies in transport sectors get transmitted to other sectors of the economy as some of the sectors are relatively heavy users of transport services and have strong linkages with rest of the economy.

THE ROAD AHEAD

This chapter has documented the extreme complexity of taxes levied on the transport sector, particularly road transport. One key area of economic reform in India has been the simplification and rationalisation of taxes, both direct and indirect, at both the central and state levels.

It is therefore imperative that just as the state sales tax structure has been greatly simplified to a state VAT system, the road transport tax structure needs detailed review. Action needs to be taken to undertake a similar exercise across states to arrive at a simple and rational road transport tax structure that promotes economic efficiency and environmental sustainability. It is therefore recommended that the Ministry of Finance may convene an Empowered Committee of State Finance Ministers to undertake this exercise on collaboration with the Road Transport Ministry.

The mandate of the Empowered Committee would be to chart out a model act on road transport taxes and user charges. This would then be circulated among states and union territories for their consideration for adoption. Replacing various taxes (MVT, P&GT, etc.) by a single composite tax (some states have already implemented it) for all states is recommended by different stake holders. A relatively uniform and transparent tax regime would facilitate the move towards a common Indian market[9]. Uniformity of taxes among the states will give a boost to the interstate vehicle movement. The road tax system needs comprehensive reform rather than piecemeal and ad-hoc reforms at state level.

There is a need to integrate tax administration related to interstate movement of freight and passengers through information and communication technology (ICT) at national, state and regional level. This will greatly reduce transaction and logistic cost due to borderless and paperless movement. A competent authority may look into the possibility of implementing 'green channel' (Gujarat has already implemented) if proper paperwork has already been done in advance for specific consignments. A 'single window' clearance system for all types of taxes and charges at state border will greatly reduce transaction cost.

User charges should be effectively collected for railway infrastructure as well. We recommend that Indian Railways should develop a system of accounting of depreciation and internalisation of all costs into its pricing system through user charges.

Transport infrastructure requires heavy capital investment and charges should be levied on users. User charges should be effectively collected for use of railway infrastructure as well. We recommend that Indian Railways should develop a system of accounting of depreciation and internalisation of all costs into its pricing system through user charges. Once the depreciation costs are accounted for, cross-subsidisation or direct subsidisation may still exist in its current form. It is important to emphasise that public transport pricing is widely used as an instrument of poverty alleviation. The fares are regulated in developing countries in order to provide affordable mode of transport to the poor. We do not recommend completely doing away with cross-subsidisation. Moreover, considering the resource constraints such as energy resources, taxation on transport is required to be designed to encourage public transportation. It is also environmentally desirable to promote the use of public transport. However, developing a system of accounting for infrastructure cost and user charges is important.

We also recommend that the competent authority proposed should undertake a study to identify and quantify the efficiency loss in transport sectors due to several obstacles for free movement of freight across states. Special focus should be given to the complexity of the tax system and lack of harmonisation of regulations across states.

Also, negative externalities need to be internalised in transport pricing, especially in urban transport. However, it is very difficult to estimate the exact monetary figure for the marginal social cost. We recommend the formation of an expert group to look into this possibility. Once a reasonable figure is found, a composite and uniform tax can replace current ad-hoc environmental cesses at state

9. This Act may be somewhat analogous to the Model Act on Agricultural Marketing (2003).

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level. It is up to the expert group to decide the proper base for the environmental tax in transport.

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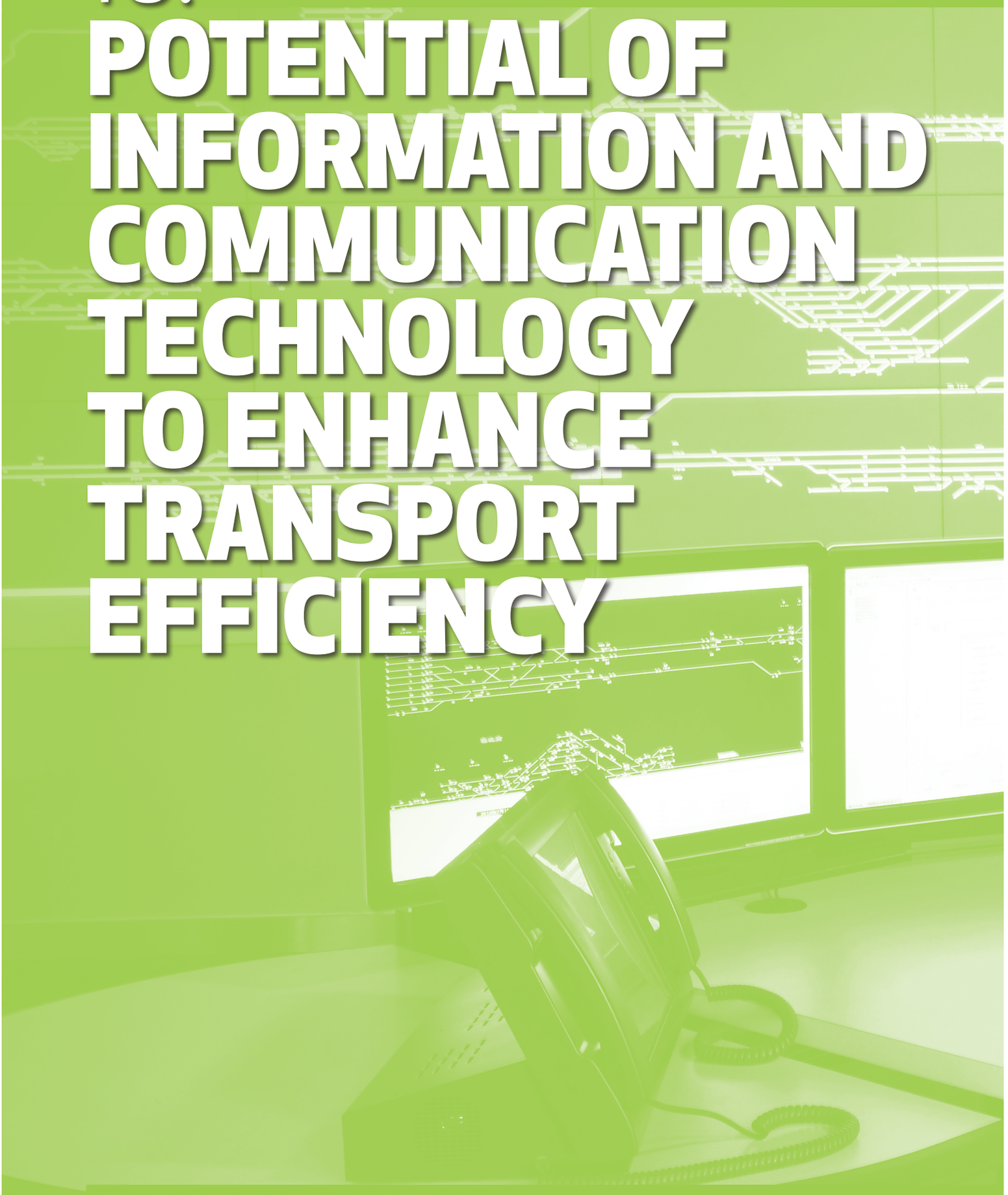
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10. POTENTIAL OF INFORMATION AND COMMUNICATION TECHNOLOGY TO ENHANCE TRANSPORT EFFICIENCY



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10. POTENTIAL OF INFORMATION AND COMMUNICATION TECHNOLOGY TO ENHANCE TRANSPORT EFFICIENCY

Across the world, ICT technologies have proved to be crucial to greatly enhance the quality of transportation networks and satisfaction of their users. Singapore introduced congestion pricing to reduce the number of cars in the city and to encourage people to use public transportation.

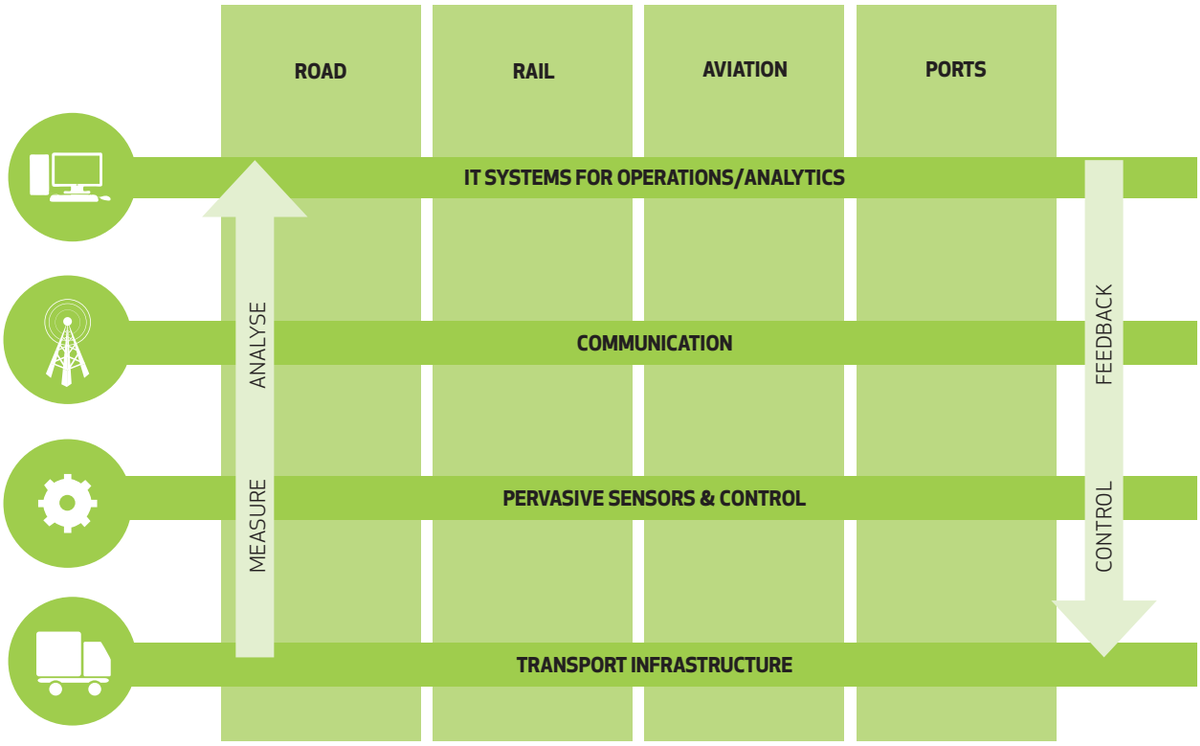
OVERVIEW OF THE POTENTIAL OF ICT IN THE TRANSPORTATION SYSTEM

Use of 'smart cards' in Hong Kong allows passengers to move seamlessly between different modes of public transport. Connected-Vehicle technology in the US is expected to greatly reduce the likelihood of road accidents. The port sector has also benefited from application of ICT. In order to improve the competitiveness of its ports and promote foreign trade, Philippines used large-scale application of ICT to implement a single window approach which has expedited the passage of goods and commodities through its customs administration. Similarly, in order to reduce congestion at the gates to the port, Singapore has installed an ICT system called 'Flow-Through Gate' which identifies container trucks, completes the necessary formalities and provides unloading instructions in less than 25 seconds per truck, handling 8,000 trucks a day.

The value of ICT goes beyond just improving transport systems; ICT can also be used to integrate transport systems with other systems resulting in reduced energy use and greater customer satisfaction. For example, South Korea is building a smart city Songdo where all buildings, roads and other

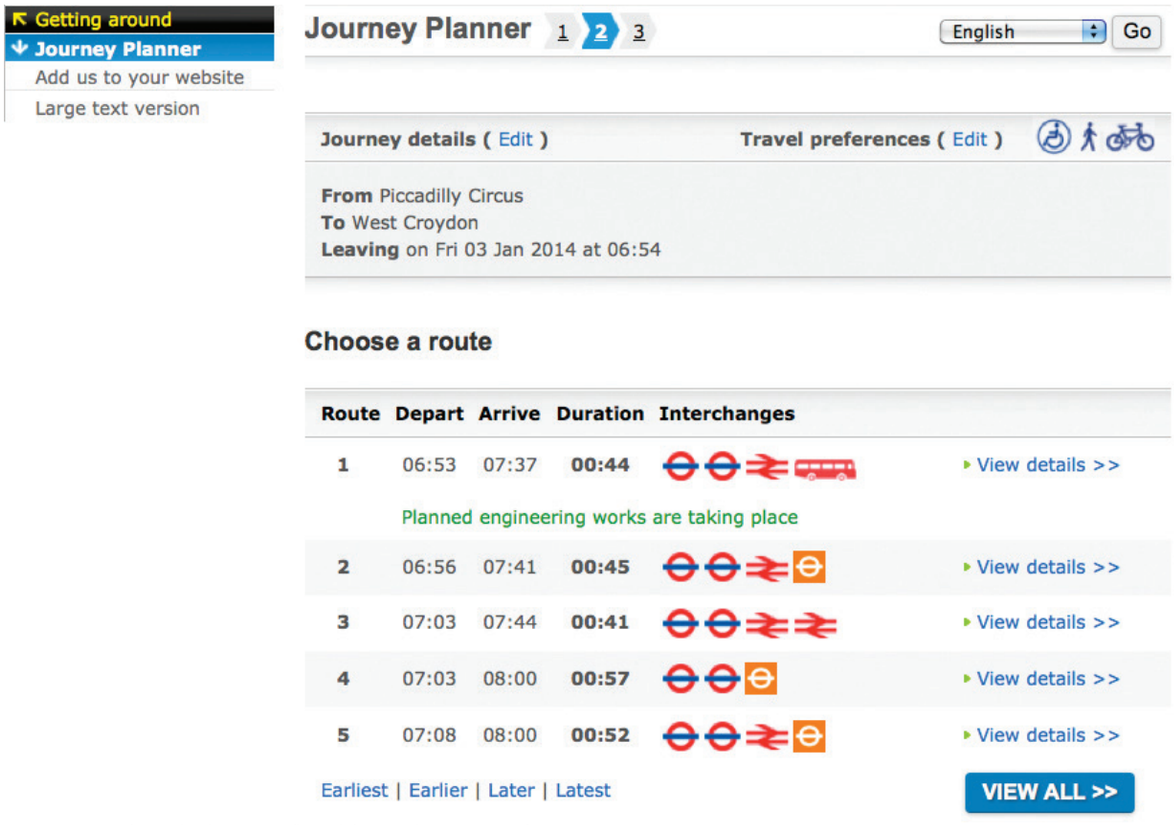
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Figure 10.1
ICT Layers Across Multiple Modes of Transport



Source: Infosys Research.

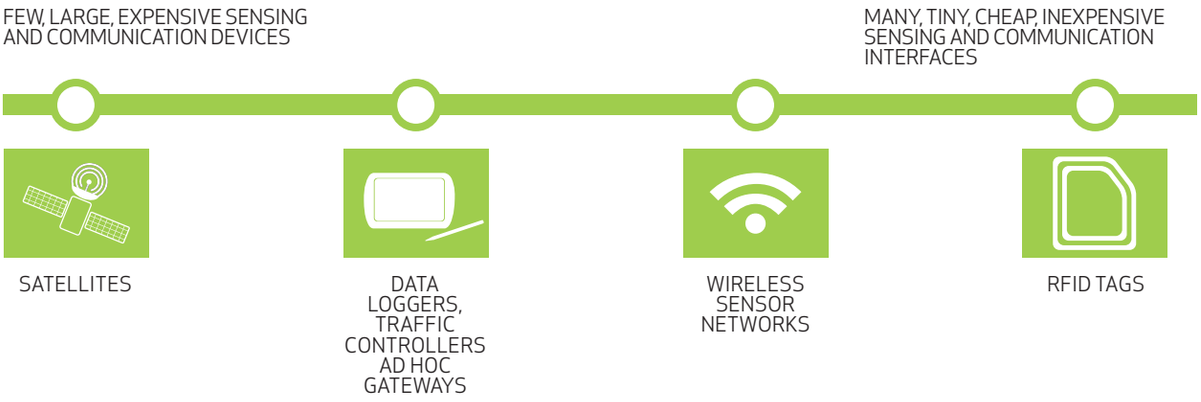
Figure 10.2
Journey Planner Snapshot



Source: Transport for London; http://www.tfl.gov.uk (accessed 2 January 2014).

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Figure 10. 3
A Spectrum of Sensing Devices



Source: Adapted from the Sensor Spectrum: Technology, Trends, and Requirements, Hellerstein, Hong & Madden
Other sources:
http://www.aimil.com/product-Data_Logger-1570.aspx
http://www.spacetoday.org/images/Sats/MilSats/DSCS_SatInSpaceLockheedMartin.jpg
http://blogs.dolcera.com/files/2009/08/wireless1.JPG
http://thesmartvan.com/wp-content/uploads/rfid-chip.jpeg (accessed 20 March 2014).

infrastructure will be connected with wireless sensors, chips and other communication technologies. Through the use of big-data computing and analytics that match supply and demand of various services or utilities, it is expected that there will be more efficient use of energy, thus enhancing the sustainability of the infrastructure. Similar efforts are being made in Masdar city in Abu Dhabi. In China too, the concept of a smart city is taking root. Ningbo is using IT to improve its port logistics and smart transportation. Wuxin is using cloud computing infrastructure to deliver benefits to its citizens.

Indian firms have been world leaders in the development of ICT technologies for the benefit of some of the world's leading business firms and various government initiatives. Given the immense knowledge, power and technology capabilities that India's organisations have deployed for the benefit of solving other countries' transportation woes, it would be in India's benefit to make use of these valuable resources for solving its own problems in transportation.

TECHNOLOGY TRENDS IN THE TRANSPORTATION SECTOR

ICT components and technologies that could be used to improve the transportation system fall into three categories: (a) automation technology (sensors and controllers) which can help in location of vehicles and control of gates at access points; (b) communication technology (e.g., 3G) which can help in receiving and transmitting information to and from vehicles; and (c) information technology (hardware and software systems) which can be built on top of the underlying automation and communication systems to manage traffic, move victims during accidents to nearby medical facilities, plan trips and coordinate transportation systems.

These three categories of technologies work together to improve transportation systems as shown in Figure 10.1. The transport infrastructure at the bottom forms the base for the system and provides a variety of information (data) such as: positions of vehicles, schedules of trains, identities of vehicles crossing check-posts. These data are 'captured' by sensors, 'transmitted' by communication networks, and 'analysed' by information systems (left side of Figure 10.1). Based on the analysis, the information systems then decide what action is necessary and that action is carried out either by a human being or directly through electronic signals to controllers which carry out the action, such as opening or closing a gate, or providing a warning message to motorists on electronic boards along highways etc. (feedback and control on the right side of Figure 10.1).

A simple example of how these three categories work to enhance customer experience is the 'Journey Planner' application provided by Transport for London shown in Figure 10.2.

This application provides 'integrated' solution options for journey planning using multiple modes. It also gives alerts in those options where there is an ongoing issue or planned maintenance activity. This solution is made possible in near real-time through the seamless usage of the three components of digital technology.

We now look at the components that are available and are likely to be available in each of these three categories of technologies.

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Figure 10. 4
Trends in Communication Technology Applicable to Transportation



Source: CETSI 2008 Intelligent Transport Systems, http://www.etsi.org/images/files/membership/ETSI_ITS_09_2012.jpg (accessed 20 March 2014).

SENSORS & CONTROLLERS

The spectrum of sensors ranges from large and expensive sensing and communication devices like satellites to tiny and inexpensive devices like RFID tags (Figure 10.3).

Satellites have been used for global positioning of vehicles. RFID tags are now commonly used in highway toll booths where the tags can be read by stationary RFID readers.

Wireless sensor networks (WSNs) have huge potential in transportation. WSNs are being used to generate safety warnings to drivers in specific black spots along the roads. These warnings are given based on data gathered in terms of vehicle volumes, speed and direction.

COMMUNICATION TECHNOLOGY

Some technologies that have been developed for transportation are: vehicle-to-vehicle, vehicle-to-infrastructure; and other central level systems to communicate traffic conditions, weather conditions and road conditions. These technologies often are extensions of existing communication technologies such as DSRC (Dedicated Short Range Communication), 4G/LTE (Long-Term Evolution), High-definition radio etc., developed to make transportation efficient and safe.

As depicted in Figure 10.4, MAN (Metropolitan Area Network), mobile, satellite communications can be used to manage traffic through receiving information from vehicles (GPS technologies etc.) and providing real-time information to vehicles. Traffic signs can be suitably altered to manage traffic according to real-time requirements. Citizens can make use of communication technologies to appropriately plan their trips. Relevant safety systems (redirection of traffic, right-of-way to ambulances and appropriate display of road signage according to real-time traffic situation) can be activated using communication technologies.

INFORMATION TECHNOLOGY

There are several new developments in software systems that could help improve the transportation sector very significantly.

BIG-DATA ANALYTICS

Big data is a term used to describe voluminous (typically petabytes[1] and above), unstructured or semi-structured data flowing in real time which can be

1. One petabyte = 10^{15} bytes.

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analysed to identify patterns and take decisions as events are unfolding.

In the transportation industry, big-data analytics have tremendous potential. Various data streams from diverse sources—weather data; data on traffic flows; information on parking lots; departure and arrival schedules of trains or flights; and global positioning systems—can be aggregated across different dimensions and analysed to come up with solutions to transportation problems and needs. Alerting drivers in real time of weather-induced traffic delays and providing them with alternate routes; providing information on the availability of least expensive parking lots in the vicinity of their destination; and prediction of potential traffic volume growth to plan for the most optimal multi-modal transport option in a city are some examples.

CLOUD COMPUTING

Cloud computing relies on sharing computing resources rather than investing in resources for exclusive use. The sharing is done through the internet, with 'the cloud' being used as a metaphor for the internet. Cloud computing has traditionally offered significantly lower upfront capital costs; it also optimises operational costs through the addition of computing resources on-demand which helps in real-time scaling up as needed. Various software applications in the transportation sector, especially the ones that interface between multiple modes, are well suited to making use of cloud computing.

SOCIAL MEDIA/COLLABORATION/MOBILITY APPLICATION PLATFORMS

The advent of smart phones, social media and mobile internet has resulted in a host of new smart mobile applications. Some examples:

- **Waze.** An application that determines if one is stuck in traffic and alerts friends to take alternative routes.
- **Zimride.** An application that connects car poolers together for a one-time ride. It also integrates with the Facebook community to assess safety of travelling with an unknown person.
- **Google Transit.** Helps people plan trips using multiple modes of public transportation in more than 425 cities.

OPEN SOURCE FRAMEWORKS

There are quite a few applications that are beneficial to users of multiple modes of transport. Data exchange is a key requirement for achieving the benefits from these applications, and consequently, uniformity of data formats is also essential. Open source[2] software greatly facilitates such uniformity through wider adoption. Google Transit Feed Specification (GTFS) is an example of an open source specification which defines a format for public transportation schedules and associated geographic information. Public agencies can publish their schedules in GTFS format so that the applications can use these data in an open and interoperable manner.

MITSIMLab is an open source application that has been developed at the MIT Intelligent Transportation Systems (ITS) Programme. It helps evaluate the impacts of alternative traffic management system designs at the operational level and assists in subsequent refinement of the design. Examples of systems that can be evaluated include Advanced Traffic Management Systems (ATMs) and route guidance systems.

The advent of smart phones and mobile internet has resulted in a host of useful applications, like Waze, which determines if one is stuck in traffic and alerts friends to take other routes; or Zimride, which connects car poolers together for a one-time ride.

The Transportation Analysis and Simulation System (TRANSIMS), is an integrated set of tools developed to conduct regional transportation system analyses. Los Alamos National Laboratory is leading the development of TRANSMIS. It is part of a programme sponsored by the US Department of Transportation and the Environmental Protection Agency (EPA).

These open source frameworks and applications help in making different systems interoperable and follow defined standards to avoid proprietary lock-in.

ICT ENABLED SYSTEMS

ICT-based systems and services fall into the following four broad categories:

- Inter and intra-vehicle systems, which as the name suggests, are systems within vehicles which help in improving safety and navigation
- Traffic management systems
- Transport co-ordination systems which help in multi-modal transport of passengers and freight
- Traveller or User Information Systems which provide users with real-time information about public transport or freight transport

Table 10.1 provides examples of systems or services under each of these broad categories.

2. Open source software refers to programmes for which the source code is available to the general public for use and modification from its original design. Open source code is typically created as a collaborative effort in which programmers improve upon the code and share the changes within the community.

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Table 10.1
ICT Enabled Systems for Transportation

INTER & INTRA VEHICLE SYSTEMS	
Parking Assist System	Aids in parallel parking of cars through sensors
Collision Avoidance System	Helps avoid various collisions including rear-end collision, road-departure collision, intersection collision, etc., through inter-vehicular communication
Vehicle Diagnostics System	Alerts the driver on key parameters of the vehicle
TRAFFIC MANAGEMENT SYSTEMS	
Violation Warning System	Detects various traffic violations (signal, stop sign, etc.)
Reroute Information System	Provides alternate routes in case of congestion in a specific route
Electronic Payment System	A common system for electronic payment for tolls, parking, etc.
TRANSPORT COORDINATION SYSTEMS	
Commercial Vehicle Operations System	Identifies and tracks commercial vehicles for ease of interstate electronic clearance, automated roadside safety inspection, onboard safety monitoring, commercial fleet management among others
Multi-modal Schedule Integration System	Integrates and continuously updates the schedules of various modes of intra and inter-city transport
Freight movement coordination system	Classifies freight and appropriately routes it to its destination using the optimal mix of transportation modes
TRAVELLER/USER INFORMATION SYSTEMS	
Real-time information of public transportation system	Helps travellers/commuters reach their destinations taking into account their priorities (price, time, comfort, convenience, etc.)
Real-time information of freight transportation system	A single-window system for consignees to send their consignments and keep track of their shipments on real-time basis. The system helps shippers send their consignments based on certain parameters (price, time of travel, etc.)
Real-time information of multi-modal transportation system	A real-time single-window system (ticketing, pass-through, interface, etc.) to help travellers schedule their travel across various modes of travel

Source: Infosys Research.

FRAMEWORK FOR PRIORITISATION OF INITIATIVES

Clearly, all the ICT-based measures and initiatives described earlier cannot be implemented all at once. How then should they be prioritised? We have developed a framework for prioritisation, shown in Figure 10.5, that groups the various ICT solutions or initiatives into three categories: solutions that need to be implemented in the short term (0-5 years); the medium term (5-10 years); and the long term (10-15 years). The solutions were prioritised by scoring them on four parameters on a scale of 1 to 10:

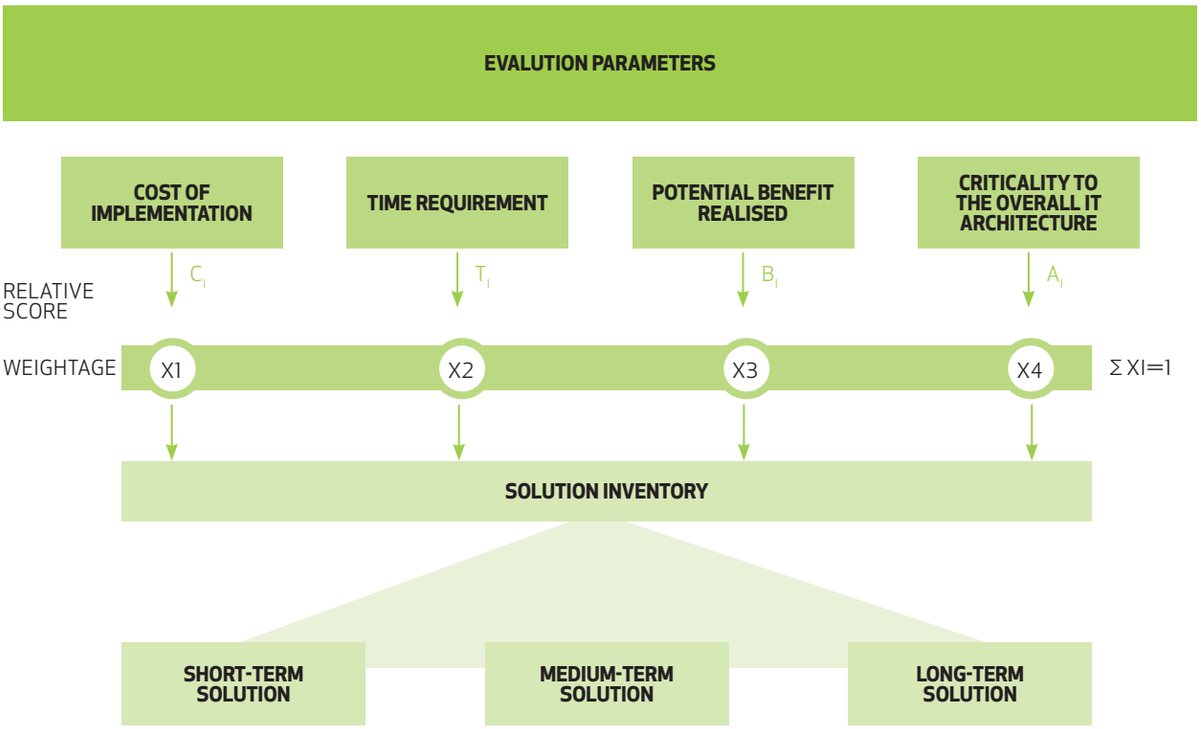
1. Cost of implementation
2. Time requirement for implementation of the solution,
3. Potential benefit expected out of the solution, and
4. Criticality of the initiative or solution to the development of the overall architecture for a sector or for the whole transportation system

We assigned a weight to each of the parameters to arrive at an aggregate score for each solution. These aggregate scores were then used to place them in the short-term, medium-term and long-term categories. The results of this exercise and details about ICT solutions recommended in each of the three periods for the various sectors are given in the sector-specific chapters.

The solutions proposed for the short term have a heavy focus on building an efficient database for various functional areas across sub-sectors. The

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Figure 10. 5
Application Prioritisation Framework



Source: Infosys Research.
** all solutions are scored on a scale of 1-10 with 10 being highest and 1 being lowest.

other sets of solutions proposed for the short term are focused on scheduling and planning, which will help in addressing some of the key capacity and efficiency issues across the sector. Solutions proposed for the medium term are the ones which will bring significant changes in operations and infrastructure and also leverage the greater availability of data and the access mechanisms developed as a result of the measures taken in the short term. The long-term solutions have customer experience and advanced technology infrastructure as some of the key focus areas. These solutions are in the long-term category because basic infrastructure installed in the short and medium term is a prerequisite. Furthermore, scheduling and planning improvements carried out in the medium term will help in designing solutions to improve customer experience in the long term.

CAPACITY BUILDING FOR INFORMATION TECHNOLOGY IN TRANSPORTATION

In this chapter and in each of the sectoral chapters, we have identified initiatives as part of the study which will enhance efficiency, utilisation and safety of transport systems. All such initiatives will require a strong institutional foundation for development and implementation.

We propose a three-dimensional institution structure (Figure 10.6) to address the needs of the Indian transport sector. The three dimensions are:

i. Geographic area of focus, which determines whether the institution is a central, state-level or a city-level organisation
ii. Functional area of focus (discussed later)
iii. Sectoral area of focus

The various functional areas of focus are described below:

a. Standards and Process
These institutions will be involved in setting the standards for technology in transportation (for example, the technology to be used for toll payments on highways across the country). They will also be involved in setting up processes which facilitate implementation of technology in transportation (such as implementation of Golden Care implementation).

b. Policy Advisory
These institutions will constantly interact with the government, central, state and city-level ministries to help develop and implement technologies for their respective sub-sector needs. They will also advise governments on the policy framework for effective traffic management.

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Figure 10.6
Proposed Structure for Transportation Institutions



Source: Infosys Research.

c. Consulting and Project Management
These institutions will also be involved in the conception of projects which will implement technologies for better transportation. They could also consult with private sector organisations and manage projects for deploying technologies in transportation.

d. Training and Research & Development
Over the years, there has been a substantial increase in the passenger and freight traffic across the transport sub-sectors. It has become imperative to build new R&D capabilities and training institutions to help in the development of technologies for solving problems in transportation. The institutions that we have proposed will develop and implement technologies for transportation and also train professionals in transportation.

We propose a multi-tier institution mechanism to oversee ICT for transportation in India (Figure 10.7):

Each of the institutions proposed can cover multiple functional areas of focus mentioned earlier. In this section, we explain the overall national level organisation, its roles and responsibilities. All the sector-specific organisation, and their responsibilities and functional areas of focus, are discussed in respective chapters on the sectors.

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY IN TRANSPORTATION (IIITT)

We recommend that an autonomous central-level institution called the Indian Institute of Information Technology in Transportation (IIITT) be created. IIITT will be similar to RITA (Research and Innovative Technology Administration), which coordinates the US Department of Transportation research programmes and helps in the deployment of state-of-the-art technologies for improving US transportation.

IIITT's charter will be to:

(1) Develop the overall framework of ICT enablement in Indian transport sector
(2) Facilitate various activities of national-level sector-specific organisations
(3) Interface with various external stakeholders, both national and international, for R&D
(4) Indigenise technology and solutions deployed by other countries for enhancing transportation in India
(5) Advise on policies regarding transportation
(6) Consult and help in the project management of implementation of technology in transportation

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Figure 10. 7
Four-Tier Institutional Framework for Transportation

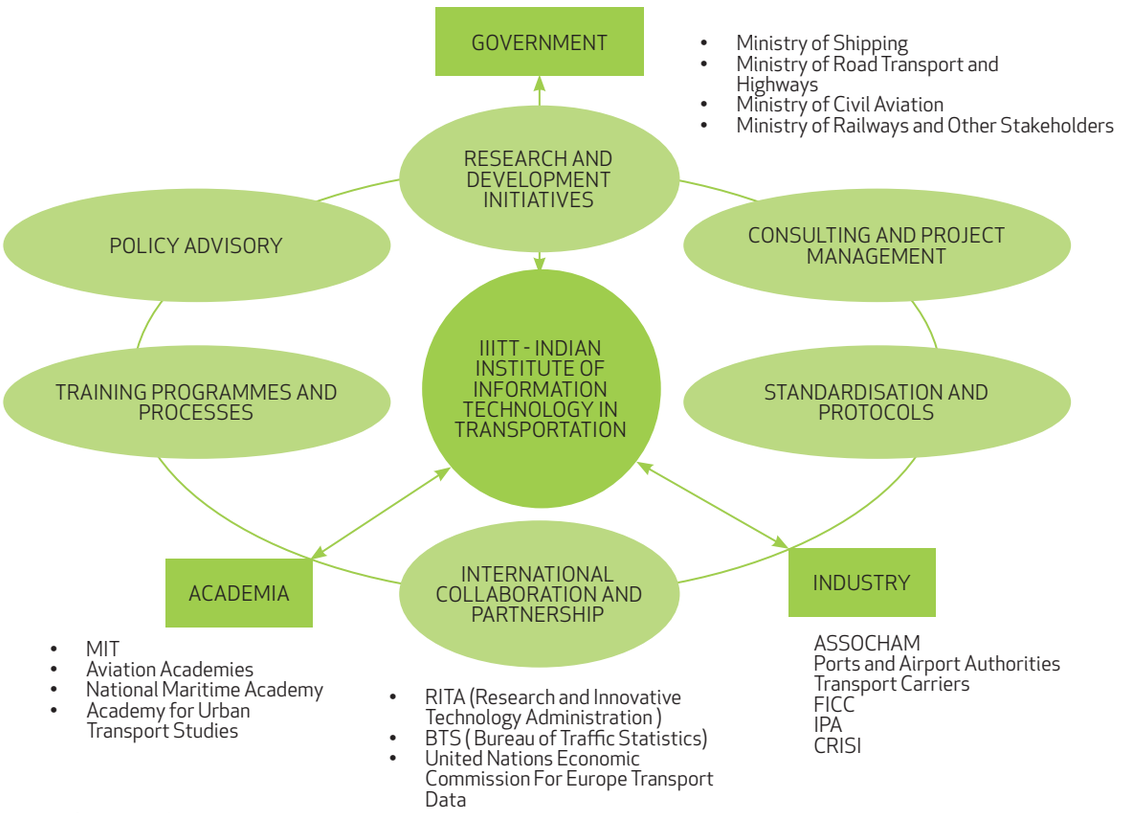


SUB-SECTORS	CENTRE	STATE	CITY*
RAILWAYS	✓	↔	
PORT	✓		
AVIATION	✓		
ROADS	✓	✓	✓
URBAN ROADS	✓		✓

* Cities with population greater than 5-6 million will have their own roads and urban roads institution for facilitating ICT in transportation.
↔ Railways will have a centre level institution which will interface with all states.

Source: Infosys Research.

Figure 10. 8
IIITT - Indian Institute of Information Technology in Transportation



Source: Infosys Research.

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Figure 10. 9
Sector-Specific Institutes of Transportation



Source: Infosys Research.

IIITT will assist the Indian government and departments related to transportation in the following functional areas (Figure 10.8):

(1) Initiate and review R&D programmes
(2) Develop and deploy new technologies relevant to transportation; consult and manage projects for implementing technologies in transportation
(3) Collect and publish transportation relevant statistics; use analytics to improve transportation
(5) Provide training for transportation professionals and serve as a knowledge and skill-dissemination repository

IIITT will coordinate with all other proposed central-level sub-sector institutions, state and city-based institutions. IIITT will also collaborate with international institutions to develop new technologies, indigenise successful technologies used in other countries for deployment in India and facilitate training for transportation professionals.

All the sector-specific national institutions (Figure 10.9) will co-ordinate with IIITT for all the areas where they need any specific assistance. The sector-specific national level institutions are as shown in Figure 10.8. Detailed roles and responsibilities of the individual sector institutions are covered in chapters on the different sectors.

ICT FOR RAILWAYS

KEY ISSUES

Indian Railways (IR) has been a pioneer in the introduction of computerisation in its major areas of activities. In the mid-1980s, it created the Centre for Railway Information Systems (CRIS) as an autonomous application development and implementation agency. Computerisation began with payroll, accounts and the apportionment of freight revenue and tonnage; then it expanded to cover almost every field of rail operations and business.

Since then, customer management, which includes booking of tickets, freight and parcels, have seen successful ICT applications. The Passenger Reservation System (PRS), Freight Operations Information System (FOIS), Unreserved Ticketing System (UTS), Parcel Tracking System (PTS) are important examples of successful implementations of ICT by IR.
Similarly, operations of trains and management of crew have had full level of ICT deployments such as the Control Office Applications (COA) and Crew Management System (CMS). Production units, maintenance of rolling assets and fixed assets, workshops, human resources, accounting, safety and medical services have seen pilot IT deployments and full scale applications will be rolled out in suitable phases.

Strategic planning, which includes decisions on new routes, capacity enhancements on existing routes etc, has been assisted by the Long Range Decision Support System (LRDSS). This has enabled

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Figure 10.10
Major Departmental Activities and Applications

CUSTOMER MANAGEMENT	Passenger Reservation & Ticketing	Freight Management System	Customer Pricing	Multichannel Management	Customer Service
DEMAND FORECAST AND PLANNING	Corporate Strategy	Demand Forecasting	Operational Planning		
SALES AND MARKETING MANAGEMENT	Sales Planning	Execution Planning	Marketing Planning	Campaign Management	
OPERATIONAL MANAGEMENT	Train Operations	Crew Planning & Scheduling	Terminal Operations/ Freight Tracking	Signaling & Safety/Train Control	Decision Support System
ASSET MANAGEMENT	Asset/ Equipment Tracking & Distribution	Asset Lifecycle Management	Capital Investments & Infrastructure	Materials Management	
PRODUCTION MANAGEMENT	Production Planning	Production Scheduling & Implementation	Quality Control		
MAINTENANCE MANAGEMENT	Maintenance of Way & Reporting	Maintenance Scheduling & Reporting	Facilities Maintenance	Work Order Management	
PROCUREMENT & 3RD PARTY MANAGEMENT	Direct Procurement	Indirect Procurement	Contracts Management	Capital Goods & Services	PPP Contract Framework
F&A, MIS	Revenue & Financial Accounting	Asset Accounting	Business Intelligence & Analytics	Corporate Governance	
WORKFORCE MANAGEMENT	Recruitment	Training & Certification	Payroll & Compensation & Benefits	HR Operations	

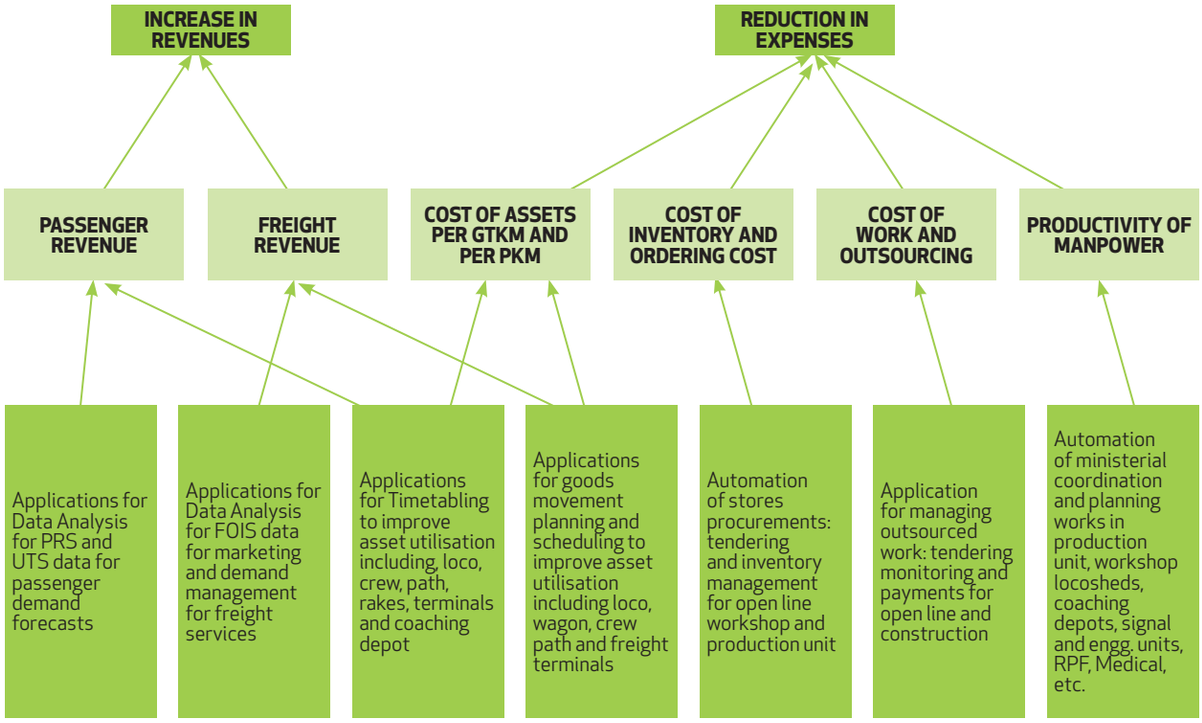
CURRENT IT ENABLEMENT ACCROSS BUSINESS UNITS

	The IT enablement has been good and has yielded positive outcomes
	The IT enablement has been done but has not yielded the desired outcomes
	The IT enablement has either not been done or requires a great deal of process re-engineering

Source: Infosys Research.

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Figure 10.11
Potential Role of ICT in Increasing Revenue/Decreasing Expenses



Source: Infosys Research.

sourcing of rich operational data and professional experience in its use in decision making. Unfortunately, this system has become dysfunctional due to software obsolescence.

Figure 10.10 shows the major departmental activities that need to be undertaken by IR, and the extent of use of ICT in each of these activities.

The time is now both ripe and opportune for IR to focus on developing decision support systems to enhance the efficiency of business, operations and assets management. The latter requires a changeover to a regime of need-based predictive maintenance of assets. Equally important is the development of compatible interfaces with the regional railway networks and major transport generating entities like ports, mines, etc. The issues of uniformity of data formats, development of ICT standards and protocols also need attention.
There are five main strategic and operational issues that need prioritisation.

INCREASING REVENUE AND DECREASING EXPENSES

IR is short of both passenger and freight capacity. However, revenue can be maximised by the introduction of ICT support systems. For example, the effort should be to deploy coaches in circuits to improve load factors and avoid the detention of wagons because of congestion and stabling.

Figure 10.11 illustrates how these factors affect revenues and expenses. It also shows how specific ICT applications can increase profits either through an increase in internal revenue generation or a reduction in expenses. In the following sub-sections, we elaborate on the interactions of various factors on each of the components of revenue generation or expenses. (The factors are identified in the middle row of Figure 10.11.)

PASSENGER REVENUE

Passenger revenue can be increased by raising seat and berth utilisation in existing trains and by increasing the number of trains with the same set of coaching rakes and locomotives. This requires better passenger demand forecasting, timetabling, integrated coaching and rake scheduling, scheduling of terminal facilities, optimisation of coach-crew allocation, locomotive allocation optimisation, and TTE allocation optimisation. IT solutions will make these complex tasks more manageable. There is extensive data available with the Passenger Reservation System (PRS) and unreserved ticketing system (UTS). It should be analysed for better demand forecasting which will need Business Intelligence applications.

FREIGHT REVENUE

Freight revenue can be increased by loading and carrying more freight with the same set of wagons and goods locomotives and without increasing the freight rates. The key lies in reducing the empty running ratio. FOIS and control office applications have the data on which advance data analytics can be run to provide a forecast of the pipeline for congested terminals and forecasting goods train arrival at the destination. As there are multiple constraints on the running of goods trains, it would be advisable

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to handle the complexity by using ICT systems for planned goods train movement. This will improve utilisation of locomotives, wagons, paths, crews and freight terminals.

COST OF PURCHASES AND INVENTORY

Procurement by the stores in the various departments is a big item of expense. A systematic management of stores and the tendering process can reduce it. Different zonal railways have different inventory management systems. This makes it difficult to integrate the management of inventory. Therefore, a best-in-class inventory management system should be deployed across the different zonal railways and production units. Having a single source of data on the level of inventory across store depots, rates paid for items, lists of obsolete items, etc., will help in better management of inventory. The resulting increase in inventory turnaround, reduction of cost of holding inventory, increased availability of materials and reduced obsolete inventory could save huge sums of money. A good inventory management system is also likely to reduce discrepancies in records of stock discrepancies and vigilance cases related to stores.

COST OF WORKS AND OUTSOURCING

An increasing amount of asset maintenance work is being outsourced. This involves tendering and contract management, which includes the maintenance of fixed assets and rolling stock. The tendering work and monitoring the work of contractors is time consuming and leaves less time for inspections and monitoring of departmental work. As a result, the overall quality of both types of work suffers. A timely measurement of works and recording the measurements in IT systems will bring transparency and accountability. Contractual works are also prone to vigilance cases and arbitration. An increase in process automation will reduce time taken in tendering related activities and work monitoring activities which will lead to better overall quality of works. Computerisation of this aspect of railway working will greatly increase quality, reduce long-term cost and improve transparency in contract management.

PRODUCTIVITY OF MANPOWER

IR employs close to 1.4 million people and human resource (HR) costs are the largest component of its operating costs. A study needs to be commissioned to understand functioning of other lean railways and to identify suitable ICT applications for adoption in IR. Workflow-based office automation[3] needs to be deployed at a very large scale. This will include automation of office work in loco sheds, coaching depots, wagon depots, signaling workshops, engineering workshops, etc.

The Personnel Department of IR needs large scale computerisation to reduce manpower and to increase transparency. Processes implemented through ICT will make the system of promotions, postings, seniority lists, service sheets, leave records, etc., efficient, transparent and employee-friendly.

The training of employees is carried out in zonal training schools and officer academies. Large scale IT deployment for training which can enable anytime-anywhere learning using mobile devices will go a long way in reducing overall training cost and increasing effectiveness of training programmes.

ENTERPRISE-WIDE INTEGRATION AND KNOWLEDGE MANAGEMENT

Most IT projects are driven by the respective departments. Different IT solutions developed by different departments or divisions function as islands of information and do not interact with one another because there is no common platform or set of standards for information exchange. This is, therefore, a fragmented process without a single, strategic and overarching roadmap driven by business objectives. Ideally, IR's business strategy should be the starting point for identifying the focus areas to be IT-enabled. This approach would ensure that there is built-in synchronisation and cohesions among different project teams which function with a clearly defined purpose.

IT in the railways is a fragmented process. Ideally, Indian Railways' business strategy should be the starting point for identifying the focus areas to be IT-enabled. This would ensure that there is built-in synchronisation and cohesion among project teams.

Enterprise-wide integration will provide additional benefits because there will be greater uniformity in data formats which will permit greater interoperability and facilitate seamless exchange of information.

UNIFIED FOCUS AND OVERSIGHT FOR APPLICATION

Currently, the Computer and Information Systems (C&IS) Directorate in the Railway Board plays the role of a CIO within the Railways. The Directorate is supported by CRIS, which is responsible for developing, implementing and maintaining ICT applications under a dynamic operational environment.

At the zonal railway level, there is an exclusive organisational arrangement for implementing and maintaining ICT applications in operational and commercial areas. There is a need to strengthen the C&IS Directorate to prepare an enterprise-wide Master Plan for ICT application and needs to be suitably empowered.

3. Simple office automation refers to archival of documents. Workflow-based office automation is used not just for document archival but also for tracking jobs from start to finish. This is particularly useful in workshops.

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Table 10. 2
Major Suggested ICT Applications

CATEGORY	ICT SOLUTIONS	APPLICATION AREA	MAJOR BENEFITS
Demand Forecasting	Passenger demand analysis and forecasting system (Augmentation of PRS and UTS)	Passenger services	Increase seat/ berth utilisation, introduction of new services, better customer satisfaction, increase in passenger revenue
	Freight demand analysis, forecasting and pricing system (augmentation of FOIS)	Freight services	Pricing system, analysis of data from FOIS, demand management
Scheduling	Passenger timetabling systems	Train operations	Optimised rake links, crew link, loco link, terminal constraint scheduling, better rake utilisation
	Goods movement planning and scheduling system	Train operations	Better customer satisfaction, increase in freight revenue
Procurement & Contract Handling	Inventory management	Stores procurement, Store depots, inventory management in Railways and production units	Reduction in inventory holding cost, increase in inventory turns, cost saving
	Management of contractual works	Construction, track and signal maintenance, loco, wagon and coach maintenance	Transparency in managing contractual works, improvement in quality of work and reduction of cost
Office Automation	Workflow-based office automation systems for loco sheds, coaching depots, wagon depots, signaling, engineering and OHE workshops	All railway establishments	Reduction of unnecessary paper work and computerisation of necessary paper work, reduction of manpower, cost saving
	Human resources management system and accounting information system	All railway establishments	Computerisation of personnel and accounts departments

Source: Infosys Research.

Table 10. 3
Issues Addressed and Expected Benefits of Demand Forecasts

ISSUES	SOLUTION FEATURES	IMPACT
Data on passenger demand is not analysed to suggest new services	Capability to analyse data available from PRS and UTS	Knowledge of demand in actionable format
Long wait list in some classes of travel while empty seats and berths in others in same train. Similarly uneven utilisation based on service type, day of week, etc.	Capability to analyse demand for specific class, day of week, time of day, season of the year.	More utilisation of berth or seating capacity
Data analysis and freight demand forecast are done manually and are not accurate which results in lack of advance planning for resource needs	Data analysis application for FOIS data	Better demand forecasts of goods service which will lead to better planning of resources to meet the demand

Source: Infosys Research.

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Table 10. 4
Benefits of Scheduling Applications for Passenger Trains

ISSUES	SOLUTION FEATURES	IMPACT
Trains wait for entry into major terminals	Simulation of terminal facilities	Smooth entry and exit at major terminals
Trains wait for precedence to higher priority trains	Simulation of timetable to check the options to reduce the impact	Better services for low precedence trains
Goods trains paths are reduced	Optimise goods train paths	More goods trains can be run
Traffic block time for maintenance is less	Optimise the designed traffic blocks	Better maintenance
Robustness of timetable in case of failures is not checked	Simulation of timetable to see impact of equipment failures	Reduced impact of equipment failures
Unexepected events such as asset failure and public agitation make scheduling difficult	Dynamic optimisation allows system to instantaneously offer optimal utilisation of available paths	Utilisation of network capacity is optimised

Source: Infosys Research.

PROPOSED ICT SOLUTIONS

A list of major ICT interventions that are required are shown in Table 10.2, and they fall into four broad categories:

(1) Demand Forecasting
(2) Scheduling
(3) Procurement and Contract Handling
(4) Office Automation

DEMAND FORECASTING: PASSENGER AND FREIGHT

IR has data on passenger demand between any two stations based on class of service, time of day, day of week and season of year. This data can be processed to get precise passenger demand forecasts. This will help in informed decision making with respect to pricing, introduction of new services, and increase in capacity of existing services.

Similarly, data on freight transport is also available for the last few years. A forecasting system can help make better forecasts of rake demand, which can lead to more efficient rake circuits. Therefore a thorough review of the working of FOIS needs to be carried out and additional applications need to be planned based on the review. This system should serve as the backbone for decision making in freight operation planning. Table 10.3 lists the issues that demand forecasts will address and the associated benefits.

SCHEDULING

PASSENGER TRAINS

Trains wait a long time for entry at the terminals. A holistic solution to address the causes that result in long waits is needed. Making a coaching timetable is a complex planning exercise. The objective of any time tabling exercise is to prepare a feasible and workable timetable by taking into account terminal facilities, path for running trains, maintenance of trains, etc. Timetable simulation software can help. Table 10.4 lists the issues that scheduling applications for passenger trains will address and the associated benefits.

FREIGHT TRAINS

Coaching trains run according to timetables but goods trains run as and when a path is available. To cope with the dynamic problems of freight operations, IR has implemented transaction processing systems. They include, FOIS, PRS, COA and CMS.

The next stage in IT implementation is a planning and scheduling system which can assist in making goods trains' schedule and control charts 24 or 48 hours in advance. This has the potential to change the basic character of railway operations from execution- to planning-intensive. In the absence of such a system, the operational planning complexity cannot be precisely managed in great detail and most of the decisions are taken at execution time. This reduces the utilisation of assets.

A scheduling and planning system has the potential to improve the operating ratio by 3-5 per cent by increasing the utilisation of assets. Table 10.5 lists the issues that scheduling applications for freight trains will address and the associated benefits.

PROCUREMENT AND CONTRACT HANDLING APPLICATION

The procurement of equipment and materials and handling of contracts for outsourced work need ICT applications to increase transparency and to make oversight easier. E-tendering has been implemented

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Table 10. 5
Benefits of Scheduling Applications for Freight Trains

ISSUES	SOLUTION FEATURES	IMPACT
Planning for goods train operations is ad-hoc. Train-running information beyond the jurisdiction of the divisional control office is non-existent and not taken into account for precision in freight train scheduling.	Planning and scheduling system for goods train	Better plan
Terminal detention of locomotives at yards is high	Locomotive planning be integral part of scheduling application	Increased loco utilisation
Rakes wait at terminal for loading and unloading	Simulation of terminal facilities	Increased wagon turnaround
Shortage of wagon rakes for freight customers	Scientific allocation of empty rakes	More revenue from same number of rakes
Sometimes crew is available but still not used and sometimes no crew is available	Crew requirements are simulated in advance to give precise forecast of requirements	Increased utilisation of crew
Some divisions have more locomotives than they can handle	Locomotive movements are planned in advance to avoid such situation	Increased utilisation of locomotives
Conflict in traffic block commitments and goods train movements	Incorporation of traffic block commitments is lacking in goods movement planning	Better traffic block planning
Out of path coaching trains adversely affects goods movements	Tactical decisions can be made keeping in view of current running of trains	Better utilisation of paths
Advance precise information about empty rake placement or loaded rake placement is difficult to give and adhere to	Precise information of rake placement	Reduction of labour wastage for freight customers and faster release of rakes

Source: Infosys Research.

Table 10. 6
Benefits of ICT Applications for Procurement and Contract Handling

ISSUES	SOLUTION FEATURES	IMPACT
Cumbersome process of tendering and tender processing	Automation of business rules and IT assistance at each stage of decision making.	Simplified system assisted process
Costly process for third parties to participate in tenders	Simplified process based on single earnest money, contractor/supplier profile, e-tendering, e-payment, etc.	Easy for third parties to participate, thus increasing competition and reducing cost for third parties
Lack of transparency and scope for manipulation	Transparent process with audit trails and time stamps for activities	Increased transparency, easy monitoring by vigilance agencies
Need for removal of opportunistic suppliers and contractors	Central system for monitoring, approval, blacklisting and rating	Improvement in quality of suppliers and contractors in long run
Unavailability of pricing trends for similar supplies and services in other zones	Centralised data on all previous tenders for works and stores	More information leads to better negotiations
Difficult to monitor the progress of tenders and works contracts	Easy access to information from anywhere will make it easy to monitor by higher officials	Better monitoring leads to more
Delay in measurements and inspections	Inspection and measurement recording in the system	Transparency and easy to fix responsibility for delays
Delay in payment	Invoice and payment tracking	Timely payments

Source: Infosys Research.

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Table 10.7
Benefits of ICT Applications for Work-Flow-based Office Automation

ISSUES	SOLUTION FEATURES	IMPACT
Need for better planning of traffic blocks, power blocks and non-interlock working	System to coordinate planning block to reduce impact on train movement	More blocks for maintenance, better utilisation of blocks, less impact on train movement
Planning for inspections, recording of defects	Handheld devices for collecting inspection reports	Saving of time for inspecting staff
Monitoring of output of scheduled maintenance activities	Update of data for schedule maintenance and visibility to senior officers	Better maintenance
Material management in field maintenance	Recording of consumption of material on time	Better material planning
Monitoring of outsourced work	Timely recording of work executed by third parties	Better quality work and work monitoring

Source: Infosys Research.

successfully for the purchase and works tenders, auctions of scrap material, and reverse auctions. The interactions between third parties and railways should be enabled by ICT applications. Previous rates should be available at a single location and ratings on quality of suppliers and contractors should be available centrally. Table 10.6 lists the issues that ICT applications for procurement and contract handling will address and the associated benefits.

WORKFLOW-BASED OFFICE AUTOMATION

The majority of IR's staff is employed in the maintenance of assets. These activities could benefit immensely by using workflow-based office automation products, particularly for recording data and scheduling of activities.

Locomotives, coaches and wagons are maintained in loco sheds, coaching depots and wagon depots and periodic overhaul (POH) workshops. The major activities at these places are inspections, preventive maintenance, breakdown maintenance, replacement of worn-out parts, lubrication, etc. These centres need unique applications, customised for their requirements. A thorough study of the activities at these places should be carried out to understand the workflow, associated paper work and record keeping, and the possibilities for improving work processes. Separate applications are likely to be needed for loco sheds, coaching departments, wagon repair shops and POH workshops.

Flexibility of operations is a key aspect of the work at these centres, and manual processes are very flexible. Therefore, any software-based application must maintain the flexibility of operations.

Fixed assets, which include rail tracks, bridges, signals, and overhead electric equipment, are maintained on location, and the maintenance staff travels to the site. Inspection, periodic maintenance, condition-based maintenance and breakdown maintenance are the major activities in the maintenance of fixed assets. Further, the maintenance of these assets often require blocking of traffic and/or electric power and disabling of interlock features.

In order to keep the number and duration of these blocks to the minimum and to make maximum use of a block when it is implemented, coordination between various departments is essential. These maintenance activities need software applications specially designed for this purpose. Separate applications will be needed for track and bridge maintenance, overhead electrical equipment (OHE) maintenance, maintenance of signals, and blocking of traffic, power and interlock operation. Table 10.7 lists the issues that office automation will address and the associated benefits.

HUMAN RESOURCE MANAGEMENT

A comprehensive HR management system should be developed to better manage processes and costs as well as to allow proper tracking of skills and gain improved efficiencies by assigning the right people to the right jobs. Such a system should also maintain an updated record of leave and entitlements, making HR management efficient and effective.

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There is a strong requirement in the railways for a comprehensive IT security framework to safeguard critical information and avoid unauthorised manipulation/ damage to the data. Numerous transactions with external users need very high levels of security.

INSTITUTION AND CAPACITY BUILDING

As can be seen from the previous sections, there are several areas where IR can benefit from the use of ICT. However, given the very large size of IR as an organisation, bringing about these changes will require strong institutions and a large number of professionals having domain knowledge and expertise in ICT.

The following four features are required for any institutional structure for implementing ICT in IR on a large scale:

- **Agency with Authority and Reach:** The Agency should have the benefit of domain knowledge of the various discipline verticals as also the authority to push the required changes across the entire system. Given the geographical spread and setup of the railway system, a body of professionals would also be required at the zonal railway level.
- **Specialised Entity for Developing, Implementing and Maintaining ICT Products:** This entity will be responsible for developing, implementing and maintaining ICT applications across the entire system. It will also develop ICT standards and protocols for the entire organisation.
- **Dedicated Organisation for Operationalising ICT Applications at Field Level:** This organisation will be responsible for operationalising and maintaining ICT applications at the field level under dynamic operational environment.
- **Human Resources:** Given the size of IR, application of ICTs in the various departments across the organisation will require large numbers of staff trained in the use of ICT for specific tasks. Taking into account the dynamic nature of ICT technology and the dynamic nature of work of railways, induction and periodic training has to be an essential component of human resource development.

We, therefore, recommend the following institutional changes which are both economical and least disruptive:

(1) Computer and Information Systems (C&IS) Directorate at the Railway Board be greatly enhanced to encompass the entire gamut of ICT applications on the network
(2) Centre for Railway Information Systems (CRIS) be converted from a society to a non-profit company with much greater freedom
(3) Organisation(s) for operationalising ICT applications at field level be converted into autonomous bodies
(4) IR Institute of Transport Management (IRITM) be entrusted with the task of human resource development

C&IS DIRECTORATE

The C&IS Directorate has the responsibility of conceptualising and driving ICT enablement across the system and functions within the Railway Board. C&IS should continue being a directorate within the Board so that it can draw on the authority of the Board. However, it should be enlarged to reflect the requirements of major disciplines and the support units of IR. Furthermore, each zonal railway should have an ICT person in an executive position so that he or she can implement decisions taken by the enhanced C&IS. This Directorate will be the interface with the external stakeholders and also oversee the functioning of CRIS and the field organisations.

CENTRE FOR RAILWAY INFORMATION SYSTEMS (CRIS)

CRIS was established as a specialized organisation under the aegis of the Railway Board as a Society under the Societies Registration Act. It brings together domain experts and qualified technical personnel to create customised software products for the railways. Over the last 25 years, this innovative organisational design has enabled IR to successfully implement and sustain major IT Projects in several areas. It has helped to develop a range of applications as part of six virtual verticals—Business, Operations, Procurement, Asset Management, Planning, Financial and Human Resources, Security. CRIS can be made into a not-for-profit company with a lot more freedom and empowerment than at present so that it can attract talent. The enhanced CRIS can also assist in creating standards and protocols in areas of technology, maintenance, data management and security.

DEDICATED ORGANISATION(S) FOR OPERATIONALISING ICT APPLICATIONS

IR has created central and field level organisations for operationalising ICT applications in operations and commercial areas. These organisations are an important interface between CRIS and zonal railways. As the workload increases, there is a need for strengthening the organisational structure both in terms of autonomy and manpower continuity.

IR INSTITUTE OF TRANSPORT MANAGEMENT

IR Institute of Transport Management (IRITM) is the premier institution for training railway managers in operations and commercial disciplines. The Institute is well endowed with physical and technical resources. It can be strengthened with minimal expenditure for capacity building of the railway personnel from vari-

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Table 10.12
IT Security Framework



Manage and govern identities and what they can access based on their role	Control access to systems & applications across physical, virtual & cloud environments	Find, classify and control how information is used based on content and identity
– Identity Governance – Role Management – Provisioning – User Activity Reporting	– Web Access Management – Federation – Authentication/Fraud Management – Privileged User Management – Virtualisation Security	– Information Discovery – Classification – Data Policy Management

Source: Infosys Research.

ous disciplines in application of ICT in their areas of working. It can also promote need-based research and scanning of new technologies.

LONG RANGE DECISION SUPPORT SYSTEM (LRDSS) PROJECT

The LRDSS is an investment planning software tool developed by an American company in the late 1990s with funding provided by the World Bank. The software was acquired by IR for the simulation of its network and identifying capacity bottlenecks on the system under operational conditions for the purposes of investment planning. With the passage of time, the software has become obsolete and the new version has not yet been developed. CRIS has the capability to develop the required software, dovetailing the same with the operational data available with them. This tool can then be gainfully used both for long range decision making as also for operational decision support on a day-to-day basis. As such, the LRDSS project should be housed with CRIS.

SECURITY

There is a strong need for a comprehensive IT security framework to safeguard critical information and avoid unauthorised manipulation/damage to the data as well as denial of service to authorised users. There are various external applications like passenger reservations, IR portal, and freight operations involving numerous financial transactions from external users which require high levels of security. Similarly, internal application like MIS, financial applications, workshop designs containing sensitive/confidential internal data stand a risk of unauthorised access, data leakage, etc., which are required to be secured. Employee transfers happen on a regular basis and in most cases, user access/accounts are not deleted/remain active post the transfer/new assignment, thereby posing a grave security risk.

Considering the above challenges from external as well as internal users, there is indeed a great need for IR to have a comprehensively secure framework for IT network/applications/infrastructure that should at the minimum provide control for identities, access and information.

In this respect, the IT Security Framework must provide the following capabilities:

- Host-based access control for protecting critical servers
- An audit trail of untampered logs of every incident that has happened
- Identity management
- Web access management and single sign-on (SSO)
- Data loss prevention

It is suggested that a Joint Working Group comprising cyber experts, representatives of Indian Computer Emergency Response Team (CIRT-In), National Critical Information Infrastructure Protection Centre (CERT-In) and railway professionals is set up to address the critical issue of cyber security.

SUMMARY OF RECOMMENDATIONS

Given that there will be large benefits from introducing ICT solutions, we recommend that there be intensive implementation of ICT as soon as possible. While generally the implementation of ICT solutions can be done relatively quickly, adequate capacity in the implementation agencies is essential for effective implementation. In that context, some ICT solutions which are likely to be more centralised, such as demand forecasting and scheduling, could be

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There is very little data available on public transport and freight movement by road. Sensors and controllers can help gather raw data; communication technology can transmit it to computer systems which analyse the data.

implemented with less strengthening of CRIS, compared to procurement, contract handling and workflow office automation which need to be introduced on an enterprise-wide level to ensure uniformity and inter-operability, and hence require integration and capacity building in the numerous field organisations

ICT in Railways should also result not only in the ability to track goods and passenger movements, but also generate 'on-time' performance in public domain to enhance transparency and accountability. We recommend that for the first three years, the focus should be on increasing both passenger and freight revenue and improving asset utilisation through ICT solutions described under demand forecasting and scheduling. Strengthening of C&IS and CRIS should also be initiated immediately, particularly to increase the number of qualified people. CRIS should be converted from a society to a non-profit company in this phase.

By the third year, we expect that CRIS would be sufficiently strengthened at both the centre and in the regional and field level so that for the it can implement ICT solutions for procurement, contract handling, office automation and human resource management. During the years three-five, we recommend that these ICT solutions be implemented and that strengthening of CRIS and C&IS continue.

ICT FOR ROAD TRANSPORT[4]

KEY ISSUES

There are three areas of the road sector where ICT could play a significant role in mitigating problems: (1) Good quality data to support evidence-based policy-making; (2) Increase in efficiency of the road transport system and satisfaction of its users; and (3) Management of safety and care of the injured.

GOOD QUALITY DATA

Effective policy making requires good quality data on aspects such as: composition and volume of current traffic; condition of roads and its association with the volume of traffic; and information about vehicles (number, kilometres travelled, level of pollution control). While a considerable amount of these data are collected, they are not available in a readily useable form and hence are not used much for policy making.

Considerable data is available on the physical achievements in the roads sector, but not much on performance and outcome-focused indicators. Such performance-related data is needed for benchmarking within the roads sector and for comparison with other modes. In that context, it should be noted that almost no data is available on non-motorised transport (NMT) even though it serves an important need for short trips and provides access to public transport.

Data is also needed on the condition of roads so that maintenance can be more effective and efficient. More extensive data is required on accidents which include the circumstances of the accidents (location, how or why the accident happened, and number of injuries and fatalities, etc.) so that roads can be designed to be safer and measures taken to reduce the number of accidents. On the requirements for data on public transport, we find that while considerable data is collected on government-owned buses, there is very little data about privately-owned buses even though they provide about 90 per cent of public transport. Similarly, almost no data is available on the movement of freight by road.

ICT will play a pivotal role in filling these data gaps. Detailed studies will be required where sensors and controllers will help gather raw data about number of vehicles, passengers, etc.; communication technologies will be used to transmit the raw data to computer systems, and hardware and software systems will be used to set up the databases. Software programs and data analysis will facilitate drawing of conclusions. For example, systematic origin-destination studies are required for freight traffic. The chapter on the roads sector describes in detail the processes required to carry out such studies.

INCREASING EFFICIENCY AND USER SATISFACTION

A lack of integration between various transport agencies, both within and between states, leads to inefficiency, delays and poor customer service.

COORDINATION BETWEEN STATES

In order to ensure uniformity and interoperability throughout the country, the Government has decided to create a National Register and State Registers of Driving Licences (DL) of drivers and Registration Certificates (RC) of motor vehicles. This initiative would help not only in interoperability between states but will also improve enforcement and instant verification of Driving Licences and Registration Certificates (see the chapter on roads

4. Chapter 2, Volume III on the roads sector covers ICT applications extensively, particularly related to issues of data collection and use.

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for more details). Sharing of data between RTOs and with traffic police and insurance companies will help in ensuring that defaulting drivers/vehicles are penalised, vehicles that are not traffic-worthy can be towed, the insurance premium of at-fault individual drivers can be increased, etc.

INTER-STATE MOVEMENT OF FREIGHT

Considerable time is lost by freight transporters at borders between states, because of long waits for border checks and payments often done manually. We give three examples of application of ICT that can expedite processes at borders.

NEW NATIONAL PERMIT SYSTEM (NNPS)

Under the NNPS that is already being used in some states, permit fees can be e-paid. The technology was developed by NIC. States should use this e-payment facility to plug revenue leakage and to reduce waiting time for the freight vehicles at the border check posts.

GREEN CHANNEL

Gujarat currently implements the 'Green Channel' concept, whereby commodities with a single destination are accorded 'Green Channel' status. The papers of such commodity movements are prepared in advance and are sent to the check post. Since freight with a single destination accounts for a large proportion of consignments and is likely to increase with containerisation, this concept helps reduce delay in freight movement. We believe high-value freight and sensitive commodities should also use the 'Green Channel'. Proper sealing and certification mechanism can be put in place for safe movement of freight.

AUTOMATION AND COMPUTERIZATION OF INTER-STATE CHECK POSTS (ICPS)

Presently, Gujarat and Andhra Pradesh have automated ICPs. This has resulted in 100 per cent checking of vehicles and a fourfold increase in revenue collection. The automation can lead to faster delivery time, fewer opportunities for leakage in revenue and stabilised revenue flows.

STANDARDISATION OF TOLL PAYMENT

Operators of the many toll roads have different methods of payment resulting in long queues at toll booths. In order to increase efficiency and productivity of the toll-based system of payment, the method of toll payments should be standardised.

The Nandan Nilekani Committee on Unified Electronic Toll Collection proposed an OBU that can be read across all tolls. Details of the Committee's recommendations appear in the chapter on roads.

INTEGRATION OF TAX PAYMENTS

Currently different data on manufacturing and transportation of products is being collected by the different taxation departments (Excise, CST and VAT). These data can be brought under a centralised database system through which movement of different commodities can be tracked. The ensuing data collection can help in efficient movement (lower cost and time) of freight.

In ports, different IT solutions function as islands of information and do not communicate with one another because there is no common platform for information exchange. This defeats the whole purpose of automation resulting in no savings in time.

SAFETY MANAGEMENT AND CARE OF THE INJURED

Indian roads have high levels of accidents and injuries. The treatment of injured persons is extremely slow and ineffective leading to a high level of fatalities. A new safety initiative (post-accident initiative) called 'Golden Care' is recommended to reduce fatalities in the event of an accident on National Highways or State Highways. The 'golden hour' is a term used in emergency medicine and refers to the time immediately following a traumatic injury, when prompt medical attention is most likely to prevent death. Under the Golden Care Initiative, when an accident occurs, medical care should be provided to the victims within the golden hour. Administrators should ensure that whenever an emergency situation occurs on the highways, victims are rushed to a nearby medical centre within 10 minutes of the accident. The chapter on roads provides further details of this proposed safety initiative.

ICT FOR PORTS

KEY ISSUES

While the cargo traffic at Indian ports is expected to grow rapidly in the coming two decades, the ports are already stretched to capacity, with the capacity utilisation already close to 100 per cent or higher at many major ports. Low productivity, congestion and delays are the norm at most Indian ports. While increases in capacity at ports will help, ICT can help improve productivity and efficiency at ports.

A preliminary study of the ICT applications at various ports in India suggests that though the basic automation of terminal operations and other functional areas has been undertaken or is being implemented, it has not yielded the desired results due to lack of integration and a holistic approach towards automation. Different IT solutions function as islands of information and do not interact with one another because there is no common platform or set of standards for information exchange. Therefore, stakeholders still need to have documents verified at multiple points, even though each of these

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Ports are dependent on a community of service providers such as shipping lines, freight forwarders, customs, clearing agents, etc. All the stakeholders need to be ICT-enabled and share real-time information and status updates with one another.

points or offices themselves might have been automated, as there is no communication link or compatibility between the existing systems. This defeats the entire purpose of automation resulting in no savings in time.

A discussion with the port operators highlights some of the problems they experienced in managing terminal operations:

- **Lack of standardisation:** Many of the Indian ports use proprietary formats for Electronic Data Interchange (EDI) with Customs, which are not compatible with international standards like UN/EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport). There are no formal standards or formats used across stakeholders. For example, codes for identification of hazardous cargo are different between ports, customs and CONCOR. Some cargo is considered normal by the ports while CONCOR considers that cargo as hazardous.
- **Lack of real time information:** In the absence of a web portal which provides real-time information on vessel schedules, expected times of vessel arrival (ETAs) and details of berth allocation to the concerned stakeholders, often a vessel has to wait for a long time in the channel before berthing. These pre-berthing detentions add to vessel turnaround time and increase cost.
- **Lack of automation in yard planning:** Most of the ports and container freight stations (CFSs) do not have automated yard plans. Yard reports are still paper-based and are not updated every time a container is moved from one location to another, making it very difficult for the Custom House Agents (CHAs) and others to track containers, especially those of foreign origin which need to be sent back within six months.
- **Manual process for documentation:** Several processes such as issue and collection of a Delivery Order (DO), Let Export Order (LEO) released by Customs are still handled manually, thereby introducing delays in the system. A CHA has to go to different shipping agents for getting Delivery Orders (DOs) for all the importers the CHA represents. Any change in the document requires several authentications and can be very cumbersome.
- **Integration of CFS with port systems:** Currently Customs is not integrated with the CFS operations at most of the ports. Therefore, the CHA is required to accompany the trucks with the necessary documents each time they move in or out of the CFS. This creates bottlenecks in speedy clearance.
- **Traffic management at port gates:** Manual verification of documents at the port gates and issuance of gate passes take up a lot of time leading to congestion and traffic jams.
- **Origins to destination tracking of EXIM goods:** Existing logistics systems available at ports and logistics service providers do not have the provision to track cargo once it has left the port's premises. It therefore becomes very difficult for importers to get a realistic estimate of the Expected Time of Arrival (ETA) of their consignment. They are dependent on the information provided by the transport operators which is not available in real time and is often unreliable

FRAMEWORK FOR IMPLEMENTATION OF ICT

As discussed earlier, introducing ICTs in individual processes is not likely to yield much benefit in the performance of Indian ports. Attention must be paid to systemic issues such as integration of various processes.

INTEGRATED IT POLICY AND PLANNING

Going forward, all major ports would need an extensive IT infrastructure to manage their day-to-day operations. In addition to their usual assets such as cranes, machinery, etc., they will need to set up data centres, have enough computers, servers, network connectivity, application software and trained manpower to manage all these ICT-related additions. In the absence of comprehensive guidelines for ICT enablement of port operations, each port has devised its own ICT strategy and implemented custom solutions which may or may not be compatible with the ICT systems at other ports. Therefore, in order to create an interconnected network of ports and ensure consistency in ICT policies, ICT infrastructure and the business processes being covered, it is required that the Ministry of Shipping lays down the ICT policy and roadmap for India's maritime sector. Towards the end of the section, we discuss additional institutions that could assist the Ministry in development of such a policy and set of standards.

INTEROPERABILITY AND ELECTRONIC DATA INTERCHANGE (EDI)

Once a uniform policy and roadmap are established for all the ports, attention needs to be focused on making the various systems interoperable both within and between ports. Ports do not work in isolation but are dependent on a community of service providers such as shipping lines, C&F agents, freight

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forwarders, transport operators, customs, clearing agents, etc. Therefore, partial technology enablement will not help; instead, it will create problems related to data sharing, redundant data entry, handling of multiple paper documents, processing delays and human errors. It is therefore envisaged that in future, all the stakeholders in maritime trade will be ICT-enabled and would be able to share real-time information and status updates with one another. The shipping line will share the location of its vessel and communicate its expected time of arrival (ETA) to the port, in order to avoid pre-berthing detentions. The ports, in turn, will plan the loading and unloading schedule and evacuation strategy. Pre-submission of cargo details to customs through EDI will also save processing time. All these initiatives for stakeholder automation can significantly reduce cargo dwell time at ports and help in improving India's trade competitiveness.

The vision for the maritime sector in India is to create a well-knit community of ports and associated service providers which will help them share the latest information, analyse data, monitor progress and support quick decision making. This will require interoperability between IT systems owned by various entities and provisions for EDI. It is therefore imperative that we lay down standards and protocols for these information exchanges. All software applications and solutions developed for the maritime industry will need to conform to these standards. Since it will involve international shipping lines and other overseas service providers, it is proposed that the standards comply with international norms.

SINGLE WINDOW SYSTEM FOR TRADE FACILITATION

Maritime trade requires interaction with a number of government agencies and private service providers. A trader has to submit documents at various counters and separately follow up with them for licenses or permits and cargo clearances. The absence of a single point of contact and limited transparency across departments reduces the overall process efficiency. The Single Window concept attempts to look at various processes and documentation requirements from the trader's point of view and weed out the redundancies. Most of the leading maritime nations are moving towards creating a National Single Window (NSW) for improving transparency and reducing process lead times. Indian ports should also move to a Single Window regime to reduce turnaround and dwell times and improve India's competitiveness in international trade.

SMART CARGO

Smart cargo is the next step in automation of maritime operations. Recent developments in RFID and GPS technologies seek to make the cargo intelligent. The containers will have smart tags and will be able to identify themselves to the RFID tag reader providing information on content, origin-destination, etc. They can also have sensors attached to them which will raise alarms in case of unauthorised seal tampering or other unusual conditions like a rise/fall in temperature beyond threshold limits. We can also track the door to door movement of these containers right from the container yard to the delivery point using sophisticated technologies. This will reduce handling time and eliminate risks associated with container security and missing consignments.

Smart cargo is the next step in maritime operations automation. Containers will have smart tags and will be able to idenify themselves to RFID tag readers and provide information on content, origin-destination, etc.

ICT TECHNOLOGIES

We now turn to some of the ICT interventions which can help in better management of port traffic and improve the overall efficiency of the system.

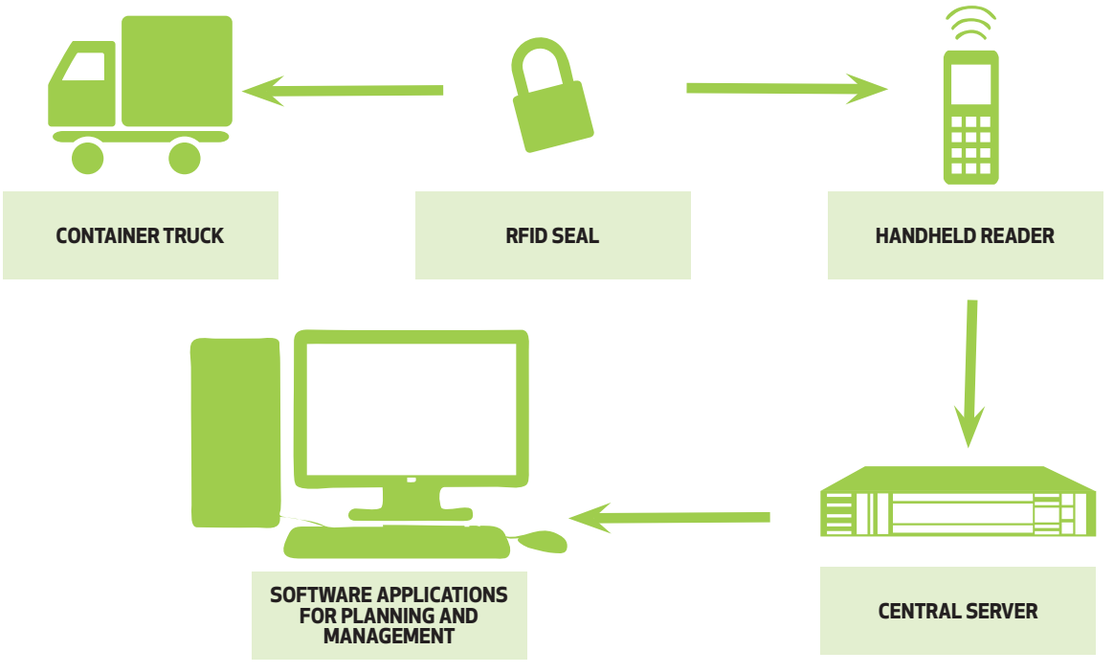
YARD PLANNING AND INVENTORY MANAGEMENT

Today over 60 per cent of the world's deep-sea general cargo is transported by containers and therefore an efficient and robust container terminal management system can play an important role in determining the overall attractiveness of a port. Efficient loading and unloading of containers and management of the storage yard is one of the most complex operations at a port and needs specialised skills. Average turnaround time for containers is a critical metric in this context, and it is here that the value of an effective and efficient yard planning and inventory management system becomes evident. In the case of consignments of perishable goods, such systems are critically important because delays can result in the loss of the entire shipment.

Currently, at most Indian ports, dry bulk cargo is stored in open yards where individual plots are not well demarcated and numbered. In most of the ports, data on the current occupancy of these plots and their availability schedule is not readily available. Exporters and importers don't get a clear view of the yard storage space to plan the movement of their cargo. This leads to sub-optimal utilisation of a port's storage yard and loss of revenue. Yet, certain sophisticated software modules are available today which employ complex algorithms to optimally utilise the available storage space in the Yard. **Geographic Information System (GIS) solutions** could be used to get a real-time view of the storage area. Data on plot allotment and expected evacuation date could be

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Figure 10.13
RFID-based Yard Planning and Inventory Management System



Source: Infosys Research.

maintained online. The software also has provisions to define various rules and controls for better yard operations and planning, thereby increasing yard throughput and enhancing customer satisfaction.

Another useful application is the **Radio Frequency Identification (RFID) technology** for monitoring container movements in the yard. RFID provides the ability to automatically collect real-time data about the physical location and properties of any container which has been RFID-tagged. An active RFID system consists of two key components: a tag which is called a transponder, and a reader device, which is referred to as an interrogator. The reader can initiate communication with the tags by sending out a wake-up signal and listening to their response. These responses could be used for the following purposes:

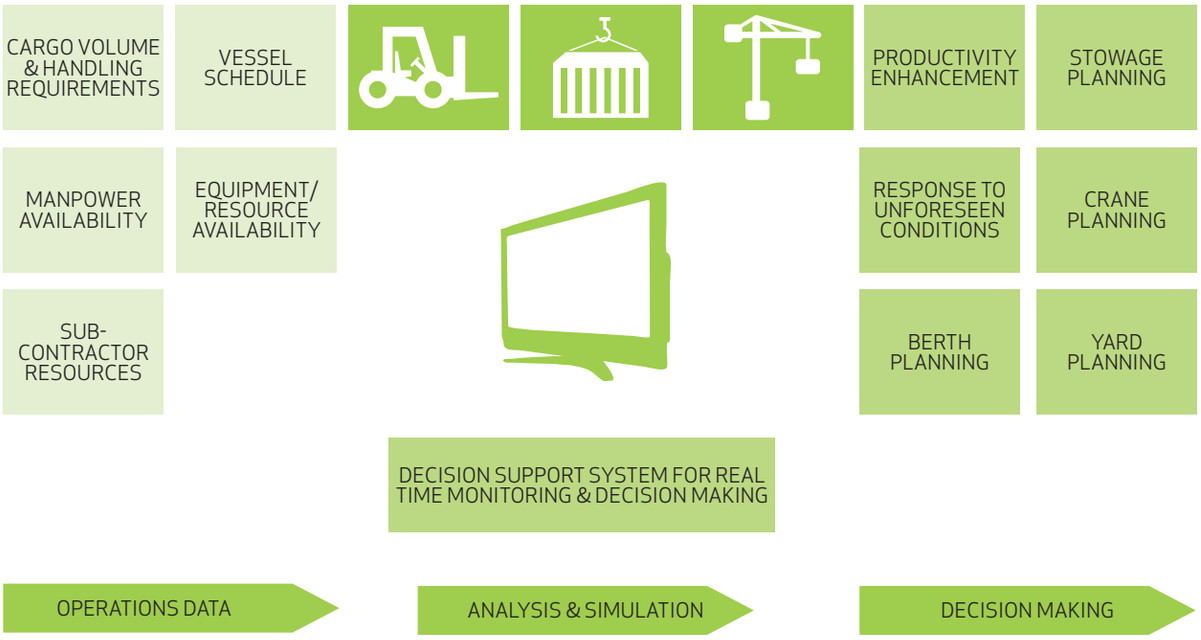
- **Identification and data capture:** Container identification number and other key information stored in the tags related to cargo origin-destination, etc., can be captured by the reader.
- **Location mapping:** RFID tags can be buried at regular intervals in the passageways to serve as location markers. These tags can be read by readers in the yard and provide information on the exact location of the container. Additionally, some tags can also have a GPS module which would transmit its location to the control room.
- **Electronic sealing (e-Seal) of containers**: Electronic container seals could be used to identify cases of seal tampering. These seals are active RFID tags which can broadcast the fact that they have been opened or removed without authorisation. These tags cannot be counterfeited. Everyday millions of containers are handled at various ports around the world and it is not feasible to physically inspect all of them. This creates a huge security risk. RFID can help in reducing security concerns without adversely affecting port productivity through real-time scanning of containers. Those with e-Seals that have not been tampered with can be processed in a fast track mode, while the others could be segregated for a detailed examination.

RFID technology can make Inventory management as simple as 'walking the yard' as shown in Figure 10.12. The operator can take a handheld tag reader and carry out a yard survey; in the process he would be able to capture the required information from the RFID tags in the stored containers. It would have all details related to origin-destination, date of entry-exit, etc. This would also eliminate the issue of data accuracy which is due to the usual lag between manual data collection and its entry into the system.

Even the shipping companies can know at any point in time where their containers are located and can track their movements for further analysis and route optimisation.

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Figure 10.14
Decision Support System (DSS)



Source: Infosys Research.

VEHICLE TRAFFIC MANAGEMENT AT PORT GATES

Traffic congestion at the port gates is another critical problem area for terminal operators. Mandatory security checks and document verification is required before a truck can enter the port premises. Currently, most of these operations are controlled manually with very little or no automation. In order to manage the expected exponential growth in traffic, technological solutions will be essential for expediting movement of vehicles in and out of port premises without compromising on security and statutory requirements.

The entry and exit of vehicles and drivers through the gates of a container terminal can be automated. An **Optical Character Recognition (OCR) system** installed at the terminal gates can be used for identifying the tags on a container and vehicle. This information can then be compared with the expected arrival or departure of the vehicle as stored in the port database for authentication. The driver's **biometric identity** and his authentication documents could be stored in a '**smart card**' which he can flash at the counter to gain entry. An automatic barrier and traffic lights system can undertake the required physical control of the gate towards the inner area of the terminal. The yard operations manager would decide on the best possible storage location for the incoming container and pass on the information to the gate operator. At the gate, the operator would be able to identify the allotted location through the GIS system and accordingly provide the truck driver with a printed message showing the exact position or slot within the parking area.

ENTERPRISE RESOURCE PLANNING (ERP) SOLUTIONS

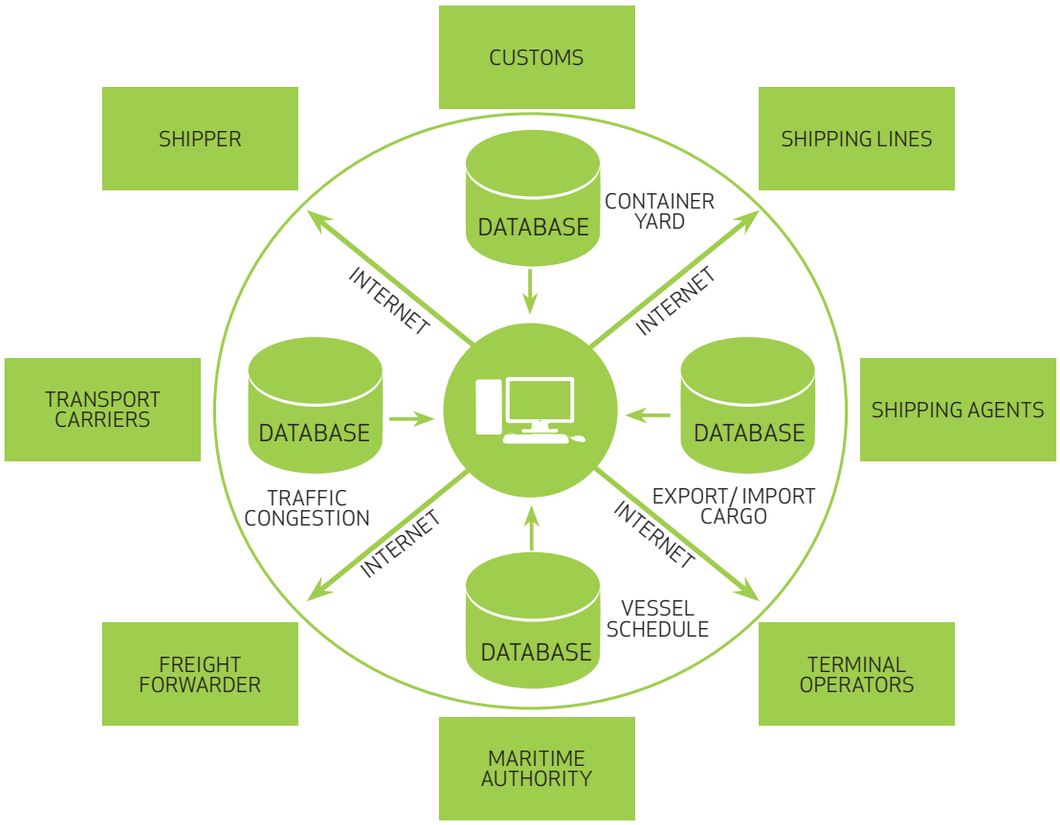
In addition to managing port operations, the port operator also needs to carry out several administrative and human resource related functions such as payroll processing, financial management, procurement, estate management, hospital management, customer grievance redressal, etc. Many Indian ports have their own custom-made IT applications to meet each of these requirements. This lack of integration, even within a port, leads to creation of multiple data pockets which do not support seamless flow of information. Therefore, the management of a port does not get an integrated 'dashboard' view of operations, leading to inefficiencies and sub-optimal resource utilisation. The lack of uniformity across ports in reporting on these important managerial functions constrains benchmarking of performance. It would be useful for the ports to consider implementing Enterprise Resource Planning (ERP) solutions driven by an integrated suite of software modules that supports the basic internal business processes of any organisation.

PORT/TERMINAL INFORMATION SYSTEMS

These systems essentially provide a dashboard view of all the operations at the port along with related performance metrics. They are equipped to collate and integrate operational information from varied sources such as vessel berthing schedule; planned

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Figure 10.15
Port Community System



Source: Infosys Research.

unloading and loading requirements; and the available equipment and manpower resources. With this information, they use complex algorithms to prepare an integrated resource management plan that includes a deployment plan and initiatives required to ensure short vessel turnaround time with maximum asset utilisation.

These modules can also be integrated with the HR management software at the port, to provide information on the availability of manpower, their skills, planned leave, etc. Detailed analysis of historical data on deployment of equipment can help in identifying underutilised or overutilised resources. Accordingly, the port management can decide to procure additional equipment which will help in increasing its throughput. It can also help in identifying critical skills which are in short supply and design training programmes for employees to acquire those skills.

SIMULATION-BASED DECISION SUPPORT SYSTEM

With the increase in size of shipping vessels and mounting pressure to reduce vessel turnaround time, most modern ports have become mechanised with sophisticated equipment for loading and unloading of cargo. Berthing of multiple vessels with competing loading or unloading schedules creates pressure on equipment operators to provide resources in time. Many factors with associated uncertainties affect the allocation of equipment. Effective and efficient allocation decisions require extensive data analysis, along with simulation that allows port operators to evaluate alternative choices. A robust Decision Support System (DSS) provides these facilities for analysis and simulation and thus can greatly facilitate more efficient allocation decisions as shown in Figure 10.14. Choices for deployment of resources assisted by a DSS can be communicated to equipment operators in real time through a Wireless LAN (WLAN).

The simulation system associated with a DSS can also be used to create a virtual environment for training the workforce. For example, training on handling of explosive or inflammable liquids such as chemicals, oils and liquefied gases and operating automated cranes can be provided under near-real conditions, thereby honing employee skills and improving efficiency.

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PORT COMMUNITY SYSTEMS

A port has several stakeholders—terminal operators, cargo owners, freight forwarders, carriers, etc. The success of a port depends largely on its ability to integrate all its stakeholders with sharing of information being a key requirement. For most Indian ports, currently this is being done offline through multiple channels thus creating problems related to availability of up-to-date data, its accuracy, and the delay in decision making.

To resolve these issues, we propose creating a single technology-based platform for bringing together all the stakeholders to form a Port Community System (PCS) (Figure 10.15). In a PCS, each port would have a web portal which would provide real-time information related to all administrative and operational activities involved in the supply chain. A combination of RFID and GPS-based solution with a web interface can enable customers to constantly monitor the movement of their containers along with other information related to vessel berthing and port operations. This would help them trace and track their assets, have a real-time estimate of their inventory, and accordingly take informed business decisions.

The website could also provide other value added services such as:

- Port gate traffic view: Displays of live feeds from multiple cameras positioned at the gates
- Vessel schedule: Online publication of vessel details and berthing schedules
- Online bulletin board: To make announcements, receive feedback and resolve queries
- Cargo availability: Loading and unloading information related to export/import cargo

Once the system matures, it can include trade regulatory bodies, banks and other government agencies in this community. For example, ports can directly send invoices to the traders' banks for services offered, banks would get the necessary authorisation from the traders and credit the port's account; all these transactions being done online. An 'e-customs' solution could also be developed later, whereby all the customs-related documentation and other formalities are carried out through this portal. Such a system would increase transparency, reduce corruption and significantly improve the port's efficiency. Reduction in paperwork and follow-ups with customs officials would also reduce the cost of operations.

Implementation of a nationwide Port Community System (PCS) has already been initiated under the supervision of Indian Ports Association (IPA). However, discussions with several port officials suggest that the current PCS rollout has not been very successful mainly due to issues around proprietary message interchange formats and lack of interoperability of the IT systems owned by varied stakeholders.

An e-customs solution should be developed, whereby all customs documentation and other formalities can be managed through this portal. This would increase transparency, reduce corruption and improve port efficiency.

We therefore emphasise the need for standards and protocols for information exchange in the Indian maritime sector, in line with international norms. Before we embark upon an ambitious plan like PCS, we should first focus on building the foundation and developing stakeholder capabilities.

AUTOMATION OF BULK CARGO OPERATIONS

A 'smart' port is characterised by seamless integration of automated equipment, existing terminal processes and terminal operating systems. 'Last mile' automation of port operations using ICT systems can go a long way in increasing even a smart port's throughput. This is especially true, in the case of ports handling bulk cargo. Personnel dealing with last mile operations can be given mobile PDAs (handheld devices) which can be used to enter real-time operational data like time of vessel berthing, crane deployment, time taken for cargo unloading or loading, etc. These data can then be compared with planned milestones to monitor progress and take corrective actions, if required. Such a system would also save time by avoiding redundant paperwork as formalities like safety checklists, cargo discharge records, etc., that can be completed online

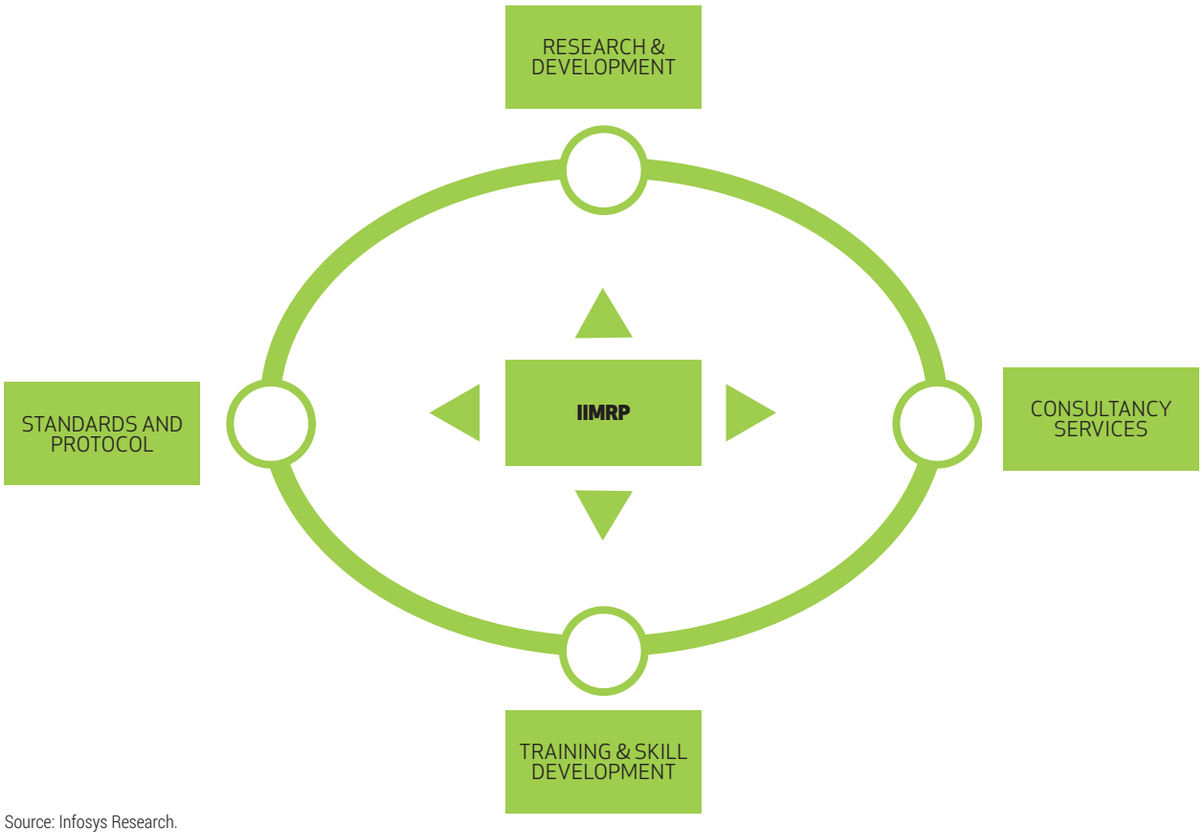
Another example of an ICT solution for last mile operations is when a ship is anchored at the port and cargo is being discharged. During unloading, the ship's position shifts due to change in distribution of material in the hold, tidal fluctuations, wind etc. All these have an adverse impact on the efficiency of the port's unloading and loading operations. Therefore, some ports use automatic grab ship unloaders which are equipped with hold and materials scanning system. They use sensors to detect the relative location between the hold and the loading machines as well as the actual distribution of materials inside the hold. These inputs are used by an inbuilt software module to prepare a discharge strategy for uniform loading and increasing the operating efficiency.

INSTITUTION AND CAPACITY BUILDING

A well-coordinated and integrated approach will require a strong institutional framework. In that context, the Committee recommends the establishment of an organisation, called the Indian Institute of Maritime Research & Planning (IIMRP). In addition to developing and implementing a well-coordinated introduction of ICT in the ports sector, IIMRP could be given a broader mandate to strengthen

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Figure 10.16
Roles and Responsibilities of Indian Institute of Maritime Research & Planning (IIMRP)



Source: Infosys Research.

India's competitiveness in sea trade and commerce, and provide direction to the policymakers for that purpose. IIMRP would be expected to perform the following functions (Figure 10.16):

- Support the government in policy making, strategic planning and developing the road-map for the sector
- Carry out high-end research and development activities to improve operational efficiency and cut costs. This will include building large scale simulation models to analyse and predict traffic flow, as well suggest infrastructure development/augmentation
- Impart training in specialised areas for maritime professionals helping in development of a pool of qualified professional ready for managing impending growth
- Provide advisory and consultancy services to industry. It will analyse changes in international trade patterns and industry developments to chart the future of Indian maritime sector
- Develop standards and protocols for ICT solutions which would ensure interoperability between organisations and seamless flow of information.

IIMRP would be controlled by an advisory board which will have representatives from the industry, government and academia as shown in Figure 10.16. Such a body could be partly funded by the central government through annual grants and partially by the private sector. Besides, the IIMRP could also generate revenue by providing commercial research and consultancy services to the international maritime industry. Training and management development programmes for the industry could be another source of income.

ICT IMPLEMENTATION ROADMAP

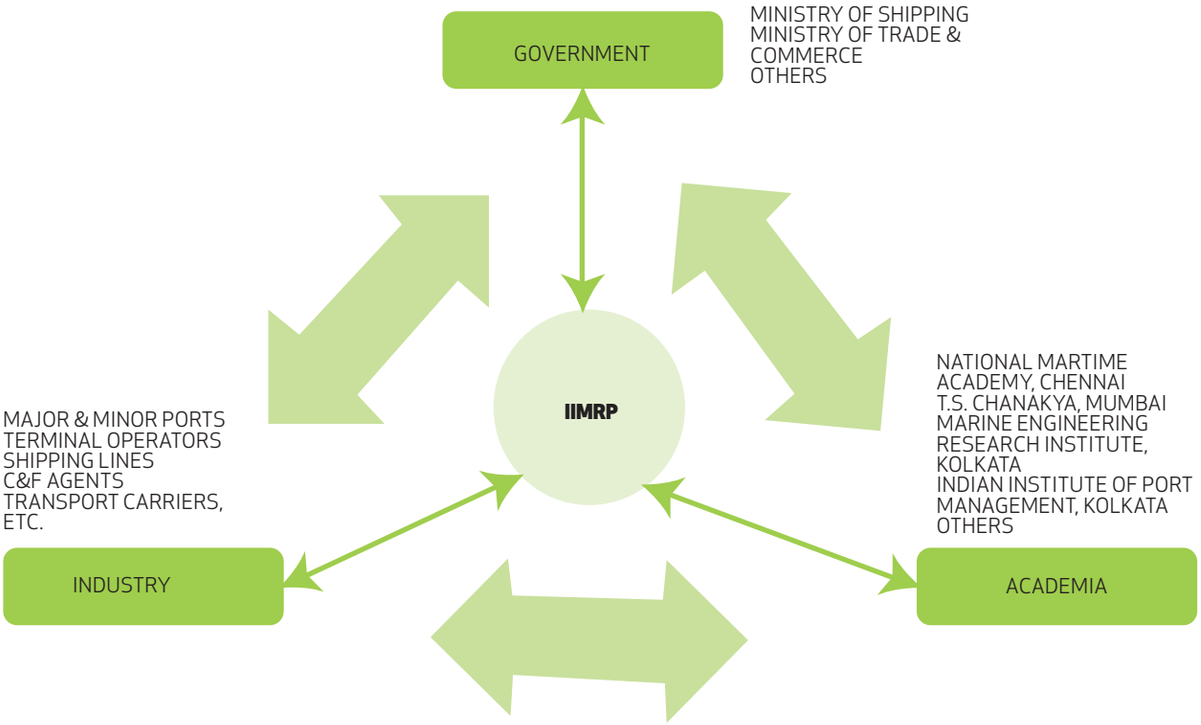
For the effective implementation of ICT applications in managing port operations, considerable groundwork is required. Therefore, we have divided this mission into three phases (Figure 10.17).

FOUNDATION BUILDING

In the first phase, the focus needs to be on: (a) developing the ecosystem; (b) capacity building; and (c) creating the necessary institutions. This phase will include initiatives such as setting up of an independent body to carry out R&D in the maritime sector, define standards and protocols for process automation, and bring about consistency in technology implementation at ports.

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Figure 10.17
Organisational Framework for IIMRP



Source: Infosys Research.

EXPANSION OF ICT IMPLEMENTATION

The second phase should then focus on setting up ICT systems at ports and to provide assistance with technology implementation to the various stakeholders. Different IT solutions like ERP, PCS, e-Customs, etc., will be implemented as per the ICT policy and standards defined in Phase I. This will help in creating an interconnected network of ports and other service providers like shipping lines, transport operators, freight forwarders, etc., which will be able to exchange real time information on cargo movements, carry out extensive data analysis and support decision making.

INTEGRATED TRAFFIC MANAGEMENT

In the third phase, the focus should be on integrating business processes and IT systems of various stakeholders so as to eliminate redundancies. Some of the initiatives which could be taken in this phase include adoption of the Single Window concept, i.e., creating one interface for a trader to manage his operations so that he does not need to coordinate separately with each of the many agencies involved. Another example would be the use of technology such as RFID tagging, GPS, etc., to make cargo 'smart' so that it can signal its location and other details to concerned parties.

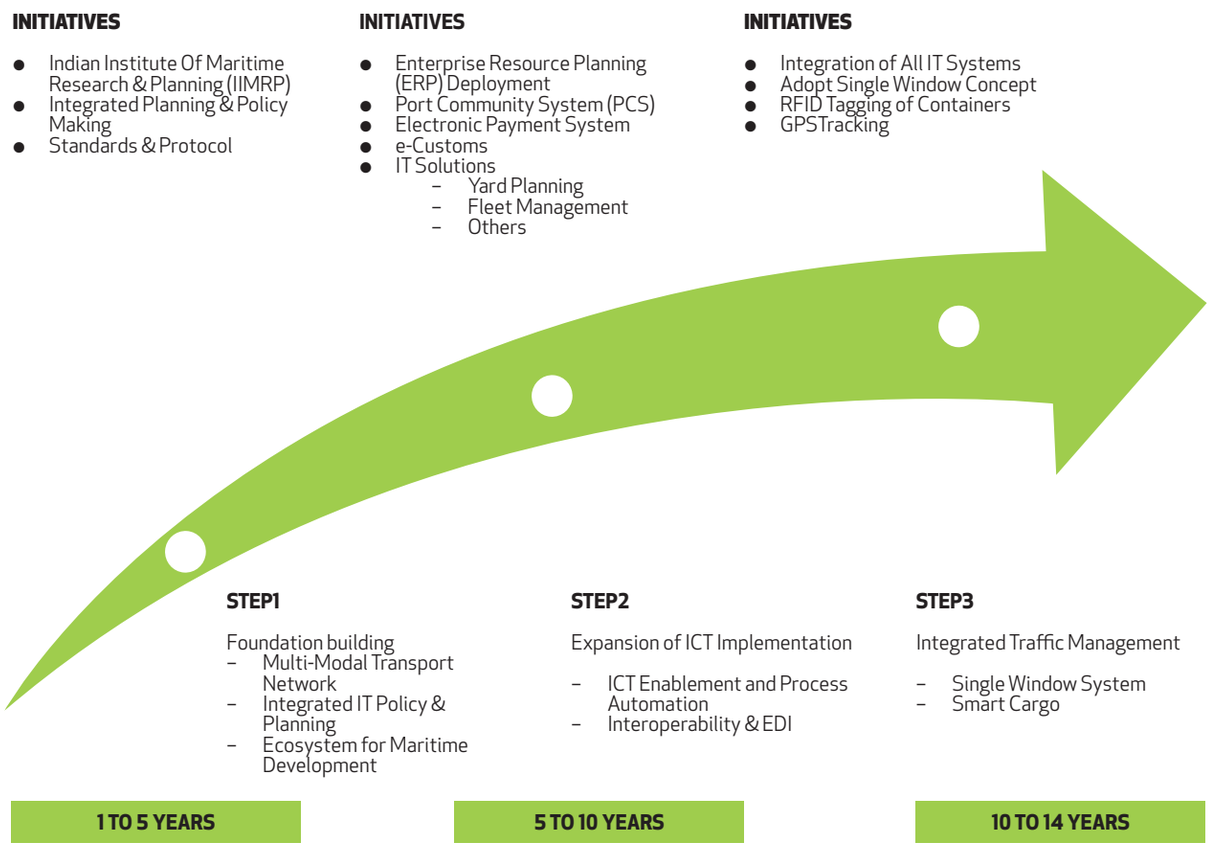
A review of various ports in India and interactions with some of the key stakeholders suggest that the use of ICT tools and their acceptance and maturity vary across the country. Therefore, a 'one size fits all' approach cannot be adopted. Separate studies will need to be taken up to assess the IT maturity of individual ports, benchmark their technology capabilities as compared to others and identify specific action items for each of them in line with the overall ICT enablement roadmap for the Indian maritime sector.

ICT FOR CIVIL AVIATION

The future of air transport in India will be governed by the willingness of the sector to adopt the latest technologies and by the capacity of government and regulators to create an enabling policy environment. With competitive forces at play in the airlines sector, regulators need to do little in the way of specifying exact technologies to deploy. Instead, the regulatory role is in specifying ICT protocols for (a) passenger and cargo management; (b) achievement of minimum service standards, including safety and security; and (c) for data collection. Once these ICT standards and protocols are defined, the various airlines

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Figure 10.18
ICT Implementation Roadmap for the Ports Sector



Source: Infosys Research.

should be permitted ICT selection and implementation choices as per their preferences, with the regulatory role changing to ensuring compliance.

The airports present a different set of issues. The market structures are such that only one airport serves an urban catchment area, effectively rendering it a monopoly service provider. Further, rules applicable to the vast majority of airports under government administration must also apply to the handful of systemically critical airports that are managed under public-private partnerships. As locations for the processing of incoming and outgoing passengers and cargo, the government also retains a vested interest in protecting the security of the entire industry and of the country. Consequently, the appropriate regulatory principles with respect to ICT allow more room for government to be more exacting in its specifications. This is so as to prevent monopoly rents, to secure bulk purchase discounts for the airport system as a whole, and to train a common pool of staff.

The final element of the aviation sector where government has perhaps the greatest rights and responsibilities to choose and manage ICTs is in the sphere of airspace control and air navigation services. India must fulfill these sovereign responsibilities as a matter of course, as well as under the Chicago Convention of 1944 to which it is a signatory. Being the sole provider of these services, the regulatory and operational roles essentially become one and the same.

ICTs has an important role to play in data collection and management. Extensive coverage and quality data make it possible for airlines to efficiently plan their networks and schedules to best meet extant and latent demand. Data on airlines' finances and operations assists regulators in efforts at maintaining a market that is viable, competitive and functions smoothly. Authorities that regulate airports, meanwhile, must have access to current and expected airport cost structures, and to current and expected usage. The development of new airports, capacity expansion at existing airports, and the identification of strategies for network management each requires the use of sophisticated economic models to analyse and forecast passenger and cargo traffic. This sophistication notwithstanding, the quality of the results on which these important decisions are based will only be as good as the data supplied.

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By rights, the aviation sector should be particularly pre-disposed to the collection, management and dissemination of complete and robust data. Each of the major agencies that participate in the sector—airlines, airports, government authorities and regulators, MRO service providers, freight forwarders and logistics firms, and so on—are established and recognised, and are subject to the oversight of some combination of domestic and international governments, shareholders, customers and specialised institutions that set safety and other operational standards. These agencies must operate robust information and technology systems to perform their activities. The closed nature of these systems means that the agencies are in complete control of all the data generated by their activities. As a simple example, airline databases maintain origin-destination records of every passenger, and or every maintenance exercise undertaken on every aircraft in their fleet. Moreover, there are in-built checks and balances within the system. For international travel, government customs and immigration databases can be used to verify the origin-destination record for any given passenger. Both airlines as well as MRO service providers maintain logs of the maintenance on an aircraft. Airports and airlines must both account for passenger traffic numbers. In short, the aviation sector normatively lends itself to the collection of high quality data. That said, there is still much that can be done to ensure the data is deployed and made widely available to best use.

By 2020, India should look towards providing a 'seamless experience' across the entire air journey for both passengers and cargo. This section looks at some specific examples of technologies that could be deployed by the sector; matters related to the creation of an enabling policy environment are considered in the Chapter on Civil Aviation.

ICT-RELEVANT ISSUES

As outlined in the chapter on Civil Aviation, growing traffic places enormous pressure on aviation infrastructure. There are five main strategic and operational issues that need attention, and where ICTs may help in reducing problems.

CONGESTION AND DELAYS

The rise in demand for air travel has led to an expansion of fleets for scheduled, non-scheduled and general aviation, leading to rapid increases in aircraft movement. This growth has put extreme pressure on Air Traffic Controllers (ATCOs) resulting in a high attrition rate. The pressure on infrastructure and personnel is exacerbated by cancellations and delays because most aircraft are not equipped with CAT III systems to aid landing during bad weather. There are high cancellation rates at Mumbai airport in the monsoon season and at Delhi airport during periods of dense winter fog. Furthermore, the majority of delays are 'reactionary' in that they are accumulated delays caused by prior unavailability of an aircraft or crew, by missed passenger connections and changed aircraft routing (see Figure 10.18).

INEFFICIENCIES IN HANDLING OF AIR FREIGHT

Air cargo represents about 10 per cent of industry revenues. Additional growth is hampered by factors such as: (a) inadequate parking bays; (b) lack of adequate warehousing space especially in Tier-2 and Tier-3 cities; (c) slow customs and other regulatory clearances; (d) 3-5 days of dwell time for import and export cargo at Indian airports vis-à-vis a global average of 6-12 hours; and (e) pilferage of goods in transit and storage.

The aviation sector normatively lends itself to collection of high quality data, yet much needs to be done to ensure that the data is deployed to best use. By 2020, India should provide a 'seamless experience' across the full air journey for both passengers and cargo.

SAFETY AND SECURITY

The Central Industrial Security Force (CISF) and state police forces hold delegated responsibilities for airport security (under the overall regulatory authority of the Bureau of Civil Aviation Security), though there is wide variation in the application of desired security and safety protocols. Technology interventions such as the use of biometrics and RFID are required to increase the effectiveness of the force deployed and to automate certain operations.

NEED TO IMPROVE CUSTOMER EXPERIENCE

Airlines and airports find themselves squeezed between rising expectations of customers regarding their experience of air travel, and rapidly increasing numbers of air passengers which stretches personnel and infrastructure, making meeting those expectations an ever greater challenge. Consequently, airlines see a market-driven imperative to: (a) reduce delay (b) decrease waiting time both during parking of vehicles, check-in and security clearance; (c) establish hassle free boarding procedures; and (d) provide safe and reliable facilities. Airlines should work in conjunction with airports to introduce technologies and develop procedures that will shorten waiting times and allow for faster aircraft turnarounds.

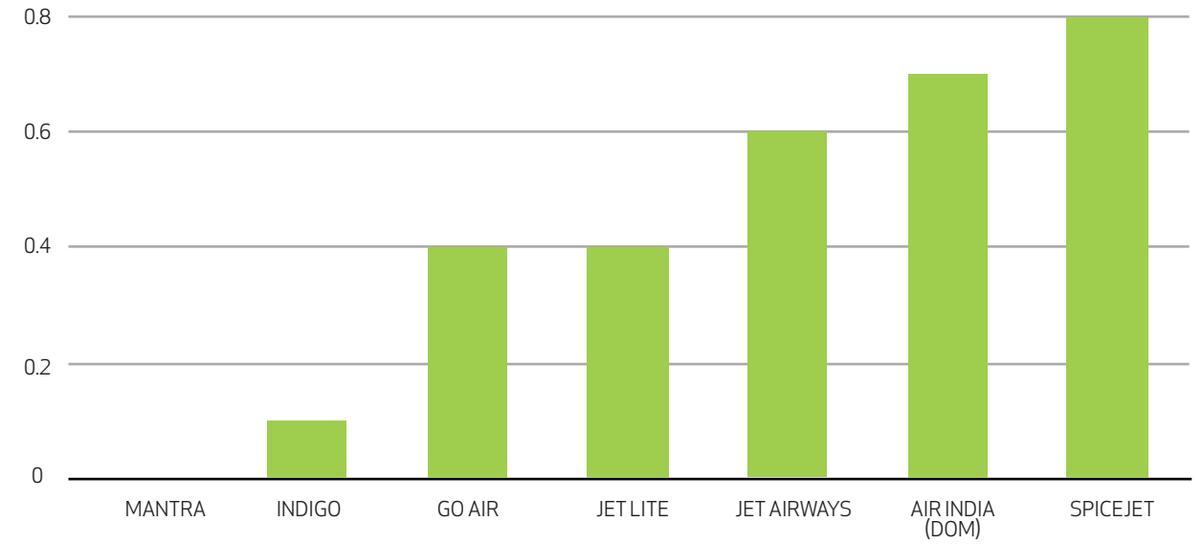
LACK OF TRAINED MANPOWER

With respect to ICT, the Chapter on Civil Aviation notes that there are shortages in the sector along the following dimensions: (a) for pilots overall; (b) for engineers trained to maintain, repair and overhaul sophisticated engines and airframes; (c) for avia-

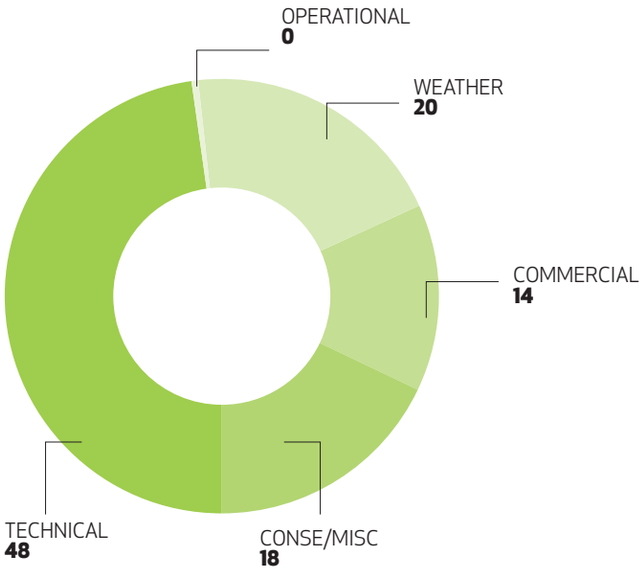
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Figure 10.19
Flight Cancellation Statistics
[per cent]

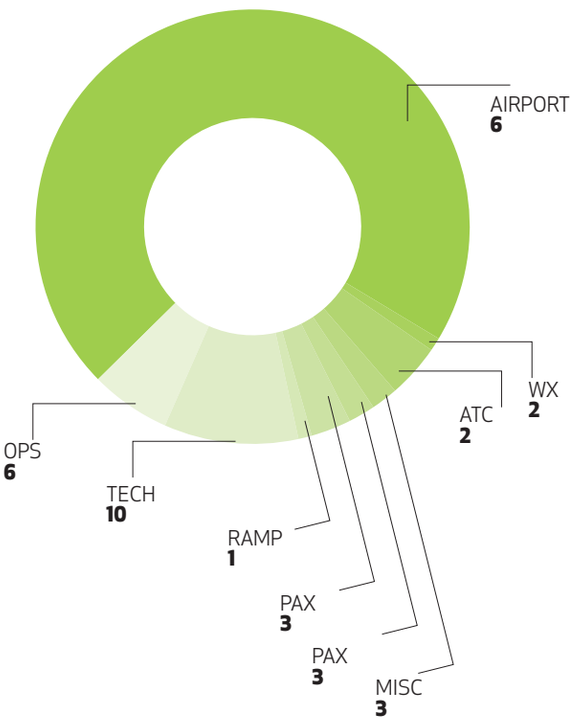
Cancellation Rate of Scheduled Domestic Flights (May 2013)



Reasons for Cancellations



Reasons for Delays

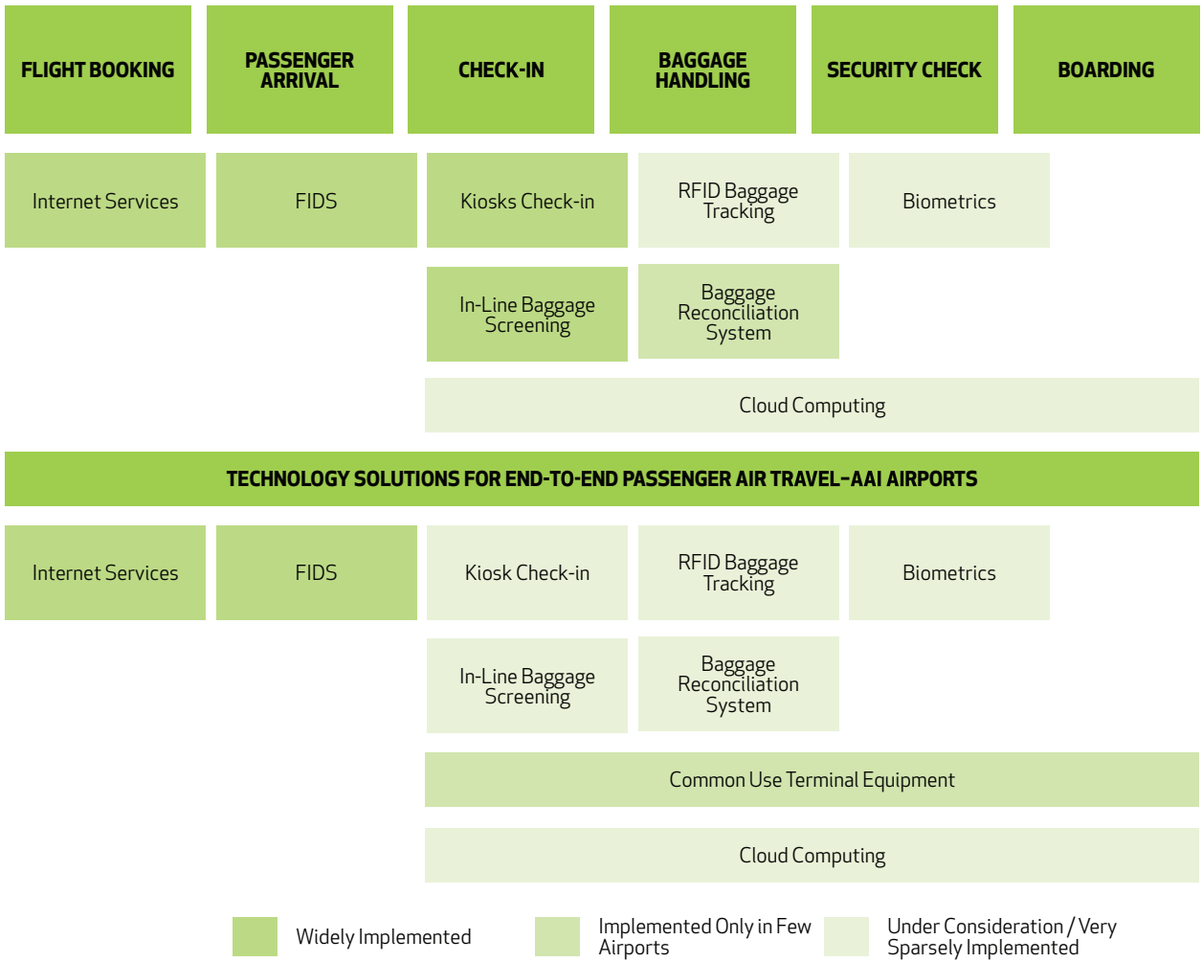


Wx = Weather
ATC = Air Traffic Control
Misc = Miscellaneous
PAX = Passengers
Tech = Technical
Ops = Operations

Source: Directorate-General of Civil Aviation (DGCA).

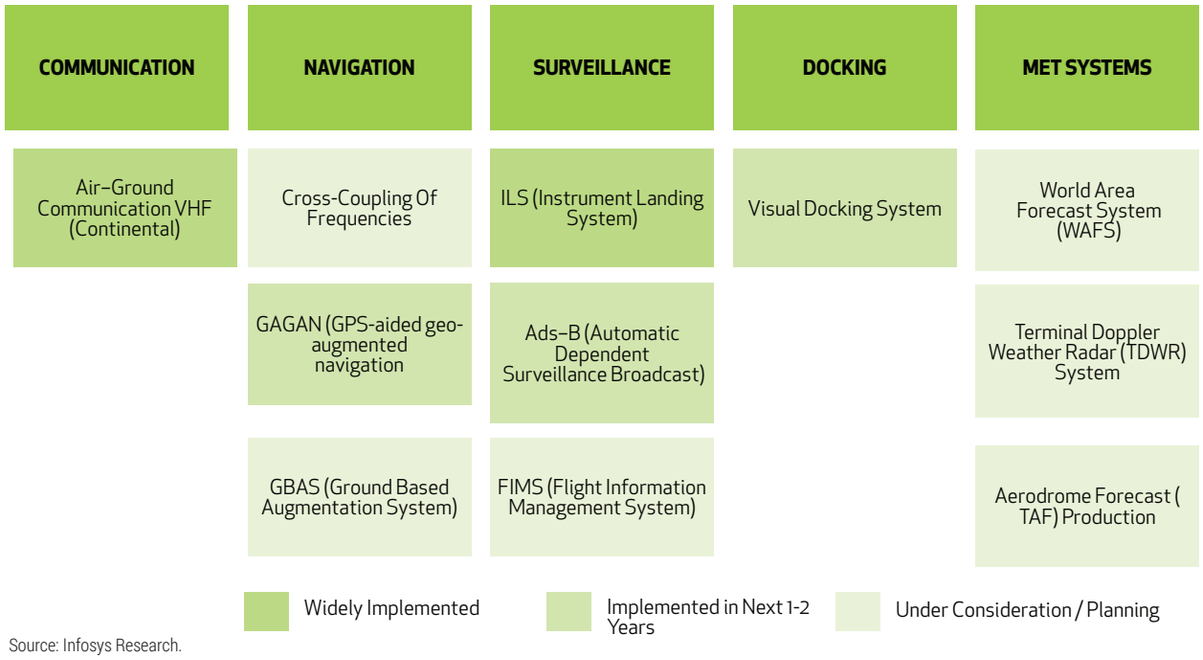
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Figure 10.20
Present Status of ICT Applications in Aviation Industry



Source: Ministry of Civil Aviation (MoCA).

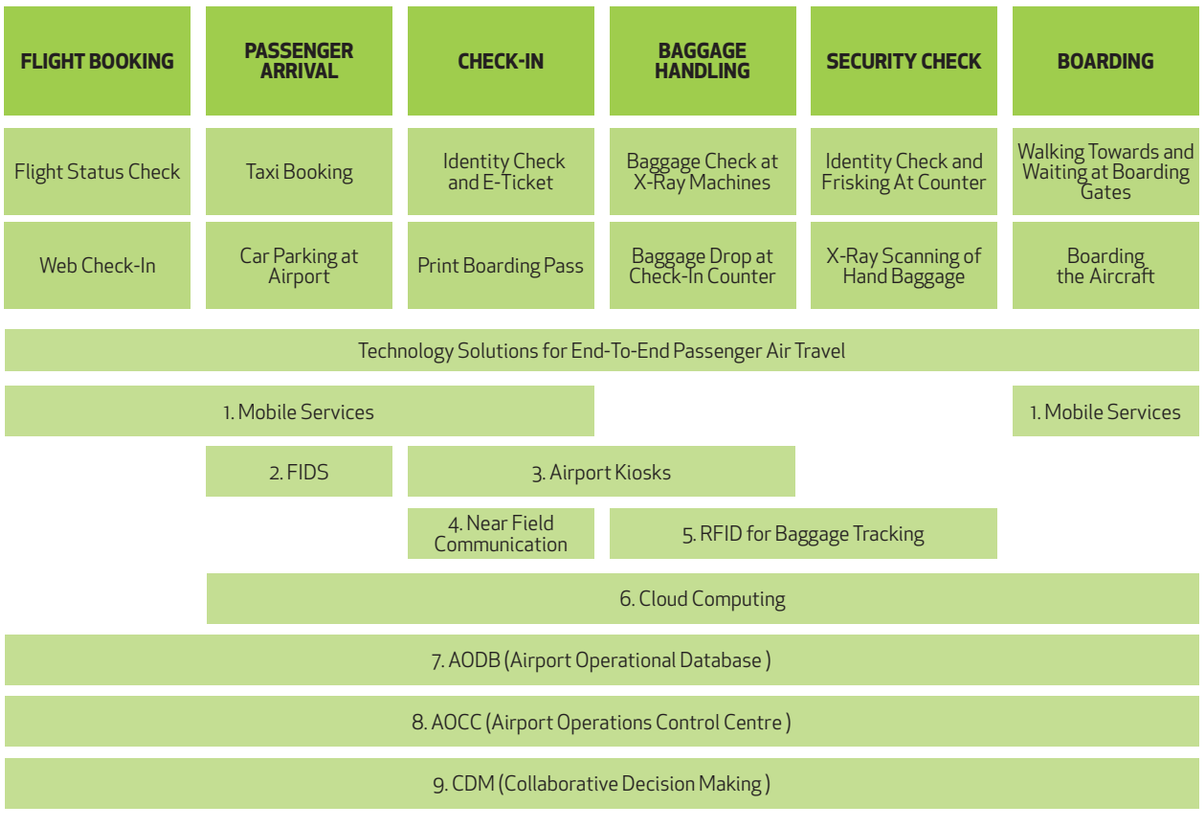
Figure 10. 21
Current Status of ICT in Air Traffic



Source: Infosys Research.

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Figure 10.22
Proposed ICT Application Map



Source: Infosys Research.

tion economists, statisticians, regulators and policy-makers. Besides the core skills and knowledge base that allow these professionals to undertake their jobs, each of them will also be required to acquire enough technical skill to keep pace with changing technologies.

PRESENT STATUS OF ICT APPLICATIONS

Airports operating under public private partnerships (PPPs) in India are keen to deploy numerous technology initiatives over the next five years. Airports under the Airport Authority of India (AAI) lag the benchmarks set by the JV airports on only a few fronts. Figure 10.21 shows the level of implementation of ICT for various aviation operations. ICTs are widely used for flight booking and flight information display systems (FIDS), for example, Common-Use Terminal Equipment (CUTE) has been implemented at 38 major airports run by AAI. But for other aspects of airport operations, ICTs are sparsely used.

ICT IN AIR TRAFFIC MANAGEMENT

Because of the increase in air traffic and international compliance requirements, there has been considerable technological development in Air Traffic Management (ATM) in India since 2010. Figure 10.22 shows the status of implementation of ICTs for various sections of ATM. Some of the key initiatives recently completed or planned over the next four or five years are:

- Starting 2008, GPS-aided geo-augmented navigation (GAGAN) is currently under implementation. GAGAN implementation will make India the fourth country to have a satellite-based augmentation system (SBAS). GAGAN is currently undergoing certification by the regulator (DGCA).
- The first phase of the implementation of Automatic Dependent Surveillance-Broadcast (ADS-B) technology is underway, replacing radar as the key method for aircraft control and navigation. ADS-B has been deployed at 21 major airports.

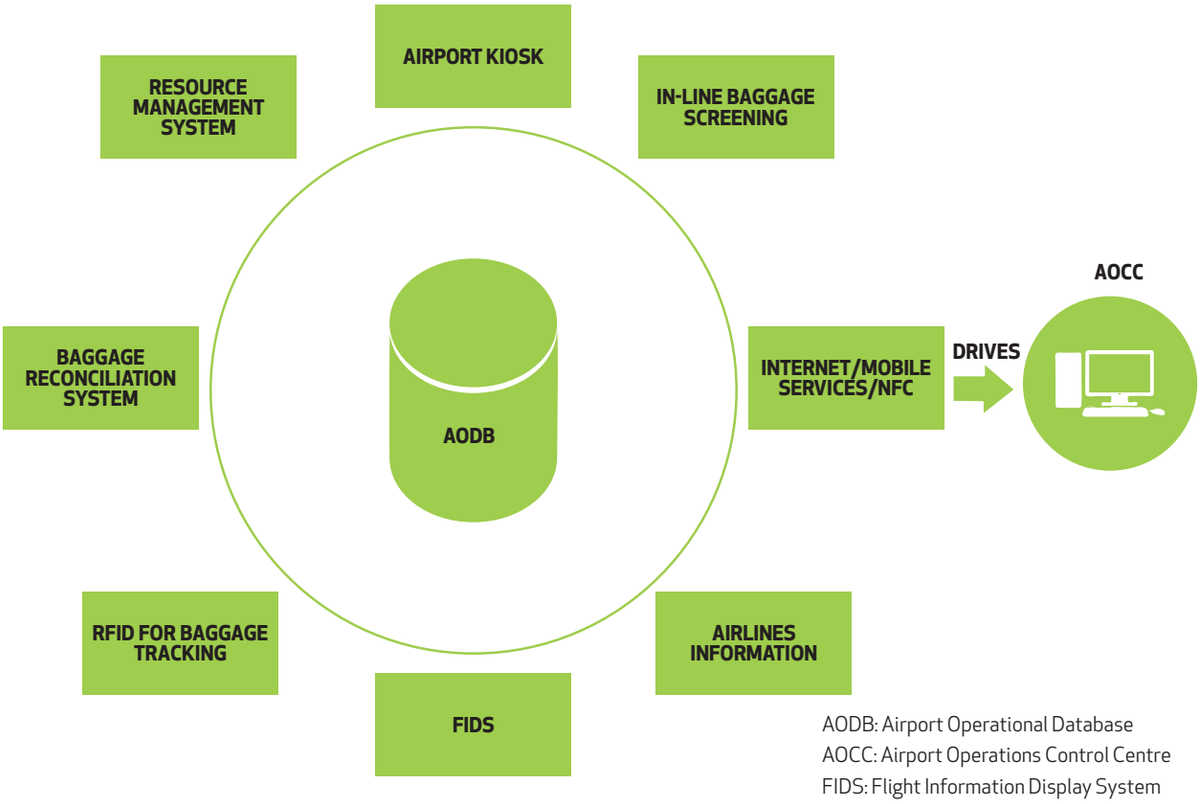
PROPOSED ICT INTERVENTIONS

We have identified four main areas where ICT can play a role in addressing the key issues discussed earlier:

- Optimisation of airport operations
- Effective management of airspace and airside operations
- Safety and security enhancement
- Efficient air cargo operations

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Figure 10. 23
The Airport Operational Database



Source: Directorate General of Civil Aviation (DGCA).

AODB: Airport Operational Database
AOCC: Airport Operations Control Centre
FIDS: Flight Information Display System
NFC: Near-Field Communication
RFID: Radio Frequency Identification

OPTIMISATION OF AIRPORT OPERATIONS

Figure 10.22 shows the various technological solutions that can be used to improve all components of airport operations starting from flight booking all the way to actual boarding of the flight by a customer. Regulatory approval and procedures should be in place to permit non-physical (i.e., via the internet of via mobile phones) check-in of passengers at all airports. This frees up requirements for physical counter space, decreases the time that passengers must spend at airports, and increases passenger processing rates. These aspects are discussed in more detail below.

MOBILE SERVICES

Smart phones have enormous potential to increase both personal and business productivity. Approximately 82 per cent of passengers carried a smart phone in 2013, up from 54 per cent in 2011, 28 per cent in 2010 and 16 per cent in 2008. Mobile phones can be used for 'on-the-go check-in' while driving to the airport. Applications are being developed by Societe Internationale de Telecommunications Aeronautiques (SITA) wherein the mobile app will guide the user through various processes based on his/her itinerary. At the airport, a mobile 2D bar coded boarding pass (BCBP) allows passengers using online check-in to carry their boarding pass in digital form on their mobile phones and then use it to navigate their way through the airport touch points—bag drop, security and boarding gate—and on to the aircraft with minimal human intervention While the technology for realising these services is available, the regulatory framework is missing.

FLIGHT INFORMATION DISPLAY SYSTEM (FIDS)

FIDS is a computer system used to display flight information (arrivals and departures) in real-time to passengers. The FIDS receives airport and flight-related information from the Airport Operational Database (AODB). AODB is a central database to store, manage and distribute information about airport operations.

AIRPORT KIOSKS

An airport kiosk is essentially an interactive computer terminal which is fully network integrated and connected with the airlines' databases. Kiosks can be used for ticket purchase, baggage check-in and flight status monitoring.

NEAR FIELD COMMUNICATION (NFC)

NFC is a wireless communication mechanism that uses electromagnetic radio fields to transmit data between digital devices such as smart phones. Depending on their configuration, NFC devices

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Figure 10. 24
Proposed ICT Application Map for Air Traffic Management



Source: Infosys Research.

can read from and/or transmit information to other enabled devices. Enabled smart phones can be put to multiple uses such as paying for airplane tickets over the POS, identity verification and security processing.

RFID FOR BAGGAGE TRACKING

Currently, bar codes are being used for tracking baggage. RFID technologies are superior to bar codes and provide the ability to automatically collect real-time data about the physical location and properties of any piece of baggage which has been tagged. RFID has three main advantages:

- More reliable, and easier to use: information is transferred via radio waves and a line-of-sight between the tag and reader is not required
- An RFID tag can store much more information and hence can identify an item uniquely
- RFID tags are very secure; it is extremely difficult to copy them and they could be made to trigger security alarms in case of theft

A RFID reader communicates with the tag to infer the identity of the object to which the tag is attached. The tags themselves consist of an electronic circuit, which stores data, and an antenna which communicates the data via radio waves. When the reader broadcasts radio waves, all the tags within range will communicate.

CLOUD COMPUTING

Cloud computing is typically subscription-based pay-as-you-go service which eliminates investment in hardware, personnel training, purchase of software licenses, and daily administration of servers. A solution provider from whom this service is purchased carries out these tasks. Thus, it results in significant cost savings in terms of infrastructure, easier software upgrades, as well as staff recruitment and training. Meanwhile, a safe and secure network to store, process and transfer confidential data is ensured. However, cloud computing may not be suitable for all applications and depends critically on the integrity and ongoing viability of the service provider, and upon the regulatory ambit of the jurisdictions in which the servers are actually housed.

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With security in aviation being of paramount importance, it may be preferable to consider a 'cloud' that is sponsored either by all parties in the aviation sector, or by the government itself, once sufficient technical capacities are acquired.

APPLICATIONS INTEGRATION

All individual systems and technologies such as FIDS, CUTE and BRS implemented at the airports should be integrated using the AODB (Figure 10.23). This AODB will be used to drive the AOCC (airport operations control centre), a control room with large screens to view all the information in form of dashboards, charts and reports. This control room will house stakeholders from various departments like the baggage, passenger, cargo and airlines who together will take informed decisions for the benefit of the airports and its passengers. Such real-time on-demand availability of common information will allow for better decisions by all participants in the industry, and by regulatory authorities. AODB has been deployed at Delhi, Mumbai, Hyderabad and Bengaluru airports. In addition, AODB is under installation at 10 major airports of AAI. While Delhi, Mumbai, Hyderabad and Bengaluru have an AODB at each airport, AAI is implementing a unique Centralised AODB, which will be accessed by all the 10 airports through VPN. The Centralised AODB is scalable and in future, more airports can be added at minimal cost. This is expected to go online by March, 2014.

EFFECTIVE MANAGEMENT OF AIRSPACE AND AIRSIDE OPERATIONS

Presently, ATM (Air Traffic Management) systems in India work well and are aligned with international benchmarks, but eventually they will need to adopt next generation standards. India's ATM system utilises ground-based navigation system such as use of radars due to which flight paths are fixed and pre-determined, leading to wastage of fuel and time. Hence, efforts are in the pipeline to transition to 'flexible use of airspace'. Using advanced technologies such as GAGAN, aircraft routes will be calculated in real time, factoring inputs such as weather and the current traffic situation, etc. This will help reduce delays due to airspace congestion as well as cut down on aircraft wait times in landing at airports. There are several areas, such as communication, navigation, etc., where ICT can play an effective role as shown in Figure 10.24.

VHF COVERAGE AND NETWORKING

Presently, VHF communication is available only in continental airspace above 20,000 feet. In order to provide overlapping coverage, VHF coverage up to 10,000 feet and above in Area Control Centres (ACCs) also needs to be implemented. Also, VHF networking should be worked out to support consolidation of sectors during lean traffic and deconsolidation during peak traffic periods. VHF networking has been implemented in the Upper Area Control in Southern FIR (Flight Information Region) in India. Consequently pilots in the en route phase transiting through this FIR have to make minimal contacts on VHF with the ATCOs thus reducing fatigue. This is to be replicated in other FIRs.

GAGAN is the planned implementation of a regional satellite-based augmentation system to support en route navigation of aircraft. Currently, planes fly along predefined air routes. Planes with GAGAN receivers, however, will be able to get guidance and take shorter routes, saving both time and fuel. This will improve efficiency and save costs.

HF RADIO TRANSMISSION

Presently, HF radio transmission is available at Delhi, Mumbai, Kolkata and Chennai to use for air-ground voice communication over oceanic space. Additionally, HF R/T signals also work in mountainous and remote regions where VHF range cannot be achieved, provision of flight Information service over the continental airspace for the uncontrolled and VFR flights and for dissemination of MET information.

SATELLITE PHONES

This is an alternative low-cost, high-quality solution to high frequency radio transmission. The use of such phones will have to be carefully managed, however, as they are presently considered sensitive by Indian security agencies.

INSTRUMENT LANDING SYSTEM (ILS)

Currently, there are 66 ILS installations at 55 airports. ILS assists a pilot to fly along a precise path, defined in three dimensions, during approach to land on a specific runway using radio guidance signals transmitted by ground equipment. ILS is used in cases of low visibility when the pilot cannot see the ground through the naked eye.

GROUND BASED AUGMENTATION SYSTEM (GBAS)

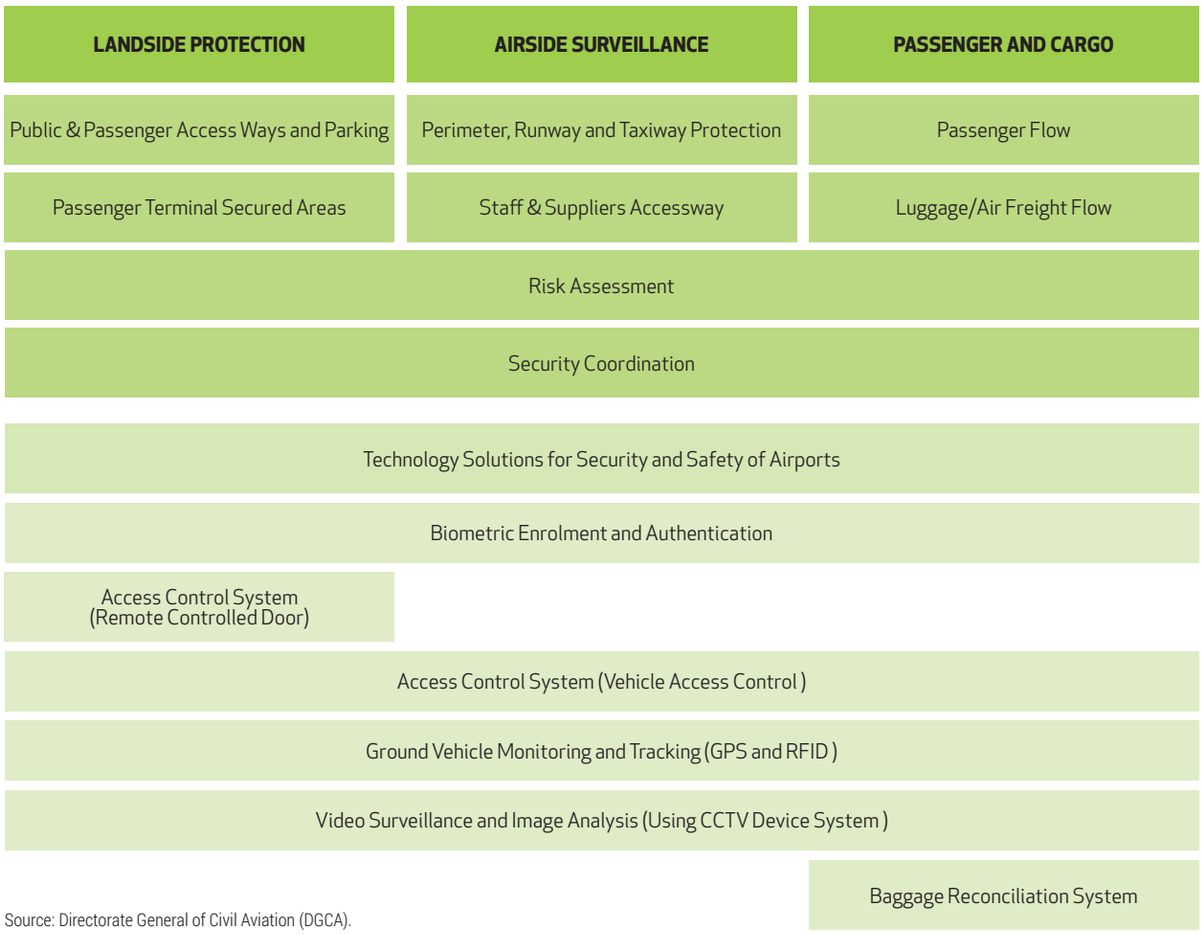
GBAS is a high-safety application which augments the GPS Standard Positioning Service (SPS) thus enhancing service levels. Compared to ILS, it is a superior technology that supports entire lifecycle of airside operations including approach, landing, departure, and surface operations within its coverage area. GBAS comprises of ground equipment which is complemented by GBAS avionics that is installed on the aircraft.

GPS-AIDED GEO-AUGMENTED NAVIGATION (GAGAN)

GAGAN is being designed to support en route navigation of the aircrafts. It is a planned implementa-

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Figure 10.25
Proposed ICT Solutions for Safety & Security



Source: Directorate General of Civil Aviation (DGCA).

tion of a regional satellite-based augmentation system (SBAS). Currently, aircrafts fly from one place to another along predefined air routes. Planes with SBAS receivers will, on the other hand, be able to take shorter routes, saving both time and fuel. Hence, GAGAN would improve efficiency and save costs by:

- Reduction of ground aids
- Reduced workload of flight crew and ATCOs
- Improved capacity through reduced aircraft separation
- Higher accuracy and global coverage
- Improved safety

This project will be able to help pilots navigate in the Indian airspace by an accuracy of 3 m compared to the current accuracy of between 8-20m by using radars. The reference stations pick up signals from the orbiting GPS satellites. These measurements are immediately passed on to the mission control centres that then work out the necessary corrections that must be made. Messages carrying those corrections are sent via the uplink stations to the satellites which then broadcast the messages. SBAS receivers on the aircrafts are able to use those messages and apply the requisite corrections to the GPS signals that they receive, thereby establishing their position with considerable accuracy.

AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST SYSTEM (ADS-B)

ADS-B allows pilots and air traffic controllers to 'see' and control aircraft with more precision, and over a far larger percentage of the earth's surface, than using radars. Unlike radar, ADS-B system's accuracy does not seriously degrade with range and atmospheric conditions. It uses conventional Global Navigation Satellite System (GNSS) technology and a relatively simple broadcast communications link. There are 21 ADS-B installations in India at present providing enhanced surveillance picture to the ATCOs.

DEPLOYMENT OF AIR GROUND DATALINK COMMUNICATION

As part of ICAO-mandated Global Air Navigation Plan, data link communication is being deployed globally for air-ground communication with the following benefits expected:

- Overcoming channel congestion
- Increased speed of data delivery

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- Freedom from interpretational errors
- Reduction of fatigue for pilots/ATCOs

In India, data links were first deployed over Oceanic Areas for communication with aircraft over long ranges in the form of CPDLC (Controller Pilot Data Link Communication) in the late 1990s for aircraft equipped with FANS1/A avionics. Subsequently data links have been deployed at 46 airports for dissemination of ATIS (Automatic Terminal Information Service) bulletins comprising latest weather information and latest runway conditions, etc., at the airport to aircraft in flight. Data links have also been deployed for issuing pre-departure clearances to aircrafts at six major airports.

VISUAL DOCKING GUIDANCE SYSTEMS (VDGS)

VDGS is a system which gives information to a pilot attempting to park an aircraft at an airport stand after it has landed at the airport, usually via visual methods. VDGS gives automatic and precise guidance of aircraft along the guidance line to their final parking positions at the gate.

TERMINAL DOPPLER WEATHER RADAR (TDWR) SYSTEM

TDWR system should be implemented in the terminal area of the airport to detect wind shear and microburst associated with convective storms to improve safety and efficiency of aircraft operations. The primary advantage of TDWR over previous radars is that it has a finer range resolution—meaning it can see smaller areas of the atmosphere. Currently, these radars are being used in the US and a few other countries such as China.

INTERACTIVE WEB-BASED GRAPHICS

Web-based graphics such as weather charts can be used to see, monitor and overlay specific areas in the airspace that contains clouds, fog, precipitation, visibility values, etc. This information can be used as input parameters while calculating the ideal navigation route using GAGAN system.

SAFETY AND SECURITY ENHANCEMENT

Currently, all Indian airports together handle close to 160 million passengers and this number is estimated to triple by 2020. Given this high level of traffic in the presence of elevated security threats, it is critical to install effective and efficient security measures and procedures at Indian airports that can handle the greatly increased traffic without causing congestion and yet ensure the safety of passengers and airports. Figure 10.24 shows the range of technological solutions available to enhance airport safety and security.

BIOMETRIC ENROLMENT AND AUTHENTICATION

Biometrics refers to an automated system that can identify an individual by measuring his or her physical and behavioural uniqueness or patterns, and comparing it to those on record. Biometric systems function under a three-step process under which individuals' biometric data is first recorded and then stored. Electronic sensors such as fingerprint readers or iris scanners or facial feature recognition systems then verify details periodically against the stored information as and when security clearances are required. There are severe ethical implications for the storage of biometric data, and especially for the general passenger population (as opposed to for employees of airports or airlines). Ensuring the integrity and security of the data is a critical issue, strict regulatory oversight will be necessary to prevent data misuse.

ACCESS CONTROL SYSTEMS (REMOTE CONTROLLED DOORS, SMART ACCESS CONTROL)

Solutions for access control include credentials management systems, contactless smart badges, vehicle identification systems, etc.

GROUND VEHICLE MONITORING AND TRACKING

The monitoring and tracking of passenger/commercial vehicles, can be achieved either using RFID or through GPS tracking.

Doppler weather radar systems should be installed in terminals to detect wind shear and microbursts associated with convective storms to improve safety and efficiency of aircraft operations. Currently, these radars are being used in the US and China.

VIDEO SURVEILLANCE AND IMAGE ANALYSIS

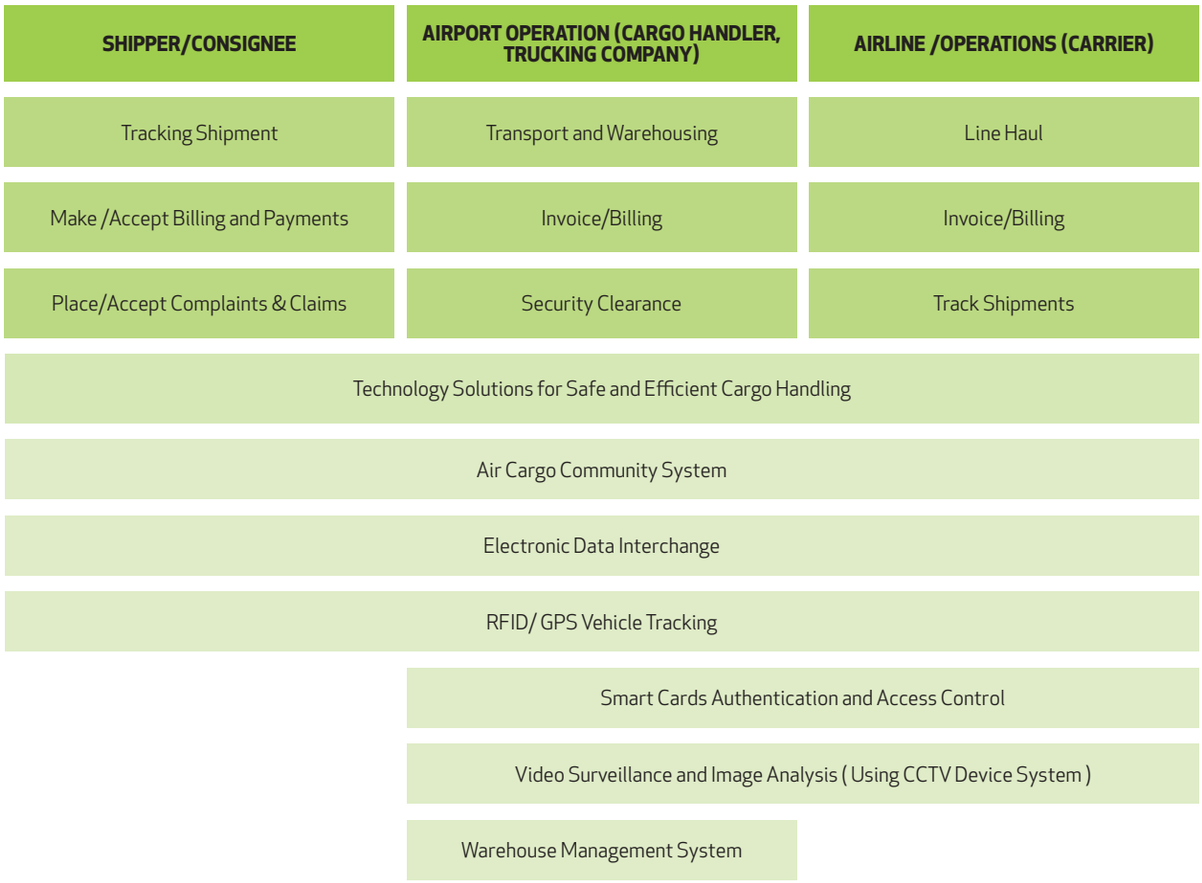
To enhance security of the air cargo and passenger terminals, terminals must install CCTV surveillance systems. Many systems also use some form of video recorders. These stored images are high resolution images with adequate zooming capability and hence can be used to obtain minute details about any suspicious activity or person. AAI has installed CCTV systems using advanced video analytics at 50 airports. Such systems have also been installed at six joint venture and greenfield airports.

BAGGAGE RECONCILIATION SYSTEMS (BRS)

BRS is used at airports to ensure that the passenger count matches the bag count for any given flight. As passengers check in, the airline Departure Control System (DCS) generates bag tags, boarding passes and messages called Baggage Source Messages (BSMs). A BSM will contain information such as passenger name, flight number identifier, destination, class etc. A BSM is unique for each passenger. The system can also be used for reconciling departing passengers and the bags that are being loaded onto their departing flight. BRS is currently installed at Delhi, Mumbai, Hyderabad and Bengaluru airports. AAI has contracted with SITA for providing their

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Figure 10.26
Proposed ICT Solutions for Air Freight Management



Source: Directorate General of Civil Aviation (DGCA).

BRS solution at 38 major airports. Installations have commenced.

EFFICIENT AIR CARGO OPERATIONS

There is significant untapped potential for air cargo in India. The total air cargo handled in 2011 by all Indian airports together was 2.3 million tonnes (mt) which is far less than that handled by individual airports such as Hong Kong, Memphis, Shanghai and Paris. This is due to lack of operational efficiency in air cargo operations at Indian airports. Now, sufficient cargo handling capacity has been created through implementation of Automated Storage and Retrieval System (ASRS), Elevated Transfer Vehicle (ETV) and introduction of multi custodians for warehouse management. This is expected to meet requirements till 2020. Figure 10. 25 shows some technological solutions to enhance the operational efficiency in air freight management. The top of the figure shows the activities that are of interest to three groups of stakeholders: (a) shippers and consignees; (b) cargo handlers or trucking companies; and (c) air carriers. The bottom half shows the various technologies available and the activities and stakeholders that would benefit from the implementation of those technologies.

AIR CARGO COMMUNITY SYSTEM

The air freight handling value chain has several stakeholders such as shippers, cargo terminal operators, trucking company, airlines, etc. Each of these entities has its own objectives and operates independently, with most of the information exchange happening manually. This leads to lost time and data inaccuracy, redundancy, increased costs and delayed decision making.

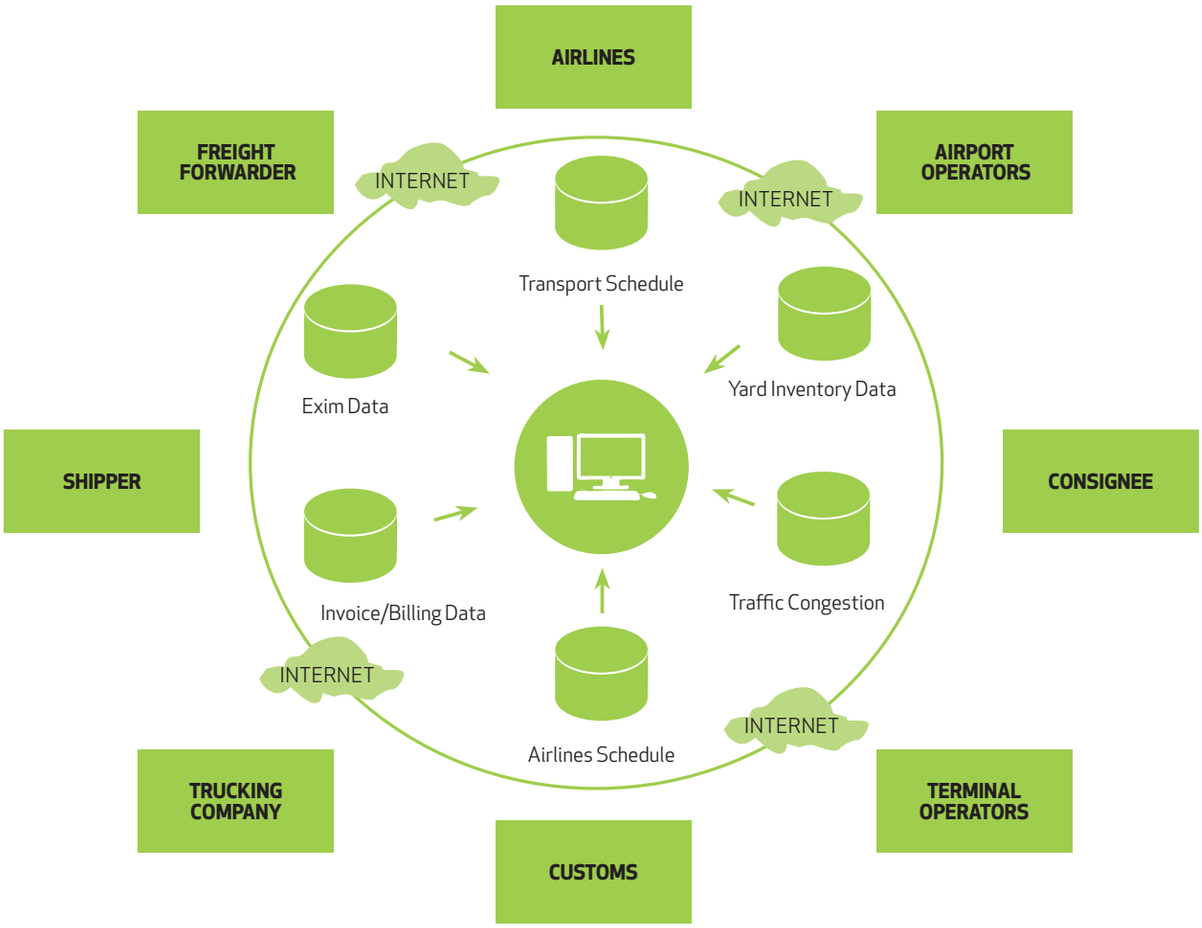
To resolve these issues, we propose a centralised information management system to integrate all these stakeholders so that there is more transparency in the entire value chain, leading to increased operational and economic efficiency. Each of the stakeholders will have a web portal wherein they can view all relevant information about other links in the supply chain (Figure 10.27).

ELECTRONIC DATA INTERCHANGE (EDI)

Generation and exchange of documents between air cargo handling authorities, customs and other agen-

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Figure 10. 27
Air Cargo Community System



Source: Directorate General of Civil Aviation (DGCA).

cies is a cumbersome and time-consuming process. The manual process leads to duplication of work making the entire process slow and more prone to errors along with the possibility of breach of security of confidential documents.

The air cargo community system discussed above can be further enhanced through EDI. Of course, EDI cannot be used for non-routine business documents like complicated contracts or information meant for humans to read and analyse. EDI is in operation at JV airports like Delhi, Mumbai, Bengaluru, Hyderabad and Kochi. At AAI-run airports, it is available at Chennai, Kolkata, Coimbatore, Amritsar, Trichy and Mangalore .

WAREHOUSE MANAGEMENT SYSTEM (WMS)

The primary purpose of a WMS is to control the movement and storage of materials within a warehouse and process the associated transactions, including shipping, receiving, storage and retrieval. The system also directs and optimises storage of stock based on real-time information about the status of bins. The key benefits of WMS are space savings, increased productivity, reduced labour, increased accuracy and reduced inventory levels. The international concept of movement of loaded unit load devices (ULDs) from the airport terminal to the bonded warehouses is already taking place at Chennai airport.

OVERVIEW OF IMPACTS OF SUGGESTED TECHNOLOGIES

Figure 10.27 shows the expected impact of the proposed ICT solutions on the key issues in civil aviation.

SUMMARY OF RECOMMENDATIONS

Because various airports are at different levels in terms of their current use of ICT, it is not possible to give a roadmap for general application to all airports, as has been done for the other sectors. The use of ICT to improve aviation is recommended for the

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Figure 10.28
Solution Impact Analysis for Proposed Solutions

ICT SOLUTION	CAPACITY AND EFFICIENCY ISSUES	SAFETY AND SECURITY ISSUES	CUSTOMER EXPERIENCE
Biometrics			
Electronic Data Interchange (EDI)			
GPS-Based Geo Augmented Nav. System (GAGAN)			
Warehouse Management System (WMS)			
Satellite Phone			
Instrument Landing System (ILS)			
Video Surveillance			
RFID For Baggage And Cargo Tracking			
Kiosks			
Air Cargo Community System			
Mobile Service			
Visual Docking Guidance System (VDGS)			
Access Control System (Remote, Smart Cards)			
Baggage Reconciliation System (BRS)			
Cloud Computing			
Airport Operational Database (AODB)			
Airport Operations Control Centre (AOCC)			
Collaborative Decision Making (CDM)			
Very High Frequency (VHF) Coverage			
Ground Based Augmentation System (GBAS)			
ADS-B System			
RFID/GPS for Vehicle Tracking			
Flight Information Display System (FIDS)			

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following activities along with the proposed technologies as follows:

- **Optimisation of airport operations:** Deploy technology solutions such as: (1) Mobile services; (2) Flight Information Display Systems; (3) Airport kiosks; (4) Near Field Communication; (5) RFID for baggage tracking (6) Airport CDM, to increase operational efficiency and reduce costs.
- **Effective management of airspace and aircraft navigation:** Proposed technology solutions are: (1) VHF coverage and networking; (2) High-frequency radio transmission for air-ground communications; (3) Satellite phones; (4) Instrument Landing System (5) ADS-B (6) SBAS and GBAS.
- **Safety and security enhancement:** (1) Biometric enrolment and authentication; (2) Access Control Systems (Remote Controlled Doors, Smart access control); (3) Ground vehicle monitoring and tracking; (4) Video surveillance and image analysis, etc.
- **Efficient air-cargo operations:** (1) Air Cargo Community System; (2) Electronic Data Interchange; (3) Warehouse Management System.
- **Capacity Building:** It is recommended that an organisation, which we tentatively call Institute of Aviation Research and Planning (IARP), be set up for conducting research, innovation and training in aviation technologies.

ICT FOR URBAN TRANSPORT

KEY ISSUES

A number of key issues that need to be addressed to improve urban transport have been discussed in detail in the chapter on urban transport of this report. That chapter documents that it is important to use ICT technologies for improving public transport and non-motorised transport (NMT). This section aims to bring out some important ways in which ICT can be deployed, particularly in these two segments.

CURRENT STATUS

Until recently, not much attention was paid to leveraging technology to meet urban transport challenges. However that is changing, but not uniformly. Some cities are far ahead in managing their transport operations with the use of technology while others are a bit behind. On the issue of ICT implementation for urban transport, cities in India can be divided into three categories:

1. **Cities using ICT for Urban Transport** such as Bengaluru, Delhi and Mumbai, where transport planning and some ICT implementation work has already been undertaken.
2. **Cities starting to use ICT for Urban Transport** such as Pune, Ahmedabad and Hyderabad, where some ICT solutions are already working, however, more work is required to develop them fully.
3. **Cities yet to start to use ICT for Urban Transport** such as Ranchi, Lucknow, Kanpur, Meerut, Mathura, where ICT implementation is at a very nascent stage, or no ICT projects have been implemented. Some of these growing cities are still in the planning stage and have yet to use technology for managing urban transport.

In order to get a feel for what can be done with ICT, we look at what has been, and is being done in Bengaluru. The city has state-of-the-art IT implementation processes in place. There has been a 7-10 per cent annual growth in the number of vehicles in Bengaluru, with personal vehicles comprising about 90 per cent of the total registered vehicles on roads, out of which 70 per cent are two wheelers and 20 per cent from light motor vehicles.

In Bengaluru, traffic signals are vehicle-activated and networked. The timing of traffic lights is controlled remotely, The automation centre receives online field information from traffic signals and surveillance cameras.

Since 2010, the city has started implementing Bengaluru Traffic Improvement Project (nicknamed B-TRAC), to address traffic congestion and safety issues by utilising the latest traffic management technologies. The focus has been to install intelligent transportation systems using digital surveillance, improve junction and street furniture, install enforcement cameras and increase awareness and capacity building. Under B-TRAC, the traffic signals were made vehicle-actuated, networked, controlled and monitored by the Traffic Management Centre. The timing of traffic lights is changed remotely and smart phones (BlackBerry) are used for enforcement. The automation centre receives the online field information from traffic signals, surveillance and enforcement cameras. Better compliance of traffic laws and rules has resulted in a reduction in the number of road accidents, less traffic congestion in central areas and reduced journey time (due to ICT-based implementation of signal synchronisation). The city has proposed a traffic training and road safety institute for capacity and institution building.

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Indian urban transport needs to use modelling and simulation models to solve some of its traffic woes. There is a need to develop simulation tools that can accurately forecast the behaviour of large, complex, multi-modal transportation systems and their interaction with people and society.

ICT INTERVENTIONS

We now describe ICTs that can be used to address, to some extent, these problems in urban transportation.

MODELLING AND SIMULATION (M&S) FOR PLANNING PUBLIC TRANSPORT

Modelling and simulation are essential in the development, assessment, operation and designing of future transportation systems. Simulations can be used for long-range planning, to evaluate the impact of changes made to the transportation system, and they also aid in operation and management. The techniques can be used to get meaningful insights from real-time information, including dynamic traffic flow and supply and demand interactions. It helps in creating powerful visuals which can help in providing insights to travellers in making choices about time, route and mode of transport. Indian urban transport needs to use modelling and simulation models to solve some of its traffic woes. There is a need to 'develop simulation tools that can accurately forecast the behaviour of large, complex, multi-modal transportation systems and their interaction with people and society'.

A promising advanced simulation model is UrbanSim which is still undergoing trials, but may be used in pilot studies now and if found appropriate can be used more widely. It is a simulation system for 'supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, the economy, and the environment'. It can be used to forecast the effects of the different transport investments and land use policies on the community. The technology can provide 3D visualisation and scenario creation. The open-source simulation system also enables civic engagement on issues of transport infrastructure and land use.

NON-MOTORISED TRANSPORT (NMT)

Indian mega-cities are increasingly investing in motorised-vehicle-friendly infrastructure, even though non-motorised transport has several benefits: reduction in congestion, fuel saving, lower cost, improved air quality and health benefits for passengers. However today, non-motorised transport is seen as unsafe, uncomfortable and a 'poor man's ride'. Promotion of NMT is made difficult because of the absence of any facilities that would make it a more attractive choice such as public bicycle systems; integration of cycles with other modes of public transport; park and ride facilities near railway stations and bus stops; priority for cyclists and pedestrians at intersections; dedicated and accessible footpaths. NMT can bring significant benefits for both passengers and society. There is need to change the mindset and policies so that these benefits are realised.

There are two potential initiatives for NMT that could benefit from the use of ICT.

- **Public 'Smart Bikes' sharing system for upcoming urban conglomerates:** Bike sharing is a plan in which an individual rents a bike from an unattended urban location. Multi-modal smart cards and mobile phones can make paying for the service easy, and can provide real-time information on the availability of bikes through the internet. Bicycles in the scheme can have RFID tags or Global Positioning System (GPS) systems to facilitate tracking. Public bicycle sharing can serve as a link between intercity travel and the public mass transit system. The idea can be extended to the sharing of public electric vehicles or electric bikes for short distances, thus cutting down on fuel use and associated air emissions.

- **Intelligent traffic signals and crosswalks:** For accelerating the use of NMT, there is a need to give priority to cyclists and pedestrians at intersections. Intelligent traffic signals, crosswalks and 'cyclist priority' lights are some ICT solutions which can help in creating safe and secure intersections. In North America, certain cities have traffic signals in which pressing a button to cross the signal triggers the 'instant walk signal'.

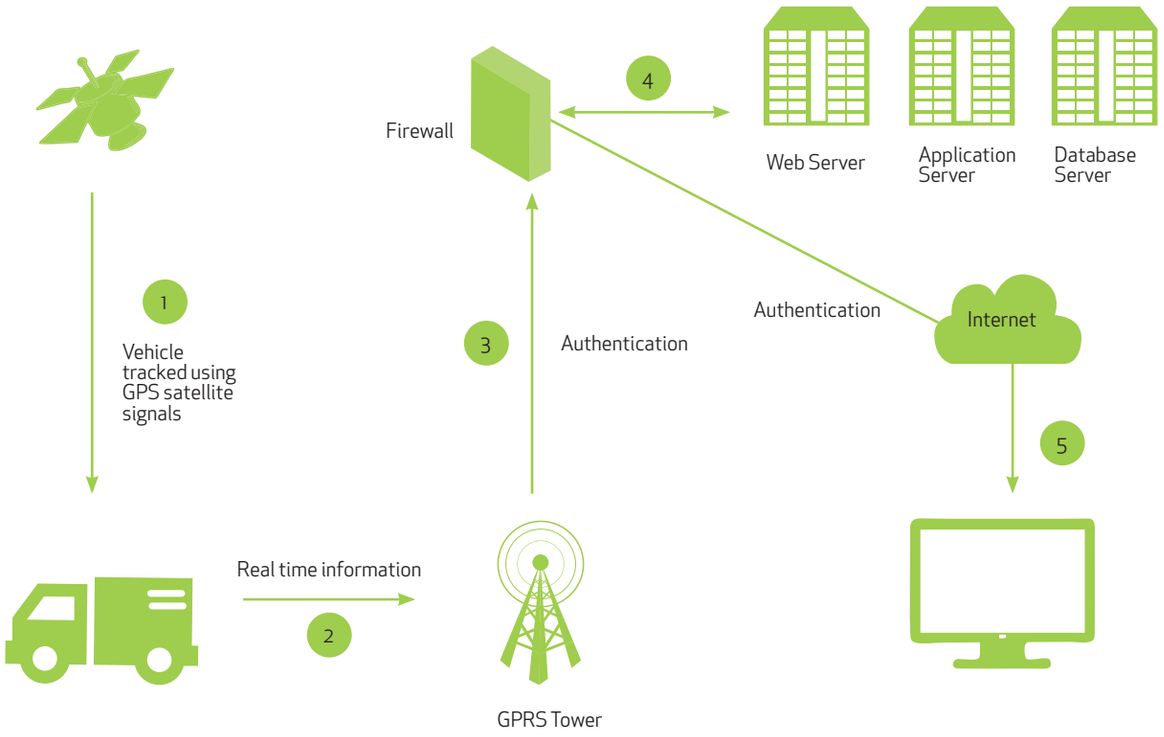
  London has installed 'cyclist priority' signals in which cyclists get a headstart before motorists get a green light by a few seconds. In this system, while there is a red light for the motorised traffic lane, cyclists have green lights allowing them to move 12m ahead to a second stop line. This allows the cyclists to clear the turning before the traffic coming behind them.

ERP FOR IMPROVING PUBLIC TRANSPORT SERVICES

Public transport agencies can utilise ERP to improve asset management and operational efficiency. ERP can have the basic functional applications integrated with special applications required for fleet management. Today, reliability is a key issue in public transport. ERP can be leveraged for preventing costly breakdowns (due to neglected fleet vehicles) and disruption of services. With ERP, the system can keep a

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Figure 10.29
Vehicle Tracking Solution



Source: Infosys Research (Adapted from VISIONTEK, Linkwell Telesystems Pvt).

record of vehicle information including insurance, fuel economy, tire purchase and repair management, driving history, etc. The system can be implemented to integrate with management information systems.

ESTIMATION OF CONGESTION THROUGH PRESENCE OF MOBILE PHONES

According to the Telecom Regulatory Authority of India, more than 65 per cent of the people in urban areas have a mobile connection. This presence of mobile phones can be used to estimate congestion on the roads. It is reasonable to assume that in urban areas, an individual in a private vehicle has a mobile phone. Therefore, the density of mobile phones in a section of road is an indicator of the level of traffic on that section. Telecom towers are continuously in touch with all the numbers in their region, and therefore, it is relatively easy to know the number of phones in the region covered by the tower. Knowing the location of the towers, one therefore can know the number of phones (and hence traffic) in each of the regions covered by the towers. Thus, the transport department can have a map showing the level of traffic at any time in the city. The department can then provide information on congestion levels, emergency blockages, accidents and bad road conditions to drivers so that they can take alternative routes. Furthermore, the Traffic Management Centres can also use the information to take remedial measures to reduce congestion. Bengaluru, one of the major ICT hubs of India, already uses such a system to identify congested areas.

VEHICLE TRACKING SYSTEMS AND FLEET MANAGEMENT

Vehicle Tracking Systems enable keeping track of the location of a vehicle in real time. The information is collected and shared with managers for management of the fleet.

Vehicles can be tracked using mobile phone technology or GPS technology.

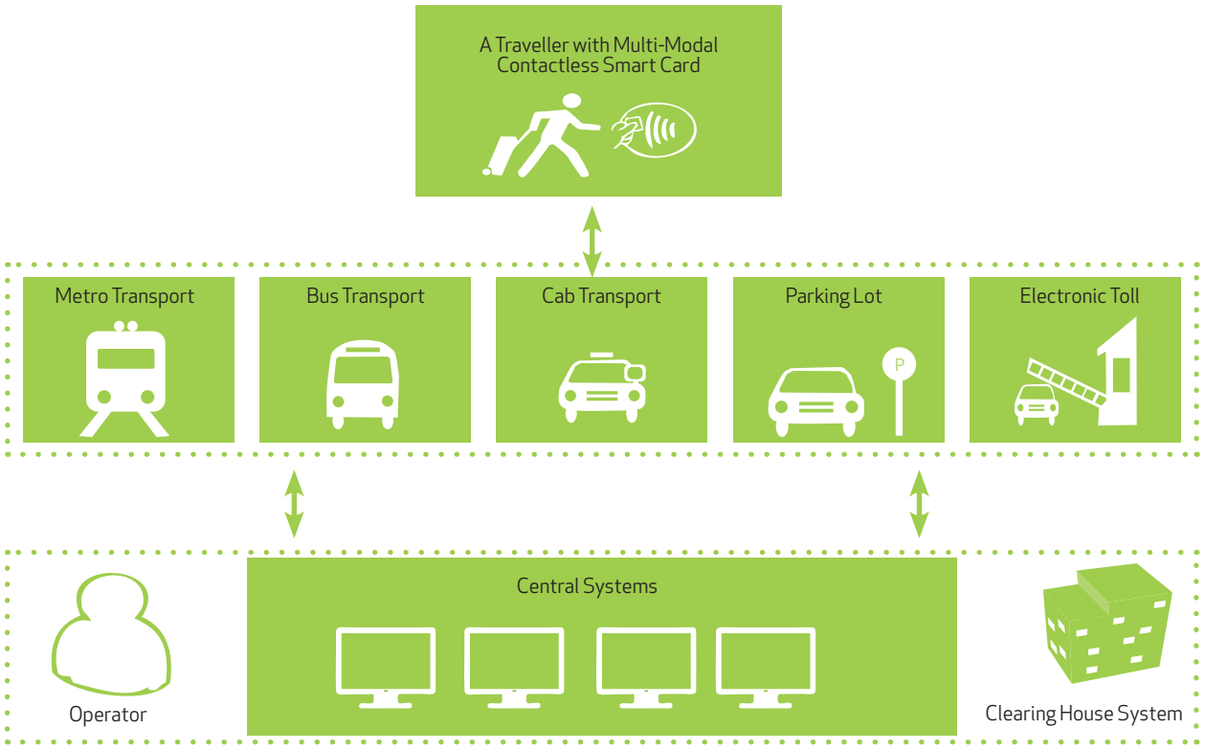
- Traffic scan with mobile phones can be used to track commercial vehicles. When a SIM card is installed in a freight vehicle with the required infrastructure, it can be used to track the precise location of the vehicle and determine the speed of traffic from its movement and hence is an efficient tool for fleet management. It helps in tracking actual travel time and the route used by the vehicle.
- Vehicles can also be tracked with GPS technology (Figure 10.29). An electronic device, installed in the vehicle emits signals. The signals are monitored by tracking agencies and helps stakeholders in remote management of the fleet.

INTELLIGENT TRAFFIC MANAGEMENT SYSTEMS

Intelligent Traffic Management Systems can remotely control and manage the network of traffic lights

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Figure 10.30
Multi Modal Contactless Smart Cards Solution Architecture



Source: Infosys Research (adapted from e-ticketing solutions).

at different locations. Embedded Web Servers (EWS) are located at each intersection. The software at Central Traffic Management Unit monitors the operation of traffic lights and helps in remotely managing them from the Traffic Department. The system enables effective traffic management because the control is based on an integrated view of traffic in a particular urban area.

INTEGRATED FARE AND TICKETING SYSTEMS

Integrated fare and ticketing systems play a vital role in attracting passengers to public transport. Passengers benefit from an overall decrease in duration of the journey and the cost of travel. In addition, payments become easier, and the journey appears 'seamless'. The government too benefits because these systems can be blended with other e-governance activities. With enhanced data mining, analytics and decision support tools, the ridership data can be converted into customer insights and could be used by the managing authorities to create strategic plans for optimal routes, fares and scheduling, making public transport more appealing for the citizens. Further, multi-modal ticketing saves cost in maintenance of ticketing facilities, improves staff utilisation, and reduces the level of fraud.

Such integrated systems use multi-modal contactless smart cards with RFID technology which can be used to pay for all modes of urban public transport (Figure 10.30). The contactless smart card is a rechargeable pre-paid card with stored value and an RFID chip embedded in it. A passenger can swipe the card across an electric reader when entering the transport system to deduct funds. The smart card can be easily reloaded through mobile wallet[5], credit-debit cards, ATMs and other authorised service providers.

The system can evolve to provide discounts for children, the elderly and students. A card holder can travel at reduced cost with earned reward points. The system can also be expanded so that one card can be used anywhere in the country for public transit. A further improvement could be the development with a personalised smart card which can be integrated with other personal details so that the card can be used not just for public transport, but also to pay parking fees and tolls.

Smart cards are successfully implemented in many Asian and European cities. Hong Kong and London are world leaders in the implementation of smart cards. Hong Kong pioneered the implementation of smart card payments systems with its Octopus card. It's one of early innovators in worldwide adoption of contactless payments in the transit market. The card can be used to make payments on public transport,

5. Mobile Wallet helps in instant money transfer and is an easier alterative to cash/card payment options.

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retailers and facilities, and it has the highest acceptance of a commercial card system.

In India, Delhi has launched the common mobility card 'More Delhi' which can be used on Delhi Metro and its feeder buses. The plan is also to extend the usage of this card to DTC buses and taxis in next few months.

PASSENGER INFORMATION SYSTEM (PIS)

The success of integrated fare and ticketing systems hinge on good passenger information systems so that passengers have valuable real-time information about the various transport modes and can make their travel plans accordingly. These information systems can significantly enhance the attractiveness of public transport.

Karnataka State Road Transport Corporation (KSRTC) has deployed ICTs in its bus fleets in Mysore. The system consists of GPS and real-time PIS in buses. KSRTC also plans to have video cameras for surveillance and installation of electronic ticketing machine in buses. There is also a plan to integrate fuel consumption data into the system, helping the KSRTC ensure higher mileage. This system will help in capturing data on distance travelled, fuel consumed and driver's behaviour.

INTERACTIVE CITY DASHBOARD

An interactive city dashboard would provide real-time information about city transport to travellers. A traveller will be able to get a digital map of a city with reports of accidents, highway and arterial congestion, road construction, special events, and weather and average travel times on the routes. The traveller will also be able to get information about public transport schedules, routing details and location of stops by simply entering his or her starting point and final destination. Based on such information, a person will be able to take the most optimum mode of travel. The dashboard will be accessible by smart phones and tablets and will be searchable and user-friendly.

Google has launched real-time traffic information maps in six Indian cities: Bengaluru, New Delhi, Mumbai, Chennai, Hyderabad and Pune. A user can activate the traffic and weather layers and get a colour-coded view of the traffic and temperature in a particular area.

CONGESTION PRICING FOR PRIVATE MOTORISED VEHICLES

Congestion pricing is a charge levied on a road user at times of congestion. This is usually implemented during peak traffic hours on roads that see a lot of congestion. It encourages use of public and non-motorised transport, and thus assists in reducing congestion and emission levels. While congestion pricing has been successful in many countries, before implementation it is advisable to ensure that public transport is available on congested roads so that people have an alternative transport option to avoid the congestion charge. Due consideration should also be given to cost and the required political will for implementing congestion pricing. In India, it should be first studied with pilot programmes and implemented only if results are promising.

There are several technologies available for implementing congestion pricing. One option uses Dedicated Short Range Communication (DSRC) charging through transponders and gantries, where the vehicle has an on-board unit which has a smart card. When the vehicle passes the charging point, the roadside equipment, typically mounted on the gantry, communicates with the smart card and the charge is deducted from the card. At the second gantry, the vehicle's number plate is photographed for enforcement purposes. Another technology is a video-based system which relies on taking an accurate image of the number plate with the use of Automatic Number Plate Recognition (ANPR). This is the system used in London. The camera takes the picture of the number plate, converts it into appropriate alphanumeric characters and matches it with the electronic list of user accounts. In India, solutions such as KLiPR have been developed for ANPR. KLiPR can detect and read heterogeneous number plates and has a module for capturing an image of the driver to provide another layer of security for enforcement purposes. Another form of technology is GPS-based distance road pricing which is still being developed.

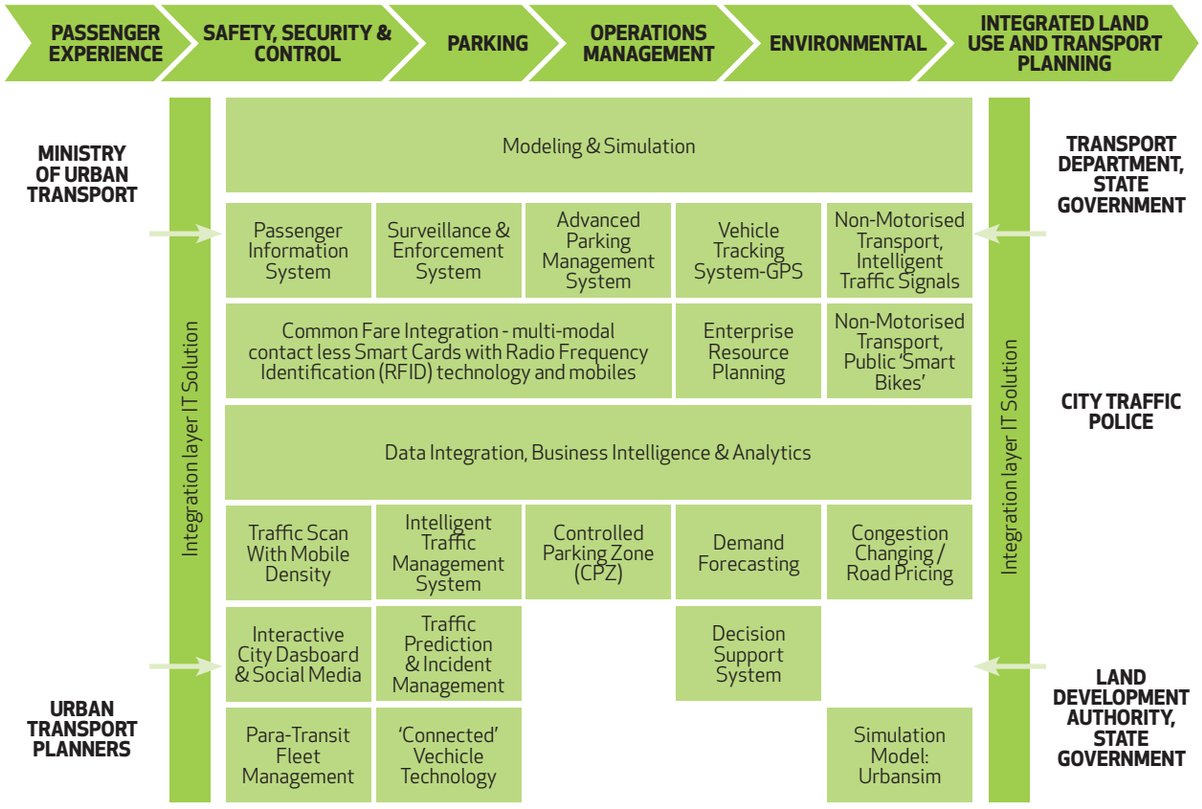
Congestion pricing has been successfully implemented in several cities around the world. In London, congestion pricing has been effective not only in increasing the use of buses by 6 per cent during the charging hours but also in raising revenue (£148m in financial year 2009/10). In 2008, Milan introduced an ECOPASS system in which vehicles are charged when they enter specified areas and the fee structure is based on the vehicles' potential air emissions. It uses the ANPR technology. In three years, the system resulted in reduction of highly polluting vehicles by 68 per cent and daily average emission of pollutants in the ECOPASS area of total PM10 by 15 per cent. In Stockholm, congestion pricing has reduced traffic by 18 per cent, increased green (tax exempt) vehicles by 9 per cent, and has reduced travel time on inner city and approach roads.

ENHANCING SAFETY THROUGH SURVEILLANCE AND ENFORCEMENT SYSTEMS

Intelligent surveillance and enforcement systems help in managing and enforcing traffic rules and regulations. These systems help in monitoring violations such as driving through a red light, jumping of

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Figure 10.31
Future IT Infrastructure for Urban Transport in India



Source: Infosys Research.

lanes, over-speeding and parking violations. For such offences, enforcement cameras capture the image of the errant vehicle, locate the owner and send him or her a notice for fines. In the case of monitoring by traffic police, the use of smart phones has assisted in registering many more cases and in making the system more transparent.

ADVANCED SYSTEMS IN THE FUTURE

There are more advanced systems that are still in nascent stages. These solutions are still undergoing trials and will need detailed feasibility study under Indian conditions before they can be implemented. We discuss two such systems here.

PARA-TRANSIT FLEET MANAGEMENT

In para-transit fleet management, an operator who owns private buses or taxis would manage the scheduling or routing of the fleet in the city. The service would be offered through a web browser, where a traveller would prepare his own itinerary with the following options: (a) advance booking of a vehicle (bus or taxi); (b) whether shared acceptable (yes or no); (c) origin and destination of the traveller; and (d) how much waiting time would be acceptable. The payment can be made through smart cards, mobile phones, cash or internet banking.

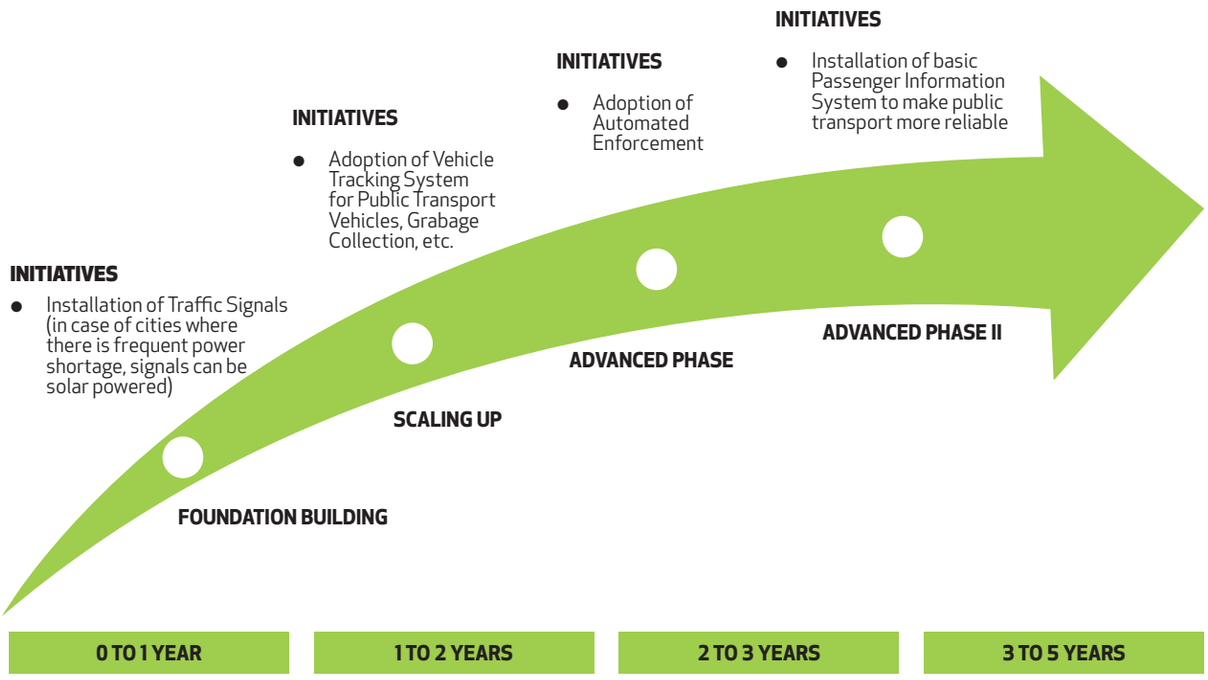
Based on the bookings, the operator will be able to optimise the use of his fleet on two factors: (a) maximum passengers per vehicle and (b) lowest kilometre per vehicle per day. This system would enable better utilisation and improved operational efficiency of the available private fleet. The traveller will get greater flexibility, a better travelling experience and better safety.

CONNECTED VEHICLE TECHNOLOGY

With this technology which is still under development, vehicles would be connected to each other through Wi-Fi. A vehicle would have information about the speed and location of other approaching vehicles, roadway conditions and hazards which a driver may not be able to see. The technology increases the driver's knowledge about his driving environment and reduces the probability of crashes, either vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I). The vehicle's system would give warnings about potential collisions and other hazards. The technology is also expected to assist in collection and consolidation of real-time data from equipment located on vehicles and within the infrastructure. These data can be further used to manage the multimodal transportation system for better performance.

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Figure 10.32
Pre-Implementation Plan (Cities currently without ICT in UT)



Source: Infosys Research.

This technology is expected to prevent accidents and injuries on roads, and increase efficiency. The technology is undergoing initial tests under the Connected Vehicle Safety Pilot Program, run by the US Department of Transportation (DOT), Research and Innovative Technologies Administration (RITA) and University of Michigan Transportation Research Institute (UMTRI).

SUMMARY

Figure 10. 31 summarises this discussion on ICT technologies that would be useful for urban transport.

INSTITUTION AND CAPACITY BUILDING

As discussed in the earlier sub-sections, efforts are being made to introduce ICT in urban transport. However, these efforts are being carried out by multiple agencies without much coordination. But the development of an effective inter-modal transport network requires coordination between transport modes and between agencies. A strong institutional structure is required for such coordination, which should be based on the basis of developing a network of IT professionals in all the different agencies involved in urban transport.

ROADMAP FOR ICT IMPLEMENTATION

Urban transportation in India requires an implementation plan which will address the issues of traffic congestion, pollution, parking, safety by utilising the latest traffic technologies feasible in Indian circumstances. The plan should be flexible to accommodate the growing population and the technology solutions should be scalable in nature. Technological solutions can be implemented in a phased manner taking into account trends in urbanisation, the existing status of technology being used and funding available for urban transport. Category 1 and 2 cities have been introducing ICT in urban transport; however cities in Category 3 have not. Therefore, the roadmap for implementing is different for Category 3 cities.

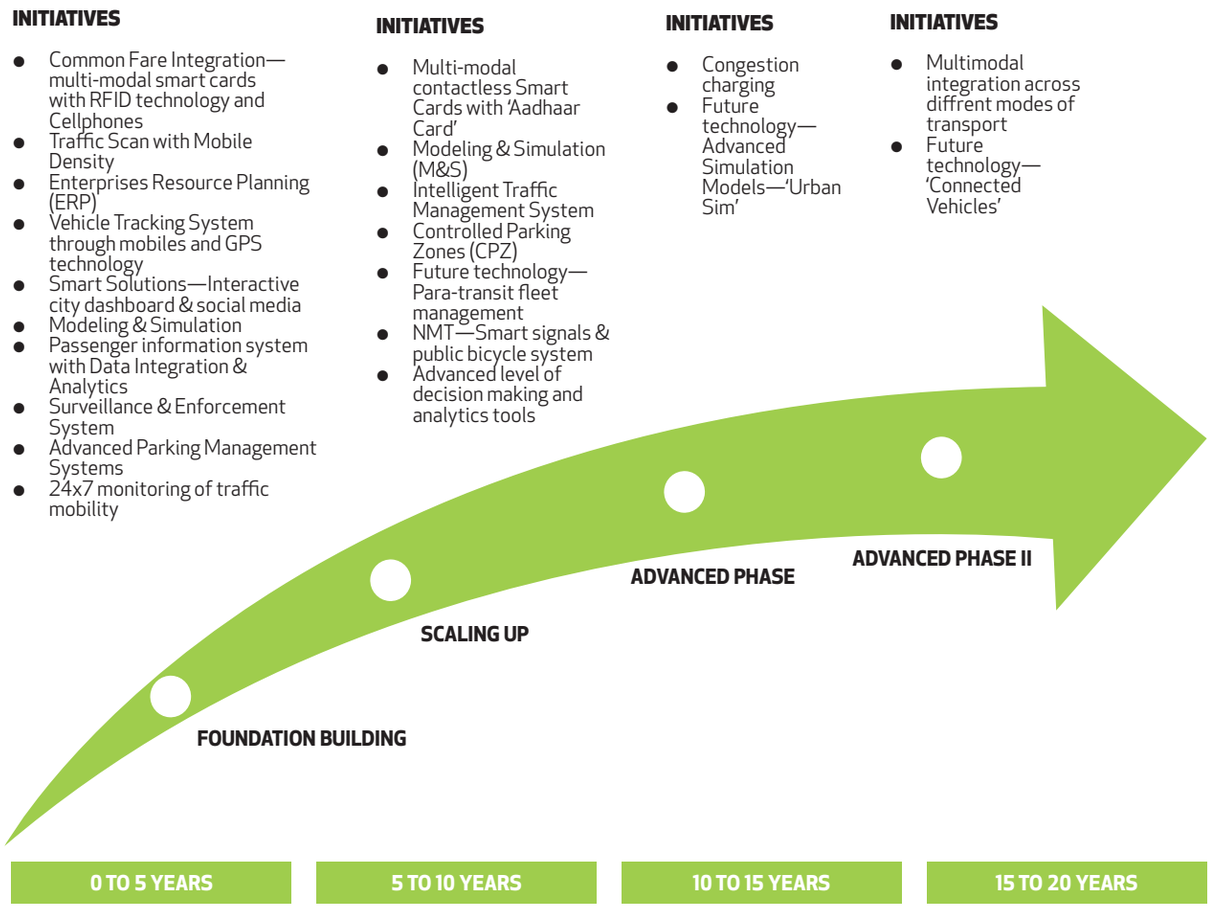
PRE-IMPLEMENTATION PLAN FOR CITIES THAT ARE YET TO START USING IT FOR UT

Cities in Category 3 need to implement a 'Pre-Implementation Plan' lasting about five years and then implement the steps that are described in the following sub-section on the Implementation Plan for Category 1 and 2 cities (Figure 10.32):

- **Foundation Building:** Installation of traffic signals. In case of cities where there are frequent power cuts, traffic signals can be powered by solar energy.
- **Scaling Up:** Adoption of a vehicle tracking system for public transport vehicles, garbage collection vehicles, etc.
- **Advanced Phase:** Adoption of automated enforcement.

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Figure 10.33
Implementation Plan for Category 1 & 2 Cities



Source: Infosys Research.

- **Advanced Phase II:** Installation of a basic passenger information system to make public transport more reliable.

Implementation Plan for more ICT-enabled urban transport system cities (Figure 10.33):

1. **Foundation Building:** Category 1 cities have used technological solutions for addressing their growing urban transport issues and have already started implementing some of these solutions. Some of proposed solutions that can be implemented at this stage are:

    - Fare Integration through multi-modal smart cards with RFID technology and mobile phones
    - Intelligent transportation systems and interventions involving digital video surveillance, 24x7 monitoring of traffic mobility, automated enforcement through smart phones and enforcement cameras and traffic modeling
    - Data collection and monitoring by using mobile density as a proxy for traffic and GPS-based monitoring of the buses
    - Setting up an interactive city dashboard and updating information of public interest on social networking websites including Facebook, Twitter
    - Information dissemination systems involving variable messaging system, use of SMS and FM channels
    - Operational efficiency through Enterprise Resource Planning (ERP) in transport agencies

2. **Scaling Up:** Some more advanced technologies can be added to urban transport in the next five to 10 years

    - Intelligent transportation systems and interventions involving intelligent traffic signals and advanced level of decision making and analytics tools, simulation models.
    - Parking management solutions—controlled parking zones (CPZ)
    - Taxi & para-transit fleet management (future technology)

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- NMT—Smart signals & public bicycle system

3. **Advanced Phase:** After a decade, urban transportation will have to be taken to a new level for a growing urban population. After feasibility studies, more advanced technologies can be considered for implementation at this phase. Some of the proposed solutions that can be implemented are:
   - Congestion charging
   - Advanced simulation models like UrbanSim which help in integrated land planning and transport
   - Bus platoon systems
4. **Integrated Urban Transport:** At this stage, more technologies can be implemented which can support multimodal integration across different modes of transport. In the next 15 years, feasibility and pilot studies on future technologies would have been performed and would be ready to be Implemented.

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11.
RESEARCH AND HUMAN RESOURCE DEVELOPMENT



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11. RESEARCH AND HUMAN RESOURCE DEVELOPMENT

In order to ensure more efficient, safer and cleaner transportation systems in India, there is an urgent need to set in place institutions and mechanisms for knowledge creation and training of professionals in all aspects of transportation planning and operations. Well-informed planning methods and use of modern scientific and technical tools for analysis and monitoring of existing systems can play an important role in transforming the transportation infrastructure in India.

The competencies of professionals working in the transportation field have to be strengthened considerably. India must also put in a place a system to continuously renew these capacities, both by updating existing workers' skills as well as inducting new expertise into public service as needed. Technology changes as well as evolving means of implementing transport projects through public-private partnerships (PPPs) require a variety of new skills from engineering, social and management sciences.

For the past many decades, transportation policies focussed mainly on increasing transport capacity and operational speeds. Over the next few decades issues concerning safety, climate change, harmful emissions, equity and energy efficiency, intermodal connectivity will also have to be an integral part of all transportation policies and embedded in all levels of decision making. This cannot be done without improving skills and increasing the knowledge of the transportation workforce and decision makers. We will also have to focus on supporting local transportation professionals through training, technology transfer and information exchange activities.

At present knowledge gaps exist in all areas of activity:

(a) Design, construction, operation, management, maintenance
(b) Safety
(c) Demand management
(d) Project management
(e) Use of Inteligent Transport System (ITS)
(f) Finance

Expertise in such areas needs a great deal of interdisciplinary work and collaboration between knowledge producers and practitioners at all levels.

Future transportation planning and policy making will also require a much more sophisticated approach to set in place systems that ensure the consideration of climate change and safety issues as integral components of infrastructure and technology options. In particular, all agencies will have to incorporate climate change and energy efficiency issues into their transportation planning processes. In the coming years all new transportation plans will have to include explicit reference to the effects of transportation on climate change and the role of transportation in mitigating these effects. There is a need for greater involvement of both central and state governments in climate change issues. Organisations at the local level in particular will need data and expertise input on how and where to incorporate climate change. The quantification of climate-forcing and health-damaging emissions as costs to be weighed in the transportation planning process is a

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new challenge for transportation agencies. All this will have to be implemented across all transport sectors and national, state and city levels for:

- Multimodal transportation planning
- Selection, integration and management of technologies
- Building, construction and maintenance of infrastructure
- Management of transportation systems
- Monitoring of systems: financial, energy, emissions, lifecycle costs, safety, efficiency, etc.

Decision-makers, transportation officials, and staff face increasingly complex issues when addressing transportation needs in their communities. Examples of expertise requirements would include:

- Air quality assessment and health impacts: natural and physical sciences, medical sciences, mathematical modelling, instrumentation
- Freight and human movement: All engineering sciences, mathematical modelling
- Safety: engineering and medical sciences, epidemiology, statistical modelling, psychology and sociology
- Asset management, cost estimation, financial planning: economics, accounting modelling
- Operations: management, operations research, survey techniques, sociology and psychology
- Public involvement: education, public relations

Expertise needs to be developed specifically in all these areas with special reference to different modes of transport. At present none of the agencies involved—educational institutions, research laboratories, operators, government agencies, non-governmental organisations (NGOs)—have adequate interdisciplinary expertise or the required number of personnel to service these needs.

One way to understand the status of knowledge production in different countries is to examine the number of scholarly articles on different subjects originating from those countries. Five key areas were identified, pertaining to the field of transportation research:

1. Road Safety
2. Civil Engineering projects related to development in transport facilities
3. Emissions, covering air and noise pollution
4. Railways
5. Transportation planning, oriented towards developing the transport facilities

Each of the areas mentioned here, were indexed using unique keywords and a search done on the online search engine Scopus™. The results of the search for the countries India, China and Brazil are shown in Table 11.1 and the output normalised for population (2011) shown in Table 11.2. These tables reveal that not only does India fare poorly in terms of total output, when normalised for population levels in 2011, India's output appears poor in comparison with both Brazil and China. Even more worrisome is the fact that the gap between India and China has widened considerably in the past decade (Table 11.3) especially on topics dealing with railway technology.

If we assume that research output may have some relationship with per capita income and number of people in each society, even then these results show India is doing much worse than China and not even as well as Brazil.

It is possible that these data do not contain studies published from India which are not included in indexed journals, and that the quality of studies from India may be better than many originating from China. However, the gaps are so large that we need to take corrective measures on an urgent basis. The number of papers from China per person per US$ per capita income are more than three times greater than that from India in all areas. This means that if we want to catch up with China in 10 years with their present levels of productivity, we will have to grow at more than 10 per cent per year. However, this would not be adequate enough for the kind of growth we need in knowledge generation and innovation to put in place systems in the next 10 years that serve us well for the next 30 years. It would be safe to assume that we need to plan for a dramatic increase in human resource development, research output and creation of jobs for highly trained professionals.

VISION

The research figures are only a symptom of general gaps in capacity available in India. Increase in research output alone is not likely to yield the kind of systemic changes required for ensuring a more evidence and knowledge based policy-making environment necessary to steer us towards a sustainable transportation future. The system we envision must address the unique issues of concern in India. Sustainable growth of transportation requires an integrated interdisciplinary approach that incorporates our special needs. Work for sustainable transport will need an innovative combination of current and future international knowledge adopted to local findings. This knowledge will have to be produced in India within the socially dominant forms prevalent here. We have to set up a system of research which responds dynamically to include a heterogeneous set of practitioners collaborating on problems defined here in localised contexts but integrating international concerns and learning from international experience in a rigorous, internally consistent format.

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Table 11.1
Number of Academic Articles Published Originating in India, China and Brazil, 2006-10

	INDIA	CHINA	BRAZIL
Road Safety	120	911	118
Railways	121	2,167	28
Emissions	15	60	51
Civil Engineering	151	1,234	19
Air Transport	33	323	29
Marine Transport	12	97	1
Transport Planning	18	129	13

Source: NTDPC Research done through Scopus™.

Table 11.2
Number of Publications, 2006-10
[Per 100 Million Population]

	INDIA	CHINA	BRAZIL
Road Safety	10	68	62
Railways	10	162	15
Emissions	1	4	27
Civil Engineering	12	92	10
Air Transport	3	24	15
Marine Transport	1	7	1
Transport Planning	1	10	7

Source: NTDPC Research done through Scopus™.

Table 11.3
Ratio of Journal Papers Published by China and India, 1961 -2005 and 2006-10

TOPIC	1961-2005	2006-10
	CHINA/INDIA	CHINA/INDIA
Road Safety	1.1	5.5
Transportation Planning	1.4	12.9
Emissions	0.6	4.0
Railways	8.1	23.0
Civil Engineering	3.3	8.4

Source: NTDPC Research done through Scopus™.

We must plan to set up systems for local knowledge producing mechanisms that aid researchers in responding to demands of society. Such systems are in a very nascent stage of development here, but the good news is that the divides between research and practice that are entrenched in many of the world's top-ranked research programmes also have not been replicated in India. It is possible to build such knowledge systems even as higher education reform moves forward, rather than having to unlearn ways of research production and then re-learn. Researchers will have develop new and appropriate tools of analysis and technological solutions for tackling the complex problems of safety, pollution, access and mobility. We must create quality resources needed for integrating hard and soft sciences research. It is these resources, publications and networking activities that will bring continuity and permanency to activities that also address quality of life issues. The effort would be to experiment with new forms of knowledge generation where there is continuous negotiation between disciplines on one hand and between scientists and society on the other, and where the solutions developed will normally be beyond that of any single contributing discipline. They will necessarily be transdisciplinary.

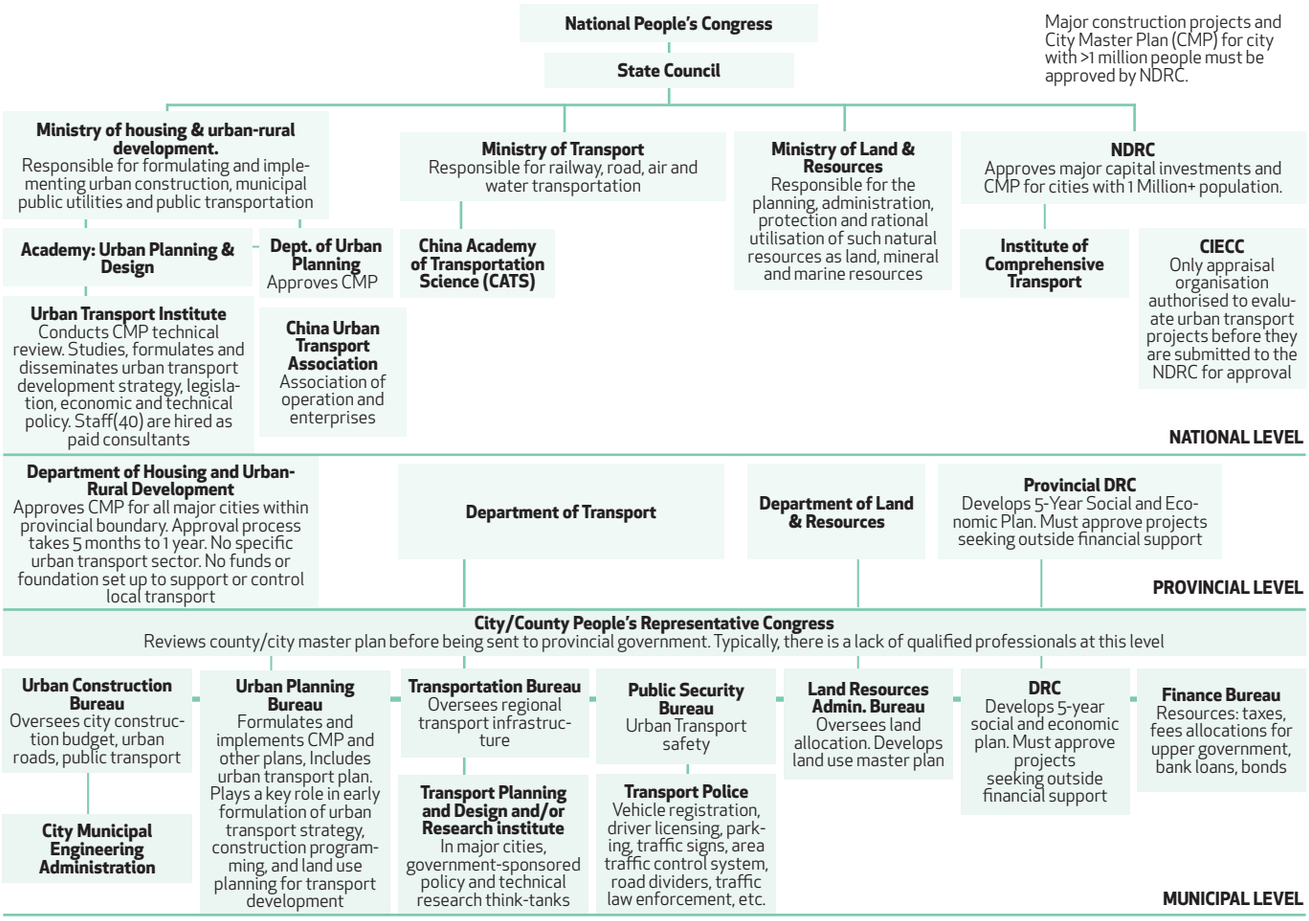
INSTITUTIONAL SET-UP

Functioning transportation systems in any location involve interactions between individuals, socio-economic imperatives, technologies, geophysical structures, built environment, organisational capacities, political compulsions, knowledge limitations, influence of special interest groups, and historical path dependencies of societies. As with any other complex structure, we tend to deal with transportation systems with little knowledge about these interactions and their myriad feedback loops. We have some knowledge of the input and output variables, but little of the transfer functions and the feedback loops. In such a situation it is very necessary to have organisational systems that keep track of inputs and outputs on a continuing basis so that transfer functions can be developed and modified periodically. This understanding would help us in technology choices, development of appropriate physical and management structures and periodic course corrections.

There are a large number of models available around the world for institutional frameworks that attempt to satisfy the above goals. To address deficiencies in data and data processing limitations, lack of infor-

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Figure 11.1
China Transport Planning and Research



Source: World Bank report prepared by Zhu Lin, 2004.

mation on costs, demand, revenues and asset condition, effective regulation procedures, management and accountability, forecasting models, technology choice assessment, different governments have established:

(a) independent research institutions at national and regional levels that work on all modes of transport and also mode-specific institutions;
(b) formally structured, information provision units within government or operating as service providers to government, whose responsibilities include defining, collecting, forecasting, structuring and disseminating information on transport problems and trends and the performance of policy instruments. Such units use information from all relevant transport agencies;
(c) relatively large policy making and technical research departments in ministries and operating agencies;
(d) centres of excellence at academic and research institutions.

The variety of institutions is important to ensure a flow of knowledge from global to local expertise: faculty and researchers move between independent departments on temporary basis, while their colleagues may establish longer-run relationships with public servants and policy-makers. The dispersed knowledge creation also creates scope for variety, and particular attention to local issues that researchers experience personally. It also ensures competition between research groups and insulates against mistakes or organisational challenges that one institution faces. For example, as Figure 11.1 shows, China has set up institutions that work on transportation related issues at different levels.

The following subsections give a few examples of knowledge-producing institutions for comparative perspective and summarise lessons from international experience with overall research production systems.

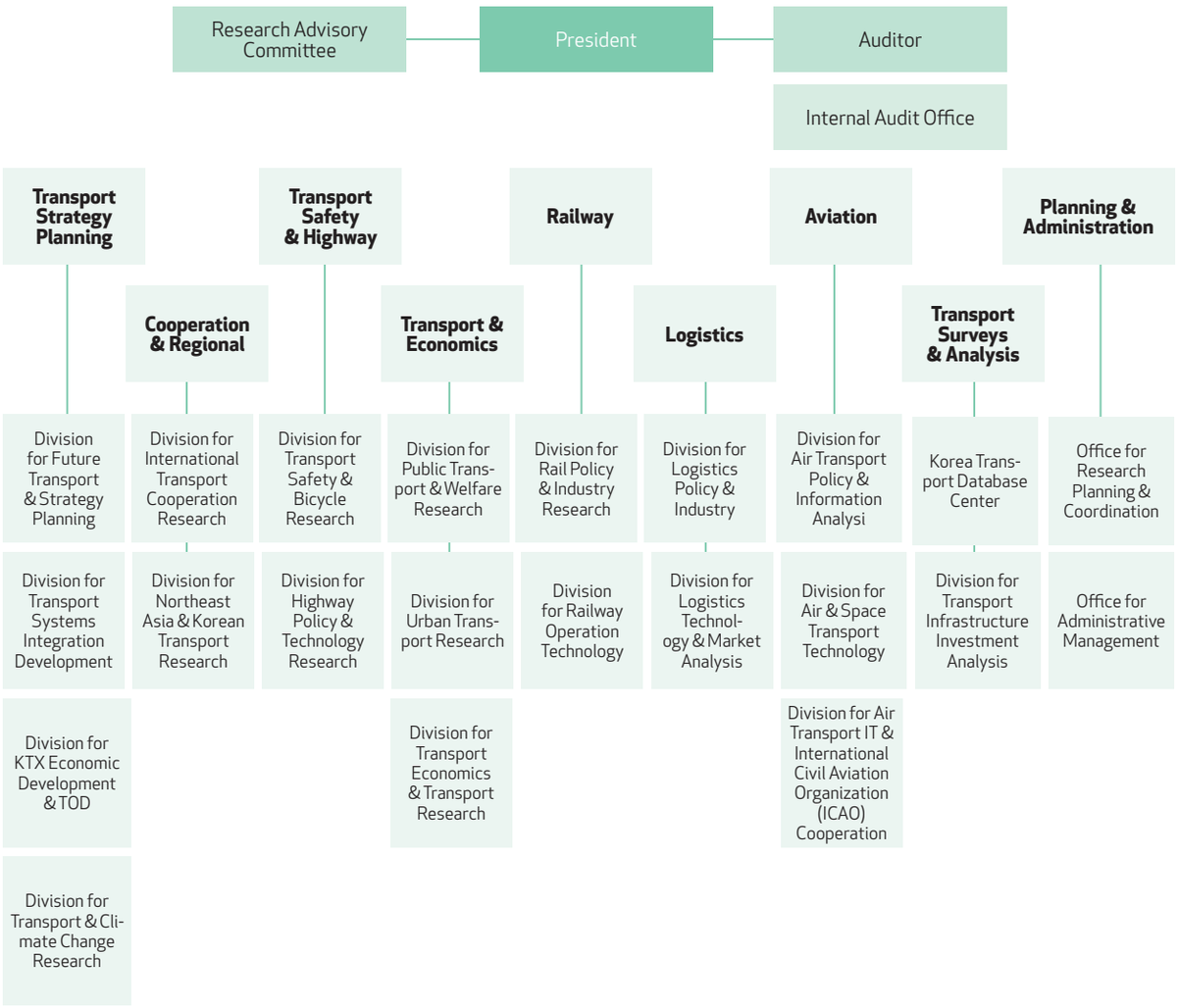
NATIONAL TRANSPORT INSTITUTIONS

THE KOREA TRANSPORT INSTITUTE (KOTI)

KOTI, established in 1985, is the official research agency for the government of the Republic of Korea. In 1987 it began operations as a government-funded institution pursuant to Article 24 of the Urban Transport Promotion Act. It joined the Korean Council of Economics & Social Research Institutes pursuant to the Article of the Government Grant Act

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Figure 11. 2
Administrative Structure of the Korea Transport Institute (KOTI)



Source: KOTI.

for the Establishment, Operation and Promotion of Research Institutes. Since then it has developed into a very influential institution for developing national policies and social agenda in the transport sector with objective of:

- Providing policy-making assistance to the government (guidelines, public hearings, seminars, etc.).
- Developing future transport technologies to explore new growth engines for the national economy.
- Devising a new strategy to support national transport policies.
- Pursuing a knowledge-sharing programme in the transport sector.
- Developing global agenda and promoting cooperation with international organisations.
- Developing creative and innovative endeavours.
- To serve as a comprehensive research institute on transport and logistics and as a National Think-Tank.
- Serve as hub for global transport cooperation.

The Institute has nine departments and the structure is shown in Figure 11.2. KOTI covers all areas of transport, employs over 200 researchers, and has agreements with a large number of Korean transportation organisations and academic institutions. These include for example: Transportation Command, R.O.K, Korea Institute of Construction and Transportation Technology Evaluation, Korea Transportation Safety Authority (KOTSA), Korea Advanced Institute of Science and Technology (KAIST), Korea Institute for Construction Technology, Graduate School of Environmental Studies at Seoul National University, Daegu University, Institute of Urban Sciences at University of Seoul, Busan Transportation Corporation, The Korea Railway Association, Korea Airports Corporation, Korea Aerospace University.

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Since its foundation, KOTI maintains close foreign relationships with foreign institutions and research organisations. These include MOUs and academic exchanges. Examples of these are given below:

- The Establishment of a master plan for the Arterial Road Network in Sumatra Island, Indonesia.
- Integrated International Transport & Logistics System for Northeast Asia (partner UNESCAP).
- MOUs with over 20 organisations including: The Institute for Transport Policy Studies (Japan), TRL (UK), OECD, Asian Development Bank, Land Transport Authority Academy (Singapore), The World Bank, Tsinghua University (Beijing, China), Gesellschaft fuer Internationale Zusammenarbeit (GIZ, Germany), MIT (US) and Electronic Navigation Research Institute (Japan).

STANDING COUNCIL ON TRANSPORT AND INFRASTRUCTURE (SCOTI), AUSTRALIA [1]

The Standing Council on Transport and Infrastructure (SCOTI) (formerly known as the Australian Transport Council) was established in September 2011 and brings together Commonwealth, State, Territory and New Zealand Ministers with responsibility for transport and infrastructure issues, as well as the Australian Local Government Association.

SCOTI is advised and assisted by the Transport and Infrastructure Senior Officials' Committee (TISOC) on all non-infrastructure priorities, and the Infrastructure Working Group providing advice and guidance on the coordination of infrastructure planning and investment, across governments and the private sector.

The Council's high-level policy responsibilities include:

- surface transport;
- transport safety and security;
- promotion of more efficient and environmentally conscious transport, including through vehicle emission standards and national cycling promotion;
- infrastructure policy and investment, including road, rail and ports;
- infrastructure and related land use planning; and
- strategic planning for infrastructure and consistency with agreed criteria for capital city strategic planning systems.

The Council works closely with the Standing Council on Regional Australia to ensure integrated action for regional Australia.

The Council's priority issues are:

(a) Achieving national systems for regulation of heavy vehicles, maritime safety and rail safety;
(b) Completion of the National Freight Strategy, including the development of a dedicated National Ports Strategy, with additional work undertaken to outline how airports and airport land use planning might be taken into account in the National Freight Strategy;
(c) Consideration of national heavy vehicle pricing and funding reform through finalisation of the COAG Road Reform Plan process;
(d) Consideration of the National Urban Policy and integration with agreed criteria for capital city strategic planning systems;
(e) Developing and implementing reforms to infrastructure investment and financing;
(f) Developing a National ePlanning Investment Plan by end 2012 through the National ePlanning Steering Committee.

INSTITUTION FOR TRANSPORT POLICY STUDIES (JAPAN) AND THE JAPAN RESEARCH CENTRE FOR TRANSPORT POLICY [2]

The Institution for Transport Policy Studies is an independent, non-profit foundation established under the auspices of the Japanese Ministry of Land, Infrastructure and Transport. The activities of the Institution involve comprehensive research and survey programs on transport matters. The Institution also evaluates transport policy and offers recommendations to the Japanese government and concerned parties on transport policy issues. The overall aim of the Institution is to contribute towards the development of transport policy in order to promote the welfare and quality of life of people in Japan, its economy, and greater harmony in international relations.

Primary activities are to:

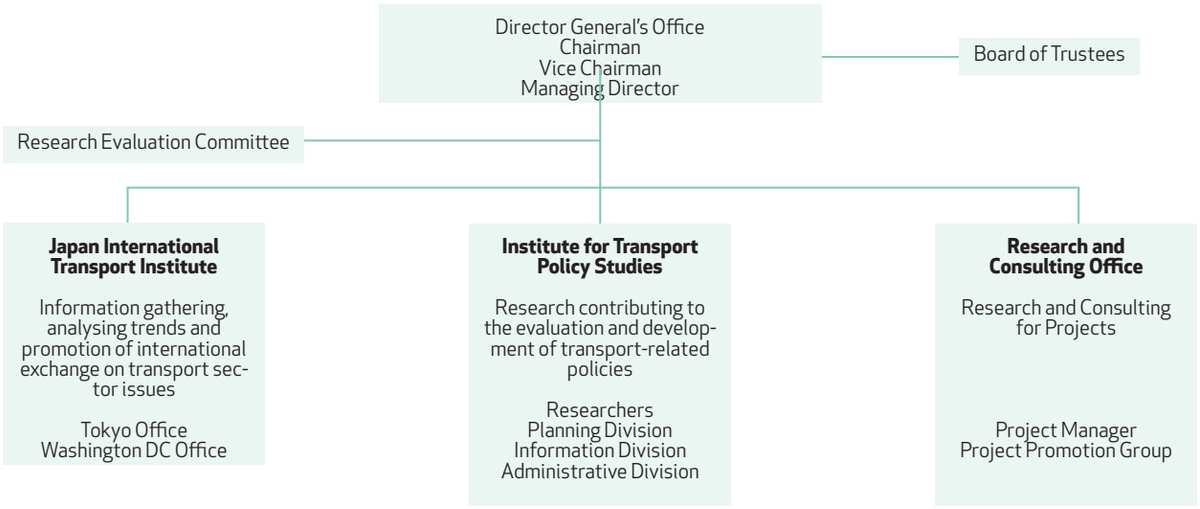
(a) Conduct research and surveys on transport matters
(b) Evaluate and advise the national government on transport policy issues
(c) Collect and analyse transport-related data
(d) Survey overseas transport trends
(e) Conduct regional and international cooperative exchange programmes and activities related to transport issues
(f) Consult on matters related to transport issues
(g) Host lecture sessions, study meetings and seminars to promote awareness of transport issues.

The Japan Research Centre for Transport Policy was founded in 1971. Since then, the Centre (a private non-profit organisation involving transportation specialists and researchers active in universities, private industry, government and local governments)

1. http://www.scoti.gov.au (accessed 12 January 2013).
2. http://www.jterc.or.jp/english/gaiyo.htm; http://www.nikkoken.or.jp/english/index.html (accessed 15 November 2012).

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Figure 11.3
Organisational Chart for Institution for Transport Policy Studies, Japan



Source: NTDPC Research.

has been carrying out interdisciplinary academic research focused on transport policies for roads and motor vehicles, and providing educational activities and proposing policies regarding a comprehensive transport system that will contribute to the beneficial development of Japanese society. It has been formally certified as a Public Interest Incorporated Association under the new organisation reform act.

The centre conducts surveys and research pertaining to transportation policy. The primary focus is the movement of people and goods that are a vital part of the socio-economic activities of the nation. Research is conducted primarily through the efforts of the Centre's regular and associate members and by securing the participation of key outside partners. Research projects include topics selected from proposals submitted by members and includes research conducted in collaboration with associate members. Another purpose is to cultivate and mentor aspiring young researchers. Special research focused on themes of particular societal concern is often chosen for study. The outcome of the research is the formation of transportation policies for entities concerned with improving the quality of life. These entities include national and local governments, concerned institutions and various other organisations.

Examples of topics on which work is done include the prevention of global warming, preservation of natural resources and energy, social and economic impacts of a dwindling birth rate, changes in population demographics (aging and shrinking population), development of a safe and comfortable transportation system, streamlining and globalisation of physical distribution, expanding inter-regional gap between outlying regions and urban centres and funding issues concerning road maintenance and improvements.

Major activities include: research of transportation policies that improve safety, comfort and mobility; study of transportation policies consistent with environmental, energy, national, regional and urban policy; research regarding transportation policies affecting businesses and the movement of people and goods; research and development of financing policy.

SECTORAL INSTITUTIONS

CHINESE ACADEMY OF RAILWAY SCIENCES (CARS)[3]

Since its establishment more than 50 years ago, the history of CARS is closely related to the railway construction of the People's Republic of China. In November 1949, only one month after the PRC was founded and everything needed to be rehabilitated, the Ministry of Railways decided to establish a railway scientific research institution. On 1 March 1950, the Railway Technology Institute of the Ministry of Railways was formally founded in and in September the same year, the name was changed into Railway Research Institute of the Ministry of Railways and its leading body was then moved to Beijing. Since the 1950s, it organised personnel and material resources to revitalise the war-torn railway network and construct new lines. After the Railway Research Institute was expanded to the China Academy of Railway Sciences in 1956, their technical personnel participated in the compilation of 1956-1967 Perspective Planning of Railway Science and Technology Development and undertook its execution. In 2002, it was transformed from a state-owned institute to an enterprise under the direct control of Ministry of Railways.

The past 50 years have seen CARS grow into a comprehensive institution with multiple disciplines and specialties and a centre of scientific research, experiment, industrial products and material inspection,

3. Guofang and Tianyun (2003).

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In 1949, only a month after the People's Republic of China was founded, it decided to set up a railway scientific research institute.

scientific and technical information, and standard and metrology. In CARS, there is a staff of 2,359, of which 1,640 are professional technical personnel accounting for 69 per cent of the total. In addition, there are 510 people with senior technical titles and 755 medium-level technical titles.

Since its establishment, CARS has undertaken several thousand scientific research topics centring around subjects such as rock engineering and geo-engineering, track structure, continuous welded rail (cwr) track, bridge and tunnel construction, hydraulic and hydrological engineering, engineering blasting, structural vibration, subgrade in desert or permafrost, prevention and control of landslide and debris flow, automation of marshalling yard, station computer control, despatching control, radio communication, optical fibre communication, data transmission, computer application, metal and non-metallic new material and techniques, non-destructive flaw detection technique, automatic detection, passenger and freight transportation organisation, transport economy, loading and unloading equipment, fundamental standard, scientific and technological information as well as soft science research.

Research Institutes

- Locomotive and Car Research Institute
- Signal and Communication Research Institute
- Railway Engineering Research Institute
- Computer Technology Research Institute
- Metals and Chemistry Research institute
- Transportation and Economics Research institute
- Environmental Control and Labor Hygiene Research Institute
- Scientific and Technological Research Institute
- Standards and Metrology Research Institute

Centres

- Railway Science and Technology Research and Development Centre
- Quality Supervision and Inspection Centre for Railway products, Railway Scientific, Technological and Economics
- Inspection and Measurement Centre for Railway Infrastructure
- State Railway Test Centre
- Railway Technology Training Centre

State Engineering Research Centre

- National Centre of Railway Intelligent Transportation System Engineering and Technology

Metrological Stations

- State Track Scale Station, State Railway Tank Car Volume Measurement Station

CARS confers master's degrees in 13 specialties and doctoral degrees in five. In addition, there are two post-doctoral research centres in CARS. CARS publishes 12 kinds of academic and technical publications (including two internal publications), and has a library with a collection of over 300,000 copies of books, documents and papers. Backed by the related departments and the Ministry of Railways, CARS actively strengthens the international cooperation and exchanges as well as extends cooperation fields.

NATIONAL AEROSPACE LABORATORY, THE NETHERLANDS (NLR)[4]

The Government Service for Aeronautical Studies (RSL) was founded in 1919 to increase air safety for military aviation. The rapid emergence of civil aviation, however, caused the RSL to focus on that sector too. In 1937, the RSL was turned into a foundation (the NLL and subsequently the NLR), which created a better basis for conducting scientific research for the national aircraft industry (Figure 11.4).

NLR is the aerospace knowledge enterprise in the Netherlands. It answers questions such as: how can aircraft be made more silent, fuel-efficient and safer whilst increasing capacity on the ground and in the air? How can you ensure that satellites remain at a constant temperature so they can continue to function efficiently?

A staff of 650 employees develops new technologies, combining disciplines such as aircraft engineering, electrical engineering, mathematics, physics, information science and psychology. NLR has state-of-the-art facilities such as wind tunnels and interconnected aircraft and air-traffic control radar and tower simulators. NLR targets the entire lifecycle of aircraft: from research, via design, servicing and maintenance to modernisation in both civil and military aviation. NLR publishes about 600 reports, including some 40 technical publications annually.

NLR is the Dutch knowledge enterprise for identifying, developing and applying advanced technological knowledge in the area of aerospace. NLR is also committed to being the most competitive knowledge organisation for the Dutch aerospace sector in Europe (with the best price-quality ratio). NLR has (inter)national collaboration with aerospace enterprises and miscellaneous small and medium-sized companies, with KLM-Air France, Schiphol and LVNL, universities, the Netherlands Aerospace Council, the regions in the Netherlands with aerospace ambitions and with its counterparts DLR.

4. http://www.nlr.nl/index.php (accessed 12 October 2012).

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Figure 11.4
Areas of work: National Aerospace Laboratory, The Netherlands

Air transport safety	ATM and airports	Operator performance
Airport noise and flight track monitoring	Avionics development and qualification	Remotely piloted aircraft regulations
Aircraft noise policy	Education and training	Rotorcraft flight procedures
Aircraft noise sources	Emission inventory and reduction	Satellite navigation
Airspace capacity	Flight testing	Simulation solutions for aircraft systems
Alternative energy and fuels	Gas turbines	Third party risk
	Noise source identification	Unmanned rotorcraft systems

Source: NTDPC Research.

SWEDISH NATIONAL ROAD AND TRANSPORT RESEARCH INSTITUTE (VTI)[5]

VTI, the Swedish National Road and Transport Research Institute, is an independent and internationally prominent research institute in the transport sector. The Institute is a government agency under the Swedish Government. VTI's principal task is to conduct research and development related to infrastructure, traffic and transport. Areas of work include: pavement technology, infrastructure maintenance, vehicle technology, traffic safety, traffic analysis, people in the transport system, environment, planning and decision-making processes, transport economics and transport system. The knowledge that the institute provides gives a basis for decisions for players in the transport sector and in many cases finds direct application in both national and international transport policies. VTI conducts commissioned research in an interdisciplinary organisation. The institute also works with investigations, provides consultancy services, and performs different kinds of measurement and testing services. The institute also has a great deal of technically-advanced equipment and world-class driving simulators. There is also a laboratory for road materials and a crash test laboratory.

VTI's researchers participate in international research projects, principally in Europe, and in international networks and alliances. In Sweden, VTI collaborates with universities and other higher education institutions that conduct related research and education. VTI has about 200 employees and is located in Linkoping (head office), Stockholm, Gothenburg and Borlänge.

KNOWLEDGE GENERATION AND GOVERNMENT MINISTRIES

US DEPARTMENT OF TRANSPORTATION

There are many different structures for knowledge generation within government ministries. The objectives and plans of the Department Transportation of USA (USDOT) are given here as an illustration[6].

USDOT's operating administrations are:

- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railroad Administration (FRA)
- Federal Transit Administration (FTA)
- Maritime Administration (MARAD)
- National Highway Traffic Safety Administration (NHTSA)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Research and Innovative Technology Administration (RITA)
- Saint Lawrence Seaway Development Corporation (SLSDC).

All of these agencies have a role to play in capacity development, research and development, and product innovation (RD&T) and many of these agencies employ more than a hundred professionals. Though the US Federal Government owns and operates only limited portions of the nation's transportation system, the USDOT has a responsibility for RD&T investment as one of the most effective ways the Federal government can contribute to the improvement of the transportation system. USDOT role for RD&T includes:

- Developing transportation research policy.
- Creating incentives for collaborative cross-modal research focusing on the interfaces of individual modes.

- Expanding the knowledge base by investing in university transportation centres (UTCs) that advance innovation, research, education, and technology transfer; and prepare the future transportation workforce to face the challenges of the 21st-century transportation network.

5. http://www.vti.se/en/om-vti/about-vti/ (accessed 21 November 2012).
6. USDOT (2012).

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- Encouraging multidisciplinary research.
- Stimulating innovation in transportation services and products through targeted partnerships with key entities, such as States, Metropolitan Planning Organisations (MPOs), transit operators, ports, counties, cities, academic institutions, and private companies or organisations.
- Funding long-term, exploratory research as well as short-term applied research.
- Identifying, facilitating and supporting the deployment of emerging technologies and best practices.
- Developing and disseminating tools and techniques that foster greater, more efficient use of technology and innovation.

In its future plans, USDOT includes crosscutting RD&T priority areas so that it encourages collaboration across operating administrations and government agencies, and promotes consultation and partnership with stakeholders in industry and academia. The development of cross-modal research projects will require discussions with stakeholders, rigorous examination of cross-cutting transportation issues and problems, and the incorporation of ideas from peers and experts within the research, asset owner, and user communities. USDOT collaborates with other agencies, such as the Environmental Protection Agency (EPA), Department of Energy (DOE), Housing and Urban Development (HUD), Department of Homeland Security (DHS), and the Department of Defense (DOD) (including the US Army Corps of Engineers), to provide the most effective transportation systems. In addition to collaborating with its Federal partners, the USDOT collaborates with and performs joint research with stakeholders and partners across the entire transportation sector, including State and local agencies, academia, industry, and not-for-profit institutions, such as the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), and the American Public Transportation Association (APTA).

USDOT's Research Clusters include senior research professionals from each operating administration. Cross-modal research working groups and online forums have been established within each Research Cluster. There are Research Clusters in the following areas:

- Infrastructure and Materials
- Human Factors
- Energy Sustainability
- Risk-Based Analysis to Address Safety Issues
- Data-Driven Decision Making
- Multimodal Intelligent Transportation Systems
- Liveability
- Modelling and Simulation
- Positioning, Navigation, and Timing
- Transportation Implications for an Aging Population and Those with Special Needs
- System Resilience and Global Logistics
- Policy Analysis
- Travel Behaviour
- Economics

STATISTICS AND ANALYSIS

In the UK, transportation statistics are collected, analysed and published by the Department for Transport.[7] The statistics are based on two main sources—data gathered from statistical surveys, and data extracted from administrative or management systems. A number of administrative sources are currently used by the Department for Transport statistical teams to compile official statistics. In all cases where such sources are used, professional statisticians are involved in quality assuring the use of the data for statistical purposes. Examples include data from the Driver Vehicle Licensing Agency (DVLA) to produce Vehicle Registration and Licensing Statistics, and by taking a sample of vehicles from DVLA records to produce statistics for road freight statistics. Estimates of vehicle excise duty evasion are also produced using the administrative data held by the DVLA. The Maritime and Coastguard Agency (MCA) Seafarer Documentation System is used as an input to UK Seafarer Statistics. The Authority's main requirements are set out in the third Protocol attached to their Code of Practice for Official Statistics and the databases include:

- Journey time database, local authority managed roads
- Journey time database, Highways Agency managed roads
- Maritime and Coastguard Agency Training Database
- Maritime and Coastguard Agency Seafarer Documentation System
- National Road Condition Database
- DVLA Vehicle Information Database
- Driving Standards Agency: Testing and Registration System

The Department has also set up a Transport Statistics User Group that aims to:

- identify problems in the provision and understanding of transport statistics and to discuss solutions with the responsible authorities;
- provide a forum for the exchange of views and information between users and providers;
- encourage the use of transport statistics through greater publicity;
- facilitate a network for sharing ideas, information and expertise.

The group holds regular seminars on topical subjects connected with the provision and/or use of transport statistics. In addition, a CLIP Transport Statistics (CLIP-TS) has been established, which is a

7. https://www.gov.uk/statement-of-administrative-sources-for-official-statistics-published-by-the-department-for-transport (accessed 15 November 2012).

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sub-group of the Central and Local (Government) Information Partnership (CLIP), the main forum for discussion between central and local government on statistical matters. Its formal terms of reference are:

- to act as a conduit for wider dissemination of transport statistics which are of particular interest to local authorities;
- to discuss transport statistics of interest to either side that are not dealt with by other topic-specific groups. In particular;
- monitoring of transport and related plans;
- sub-national statistics (including neighbourhood statistics);
- to identify gaps in coverage and investigate methods of filling these;
- to investigate methods of using local authority data to satisfy local, regional and national needs.

The membership of CLIP-TS includes representatives from the Local Government Association, Association of London Government, Passenger Transport Authorities, Shire Counties, Transport for London and the Department for Transport.

FUNDING RESEARCH AND TRAINING IN ACADEMIC INSTITUTIONS

USDOT UNIVERSITY TRANSPORTATION CENTRES (UTCS)[8]

In the US, The Safe, Accountable, Flexible, Efficient Transportation Equity Act, enacted on 10 August 2005, authorised up to $76.7 million (Rs 415 crore) per year from central funds for grants to establish and operate up to 60 University Transportation Centres (UTCs) throughout the US. Twenty of these centres were competitively selected during 2006. The University Transportation Centres (UTC) programme, initiated in 1987 under the Surface Transportation and Uniform Relocation Assistance Act, authorised the establishment and operation of transportation centres in each of the 10 standard federal regions. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) reauthorised the UTCs for an additional six years and added four national centres and six University Research institutes (URI). The mission of the 14 UTCs was to advance US expertise and technology transfer. The six URIs each had a specific transportation research and development mandate.

In 1998, the Transportation Equity Act for the 21st Century (TEA-21) reauthorised the UTC Program for an additional six years and increased the total number of Centres to 33. In addition to the 10 regional Centres, which were to be selected competitively, TEA-21 created 23 other Centres at institutions named in the Act. TEA-21 established education as one of the primary objectives of a University Transportation Centre and institutionalised the use of strategic planning in university grant management.

Vision: Internationally recognised centres of excellence, fully integrated within institutions of higher learning, that serve as a vital source of leaders who are prepared to meet the nation's need for safe, efficient and environmentally sound movement of people and goods.

Mission: To advance US technology and expertise in the many disciplines comprising transportation through the mechanisms of education, research and technology transfer at university-based centres of excellence.

Goals: (a) Education: a multi disciplinary programme of course work and experiential learning that reinforces the transportation theme of the Centre. (b) Human Resources: an increased number of students, faculty and staff who are attracted to and substantively involved in the undergraduate, graduate and professional programmes of the Centre. (c) Diversity: students, faculty and staff who reflect the growing diversity of the US workforce and are substantively involved in the undergraduate, graduate and professional programmes of the Centre. (d) Research Performance: an ongoing programme of basic and applied research, the products of which are judged by peers or other experts in the field to advance the body of knowledge in transportation. (e) Technology Transfer: availability of research results to potential users in a form that can be directly implemented, utilised or otherwise applied.

A UTC must be located in the US or territories. It may be a single university or a consortium of two or more universities. Each Centre is required to obtain matching funds from non-federal sources. National and Regional UTCs must obtain matching funds in an amount at least equal to the USDOT grant amount. The amount of funds to be disbursed are reflected in the 2013-14 call for proposals:

- Five National UTCs, up to $3.0 million (Rs 160 million) per Centre per fiscal year;
- Ten Regional UTCs, one of which must be dedicated to comprehensive transportation safety, up to $2.75 million (Rs 150 million) per Centre per fiscal year; and
- Up to 20 Tier-1 UTCs, up to $1.5 million (Rs 80 million) per Centre per fiscal year.

UNIVERSITY RESEARCH CENTRES

DALIAN MARITIME UNIVERSITY, CHINA (DMU)[9]

DMU was created in 1953 through the amalgamation of three merchant marine institutions: Shanghai Nautical College, the Northeast Navigation College and Fujian Navigation School. In 1960, DMU was designated a national key institution of higher education. Later in 1983, the Asia-Pacific Region Maritime Training Centre was established at DMU by the United Nations Development Program (UNDP), and the IMO and in 1985 a branch of the World Maritime University (WMU) was established.

The University specialises in Maritime research and training with the following departments: (a) Navigation College, (b) Marine Engineering College, (c) Information Science and Technology College, (d) Transportation Management College, (e) Transportation

8. http://www.rita.dot.gov/utc/about (accessed 15 November 2012).
9. http://english.dlmu.edu.cn (accessed 15 November 2012).

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& Logistics Engineering College. Over the past few decades it has broadened its scope and in addition established the following schools and departments: School of Law, Environmental Science and Engineering College, Humanities and Social Sciences College, School of Foreign Languages, Department of Mathematics, Department of Physics, Department of Physical Education, Continuing Education College.

The University includes the following special research centres: Waterway Transportation Regulations Institute, International Maritime Law Research Centre, Ship Automation and Simulation Institute, Environmental Information Institute, Marine Environment Research Centre, Ocean Development and Management Research Centre, Marine Transportation Safety Institute, Waterway Transportation Planning and Design Institute, International Shipping Human Resource Institute, Transportation Economy Institute, Ship Electromechanical Equipment Institute, High Performance Ceramics Institute, Ship Power Engineering Institute, China Navigation History Documentation Research Centre.

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE, AUSTRALIA

The Monash University Accident Research Centre (MUARC) was established in 1987 and is Australia's largest transport safety research centre. Research, consultancy and training include safety across all modes of transport. Since its founding it has developed research-based solutions that have led directly to making Australians safer and made it an acknowledged leader in the field. The Centre works with a number of key stakeholders including VicRoads, the Transport Accident Commission, the Department of Justice, and Victoria Police. The work is conducted across six priority areas:

- Behavioural safety science
- Human factors
- Injury analysis and data
- Global engagement
- Regulation and in-depth crash investigations
- Safe system strategies and road infrastructure

MUARC is a part of the Monash Injury Research Institute where around 100 researchers and postgraduate students work across a range of specialised areas, including: biostatistics, computer science, engineering, epidemiology, human factors Medicine, psychology, public health, statistical analysis.

INSTITUTE OF TRANSPORTATION STUDIES AT THE UNIVERSITY OF CALIFORNIA, BERKELEY (US)[10]

The Institute was created as an Organised Research Unit in 1948 by the California state legislature in response to the deferred maintenance of transportation facilities during World War II. Its mission was to conduct research and provide instruction to a new generation of transportation professionals. More than 100 graduate students pursuing master's degrees and PhDs currently study there. The Institute's programs receive an average of $20 million in extramural funds each year, one of the largest such totals at the University for a research facility or academic department, and leverages its core state funding by a ratio of about 20:1.

ITS Berkeley is home to seven transportation research centres:

- California Partners for Advanced Transit and Highways (PATH) is the one of the world's largest programmes for intelligent transportation research. It has recently merged with California Centre for Innovative Transportation (CCIT)
- National Centre of Excellence for Aviation Operations Research (NEXTOR) is the nation's leading centre for aviation research
- University of California Pavement Research Centre (UCPRC) is an international authority on pavement materials and management
- Safe Transportation Research and Education Centre (SafeTREC)—formerly Traffic Safety Centre—is devoted to the reduction of transportation system-related fatalities and injuries through education and research
- Transportation Sustainability Research Centre (TSRC) focuses on six major research areas that include advanced vehicles and fuels, energy and infrastructure, and goods movement
- UC Berkeley Centre for Future Urban Transport (Volvo Centre) concentrates on the interplay of technology and policy for urban transportation

University of California Transportation Centre (UCTC), a multi-campus research unit, is currently headquartered at ITS Berkeley.

THE INSTITUTE FOR TRANSPORT STUDIES, UNIVERSITY OF LEEDS (UK)[11]

The Institute's primary purpose is to advance the understanding of transport activity, operations and use, and to develop skills and best practice among transport professionals and decision makers. The history of ITS goes back more than 40 years and the University of Leeds first offered a transport Masters programme in 1965. The Institute was formally established in 1972, and is the UK's largest single academic group providing transport courses and training. In a typical year there are around 500 students taking undergraduate modules, 80 students on Master's programmes, up to 40 registered PhD students, and dozens of delegates participating in short courses.

The research at ITS is sponsored by a variety of organisations, including the UK Department for Transport, the European Commission, and the Engi-

10. http://www.its.berkeley (accessed 15 November 2012).
11. http://www.its.leeds.ac.uk/about/ (accessed 15 November 2012).

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neering and Physical Sciences Research Council. ITS has approximately 50 academic/research staff and about a dozen support staff. The staff come from a wide variety of background disciplines, including economics, engineering, geography, mathematics, computing, psychology and social science. ITS staff have provided expert advice to international organisations such as the World Bank, the European Commission and the International Transport Forum, to national governments around the world and to UK entities such as the House of Commons Transport Select Committee.

OVERALL SYSTEMIC LESSONS

International experience offers several relevant lessons for building expertise and a professional community. First, it is important to establish transport planning as a high-status occupation and applied science makes it easier to attract ongoing political and financial support as well as some of the most competent professionals. In Europe, the Commissioner of Transport is often selected by the President to be one of the Vice-Presidents of the European Commission, a designation that conveys little real power but signals an important appointment and comes with a higher salary.

Boarnet argues that the ability of the National Advisory Board of Highway Research (1920) and its successors, the Highway Research Board (1925) and Transportation Research Board (1974) to create a strong culture of cutting edge research and attracting top engineers was in part due to its position as part of the National Research Council (NRC).[12] The NRC is the top science, engineering, and medicine advisory body in the US, so the membership signalled that transportation research was a high priority rather than a low-status applied version of civil engineering. The Transportation Research Board continues to be one of just five divisions of the NRC as well as one of the most specifically defined. Similarly, merging the HRB transport research and data module within the premier data collection effort, the US Census, in 1956 reiterated the importance of transport research in US policy.

The Indian structure of having CRRI as part of the CSIR, with the Prime Minister as President and the Minister of Science and Technology as Vice President, could be seen as superficially similar to the positioning of transportation research within the NRC. However, CSIR is associated with one of several 'science policy' Departments within the Ministry of Science and Technology (the Department of Scientific and Industrial Research, distinct from the Department of Science and Technology, the Department of Biotechnology, etc) in contrast to the NRC's position as a science policy advisory body for all science- and engineering-related questions. The CRRI also operates more like a government department than a node in larger professional ecosystem of university departments, think-tanks, and other employers of independent researchers.

Second, it is important to decentralise the institutional system and build networks. The Transportation Research and Innovation Portal[13] is one example of a platform for bringing together research and datasets across a federation (the 'European Research Area') as well as providing information on events that help foster exchanges between the community of experts. Other countries visited as part of the 2008 FHWA study tour used universities and non-government research institutions as a way to encourage work with a broad perspective land, infrastructure, energy, and social outcomes that might not otherwise be undertaken by a particular Ministry. The report of the study tour also noted, 'host countries' research programmes incorporated academic and industry participation earlier in the research process than those of the US. In the host countries there is a continuous flow that incorporates collaboration throughout the research process—from problem definition (which may include participation in establishing the research framework) through the conduct of the research and the delivery of research products'[14].

In the US, the fact that National Association for Biomedical Research (NABR), HRB and Transportation Research Board (TRB) NABR/HRB/TRB funded studies by other agencies, states and universities rather than doing the work in-house had significant long-run benefits for policy. It meant that the program build up a regionally-dispersed, diverse group of experts who shared a common professional network. Boarnet argues that this was one of the factors that allowed the US to quickly create functional national and state agencies as new transportation needs became apparent[15]. The tradition continues today with the Research and Innovative Technology Administration's funding of University Transport Centres and regional Transport Knowledge Networks. The distribution of funds for UTC is designed to be balanced across regions, but otherwise merit-based, fostering competition among researchers to establish strong incentives for excellence.

The funding also enabled the NABR/HRB/TRB to actively manage the portfolio of research to support state-level experiments and disseminate successful results across states, as well as to set standards for data collection that improved quality and comparability of locally-generated statistics. The Bureau of Public Roads, for example, cooperated with Chicago

12. Boarnet (2011).
13. http://www.transport-research.info (accessed 10 February 2014).
14. FHWA (2008).
15. Boarnet (2011).

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and Cleveland in their landmark local and regional traffic counting studies in the 1920s, and then encouraged other states to follow. Eleven other states had traffic counting efforts underway by 1930.[16]

Third, it is important to encourage transport stakeholders to learn by doing. FHWA found that several of the countries studied encourage 'collaborative innovation'—research partnerships between academia and parts of government to design programmes eligible for funding.[17] Similarly, the United States' Bureau of Public Roads developed national programmes based on reviewing states' suggestions using transparent analytical criteria. The states that were more successful in proposing technically strong projects were thus better able to shepherd their priorities through the system to obtain concrete rewards for building capacity to site and justify roads. Boarnet (2011) argues that the collaborative approach paid off in quick implementation of the plan: 'Possibly more importantly, the decades-long effort by the BPR to develop and disseminate knowledge-based approaches to highway planning and construction had built a professional community that was ready to quickly build the national network, per accepted methods of analysis and federal standard-setting, once political questions had been settled'.[18]

The United States' Bureau of Public Roads used transparent criteria to review states' suggestions. States that were more successful in proposing concrete projects were able to shepherd their priorities through the system.

INDIAN CONTEXT

EXISTING INSTITUTIONS AND ORGANISATIONS

RAIL TRANSPORT

A. Institutions under the Ministry of Railways

a. Indian Railways Institute of Civil Engineering (IRICEN), Pune

IRICEN was established in 1959 when a 'Permanent Way Training School' was set up at Pune to provide in-house training to freshly recruited civil engineers of Indian Railways. Over the years, advancement in track and bridge technology led to the upgrading of the institute to cover track, bridges and other modules that a railway civil engineer encounters.
Professional staff: 16 (mostly BE and ME level)

b. The Indian Railways Institute of Mechanical & Electrical Engineering (IRIMEE), Jamalpur

IRIMEE is the centralised training institute of Indian Railways, for the training of officers and supervisors of the Mechanical Engineering department. It conducts (a) Professional courses for serving officers and supervisors of Mechanical Department, (b) Training of IRSME probationers, (c) Theoretical and practical training of Special Class Apprentices (d) Technical Training of Apprentice Supervisors of all Indian Railways, (e) Special courses as per requirement for Non-Railway Organisations and Foreign Railways.
Professional staff: 27 (mostly BE and ME level)

c. Indian Railways Institute of Electrical Engineering (IRIEEN), Nasik Road

The Institute was set up in the year 1988 at Nasik Road, Maharashtra, for imparting training to Electrical Engineers of Indian Railways and other departments involved in train-operation. The Institute imparts training as a statutory measure to: (a) IRSEE Probationers, (b) Integrated orientation course for Group-B, (c) Senior Professional Development Course for Junior Administrative Grade, (d) Short-term special courses conducted throughout the year on specialised subjects.
Professional staff: 9 (mostly BE and ME level)

d. Indian Railways Institute of Signal Engineering and Telecommunications (IRISET), Secunderabad

IRISET provides initial as well as advanced training, theory as well as hands on, in Railway Signalling and Telecommunications. It caters to the total training requirement of the officers and supervisors of the Signal and Telecommunication department of Indian Railways. IRISET is in the approved list of ESCAP and UNDP. It provides training in railway signalling and telecommunications to private and public sector enterprises as well.
Professional staff: 21 (mostly BE and ME level).

e. National Academy of Indian Railways (NAIR), Vadodara

NAIR functions as the apex training institute for the officers of all departments of Indian Railways in general and Accounts, Personnel, Stores and Medical departments in particular. The Academy runs training programmes for officers of all disciplines and all grades right from Probationers to General Managers. Around 2,500 officers participate in various training programmes each year. The duration of programmes varies from one to 10 weeks. Managers of a few public sector undertakings, other ministries of the government and a few managers from railway systems abroad also attend training programmes in this college.
Professional staff: 25 (mostly BE and ME level).

f. Indian Railway Institute of Transportation Management (IRITM), Lucknow

The institute is a training centre for probationary officers of the Indian Railway Traffic Service (IRTS).

16. Seely (1987), summarised in Boarnet (2011).
17. FHWA (2008).
18. Boarnet (2011).

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The training module includes, planning, financing and management of transport infrastructure, transportation and logistics management, operational practices, commercial principles, transport economics, information technology, etc. The institute also imparts advanced training to in service railway officers in these areas. Besides, it also functions as a research centre in PPP and as an accident investigation cell.
Professional staff: 7

g. Indian Railway Institute of Financial Management (IRIFM), Secunderabad
It is being set up to impart structured and professional training to finance and accounts officers of Indian Railways in contemporary areas and equip them with necessary skills on a regular basis to enable them to face emerging challenges and tap opportunities for strengthening the finances of the organisation.

B. Academic Institutions

a. The Centre for Railway Research (CRR)
CRR was set up at Indian Institute of Technology Kharagpur based on the MoU signed between the Ministry of Railways, Government of India and Indian Institute of Technology Kharagpur on 13 February 2010, to develop a long-term framework for research collaboration. This is the first such research centre set up in an academic institute with direct and full funding by the Indian Railways. The following have been identified as core areas of research focus:

- Advanced Materials and Manufacturing
- Heavy Haul Technology
- High Speed Rail
- Advanced Maintenance and Operation

b. Railway Technology Cell at Indian Institute of Technology Kanpur
This cell has been established in collaboration with RDSO to handle projects related to development of a detector for wheel flats, finite element method (FEM) analysis of wheels and geo-technical problems such as field validation of design methodologies for rehabilitation of unstable structures and strengthening of existing structures for heavier axle loads.

The Centre for Railway Research at IIT Kharagpur, funded by Indian Railways, focuses on advanced materials and manufacturing, heavy-haul technology, high-speed rail and advanced maintenance and operation.

AIR TRANSPORT

A. Directorate General of Civil Aviation

DGCA is the regulatory body governing the safety aspects of civil aviation in India. Its functions include:

1. Registration of civil aircraft
2. Formulation of standards of airworthiness for civil aircraft registered in India and grant of certificates of airworthiness to such aircraft
3. Licensing of pilots, aircraft maintenance engineers and flight engineers, and conducting examinations and checks for that purpose
4. Licensing of air traffic controllers
5. Certification of aerodromes and CNS/ATM facilities
6. Maintaining a check on the proficiency of flight crew, and also of other operational personnel such as flight dispatchers and cabin crew
7. Granting of Air Operator's Certificates to Indian carriers and regulation of air transport services operating to/from/within/over India by Indian and foreign operators, including clearance of scheduled and non-scheduled flights of such operators
8. Conducting investigation into incidents and serious incidents involving aircraft upto 2250 kg and and taking accident prevention measures including formulation of implementation of Safety Aviation Management Programmes
9. Carrying out amendments to the Aircraft Act, the Aircraft Rules and the Civil Aviation Requirements for complying with the amendments to ICAO Annexes, and initiating proposals for amendment to any other Act or for passing a new Act in order to give effect to an international Convention or amendment to an existing Convention
10. Coordination of ICAO matters with all agencies and sending replies to State Letters, and taking all necessary action arising out of the Universal Safety Oversight Audit Programme (USOAP) of ICAO
11. Supervision of the institutes/clubs/schools engaged in flying training including simulator training, AME training or any other training related with aviation, with a view to ensuring a high quality of training
12. Granting approval to aircraft maintenance, repair and manufacturing organisations and their continued oversight
13. To act as a nodal agency for implementing Annex 9 provisions in India and for coordinating matters relating to facilitation at Indian airports including holding meetings of the National Facilitation Committee
14. Rendering advice to the Government on matters relating to air transport including bilateral air services agreements, on ICAO matters and generally on all technical matters relating to civil aviation, and to act as an overall regulatory and developmental body for civil aviation in the country
15. Coordination at national level for flexi-use of air space by civil and military air traffic agencies

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and interaction with ICAO for provision of more air routes for civil use through Indian air space
16. Keeping a check on aircraft noise and engine emissions in accordance with ICAO Annex 16 and collaborating with the environmental authorities in this matter, if required
17. Promoting indigenous design and manufacture of aircraft and aircraft components by acting as a catalytic agent
18. Approving training programmes of operators for carriage of dangerous goods, issuing authorisations for carriage of dangerous goods, etc.
19. Safety Oversight of all entities approved/ certified/licensed under the Aircraft Rules 1937.

B. CSIR National Aerospace Laboratory

National Aerospace Laboratories (NAL), a constituent of the Council of Scientific and Industrial Research (CSIR), India, is the only civilian aerospace R&D laboratory in India. CSIR-NAL is a high-tech oriented institution focusing on advanced topics in aerospace and related disciplines and has a mandate to develop aerospace technologies with strong science content, design and build small and medium-size civil aircraft and support all national aerospace programmes.

CSIR-NAL has many advanced test facilities (many of them recognised as National Facilities) and has a strength of 1,100 with 400 scientists, 460 technical staff and 160 administrative staff. CSIR-NAL has also provided value-added inputs to all national aerospace programmes. CSIR-NAL mandate is to develop aerospace technologies with strong science content, design and build small and medium-sized civil aircraft, and support all national aerospace programmes.

CSIR-NAL activities involve the design, development, manufacturing and certification of small civil aircraft, the only such centre in the country. Major projects completed/in progress include certification of a two-seat ab-initio all-composite aircraft HANSA-3 (15 aircrafts built so far); a 14-seat light transport aircraft SARAS, that is presently under development (two prototypes built and test flown; a production standard aircraft with CFC wing under assembly for flight testing and final certification); and the development of a new five seat general aviation aircraft C-NM5 in association with Mahindra Aerospace Pvt Ltd, Bangalore, of the Mahindra corporate group. Marking the milestone event for India's first public-private partnership in aircraft development, the C-NM5 successfully completed its maiden flight at Australia on 1 September 2011. CSIR-NAL is the lead agency identified by the Government of India for carrying out feasibility study for the development of a National Civil Aircraft (70 and 90) seater for re-gional connectivity.

Academic Departments

Institutions with special departments for aerospace engineering include:

- Indian Institute of Science Bangalore
- Indian Institute of Technology Kanpur
- Indian Institute of Technology Kharagpur
- Indian Institute of Technology Chennai
- Indian Institute of Technology Mumbai

These departments offer courses from bachelor's to PhD level, but are largely confined to engineering aspects of aviation.

WATER TRANSPORT

A. Indian Maritime University

The Indian Maritime University, came into being through an Act of Parliament (Act 22) on 14 November 2008 as a Central university. The objectives of the University are to facilitate and promote maritime studies, training, research and extension work with focus on emerging areas of studies like oceanography, maritime history, maritime laws, maritime security, search and rescue, transportation of dangerous cargo, environmental studies and other related fields. The IMU has its regional campuses at Chennai, Mumbai, Kolkata, Visakhapatnam, Kochi and Kandla. IMU presently offers port and marine short-term courses and degree courses in Nautical Science, Marine Engineering, Naval Architecture and Ocean Engineering, Ship Building and Repair. The Indian Maritime University encompasses under its fold the following seven premier government institutions

a. National Maritime Academy, Chennai
b. TS Chanakya, Mumbai
c. Lal Bahadur Shastri College of Advanced Maritime Studies and Research, Mumbai
d. Marine Engineering Research Institute, Mumbai
e. Marine Engineering Research Institute, Kolkata
f. Indian Institute of Port Management, Kolkata
g. National Ship Design and Research Centre, Visakhapatnam
h. IMU Kochi Campus
i. IMU Kandla Campus

ROAD TRANSPORT

The Central Road Research Institute (CRRI), Delhi

CRRI is a national research organisation for highways traffic and transport planning and all other allied aspects. It carries out R&D in the areas of road and road transportation. CRRI was established in 1952 as a constituent laboratory of the Council of Scientific and Industrial Research (CSIR). The major

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R&D programmes of CRRI related to the entire spectrum of pavement design and performance, road condition monitoring, pavement deterioration modeling, maintenance planning and management, pavement management system, landslide management and hazard mitigation, geotechnical investigations and ground improvement techniques, traffic engineering and management and improved transportation planning technology for emerging urban needs. Besides these, applied research in the area of planning and engineering aspects of rural roads, material characterisation, pavement evaluation, highway instrumentation, conditioning monitoring and rehabilitation of bridges, design of high embankments and reinforced earth walls, subways and underpass construction, transportation planning, traffic engineering, road safety and environmental problems, form an integral part of the programme of the institute. The Institute employs about 60 scientists in eight departments.

B. Indian Academy of Highway Engineers (IAHE), NOIDA (UP)

IAHE is the apex training institute set up to address the training needs of Highway and Bridge Engineers in the country. It was set up as an institute in the year 1983 with the primary objective to fulfill the need for training of highway engineers at the entry level and during the service. Its objectives include:

- To impart training to engineers and professionals of Highway Sector at entry level and during service at different levels of central and state governments, public and private sectors
- To help highway sector engineers build up character and develop an all-round personality as a part of Human Resource Development
- To assist various organisations in developing their training institutes and training of their faculty
- To promote cooperation and foster exchange of knowledge, ideas and experience in all the sphere of highway engineering among engineers in India and abroad
- To impart training to Highway sector professionals from India and abroad (SAARC countries, Afro-Asian countries under schemes pertaining to IAFS, ITEC, Colombo Plan, etc.)

IAHE has officers on deputation from the government and uses experts available in the area for delivering lectures in the raining programmes. There is no research activity at the IAHE.

C. Central Institute of Road Transport (CIRT), Pune

CIRT is funded by the Government of India and offers management development programmes covering general management, transport operations and maintenance engineering. The programmes are meant for practicing managers in state transport undertakings, other organisations operating transport services besides road transport officials. All programmes are residential and their duration ranges from one week to four weeks. In addition, the Institute undertakes consultancy and research assignments on transport policy, transportation planning, traffic management, maintenance management, materials management, human resource management and management information systems. CIRT employs about 15 professionals mostly at bachelor's and master's level.

D. Academic Institutions

Most Indian Institutes of Technology (IITs), National Institutes of Technology (NITs), and many state universities and private institutes offer courses in Transportation Engineering based in the civil engineering department. Most IITs, Indian Institute of Science Bangalore, and some NITs also offer masters degrees in transportation engineering, again in the civil engineering department. Institutions offering Masters programmes in Transportation Planning include Birla Institute of Technology Ranchi, CEPT University Ahmedabad, and School of Planning and Architecture Delhi.

Over the past few years, five centres of excellence for urban transport have been recognised and funded by the Ministry of Urban Development (MoUD), and one by the Government of Karnataka (GoK):

- Transportation Research and Injury Prevention Programme (TRIPP), Indian Institute of Technology Delhi (MoUD)
- Centre of Excellence in Urban Transport, Indian Institute of Technology Madras (MoUD)
- Centre for Urban Transportation Studies, NIT Warangal (MoUD)
- Centre for Excellence in Urban Transport, CEPT University Ahmedabad (MoUD)
- Centre for Infrastructure, Sustainable Transportation and Urban Planning (CiSTUP), Indian Institute of Science Bangalore (GoK)

These centres have been awarded grants that provide research support of the order of Rs 20-30 million per year, but no support has been provided for hiring extra faculty members or building significant infrastructure or laboratories.

INDEPENDENT TRANSPORT RESEARCH INSTITUTIONS

Asian Institute of Transport Development (AITD)

The National Transport Policy Committee (1980) in its Report had observed that transport studies had been comparatively neglected in the country and there was no institution that could undertake studies on transport problems from a common outlook and approach. It had also emphasised the need for aug-

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Capacity building comprises three challenges: training individuals, building systems for R&D to update capacity, and ensuring that these individuals have the ability and incentives to be productive within teams and organisations. India must not only increase supply of capacity, it must also ensure a strong demand side.

menting training facilities for building capacity to cater to the growing requirements of evolving, implementing and monitoring the transport projects, plans and policies. As a result, the Asian Institute of Transport Development (AITD) came into being in 1989 as an independent, not-for-profit, inter-disciplinary centre devoted to research, human resource development and regional cooperation in infrastructure sector with special focus on transport and logistics.

The Institute has since grown professionally and gained credentials both at national and regional levels. It has been granted special consultative status by the United Nations. It has also acquired a pan-Asian footprint through its activities aimed at capacity building, environmental concerns and development of regional transport corridors.

The Institute has collaborated with centres of excellence dealing with critical areas in transport sector, for example Transport Research and Injury Prevention Programme (TRIPP) at IIT Delhi. It also provides substantial support to regional country groupings—SAARC, BIMSTEC, Mekong Ganga Cooperation etc.—in human resource development.

The Institute has carried out inter-disciplinary studies dealing with intermodal choices, environmental and social sustainability, poverty alleviation, regulatory structures, funding of infrastructure, etc. The Planning Commission has drawn on its expertise and knowledge while formulating the Five Year Plans and long-term policy perspectives.

FUTURE REQUIREMENTS

'Capacity building' comprises three challenges: training individuals, building systems for research and development to update capacity, and ensuring that these individuals have the ability and incentives to be productive within teams and organisations. India must not only increase the supply of capacity by expanding the number and quality of opportunities to study transport planning and allied fields, but it must also ensure a strong demand side. The effective 'demand' for capacity will depend on employment policies that attract these transport planners to public sector work as well as public expenditure and programmatic policies that encourage Ministries, state agencies and metropolitan bodies to spend discerningly on capacity building. It will also need to invest in transport research so that training, decision support, and policy action improve over time and adapt to changing opportunities and challenges. Capacity building should also be designed to also support India's efforts integrate its many transport-related organisations with a common culture focused on transport systems across national, state and metropolitan scales. This section discusses future requirements across these three dimensions.

SKILLS GAP

Little seems to be known about the extent and nature of the 'skills gap' in transport planning. Although all of the sector Working Groups of NTDPC were asked to 'assess the availability of human resources' and 'suggest measures for skill development and institutional capacity building for various stakeholders', there is very little information in the Working Group reports on the scale or nature of training required.

The civil aviation and ports Working Groups provided some figures on the numbers and general skills required for the sector over the coming decade, but these are not broken down by level of government, region, or compared in detail to existing available personnel. However, the civil aviation Working Group report does highlight the magnitude of the problem faced: 'Closely related to safety in civil aviation is skill augmentation in its entire dimension. The task ahead would be of identifying the different categories of personnel required whether technical, managerial, pilots and cabin crew, trainers etc to meet the needs of airport development and operations…According to the Report of Working Group on Civil Aviation for formulation of 12th Five Year Plan (2012-17), the total manpower requirement of Indian carriers is estimated to rise from 62,000 in FY-2011 to 117,000 by FY-2017'.[19]

The Working Group on urban transport gives some estimates of staff strength, but not broken down by skill. Railways and roads reports called for a 'training needs assessment' and a consultant to prepare a capacity-building plan. There appears to be no information about the numbers and distribution of transport planning professionals familiar with GIS, impact assessment, traffic modelling, and other skills required to anticipate network needs.

What is needed is an organised approach to interdisciplinary policy-relevant research. For example, an integrated approach is needed to address transport related health impacts, from emission-related respiratory illness to injuries from traffic accidents. This

19. NTDPC (2012).

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can be done only if faculty members from various departments at the best institutions like IITs collaborate with government departments, industry bodies, international organisations, and other experts on research, teaching, applied projects, and on policy advice on developing urban transport systems, intercity connections, vehicles, and transport infrastructure plans. Researchers also need to collate and analyse available data to assess and report on the impact of transport infrastructure development and policies on freight patterns, mobility, congestion, and other performance indicators.

It would be worthwhile to strengthen and replicate such structures at high-quality research institutions in India to encourage and support research on other socio-economic impacts that the transport system could have. With sufficient core funding, these programs could also play an important role as data repositories for aggregating and managing information from various government and private sources. Active researchers, as users of data, are likely to have a stronger incentive to collect and maintain up to date databases than are individuals who are simply charged with building a database.

Current institutions that conduct interdisciplinary research on some of these areas include:

- The Transport Research and Injury Prevention Programme (TRIPP) at IIT Delhi, which draws on faculty across academic departments, while developing a core expert team
- The Energy and Resources Institute (TERI), which, in its transport related research, focuses on issues related to energy and environment and draws on experts from its different departments
- The Asian Institute of Transport Development, which calls on experts from different fields to collaborate on research related to planning and policy issues with a focus on transport and logistics, often with an international perspective.

DATA REQUIREMENTS

There is very little reliable data available for intercity or urban passenger or freight travel patterns. In this situation infrastructure investment has to be done on a fire-fighting basis with little knowledge of long-term consequences on efficiency, or financial and environmental stability. Technology choices have to be based on hunches and influenced by powerful supplier lobbies. This situation is likely to get worse in the face of accelerated economic growth and urbanisation, as political and public pressure for provision of transportation services will demand quick fixes.

Analysis for transport governance rests on the following types of data, among others:

Much of the Indian data needed for transport governance are scattered across agencies and departments, with no common geo-referencing and metadata standards.

(a) Transportation Planning and Management characteristics in cities and regions (encompassing institutions, policies, projects planned and under implementation, funding mechanism, taxation regime, etc.)
(b) Traffic Management characteristics in cities (including agencies, signal time details for signalised intersections, one-ways, etc.)
(c) Spatially referenced transportation network database for all modes: roadways, railways, airways and waterways (spatial)
(d) Mobility/Accessibility/Congestion index measurements for cities
(e) Commuter travel characteristics by all modes (modal split) across (time series):
    (i) Cities-intercity commuting
    (ii) Within cities
(f) Freight transport characteristics by all modes (time series)
(g) Public transport characteristics (modes and supply details)
(h) Public terminal commuter characteristics (spatial and time series)
(i) Automobile registration database (time series)
(j) Emissions and air quality characteristics (time series)
(k) Fuel consumption characteristics (time series)
(l) Accident characteristics across modes—no of accidents, fatalities, injuries (time series)
(m) Demographic, economic, employment and density patterns of the region and/or cities
(n) Land-use characteristics for key cities in question and their densities (spatial)

Many of these data exist, but are scattered across agencies and departments, without common georeferencing and metadata standards that allow them to be collated for system-wide analysis. The first step in building transport research capacity, or encouraging more research attention to transport issues, might be to lower the transactions costs of empirical research by collating and making public these kinds of data.

India must also invest in decision support systems so that available capacity can actually be exercised for maximum effect. Geospatial Information System (GIS) expertise, for example, is wasted when available datasets on infrastructure or traffic are neither comprehensive nor spatially referenced. Decision support tools can also substitute for expertise in some cases by embedding rules of thumb in analytical

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algorithms. The IT backbone for decision support can also be an infrastructure for de facto integration of decision-making, by making data more easily shareable across departments, automating sharing, and automating some processes for common application across agencies, geographies, or levels of government.

CONVERTING INFORMATION INTO KNOWLEDGE

Second, the institutional framework must also be capable of converting information into transport knowledge A review of international practices in transportation research, training and development clearly shows that a large number of countries have established well-funded and professionally-staffed institutions at all levels and across disciplines. These institutions exist within government departments, as standalone institutions, within transport management organisations, and in universities and academic institutions (Annex). Many countries do not depend mainly on knowledge and technology transfer from other countries, even when there are peers at similar levels of income and styles of living. For example, though Australia is not very different from the US in per capita income or lifestyles, the Australian central and state governments have set up a large system with significant funding for knowledge generation and training. This is because most societies have realised that while basic theories, issues and technologies may be somewhat similar across nations, how they get applied and administered very often can be substantially different. In addition, priorities and strategies to be followed can vary dramatically depending on political structures and administrative models from place to place.

The shift from public to private delivery with public facilitation actually places a greater burden on the public sector's project planning skills, especially ex-ante characterisation of risks in order to allocate them between partners.

It is quite clear that there is already a great shortage of trained manpower and absence of institutional support for policy making and technology development in India. We do not have any institutions within government departments and operating agencies, universities centres or stand-alone institutions in any area of transportation that compare favourably with institutions reviewed in previous sections except for an institution or two like the National Aerospace Laboratory. The research centres at academic institutions are sub-critical in number of faculty members involved, and resources available. Except in a few centres, most of the academic activity is not interdisciplinary in nature, and there is almost a complete absence of involvement of professionals from the social sciences–economics, law, etc.

Most of these groups appear to have limited exchange with global transport researchers. Researchers are thus not placed in the kind of active, evolving research environment that many would view as important for innovation. The overall number of recognised experts seems small relative to the magnitude of the policy challenges. Non-governmental organisations such as EMBARQ (Mumbai and Bangalore), MapUnity (Bangalore), City Connect (Chennai, Bangalore, and Hyderabad) are also sources of policy expertise and networks of global experts, but are sometimes seen as advocacy groups rather than neutral parties.

NEW INSTITUTIONS FOR CAPACITY BUILDING

Management of transportation systems in the face of increasing energy costs and environmental pollution and threats of global warming requires that we set up new institutions and organisations at an accelerated and urgent basis for all transportation sectors. These are needed for skill development and knowledge generation for:

a. Planning
b. Management
c. Designing standards
d. Design of transport systems
e. Integration of policy options across transportation sectors
f. Dealing with environmental degradation and global warming issues

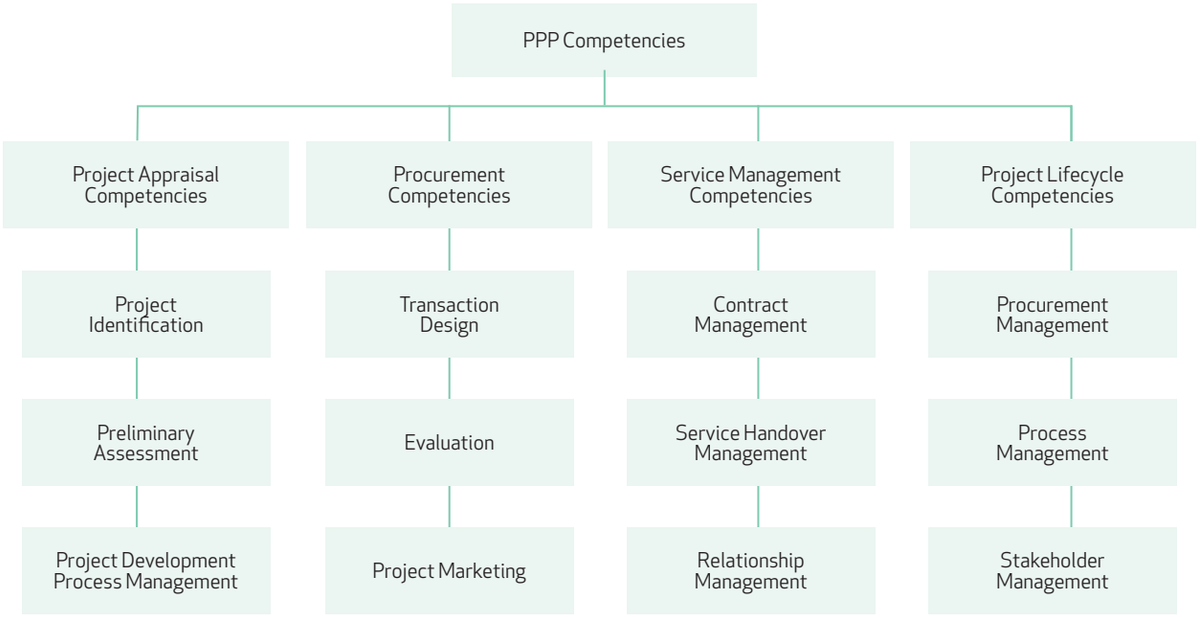
EXPERTISE FOR PUBLIC-PRIVATE PARTNERSHIPS

The move toward relying more extensively on PPPs and private provision of inf-astructure is not unique to transport, but it is particularly common in roads, ports, airports and other transport infrastructure. This shift from public delivery to private delivery with public facilitation is often seen as a remedy for public sector weakness, but it actually places a greater burden on the public sector's project planning skills including especially ex-ante characterisation of risks in order to allocate these between partners. It also magnifies the consequences of poor project planning: mistakes in sequencing or delays in critical steps such as land acquisition can affect the allocation of costs between partners and lead to additional delays during dispute resolution. Figure 11.5 shows some of the individual capacities required for PPPs.

Many of the existing efforts to build capacities for PPPs have focused on building capacity for project appraisal and transaction design, both through training, lending of expert consultants, and creation of templates to allow relatively less-trained people to manage PPPs. However, the service management and project lifecycle competencies should not be overlooked.

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Figure 11. 5
Capacities Required for Implementation of PPP Projects



Source: Devkar (2013).

RECOMMENDATIONS FOR INSTITUTION BUILDING

The following sections describe the effort necessary for setting up institutions and structures needed for planning, decision-making and implementation for the next two decades. This will require that funds be earmarked for these institutions as 1-2 per cent of investment for each transport sector. This is a very small amount to invest considering the challenges facing us. We have to start planning for these institutions now to catch up with other nations in a decade or so.

The number, size and type of institutions being recommended is based on international comparisons, in particular with countries with similar levels of development at present. As indicated earlier, India is significantly behind countries like China and Korea in knowledge production, skills, innovation and technology development at all levels and areas of transport operations. It has to be emphasised that scientific findings and innovation cannot be ordered. We must build capacity with a number of professionals in all fields so that a few of them may come up with path braking ideas in the future. The enormity of this task can be illustrated by the fact that in the US the Federal Government alone employs a few hundred professionals to work on road safety, where as in India the combined strength of such professionals in the central and state governments would be less than a handful.

International experience suggests that it takes more than a decade to build viable quality institutions. A demand has to be created for persons with expertise in these areas with availability of jobs in institutions. This sends a signal to academic institutions to start relevant academic programmes and for potential students to apply for the same. In the absence of a large number of such institutions good quality students do not apply for transportation related programmes even when they exist in some academic institutions. Even worse, the Indians being trained in foreign institutions on different aspects of modern transportation planning and implementation have no incentive to return to India as there is a dearth of employment opportunities that provide a meaningful work environment.

We present these institutions as distinct public and private entities, but collaboration is also important to ensure that transportation research is seen as neutral and credible, particularly if/as recommended action on route planning for road and rail, subsidies for passenger transport, air quality regulation, reinvigorating different forms of mass transport and investing in non-motorised transport takes place.

The Health Effects Institute is one example of an institutional design meant to produce credible research in a contentious setting. It was established to help overcome arguments between the US Environmental Protection Agency and the automobile industry over the impacts of automobile-related

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air pollution: both groups were separately funding studies, neither trusted each-others' selection of studies or examples, and the argument was playing out in public politics. The HEI was set up with equal funding from the EPA and the auto industry, and staffed with an independent board of directors pulled from eminent academic institutions (including the Presidents of Stanford University and Bell Labs). It performed wide-ranging reviews of existing literature on health impacts (to overcome each side's accusations of selection bias among studies) and funded independent research, which was then peer reviewed by external experts (to avoid claims of insider approvals).

STANDALONE NATIONAL INSTITUTIONS

Indian Institute for Transport Research (IITR)

The proposed Indian Institute for Transport Research will be responsible for research on all aspects of transport and logistics by all modes, and play a leading role in transport policy and technology development.

The Institute would be responsible for research on all aspects of transport and logistics by all modes. It will be expected to play a leading role in national transport policy and technology development. The Institute may be set up under the Ministry of Science and Technology and would work closely with the Office of Transport Strategy (OTS)[20] recommended by the Committee. It would cover all modes and type of transportation by setting up departments covering aviation, national highways, urban transport, railways, maritime transport, inland water transport, environmental impact assessment, policy planning, extramural research, and statistical analysis.

IITR could develop four or five regional centres to focus on regional issues and coordination with regional authorities. At maturity, IITR should expect to employ about 300-500 professionals at the postgraduate level by the end of the 13th Five Year Plan period.

IITR would be responsible for:

(a) Providing policy options and analysis to transport ministries (central and state), operating agencies and city governments.
(b) Conducting cost effectiveness studies across different modes of transport and available technologies.
(c) Conducting exploratory and future technology studies.
(d) Providing a framework and modalities for interdisciplinary and inter-sectoral studies.
(e) Identifying, facilitating, and supporting the deployment of emerging technologies and best practices.
(f) International technology assessment.
(g) International collaboration.
(h) Funding research and establishing centres of excellence at academic institutions.
(i) Taking up studies for different transport ministries at central and sate level.
(j) Identifying data needs and coordination with Indian Institute for Transportation Statistics.

A similar recommendation was made by the National Transport Policy Committee, 1980 as mentioned earlier, and AITD was set up as an independent non-government institution. The Planning Commission has extended its support to AITD, keeping in view the long-term role of the Institute in building human capital as also for providing research support on all aspects of transport and logistics. In future, the IITR could play the role for supporting and extending financial support for research to such institutions.

Indian Institute for Transportation Statistics (IITS)

IITS will be responsible for acquiring, preserving, managing, disseminating transportation data, statistical analysis and associated information for use by central, state and city transportation departments, researchers and any other concerned agencies. Its various roles would include:

- Coordinate with all national and state statistical organisations associated with collecting transport related data, especially the Office of the Registrar General & Census Commissioner and the National Sample Survey Organisation.
- Serve as a central depository for data, statistics, research results and technical publications of all agencies dealing with various sectors of transport services.
- Publicise, facilitate and promote access to the information products and services.
- Publish an annual transport statistics database.
- Conduct a national personal passenger and goods transportation survey every five years. This will include flows of people, goods and vehicles, social, economic, and environmental data, conditions that affect or are affected by the transportation networks for all modes of transport.
- Coordinate with all agencies associated with transportation issues and IITR.
- Fund studies and research in academic organisations.

It would be responsible for synchronising other demographic and socio-economic data for the country. At the end of the 13th Five Year Plan IITS would have a staff of about 150-200 postgraduate professionals.

20. Please see Chapter 5 on Institutions for Transport System Governance.

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SCIENCE AND TECHNOLOGY CAPABILITY IN TRANSPORT MINISTRIES

RESEARCH INSTITUTIONS

Each department associated with transport (air, water, road and railways) should establish a multidisciplinary research organisation for applied research on current concerns and future technology development:

- Indian Institute for Aviation Research
- Indian Maritime and Water Transport Research Institute
- Indian Institute for Intercity Road Transport
- Indian Institute for Urban Transport
- Railway Research and Development Institute

By the end of the 13th Five Year Plan, each of these research institutes would have:

- 100-300 research professionals (60-70 per cent permanent employees of the institute and 30-40 per cent on deputation)
- Regional centres for coordination with state and city governments
- Advanced laboratories for technology development and testing
- Statutory responsibility for setting standards and regulations

The service conditions at these institutions should be similar to those at CSIR and the Director General of each Institution with rank and facilities similar to those of at CSIR laboratories/Secretary to the Government of India. The Director Generals will report directly to the Minister of the appropriate Ministry. Terms of reference would be similar to those at the IITR, but with greater emphasis for applied work as per needs and requirements of each Department. We have recommended elsewhere (Chapter 5, Volume II) the need to set up a unified Ministry of Transport. Once that happens, all these institutions would come under the umbrella of this Ministry and it would then be easier for these institutions to collaborate with each other more.

DEPARTMENT OF TECHNOLOGY DEVELOPMENT AND POLICY ANALYSIS

Each Transport Department must set up an internal Division of Technology Development and Policy Analysis. The Division must be staffed by 20-50 professionals headed by an officer of the rank of Additional Secretary to the Government of India. However, two-thirds of the professionals working in the Division would be permanent employees with service conditions same as those of scientists working in the CSIR, and one-third would be on deputation. The role of the Division Department would include:

- Liaison with IITR, IITS and with the respective ministerial research institution

At the state level, each ministry dealing with transport issues should establish a transport research department focusing on the special needs of the state.

- Technology evaluation and assessment
- Data collection and analysis
- Responding to needs of operating agencies
- Funding research in academic institutions
- Outreach
- Organising scientific workshops and conferences
- Policy assessment and strategic planning
- Align areas of research with ministry goals.
- Investment policy regarding ministry R&D
- Track redundancy and duplication of effort

We have recommended elsewhere the establishment of an Office for Transport Strategy (OTS). Once such an office is established, these entities could work intensively with the OTS.

STATE- AND CITY-LEVEL INSTITUTIONS

a. All states should consider establishing State Institute for Transport Research (SITR) with objectives similar to the Indian Institute for Transport Research (IITR), but with greater focus on local issues. The SITR should include a special transport statistics division that would liaison with the Indian Institute for Transportation Statistics. At maturity these institutes should have a staff of 50-100 professionals.
b. At the state level, each ministry dealing with transport issues should establish a transport research department focusing on special needs of that state. The responsibility of the department would be to generate state level detailed plans, data needed for the same, evaluation of projects and policies, liaison with the Central Government, and funding of research projects at state-level institutions and universities.
c. All megacities (population >5 million) must establish transportation planning research departments that could have responsibilities similar to state-level units.

ACADEMIC CENTRES OF EXCELLENCE

At present, most of the academic programmes in India related to transport capacity appear to be much less integrated than the global norm. Outside of India, these tracks are often presented as specialisations within a single Transport Engineering programme (See Annex). Brazil's University of Sao Paulo, for example, offers a single Transport Engineering Masters with specialisations in Transport Infrastructure Planning and Management, Transport Infrastructure Construction, and Spatial Infor-

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Table 11. 4
Suggested Number of Academic Centres of Excellence

SUBJECT	NUMBER BY 2020	NUMBER BY 2030
Urban transport	20	40
Highways	20	40
Rail	15	30
Air	5	10
Water and marine	5	10

mation. Transport and Sustainable Development as a combination seems to be most prevalent in Europe, perhaps reflecting that region's focus on transport policy as a part of climate change/environmental strategy. The London Centre for Transport Studies offers an MSc in Transport with specialisations in Business Management and Sustainable Development, as does the Paris Institute of Technology and the Institute of Transport Studies at University of Leeds. Australia's Planning and Transport Research Centre (PATREC) and South Africa's University of Capetown offer Transport Studies courses with a core focus on systems planning and clusters of electives in management and specialised planning topics. University of California, Berkeley offers a similar combination of core courses plus electives, in Transportation Engineering and Transports Systems Analysis.

Within India, this split seems to be between schools: specialised masters in transport planning within urban planning programs for the former and the latter training taking place in Civil Engineering departments. Specialised courses on transport management are within business schools, for example at the Indian Institute for Social Welfare and Business Management. Most of the courses are offered within particular departments, often urban planning or civil engineering, though there appears to be some tendency for more recently founded programmes to be linked to multiple departments or even multiple schools. There is clearly precedent for building specialised centres that can draw on faculty from different departments while avoiding getting locked into particular forms of teaching, class schedules, policy framing, or other aspects of particular departments than may complicate launching transport-related degree programmes and shorter courses.

Investments in transport research must be spread over a wider group of professionals. Government support for research appears to be primarily directed to designated public-sector research bodies focused on sectors rather than transport overall. Each Department dealing with transport and the Ministry of Human Resource Development must set up academic centres of excellence. It is expected that the centres funded by transport ministries would be more focussed on applied research, whereas those set up by the Ministry of Human Resource Development would help provide graduate scholarships, extra faculty positions and infrastructure funds. These new centres should cover all modes of transport to deal with the following subjects and societal concerns:

- Energy sustainability and global warming
- Safety
- Health effects of transport
- Energy sources, availability and future technology assessment
- Integration of transportation modes
- Affordability and economic issues
- Modelling and simulation
- Needs of children, the aging and physically challenged population
- New materials
- Human factors, psychology and social implications of transport policies
- International issues and global logistics
- Policy analysis and cost effectiveness studies
- Influence of infrastructure design and technology on travel behaviour
- Economics

Such centres must of necessity be of interdisciplinary nature and be established based on open competition among academic institutions by inviting proposals for the same. Each centre must demonstrate its interdisciplinary nature by ensuring that the participating scientists are drawn from two or more departments and can be established in all academic institutions including medical colleges. The suggested number of centres to be established are given in Table 11.4.

The level of funding would be Rs 30-50 million per year per centre. In addition to equipment, supplies, travel and research funds, the funding must include 5-10 endowed permanent Chairs and 10-20 endowed post-graduate scholarships. The establishment of these centres must include funds for development of infrastructure and extra faculty positions equal to the number of endowed Chairs.

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Table 11. 5
Scholarship Proposed for Study in Transportation-Related Subjects

ORGANISATION	NUMBER OF NATIONAL SCHOLARSHIPS PER YEAR	NUMBER OF INTERNATIONAL SCHOLARSHIPS PER YEAR
Ministry of Road Transport and Highways	50	25
Ministry of Railways	50	25
Ministry of Civil Aviation	10	5
Ministry of Environment and Forests	40	20
Ministry of Heavy Industries and Public Enterprises	10	5
Ministry of New and Renewable Energy	10	5
Ministry of Shipping	20	10

KNOWLEDGE GENERATION IN OPERATING COMPANIES/ ORGANISATIONS/MUNICIPALITIES

Present operating companies like DMRC, BEST, DTC, etc., and municipalities, have very little knowledge generation capacity. Mechanisms have to be set up to revamp these organisations and make them much more professional. Each one of these organisations must have a knowledge generation unit that has a budget of about 3-5 per cent of the turnover of the organisation by 2020.

JOB OPPORTUNITIES FOR HIGHLY-TRAINED PROFESSIONALS IN THE TRANSPORT SECTOR

a. Just the creation of research centres in academic institutions will not be sufficient for ensuring professionalisation of transportation services. Individuals trained at post-graduate levels must have job opportunities that excite and satisfy them. The creation of research centres as outlined above will create a part of this demand. However, the operating departments/organisations will also have to create a demand for highly qualified individuals who work in-house with different job responsibilities and working conditions.
b. At present India produces approximately 1,000 PhDs per year in engineering, whereas China produces >7,000 per year. Most Chinese PhDs find jobs within China, whereas even this smaller number of PhDs in India have problems finding a satisfying job, especially one with an operational orientation. There needs to be strong demand creation for graduates with advanced degrees, in both research as well as operational organisations, so that the country could move systematically toward a sustainable transportation future.
c. Central, state and local governments and agencies such as Railways, NHAI, State and City Road Transport Corporations, Port Trusts, Airport Authorities, NTPC, ONGC, etc. would need to take the lead to house highly-trained personnel in relevant areas sectors such as Energy, Power, Environment, Integrated Transport, Urban Development, Planning, Economics and Finance and disciplines so that new technologies, management and operational systems are explored in transportation service delivery aimed at improving the quality of mobility as well as the efficiency of the transport system.
d. Concrete policies at each agency would need to be worked out. Each agency and department should create 10-year projections for expanding the employment of higher-skilled operational staff including, MTechs and PhDs to a desirable level. This would need to be accompanied by a revision of salary and service conditions that suit people with a knowledge base (CSIR service conditions can be a starting point).

PRODUCTION OF THE WORKFORCE

Each ministry/department associated with transportation issues should establish scholarships, which can be awarded through open competition at a national level. Scholarships may be given with all expenses covered to those who are able to get admission to reputed Indian and foreign universities. Those availing of scholarships at international universities would have to sign a bond to serve an Indian organisation for three years upon graduating. Students opting to study at Indian universities should get scholarships without and bonds and constraints. The number of scholarships for study in transportation related subjects to be awarded by different ministries per year for the first five years after the launching of the scheme are given in Table 11.5.

SPONSORED MASTER'S AND BACHELOR'S DEGREE PROGRAMMES

All operating departments, institutions and corporations related with transportation should be required to sponsor about 2-5 per cent of their staff for obtain-

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ing masters degrees in relevant subjects as fulltime students every year.

A task force should be constituted by the Planning Commission to prepare a report on the number of new special bachelor's and master's degree programmes that need to be set up at different institutions around the country for training of the workforce necessary over the next 10-year period. The taskforce would also assess the financial implications of starting these new courses and the source of funds for the same. The task force should be able to submit its report by the end of 2014, and programmes started by 2016.

IN-SERVICE TRAINING

The skills gap cannot be taken care of by the production of new professionals alone. Many of those already in service will be around for the next 15-20 years and it is essential that they have an opportunity to improve their skills and acquire knowledge necessary to apply modern tecniques and technologies. In service training and knowledge acquisition requires three parallel efforts:

1. Periodic testing of engineers and technical personnel.

It is essential that India builds a pool of transport professionals. The existence of a large number of professionals will ensure competition among them to keep them honest and throw up a few outstanding individuals of international standing in each area of activity.

Each area of professional activity (e.g., civil engineering, mechanical engineering, electrical engineering and important sub disciplines) should require a mid-career evaluation of professional expertise after 7-10 years of service. The form of the evaluation may be based on modern education methods based on self-paced internet learning and testing methods with some practical evaluation. The purpose of this evaluation will not be to necessarily fail individuals, but to ensure that individuals can advance in their careers only when they demonstrate they have kept up with the technical advancements in knowledge in their respective disciplines. A special task force should be set up to design the format, rules and procedures for these professional examinations and for Professional Certification by empowered agencies.

2. Short-term training programmes
All professionals should be required to participate short-term training programmes in areas for which policy movement is urgent and capacity gaps are significant at least once every five years. These courses could be one week to one month in length and organised by the department concerned with outside experts or in collaboration with existing academic institutions. Efforts in this direction have already been instituted in the 12th Five Year Plan. What is needed is greater emphasis on quality and ensuring continuity in service of those trained so that they can put their knowledge to use. Short-term training programmes being offered in other countries should be evaluated for quality and relevance periodically and 25-30 per cent of officers eligible for such training sent out of the country to gain international experience.

3. Pursuing higher degrees
All professionals should be eligible for pursuing a course of studies at the Master's or PhD level at departmental expense after about five years of service. At any given time about 10 per cent of officers should be allowed to proceed on leave with appropriate adevaluation of the need for expertise and skills required. Adequate budget provisions would be necessary for about a third of such professionals being deputed to institutions outside India. Arrangements will have to be made to establish appropriate career opportunities and job responsibilities for persons acquiring higher qualifications. For example, some of them may be deputed to the new research and development organisations at the local, state or central level as proposed in this report. It is essential that professionals be given opportunity to place themselves where they fit best (on-line engineering responsibilities, management, research, etc.) as they mature mid-career onward.

LATERAL HIRING

Lateral hiring could also be a way to build critical expertise within the public sector as quickly as it is built in the country more broadly. As discussed here, India does not yet have significant reserves of transport planning capacity in the private sector, but these may be built faster than public expertise and thus ease of movement between public and private would ensure capacity flows to the areas of greatest need.

The Approach Paper of the 2nd Administrative Reforms Committee also emphasises the need to build a framework for lateral induction as policy complexity increases, including designating some policy offices requiring specific forms of expertise. Other working groups and expert committees such as the Planning Commission Working Group on Capacity Building in the 12th Plan have reiterated the value of opening hiring to appointments from outside the public sector in complex areas with significant gaps in public sector capacity.

SUMMARY

Transportation planning and policy implementation has become a very complex and contentious activ-

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ity. This is partly because many infrastructure projects are capital intensive and invite narrow interest of lobbyists and technology providers, and partly because solutions to many issues are not very clear. In an age of instant information transfer, decisions can be based ahistorically on current fashions that may not suit our socio-economic environment. The fact that the future of energy availability and environmental concerns is highly uncertain makes the job even more difficult.

In this scenario, it is very important the country has a large number of professionals who are aware of all international developments in policy and technology and also have an in-depth knowledge of our local conditions and needs. The existence of a large number of such professionals will ensure competition among them to keep them honest and also throw up a few outstanding individuals of international standing in each area of activity.

At present, knowledge gaps exist in all areas of activity:

- Design, construction, operation, management, maintenance
- Safety
- Demand management
- Project management
- Use of ITS
- Finance

Future transportation planning and policy making will also require a much more sophisticated approach to set in place systems that ensure the consideration of climate change and safety issues as integral components of infrastructure and technology options.

At present, India fares poorly in terms of total knowledge output. When normalised for population levels in 2011, India's output appears poor in comparison with both Brazil and China. Even more worrisome is the fact that the gap between India and China has widened considerably in the past decade especially on topics dealing with railway technology safety and environment. This means that if we want to catch up with countries like China in 10 years with their present levels of productivity, we will have to grow at more than 10 per cent per year. We must plan to set up systems for local knowledge producing mechanisms that aid researchers in responding to demands of society.

Functioning transportation systems in any location involve interactions between individuals, socio-economic imperatives, technologies, geophysical structures, built environment, organisational capacities, political compulsions, knowledge limitations, influence of special interest groups, and historical path dependencies of societies.

International experience offers several relevant lessons for building expertise and a professional community. First, it is important to establish transport planning as a high-status occupation and applied science makes it easier to attract ongoing political and financial support as well as some of the most competent professionals. Second, it is important to decentralise the institutional system and build networks. Third, it is important to encourage transport stakeholders to learn by doing

India must invest in decision support systems so that capacity can be used for maximum effect. The institutional framework must also be able to convert information into knowledge.

'Capacity building' comprises three challenges: training individuals, building systems for research and development to update capacity, and ensuring that these individuals have the ability and incentives to be productive within teams and organisations. India must not only increase the supply of capacity by expanding the number and quality of opportunities to study transport planning and allied fields, but it must also ensure a strong demand side. The effective 'demand' for capacity will depend on employment policies that attract these transport planners to public sector work and also on public expenditure and programmatic policies that encourage ministries, state agencies, and metropolitan bodies to spend discerningly on capacity building. In addition, as some private sector infrastructure companies become large and engage in large transport projects, they can also be encouraged to use the services of transport planning specialists. The Government will also need to invest in transport research so that training, decision support, and policy action improve over time and adapt to changing opportunities and challenges. Capacity building should also be designed to also support India's efforts to integrate its many transport-related organisations with a common culture focused on transport systems across national, state, and metropolitan scales. This section discusses future requirements across these three dimensions.

There is little reliable data available for inter-city or urban passenger or freight travel patterns. In this situation, infrastructure investment has to be done on a fire-fighting basis with little knowledge of long-term consequences on efficiency, or financial and environmental stability. Technology choices have to be based on hunches and influenced by powerful supplier lobbies. This situation is likely to get worse in the face of accelerated economic growth and urbanisation, as political and public pressure for provision of transportation services will demand quick fixes. India must also invest in decision support systems so that available capacity can actually be exercised for maximum effect. The institutional framework must also be capable of converting information into transport knowledge A review of

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If India is to emerge as an economic power by 2030, it needs to invest significantly in human resource institutions to exhibit much greater soft power than it does at present.

international practices in transportation research, training and development clearly shows that a large number of countries have established well-funded and professionally-staffed institutions at all levels and across disciplines.

It is quite clear that there is already a great shortage of trained manpower, alongwith absence of institutional support for policy making and technology development in India. We do not have any institutions within government departments and operating agencies, universities centres or stand-alone institutions in any area of transportation that compare favourably with institutions reviewed in previous sections except for an institution or two like the National Aerospace Laboratory. The research centres at academic institutions are sub-critical in the number of faculty members involved, and resources available. Except in a few centres, most of the academic activity is not interdisciplinary in nature, and there is almost a complete absence of involvement of professionals from the social sciences–economics, law, etc.

INVESTMENT IN INSTITUTIONS

The effort necessary for setting up institutions and structures needed for planning, decision-making and implementation for the next two decades will be quite substantial. This will require that funds be earmarked for these institutions as 1-2 per cent of investment for each transport sector. This is a very small amount to invest considering the challenges facing us. We have to start planning for these institutions now to catch up with other nations in a decade or so.

The number, size and type of institutions being recommended is based on international comparisons, in particular with countries with similar levels of development at present. Furthermore, if India is to emerge as an economic power by 2030, it needs to invest significantly in human resource institutions to exhibit much greater soft power than it does at present. As indicated earlier, India is significantly behind countries like China and Korea in knowledge production, skills, innovation and technology development at all levels and areas of transport operations. It has to be emphasised that scientific findings and innovation cannot be ordered. Capacity has to be built with a large number of professionals in all fields so that a few of them may come up with path-breaking ideas in the future.

International experience suggests that it takes more than a decade to build viable quality institutions. Demand has to be created for persons with expertise in these areas with availability of jobs in institutions. This sends a signal to academic institutions to start relevant academic programmes and for potential students to apply for the same. We present these institutions as distinct public and private entities, but collaboration is also important to ensure that transportation research is seen as neutral and credible, particularly if the recommended action on route planning for road and rail, subsidies for passenger transport, air quality regulation, reinvigorating different forms of mass transport and investment in non-motorised transport takes place.

STANDALONE NATIONAL INSTITUTIONS

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The Institute would be responsible for research on all aspects of transport and logistics by all modes. It will be expected to play a leading role in national transport policy and technology development. The Institution may be set up under the Ministry of Science and Technology and would work closely with the Office of Transport Strategy recommended by NTDPC. IITR could develop 4-5 regional centres to focus on regional issues and coordination with regional authorities. At maturity, IITR should expect to employ about 300-500 professionals at the post-graduate level by the end of the 13th Five Year Plan period.

(b) Indian Institute for Transportation Statistics (IITS)
IITS will be responsible for acquiring, preserving, managing, disseminating transportation data, statistical analysis and associated information for use by central, state and city transportation departments, researchers and any other concerned agencies.

SCIENCE AND TECHNOLOGY CAPABILITY IN TRANSPORT MINISTRIES

(a) Research Institutions
Each Department associated with transport (air, water, road and railways) should establish a multidisciplinary research organisation for applied research on current concerns and future technology development. Elsewhere (Chapter 5, Volume II) we have recommended the formation of a unified Ministry of Transport. As soon as such a Ministry is established, it would become easier for these institutions to collaborate with each other.

- Indian Institute for Aviation Research
- Indian Maritime and Water Transport Research Institute
- Indian Institute for Intercity Road Transport
- Indian Institute for Urban Transport
- Railway Research and Development Institute

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By the end of the 13th Five Year Plan each of these research institutes would have:

- 100-300 research professionals (60-70 per cent permanent employees of the institute and 30-40 per cent on deputation)
- Regional centres for coordination with state and city governments
- Advanced laboratories for technology development and testing
- Statutory responsibility for setting standards and regulations

(b) Department of Technology Development and Policy Analysis

Each Transport Department must set up an internal Division of Technology Development and Policy Analysis. The Department must be staffed by 20-50 professionals headed by an officer of the rank of Additional Secretary to the Government of India. However, two-thirds of the professionals working in the Department would be permanent employees with service conditions same as those of scientists working in the CSIR, and one third would be on deputation. These entities could collaborate intensively with the Office of Transport Strategy (OTS) recommended elsewhere (Chapter 5, Volume II)

STATE- AND CITY-LEVEL INSTITUTIONS

a) All states should consider establishing a State Institute for Transport Research (SITR) with objectives similar to the Indian Institute for Transport Research (IITR), but with greater focus on local issues. The SITR should include a special transport statistics division that would liaison with the Indian Institute for Transportation Statistics. At maturity these institutes should have a staff of 50-100 professionals.

b) At the state level the each ministry dealing with transport issues should establish a transport research department focusing on special needs of that state. The responsibility of the department would be to generate state level detailed plans, data needed for the same, evaluation of projects and policies, liaison with the Central Government, and funding of research projects at state-level institutions and universities.

c) All megacities (population >5 million) must establish transportation planning research department that could have responsibilities similar to state level units.

ACADEMIC CENTRES OF EXCELLENCE

At present most of the academic programmes in India related to transport capacity appear to be much less integrated than the global norm. Each Ministry dealing with transport and the Ministry of Human Resource Development must set up academic centres of excellence. It is expected that the centres funded by transport ministries would be more focussed on applied research, whereas those set up by the Ministry of Human Resource Development would help provide graduate scholarships, extra faculty positions and infrastructure funds.

Such centres must of necessity be of interdisciplinary nature and be established based on open competition among academic institutions by inviting proposals for the same. Each centre must demonstrate its interdisciplinary nature by ensuring that the participating scientists are drawn from two or more departments and can be established in all academic institutions including medical colleges. The suggested number of centres to be established are given in Table 11.4.

KNOWLEDGE GENERATION IN OPERATING COMPANIES/ORGANISATIONS/MUNICIPALITIES

Present operating companies like DMRC, BEST, DTC, etc., and municipalities, have very little knowledge generation capacity. Mechanisms have to be set up to revamp these organisations and make them much more professional. Each one of these organisations must have a knowledge generation unit that has a budget of about 3-5 per cent of the turnover of the organisation by 2020.

JOB OPPORTUNITIES FOR HIGHLY-TRAINED PROFESSIONALS IN THE TRANSPORT SECTOR

There needs to be strong demand creation for graduates with advanced degrees, in both research as well as operational organisations, so that the country could move systematically toward a sustainable transportation future. Concrete policies at each agency would need to be worked out. Each agency and department should create ten year projections for expanding the employment of higher-skilled operational staff including, MTechs and PhDs to a desirable level. This would need to be accompanied by a revision of salary and service conditions that suit people with a knowledge base (CSIR service conditions can be a starting point).

PRODUCTION OF THE WORKFORCE

Each Ministry associated with transportation issues should establish scholarships, which can be awarded through open competition at a national level. Scholarships may be given with all expenses covered to those who are able to get admission to reputed Indian and foreign universities.

The number of scholarships for study in transportation related subjects to be awarded by different ministries per year for the first five years after the launching of the scheme are given in Table 11.5.

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SPONSORED MASTER'S AND BACHELOR'S DEGREE PROGRAMMES

All operating departments, institutions and corporations related with transportation should be required to sponsor about 2-5 per cent of their staff for obtaining masters degrees in relevant subjects as fulltime students every year.

A task force should be constituted by the Planning Commission to prepare a report on the number of new special bachelor's and master's degree programmes that need to be set up at different institutions around the country for training of the workforce necessary over the next 10-year period.

IN-SERVICE TRAINING

The skills gap cannot be taken care of by the production of new professionals alone. Many of those already in service will be around for the next 15-20 years and it is essential that they have an opportunity to improve their skills and acquire knowledge necessary to apply modern techniques and technologies. In service training and knowledge acquisition requires three parallel efforts:

1. Periodic testing of engineers and technical personnel.
Each area of professional activity (e.g., civil engineering, mechanical engineering, electrical engineering and important sub disciplines) should require a mid-career evaluation of professional expertise after 7-10 years of service. A special task force should be set up to design the format, rules and procedures for these professional examinations and for Professional Certification by empowered agencies.

2. Short-term training programmes
All professionals should be required to participate short-term training programmes in areas for which policy movement is urgent and capacity gaps are significant at least once every five years.

3. Pursuing higher degrees
All professionals should be eligible for pursuing a course of studies at the Master's or PhD level at departmental expense after about five years of service. At any given time about 10 per cent of officers should be allowed to proceed on leave with appropriate evaluation of the need for expertise and skills required.

LATERAL HIRING

Lateral hiring could also be a way to build critical expertise within the public sector as quickly as it is built in the country more broadly. As discussed previously, India does not yet have significant reserves of transport planning capacity in the private sector, but these may be built faster than public expertise and thus ease of movement between public and private would ensure capacity flows to the areas of greatest need.

CONCLUSIONS

We have placed great emphasis on the importance of human resource development in all aspects of the transportation sector. This also reflects the difficulties we have faced in compiling this report as we have interacted with ministries and government agencies at the central, state and local levels, and with the best professionals available. At the same time, the ramping up of investment in all areas of transport is already taking place, and we are recommending a further enhancement in such investment over the next two decades. Corresponding with economic growth and higher income levels, aspirations of people for higher quality of transportation are also going up consistently. Accordingly, we are also witnessing increasing demands for investment in capital intensive projects such as high-speed trains (HST), limited access expressways, urban mass transit systems such as Metros, and the like. The decision making in such projects is now being done without adequate availability of data, nor adequate appreciation of the various trade offs involved in resource allocation between different modes and options.

It is in this context that we are recommending the establishment of new institutions connected with transport on a somewhat large scale. We are aware of various criticisms, which characterise these recommendations as being utopian and unrealistic. As we have documented, comparison even with other emerging market economies shows that the kind and size of institutions recommended are quite comparable with those already existing in these countries. Compared with the magnitude of overall investment envisaged in the transport sector, the investment in such institutions would amount not more than 1-2 per cent of GDP. The gains in better planning and execution of transport projects will far outweigh the cost of such investment in essential human resource development.

Of equal importance is a focused and sustained programme of upgrading existing personnel, most of whom will be in service over the next 20 years.

Transportation planning, engineering, design, execution must all be seen as exciting areas of work, as indeed they are. Thus, we recommend that the Planning Commission establish a Special Mission to carry forward the recommendations in this chapter on unified basis, within the 12th Plan period.

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Annex

Transport Planning Curricula

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
Master of Transport	Monash University–Monash Institute of Transport Studies, Department of Civil Engineering	Australia	Core Units: Traffic engineering fundamentals Quantitative methods Intelligent transport systems Transport modelling Infrastructure project and policy evaluation Transport planning and policy Transport economics Elective Units: Road traffic: Engineering and management Road safety engineering Parking policy and design Case studies in transport Fundamentals of urban public transport Link: http://monash.edu/pubs/handbooks/courses/3272.html
Master of Transport Studies	Planning and Transportation Research Centre (PATREC), a collaboration between three public universities of Western Australia: Curtin University, Edith Cowan University and The University of Western Australia	Australia	Core Units: Planning for Accessibility Transport Assessment & Evaluation Cities & Sustainability Transport Systems & Policy Elective Units: Global Distribution & Transportation Integrated Plan Making Principles of Enterprise Logistics Management Business Strategy Managing Change Contemporary Issues in Aviation Management Risk Management Advanced Transport Modelling Logistics Management Transport Safety Transport Research Methods Curriculum: http://humanities.curtin.edu.au/local/files/courses/308322/brochure.pdf PATREC Home Page: http://www.patrec.org/
Masters in Transportation Planning	University of Sao Paulo	Brazil	Offers three specialisations: - Transport Planning and Systems Operation - Infrastructure Construction and Project Management - Spatial Analysis for Transport Link: http://www.euni.de/tools/jobpopup.php?lang=en&option=showJobs&jobid=346190&jobtyp=5&jtyp=2&university=University+of+S%C3%A3o+Paulo&country=BR&sid=46751&name=Transport+Engineering+%28Master%29
Master of Engineering in Transport Studies Master of Philosophy in Transport Studies Postgraduate Diploma in Transport Studies Dissertation PhDs in Transport Studies	University of Cape Town	South Africa	Core Courses: Transport demand analysis and project assessment Transport modelling Intermodal public transport planning and economics Integrated land use-transport planning Management of transport supply and demand Elective Courses: Intermodal public transport planning and economics Rail planning and operations management Bus planning and operations management Local area transport planning, management and design Non-motorised transportation Transport planning Link: http://www.cfts.uct.ac.za/study_2.html
Master of Science and Doctor of Philosophy–Transport Engineering and Logistics	Transport Engineering and Logistics Department, Pontificia Universidad Católica de Chile	Chile	Transport Economics Social Projects Evaluation Advanced Demand Traveling Models Engineering Econometric Models Transport Externalities Advanced Traffic Models Transport Networks Equilibrium Logistics Topics Highway Traffic and Queuing Theory Advanced Methods for Transport and Logistics Systems Urban Transport Systems Planning Urban Road Design Seminar Link: http://wwwold.ing.puc.cl/ict/

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Transport and Planning	Cardiff University	United Kingdom	Core Modules: Principles of Transport Economics Researching Transport Sustainable Transport Tools for Transport Analysis Transport and the City Optional Modules: Environmental Behaviours: Citizens, Consumers and Communities Environmental Management Local Food and Sustainable Development Space and Place: International Planning Practice Spatial Planning Link: http://www.cardiff.ac.uk/cplan/degreeprogrammes/postgraduate/mastersprogrammes/transportplanning/index.html
MSc Transport MSc Transport with Business Management MSc Transport with Sustainable Development	Imperial College / University College (University Of London Centre For Transport Studies)	United Kingdom	MSc Transport Core Units: Transport and its context Quantitative methods Transport engineering and operations Transport economics Transport demand and its modelling Transport policy Optional Units: Highway engineering Road traffic theory and its application Public transport Transport safety Quantitative techniques for transport engineering and planning Advanced transport modelling Understanding and modelling travel behaviour Transport and the environment Intelligent transport systems Design of accessible transport systems Freight transport Asset management, project planning and maintenance Design of roads, rail, bridges, tunnels and embankments Air traffic management Ports and maritime transport Urban street planning and design Business Management Extension Modules: Microeconomic Theory Principles of Accounting Project Management Business Environments and Construction Law Sustainable Development Extension Module: The concept of sustainable development Sustainable development and engineering innovation Applying the principles Special project Link: http://www.ulcts.cv.imperial.ac.uk/
Master of Science (MS)/Master of Engineering (MEng)/MCP (City and Regional Planning)/PhD in Transportation Engineering	University of California, Berkeley	United States of America (USA)	Core Courses: Transportation Policy, Planning and Development Operation of Transportation Facilities Systems Analysis in Transportation Transportation Engineering Courses: Design and Construction of Transportation Facilities Transportation Systems Engineering Infrastructure Planning and Management Intelligent Transportation Systems Highway Traffic Operations Public Transportation Systems Air Transportation Operations of Transportation Terminals Selected Topics in Air Transportation Transportation Systems Analysis Courses Transportation Economics Logistics Transportation Infrastructure Management Analysis of Transportation Data Behavioral Modeling for Engineering, Planning, and Policy Analysis Advanced Topics in Transportation Theory Transportation Planning Courses Transportation Planning Transportation Sustainability Traffic Safety and Injury Prevention Transportation and Land Use Planning Transportation Finance Link: http://www.ce.berkeley.edu/programs/trans

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
Undergraduate Degree in Transportation Engineering/ Doctoral Degree Transportation Planning and Management	Beijing University of Technology	China	No information on coursework Link: http://bjut.edu.cn/bjut_en/colleges.jsp?columnID=222
Master of Engineering (Transport Option)/Master of Science (Transport and Sustainable Development)	Paris Institute of Technology	Paris, France	Master of Engineering (Transport Option): Common Core Courses: Introduction to management Statistics Introduction to law Fluid mechanics or soil mechanics Transport Option: Economics of transport Modelling of demand Transport safety Transport pricing Methods for territorial analysis Master of Science–Transport and Sustainable Development • Transport Stakes and Sustainable Development • Analysis and Prevision of Transport Supply and Demand • Transport, Energy and Environment • Transport and Social, Economic and Political Regulation • Management and communication • Projects Transport et Développement Durable • French (for not-French speaking students) • Professional internship Link: Master of Engineering (Transport Option): http://www.enpc.fr/english/academics/vet.htm?sr=2&ur=3 Master of Science–Transport and Sustainable Development: http://www.enpc.fr/english/enpc/tradd_gb.pdf
BSc Transport Management	Engineering & Applied Science, Aston University	Birmingham, UK	Year 1 Modules: Introduction to Logistics Planning & Controlling Logistics Law Principles of Economics Financial Accounting Study Skills Literature Review Project Marketing Goods & Services Introduction to Business Management Year 2 Modules Transport Planning Systems Environmental Economics Project Management Operational Research 1 Management Accounting European Transport Maritime Transport Database Management Multimodal Transport Management Implementing Transport Policy Environmental Managements & Audit Final Year Modules: Passenger Service Provision Traffic and Transport Engineering Human Resource Management Operational Research II Statistical Methods Air Transport International Trade Law Final Year Project GIS Transport Impact Assessment Link: http://www1.aston.ac.uk/eas/undergraduate/our-courses/bsc-transport-management/

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
BSc Management Transport & Logistics	Liverpool John Moores University	Liverpool, UK	Year 1: Transport Systems and Policy; Introduction to Logistics; Principles of Law; Organisation, Economics and Finance; Study Skills. Year 2: Managing Transport Operations; Logistics Operations and Materials Management; International Trade and Commerce, Research Planning and Quantitative Methods. One option from: Law of Carriage of Goods; Port Policy; Employment Law and Human Resource Management. Year 3: Transport Policies and Practices; Project. Plus three options from: Multimodal Transport and Global Logistics; Port Strategy and Development; Applied Marketing and Strategy; Management of Finance and Investment Appraisal. Link: http://www.ljmu.ac.uk/courses/undergraduate/2012/course.asp?CourseId=NK24
BSc (Hons)Transport and Logistics Management	University of Huddserfield	UK	Year 1 Core modules: • Transport: Challenges and Issues • Economics and Business Statistics • Principles of Logistics and Marketing • Professional Skills and Personal Development • Commercial Management Option modules: Choose one from - • Introduction to Air Transport • Fundamentals of Tourism • Languages Year 2 Core modules: • Logistics Management • Freight Transport Management • Managerial and Enterprise Skills • Passenger Transport Management • Logistics Planning Techniques and Applications Option modules: Choose one from - • Languages • European Business and Global Markets • Operations Management • The Travel and Tourism Industry • Airline Marketing and Operations Management Year 3 Core modules: • Strategic Management • Project • Strategic Supply Chain Management Option modules: Choose two from - • Retail Logistics • Languages • Sustainable Tourism • Global Logistics and Supply Chain Management • Supply Chain Modelling • Project, Quality and Production Management • Transport Economics and Policy Link: http://www.hud.ac.uk/courses/2013-14/full-time/undergraduate/transport-and-logistics-management-bsc-hons/
BSc (Hons) in Transportation and Logistics with Business Management	Malaysia University of Science And Technology	Malaysia	Modules Introduction to Transportation Systems Fundamental of Operations Research Introduction to Supply Chains Sustainable Development and Transportation; Transportation Planning Computer Algorithms for Transportation and Logistics Introduction to Transportation Flow Systems Transportation Demand Analysis Transportation Policy Public Transport Systems Operations and Management Transportation Economics Air Transportation Management Maritime Transportation and Logistics Freight Transportation Link:http://www.must.edu.my/index.php?option=com_content&view=article&id=107&Itemid=167

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc/PgDip/ PgCert Transport Planning and Management	Sheffield Hallam University	UK	Level one modules: Economy, society and sustainability Geographical information systems (GIS) and transport Global perspectives on regeneration Professional management skills Level two modules: Strategic land use and transport planning Financial policy and management Transport appraisal Level three modules: Applied research methods Dissertation Link: http://www.shu.ac.uk/prospectus/course/365/content/
BA Geography with Transport Planning	Institute for Transport Studies, University of Leeds	UK	Year 1: Introduction to transport policy, in addition to the key themes of human and environmental geography. Year 2: Specialise in human geography, alongside transport studies. Link:http://www.its.leeds.ac.uk/courses/undergraduate/geography-with-transport-planning/
BA Economics with Transport Studies			**Year 1**
			Compulsory Modules: / Elective Modules include:
			Introduction to Transport Policy / Economic Institutions (Labour)
			Information Technology & Communication Skills / Economic Institutions (Industry)
			Maths and Stats for Business and Economics / Introductory Financial Accounting
			Research Skills for Economists / Introductory Management Accounting
			Economic Theory and Applications / Understanding Social Enterprises
			Personal Tutorials for Economics / Organisational Behaviour
			Instruments of Transport Policy
			Year 2
			Compulsory Modules: / Optional Modules include:
			Intermediate Microeconomics / Business Economics
			Applied Economics / Industrial Economics
			Intermediate Macroeconomics / International Economic Environment
			Transport Economics / Introduction to Econometrics
			Project Appraisal / Transport Land Use and Development
			Transport and the Environment
			Transport and Society
			Final year
			Compulsory Module: Transport Dissertation
			Optional Modules include:
			Advanced Microeconomics / Public Transport Policy and Practice
			Public Enterprise and Regulation / Environmental Economics
			International Banking and Finance / Topics in Transport
			Travel Activity and Social Analysis / Physical Distribution and Logistics
			Advanced Macroeconomics / The Economics of Unions
			Economics of Business & Corporate Strategy / Current Topics in European Integration

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Sustainabilty (Transport)	Institute for Transport Studies, University of Leeds	UK	Compulsory modules Business, Environment and Sustainability Introduction to Sustainability Transport Planning and Policy Transport Data Collection and Analysis Sustainable Land-Use and Transport Planning Global Issues in Transport Transport Dissertation Optional modules: Climate Change: Impacts and Adaptation Environmental Governance and Sustainability Climate Change Mitigation Tools and Techniques for Integrated Ecological Economic Modelling Participatory Environmental Project/Policy Evaluation Green Logistics Analysing Transport and Society Public Transport Planning and Management Stated Preference Analysis Methods Traffic Network Modelling Transport Investment Appraisal Transport and Urban Pollution Transport in Development Safety of Road Transport Link:http://webprod1.leeds.ac.uk/catalogue/dynprogrammes.asp?Y=201011&P=MSC-TRN%2FSUS
MSc (Eng) Transport Planning and Engineering			Compulsory Modules Principles of Transport Engineering Principles of Transport Modelling Transport Planning & Policy Transport Data Collection & Analysis Dissertation Optional Modules Analysing Transport & Society Funding for Projects Global Issues in Transport Green Logistics Public Transport Planning & Management Road Geometry & Infrastructure Safety of Road Transport Stated Preference Analysis Methods Sustainable Land-Use & Transport Planning Traffic Management Transport & Urban Pollution Transport in Development Transport Investment Appraisal Traffic Network Modelling Link: http://www.its.leeds.ac.uk/courses/masters/msc-transport-planning-engineering/
MA Transport Economics			Compulsory Modules Principles of Transport Economics Welfare Economics & Cost-Benefit Analysis Transport Econometrics Principles of Transport Modelling Transport Data Collection & Analysis Economics of Transport Regulation Dissertation Optional Modules Analysing Transport & Society Funding for Projects Global Issues in Transport Green Logistics Public Transport Planning and Management Stated Preference Analysis Methods Transport in Development Transport Investment Appraisal Link: http://www.its.leeds.ac.uk/courses/masters/ma-transport-economics/

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Transport Planning			Compulsory Modules Transport Planning & Policy Principles of Transport Modelling Understanding Travel Behaviour Transport Data Collection & Analysis Sustainable Land-Use & Transport Planning Dissertation Optional Modules Analysing Transport & Society Global Issues in Transport Green Logistics Public Transport Planning & Management Safety of Road Transport Stated Preference Analysis Methods Traffic Management Transport in Development Transport Investment Appraisal Transport & Urban Pollution Traffic Network Modelling Funding for Projects Link: http://www.its.leeds.ac.uk/courses/masters/msc-transport-planning/
Graduate Courses in Transportation Systems Engineering (classified under School of Civil and Environmental Engineering)	Georgia Tech (Georgia Institute of Technology)	Georgia, US	Courses include: Computer-Aided Site Engineering & Road Design Construction Engineering Management Construction Safety and Health Discrete Choice Analysis Environmental Impact Analysis Freight Planning Geometric Design GIS in Transportation Infrastructure Management: IT Applications Infrastructure Systems Multimodal Transportation Systems Pavement Technology Project Front End Planning and Monitoring Signali sed Intersections & Networks Simulation Models in Transportation Spatial Analysis Statistical Analysis of Travel Demand Traffic Engineering Traffic Flow Theory Transportation Administration & Policy Analysis Transportation Energy & Air Quality Transportation Energy Infrastructure Management Transit Systems Planning & Design Urban Transportation Planning http://www.ce.gatech.edu/research/tse/courses
Rahall Appalachian Transportation Institute	Marshall University	West Virginia, US	Courses Relevant to Transportation offered at Different Departments: Principles of Domestic Transportation Marketing | Physical Distribution Marketing | Traffic Management Marketing | Purchasing and Inventory Control Marketing | Transportation Law and Public Policy Marketing | Carrier Management Marketing | Advanced Transportation Marketing | Advanced Physical Distribution ISC | Special Topics: Transportation and the Environment ISC | Special Topics: Transportation and the Environment PS | Physical Principles of Remote Sensing with Applications in Transportation (B) – Denotes baseline courses included in strategic plan from grant inception. For a full list of courses, go to: http://www.njrati.org/education/degree-programs/courses/
Master of Urban and Regional Planning, Specialisation in Transportation Planning	Portland State University	Portland, Oregon, US	Required Course: Urban Transportation: Problems and Policies Choose 3: Economics of Urban Transportation Urban Transportation Planning Transportation and Land Use Travel Demand Modeling Choose 1 (3 credits, minimum): (Note: if you take all four classes in the list above, you do not need to take a class from the list below.) Transportation Seminar (one credit, can take more than once)* Sustainable Transportation Geographic Applications in Planning Pedestrian and Bicycle Planning Cost Benefit Analysis in Transportation (1 credit, can only take once)* Transportation Safety Analysis Freight Transportation and Logistics

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
			Intelligent Transportation Systems Public Transportation Systems Transportation Operations http://www.pdx.edu/usp/urban-regional-planning-transportation
Transportation Policy and Planning Concentration, Urban Planning Program	Rutgers University	United States	Core Courses (select four of six) Urban Transportation Policy Analysis Urban Transportation Planning Transportation and the Environment Transportation and Land Use International Transport Policy Public Transit Planning and Management Elective Courses Security and Safety in Maritime Transportation and Port Operations Maritime Transportation Traffic Engineering Transportation Planning Traffic Operations Design of Transportation Facilities Transportation Systems Analysis Intelligent Transportation Systems Freight Transportation Systems Advanced Transportation Economics and Modeling Port Planning, Management and Operations State and Local Public Finance Comprehensive Planning Advanced Multivariate Methods Locational Conflict Introduction to GIS for Planning and Public Policy Program Evaluation Introduction to Planning and Design Zoning for Communities of Place Environmental Planning and Management Seminar in Urban Planning: Walking and Cycling Link: http://policy.rutgers.edu/academics/uppd/concentrations/transportation.php
Master of Urban Planning, Concentration in Land Use and Transportation Planning	University of Illinois, Urbana-Champaign	United States	(Recommended) foundation courses: Transportation Planning GIS for Planners Land Use Policy Growth Management and Regional Planning Evironmental Planning Workshop (Recommended) Electives: Watershed Ecology and Planning State and Local Public Finance Urban Ecology Planning for Historic Preservation Land Resource Evaluation Economic Development Planning Sustainable Planning Seminar Environmental Planning Workshop Housing and Urban Policy Planning Neighborhood Planning Advanced Sustainable Planning Workshop Ecology for Land Restoration Watershed Hydrology Earth Systems Modeling Environment & Sustainable Development Environmental Policy Biological Modeling Spatial Ecosystem Modeling Link: http://www.urban.illinois.edu/academic-programs/MUP/concentrations/lut.html
Master of Science in Transportation (interdepartmental programme)	Massachusetts Institute of Technology		Transportation Subjects by Programme Area: Air Transportation: The Airline Industry Air Traffic Control Airline Management Air Transportation Operations Research Planning and Design of Airport Systems Analysis and Planning Methods: Demand Modeling Logistical & Transportation Planning Methods Computer Modeling: From Human Mobility to Transportation Networks Advanced Demand Modeling Computer Algorithms in Systems Engineering Transport Modeling Course Network Optimisation Logistics and Supply Chain Management: Logistical & Transportation Planning Methods Logistics Systems Case Studies in Logistics and Supply Chain Management International Supply Chain Management

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
			Logistics and Supply Chain Management Transportation Policy: Transportation Policy and Environmental Limits Transportation Policy and Planning Law, Technology, and Public Policy Environmental Law, Policy, and Economics: Pollution Prevention and Control Transportation Management: Case Studies in Logistics and Supply Chain Management Logistics and Supply Chain Management Airline Management Urban Transportation: Demand Modeling Computer Modeling: From Human Mobility to Transportation Networks An Introduction to Intelligent Transportation Systems Comparative Land Use and Transportation Urban Transportation Planning Transport Modeling Course Public Transportation Systems Cities and Regions: Urban Economics and Public Policy Comparative Land Use and Transportation Planning Advanced Seminar in Transportation Finance Link: http://cee.mit.edu/graduate/transportation/areas
Master of Science in Transportation and Urban Systems/Master of Transportation and Urban Systems/Certificate in Transportation and Urban Systems	North Dakota State University	North Dakota, US	Compilation of courses (required and elective) specific degree programmes: Spatial Analysis Focus: Introduction to Geographic Information Systems Advanced Georgraphic Information Systems Spatial Analysis in Transportation Transportation Planning Focus: Research in Transportation and Logistic Transportation Planning Information Systems Technologies Focus: Technology Advances and Logistics Emergency Response and Disaster Focus: Crisis Analysis and Homeland Security Enterprise Management Focus: Enterprise Resource Planning Organisational Change Management Electives: Logistics Systems International Logistics Management Advanced Supply Chain Planning Adaptive Planning in Logistics Logistics Research Methods Acquisition Contracts: Law & Management Transportation Systems Security Transportation Planning and Environmental Compliance Transportation System Modeling Urban Transportation Systems Analysis Context Sensitive Solutions Transportation Systems Laboratory Public Transportation Link: http://www.ndsu.edu/transportation/tus/courses/
Transportation Engineering Masters Program	University of Washington	United States	Required: Transportation Engineering Probability and Statistics Analytical Methods in Transportation One course from each of the following key areas: Planning: Transportation Survey Methods or Travel Demand Forecasting Operations and ITS: Traffic Systems Operations or Trans Data Management and Analysis Freight and Logistics: Freight Transportation or Freight Transportation and Logistics Electives: Pavement Design GIS for Civil Engineers Urban Transportation Planning and Design Infrastructure Construction Energy and the Environment Traffic Engineering Fundamentals Transportation and Construction Capstone Transportation Logistics Pavement Construction and Quality Control Link: http://www.ce.washington.edu/prospective/grads/transportation.html
MSc Transport Sustainability & Society.	University of East London	UK	Core Modules: Planning, Mobility and Sustainability, Mobility, Society, and Culture Optional modules: two of - Cycling in Society Comparative Mobilities

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
			Unequal Mobilities Global Environmental Politics Transportation Engineering Sustainability and the Commons http://www.uel.ac.uk/lss/postgraduate/programmes/TSS.htm
MSc Intelligent Transport Systems & Intelligent Mobility MSc Transport Engineering & Operations MSc Transport & Business Management MSc Transportation Planning & Policy MSc Transport & the Environment	Newcastle University	UK	Modules: intelligent mobility—policy and practice, systems and services quantitative methods transport policy in practice Intelligent Transport Systems and e-Services; transport modelling road safety characteristics of public transport systems economic and environmental appraisal of transport activities Dissertation design of transport infrastructure railway management economics and practice transport planning for sustainable development air pollution and transport emission modelling for sustainability. http://www.ncl.ac.uk/ceg/study/postgraduate/taught/
MSc/Postgraduate Diploma in Transport Engineering and Planning	University of Salford, Manchester	UK	Courses: Transport Planning Principles The general aim of this module is to provide an introduction to the key concepts and methods which underlie the four-stage model central to the theory and practice of transport planning. More particular aims are as follows: a) to present a systematic representation of the demand for travel and the supply of transport; b) to provide experience in the application of one of the main systems of software (TRIPS) used in practice for transport planning; and c) to provide the basis for study in detail of the main methods used in transport planning. close Integrated Transport Planning The aims of this module are a) to present the principles and methods involved in planning coherently for all modes of transport; b) to illustrate the application of those principles through examination of case studies; and c) to review the measures available to reduce the use of the motor car and to promote the use of alternative modes. close Traffic Data Collection and Analysis In this module you will design, construct and assess standard traffic surveys and to apply statistical methods for analysing traffic data and interpreting results. close Transport systems design This module looks at the issues underlying current practice in the basic design of transport infrastructure for a range of transport modes including cycles, motor vehicles, rail and mass transit systems. close Transport Modelling You will study the key methods which comprise the four-stage model central to the theory and practice of transport planning: a) trip generation; b) trip distribution; c) mode choice; and d) highway-traffic and passenger-transport assignment. Estimation of trip-matrices from traffic-counts will also be introduced as an auxiliary method. close Traffic Management and Road Safety This module will teach you to analyse problems and propose outline solutions relating to the management and control of traffic, with an emphasis on road safety, environmental and amenity objectives. close Analysis of Highway Links and Junctions On completion of this module you should be able to analyse problems and propose outline solutions relating to the operation of highway links and junctions and to apply theoretical models in relation to traffic flow characteristics. close Appraisal of transport schemes This module will give you a systematic understanding and critical awareness of the current and innovative methods used to appraise and evaluate transport schemes, with specific reference to economic, environmental and safety issues and to give an opportunity to obtain practical experience in these methods. close MSc Project and Dissertation http://www.salford.ac.uk/courses/transport-engineering-and-planning?mode=cd

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NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Transportation Planning & Engineering	University of Southampton	UK	Transportation Planning: Policies & Methods Transport Engineering: Analysis & Design Transport Data: Analysis & Techniques Transportation Planning: Practice Transport Economics Research Project http://www.southampton.ac.uk/engineering/postgraduate/taught_courses/msc_transportation_planning_and_engineering.page?
Traffic Engineering–Certificate Transport and Spatial Development - Short course Transport Assessment - Short course Transport Planning - Professional Development - a series of short courses Transport Planning - MSc/Postgraduate Diploma/ Postgraduate Certificate	University of West England, Bristol	UK	Courses: development control; junction design; economic and environmental appraisal of road schemes; road safety investigation; traffic management, signal control and data collection; transport administration policy and legislation the role of transport in encouraging economic development and regeneration, especially unintended effects the effect of increasing road capacity in inducing traffic, and the effects of reducing (or reallocating) road capacity in reducing traffic the effectiveness of travel plans and other so-called 'soft' instruments of transport policy http://www1.uwe.ac.uk/whatcanistudy/courses/professionalandshortcourses.aspx#T
MSc Transport Planning & Management	University of California, Los Angeles	US	Core Courses: (any two) Transportation, Land Use, and Urban Form Transportation Planning Introduction to Transportation Engineering Parking, Transportation, and Land Use http://publicaffairs.ucla.edu/content/transportation-policy-and-planning
Certificate in Transportation Systems	University of Southern California		Required Courses Transportation Engineering Traffic Engineering and Control Engineering Project Management Urban Transportation Planning and Management Institutional and Policy Issues in Transportation http://www.usc.edu/schools/price/programs/certificate/transportation_systems.html

Source: NTDPC Research.

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12. SAFETY



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12. SAFETY

Hospitalisation and death due to injuries and violence are major threats to health across the world. It is estimated that more than five million people die each year as a result of some form of injury and many more are disabled for life[1].

Transportation-related death and injuries constitute a significant proportion of this. For young adults and working age males, road traffic accidents have become a leading cause of death in most countries including India. Given current trends, the global burden of injuries and violence is expected to rise considerably in the coming decades, particularly in low- and middle-income countries like India.

Table 12.1 shows the number of fatalities associated with various modes of transport in India for the years 1971-2011. Statistics for non-fatal injuries are not included as the numbers reported are unreliable. Except for air crash statistics, it is possible that all other numbers are underestimates, as no systematic methods of recording injury and fatality statistics have been established in the country. The statistics as reported by the National Crimes Record Bureau (NCRB) are based on cases reported to the police in the locality where the accident occurred and then collated and sent to the central authorities. Some detailed studies for road traffic crashes estimate that the number of serious injuries reported may be only 20-30 per cent of the actual number[2].

The statistics as reported show that the maximum numbers of fatalities per year occur in road transport, followed by those on railway property. The NCRB classifies railway accidents under two subheadings—'Railroad' and 'Railway other'. The former includes accidents that railway authorities consider to be 'consequential' and the latter includes accidental deaths occurring on railway property. 'Consequential' accidents include collisions, fire cases, level crossing accidents and derailments. In 2011, there were 2,366 'railroad' deaths and 25,872 'railway other' deaths. This latter group would include those killed crossing railway tracks, falling off trains, and other reasons not classified as consequential.

Table 12.1
Incidence of Accidental Deaths by Different Modes of Transport: 1971-2011

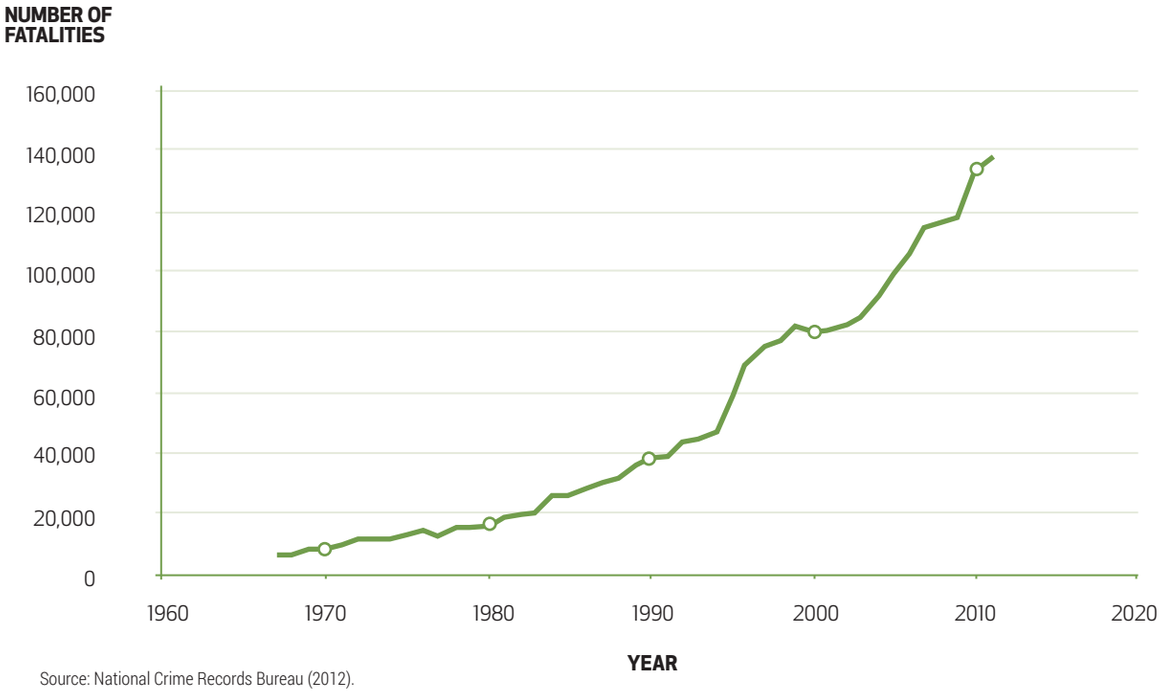
	1971	1981	1991	2001	2011
Air crash	205	54	15	30	18
Boat capsize	250	312	422	781	849
Road accident	9,528	17,964	38,973	80,262	136,834
Railroad	1,546	2,614	5,957	2,178	2,366
Railway other	9,652	12,408	16,080	17,076	25,872

Source: National Crime Records Bureau (2012).

1. Schopper, et al.(2006).
2. Gururaj (2005); Mohan, et al. (2009).

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Figure 12.1
Road Traffic Fatalities in India, 1967-2011



Source: National Crime Records Bureau (2012).

A few of the inland water transport deaths are captured by the NCRB but not all those associated with coastal shipping. A Planning Commission report states: 'There is also high incidence of accidents in the inland water transport (IWT) sector which caters mainly to passenger traffic. The IWT, however, is in the unorganised sector and there is absence of proper data on such accidents'[3]. It is possible that the number of deaths and injuries associated with water transport and associated infrastructure is much larger than reported by the NCRB.

It is road transport that sees the highest number of fatalities, and the number has been increasing continuously for the past few decades (Figure 12.1). The rate of increase in deaths per year shows a marked upward trend starting in the mid 1990s. Since then, the annual fatality rate has increased at a rate of about 6-8 per cent a year, and shows no sign of decreasing. Two modelling exercises have attempted to predict the time period when we might expect this rate to start to decline in India[4]. Kopits and Cropper used the experience of 88 countries to model the dependence of the total number of fatalities on fatality rates per unit vehicle, vehicles per unit population, and per capita income. They predicted that fatalities in India would continue to increase before starting to decline in 2042. Koornstra, using a cyclically modulated risk decay function model that incorporates the cyclically varying nature of a society's concerns for safety, predicted an earlier date of 2030 for peak traffic fatalities in India. If fatality rates continue to increase at the present level then we can expect about 260,000 fatalities in 2030. Neither of these projected dates (2042 and 2030) can be accepted as road safety goals for the country.

Altogether, more than 166,000 persons died in transportation-related accidents in 2011, or more than 450 a day. International experience suggests that for each transportation death, one can expect about three to five permanent disabilities, 15-20 hospitalisations, and 80-100 minor injuries[5]. This would mean that in addition to the more than 450 deaths a day in 2011, at least 1,500 persons were disabled, 7,000 hospitalised and more than 40,000 sustained minor injuries every day in traffic-related accidents in the country. Table 12.2 shows the disability adjusted life years (DALYs) lost in India due to different causes in 2010[6]. DALY is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. By this measure, road traffic injuries rank 8th among all causes of ill health, ahead of stroke (13), HIV/AIDS (15), diabetes (16), and protein-energy malnutrition. Other causes ranked lower than traffic injuries are (not included in Table 12.2): cirrhosis (22), rheumatic heart disease (35), hypertensive heart disease (40), malaria (43) and lung cancer (46). It is also significant that road traffic injuries have moved up from rank 13 in 1990 to eight in 2010. Among the seven causes that rank higher than road injury, at least four are associated with malnutrition, hygiene and lack of child care facilities (pre-term birth complications,

3. Planning Commission (2002).
4. Koornstra (2007); Kopits and Cropper (2005).
5. Evans (1991); Gururaj (2006); Martinez (1996); NHTSA (2008); Varghese and Mohan (2003).
6. Murray, et al. (2012).

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Table 12. 2
Ranking of Health Burden by DALYs Lost Due to Different Causes in India, 2010

RANK	CAUSE	RANK	CAUSE
1	Pre-term birth complications	11	Neonatal encephalopathy
2	Diarrheal diseases	12	Low back pain
3	Lower respiratory infections	13	Stroke
4	Ischemic heart disease	14	Major depressive disorder
5	Chronic obstructive pulmonary disease	15	HIV/AIDS
6	Tuberculosis	16	Diabetes
7	Neonatal sepsis	17	Fire
8	Road injury	18	Congenital anomalies
9	Iron-deficiency anemia	19	Protein-energy malnutrition
10	Self-harm	20	Falls

Source: Murray, et al. (2012).

diarrheal diseases, lower respiratory infections, neonatal sepsis). These estimates clearly indicate that transportation-related injuries and deaths have become a very significant health problem in India.

It is estimated that the cost of road traffic crashes alone may be about 3 per cent of GDP[7] Obviously, the situation is quite serious and unless policies and evidence-based countermeasures are put in place urgently, it is likely to worsen. The air rates are low partly because of the smaller number of people exposed to this mode of travel and especially because safety procedures are governed by international practices.

INTERNATIONAL EXPERIENCE

TRENDS IN TRANSPORTATION-RELATED ACCIDENTS

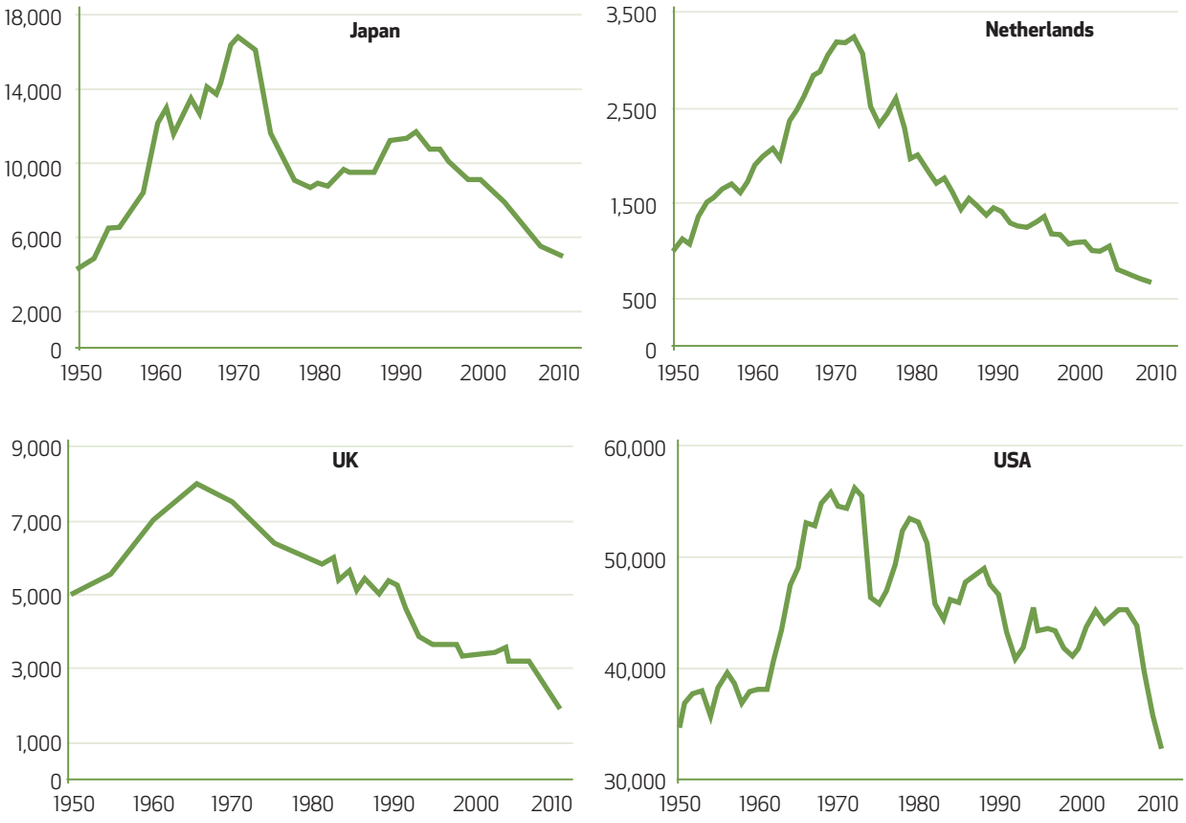
The main reason we have not been able to address the safety issue effectively is that there is little expertise, data, or information available to tackle the problem in a scientific manner. In the international safety professional community, a consensus emerged about half a century ago that it is not very productive to focus on human error alone. Writing many decades ago, Haddon, W., Jr. asserted that the successes of modern public health measures are substantially the result of a shift from an individual to a community-centred emphasis. He insisted that the 'emphasis has been on the responsibility of individuals in the general public to take steps to reduce injuries, not on the responsibility of the small number of key individuals in public and private power structures. This damagingly lopsided balance is now, however, ponderously shifting as more legal responsibility is being placed on policy-level executives to do what they can'[8]. This shift Haddon refers to is reflected in the time trends of fatal road traffic accident statistics for Japan, Netherlands, UK and the US as shown in Figure 12.2.

The number of road traffic fatalities increased continuously from 1950 to 1970 in all these countries and the general decline started in the early 1970s. The trend is similar in most western European countries, Canada, Australia and New Zealand. Other countries were not able to make this shift and the number of deaths in traffic accidents has continued to increase. The fatality rates per 100,000 persons at the peaks for Japan, Netherlands, UK and the US were 16, 24, 15 and 26 respectively. The rate in India in 2011 was 12. There does not seem to be any pattern regarding the fatality rate at which one should expect a downturn. Recent studies also suggest that there may not be any strong relationship between income and fatality rates, and the level of safety depends on policies and safety measures put in place[9]. With appropriate

7. Committee on Road Safety and Traffic Management (2007).
8. Haddon (1980).
9. Mohan and Bangdiwala (2013).

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Figure 12. 2
Road Traffic Fatalities in India, 1967-2011



Source: National Crime Records Bureau (2012).

safety measures, it should be possible to reverse the upward trend in India as road safety knowledge and technologies available today are superior to those in 1970.

As Figures 12.3, 12.4 and 12.5 show, air traffic fatalities reduced tenfold between 1945 and 1968, and then another significant reduction between 1970 and 1980. This is attributed to major changes in airplane and communication technologies. Railroad accident data from the US shows a sixfold decrease in accidents per million train miles between 1980 and 2000, and the UK data a fourfold reduction between 1970 and 1995.

It is interesting that these significant reductions in accident rates seen in all modes of transport in Western Europe and the US start about the same time in the 1960s and 1970s. The reduction in accidents in all these modes is probably not due to any single factor in isolation but to a wide variety of improvements in design of vehicles, operating environment and infrastructure, and enforcement of safety regulations and standards.

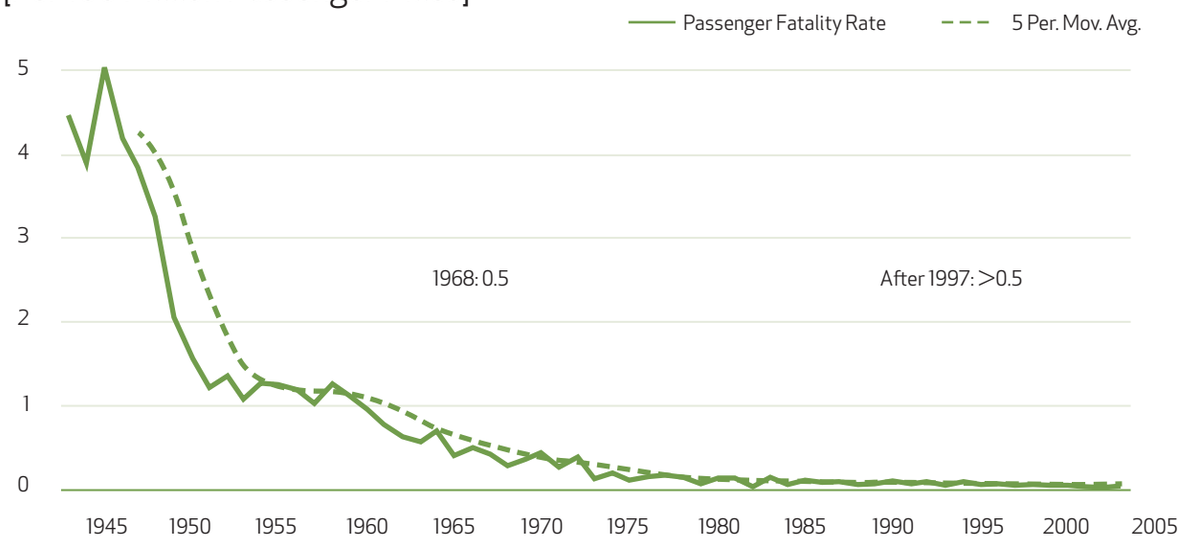
Water transportation-related deaths have not been included in this discussion as data on this is notoriously poor within India and internationally[10]. There is no uniform data collection and analysis system and procedures vary from one nation to another. The data is grouped under different heads and types of injuries and are collected by different departments within nations. Data for larger ships may be recorded separately from those for smaller fishing vessels. Many vessels may pick up foreign nationals once underway, and deaths and injuries of these individuals may not be reported in the vessel's country of origin. Injuries and fatalities associated with passengers and crew of vessels other than due to drowning are also reported separately from drowning cases.

However, to get an idea of developments in efforts to prevent drowning, data for deaths due to drowning, including water transport deaths in the US, are shown in Figure 12.6. In 2008, there 3,576 drowning deaths in USA, of which 76 were attributed to water vehicle accidents[11]. The latter number does not include deaths associated with international shipping and other injuries to passengers. However, it is interesting to note that even in the case of drowning deaths in the US, the real reduction in death rates starts in the 1970s.

10. Planning Commission (2002); Waller (1985).
11. National Safety Council (2011).

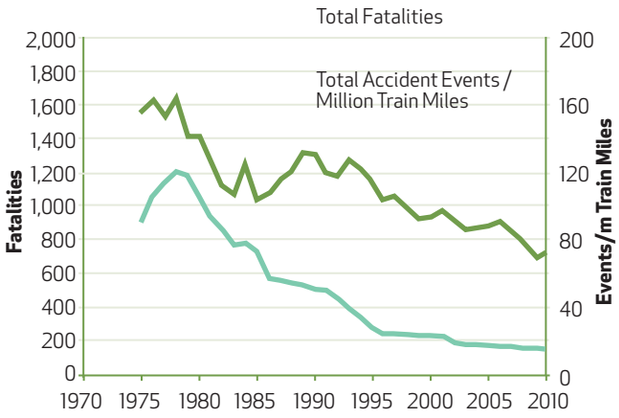
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Figure 12. 3
Air Passenger Fatalities
[Per 100 Million Passenger Miles]



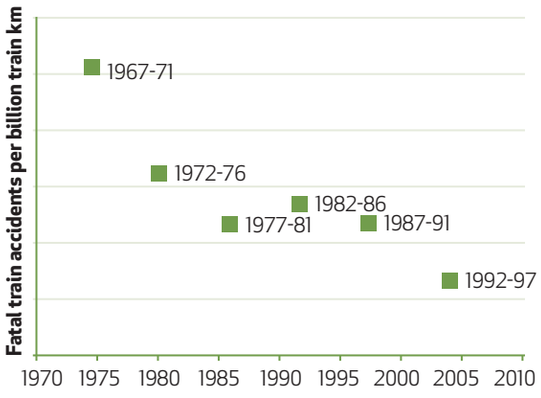
Source: EASA (2005).

Figure 12. 4
Railroad Accidents in the US, 1975-2010



Source: FRA (2012).

Figure 12. 5
Fatal Railroad Accidents per Billion Train Km in the UK, 1967-97



Source: Adapted from Evans (2000).

The data indicate that policy makers and transportation safety professionals in every country have found it very difficult to institute changes that actually result in a dramatic decrease in traffic fatalities and injuries in a short time. Experience has also shown that not all individuals follow all the instructions given to them to promote road safety. Attempts to 'educate' people were also not always very effective and wide variations are found between people's knowledge and their actual behaviour[12]. This is partly because we cannot select who is going to use the system and who is not. While some control can be exercised in licensing drivers of motor vehicles, almost no control is possible in selection of pedestrians and bicyclists. Control over the system is most difficult in the case of road transport, much easier in the case of air transport, and railroad and water transport fall somewhere in between. Almost everyone in a population can be a road or railroad user and this has implications on how we deal with the issue of traffic injuries as a public health problem.

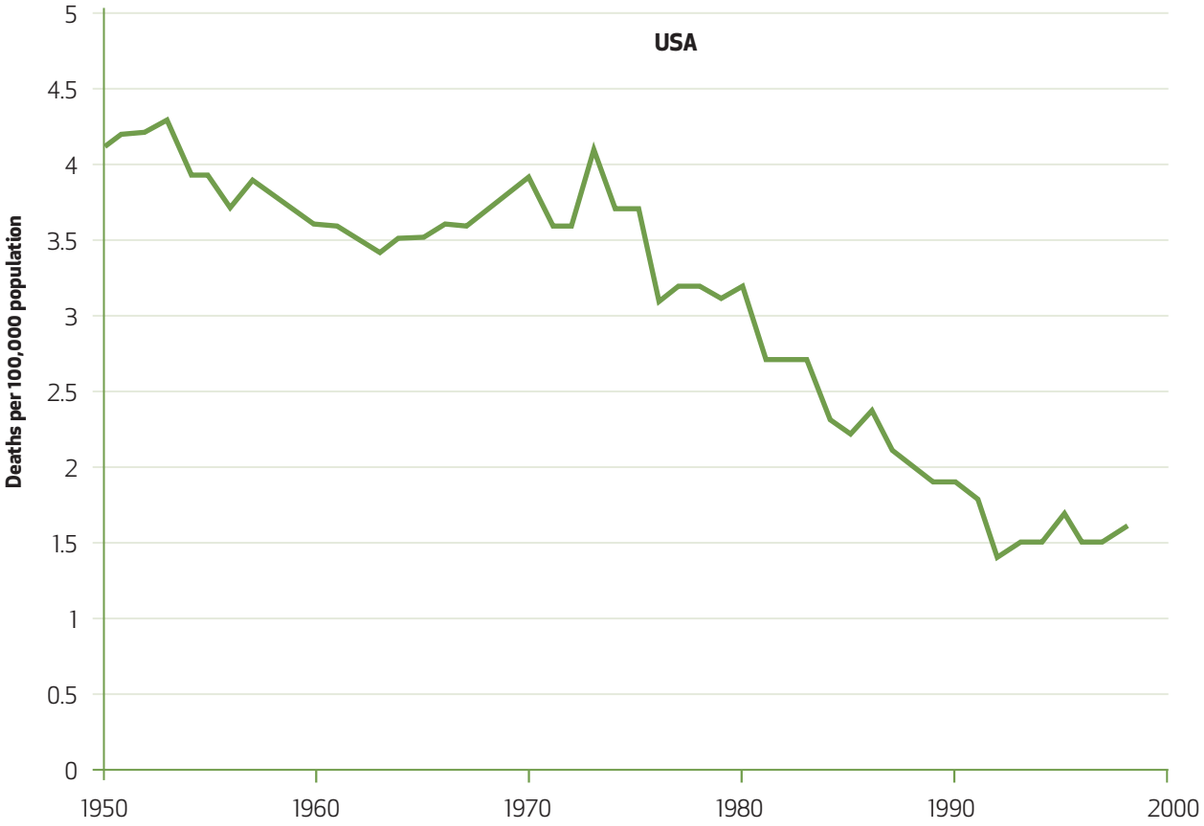
The major shift in regarding injuries sustained by people in day-to-day activities as opposed to problems caused by errant individual behaviour took root among safety professionals in the 1960s and 1970s. This helped in analysis of transportation accidents as due to system failures that included mistakes made by individuals. It became important to understand why people make mistakes or behave in

12. Haddon (1968); Mayhew and Simpson (1996); Peden, et al. (2004); Robertson (1983); Robertson, et al. (1974); Sandels (1975).

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Figure 12.6

Deaths due to Drowning (Including Water Transport Accidents) in the US, 1950-2010



Source: National Safety Council (2011).

ways harmful to themselves and others. An important part of this understanding was that people's behaviour is itself influenced by vehicle—car, train, plane, boat—design, the infrastructure within which they operate and the level of enforcement of rules and regulations. For example, a significant part of the reduction in road traffic deaths in Western Europe and USA after the 1970s has been attributed to improving crashworthiness of cars, use of protective systems—helmets, seatbelts, airbags, development of safer and forgiving roadways, and enforcement of laws against speeding and driving under the influence of alcohol[13].

The first motorcycle helmet use law in the world was enacted in the state of Victoria, Australia, in January 1961, and the use of seatbelts by vehicle occupants was made compulsory in the state in 1971, followed by the rest of Australia and some other countries in the 1970s and 1980s. Motor vehicle crash-worthiness tests became mandatory in these countries in the 1970s.

Many road and highway design changes were also initiated in the same period:

- Divided highways: 1960s
- Breakaway devices: 1970s
- Energy-absorbing barrier end treatments: late 1970s
- Shoulders widening: 1970s
- Intersection angle limits (> 70°): mid-1960s
- Clear Zone widening: 1970s

This was a major shift away from the policies in the pre-1970s which focussed mainly on changing individual behaviour through 'education' and retribution. Many of these interventions adopted over 30 years ago are still absent in India.

This move from unsuccessful to successful strategies is summarised in Table 12.3.

INTERNATIONAL BEST PRACTICES

Transportation safety management is a systematic process in which we consider the infrastructure, the users and the vehicles as integral components of a complex interactive system. The transport system has to be developed in a way that does not jeopardise the environment or public health and welfare. In this approach, it is essential that an environment be created that minimises the risk of transport users

13. Elvik and Vaa (2004); Johnston (2010); Noland (2003); Trinca, et al. (1988).

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Table 12. 3

Historical Experience and Road Safety Paradigms in Vogue During Different Periods in American and European History

ASPECT	RELATIVELY UNSUCCESSFUL		RELATIVELY SUCCESSFUL	
	PARADIGM I	PARADIGM II	PARADIGM III	PARADIGM IV
Period of domination	**1900-1925/35**	**1925/35-1965/70**	**1965/70-1980/85**	**1980/85 →**
Description	Control of motorised carriage	Mastering traffic situations	Managing traffic system	Managing transport system
Main idea and focus	Use cars as horse-drawn carriages	Adapt people to manage traffic situations	Eliminate risk factors from road traffic system	Consider exposure of risks, regulate transport
Motor Vehicles per 1,000 people	Less than 25	25-250	250-500	> 500
Main disciplines involved	Law enforcement	Car and road engineering, psychology	Traffic engineering, traffic medicine, advanced statistics	Advanced technology, systems analysis, sociology communications
Organisation of vehicle production	Craft-production, craftsmen manufacturing	Mass-production workers assembling	Lean production, group assembly on sub-contracting	Recycling materials
Terms used about unwanted events	Collision	Accident	Crash, casualty	Costs, suffering
Idea concerning accidents	Transitional problem, passing stage of maladjustment	Individual problem, inadequate morale and skills	Defective traffic system	Risk exposure
Data ideals in research	Basic statistics, answers on 'what'	Causes of accidents; 'why'	Cost/benefit ratio of means, 'how, why, what, when, where.'	Multidimensional
Organisational form of the safety work	Separate efforts on trial-and-error basis	Co-ordinated efforts on voluntary basis	Programmed efforts, authorised politically	Decentralisation, local institutional management
Typical countermeasures	Vehicle requirements and inspection, school patrols	The three E's doctrine, screening of accident-prone drivers	Combined samples of measures for diminishing risks, focusing on the whole system	Networking and pricing transport costs
Effects	Gradual increase in both traffic and health risks	Increase in deaths and injuries continues	Successive cycles of decrease of health and traffic risks	Continuous reduction of serious road accidents

Source: OECD (1997).

making mistakes and that prevents serious human injury when designing, operating and maintaining the system. The entire traffic and transport system must be designed to account for the limitations and capabilities of users and operators.

In a transport system, the design of vehicles, infrastructure and policing methods have to be aimed primarily at the prevention of traffic crashes irrespective of the characteristics and skills of ordinary users. The system has to be designed such that, in the event of a crash, the consequences are kept to the absolute minimum.

It is far more effective to provide automatic protection than to hope that people will behave in a 'safe' way. Automatic approaches protect individuals without their having to perform some action or behave in a specific manner. For example, a person who chooses not to use her manual seatbelt (or who forgets to buckle it) has no protection in the event of her car crashing. If there is an air cushion system in her car, however, it will inflate to protect her, regardless of her state of mind, level of inebriation, or intelligence.

Since each accident is a result of a combination of human, technology and environmental factors, one cannot understand the risk factors associated with an event unless a sophisticated systems approach is followed. This understanding was behind the Zero Vision of the Road Safety Bill adopted by the Swedish Parliament in October 1997 (Box 12.1)[14]. The vision states that 'the entire transport system must be designed to accommodate the individual who has the worst protection and the lowest

14. Tingvall (1997).

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Box 12.1
The Swedish Vision

Vision Zero is a traffic safety policy developed in Sweden in the late 1990s and based on four elements: ethics, responsibility, a philosophy of safety and creating mechanisms for change. The Swedish parliament voted in October 1997 to adopt this policy, and since then several other countries have followed suit.

Ethics Human life and health are paramount. According to *Vision Zero*, life and health should not be allowed in the long run to be traded off against the benefits of the road transport system, such as mobility. Mobility and accessibility are therefore functions of the inherent safety of the system, not vice versa as it is generally viewed today.

Responsibility Until recently, responsibility for crashes and injuries was placed principally on the individual road user. In *Vision Zero*, responsibility is shared between the providers of the system and the road users. The system designers and enforcers—such as those providing the road infrastructure, the car-making industry and the police—are responsible for the functioning of the system. At the same time, the road user is responsible for following basic rules, such as obeying speed limits and not driving while under the influence of alcohol. If road users fail to follow such rules, the responsibility falls on the system designers to redesign the system, including rules and regulations.

Safety philosophy Traditionally. the approach to road safety was generally to put the onus on the road user. In *Vision Zero*, this is replaced by an outlook that has been used with success in other fields. Its two premises are: human beings make errors; and there is a critical limit beyond which survival and recovery from an injury are not possible. It is clear that a system that combines human beings with fast-moving, heavy machines will be very unstable. It is sufficient for a driver of a vehicle to lose control for just a fraction of a second for a human tragedy to occur. The road transport system should therefore be able to take account of human failings and absorb errors in such a way as to avoid deaths and serious injuries. Crashes and even minor injuries, on the other hand, need to be accepted. The important point is that the chain of events that leads to a death or disability must be broken, and in a way that is sustainable, so that over the longer time period, loss of health is eliminated. The limiting factor of this system is the human tolerance to mechanical force. The chain of events leading to a death or serious injury can be broken at any point. However, the inherent safety of the system—and that of the road user—is determined by people not being exposed to forces that go beyond human tolerance. The components of the road transport system, including road infrastructure, vehicles and restraint systems, thus need to be designed in such a way that they are interlinked. The amount of energy in the system must be kept below critical limits by ensuring that speed is restricted.

Driving mechanisms for change To change the system involves following the first three elements of the policy. While society as a whole benefits from a safe road transport system in economic terms, *Vision Zero* relates to the citizen as an individual and his or her right to survive in a complex system. It is therefore the demand from the citizen for survival and health that is the main driving force. In *Vision Zero*, the providers and enforcers of the road transport system are responsible to citizens and must guarantee their safety in the long term. In so doing, they are necessarily required to cooperate with each other, because simply looking after their own individual components will not produce a safe system. At the same time, the road user has an obligation to comply with the basic rules of road safety. In Sweden, the main measures undertaken to date include:

- Safety performance goals for various parts of the road traffic system;
- Focusing on vehicle crash protection, and support for the consumer information programme of the European New Car Assessment Programme (EuroNCAP) and securing higher levels of seat-belt use and fitting smart, audible seatbelt reminders in new cars;
- Installing crash-protective central barriers on single-carriageway rural roads and encouraging local authorities to implement 30 km/h zones;
- Wider use of speed camera technology, and an increase in the number of random breath tests;
- Promotion of safety as a competitive variable in road transport contracts.

While *Vision Zero* does not say that historically, road safety ambitions have been wrong, it is clear that the actions that would have to be taken are partly different. The main differences probably can be

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found within how safety is being promoted; and also, some innovations result from the vision, especially in infrastructure and speed management.

A tool for all *Vision Zero* is relevant to any country that aims to create a sustainable road transport system, and not just for the excessively ambitious or wealthy ones. Its basic principles can be applied to any type of road transport system, at any stage of development. Adopting *Vision Zero* means avoiding the usual costly process of trial and error, and using a proven and effective method right from the start.

Source: Peden, et al. (2004).

Box 12.2
Safe Systems Approach in Road Safety

A Safe System approach is also well attuned to the high priority global, regional and country development goals of sustainability, harmonisation and inclusiveness. A Safe System is dedicated to the elimination of deaths and injuries that undermine the sustainability of road transport networks and the communities they serve. Its focus on safer and reduced speeds harmonises with other efforts to reduce local air pollution, greenhouse gases and energy consumption. And its priority to afford protection to all road users is inclusive of the most vulnerable at-risk groups such as pedestrians, young and old, cyclists and motorcyclists. These co-benefits of shifting to a Safe System approach further strengthen the business case for its implementation.

Source: Bliss and Breen (2009).

tolerance of violence. No event must be allowed to generate a level of violence that is so high that it represents an unacceptable loss of health for that vulnerable individual,' and, 'the responsibility for every death or loss of health in the road transport system rests with the person responsible for the design of that system.' This approach has not been internalised by any official organisation or institution dealing with safety in India, and we still operate on the outmoded principles of finding fault with an individual and then acting accordingly.

Transportation safety management has seen a shift from action based on experience, intuition, judgement and tradition, to action based on scientific research, empirical evidence, and from consideration of safety that is tacit and qualitative to consideration of transportation safety that is explicit and quantitative. Therefore, expanding the existing system without changing it is not the best use of scarce resources. Most importantly, structures and processes need to be put in place that outlast individuals and ensure regular review and renewal of strategies. The requirements of a Safe System approach (Box 12.2) are:

(a) Institutional structure that creates a demand for scientific work in safety issues.
(b) Formulation and enforcement of laws and regulatory requirements.
(c) Monitoring and measurement—national databases with relevant information to monitor and assess various aspects of safety policies, technologies and knowledge needs.
(d) Assuring and improving the quality of safety services provided through professionals, individual institutions and with the use of specific technologies and devices.

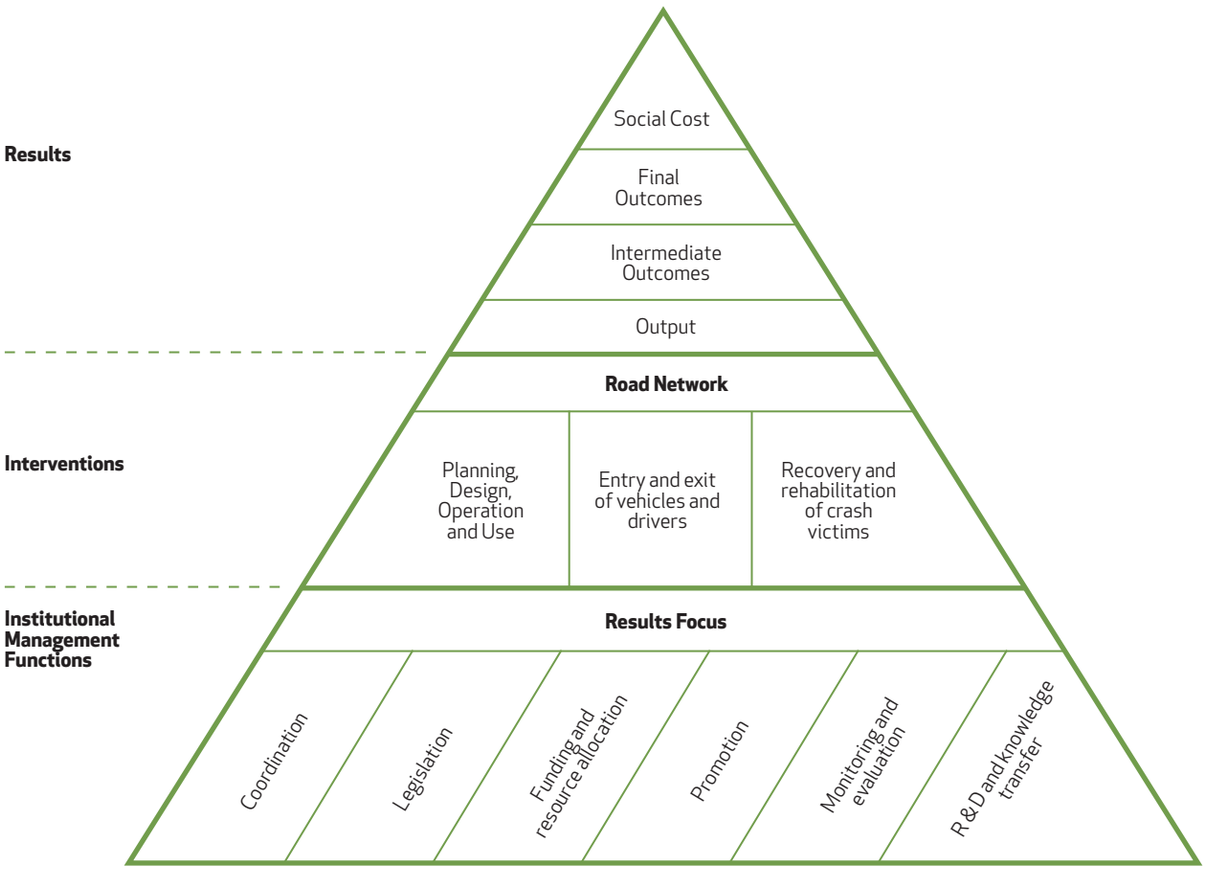
An example of how the Safe Systems approach can be institutionalised is given in Figure 12.7. Though this example is taken from recommendations made for setting up road safety institutional mechanisms, the approach and principles can be used for all transport systems in the planning, design, operation and use of aviation, rail or maritime networks. The same methodology applies to entry and exit of aircraft, trains and ships to these networks, and in the event of system failure, and to the management of the recovery and rehabilitation for victims from these networks.

INSTITUTIONAL SYSTEMS

Countries that have been successful in reducing transportation accident rates set up institutional mechanisms over a few decades and the results became evident starting in the 1970s. This knowledge evolved over many years through experience

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Figure 12.7
Road Safety Management System



Source: Bliss and Breen (2009).

based on research, experimentation and knowledge-sharing across nations. The positive outcomes are the result of many years of capacity-building and investments by governments in institution-building and knowledge production capabilities supported by political commitment and coordination among government departments. Figure 12.7 shows the seven institutional management functions that provide the foundation on which safety management systems are built. According to Bliss and Breen, 'they produce the interventions to achieve the desired long and medium-term road safety results (expressed as a vision and related performance targets) which have been agreed across the road safety partnership at national, regional and local levels. Without effective institutional management across these functions, a country has little chance of implementing successful road safety interventions and achieving desired results on a sustainable basis. The institutional management functions are delivered primarily by the government entities producing interventions but they are also delivered in government partnerships with civil society and business entities to achieve the desired focus on results.'

The lead agency[15]:

- Plays a pre-eminent role in most of the institutional management functions
- Takes responsibility within government for the development of the national safety strategy and its results focus
- Takes responsibility for horizontal inter-governmental coordination arrangements
- Ensures vertical coordination of national, regional and local activities
- Coordinates the necessary delivery partnerships between government partners and stakeholders, the professional, non-governmental and business sectors, and parliamentary groups and committees
- Ensures a comprehensive legislative framework
- Secures sustainable sources of annual funding and creating a rational framework for resource allocation
- Promotes safety strategy across government and society

15. Adapted from Bliss and Breen (2009).

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Figure 12.8
National, Prefectural and Municipal Programmes for Road Safety in Japan

Japan: Central Traffic Safety Policy Council



Source: Adapted from Kojima et al. (2012).

- Sets up systems for periodic monitoring and evaluation of safety performance, and the direction of research and development and knowledge transfer

Examples of structures of lead agencies, data collection agencies and research institutions from successful nations are given in the following sections.

ROAD SAFETY AGENCIES

Figure 12.8 shows the institutional arrangements in Japan for promoting road safety in the country. Under the provisions of the Traffic Safety Policies Basic Act, which passed into law in 1970, the Prime Minister's Office established a Central Traffic Safety Policy Council. This Council, which is chaired by the prime minister, comprises the chief cabinet secretary, the heads of specified government agencies, and other ministers of state for special missions as named by the prime minister and is responsible for promoting the drafting and implementation of Traffic Safety Basic Action Plans[16]. The Traffic Policy Institute, which was established as part of the Prime Minister's Office in 1960, was transferred to Japan's Management and Coordination Agency in 1984. During reorganisation of the central ministries in 2001, most of the duties performed by the Traffic Safety Policy Office as part of the Management and Coordination Agency we re transferred to the office of the Director-General for Policies on Cohesive Society Planning in the Cabinet Office.

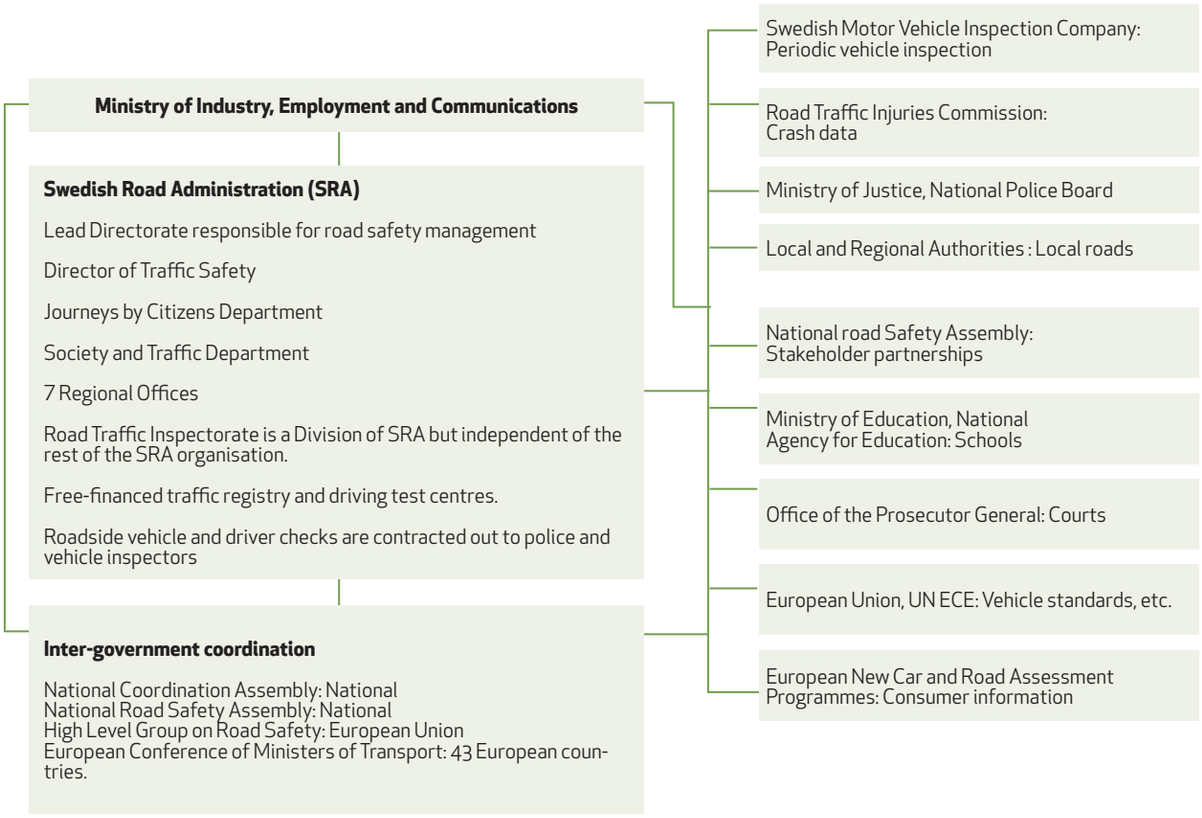
The Traffic Safety Policies Basic Act provides for the establishment of Prefectural Traffic Safety Policy Councils in each prefecture as well as for the voluntary establishment of Municipal Traffic Safety Policy Councils in municipalities that wish to establish them. These Councils are responsible for promoting deliberation on and implementation of comprehensive measures related to overland traffic safety as well as the drafting and implementation of traffic safety plans. These prefectural and municipal organisations are to establish traffic policy departments, traffic safety policy offices and other agencies as necessary, to coordinate administration and comprehensive promotion of traffic safety policies on their behalf.

Based on the incidence of traffic accidents and other criteria such as traffic volume, the Japanese government designated 'roads recognised as being particularly important to ensuring traffic safety' as eligible for 'complete or partial funding, or provision of supplemental funding, from the national government for improvements to traffic safety facilities.' The Japanese government would bear half the cost of special traffic safety facility improvement projects undertaken by the roadway administrator of national highways, prefectural roadways, and municipal roads, as well as provide supplemental funding amounting to 55 per cent of the cost of traffic safety

16. Kojima, et al. (2012).

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Figure 12. 9
Organisational Structure for Implementation of Road Safety Policies in Sweden



Source: Bliss and Breen (2009).

projects undertaken on municipal roads designated as school routes by government ordinance.

A system for traffic fines was instituted as part of the 1968 revision of the Road Traffic Act, and served as the basis for the collection of fines. Accounting procedures for these monies specified that they should be used to defray the cost of improvements to road traffic safety facilities. Specifically, these monies were to defray the cost of the installation and maintenance for road traffic safety facility projects undertaken independently by local public agencies that were designated by government ordinance, and were used for traffic signals, roadway signage, pedestrian crossings and other facilities.

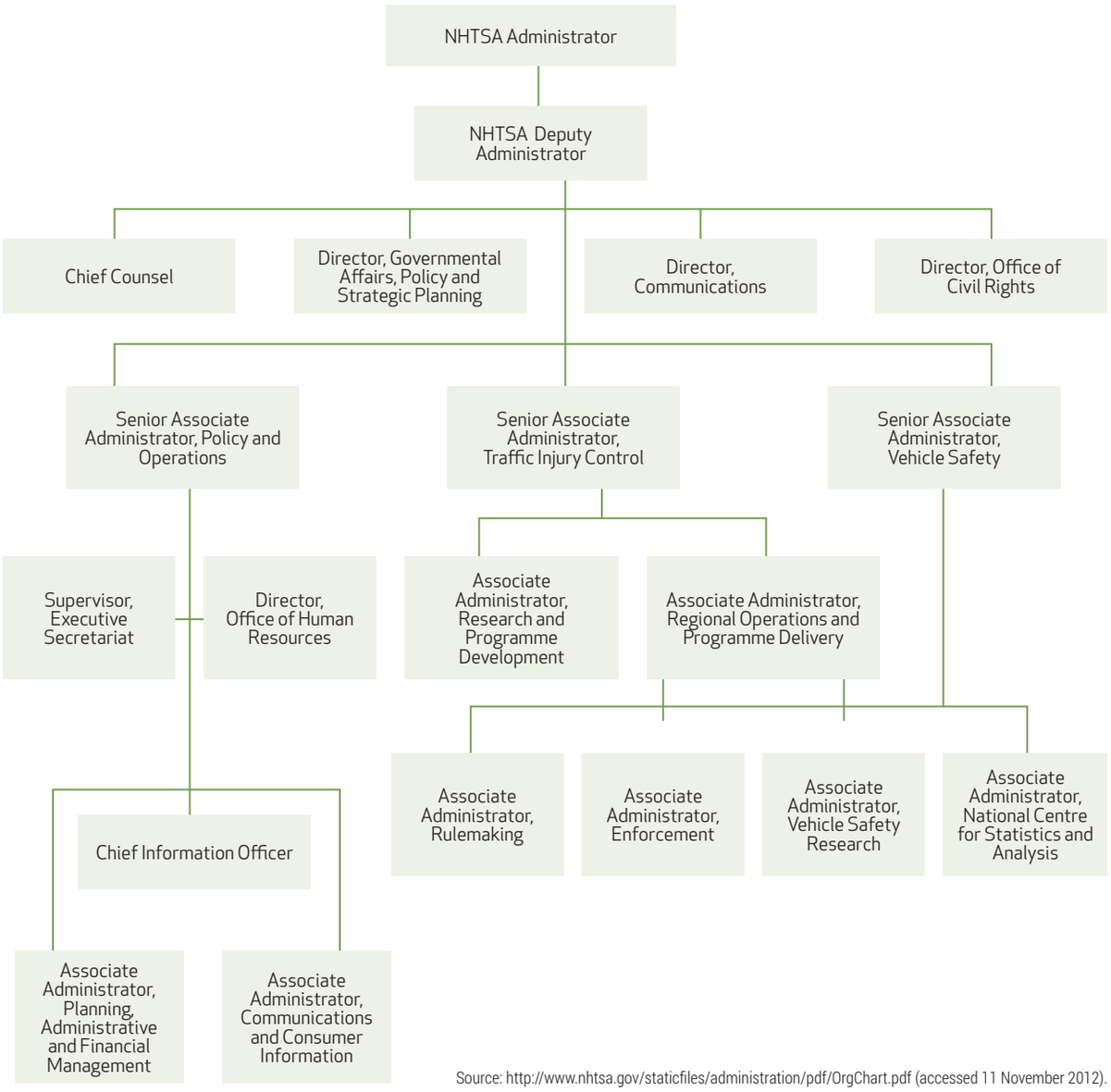
Since the enactment of the Traffic Safety Policies Basic Act, the government has implemented eight traffic safety basic action plans. This has resulted in a reduction in road traffic fatalities from 16,765 in 1975 to 5,009 in 2010.

The Ministry of Industry, Employment and Communications has legal responsibility for road safety in Sweden, but the Swedish Road Administration (SRA) is the national authority assigned the overall sectoral responsibility for the entire road transport system, and the SRA is the lead agency for road safety management (Figure 12.9). The SRA is responsible for proposing national road safety goals and targets, reviewing performance and carrying out interventions in the road network. The agency also leads the Vision Zero goals through a performance agreement with the Ministry of Industry, Employment and Communications. Vertical coordination between governmental bodies, funding mechanisms for use by regional and local authorities, as well as specific road safety outputs, are overseen by the SRA.

In its capacity as road manager, the SRA is responsible for road safety on the state road network. As part of its mandate, the SRA must ensure that the construction and maintenance works contracted by it are subjected to stringent environmental demands, and encourage contractors to develop production methods that are adapted to road safety. Every head of division is to make sure that road safety is taken into consideration within his/her area of responsibility. He/she shall also endeavour to ensure that colleagues increase their awareness and knowledge about the impact of their own activities and that of the entire road transport system on road safety.

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Figure 12.10
Organisation of the National Highway Traffic Safety Administration



Source: http://www.nhtsa.gov/staticfiles/administration/pdf/OrgChart.pdf (accessed 11 November 2012).

The SRA has in-house capacity to propose, ensure compliance with, and monitor road safety standards for vehicles, roads and people, as well as to provide policy advice. It establishes Commissions of Enquiry when developing and consolidating major primary legislation[17]. It is the responsibility of the SRA to establish comprehensive legislation and propose vehicle, roads and road user rules and standards. Sustainable annual funding for road safety is ensured from general tax revenues which the SRA allocates to its agencies through annual agreements and transport plans. The SRA and its partners have established databases to identify and monitor final and intermediate outcomes against targets, and the results are published annually. Safety rating programmes are used to monitor aspects of vehicle fleet and road network safety respectively. The SRA established the Road Traffic Inspectorate to help monitor road safety performance and the effectiveness of partner and stakeholder activity.

Support of research and development and knowledge transfer is a very important component of the SRA's activities and responsibilities. The agency secures funding and ensures capacity for road safety research, demonstration projects and support for attendance of its personnel at international road safety meetings, seminars, workshops and field visits. Sweden in 2010 had one of the lowest road traffic fatality rates at 2.9 deaths per 100,000 persons in the country[18].

17. Bliss and Breen (2009).
18. IRTAD (2012).

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Reducing transport accident rates is usually the result of many years of capacity building and investment in institution building and knowledge production capabilities.

THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION (NHTSA), US

The National Highway Safety Bureau was created by Congress in 1966. It was replaced by the NHTSA, which was established by the Highway Safety Act of 1970. The agency directs the highway safety and consumer programmes established by the National Traffic and Motor Vehicle Safety Act of 1966, the Highway Safety Act of 1966, the 1972 Motor Vehicle Information and Cost Savings Act, and succeeding amendments to these laws. The organisation chart of NHTSA is given in Figure 12.10. NHTSA consists of just over 600 staff located in Washington DC, and in 10 regions across the United States. The agency's enacted budget for FY 2012 was $860 million of which 15 per cent was for research and development. It is one of eight administrations under the Department of Transportation. The strategic goals for the organisation are:

- Lead the effort to make traffic and motor vehicle safety a priority of the nation's healthcare agenda, and a national initiative to address the most significant traffic and motor vehicle safety issues.
- Deliver the highest quality technical and programme assistance to states and communities, and promote international cooperation.
- Improve data collection and analysis to better identify and understand problems, and support and evaluate programmes; expedite the availability of information to customers and partners.
- Support research and apply the results to education, engineering and enforcement to reduce road casualties and costs.
- Reduce the number and severity of road collisions.
- Mitigate the consequences of motor vehicle crashes.
- Advance the non-safety mandates of the Agency.
- Improve NHTSA's internal processes, management, and structure to create a more effective and efficient agency that is better able to pursue its mission.
- Listen to, involve, and serve customers and partners in the planning, programmes and activities of the agency.
- Build and maintain a professional, productive, innovative, diverse work force.
- Effectively manage and use information resources.

- NHTSA's activities were the following[19]: Set safety standards for motor vehicles and associated equipment, investigate possible safety defects, assure that products meet safety standards and are not defective—through recalls if necessary, and track safety-related recalls. Also enforce regulations on fuel economy, odometer fraud and vehicle theft.
- Work through state highway safety agencies and other partners to encourage safe behaviour of drivers, occupants, cyclists and pedestrians across the country: impaired driving, occupant protection, motorcycle safety, pedestrian and bicyclist safety, school bus transportation, older driver safety, national driver register, driver licensing, driver education and graduated driver licensing, speed enforcement, emergency medical services.
- Highway Safety Grant Programmes: Every state, US territory and Indian Nation, along with the District of Columbia and Puerto Rico, has an agency responsible for coordinating its highway safety programmes. NHTSA, under Section 402 of the Highway Safety Act, distributes State and community grant funds to these agencies, based on a statutory formula. The grants support highway safety plans, provide start-up money for new programmes, and give new direction to existing programmes.
- State and Community Outreach: NHTSA's 10 regional offices deliver highway safety support at the local level.
- Research and development: NHTSA conducts and sponsors a wide range of research and development projects. Examples include crash data collection and analysis, crash tests, research on human behaviour and analytical studies of vehicle components. Results of these activities are disseminated via technical reports, conferences and briefings, at workshops and public meetings.
- Keeping the public informed is a particularly important NHTSA responsibility. As the federal authority on traffic safety issues, the agency works with the national news media, the automotive industry trade press, and other sources to provide the public with information that can make motor vehicle travel much safer.

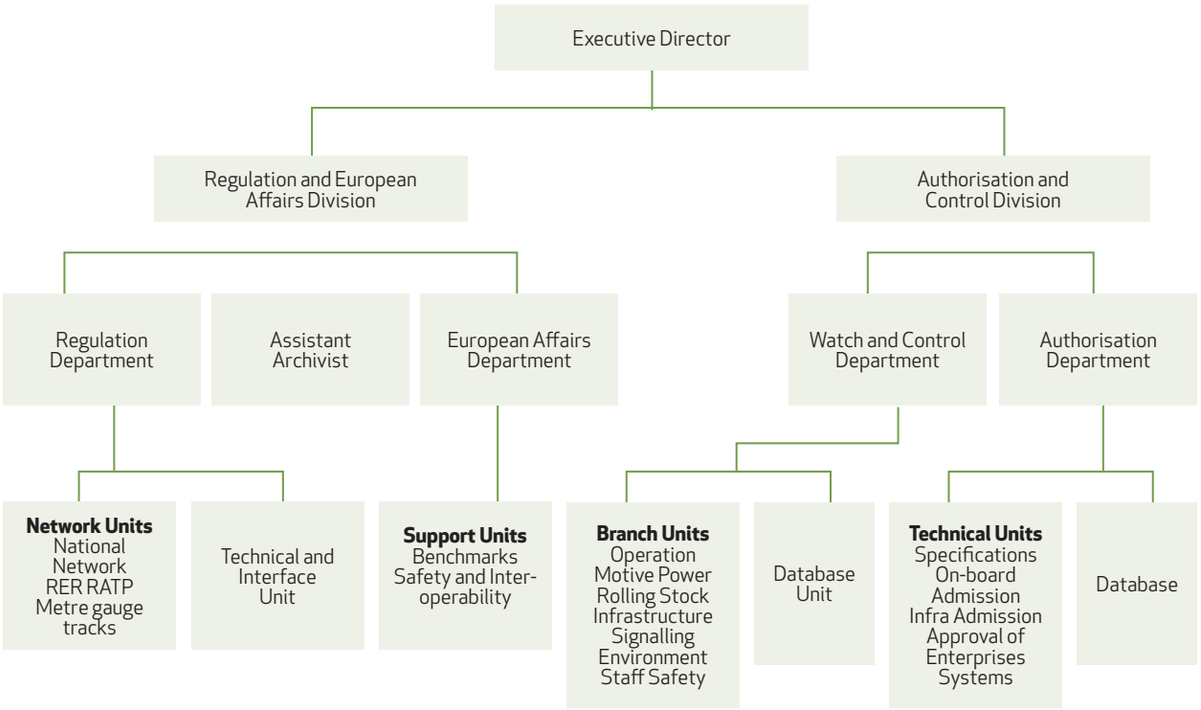
OFFICE OF SAFETY IN THE FHWA, US[20]

Within the broad highway safety mission, the Office of Safety's mission is to reduce highway fatalities by making roads safer through a data-driven, systematic approach to putting safety first when applying engineering, education, enforcement and emergency medical services. Focus areas include: comprehensive strategic planning, roadway departure,

19. NHSTA (2006).
20. Source for information: http://safety.fhwa.dot.gov/about/ (accessed 29 October 2012).

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Figure 12.11
Organisational Structure of the French Public Railway Safety Authority EPSF



Source: Troadec (2006).

intersections and pedestrians safety. The office also coordinates with other DOT agencies—the National Highway Traffic Safety Administration (NHTSA), the Federal Motor Carrier Safety Administration (FMCSA), and the Federal Railroad Administration (FRA)—to develop and implement multi-faceted, intermodal safety programmes.

The Office of Safety staff at the FHWA Headquarters in Washington DC is organised into two programme area units. Office of Safety Technologies is responsible for highway designs and technologies that improve safety performance. Major programme areas and initiatives include roadway departure, roadside hardware, retro-reflectivity, roadside safety, pavement safety, roadway systems design, intersections, geometric design, road safety audits, speed management, safe routes to school, safety countermeasure analysis and evaluation, safety performance measures and monitoring and data analysis and tools.

The Office of Safety Programmes is responsible for comprehensive federal and state highway safety programmes and activities that improve safety for all road users. Major programmes and initiatives include programme and strategic planning, the Highway Safety Improvement Program (HSIP), vulnerable road user safety, as well as coordination with external and internal safety stakeholders and advocates. The Office of Safety Programmes staff also provides customer assistance for local programmes, and support for state programmes, including policy and guidelines assistance. The Office produces a wide range of tools and technology and community resources for improving roadway user safety.

RAILROAD SAFETY AGENCY

FRANCE: ETABLISSEMENT PUBLIC DE SÉCURITÉ FERROVIAIRE (EPSF)

EPSF is the French public railway safety authority, an organisation holding all the necessary powers and competence in the field of railway safety while remaining independent of the railway operators[21]. It is entrusted with the task of issuing authorisations and ensuring, through audits and inspections, that regulatory requirements are complied with, while treating all the operators equally. It thus guarantees the homogeneity of technical and safety operating conditions and helps to enhance the interoperability of the European railway networks.

The EPSF was established by law in 2006. It is funded through a safety fee paid by railway undertakings using the national railway network and through the

21. EPSF (2009); Troadec (2006).

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charges paid by promoters when asking for authorisations. This allows EPSF to use high quality means and reinforces its independence from operators. It recruits and manages its staff independently, whatever their former employment backgrounds. In 2009, EPSF had a staff of about 100 professionals. The main missions of EPSF are:

- Authorising new systems—infrastructure and rolling stock, training centres, accrediting independent experts and delivering safety certificates to railway undertakings and safety authorisations.
- Controlling the correct use of the authorisations delivered
- Publishing technical recommendations
- Coordinating relationships and setting up partnerships at the European level

The State sets the safety objectives and determines how they are to be met. It is responsible for the regulations and for ensuring that they are applied. ARAF, the railway regulation authority, makes sure that all concerned have equal access rights to the national railway network.

RFF, the owner and infrastructure manager of the network, designs and maintains the installations, handles traffic and intervenes in the event of incidents or accidents on the network. A State public authority, RéseauFerré de France has entrusted SNCF, the established French operating company, with operational management of the network.

The railway operators implement their equipment, train their staff and draw up their operating procedures and instructions in compliance with the operating regulations and documentation. They are responsible for checking application of all these rules. The emergency services also intervene to limit the consequences of accidents, especially in the case of a fire or risks involving people. The Land Transport Accident Investigation Bureau carries out inquiries in the event of railway accidents. It has a separate and complementary role to that of EPSF.

Authorisations that EPSF issues include:

- Safety certificates for railway undertakings
- Safety approvals for the infrastructure management entities
- Authorisations to put new or substantially modified systems into commercial operation
- Safety certificates for undertakings that have signed operating agreements with SNCF
- Approvals for training centres and qualified organisations
- Approvals for rail tankers carrying hazardous materials
- Specific authorisations for exceptional traffic, such as trial runs

To fulfil its mission, EPSF undertakes several types of inspections:

- Audits carried out following issue of authorisations, and programmed to make periodical and methodical checks of compliance with the conditions of issue
- Audits 'as required' if the authority's attention is drawn to repeated significant safety-related events
- Unscheduled inspections to examine specific situations

EPSF also regularly updates its database concerning the most significant safety events, which it uses to trigger its audits 'as required' and alert operators when necessary.

EPSF has also set up long-term relationships with the other European national safety authorities (NSAs) entrusted like itself, with issuing authorisations, supervising safety on their national networks, and participating in harmonisation of practices at an European level. Within this framework, cross-acceptance agreements have led to simplifications in the authorisation procedures for rolling stock.

EPSF is also entrusted with the task of drawing up and publishing technical documents, rules of good practices and recommendations concerning railway safety.

AIR SAFETY AGENCY

EUROPEAN AVIATION SAFETY AGENCY (EASA)

The European Union decided on a common initiative to keep air transport safe and sustainable, allowing for growth and improved safety, and established the European Aviation Safety Agency[22]. As a Community Agency, EASA is a body governed by European public law and was set up by a Council and Parliament regulation and given specific regulatory and executive tasks in the field of civil aviation safety and environmental protection. Figure 12.12 shows the structure of the organisation.

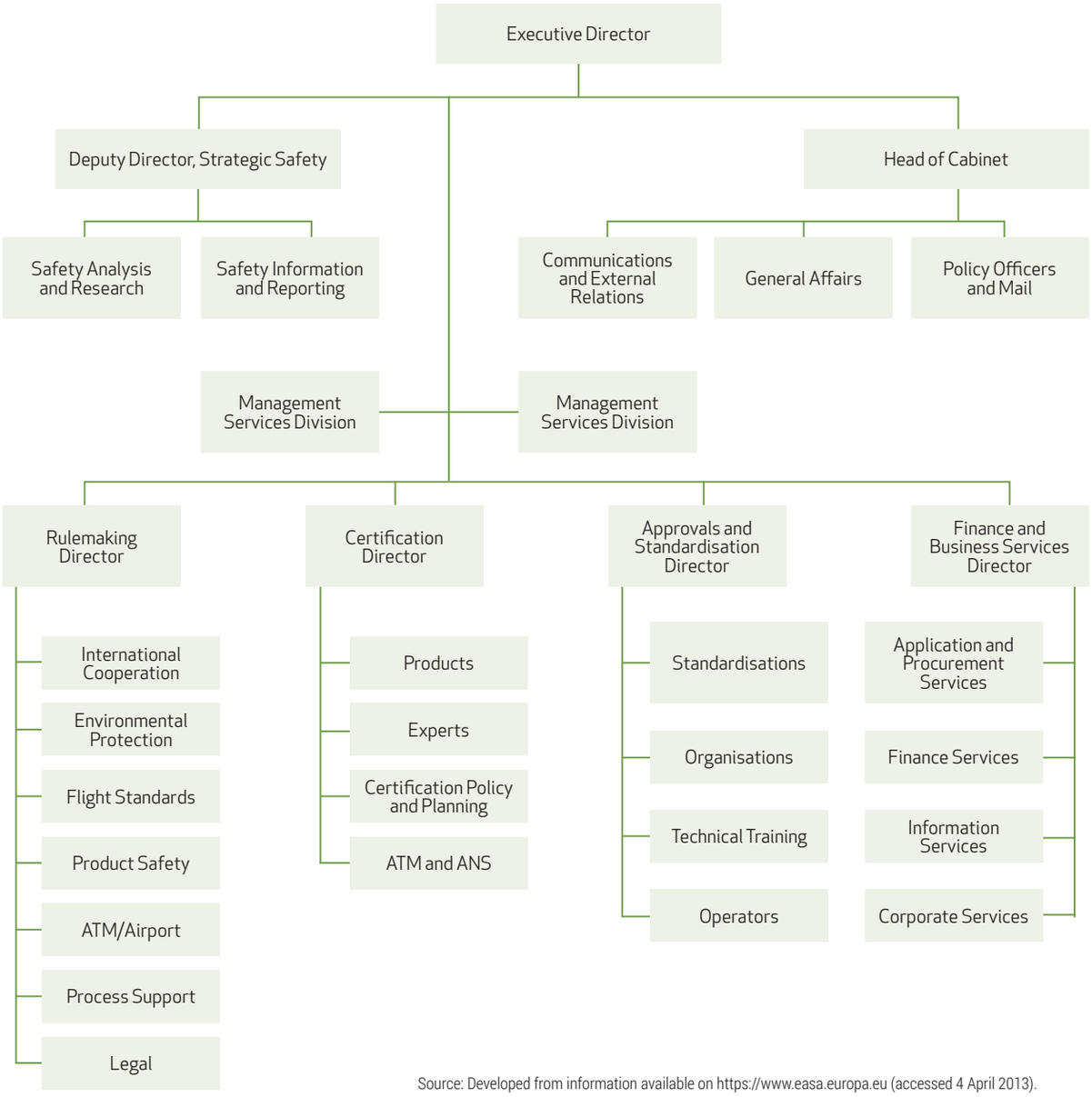
Its mission is to promote the highest common standards of safety and environmental protection in civil aviation, and develops common safety and environmental rules at the European level. It monitors the implementation of standards through inspections in the member states and provides the necessary technical expertise, training and research. The agency works hand in hand with the national authorities which continue to carry out many operational tasks, such as certification of individual aircraft or licensing of pilots.

EASA currently employs about 600 staff members and its main tasks include:

22. Source of information: https://www.easa.europa.eu (accessed 23 March 2013).

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Figure 12.12
Organisation Structure of the European Aviation Safety Agency



Source: Developed from information available on https://www.easa.europa.eu (accessed 4 April 2013).

- Rulemaking: Drafting aviation safety legislation and providing technical advice to the European Commission and to member states
- Inspections, training and standardisation programmes to ensure uniform implementation of European aviation safety legislation in all member states
- Safety and environmental type-certification of aircraft, engines and parts
- Type certification of aircrafts and components as well as the approval of organisations involved in the design, manufacture and maintenance of aeronautical products.
- Authorisation of third-country—non-EU—operators
- Coordination of the European Community programme Safety Assessment of Foreign Aircraft (SAFA) regarding the safety of foreign aircraft using Community airports
- Data collection, analysis and research to improve aviation safety

The agency has been designed in order to ensure a degree of separation between the political process—the role played by the European Commission, Council and Parliament in drafting and enacting legislation relating to aviation safety—on the one hand, and the design and implementation of the technical measures necessary for safety, on the other. This explains why the Executive Director is granted independence

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in decisionmaking relating to the safety issues under the agency's responsibility. This, however, is without prejudice to the chain of accountability to which the agency and its Executive Director are subject. The rules applicable to flight crew licensing (FCL) and flight time limitations (FTL) are the national rules of the EU member states.

All aircraft accidents are investigated by designated independent agencies. The safety investigation of accidents and incidents aims solely at the promotion of aviation safety, through accident prevention. It does not apportion blame or liability. Following the investigation, the published reports share the lessons learned and may contain safety recommendations for consideration.

To successfully discharge its responsibilities in this area, EASA has developed an Accident Investigation Section that is responsible for the follow-up of investigations and subsequent recommendations. Its main devoted tasks are:

- Follow the progress of aircraft accidents and incidents investigations
- Be represented in investigations and deliver technical expertise whenever needed
- Achieve the processing of safety recommendations addressed to the agency and monitor follow-up
- Provide progress reports and statistics on safety recommendations processing
- Maintain a working coordination with European accident investigation bodies
- Be aware of safety deficiencies and disseminate related information for establishing corrective actions

WATER TRANSPORT SAFETY AGENCY

UK: MARITIME AND COASTGUARD AGENCY (MCA)

MCA was established in 1998 as an Executive Agency within the Department for Transport. The Agency has an annual budget in excess of £120m, and around 1,200 staff supported by over 3,500 volunteer Coastguard Rescue Officers[23]. Operational priorities of the agency are:

- Maintaining national maritime emergency response capability, including coordination of search and rescue. The agency provides a 24-hour maritime search and rescue service
- Ensuring ship survey, inspection and certification capability, and parallel work in relation to seafarers, to meet domestic and international obligations
- Working with the maritime industry to encourage quality companies and ships to join the UK register
- Promoting improved safety among seafarers, the commercial fishing community and the recreational sector
- Supporting a successful and sustainable maritime sector through better regulation
- Working with other government departments and industry to reduce the likelihood of, and improve the capacity to deal with, pollution incidents in UK waters

The Secretary of State, or another minister designated by the Secretary of State, is responsible for the policy framework in which the agency operates and for agreeing on its strategic objectives. The minister is supported in the discharge of these functions by an Agency Advisory Board chaired by a Director General in the Department for Transport who acts as the Agency Owner. The Secretary of State appoints the Chief Executive, on the advice of the Permanent Secretary, for a fixed term, following an open competition, with the possibility of extension, subject to satisfactory performance. The Secretary of State is accountable to Parliament on all matters concerning the agency, but will not normally become involved in its day-to-day operational matters.

The investigation of marine accidents is the responsibility of the Marine Accident Investigation Branch (MAIB), which is not part of the agency. It reports directly to the Secretary of State. The agency has an operating agreement with the MAIB. The MAIB has the primary function of learning lessons to improve maritime safety. The agency may also investigate accidents but will focus its investigation on any significant breaches of legislation. The MCA works together with many other government departments, including the Department for the Environment and Rural Affairs, the Department of Energy and Climate Change, the Foreign and Commonwealth Office, the Home Office and the Ministry of Defence, to deliver its responsibilities. It also works in close partnership with the other emergency services to provide its search and rescue services.

Accident prevention work encompasses everything the Agency does in its role as a regulator, from the development of technical policy and standards, through to the enforcement of those requirements. This work includes international negotiations, primarily through the International Maritime Organisation (IMO), the European Commission (EC) and the European Maritime Safety Agency (EMSA), but also at the International Labour Organisation (ILO). Merchant ships on the UK Ship Register undergo in-depth ship surveys which cover ship construction, equipment and on-board operations. The MCA ensures that seafarers have the right skills, are medically fit, and hold valid certificates to serve on UK-registered ships. The MCA has six National Liaison Officers for various recreational activities who provide the public with information about safety messages and campaigns.

The environmental prevention work reduces pollution from shipping, and the response activities minimise

23. MCA (2010); MCA (2012).

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Table 12. 4

Major Federal Safety and Activity Databases Associated with Transport Safety in the US

S No	DATABASE	S No	DATABASE
1	NTSB Aviation Accident Database	22	FMCSA Motor Carrier Management Information System (MCMIS)
2	FAA Accident/Incident Data System (AIDS)	23	FRA Rail Equipment Accident/Incident Report (RAIR) Database
3	FAA/NASA Aviation Safety Reporting System (ASRS)	24	FRA Highway-Rail Grade Crossing Incident Report (GXIR) Database
4	FAA National Airspace Incident Monitoring System (NAIMS)	25	FRA Railroad Injury and Illness Summary Database
5	FAA General Aviation and Air Taxi Activity Survey (GAATA Survey)	26	FRA Railroad Operations Database
6	Near Mid-Air Collisions System (NMACS)	27	FTA National Transit Database (NTD)
7	Pilot Deviations (PD)	28	FTA Safety Management Information Statistics (SAMIS) Database
8	Operational Errors (OE)	29	RSPA Hazardous Liquid Pipelines Accident Database
9	BTS Omnibus Survey	30	RSPA Natural Gas Gathering and Transmission Systems Incident Database
10	BTS Form 41, Schedules T100 and T100(f) Air Carrier Data	31	RSPA Natural Gas Distribution Systems Incident Database
11	BTS Form 41 T-3 passengers enplaned and other traffic data	32	RSPA Hazardous Materials Information System (HMIS) Incident Database
12	NHTSA Fatality Analysis Reporting System (FARS)	33	US Army Corps of Engineers Lock Performance Monitoring System
13	NHTSA National Accident Sampling System/ General Estimates System (NASS/GES)	34	US Census Bureau/BTS Commodity Flow Survey (CFS)
14	NHTSA National Accident Sampling System/ Crashworthiness Data System (NASS/CDS)	35	University of Michigan Transportation Research Institute
15	NHTSA Crash Outcome Data Evaluation System (CODES)	36	Trucks Involved in Fatal Accidents (TIFA)
16	NHTSA Motor Vehicle Defects Investigation Database	37	USCG Boating Accident Report Database (BARD)
17	NHTSA Motor Vehicle Defects Non-compliance Database	38	USCG Search And Rescue Management Information System (SARMIS)
18	NHTSA National Occupant Protection Use Survey (NOPUS)	39	USCG Marine Safety Information System (MSIS) Vessel Casualty Data
19	FHWA Highway Performance Monitoring System (HPMS)	40	USCG Marine Safety Information System (MSIS) Pollution Data
20	FHWA Licensed Drivers Data	41	USCG Merchant Mariner Licensing and Documentation (MMLD) System
21	FHWA/BTS National Household Travel Survey (NHTS)	42	USCG Marine Information for Safety and Law Enforcement (MISLE)

BTS = Bureau of Transportation Statistics; FAA = Federal Aviation Administration; FMCSA = Federal Motor Carrier Safety Administration; FRA = Federal Railroad Administration; FTA = Federal Transit Administration; NASA = National Aeronautics and Space Administration; NHTSA = National Highway Traffic Safety Administration; NTSB = National Transportation Safety.
Source: Adapted from NTSB (2002).

its impact. To help reduce the risk of pollution without unduly restricting legitimate activity, MCA brought into force an amendment to the UK ship-to-ship transfers regime, intended carefully to balance economic, environmental and social concerns. MCA's international negotiations have also resulted in significant changes to the regime for garbage, intended to deliver increased protection of the marine environment from ship-generated waste. MCA was closely involved in the delivery of the mandatory energy efficiency measures adopted by IMO, which have a key role in reducing emissions from the sector.

DATA COLLECTION AND ANALYSIS AGENCIES

Enactment of safety policies and monitoring effectiveness of policies and interventions requires that reliable and accurate data regarding accidents be collected and made available. All countries that have been successful in controlling death and disability due to transportation accidents have set up systems for surveillance and analysis. The institutional systems vary from country to country, but most countries adhere to the following principles:

- Establishment of agencies professionally staffed for designing and implementing data collection systems
- Ensuring compatibility of data formats between different departments and users
- Responding to the demand of lead agencies for special needs regarding availability of data

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- Ensuring that all non-proprietary and non-personal data are publicly available to all concerned stakeholders
- Setting up of systems for periodic review of the efficiency of data collecting and analysis procedures and responding to new demands as they arise from time to time

The databases help in observing trends over time and for understanding the occurrence of harmful events and their relationships to characteristics of people, technologies and environments. Table 12.4 shows the major transport-related safety data systems maintained in USA and coordinated by the the Bureau of Transportation Statistics (BTS), established in 1992 [24]. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 created BTS to administer data collection, analysis and reporting, and to ensure the most cost-effective use of transportation monitoring resources. BTS brings a greater degree of coordination, comparability and quality standards to transportation data, and facilitates in the closing of important data gaps.

BTS is headed by a Director, appointed by the Secretary of Transportation. BTS' basic authorising legislation is the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), which authorised $27 million each year for a five-year period (2005-09). This funding comes from the Highway Trust Fund, and is administered within the research and development account under the Federal Highway Administration.

As a statistical agency, BTS:

- Is policy-neutral—an objective broker for the facts
- Covers all transportation; BTS is cross-modal in nearly everything it does
- Does independent data collection and analysis, but BTS also serves all the other modes to help them be more effective and efficient
- Sets standards for transportation data and has special statutory protections for the confidentiality of data it collects
- Has unique competencies in statistics, economics, information technology, geographic information systems and transportation

Over the years, BTS has established itself with a focus in three key areas, each mandated by legislation: compiling, analysing and publishing a comprehensive set of transportation statistics; making statistics readily accessible; and implementing a long-term data collection programme. BTS serves Congress, DOT, other federal agencies, state governments, metropolitan planning organisations, local governments, universities, the private sector and the general public.

The main purpose of BTS' work is to help advance DOT strategic goals. It also aims to anticipate future needs and policy issues.

NATIONAL SAFETY RESEARCH AGENCIES

Research activities regarding transportation safety are organised in different ways across nations. This activity is carried out at four levels:

1. Regional international agencies where inter-country cooperation and coordination is essential
2. National agency
3. State level agencies
4. University departments and civil society organisations

In some countries, a national research department is included within the lead agency for each transport sector, and in others, standalone safety institutions have been established. Two examples of independent national agencies are given below.

INSTITUTE FOR ROAD SAFETY RESEARCH (SWOV), THE NETHERLANDS

SWOV was established in 1962. The founding fathers are the Ministry of Transport and three private organisations: the vehicle industry (RAI), the motor vehicle insurance industry, and the Dutch motoring/tourist club (ANWB). SWOV is an independent institute which contributes to the improvement of road safety by using knowledge from scientific research. This knowledge is in the public domain and it is made available to anyone who is (professionally) involved in traffic and road safety, both in the Netherlands and abroad. Figure 12.13 shows the organisation structure of SWOV, which has over 100 employees.

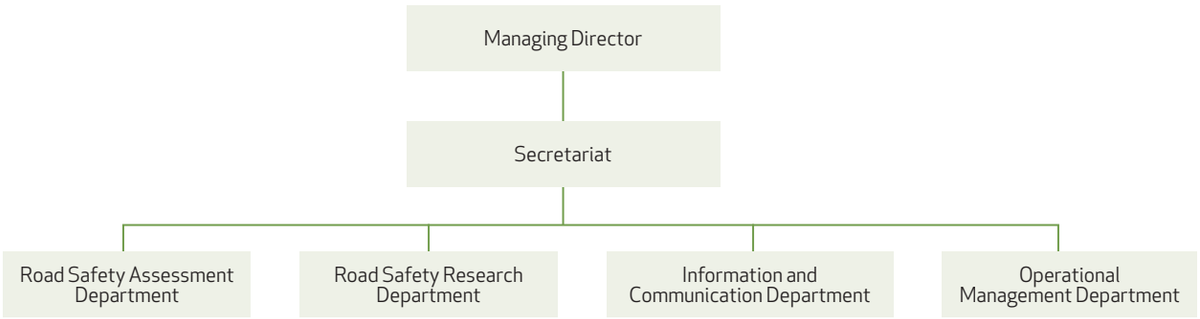
SWOV carries out high quality fundamental and anticipatory research that can be used for practical purposes. SWOV's knowledge covers the entire range of road safety subjects. It aims at inter-disciplinary cooperation between researchers within the institute, and with other research institutions in the Netherlands and abroad. The target groups' requirements determine SWOV's activities. An essential task is distribution of knowledge and information to everybody professionally involved with traffic and road safety, both at home and abroad. SWOV's main target groups are:

- National politicians
- National, regional and municipal governments
- Advisory bodies of these governments
- Fellow researchers in the Netherlands and abroad
- Educational and knowledge institutes
- Media—parliamentary press, newspapers and professional journals

24. http://www.rita.dot.gov/bts/about (accessed 15 September 2012).

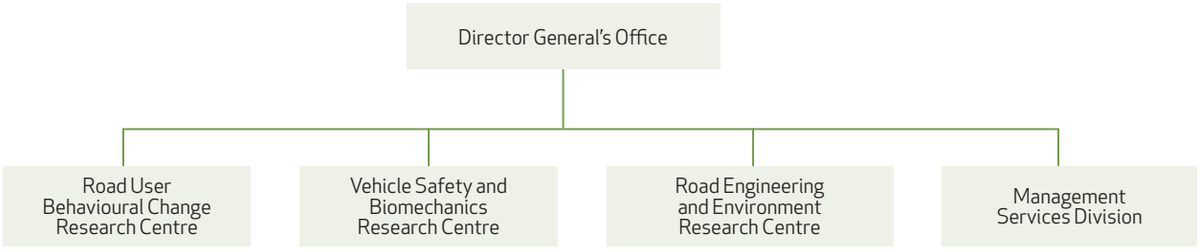
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Figure 12.13
Organisation Structure of Institute for Road Safety Research [SWOV], The Netherlands



Source: Adapted from http://www.swov.nl/UK/Profiel/organigram.asp (accessed 30 September 2012).

Figure12.14
Organisation Structure of Malaysian Institute of Road Safety Research [MIROS]



Source: Adapted from http://www.miros.gov.my/web/guest/organisation (accessed 30 September 2012).

MALAYSIAN INSTITUTE OF ROAD SAFETY RESEARCH (MIROS)

MIROS is headed by a Director General and administratively organised into three Centres and one Division. The organisation structure is given in Figure 12.14.

MIROS, established in 2007, functions as a one-stop centre for the generation and dissemination of road safety information through the print media and a concerted training programme. MIROS carries out studies and evaluates current procedures on road safety to generate information that will form the core of its evidence-based intervention programmes to enhance road safety. MIROS has the following functions:

- Conduct high impact research that will be translated into road safety policies
- Develop national objectives, policies and priorities for the orderly development and administration of road safety research
- Enhance and increase knowledge based on new developments in issues related to road safety
- Serve as an audit and accreditation agency in curriculum design and standards on road safety
- Propose evidence-based cost-effective interventions/programmes
- Serve as a repository of knowledge and linkage on road safety
- Serve as a centre providing consultation and advice on road safety

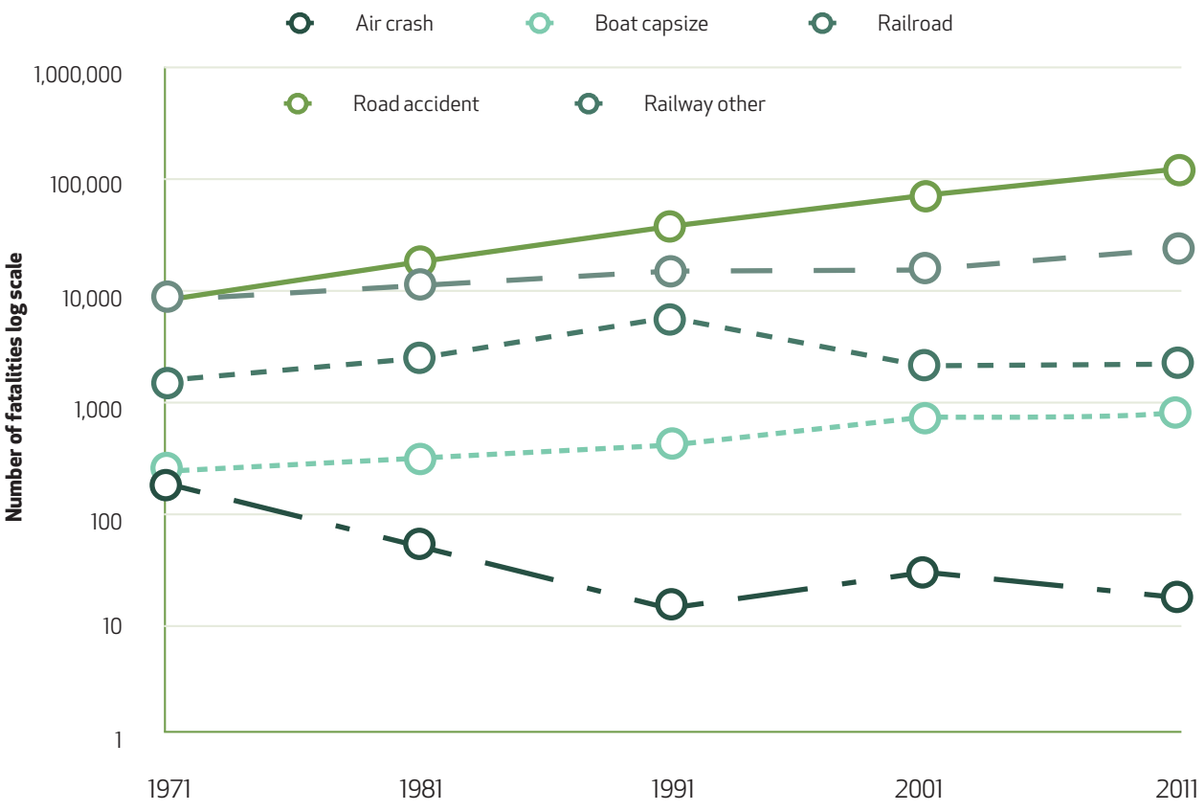
CHARACTERISTICS OF LEAD AGENCIES FOR SAFETY[25]

A variety of lead agency models can be effective in road safety management, and countries must create

25. Adapted from (1) Bliss and Breen (2009). Implementing the recommendations of the World Report on Road Traffic Injury Prevention, Washington DC, The World Bank Global Road Safety Facility. (2) Report of the Committee on Road Safety and Traffic Management (2007). http://morth.nic.in/writereaddata/linkimages/SL_Road_Safety_sundar_report4006852610.pdf (accessed 4 March 2014).

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Figure 12.15
Number of Fatalities in Accidents Associated with Different Modes of Transport



Source: National Crime Records Bureau (2012).

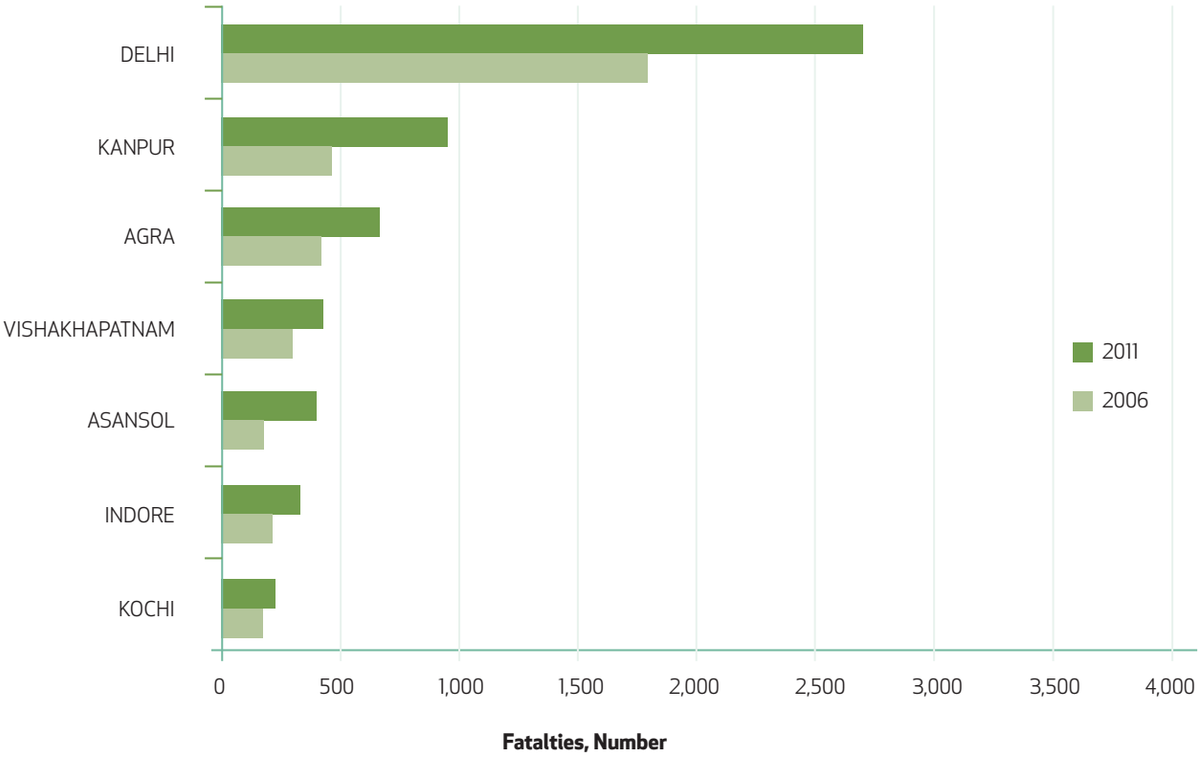
a lead agency appropriate to their own circumstances. Successful practice underscores the need for the agency to be a governmental body and for its leadership role to be accepted and fully supported by the rest of government to ensure appropriate funding and capacity development.

The lead agency may take the form of a designated, standalone entity with a coordinating committee representing partner government agencies. It may also be part of a larger transport organisation or be part of a Prime Minister's department. The agency might undertake much of the work itself or it might delegate aspects of work to other organisations, including provincial and local governments, research institutes or professional associations. All agencies have complex organisational structures and processes, and many partners and stakeholders. Most agencies perform all or most of the following functions:

- Set evidence-based national, regional and local safety policies, strategies and targets
- Establish systems for monitoring of progress regarding targets set and effectiveness of safety interventions
- Set performance standards for vehicles, equipment and infrastructure
- Conduct/commission safety audits of vehicles, equipment and infrastructure
- Identify subjects and institutions for research in different areas of safety, and commission and fund research projects and publish research findings, create linkages between research institutions at the local, regional and national levels
- Establish Centres of Excellence and fund safety research and education
- Establish the methodology for multidisciplinary crash investigation, data collection, reporting and analyses
- Establish procedures and systems for data collection, transmission and analysis at appropriate levels and define the role of different agencies involved in the process, and maintain comprehensive databases on safety-related issues
- Establish policies and framework for capacity building and skills among personnel of concerned government agencies, NGOs and other relevant organisations dealing with safety
- Liaise with all concerned government ministries, educational institutions, health service providers, NGOs, international agencies and organisations in other countries

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Figure 12.16
Road Traffic Fatalities in 2006 and 2011



Source: National Crime Records Bureau.

working in any area related to safety and transport management

- Promote best practices in safety and transport management, undertake safety and traffic management education programmes, and conduct campaigns to create awareness on matters relating to safety
- Establish guidelines for upgrading trauma care systems at all levels and create a grid of medical, allied medical and rehabilitation facilities to provide first aid, care during transportation, emergency care in the hospital and rehabilitation
- The agency should not only set standards but also monitor their adoption and implementation. If standards are not adhered to, the agency should have powers to take corrective action.

Two important conclusions from good practices are drawn with regard to lead agency forms and related structures and processes. First, no one lead organisational arrangement is prescribed as being the best, given the diversity of country conditions which road safety managers have to meet. However, a central road safety office with adequate human, technical and financial resources is essential. Second, effective coordination arrangements are subordinate to the leadership role. Without adequate funding, technical resources and an authoritative lead agency support, coordinating the shared responsibility for achieving road safety results has little chance of success.

CURRENT STATUS IN INDIA

The time trends of total number of deaths in accidents associated with various modes of transport as reported by the National Crime Records Bureau (NCRB) are shown in Figure 12.15. Between 1971 and 2011, the total number of deaths decreased only for air accidents. The reported number of accidents in this period increased by a factor of 14.3 for road accidents, 2.7 for 'railway other', 1.5 for 'railroad' and 3.4 for boat capsize. Of the four modes of transport, accurate statistics for accident fatalities are only available for air transport (18 deaths in 2011). The number reported killed in road traffic accidents in 2011 was 136,834[26]. But road traffic accident fatality statitistics are considered to be underestimated by 15-100 per cent by different investigators[27]. The total number of rail-related fatalities in 2011 was 28,238.

26. NCRB (2012).
27. Gururaj (2006); WHO (2009).

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Table 12.5
Changes in Road Traffic Fatalities in Selected Indian Cities, 2006-11 and Fatality Rates per 100,000 Persons in 2011

CITY	FATALITIES PER 100,000 PERSONS IN 2011	INCREASE IN FATALITIES 2006-11 (PER CENT)
KOCHI	36	33
INDORE	15	58
ASANSOL	69	132
VISHAKHAPATNAM	24	51
AGRA	41	56
KANPUR	34	107
DELHI	16	50

Source: National Crime Records Bureau (2012).

Table 12.6
Railway Accidents Associated with the Local Rail Network in Mumbai

ACTIVITY	FATALITIES, NUMBER	
	2003	2011
Crossing tracks	2,148	-
Falling from train	532	-
Others	127	-
Total	2,807	3,458

Source: Adapted from Krishna (2012); Parasnis (2005).

For water transport, there are no reliable statistics or estimates.

The increasing trend of accidents for water, roads and railroad is a serious cause for concern and needs special attention. Figure 12.16 shows the statistics for road traffic fatalities for selected large and small cities in India in 2006 and 2011. The data show that within a period of five years, fatalities have increased by 30 per cent to 130 per cent in these cities (Table 12.5). The range was 15-69 fatalities per 100,000 persons in 2011. This compares poorly with 4-6 fatalties per 100,000 persons per year in cities like Tokyo, London, Amsterdam, Stockholm and New York.

Urban traffic accidents are also associated with railway traffic through cities. Table 12.6 shows reported deaths on the Mumbai suburban rail network. The number is higher than the annual death toll on Delhi roads. Anecdotal evidence suggests that the number of railroad-associated injuries and deaths in other cities is also not insignificant.

It is evident that both the existing rates of fatalities are far too high and that the rate of increase in accidents is unacceptable. As shown in earlier sections, it is not necessary that accident rates increase with increase in transportation volumes in any mode of transportation if appropriate safety systems are put in place. It is imperative that we give much more importance to transportation safety in India, and this will only happen if the whole system is improved and strengthened on an urgent basis.

ROAD

The number of persons reported killed in road traffic accidents in 2011 in India was 136,834. Accurate numbers for serious injuries and disabilities are not available. Taking the 2011 number as the base, it is possible that there were about 2,800,000 hospitalisations due to serious injuries and 420,000 persons permanently disabled due to road traffic accidents in India[28]. Table 12.7 shows the road traffic fatality rates in a few countries arranged by per capita income in 2010[29]. Two fatality rates are given—one as reported by the countries, and the second estimated by the WHO, adjusted for a 30-day period for death after the crash. A negative binomial regression model was used for estimating fatalities for each country by accounting for income, exposure, risk factors and strength of the health system. For many high-income countries, reported fatality rates and estimated rates are very similar, indicating that their reporting systems may be quite reliable. This is true for only a few low-income countries; for instance, Zimbabwe and Sri Lanka. However, this does prove that it is possible to have reliable reporting systems at low income levels if appropriate arrangements are put in place.

In Table 12.7, Sweden and the UK have the lowest death rates of 2.8 and 3.1 per 100,000 persons respectively. The reported rate for India is 10.6 and estimated 18.9 per 100,000 persons. Some nations have rates greater than 30, so India ranks somewhere in the middle among countries worldwide. It is important to note that some countries with high-income levels can have high death rates—the United Arab Emirates, Saudi Arabia, the Russian Federation and some with low income levels relatively lower rates. This is ample evidence that road traffic death rates do not have a strong correlation with per capita incomes, and that economic growth does not necessarily result in lower death rates unless evidence-based safety policies are implemented.

28. Gururaj (2005); Mohan, et al. (2009).
29. WHO (2013).

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Table 12.7.
Road Traffic Accident Fatality Rates per 100,000 Persons, 2010

COUNTRY	GNI PER CAPITA FOR 2010 IN US$	REPORTED FATALITY RATE PER 100,000 POPULATION	ESTIMATED FATALITY RATE PER 100,000 POPULATION
ETHIOPIA	390	3.0	17.6
ZIMBABWE	480	14.2	14.6
BANGLADESH	700	1.9	11.6
CAMBODIA	750	12.9	17.2
VIETNAM	1,160	11.5	24.7
NIGERIA	1,170	3.3	33.7
INDIA	**1,260**	**10.6**	**18.9**
SRI LANKA	2,260	11.8	13.7
ECUADOR	3,850	22.3	27.0
COLOMBIA	5,520	11.9	15.6
MALAYSIA	7,760	24.2	25.0
BRAZIL	9,540	18.7	22.5
RUSSIAN FEDERATION	9,880	18.6	18.6
SAUDI ARABIA	16,610	24.0	24.8
UNITED KINGDOM	38,140	3.1	3.7
SINGAPORE	39,410	3.8	5.1
UNITED ARAB EMIRATES	39,640	11.0	12.7
JAPAN	42,050	4.6	5.2
AUSTRALIA	46,200	6.1	6.1
SWEDEN	50,580	2.8	3.0

Source: World Health Organisation (2013).

INSTITUTIONAL SETUP

Ministry of Road Transport and Highways in the Government of India is the administrative ministry responsible for road safety efforts in the country. National Road Safety Council (NRSC), headed by the Union Minister for Road Transport and Highways is the apex advisory body. It includes the ministers in-charge of transport in the state governments and various official and non-official members. NRSC does not have adequate statutory backing, budgetary resources, professional expertise, or the mandate to be an effective organisation for executing road safety plans. The Transport Development Council chaired by the Union Minister of Transport, with the Union Ministers of Commerce, Industry, Railways and Member in-charge of Transport in Planning Commission as members, is a high level forum for the formulation of common policies for the development of road transport. It also includes all the Lt Governors/ Chief Commissioners of Union Territories and all ministers in charge of transport in the state governments. The Transport Division of the Department of Road Transport and Highways deals with matters relating to safe movement of vehicles on roads and safety awareness among users. The Road Transport Division has three sections dealing with motor vehicle legislation, transport-related matters and administration of road safety schemes. A Joint Secretary heads the Division, assisted by a Director and two Under Secretaries. The Roads Wing of the Department sets engineering standards for safety in design, construction and operation of National Highways in consultation with the Indian Roads Congress (IRC).

NCRB collects data of fatal and non-fatal road traffic accidents as reported to the police stations across the country and publishes a consolidated annual report. This is the only source for national data. However, the data is of a very rudimentary nature and as a result, we do not even have a reliable estimate of different types of road users killed. The data is not adequate for informed evidence-based detailed road safety policymaking.

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At present, existing institutions are not well-equipped to deal with increasing traffic on the roads or adopt the advances in technology that would promote road safety. There are hardly any trained road safety professionals at central or state government level.

The Government of India has established National Automotive Testing and R&D Infrastructure Project (NATRiP) between the Government, a number of state governments and the Indian automotive industry to create testing, validation and research and development infrastructure in the country. The following centres have been finalised to setup the test facilities:

- International Centre for Automotive Technology (iCAT), Manesar, is the principal vehicle homologation testing agency in Northern India
- Global Automotive Research Centre (GARC), Chennai, is expected to have certification test facilities to conduct performance testing of a full range of automobiles, tractors and construction equipment vehicles. It is expected to be fully operational in 2014
- National Automotive Test Tracks (NATRAX), Indore, also expected to be fully operational in 2014, will be an automotive proving ground with test tracks for vehicle dynamics
- Automotive Research Association of India (ARAI), Pune, provides technical expertise in R&D, testing, certification, homologation and framing of vehicle regulations
- Vehicle Research and Development Establishment (VRDE), Ahmednagar, is a homologation centre belonging to DRDO and has set up a electromagnetic compatibility laboratory and a multi-function braking track
- National Institute for Automotive Inspection, Maintenance and Training (NIAMINT), Silchar
- National Centre for Vehicle Research and Safety (NCVRS), Rae Bareli, will have a full-fledged tractor and off-road vehicles test facility and a national data analysis centre

Many states have taken initiatives in promoting road safety at the local level, but none have established a professional road safety agency. Examples of initiatives include those in the states of Kerala, Punjab and Tamil Nadu, where data collection and safety programmes have been stepped up with financial assistance from the World Bank. However, there is no evidence of any significant advances yet in controlling road traffic crashes.

ACADEMIC SAFETY RESEARCH CENTRES

The Central Road Research Institute, New Delhi, has a small group that carries out research on road safety and transportation, and it is the only agency funded by the government specifically for this purpose. A Transportation Research and Injury Prevention Programme was established at the Indian Institute of Technology Delhi over a decade ago, and this is the only multidisciplinary research centre focussing on traffic safety in the country. Some research on traffic safety gets done at other Indian Institutes of Technology, National Institutes of Technology, and medical institutions, but is mainly based on individual initiative.

At present, existing institutions are not well-equipped to deal with the increasing traffic on the roads or to adopt the advancements made in techniques and technology that would promote road safety. There are hardly any trained road safety professionals employed at the central or state government level or in academic institutions. Responsibility for road safety is diffused and there is no single agency to deal with a range of problems associated with it. There is also no effective mechanism for coordinating the activities of the different agencies dealing with the issue.

RAIL

The Commission of Railway Safety, working under the administrative control of the Ministry of Civil Aviation of the Government of India, deals with matters pertaining to safety of rail travel and train operation and is charged with certain statutory functions as laid down in the Railways Act (1989), which are of inspectorial, investigatory and advisory nature. The most important duties of the Commission is to ensure that any new railway line to be opened for passenger traffic conforms to standards and specifications prescribed by the Ministry of Railways and the new line is safe in all respects for carrying of passenger traffic. This is also applicable to other works such as gauge conversion, doubling of lines and electrification of existing lines. The Commission also conducts statutory inquiries into serious train accidents and makes recommendations for improving railway safety[30].

Injuries and fatalities associated with the Indian Railways can be divided into three groups:

(1) 'Consequential accidents'. The total number of deaths in this category per year generally remain less than 1,000.

(2) Injuries sustained by Indian Railways employees while on duty. In the period 2007-08 to October 2011, there were 1,624 fatalities and 8,709 injuries in this category[31].

30. http://civilaviation.gov.in/CRSS/Commission%20of%20Railway%20Safety.html, (accessed 23 September 2012).
31. High Level Safety Review Committee (2012).

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(3) Deaths and injuries among railway passengers and others on railway property not considered as 'consequential' or due to a 'fault' of the Indian railways. The number of deaths reported in this category was 25,872 in 2011[32]. According to National Sample Survey Organisation (NSSO) surveys, about 1 per cent of the Indian population suffers from locomotor disabilities, of which 26 per cent are due to injuries[33]. This means that about 3.3 million Indians are physically disabled due to accidents and about 10-15 per cent of these are associated with railway accidents[34]. However, the Indian Railways does not have any formal policy or any dedicated system for reduction of deaths and injuries.

Concerned with the high rate of railway accidents, the Ministry of Railways set up a High Level Safety Review Committee which submitted its report in February 2012[35]. The Committee noted that:

There is no practice of independent safety regulation by an independent agency separate from operations. The Railway Board has the unique distinction of being the rule maker, operator and the regulator, all wrapped into one. Commissioners of Railway Safety, though considered to be the safety watchdogs, have negligible role at the operational level. Compliance of safety standards set by Railways for themselves are often flouted for operational exigencies.

Regarding accidents not considered 'consequential', the Committee noted that :

Reluctance of Indian Railways to own these casualties, which do not fall under the purview of train accidents but are nevertheless accidents on account of trains can by no means be ignored. No civilised society can accept such massacre on their railway system.

The main recommendations of the Committee are:

1. Setting up of a statutory Railway Safety Authority (RSA) and a safety architecture which is powerful enough to have a safety oversight on the operational mode of Indian Railways without detaching safety with the railway operations. The Committee has also recommended measures to strengthen the present Railway Safety Commission to undertake meaningful regulatory inspections.
2. A Railway Research and Development Council (RRDC) to be set up at the apex level directly under the Government. This Council will have an Advance Railway Research Institute (ARRI) and five Railway Research Centres, for key safety-related railway disciplines such as rolling stock, signalling and telecommunications, motive power, tracks and bridges and operations management.
3. Elimination of all level crossings (manned and unmanned) within five years at an estimated cost of Rs 500 billion which will get recovered over seven to eight years due to savings in operation and maintenance costs, and improved train operation.

Commissioners of Railway Safety, though officially the safety watchdogs, have negligible role at the operational level. Safety standards, set by the Railways for themselves, are often flouted for operational exigencies.

ACADEMIC SAFETY RESEARCH CENTRES

At present, there are no independent academic research centres of any consequence dealing with railway safety.

AIR TRANSPORT

Safety in air transport in India is under the supervision and control of Directorate General of Civil Aviation (DGCA). As per DGCA data, India witnessed only four accidents in scheduled commercial air transport during the period 2000-2010, and non-scheduled air operations account for 22 accidents in the same period. According to the DGCA Working Group Report, 'Though regulatory framework is amended from time to time to suit immediate needs and to meet safety norms, the basic regulatory structure remains archaic. Stakeholders indicated that DGCA broadly conforms to International Civil Aviation Organization (ICAO) norms, but lacks in detailed regulatory framework which is essential for safe operations. While model regulations based on US and European regulations are available, the same have not been adopted by DGCA due to lack of in-house resources to undertake a complete review.'

The Air Safety Directorate within DGCA is responsible for all aspects of safety associated with air travel, including:

1. Investigation of civil registered aircraft incidents
2. Accident/incident prevention work
3. Approval of flight safety organisation and personnel
4. Cabin safety facilities, crew training, in-flight cabin inspection, etc.
5. Collection, maintenance and analysis of accident data
6. To coordinate with the ICAO and other aviation agencies concerning safety
7. Ensure that operators and service providers establish and maintain the Safety Management System (SMS) in their operation

32. NCRB (2012).
33. Pandey and Chatterjee (2007).
34. Singh, et al. (2009).
35. High Level Safety Review Committee (2012).

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The 12th Plan envisages setting up an Air Navigation Services Corporation to manage safety, congestion and efficiency issues.

However, the shortcomings persist and in the absence of a well-staffed professional safety agency the effectiveness of DGCA has been affected by shortage of experienced manpower to oversee fast-growing aviation activities in the country. Some of the issues facing the aviation sector are:

- It is not possible to carry out meaningful audits, surveillance of a large number of airlines, non-scheduled operators, training institutes for pilots and engineers, maintenance organisations, airport service providers without adequately trained staff
- DGCA has to discharge its responsibilities of compliance with ICAO standards, approve organisations, license personnel, certify organisations, aircraft, communication systems and so on. Investigation into incidents and accidents and learning from the outcome of such investigation by implementation of the ensuing recommendations cast huge responsibilities on the regulator. However, DGCA has been crippled by the absence of the minimum required manpower, which was reduced by half over the years due to officers retiring and the organisation not being able to recruit.
- ICAO has recommended transformation of DGCA into a Civil Aviation Authority (CAA) with necessary autonomy
- The introduction of space-based navigation systems and use of satellites for navigation are on the cards. DGCA at present has limited capacity to deal with these issues
- Training facilities for various categories of aviation personnel have not yet reached a satisfactory level. While airlines are able to meet their requirements for technical training within the country, operational/flying training for many airlines is carried out abroad.
- In the General Aviation (GA, non-scheduled) sector, specialised aspects of flight training like low visibility operations, instrument approaches, performance-based navigation, etc., are not adequately addressed. The GA sector needs to be organised to introduce manufacturers' recommended training profiles, to ensure that GA pilots are as proficient in handling modern aircraft as airline pilots.
- An appellate mechanism outside DGCA, preferably in the Ministry of Civil Aviation, should be available to operators to ensure fair enforcement of regulations

The 12th Five Year Plan strategies for civil aviation include the strengthening of regulatory framework on safety and economic regulatory aspects of civil aviation, by setting up a Civil Aviation Authority and also an independent Air Navigation Services Corporation to manage capacity, safety, congestion and efficiency issues.

ACADEMIC SAFETY RESEARCH CENTRES

At present, there are no independent research centres dealing with aviation safety in India.

WATER TRANSPORT

The Director General of Shipping is the statutory maritime authority, appointed by the Government of India under the Merchant Shipping Act, 1958, and is responsible for implementation of the provisions of the Act. The Directorate General ensures implementation of various international conventions, relating to safety requirements for prevention of pollution and other mandatory requirements of International Maritime Organisation (IMO).

The Central Government is expected to verify compliance with Merchant Shipping (Management for the Safe Operation of Ships) Rules 2000 by all the companies with the requirements of the International Safety Management Code by determining that

(a) Company's Safety Management System conforms with the requirements of International Safety Management Code; and
(b) The Safety Management System ensures that the following objectives are achieved:
  (i) Compliance with mandatory rules and regulations, and
  (ii) The applicable International Safety Management Code, guidelines and standards recommended by IMO, the Central Government, classification societies and maritime industry organisations are taken into account.

Navigational Safety in Port Committee (NSPC) is expected to cover major as well as non-major ports and its duties include port navigational safety issues, cargo-related safety aspects, and oversight function of oil pollution response mechanism, reception facilities in the ports, and so on.

The Government has established an Indian Maritime University (IMU) in Chennai, with campuses in Kolkata, Mumbai, Visakhapatnam, Kochi, Chennai and Kandla. The IMU aims to play the role of a centralised nodal agency to facilitate maritime studies and research in emerging areas such as marine science and technology, and marine environment. However, it is not clear whether there is a special focus on safety at the IMU.

The Inland Waterways Authority of India (IWAI) came into existence in 1986 for development and regulation of inland waterways for shipping and navigation. The Authority primarily undertakes projects for development and maintenance of IWT infrastructure on national waterways through grants received from the Ministry of Shipping. Based in Noida, the

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Authority also has regional offices at Patna, Kolkata, Guwahati and Kochi, and sub-offices at Allahabad, Varanasi, Bhagalpur, Farakka and Kollam.

It appears that there is no special agency focusing on maritime or inland water transport safety and reliable statistics regarding safety, injuries and deaths in this sector are not available.

ACADEMIC SAFETY RESEARCH CENTRES

At present, there are no independent academic research centres of any consequence dealing with water transport safety.

WAY FORWARD

Demand for better knowledge and technologies in the transport sector can only be provided by public bodies: central and state governments, and local bodies like municipalities and transit authorities. It is the responsibility of the public sector to create long-term stable demand for safety work, with the implicit understanding that progressive employment for a well-trained workforce will be available for some time to come. If respectable professional jobs become available with promising and secure career paths in safety research and operations, talented professionals will gravitate to the field. This in turn will encourage educational and training institutions to provide the programmes necessary. Thus, the problem is structural.

Institutions for road, railway, water and air transport safety need to be set up to:

(a) ensure that safety professionals in the country are abreast of international knowledge and findings
(b) provide information about the size and severity of these problems
(c) help improve our information to help prioritise problems and measure our progress in solving them
(d) gather information about strategies in situations similar to our own, and about their effectiveness
(e) ensure that evidence of the effectiveness of safety countermeasures is made part of decisionmaking at different stages, rather than just reacting to problems or political demands

NATIONAL LEVEL

ESTABLISH NATIONAL BOARDS/AGENCIES FOR ROAD, RAILWAY, WATER/MARINE AND AIR SAFETY

These Boards must be:

(a) Independent of the respective operational agencies to avoid conflict of interest

If respectable safety-related jobs become available with promising career paths, talented professionals will gravitate to the field.

(b) The CEO of the Boards should be of a rank of Secretary to the Government of India and report directly to the Minister of the concerned ministry
(c) The Boards should be staffed by professionals who have career opportunities and working conditions similar to professionals working in IITs/CSIR laboratories
(d) The Boards should have an adequate funding mechanism based on the turnover of that sector
(e) The terms of reference can incorporate the recommendations similar to those included in the reports submitted by the Committee on Roads Safety and Traffic Management[36] and the High Level Safety Review Committee on railway safety. Salient features of these two reports are given below.

a. Proposed National Road Safety and Traffic Management Board

The organisational chart for the proposed National Road safety and Traffic Management Board is shown in Figure 12.17. The structure of the Board is expected to ensure that this national agency would be able take a multidisciplinary view of the problem of road safety in India and use evidence-based systems approach for recommending safety interventions, strategies and policies in India. The following functions are proposed for the Board[37]:

(1) Road-related measures: Designing, setting standards and conducting audits
   a. Set safety standards for the design, construction and operation of the National Highways, including road infrastructure and furniture
   b. Conduct/commission road safety audits of National Highway projects through all phases (pre, during and post) to monitor adherence to prescribed standards and issue directions, where necessary, to take corrective action
   c. Recommend minimum safety standards for the design, construction and operation for roads other than National Highways
   d. Conduct/commission black spot surveys and recommend treatment
   e. Recommend traffic calming and similar safety practices
(2) Vehicle-related measures: Prescribing safety features
   a. Set standards for safety features for all mechanically propelled vehicles

36. Committee on Road Safety and Traffic Management (2007).
37. Ibid.

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b. Conduct/commission audits to monitor adherence to standards
c. Set the minimum conditions for the safe usage of mechanically propelled vehicles and safety standards for vehicular traffic on various types of roads
d. Conduct/commission safety audits to monitor adherence to prescribed standards
e. Recommend minimum safety features for vehicles other than mechanically propelled vehicles and promote safe carriageways for such transport and other vulnerable road users

(3) Road safety research: Institutional linkages and training
a. Identify subjects and institutions for research in different areas of road safety, and commission and fund research projects and publish research findings
b. Create linkages between research institutions at the local, regional and national levels
c. Establish Centres of Excellence in road safety research and education
d. Establish the methodology for multidisciplinary crash investigation, data collection, reporting and analyses
e. Establish the procedure and methodology for data collection, transmission and analysis at appropriate levels and define the role of different agencies involved in the process
f. Maintain a comprehensive database on road safety-related matters

(4) Traffic laws, operations and management
a. Recommend guidelines to state governments for computerising information regarding vehicle and driver licensing
b. Recommend guidelines for training, testing and licensing of drivers

(5) Capacity Building
a. Lay down guidelines for building capacity and skills among personnel of traffic police, hospitals, highway authorities, NGOs and other relevant organisations dealing with road safety, and for training of trainers

(6) Road user behaviour strategies, public awareness and education
a. Promote best practices in road safety and traffic management, undertake road safety and traffic management education programmes, and conduct campaigns to create awareness on matters relating to road safety
b. Identify/recognise NGOs working in the area of road safety, and assist them in promoting road safety

(7) Medical care and rehabilitation
a. Lay down guidelines for establishing and upgrading trauma care systems at all levels including district hospitals and tertiary-care medical college hospitals and creating a grid of medical, allied medical and rehabilitation facilities to provide first aid, care during transportation, emergency care in the hospital and rehabilitation

(8) Other functions
a. Advise the Central Government on road safety and on the administration of the provisions relating to safety as contained in the Central Motor Vehicles Act 1988 and rules thereunder
b. Provide technical assistance to State Boards and other agencies engaged in road safety
c. Enter into agreements with state governments on behalf of the Minister for Road Transport and Highways in the Government of India for promotion of road safety and traffic management, monitor compliance and recommend the grants to be paid to/withheld from the states
d. Liaise with other agencies like education boards and institutions, health service providers, NGOs, etc., who play an active role in matters relating to road safety
e. Liaise with international agencies and organisations in other countries working in any area related to road safety and traffic management

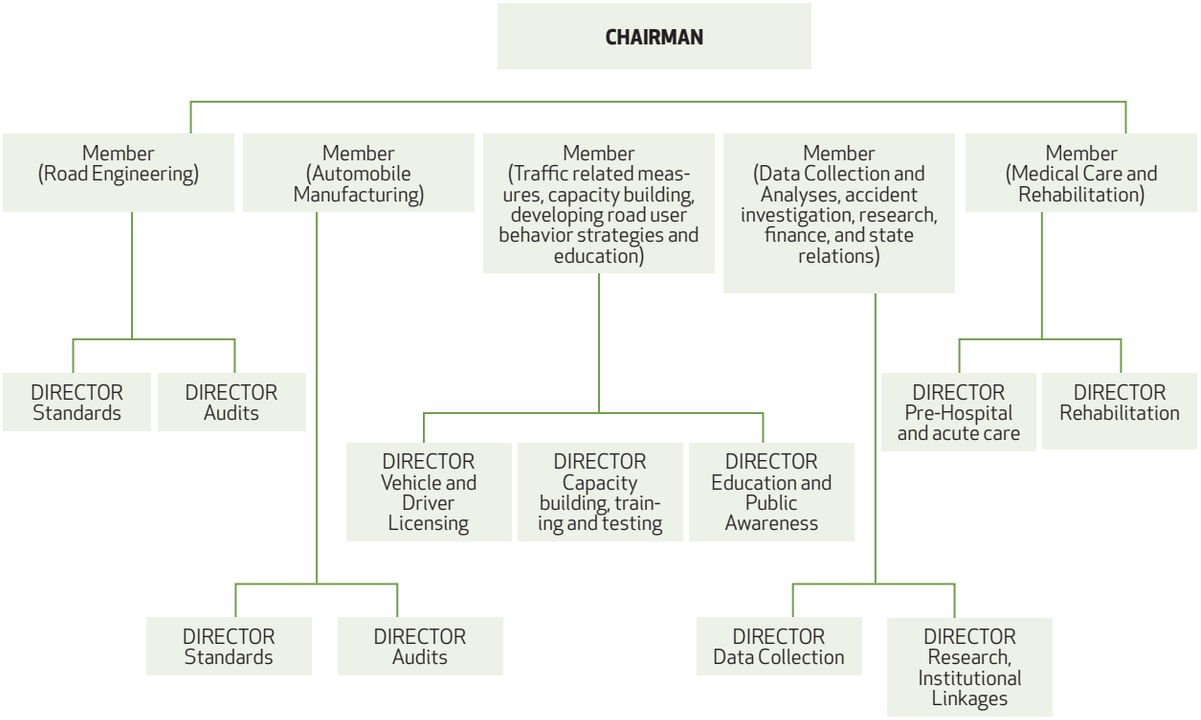
The Committee also recommended that the Board be given power to not only set standards but also monitor their adoption and implementation. For this purpose, the Board would empanel auditors to do spot checks and audits of highways under design, construction or operation to ensure that safety standards are adhered to. If standards are not adhered to, the Board would have powers to issue suitable directions with regard to corrective measures. The Board would have similar powers with regard to mechanically propelled vehicles, and also to seek information and reports, and access records and documents. Where standards set or directions issued by the Board have not been adhered to, the Board should have the power to levy penalties.

The Committee recommended that a minimum of one per cent of the total proceeds of the cess on diesel and petrol should be available to the Road Safety Fund of the Centre and the states, as road safety is a matter of concern not only on National Highways but also on the state roads, village roads and railway level crossings. Also, at least 50 per cent of the amount retained by the Government of India by way of the share of the National Highways and the Railways should be allocated to accident-prone urban conglomerations and states in addition to their entitlement. Assistance to the states from the National Road Safety Fund should be released provided that the states enter into agreements with the Government of India over road safety-related activities and faithfully implement the agreements.

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Figure 12.17

Organisational Chart Proposed for the National Road Safety and Traffic Management Board



Source: Committee on Road Safety and Traffic Management (2007).

STATE LEVEL ARRANGEMENTS

The Committee on Roads Safety and Traffic Management also recommended that each state pass enabling legislation to set up state level safety boards with functions, powers and obligations similar to the National Board. This would be necessary in a federal set-up for implementation of safety policies and interventions that are the responsibility of the state government. In addition to the functions proposed for the National Board, the state level boards would also have the following responsibilities:

a. Liaise with the National Road Safety and Traffic Management Board
b. Specify minimum standards for design, construction and operation of roads other than National Highways
c. Specify minimum standards for establishing and operating trauma facilities and para-medical facilities for dealing with traffic related injuries on all roads other than National Highways
d. Specify minimum safety requirements and standards for the design and manufacture of vehicles other than mechanically propelled vehicles and promote safe carriageways for such transport and other vulnerable road users

MANPOWER REQUIREMENTS

International experience suggests that the proposed National Road Safety and Traffic Management Board at maturity would need at least 250-350 professionals to man the 11 departments envisioned by the Committee. Almost all these professionals would have to be post-graduates in different areas of expertise needed for road safety. This is essential for the following reasons: (a) the agency would need in-house technical expertise to keep abreast of scientific and technical advancements in road safety knowledge internationally; (b) Since the Board will have the responsibility of establishing safety standards, it is essential that its staff have domain expertise; (c) Since the Board will be sponsoring research in various areas of road safety, it would need to have professionals whose expertise is similar to those working in academic and research institutions, to establish research priorities and monitor projects.

The role of a national agency such as the one proposed above was highlighted in the World Report on Road Traffic Injury Prevention[38]. Without such an agency, accountable road safety leadership at country, state, provincial and city levels does not get established. It then becomes almost imposable to evolve sustainable policies and establish mechanisms for their implementation. The national agency will have to focus on the following objectives in the immediate future[39]:

1. Set project objectives
2. Determine scale of project investment

38. Peden, et al. (2004).
39. Bliss and Breen (2009).

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Box 12.3

Checklist for Lead Agency Role and Institutional Management Functions

1. Does the lead agency (or de facto lead agency/agencies) effectively contribute to the results focus management function?
   - Appraising current road safety performance through high-level strategic review? Adopting a far-reaching road safety vision for the longer term?
   - Analysing what could be achieved in the medium term?
   - Setting quantitative targets by mutual consent across the road safety partnership?
   - Establishing mechanisms to ensure partner and stakeholder accountability for results?

2. Does the lead agency (or de facto lead agency/agencies) effectively contribute to the coordination management function?
   - Horizontal coordination across central government?
   - Vertical coordination from central to regional and local levels of government?
   - Specific delivery partnerships between government, non-government, community and business at the central, regional and local levels?
   - Parliamentary relations at central, regional and local levels?

3. Does the lead agency (or de facto lead agency/agencies) effectively contribute to the legislation management function?
   - Reviewing the scope of the legislative framework?
   - Developing legislation needed for the road safety strategy?
   - Consolidating legislation?
   - Securing legislative resources for road safety?

4. Does the lead agency (or de facto lead agency/agencies) effectively contribute to the funding and resource allocation management function?
   - Ensuring sustainable funding sources?
   - Establishing procedures to guide the allocation of resources across safety programmes?

5. Does the lead agency (or de facto lead agency/agencies) effectively contribute to the promotion management function?
   - Promotion of a far-reaching road safety vision or goal?
   - Championing and promotion at a high level?
   - Multi-sectoral promotion of effective interventions and shared responsibility?
   - Leading by example with in-house road safety policies?
   - Developing and supporting safety rating programmes and the publication of their results?
   - Carrying out national advertising?
   - Encouraging promotion at the local level?

6. Does the lead agency (or de facto lead agency/agencies) effectively contribute to the monitoring and evaluation management function?
   - Establishing and supporting data systems to set and monitor final and intermediate outcome and output targets?
   - Transparent review of the national road safety strategy and its performance?
   - Making any necessary adjustments to achieve the desired results?

7. Does the lead agency (or de facto lead agency/agencies) effectively contribute to the research and development and knowledge transfer management function?
   - Developing capacity for multi-disciplinary research and knowledge transfer?
   - Creating a national road safety research strategy and annual programme?
   - Securing sources of sustainable funding for road safety research?
   - Training and professional exchange?
   - Establishing good practice guidelines?
   - Setting up demonstration projects?

Source: Adapted from Bliss and Breen (2009).

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Box 12.4.

An Illustrative List of Road Safety Policies and Interventions

A. DATA
- Establish nationwide online road accident recording system for police departments
- Organise road traffic injury epidemiological data surveillance system in selected hospitals
- Establish multidisciplinary fatal accident recording system teams nationwide

B. VEHICLE SAFETY
- Near future (~5 years)
  - Standards for greater conspicuity of bicycles and other non-motorised vehicles
  - Daytime running lights and anti-skid braking systems for motorcycles
  - Mandatory crashworthiness standards for all cars including ABS, electronic stability control and air-bags for all vehicles
  - Establish an Indian New Assessment Programme (NCAP) as already present in Europe, North America, Japan, Australia, China, ASEAN and Latin America.
- Longer term (>5 years)
  - Judicious selection of active safety technology for Indian conditions—adaptive speed control, emergency braking, lane departure warning, alcohol interlock, etc.
  - Pedestrian impact safety standards for all vehicles including trucks and buses
  - Establish safety standards for para-transit vehicles
  - ITS measures for communication between vehicles and road infrastructure

C. ROAD INFRASTRUCTURE
- Near future
  - Establish procedures and measures for mandatory road safety impact assessment, road safety audit, road safety inspection, black spot management, network safety management and speed management for all urban and rural roads
  - Set targets for provision of adequate universal design pedestrian and bicycle facilities on all urban arterial roads
  - Standards for provision of service and slow traffic lanes along all four-lane and six-lane highways
  - Traffic calming on all urban roads and highways passing through urban and semi-urban areas
  - Establish standards for construction of modern roundabouts in urban areas and rural roads for different traffic volumes
- Longer term
  - Establish standards for safer urban arterials including the use of ITS systems for speed control
  - All new highways to be constructed according to new safety standards established with specific consideration of local rural needs and non-motorised road users in India

D. ENFORCEMENT AND LICENSING
  - Establish appropriate funds and policing systems to ensure nationwide enforcement of: (a) helmet use and daytime running lights by motorised two-wheeler riders; (b) seatbelt use by all motor vehicle occupants; (c) drinking and driving laws; (d) speed limits on all roads
  - Introduce Graduated Driver Licensing Systems
  - Introduce evidence based safer driver training programmes and vehicle testing systems

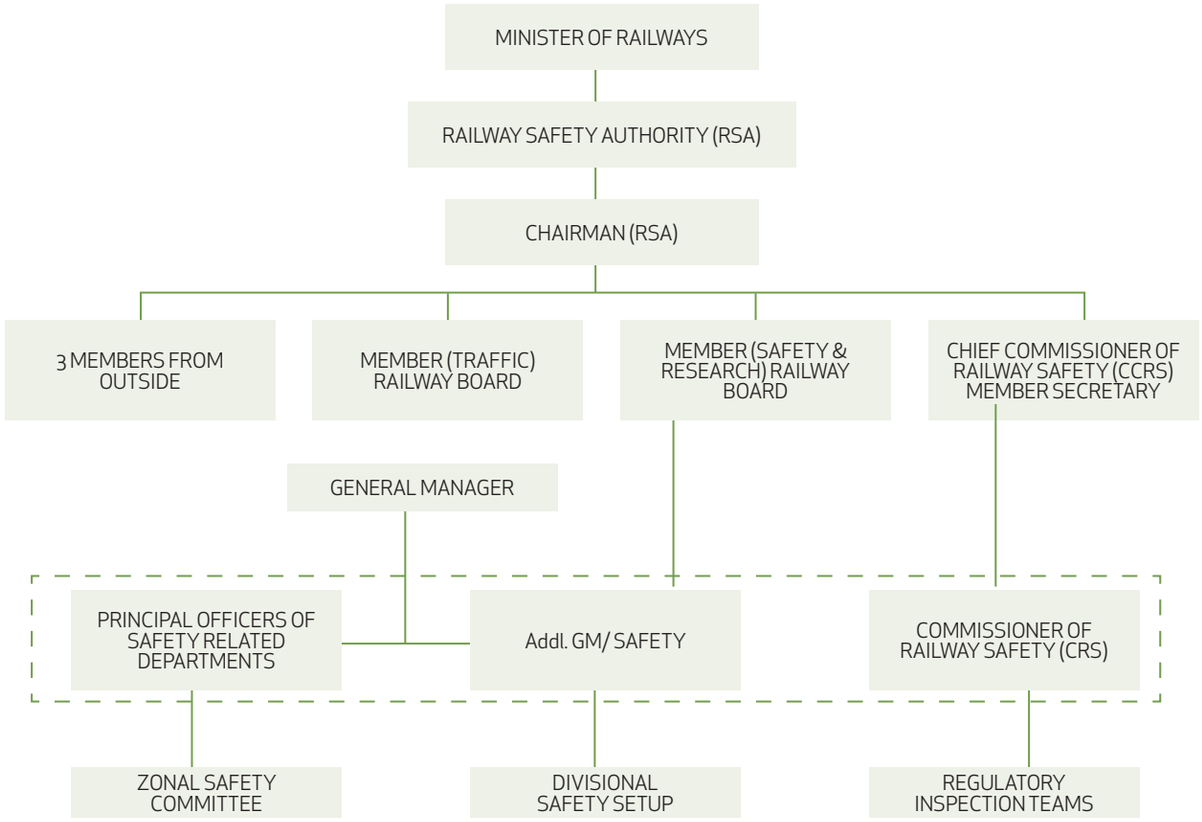
E. MEDICAL CARE
  - Set up one number countrywide for ambulance systems
  - Nationwide trauma care training programme for first responders, paramedics, all physicians, surgeons and trauma specialists
  - Establish advanced trauma care and rehabilitation systems in all tertiary hospitals
  - Introduce a universal insurance scheme for accident victims

F. EDUCATION
  - Educate policy makers and professionals regarding the gravity of the problem and countermeasures needed
  - Public education programme for acceptance of safety countermeasures and regulations

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Figure 12.18

Organisational Chart of the Railway Safety Authority Proposed by High Level Safety Review Committee



Source: High Level Safety Review Committee (2012).

3. Identify project partnerships
4. Specify project components
5. Confirm project management arrangements
6. Specify project monitoring and evaluation procedures
7. Prepare detailed project design
8. Highlight project implementation priorities

Bliss and Breen have proposed a set of questions that can be asked to evaluate the strengths and weaknesses of a national safety agency (Box 12.3)[40]. The project implementation and research priorities will have to be developed on an urgent basis and measureable targets established for each Five Year Plan period. An illustrative list is given in Box 12.4. The measures and principles outlined for the agency can be modified appropriately for national agencies for other sectors.

b. National Railway Safety Agency

The High Level Safety Review Committee appointed by the Railway Ministry has recommended a statutory Railway Safety Authority (RSA) and a safety architecture which is powerful enough to have a safety oversight on the operational mode of Indian Railways without detaching safety with the railway operations. The Committee has also recommended measures to strengthen the present Railway Safety Commission to undertake meaningful regulatory inspections.

The Committee proposed that a Railway Research and Development Council (RRDC) be set up at the apex level directly under the Government. This Council would have an Advance Railway Research Institute (ARRI) and five Railway Research Centres, for key safety-related railway disciplines such as rolling stock, signalling and telecommunications, motive power, tracks and bridges and operations management. As a large proportion of deaths and injuries associated with railway operations occur at railroad crossings, they also recommended total elimination of all level crossings—manned and unmanned, within five years at an estimated cost of Rs 500 billion which will get recovered over seven to eight years due to savings in operation and maintenance costs and improved train operation. The project will also need setting up of a dedicated and empowered SPV for each railway zone to accomplish this task within a five-year period.

The Committee recommended that a Railway Safety Authority (RSA) should be set up as a statutory body independent of Railway Board

40. Bliss and Breen (2009).

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under the Government. The Authority shall have a separate budget fully funded by the Ministry of Railways and shall be backed by a full-fledged Secretariat.

The structure of the proposed RSA is shown in Figure 12.18. RSA will liaise with the Railway Board through the Member (Safety and Research), Railway Board, and with the proposed Railway Research and Development Council. RSA will also have Zonal Safety Committees, Regulatory Inspection Teams and Divisional Safety Setup.

The Committee has proposed a total investment of Rs 25 billion over a period of five years in the Railway Research & Development Council (RRDC), Advanced Research Centres, RDSO upgradation, etc. This is in addition to Rs 1,006 billion proposed for all technical upgradation of the railway infrastructure. The Committee has recommended that a safety surcharge should be levied on rail passengers which is projected to yield Rs 50 billion annually at 2012 prices. Operational recommendations include:

- A new post of Member (Safety and Research) on the Railway Board should be created. This person will be the link between the Board, RSA and RRDC at the apex level
- The institution of Commissioner of Railway Safety (CRS) should be merged with RSA and should be strengthened and empowered. There should be a CRS for each zonal railway and each CRS should have a Regulatory Inspection Team consisting of HODs of the concerned technical departments
- Enhanced powers to be delegated to General Managers in regard to safety
- Core Safety Groups to be formed under the convenorship of the Additional General Manager (Safety)
- A High Level Task Force involving state governments and NGOs should be set up to recommend constructive measures which will alleviate or eliminate casualties due to railway infrastructure in the near future
- State-of-the-art signalling and protection system
- A national level expert committee should be constituted to establish the root cause of rail track failures
- All level crossings should be eliminated within the next five years
- Projects of importance to railway safety should be regularly awarded to select engineering academic institutions
- All officers should be periodically imparted training in safety engineering
- One training institute at the divisional level should be nominated and upgraded for training staff on the safety environment

The Government should consider establishment of an independent National Board on Water Transport Safety.

Research and development activities

- The apex body to be established, RRDC, should be chaired by an eminent technologist/scientist reporting to the Railway Minister

- Financial support up to two per cent of yearly revenue of Indian Railways should be available to support the entire research ecosystem of railways
- ARRI should be established as a high-end research organisation focusing on engineering challenges in railway-specific areas
- A string of five or so Railway Research Centres should be established which should be co-located on the campuses of Indian technological academic institutions of national importance. Each centre should specialise in specific areas like signalling, rolling stock, motive power, tracks and bridges, operations management
- The present system of only having railway officers on deputation at senior positions in RDSO should be done away with, and professionals and scientists from reputed technical institutions should also be inducted at higher levels on the permanent cadre. Their career progression should be on the similar lines as followed in other Government research institutions

c. National Water Transport and Aviation Safety Agencies

At present there are no proposals for setting up independent National Safety Agencies for water/marine transport and aviation. The lack of research and data collection/analysis capabilities in the country in these sectors is also self-evident. While aviation safety will be guided by international regulations, this may not be true for the growing private aircraft ownership and airport operations.

The Government of India should consider establishment of an independent National Civil Aviation Safety Agency and a National Board on Water Transport Safety. The latter could be headquartered at one of the major port cities with a branch in the Northeast for inland water transport safety. Both these agencies could take a similar approach as the proposed agencies for road and rail transport, and satisfy the guidelines listed in Box 12.3.

It is important that the setting up of these Boards is not delayed any further, as international evidence suggests that no country has been able to deal with the problem of safety without very strong professional institutional mechanisms.

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Table 12.8
Proposed Multidisciplinary Safety Research Centres in Academic and Research Institutions

SAFETY RESEARCH CENTRES	NO. OF CENTRES	
	WITHIN 5 YEARS	WITHIN 10 YEARS
Road transport	15	30
Railroad	5	15
Marine and inland water transport	4	10
Civil Aviation	2	5

NATIONAL DATABASE AND STATISTICAL ANALYSIS SYSTEMS

At present, very little epidemiological information is available in India for deaths and injuries associated with the various modes of transport, except civil aviation. The information from the latter sector is also not available in the public domain. For evolution of evidence-based safety policies and strategies based on the systems approach, it is necessary to set up reliable data collection and analysis procedures for traffic accidents at different levels in consonance with international practices. This needs a special input for establishing special agencies in all sectors of transport. The level of effort needed is illustrated in Table 12.4 where 42 systems are listed to serve these needs in the US.

National safety agencies for each mode of transport must include a special department for data collection and statistical analysis. International experience suggests that such departments need to employ about 50-100 statistical and epidemiology experts who design surveys, data collection methods, perform statistical analyses and publish reports. It is equally important that all such data be available in the public domain so that independent researchers outside the official agency can also perform analyses and studies.

The functions of these Departments for each mode of transport could include:

- Collating relevant data from existing surveillance systems: Census Bureau, NSSO, NCRB, Central Bureau of Health Intelligence, etc.
- Establishing systems for scientific data collection by the police department
- National surveillance systems for all fatal accidents
- Sample surveys for specially identified problems
- Sample surveillance systems in identified hospitals
- Establishment of multidisciplinary accident investigation units in academic and research institutions
- Coordinating with relevant ministries and departments at the central, state and city level for collating data collected by the respective agencies

ESTABLISHING SAFETY DEPARTMENTS WITHIN OPERATING AGENCIES

Every Ministry dealing with transport should have an internal safety department (at different levels) for ensuring day-to-day compliance with safety standards, studying effectiveness of existing policies and standards, conducting safety audits, collecting relevant data, and liaison with the National Safety Agency, etc. These departments must employ 30-60 professionals with expertise in relevant areas of safety, with 30-40 per cent of the staff on deputation from the field.

Agencies operating under the Ministries (e.g., National Highway Authority of India, Airport Authority of India, Central Inland Water Transport Corporation) should also establish their own departments of safety with domain specialists. The functions of these departments would include field audits, before-and-after studies, data collection from the field, and liaison with the relevant ministry and the national safety agency.

d. Funding Establishment of Multidisciplinary Safety Research Centres at Academic Institutions

The national safety agencies in each of the transport ministries should establish multidisciplinary safety research centres in independent academic and research institutions. These centres would ideally include three or more disciplines of research, and work in each area should be pursued at three or more centres. This would promote competition among centres and is likely to result in more innovation. Safety research involves the following disciplines: relevant engineering sciences, statistics and epidemiology, trauma and medical care, sociology, psychology, jurisprudence and computer science.

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For these centres to be productive, each centre should have a minimum of 8-10 professionals. It is also possible that one academic institution has more than one of these safety research centres.

The funding for each of these centres should include:

- Endowment for three or more professorial chairs
- Endowment grant for at least two post-graduate scholarships per endowed chair
- Establishment funds for critical laboratories
- Funds for supporting visiting professionals
- Support for surveys, software, travel

For these centres to function effectively, the minimum grant per centre per year would be in the range of Rs 30-40 million annually, including endowment funds. Each national safety agency should establish procedures for issuing call for proposals and for evaluating the same under open completion. A procedure should also be established for an academic peer evaluation of each centre every two years.

SAFETY POLICIES AND TARGETS

The government must announce safety policies with measurable indicators for evaluation in each sector for a five-year and 10-year period before the end of 2015.

In the area of road safety, motor vehicle standards must be in conformity with international standards and the NCAP programme in place, by 2015.

A railway safety policy covering all injuries and fatalities associated with railway property must be announced by 2015.

STATE AND CITY LEVEL

Each state must establish a Road Safety Board on the lines suggested by the Committee on Roads Safety- and Traffic Management.

Those states dealing with significant amount of water transport must set up State Water Transport Safety Boards.

Safety Departments must be established within operating agencies at different levels for ensuring day-to-day compliance with safety standards, studying effectiveness of existing policies and standards, conducting safety audits, collecting relevant data, and so on. These agencies could be state PWDs, Railway Regional headquarters, port trusts, large urban transit agencies, and municipalities of large cities. These departments must employ 50-60 per cent professionals with expertise in the relevant area of safety, and 40-50 per cent of the staff could be on deputation from the field.

The Government must announce safety policies with measurable indicators for evaluation in each sector for a five-year and 10-year period before the end of 2015.

SUMMARY

More than 166,000 persons died in transportation-related accidents in 2011 in India, or more than 450 a day. This would mean that in addition to the more than 450 deaths a day in 2011, at least 1,500 persons were disabled, 7,000 hospitalised and more than 40,000 sustained minor injuries every day in traffic-related accidents. It is estimated that the cost of road traffic crashes alone may be about 3 per cent of the GDP. The situation is quite serious and unless policies and evidence-based countermeasures are put in place urgently the situation is likely to worsen.

The existing rates of fatalities and the rate of increase in accidents are both unacceptably high. It is not necessary that accident rates increase with increase in transportation volumes in any mode of transportation if appropriate safety systems are put in place. It is imperative that we give much more importance to transportation safety in India, and this will only happen if the whole system is improved and strengthened on an urgent basis. At present, there is very little expertise, data or information available in India to address issues of safety scientifically for any mode of transport.

Significant reductions in accident rates were seen in all modes of transport in Western Europe and USA starting about the same time in the 1960s and 1970s. The reduction was probably not due to any single factor in isolation but to a wide variety of improvements in design of vehicles, operating environment and infrastructure, and enforcement of safety regulations and standards.

Transportation safety management is a systematic process in which we consider infrastructure, users and vehicles as integral components of a complex interactive system. The transport system has to be developed in a way that does not jeopardise the environment or public health and welfare. In this approach, it is essential to create an ecology that minimises the risk of transport users making mistakes and prevents serious human injury when designing, operating and maintaining the system. The entire traffic and transport system must be designed to account for the limitations and capabilities of users and operators. Since each accident is a result of a combination of human, technology and environmental factors, one cannot understand the risk factors associated with an event unless a sophisticated systems approach is followed.

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Transportation safety management has seen a shift from action based on experience, intuition, judgement, and tradition, to action based on scientific research, empirical evidence, and from consideration of safety that is tacit and qualitative to consideration of transportation safety that is explicit and quantitative. The requirements of a safe system approach are:

a. Institutional structure that creates a demand for scientific work in safety issues.
b. Legislation and regulation—formulation and enforcement of laws and regulatory requirements
c. Monitoring and measurement—national databases with relevant information to monitor and assess various aspects of safety policies, technologies and knowledge needs
d. Assuring and improving the quality of safety services provided through professionals, individual institutions and with the use of specific technologies and devices

All countries that have been successful in reducing transport-related injuries and deaths have set up relatively large professional national safety agencies for each mode of transport. These agencies have different structures owing to different political and administrative systems in different countries, but are generally kept independent of the operating departments. However, most countries adhere to the following principles:

- Establishment of agencies professionally staffed for designing and implementing data collection systems
- Ensuring compatibility of data formats between different departments and users
- Responding to the demand of lead agencies for special needs regarding availability of data
- Ensuring that all non-proprietary and non-personal data are publicly available to all concerned stakeholders

The national agencies have to be supported at four levels:

a. State level
b. Departmental organisations at the local level
c. University departments
d. Civil society organisations

Demand for better knowledge and technologies in the transport sector can only be provided by public bodies: central and state governments, and local bodies like municipalities and transit authorities. It is the responsibility of the public sector to create long-term stable demand for safety work, with the implicit understanding that progressive employment for a well-trained workforce will be available for some time to come. If respectable professional jobs become available with promising and secure career paths in safety research and operations, talented professionals will gravitate to the field. This in turn will encourage educational and training institutions to provide the necessary programmes. Thus, the problem is structural.

Institutions for road, railway, water and air transport safety need to be set up to (a) ensure that safety professionals in the country are abreast of international knowledge and findings, (b) provide information about the size and severity of these problems, (c) help improve our information to help prioritise problems and measure progress in solving them, (d) gather information about strategies in situations similar to India's, and about their effectiveness, (e) ensure that evidence of the effectiveness of safety countermeasures is made part of decision making at different stages, rather than just reacting to problems or political demands.

THE WAY FORWARD

a. Establish National Boards/Agencies for Road, Railway, Water/Marine and Air Safety.
b. National Database and Statistical Analysis Systems.
c. Establish safety departments within operating agencies.
d. Fund establishment of multidisciplinary safety research centres at academic institutions.
e. The government must announce safety policies with measurable indicators for evaluation in each sector for a five-year and 10-year period before the end of 2015.
f. Each state must establish a Road Safety Board on the lines suggested by the Committee on Roads Safety and Traffic Management.
g. States dealing with significant amount of water transport must set up State Water Transport Safety Boards.
h. Establish Safety Departments within operating agencies at different levels for ensuring day-to-day compliance with safety standards, studying effectiveness of existing policies and standards, conducting safety audits, collecting relevant data, etc.

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13. PROMOTING INTERNATIONAL TRANSPORT CONNECTIVITY BETWEEN INDIA AND THE SOUTH AND SOUTH EAST ASIA REGIONS

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13. PROMOTING INTERNATIONAL TRANSPORT CONNECTIVITY BETWEEN INDIA AND THE SOUTH AND SOUTH EAST ASIA REGIONS

It has become increasingly clear that among sub-regions of the world, South Asia stands out as having the least developed transport connectivity between its constituent countries. Consequently, it is also among the least interconnected regions in economic terms.

All the countries in the region have therefore suffered from an economic point of view from the lack of transport links. The irony is that, prior to Independence and partition in 1947, the whole region was much better connected since there were no such international borders. Despite the long passage of time, political developments in the region have not been conducive to the development of transport and trades linkages across borders in the region.

The situation has now begun to change for the better with a number of diplomatic and other initiatives for the expansion of trade within the region, which would augur well for the future (Box 13.1).

It is with this in mind that the NTDPC is proposing a bolder effort towards the opening of international borders for trade and commerce, and for personal movement for tourism and other purposes. We feel that, if the current momentum continues, the kind of recommendations given in this chapter would be well within the realm of reality. As such, while being aware of them, we have abstracted from the political and diplomatic impediments that would restrain

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Box 13.1
ASEAN-India Connectivity: The Government of India's Approach

At the 11th ASEAN-India Summit in Brunei Darussalam on 10 October 2013, the Prime Minister of India announced that connectivity with the ASEAN region is a strategic priority for India and that the ASEAN-India Transport Agreement should be completed by 2015.

The flagship project under the ASEAN-India Connectivity initiative is the India-Myanmar-Thailand Trilateral Highway, which also constitutes part of the proposed Asian Highway network AH 1 within Myanmar. The length of the Trilateral Highway is approximately 1360 km, which will pass through Mandalay (Chaungma-Mandalay-Meitkila). India has undertaken to build the section between Tamu-Kalewa-Kalemyo (TKK) (Friendship Road), about 160 km in length. There is also a proposal for a bus service between Imphal and Mandalay.

India has set up an internal Inter-Ministerial Group on ASEAN Transport Connectivity to strengthen ASEAN-India connectivity. On 10 June 2013, India initiated an annual meeting with the ASEAN Connectivity Coordinating Committee (ACCC) as the primary policy level forum to take ASEAN-India connectivity agenda forward. At the ACCC-India Meeting, India suggested setting up of a Joint Working Group (JWG) on Maritime Connectivity between India, Myanmar, Thailand, Cambodia and Vietnam and also that work begin on creation of soft infrastructure in order to permit seamless movement of goods and passenger traffic along the ASEAN-India connectivity corridors. The Commerce and Industry Minister also reiterated that soft infrastructure requirements for movement of goods and services across geographic connectivity corridors be discussed at a Working Group level.

In addition to the above, there is a study on a Mekong-India Economic Corridor conducted by the Economic Research Institute for ASEAN and East Asia (ERIA), which suggests connecting the production networks in the Mekong region along the GMS Southern Economic Corridor (Ho Chi Minh City-Phnom Penh-Bangkok) to the corridors in India (Delhi-Mumbai-Industrial Corridor and Mumbai-Bangalore-Chennai Industrial corridor) through the Chennai-Dawei Sea link. There is even broader potential to link trade routes from sea ports in Myanmar, Thailand, Cambodia and Vietnam and even Japan to ports along India's eastern seaboard.

Subject to reciprocal rights to the Indian carriers, at present designated airlines of all ASEAN countries (except Lao PDR) are offered the facility to operate a daily service to 4-metro destinations besides unlimited access to another 18 tourist destinations (Patna, Lucknow, Guwahati, Gaya, Varanasi, Bhubaneswar, Khajuraho, Aurangabad, Goa, Jaipur, Port Blair, Cochin, Thiruvananthapuram, Calicut, Amritsar, Vishakapatnam, Ahmedabad and Tiruchirapally). As of February 2013, India has offered to conduct negotiations on an open sky policy on cargo on a quid pro quo basis.

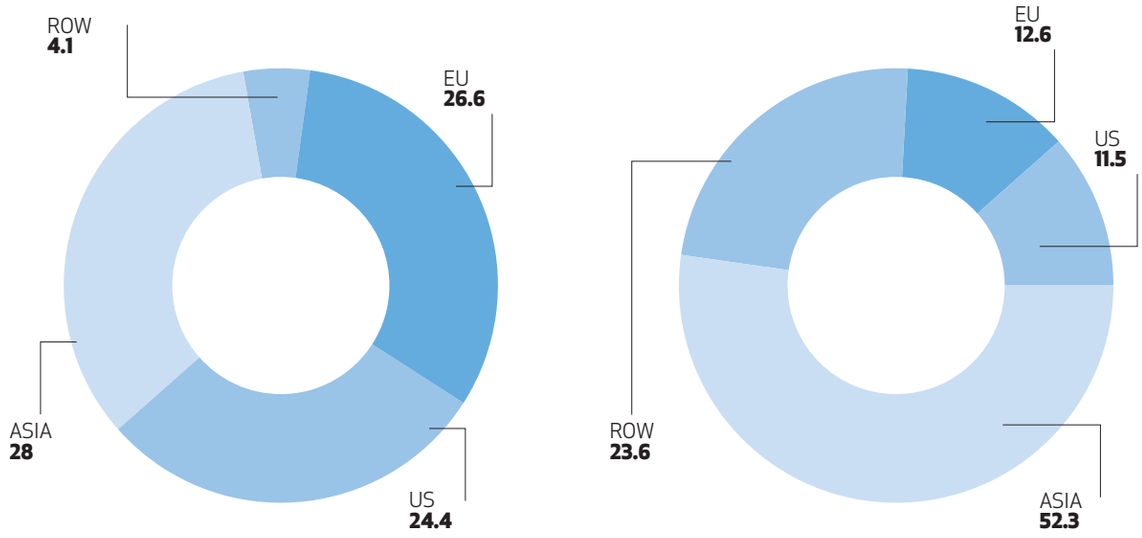
Looking ahead, the main thrust areas in ASEAN-India connectivity are as follows:

- Completion of the India-Myanmar-Thailand Trilateral Highway by 2016 and its further extension;
- Creation of soft infrastructure for utilising the Trilateral Highway and improving the surface connectivity with ASEAN through mechanisms to allow seamless movement of goods and traffic, in particular through an ASEAN India Transit Transport Agreement to be negotiated under an ASEAN-India Joint Working Group on Soft Infrastructure;
- A multimodal link-up with maritime ports in the region by working out necessary arrangements under the aegis of a Working Group on Maritime Connectivity;
- Leveraging geographic connectivity into corridors for economic cooperation to bring economic viability to the geographic corridors and make the connectivity between ASEAN and India more sustainable;
- Strengthening air services arrangements between ASEAN and India especially for air cargo and better utilisation of the open skies arrangements to the 18 tourist destinations in India, extended to the ASEAN in 2003;
- Strengthening the backend linkages into India, particularly in the North East and along the eastern seaboard

Source: Ministry of External Affairs, Government of India.

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Figure 13.1
Share of Major Regions in World GDP
[Per cent]



BASELINE, 2009

ASIAN CENTURY SCENARIO, 2050

Source: ADB (2010b).
Note: ROW - Rest of World.

the implementation of the kind of recommendations made in this chapter.

Fortunately, there is a significant body of technical work that exists for the development of transport and transport linkages in South Asia. Agencies such as UNESCAP, SAARC, ADB and BIMSTEC have conducted extensive technical work over the years in this area. The NTDPC has drawn liberally from these sources to make the recommendations that have been put forward in this chapter.

It is our hope that, just as Europe has integrated economically in the six to seven decades since World War II, it should be possible for the South Asia region to get similarly integrated over the next two decades. This would require extensive investment in transport linkages across borders along with technical agreements that will be necessary to make cross-border transport feasible.

ESTABLISHING THE CONTEXT

THE RISE OF THE DEVELOPING WORLD AND ASIA

Until the 1980s, an area that geographically covered 60 per cent of the world, comprising Africa, developing Asia, Latin America, and the Middle East, collectively known as the 'South', contributed to less than 30 per cent of world GDP. Growing at an average annual rate of 4.8 per cent since then, the combined economic output of the South accounted for 45 per cent of world GDP by 2010. In recent years, there has been further decline in the share of developed economies in world GDP and trade, and a concurrent rise in the share of the South, and it is evident that these economies will be the potential drivers of growth in the coming decades.

In the aftermath of the global slowdown which particularly hit the industrialised economies the most, the southern economies realised the need to deepen intra-regional trade. Also, given the high population growth rates and rising average incomes, the South offers tremendous potential markets for capital investment as well. However, till date, barriers to South-South trade and investments are still higher than those with the industrial world, broadly owing to high tariff and non-tariff barriers within South. Thus, addressing this issue by promoting global and regional integration and reducing internal trade and investment barriers has become increasingly important[1].

Further, the developing economies of Asia, which constitute a large share of the South, have not only demonstrated resilience through the global recession, but also succeeded in maintaining a robust growth rate. Per capita income in developing Asia grew at 9.4 per cent annually during the period 2000 to 2010 and investment rates averaged 35 per cent of GDP over the decade. These aggregate numbers are strongly influenced by the two Asian giants—the People's Republic of China (PRC) and India. Backed by prudent macro-economic policies, it is predicted

1. This section draws on the arguments in ADB (2010a).

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Table 13.1
Structure of Global GDP
[In current US$ trillion]

	2000	2011	2016	2020	2025
World GDP	32.2	68.7	90.5	110.5	140.5
Advanced Economies	25.7 (79.7)	44.4 (64.6)	53.3 (58.9)	61.1 (55.3)	71.7 (51.1)
Developing and Emerging Economies	6.5 (20.3)	24.3 (35.4)	37.2 (41.1)	49.4 (44.7)	68.8 (48.9)
of which					
Developing Asia	2.3 (7.3)	10.5 (15.2)	17.4 (19.3)	26.6 (24.1)	40.7 (28.9)
of which India	0.5 (1.5)	1.9 (2.8)	3.6 (4.0)	5.8 (5.2)	10.0 (7.1)
Sub-Saharan Africa	0.3 (1.0)	1.2 (1.8)	1.7 (1.9)	2.5 (2.2)	3.9 (2.8)
West Asia and North Africa	0.8 (2.5)	2.8 (4.0)	3.8 (4.2)	5.0 (4.5)	7.1 (5.0)
Latin America and Caribbean	2.1 (6.6)	5.5 (8.0)	7.4 (8.2)	9.7 (8.8)	13.3 (9.5)

Source: 12th Plan Approach Paper, Planning Commission.
Note: Numbers in parentheses are percentages.

Table 13. 2
India's Merchandise Trade, Region-wise
[Trade data-dated]

REGION	1997-98 PER CENT EXPORTS	2010-11 PER CENT EXPORTS	1997-98 PER CENT IMPORTS	2010-11 PER CENT IMPORTS
EU Countries (27)	26.50	18.33	27.16	12.05
Other West and East European Countries	1.77	1.51	3.20	7.20
North America	20.64	10.61	10.04	5.97
Latin America	1.42	4.08	1.46	3.84
Africa	4.03	6.27	5.85	7.05
Asia	41.48	52.05	39.35	61.16
East Asia	1.36	0.78	3.58	3.15
ASEAN	8.67	10.20	7.50	8.28
WANA	9.99	21.59	15.89	28.56
North East Asia	16.31	14.84	11.76	20.58
South Asia	5.15	4.64	0.62	0.59
Others	4.28	7.13	12.92	2.62

Source: Ministry of Commerce and Industry, Government of India.

that Asia could host some of the largest global equity, debt and banking markets and the region could become increasingly crucial in shaping the global financial architecture, monetary system and financial intermediation[2].

INTEGRATING INDIA WITH ASIA

India is expected to contribute close to 16 per cent of global GDP by 2050, and achieve per capita incomes of $22,000 by 2039[3]. Table 13.1 is a comparison of the structure of global GDP and India's share. However, the high growth rates that underpin these expectations are not pre-ordained. Given the new global rebalancing, India has to look to the South, to developing Asia, eastward, and within the South Asia region in order to grow (Figure 13.1). Tables 13.2 and 13.3 establish the declining share of Europe and North America as a market for South Asian countries and the rising share of Asia.

INDO-ASEAN TRADE

As global growth gravity shifts towards Asia, the Association of Southeast Asian Nations (ASEAN), with a population of over 615 million and strong domestic consumption, is becoming one of the most promising markets for now and the future. In absolute terms, the total trade within this area is about $1.7 trillion and gross domestic product is $2.3 trillion. For many ASEAN countries, an increasing

2. See ADB (2010b).
3. Ibid.

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Table 13.3
Direction of Trade for Countries of South Asia

TO	ASIA		EUROPE		NORTH AND CENTRAL AMERICA		REST OF THE WORLD	
FROM	**1990**	**2011**	**1990**	**2011**	**1990**	**2011**	**1990**	**2011**
Percentage of total merchandise exports								
Afghanistan	17.6	75.6	73.7	13.1	4.4	4.3	4.3	7
Bangladesh	14.8	13.2	41.8	57.2	32.3	24.2	11.2	5.4
Bhutan	99.3	97.7	0.6	1.9	0.0	0.2	0.1	0.1
India	**21.0**	**32.4**	**47.2**	**19.4**	**16.3**	**13.6**	**15.4**	**34.5**
Maldives	47.0	51.4	26.5	43.0	26.3	1.5	0.2	4.1
Nepal	14.7	68.5	60.0	14.9	24.1	11.1	1.2	5.5
Pakistan	28.2	32.0	40.7	24.5	14.3	16.4	16.9	27.2
Sri Lanka	14.8	19.3	30.9	35.6	28.8	23.0	25.7	22.1
Percentage of total merchandise imports								
Afghanistan	79.1	44.4	17.1	21.4	1.3	32.1	2.3	2.2
Bangladesh	47.7	62.5	22.0	8.7	8.4	3.7	21.8	25.1
Bhutan	11.2	83.6	72.1	14.8	11.3	1.4	5.3	0.2
India	**17.4**	**30.3**	**41.3**	**18.4**	**12.9**	**6.1**	**28.5**	**45.2**
Maldives	85.2	61.3	13.3	8.3	0.5	3.9	0.9	26.5
Nepal	69.4	90.5	20.1	2.6	2.8	1.1	7.7	5.8
Pakistan	30.3	43.9	29.3	11.5	14.2	5.9	26.3	38.9
Sri Lanka	47.5	67.9	17.8	11.2	8.9	3.4	25.8	17.5

Source: ADB (2011).

trade deficit with, and dependence on, the Chinese economy have compelled them to forge stronger economic ties with India as an alternative balancing source for growth. India's overall merchandise trade increased from $93 billion in 2000 to $792 billion in 2012-13, with a high compound average growth rate of 19.5 per cent. During the same period, merchandise trade between ASEAN and India also recorded a significant increase from $7.1 billion in 2000 to $77 billion in 2012-13, with a compound average growth rate of 22 per cent.

However, despite the good growth performance and the geographical proximity, the trade relationship between ASEAN and India is still limited. One of the major obstacles to the expansion of trade is the high cost of moving goods across the borders reflecting insufficient infrastructure for physical connectivity[4]. Greater connectivity will provide more development opportunities for less developed areas in India such as the North East, and less developed ASEAN member countries, particularly Myanmar, which are surrounded by the three of the most vigorous economies in the world—China, India and ASEAN. These regions are also expected to play a very important role as the physical connecting nodes. Consequently, development policies for Myanmar and North East India will be at the core of the regional approach to enhance ASEAN-India connectivity.

INDIA-SOUTH ASIA TRADE

In the past three decades, although South Asia has been second to East Asia as the fastest growing region of the world, intra-regional trade as a share of world trade has gone up only marginally. Despite favourable conditions for establishing a successful trading agreement in South Asia and the geographic proximity of countries, factors like high tariff rates and protection measures have resulted in intra-regional trade in South Asia being amongst the lowest in the world: only 4.3 per cent of its total merchandise trade in 2010 as compared to 5.5 per cent for Central Asia (including Georgia and Armenia), 26.4 per cent of ASEAN, 50 per cent for NAFTA, and 71 per cent for the EU[5].

Besides tariffs, trade costs also rise due to weak trade-related infrastructure and logistics, institutional barriers, and insufficient infrastructure for physical connectivity. For example, in 2010, it took 11 days and fewer than five documents, on average, to export or import a standardised unit of cargo among OECD economies, but it took more than twice as many days

4. RIS (2012).
5. Figures for Central Asia and ASEAN are obtained from the ARIC website, ADB. Central Asia is composed of the following ADB countries members: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan. NAFTA and EU figures computed from WTO International Trade Statistics, 2011.

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Geographically, India is strategically positioned to connect East and West Asia. It is also centrally placed within South Asia, connecting most of the countries to one another. India can provide key support for establishing an effective Asian institutional architecture as an important member of various regional cooperation arrangements.

for countries in East Asia and almost three times as long for those in South Asia, with many more documents involved[6]. Studies based on primary surveys show high level of informal trade between countries of the region[7] which are attributable to such institutional barriers.

Transport and communication linkages that increase current physical connectivity will also help expand future transfer of technology and investments. Closer trade links, intra-regional supply chains, and stronger financial links help bridge development gaps within a country as well between countries, promoting stable and inclusive growth. Cross-border investment, a key driver of international trade in recent years is almost completely absent in the South Asia region. While India has bilateral promotion and protection agreements (BIPAs) with 82 countries (10 in the process of ratification), there are only three with South Asian countries: Sri Lanka, Bangladesh and Nepal (up for ratification). But even with these countries, surveys repeatedly point to the lack of physical infrastructure. Without actual physical connectivity, there is little that can move, literally. Infrastructure, particularly power and transportation, are the major constraints

PROMOTING REGIONAL TRANSPORT CONNECTIVITY

Post-1947, when India gained independence, the subcontinent was divided into the territories known today as the countries of South Asia. Land borders of almost 7,400 km were created. Initially, the transport links between countries continued to operate, but subsequently were discontinued due to political issues. For example, rail and inland waterways transport (IWT) across the then East Pakistan (now Bangladesh) were suspended in 1965 during the Indo-Pak war and only IWT was restored in 1972, after East Pakistan became the sovereign nation of Bangladesh. Transit through Pakistan from India to Afghanistan remains suspended.

Border management led to closure of historical land routes at several points. North East India became a landlocked territory with its only connection to the mainland being the narrow 'chicken's neck' area through Siliguri. In subsequent years, incompatible transport technology platforms also emerged, impairing interoperability of cross-border services. This is particularly in the case of rail transport with differences in gauge. Even for road transport, the axle load for Indian trucks at 12.8 tonnes is higher than in Bangladesh at 8.14 tonnes. Intra-South Asia trade, which was 18 per cent of the total trade in 1948, dropped to 4.3 per cent by 2010.

National highway and railway networks are dense in most of India but sparse in the border areas where there are substantial missing links across national boundaries. Today's border areas, which were relatively wealthy before Partition in 1947, have become hinterlands. All this has resulted in high transaction costs, ranging between 13-14 per cent of the commodity value compared to 7-8 per cent in developed countries. Investments towards regional connectivity and especially in promoting 'last mile' efforts will have a major positive impact on India's trade potential.

THE CENTRAL ROLE OF CONNECTIVITY

National connectivity needs to be upgraded and dovetailed into a regional roadmap. For regional connectivity, border areas and gateways need hard and soft infrastructure. Hard aspects cover physical infrastructure including improvement of roads and trade and transit facilities. The softer aspects of connectivity include measures that facilitate smooth movement of goods and people such as free trade agreements (FTAs) and transport agreements. However, soft aspects will not see benefits without the hard infrastructure being in place.

However, soft aspects will work only with the hard infrastructure in place.

Geographically, India is strategically positioned to connect East and West Asia. It is also centrally placed within South Asia, connecting most of the countries to one another. India is in a position to provide key support for establishing an effective Asian institutional architecture as an important member of various regional cooperation arrangements and sub-regional initiatives including the South Asian Association for Regional Cooperation (SAARC), South Asia Sub-regional Economic Cooperation (SASEC), Bay of Bengal Initiative for Multisectoral Technical and Economic Cooperation (BIMSTEC), ASEAN+1, and the Bangladesh-China-India-Myanmar (BCIM) initiative. Figure 13.2 shows the centrality of India in these regional and sub-regional projects.

India is also at a centre of a web of dynamic bilateral and regional FTAs within South Asia and between South and East Asia and South East Asia. It is thus essential that transport, communication and energy linkages that increase connectivity and expand

6. World Bank (2010).
7. Taneja (2005).

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Figure 13. 2
Regional and Sub-regional Initiatives in Asia



Source: Asian Development Bank.

logistical networks through transfer of technology, managerial knowhow, and investments are strengthened. This will result in widespread economic benefits, and as the largest country in South Asia, India has to take the lead. The critical step is connectivity. The time for South Asian integration has indeed arrived[8].

It is important to project India as the most convenient and economical transit country for all our neighbours, who should be encouraged to use the Indian transport network, its ports and airports for both import and export of goods worldwide.

Cross-border infrastructure, in the form of immigration, customs and phyto-sanitary facilities need to be developed and upgraded virtually all along India's borders. Most of the border areas have been left deliberately underdeveloped due to security concerns; borders have been looked at as separating walls rather than as connectors bringing peoples and economies together. There is also a need to plan cross-border linkages not just for border trade but as entry and exit points through which normal trade, including third country trade, can take place on most favoured nation (MFN) terms. While trade through most border trade points is currently limited to mutually agreed lists of commodities, in reality a large volume of contraband trade takes place, encouraging criminalisation, loss of revenue and threats to national security. Cross-border transport linkages must factor in this aspect.

For India to emerge as an economic powerhouse in South Asia and South East Asia, the development of a dense network of transport linkages throughout this larger neighbourhood is absolutely vital.

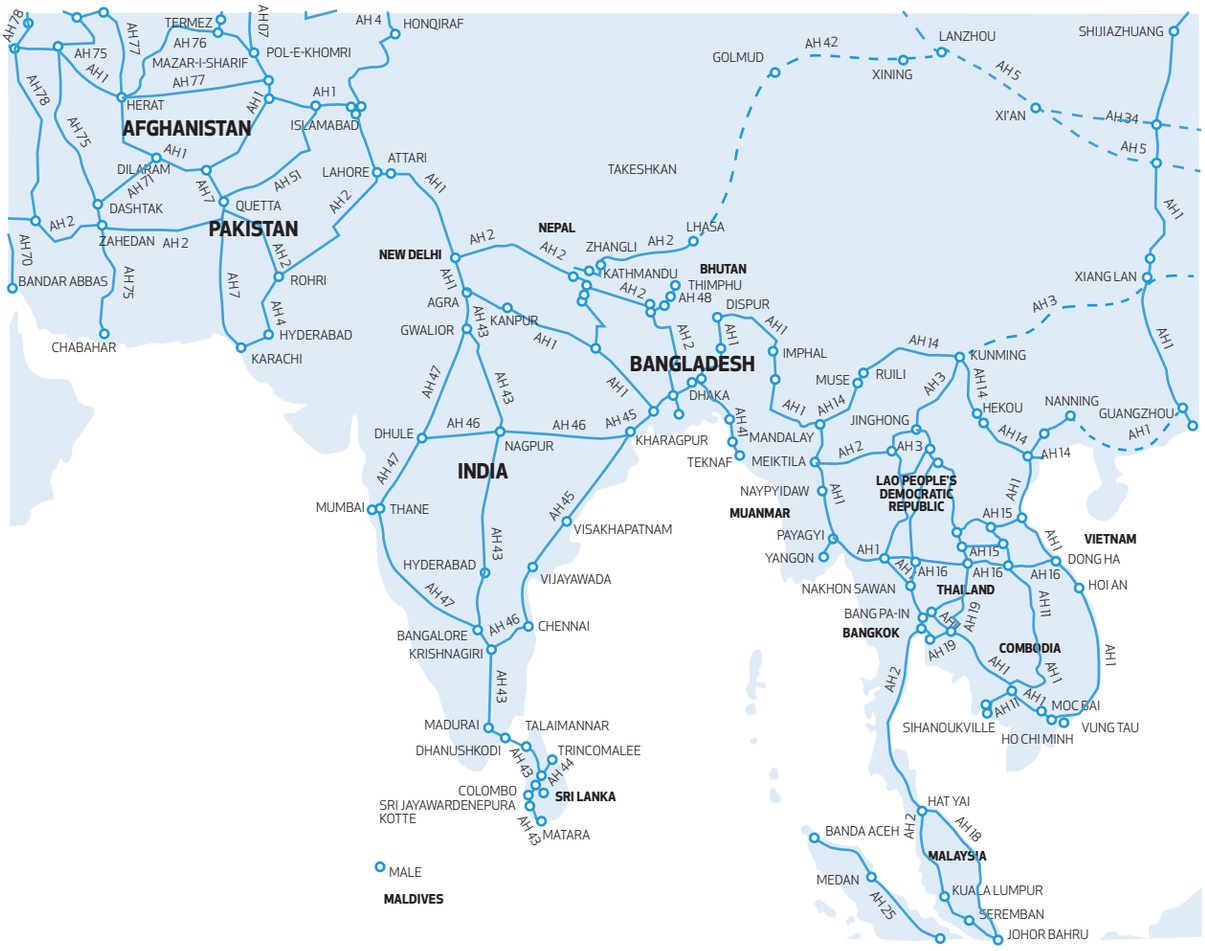
ASEAN'S COMPREHENSIVE ASIA DEVELOPMENT PLAN

Connectivity is a central theme of the ASEAN. Its connectivity priorities include enhancing multimodal transportation links, connecting archipelagic member states to the mainland, narrowing the digital divide, facilitating energy

8. Roy (2012).

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Figure 13. 3
Asian Highway Network



Source: Reworked from UNESCAP Asian Highway Network Map.

trade, and strengthening institutional connectivity. ASEAN has drafted strategies to upgrade existing road links, construct missing rail links, enhance infrastructure of key ports, and promote greater use of roll-on roll-off activities to integrate its economies despite physical and financial challenges. Connectivity through air is the most developed in the region.

ASEAN-India connectivity is the main theme of the Comprehensive Asia Development Plan (CADP) Phase II report. CADP recommends a strategy based on a multi-modal, multi-functional and multi-tier approach. As already mentioned, greater ASEAN-India connectivity will provide significantly more development opportunities for less developed areas in India such as the North East, and less developed ASEAN member countries, particularly Myanmar.

Reducing transport costs will do more than just increase trade. It will also help change the location of economic activities[9]. Trade between India and ASEAN is expected to reach about US$100 billion in the next two years. India-Myanmar border trade contributed an insignificant 2.08 per cent and 0.49 per cent in India's total export to and import from Myanmar respectively in the last decade which shows that the border trade potential between the two nations is far from being realised.

SAARC REGIONAL MULTIMODAL TRANSPORT STUDY (SRMTS)

Following the partition of British India, the transport systems of South Asia have developed only in the national context and little consideration has been given to cross-border issues of compatibility, uniformity of standards in infrastructure and equipment design. In general, the key issues for international road transport are the types of vehicles used, the size of operators and poor vehicle utilisation. The SAARC Regional Multimodal Transport Study (SRMTS) endorsed by SAARC countries at the 2007 New Delhi Summit, charts out an integrated plan for individual countries of the South Asia region. It recognises that regional connectivity in transport is essential and capacity augmentation is required to cater to the anticipated increased traffic along intra-regional corridors. It has been estimated for South

9. Myo (2004).

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Figure 13. 4
Asian Railway Network



Source: Reworked from UNESCAP Asian Highway Network Map.

Asia that for every 1 per cent reduction in transport cost, there is a 5 per cent stimulus to trade. This reduced transportation cost then gets translated into a 1.5 per cent reduction in costs to end-users of goods moved along that corridor, which eventually leads to an estimated 1 per cent addition to regional GDP.

In 2003, under the auspices of the United Nation Economic and Social Commission for Asia and the Pacific (UNESCAP), the Intergovernmental Agreement on Asian Highway Network was signed, which specified the technical specifications for the regional road network. The Asian Highway Network (Figure 13.3) extends through 32 member countries and comprises 142,000 km of highways with very few missing links, but only 32 per cent of which is currently classified as Primary and Class I. The project aims to upgrade all designated national routes to Class I standards by 2020, although Class II standards would be acceptable for low-traffic, non-arterial routes. The Asian Rail Network (Figure 13.4) faces the problem of missing links.

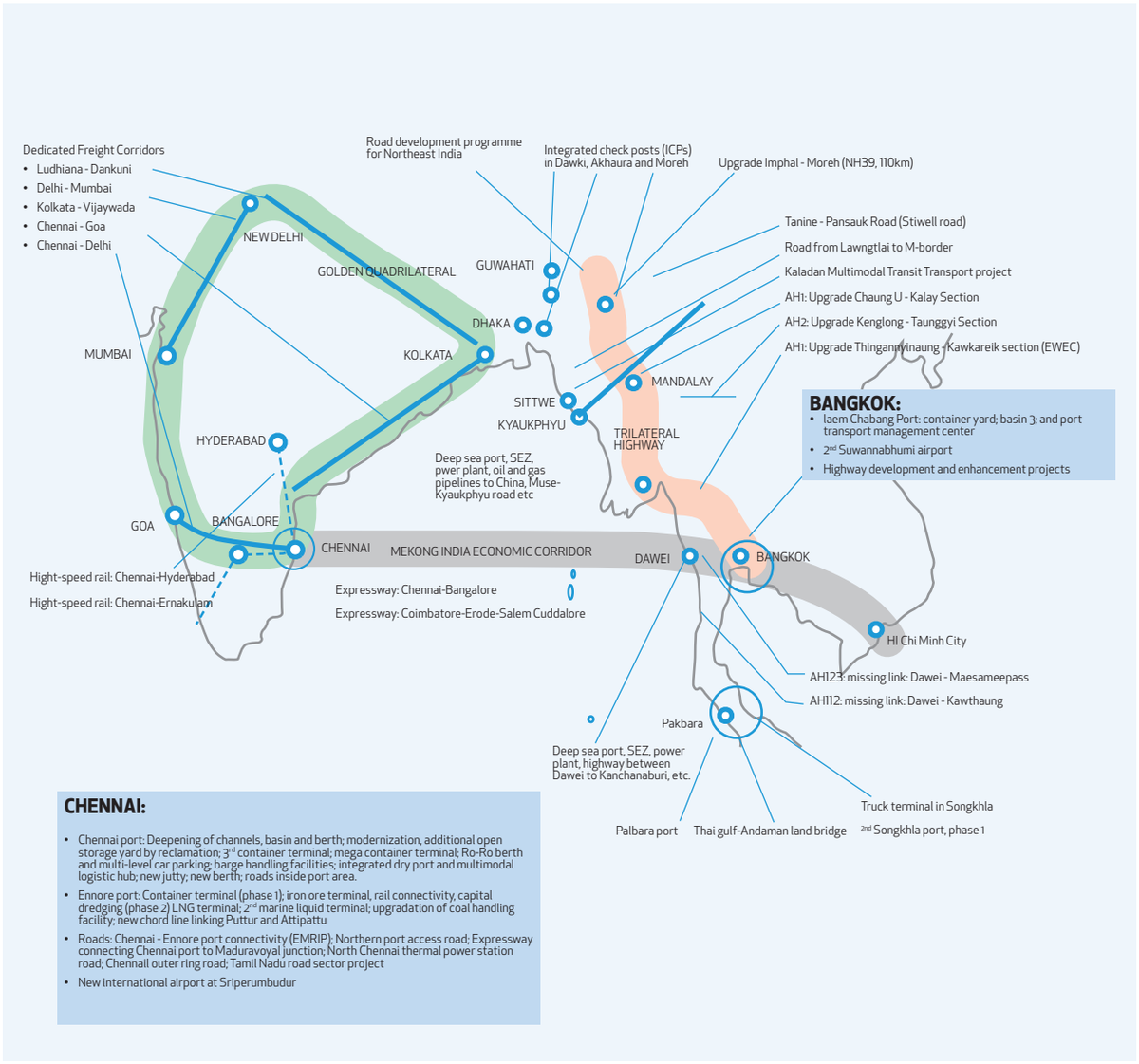
The next sections list the important corridors for India and the measures needed to establish connectivity with its regional trading partners in a 20-year timeframe. There is need to restore the transport infrastructure which was integrated prior to independence. Assuming political and diplomatic cooperation over the near, medium and long term, this chapter proposes all the links that need to be put in place, to achieve the potential of regional economic integration.

THE MAJOR CORRIDORS: INDIA AND ASEAN

Connectivity with ASEAN in all its dimensions—physical, institutional and people-to-people—continues to be a strategic priority for India. Two major Commemorative events this year—the India-ASEAN Car Rally and the ASEAN sailing expedition of the Indian Naval Ship Sudarshini—highlight the importance and the potential for connecting India and ASEAN by sea, surface and air links. These are

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Figure 13.5
India-ASEAN Multimodal Connectivity Projects



Source: Economic Research Institute for ASEAN and East Asia.

welcome steps in implementing the vision of India-ASEAN connectivity.

Prime Minister Manmohan Singh at the
10th India-ASEAN Summit, November 2012

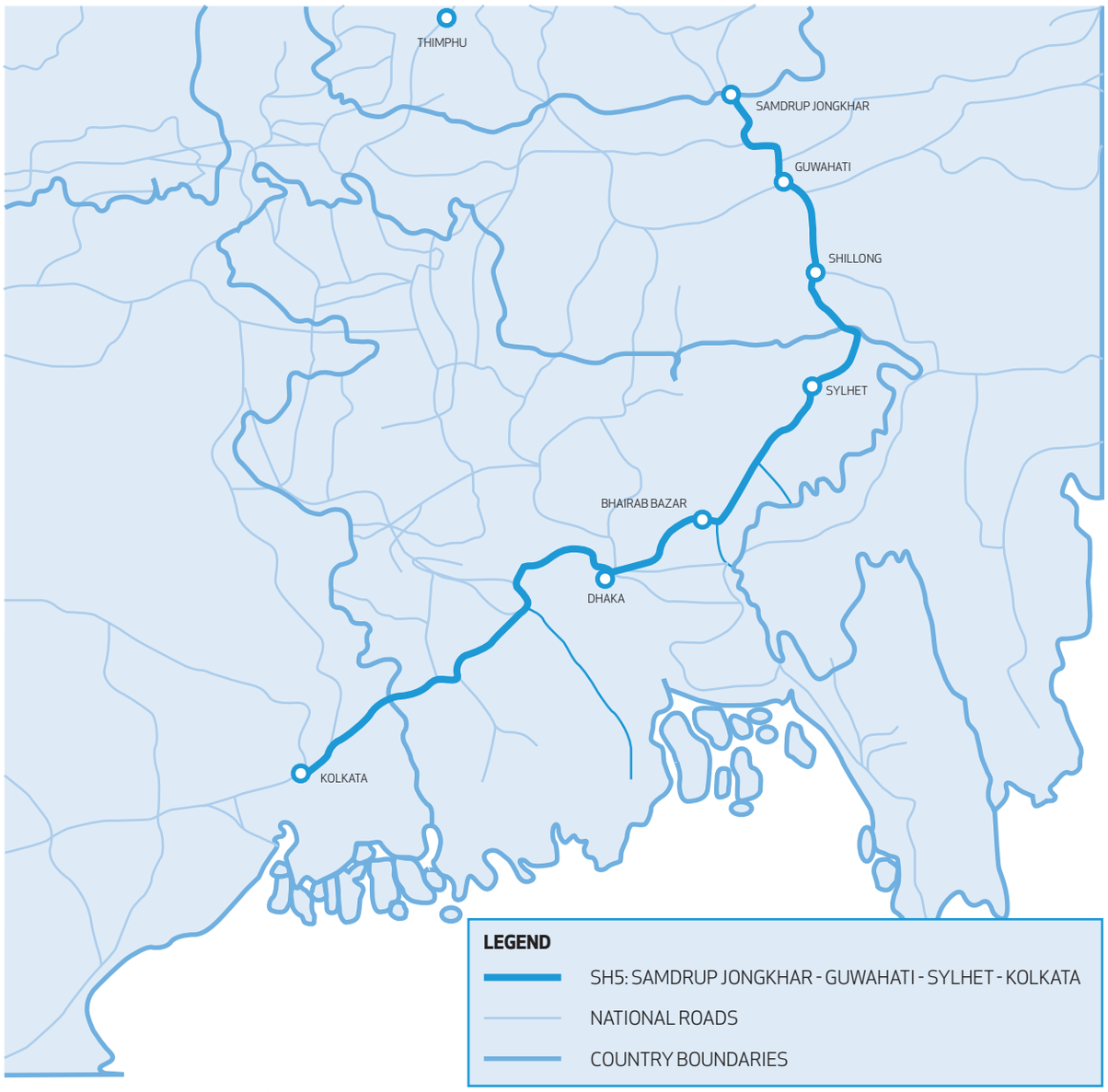
ASEAN-India relations have grown rapidly from a sectoral dialogue partnership in 1992 to the signing of the ASEAN-India Trade in Goods (TIG) Agreement in Bangkok on 13 August 2009. The agreement paves the way for the creation of one of the world's largest free trade areas—a market of almost 1.8 billion people with a combined GDP of $4.1 trillion. ASEAN and India have concluded negotiation on the ASEAN-India Trade in Services and Investment Agreements and look forward to an its signature soon. However transport connectivity is essential to realise the potential of these agreements. The two principal proposed modes to enhance ASEAN-India connectivity are:

- Sea route along the Mekong-India Economic Corridor (MIEC), the most important need here being the development of the deep sea port at Dawei, Myanmar and port along the eastern seaboard of India including Chennai;
- Land routes along the Trilateral Highway (TH)/Asian Highway (AH)1 connecting Thailand, Myanmar and India.

ASEAN Plan of Action in Transport (1996-98) explored various areas of transport infrastructure and facilities to enable free flow of goods, peoples and ideas across the region, similar to the European Union. The transport links established within Greater Mekong Sub-region (GMS), for example, the

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Figure 13. 6A
Kaladan Multimodal Transport Project



Source: http://www.arakanrivers.net (accessed 4 April 2013).

North-South Corridor, Southern Economic Corridor and the 1,500 km long East-West Corridor financed by the ADB, link different parts of Vietnam to Laos, Cambodia, Thailand and Myanmar. The ASEAN Highway Network (AHN) is a flagship land transport infrastructure project which forms the major road (interstate highway) component of the overall trans-ASEAN transportation network ans is one of the 15 priority projects under the Master Plan of ASEAN Connectivity (MPAC). The ASEAN-India projects can be seen in Figure 13.5.

MEKONG-INDIA ECONOMIC CORRIDOR (MIEC)

The concept of the Mekong-India Economic Corridor (MIEC) has been under consideration for several years as a major India-ASEAN connectivity initiative. Integrating the four Greater Mekong Countries, namely Myanmar, Thailand, Cambodia and Vietnam with India through its east coast and North East region, it will link vibrant emerging economies through a network of land and sea infrastructure. The Corridor is envisaged as a dynamic industrial region comprising large investment zones, rapid port and rail connectivity, and smart cities.

The three major areas of cooperation to enhance the connectivity between India and ASEAN is physical, institutional and people-to-people ties and this is conceptualised to come up around the main highway connecting Vung Tau in Vietnam to Dawei in Myanmar, passing through Ho Chi Minh City, Phnom Penh and Bangkok. The highway passes through three borders: (i) Moc Bai-Bavet (Cambodia-Vietnam); (ii) Poipet-Aranyaprathet border (Cambodia-Thailand); and (iii) Sai Yok-Bong Tee (Thailand--Myanmar). On

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Figure 13. 6B
Kaladan Multimodal Transport Project



Source: http://www.arakanrivers.net (accessed 4 April 2013).

the land route, the MIEC is proposed to connect Ho Chi Minh City (Vietnam) with Dawei (Myanmar) via Bangkok (Thailand) and Phnom Penh (Cambodia) with India's North East region. On the sea route, Chennai on the eastern coast of India would connect to Bangkok, and hinterland to Vietnam and Cambodia in the eastern direction and Myanmar to the west. The road alignment connecting major economic centers will serve as the main transport spine of the corridor. It is estimated that the influence zone of the corridor extends to 80-100 km on both sides of the alignment.

ASIAN AND ASEAN HIGHWAY NETWORKS

The vital projects to enhance stronger and deeper economic cooperation and regional integration are Asian Highway Network 4 linking the five neighboring countries, the ASEAN highways to improve within-ASEAN linkages, the GMS economic corridors, the BIMSTEC highway, the India-Myanmar-Thailand TH, the India-Myanmar Highways, the Paletwa border road, the Kaladan River Project, and the Kyautphyu and Dawei Deep Seaport Projects.

The three important land customs stations (LCSs) between India and Myanmar are Moreh in Manipur/Tamu in Sagaing, Zolkawtar in Mizoram/Rihkhawdar (Chin), and Avakhung in Nagaland/Layshi in Sagaing. Out of these, the Moreh LCS has been the busiest, handling almost 99 per cent of the region's trade with Myanmar, although North East India's trade with Myanmar has always remained less than a per cent of India's total trade with that country. The road from Imphal to Palel (49 km) is largely two-lane, flat terrain, and the surface is fairly paved and maintained. In contrast, the road from Palel to Moreh (60 km) is single-lane and mostly mountainous. The surface is paved but not maintained well, and a number of sections need to be repaired.

THAILAND TRILATERAL HIGHWAY

The India-Myanmar-Thailand Trilateral Highway (TH) project which was initiated at the meeting of the Foreigh Ministers of India, Myanmar and Thailand in December 2003 is a major Initiative to enhance connectivity, trade, investment and tourism by linking the countries. The plan is to build a 1,360 km long MorehMae Sot highway the original alignment of which was to pass through Bagan, but on the suggestion of Myanmar, has been modified to pass through Mandalay now. The objective is to create a link between North East India and South East Asia.

INDIA-MYANMAR FRIENDSHIP ROAD

On the Myanmar side, a 150 km road from Tamu to Kalemyo and a 10 km road from Kyigone to Kalemyo have been constructed by the Border Road Organisation (BRO) of India, and named as a Friendship Road. Completion of the project on Myanmar territory was an imperative sub-regional initiative. With the grant-aid of the government of India, the Kaly-Tamu road was completely upgraded and opened in February 2001. Of the 160 kms Tamu-Kyigone-Kalemyo section, work on 132 kms has been completed, resurfaced and handed over to Myanmar in September 2009. Of the remaining 28 kms, work has been

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Box 13. 2
ASEAN Infrastructure Financing

The setting up of the ASEAN Infrastructure Fund (AIF) was announced in 2012. The AIF aims to finance the development of the region's road, rail, power, water and other critical infrastructure. It is estimated that ASEAN nations will require about $60 billion annually to fully address their infrastructure needs. AIF's total lending commitment through 2020 is expected to be approximately $4 billion. With a projected 70 per cent co-financing by ADB, AIF plans to leverage more than $13 billion in infrastructure financing by 2020. The AIF will be established with an initial equity contribution expected to be $485 million, of which $335 million is being provided by nine ASEAN members. The remaining $ 150 million is being provided by ADB. It is the largest initiative in ASEAN's history. A unique feature of AIF is that it will issue debt, which is targeted to be purchased through the Central Banks' foreign exchange reserves. With ASEAN countries holding over $700 billion in reserves, AIF offers an avenue for recycling the region's resources for its growing infrastructure requirements.

Private sector funding is essential for large scale infrastructure financing in ASEAN, but historically, the high degree of perceived risk on long-tenor infrastructure transactions has been a barrier for private investment. AIF is expected to help mitigate these risks, providing financing for a portion of public-private partnerships. The Fund is expected to finance approximately six infrastructure projects each year. Projects will be selected based on sound economic and financial rates of return, and the potential impact on poverty reduction. AIF will be based in Malaysia as a limited liability company. ADB has been requested by the ASEAN shareholders to administer the Fund.

Source: Asian Development Bank.

completed except 8 kms of resurfacing. This Friendship Road is a major part of the TH project.

TIDDIM-RHI-FALAM ROAD

Zolkawtar (Mizoram) and Rihkhawdar (Rhee, Chin) have been the secondary gates for border trade between India and Myanmar. Zolkawtar is 225 km from Aizawl, capital of Mizoram. The Aizawl-Zolkawtar stretch is largely double-lane through highly mountainous terrain, although the surface is paved and better maintained compared with the Palel-Moreh section in Manipur. If the route from Aizawl to Agartala is improved, and the transit trade through Bangladesh is realised, this will become the shortest land route connecting Myanmar and Kolkata. Engineers and surveyors from the BRO and Public Works of Myanmar have prepared a Detailed Project Report (DPR) for upgrading the Tiddim-Rhi-Falam road. India has allocated $60 million for the project. India signed a MoU for construction of Rhi-Tiddim road in December 2012, which would provide connectivity from Zowkhathar in Mizoram to Tedim in Myanmar.

BANGLADESH TRANSIT ROUTE

The Asian Highway (AH) routes provide road links between Bangladesh, China, India and Myanmar. It directly links New Delhi and Kunming in China through Bangladesh and Myanmar. If transit trade through Bangladesh were allowed with a reasonable level of efficiency, the scenario would change dramatically. Indeed, India and Bangladesh have already reached to an agreement on transit trade through inland waterways. Among the four states of the North East sharing national borders with Bangladesh—Assam, Meghalaya, Tripura and Mizoram, Meghalaya is the largest gateway. The enhanced connectivity between India and Bangladesh, both in physical and institutional terms, could boost border trade and open new opportunities for North East India.

MARITIME GATEWAYS

ASEAN countries are naturally endowed with some 51,000 km of navigable inland waterways. However, this is underutilised due to poor network, poor river ports and facilities, and poor intermodal connectivity. There is urgent need to develop IWT connectivity to reduce freight transport cost and time lag. The Kaladan Multimodal Transport Project will be a significant step forward, utilising Kaladan river transport and land transport for better connectivity.

The construction of new ports in Dawei, Kyaukphyu, and Pakbara are in the pipeline, and the expansion or upgrading of existing ports, such as Yangon, Sittwe, and Chennai, has been identified. Inland waterways along the Kaladan River and Ganga will significantly enhance connectivity between the mainland and Northeast India via Myanmar

RAIL CORRIDORS

Myanmar has made tremendous progress in railway construction in the last two decades. However,

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Table 13. 4
Paved Roads in South Asia
[Percentage of Total Roads]

	2003	2004	2005	2006	2007	2008	2009
South Asia	57.0	55.7					53.9
Afghanistan		23.7	27.5	29.3			
Bangladesh	9.5						
Bhutan	62.0						
India		48.6	47.0	47.7	48.2	49.5	
Maldives			100.0				
Nepal	53.9	55.7	56.1	55.9	55.1	53.9	
Pakistan	60.0	64.7		65.4			
Sri Lanka	81.0						
World	49.4	45.0					64.9

Source: World Development Indicators, World Bank (2012).
Note: Paved roads are those surfaced with crushed stone (macadam) and hydrocarbon binder or bituminised agents, with concrete, or with cobblestones, as a percentage of all roads in the country, in length terms.

Table 13. 5
Selected Road Corridors

	CORRIDOR	COUNTRIES	BASIS OF SELECTION
SHC 1	Lahore-New Delhi-Kolkata-Petrapole/Benapole-Dhaka-Akhaura/Agartala	Pakistan, India and Bangladesh	Potential to carry major intraregional traffic; potential to providing shorter route leading to transport cost savings
SHC 2	Kathmandu-Birgunj/Raxaul-Kolkata/Haldia	Nepal and India	Access to landlocked Nepal to Indian ports
SHC 3	Thimphu-Phuentsholing-Jaigon-Kolkata/Haldia	Bhutan and India	Access to landlocked Bhutan to Indian ports
SHC 4	Kathmandu-Kakarvitta-Phulbari-Banglabandha-Mongla /Chittagong	Nepal, India and Bangladesh	Access to landlocked Nepal to Bangladeshi ports
SHC 5	Sandrop Jongkhar-Guwahati-Shillong-Sylhet-Dhaka-Kolkata	Bhutan, India and Bangladesh	Potential to providing shorter route leading to transport cost savings
SHC 6	Agartala-Akhaura-Chittagong	India and Bangladesh	Shorter access to Chittagong port for Indian North Eastern States
SHC 7	Kathmandu-Nepalganj-New Delhi-Lahore-Karachi	Nepal, India and Pakistan	Potential of the corridor to carry future traffic
SHC 8	Thimphu-Phuentsholing–Jaigaon-Burimari-Mongla/Chittagong	Bhutan, India and Bangladesh	Access to landlocked Bhutan to Bangladeshi ports
SHC 9	Maldha-Shibganj-Jamuna Bridge (Bangladesh)	India and Bangladesh	Potential to provide direct connectivity to carry future traffic
SHC10	Kathmandu-Bhairahawa–Sunauli-Lucknow	Nepal and India	Potential of the corridor to carry future traffic

Source: SAARC Secretariat (2006)..

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missing links still exist in the Trans-Asian Railway (TAR), which need to be tackled for India—and South Asia—to derive maximum benefit from SKRL.

Designing of the UNESCAP's TAR began in the 1960s with the objective of providing a continuous 14,000-km rail link between Singapore and Istanbul. The TAR programme promotes railways as an energy-efficient mode of transport. But there is a missing link between North East India and Bangladesh. The railroad connecting Kulaura-Shahbajpur in Bangladesh to Mahisason in India has been defunct since 2002 due to lack of traffic as well as facilitation measures.

AIR TRANSPORT

The ASEAN Multilateral Agreement on Air Services and the ASEAN Multilateral Agreement on the Full Liberalisation of air freight services were simultaneously approved in May 2009. They call for a calibrated and gradual implementation in each contracting state, to allow countries with less developed airline industry to cope up with more developed ones. It is part of the broader ASEAN Air Transport Integration and Liberalisation Plan.

INDIA-SOUTH ASIA CONNECTIVITY

I dream of a day, while retaining our respective national identities, one can have breakfast in Amritsar, lunch in Lahore and dinner in Kabul.

Prime Minister Manmohan Singh, January 2009

In South Asia, political histories, poor physical connectivity, trade barriers, and impediments to cross-border investment are the main factors for weak economic integration. Although there have been reports identifying important connectivity corridors[10] and investment options, there has been little progress in opening connectivity.

PRIORITY ROAD CORRIDORS

Road transport has been the dominant mode in the region and has been catering to 65-70 per cent or more of the movement in the mainland countries. SAARC countries had 3.82 million km of roads in 2002, 10 per cent of the world's road network. However, the percentage of paved roads varied greatly among countries: 47.7 per cent in India and 53.9 per cent in Nepal in 2008; 65.4 per cent in Pakistan in 2006 and 81 per cent in Sri Lanka in 2003. A physical assessment of the road corridors reveals that the quality of the road network is good, and 90 per cent of the corridors, totalling around 8,800 km, have two or more lanes; a large chunk of regional road corridors in India and Pakistan are, in fact, four-lane divided highways. Less than 5 per cent of the corridors need physical improvement and another less than 5 per cent, mostly near the border areas, need widening up to two lanes. In the context of regional road corridors, one of the most crucial non-physical barriers is the lack of a bilateral transport agreement to facilitate uninterrupted movement of goods and vehicles between India and Bangladesh, and between India and Pakistan. As a result, goods are required to be trans-shipped at the border between the trucks of neighbouring countries.

In the country reports prepared under Phase I of the SAARC Regional Multimodal Transport Study (SRMTS), a total of 18 regional road corridors (both existing and potential) were identified in view of their importance in carrying both goods and passenger bilateral traffic. The corridors were selected on the basis of:

- Trends of existing traffic and the potential to carry future traffic
- Potential to provide direct connectivity by enabling movement across the region
- Ability to provide access for landlocked countries to ports or to other major transport networks
- Potential to provide shortcuts that would bring major transport cost savings, and
- Need to revitalise historical links or provide linkages for meeting socio-political requirements.

Of these, 10 were selected as priority[11]. The corridors are listed in Table 13.5 and depicted visually in Figure 13.7.

In South Asia, political histories, poor physical connectivity, trade barriers and impediments to cross-border investments are the main factors for weak economic integration. There has been little progress in opening connectivity.

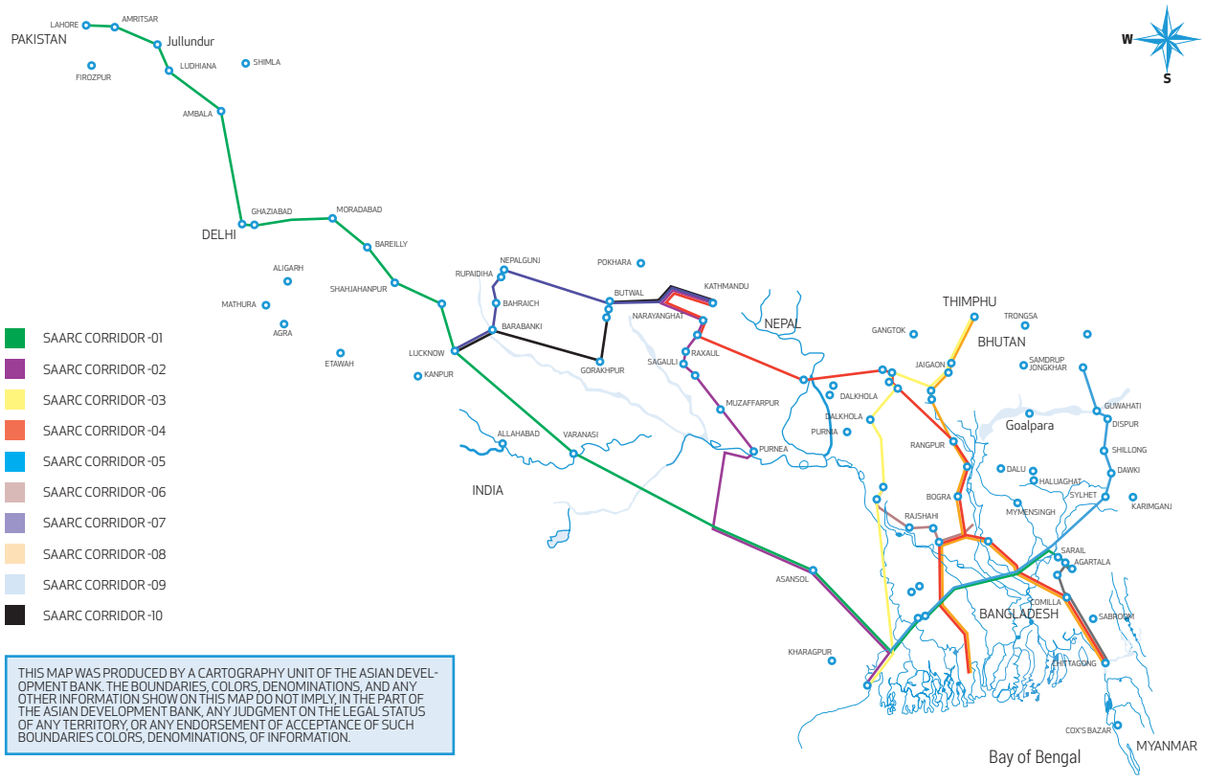
PRIORITY RAIL CORRIDORS

Railways have the potential of becoming one of the most important transport modes in South Asia, particularly for intra-regional movement between India, Bangladesh, Pakistan and Nepal (Sri Lanka does not have any rail link with India, and Bhutan and the Maldives do not have rail networks). South Asia also has one of the largest railway networks in the world, spreading over 77,000 route-kilometres of which 70 per cent is with three countries—India, Pakistan and Sri Lanka[12].

10. ADB (2002, 2006).
11. The SAARC Regional Multimodal Transport Study (SRMTS) was undertaken in two phases and the report was submitted to the SAARC Secretariat in June 2006. Subsequently, the 16th SAARC Thimphu Summit in 2010 recognised the importance of developing transport infrastructure and transit facilities, especially for the landlocked countries to promote intra-SAARC trade and declared 2010–2020 as the 'Decade of Intra-regional Connectivity in SAARC'. The countries agreed on the need to expedite negotiations with a view to finalising the two agreements on motor vehicles and railways. Sustaining the momentum of the 16th Summit, the 17th SAARC Summit in November 2011 at Addu.
12. The Imperial Gazetteer of India Atlas maintained by University of Chicago. http://dsal.uchicago.edu/reference/gaz_atlas_1909/pager.html?object=28 (accessed 5 April 2013).

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Figure 13. 7
SAARC Road Corridors, Inland Customs Stations and Ports



Source: Asian Development Bank.

Of the 15 rail corridors, seven already exist. Three of them are broad gauge rail connections between India and Bangladesh through which there is regular movement of freight. The broad gauge connectivity between Nepal and India primarily caters to the transit traffic meant for Nepal that passes through Kolkata/Haldia ports. There is no passenger movement by rail between Nepal and India. The rail connectivity between India and Pakistan through Wagha handles both passenger and small quantities of freight traffic, and the link between Munabao in India and Khokhrapar in Pakistan, passenger traffic. The other eight corridors identified existed historically and/or have the potential to be developed as future rail corridors.

The five prioritised rail corridors are listed in Table 13.6 and depicted in Figure 13.8.

INLAND WATERWAYS

Water transport is still considered to be the cheapest mode of transport in terms of costs/km for freight, as well as passenger movements. The largest inland waterways exist in India and Bangladesh. The Palk Strait, the narrow channel between India and Northern Sri Lanka, is considered to be the part of South Asia's inland waterways.

Four inland waterway corridors have been identified between India and Bangladesh. These include both existing and potential corridors of regional significance. The corridors primarily use five major rivers—Brahmaputra/Jamuna, Padma/Ganga, Meghna, Hooghly and Bhagirathi. The existing corridors are currently used for transportation of transit traffic between India and Bangladesh, as well as intercountry traffic, for which there is a number of ports of call designated under the bilateral transit agreement. The two prioritised corridors are based on traffic volume and ability to provide direct waterway connectivity for North Eastern India to seaports at Kolkata/Haldia.

MARITIME PORTS

Maritime gateways that contributed a great deal in establishing connectivity in South Asia before Partition included Chennai, Chittagong, Colombo, Karachi, Kolkata and Mumbai. However, other gateways have been making substantial contribution in

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Box 13. 3
Railways, 1947

In 1947, the single Indian railway system was divided overnight into two entirely separate systems. The North Western Railway and the Bengal Assam Railway were the most profoundly affected in that they straddled the new international boundary between India and Pakistan. The railway lines within the state of India, including 1855 miles of the North Western Railway and 1942 miles of the Bengal Assam Railway, formed the Indian Railway network. The railway lines within the state of Pakistan, including the remaining 5026 of the North Western Railway and 1613 miles of the Bengal Assam Railway, formed the Pakistan Railway networkt[13].

1947

- 1 April: Mandra-Bhaun line taken over by state (now in Pakistan).
- Independence/Partition. Two big systems, Bengal Assam Railway and North Western Railway, are no longer in India (these included the workshops of Saidpur and Mogulpura, respectively). Some 2955 route-km of NWR became the East Punjab Railway in India, leaving 8070 km in the then West Pakistan. Part of the Jodhpur Railway also went to West Pakistan. Much of the Bengal Assam Railway went to the then East Pakistan (now Bangladesh). Exchanging assets and staff dislocates all normal work, as does the large-scale movement of people between India and Pakistan.
- Assam Railway is cut off from the rest of the Indian system.
- Traffic patterns change drastically. Instead of Karachi to northern India, now all traffic is from Bombay.
- Traffic from and to Jammu and Kashmir which used to be through Lahore (via Rawalpindi and Jammu) now had to go directly to Delhi.
- There are 42 separate railway systems, including 32 lines owned by the former Indian princely states.
- Baldwin supplies the first batch of prototypes of the WP class locos (classified WP/P).
- TELCO starts production of boilers.
- 19 December: 56 EMU coaches ordered for Bombay suburban system from Metropolitan Cammell

Source: Chronology of Railways in India, Part 4 (1947-1970) http://www.irfca.org/faq/faq-history4.html (accessed 15 May 2013).

handling regional trade in recent years, due to the growth in containerisation. Several more have the potential to do so, including Kochi, Haldia, Tuticorin, JNPT (Nhava Sheva, south of Mumbai) in India, Mongla in Bangladesh and Bin Qasim in Pakistan. In addition, given its island status, the port of Male is critical for connectivity between the Maldives and other SAARC countries. Table 13.8 lists the prioritised corridors for India.

AIR TRANSPORT

Even though air transport has seen phenomenal growth over the last two decades, South Asia lags behind many other regions. Historically, the region developed its air travel links with Europe and more lately with East Asia and the Middle East. But it has not developed the intra-regional corridors or a regional network in the same manner. However, given the lowering of trade barriers and the anticipated relaxation in personal travel restrictions, growth potential for regional travel is high. There is evidence to this already in some corridors such as between Sri Lanka and India, which have adopted liberal aviation policies. Freight transport also stands on the threshold of rapid growth.

However, connectivity between the regional centres, especially the capital cities in terms of direct flights is still very low. Cost of travel is relatively high when compared to other regions.

Investment has failed to keep pace with the demand for airport capacity, particularly in relation to the provision of modern terminals and additional runway capacity. There are still many regulatory barriers in some countries in the region that prevents

13. Source: ' Statute Law Revision- Indian Railway Repeal Proposals, August 2007, published by the Law Commission of the United Kingdom (http://www.irfca.org/docs/history/ir-uklaw-intro.html (accessed 15 May 2013).

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Table 13. 6
Selected Rail Corridors

	CORRIDOR	COUNTRIES SERVED	BASIS FOR SELECTION
SRC 1	Lahore (Pakistan)-Delhi/ Kolkata (India)-Dhaka (Bangladesh)-Mahishasan-Imphal (India)	Pakistan, India and Bangladesh	Potential growth of intraregional traffic. Reduced distance and shorter transit time.
SRC 2	Karachi (Pakistan)-Hyderabad-Khokrapar-Munabao-Barmer-Jodhpur (India).	Pakistan and India	Shorter route for intra-regional traffic. Access to Karachi Port and potential third country traffic.
SRC 3	Birgunj (Nepal)-Raxaul-Haldia/Kolkata (India)	Nepal and India	Access to the landlocked Nepal. Potential corridor for third country and bilateral traffic.
SRC 4	Birgunj (Nepal)-Raxaul-Katihar (India)-Rohanpur-Chittagong (Bangladesh) with links to Jogbani (Nepal) and Agartala (India)	Nepal, India and Bangladesh	Access to Chittagong Port for Indian & Nepalese traffic. Shorter route for North Eastern States of India through Bangladesh
SRC 5	Colombo (Sri Lanka)-Chennai (India)	Sri Lanka and India	Restoration of old rail ferry link to provide passenger and goods access from the island Sri Lanka to mainland South Asia

Source: SAARC Secretariat (2006).

Table 13. 7
Selected Inland Water Transport Corridors

	CORRIDOR	COUNTRIES SERVED
SIWC 1	Kolkata-Haldia-Raimongal-Mongla-Kaukhali-Barisal-Hizla-Chandpur-Narayanganj-Aricha-Sirajganj-Bahadurabad-Chilmari-Pandu	India and Bangladesh
SIWC 2	Kolkata-Haldia-Raimongal-Mongla-Kaukhali-Barisal-Hizla-Chandpur-Narayanganj-Bhairabbazar-Ajmiriganj-Markuli-Sherpur-Fenchuganj-Zakiganj-Karimganj	India and Bangladesh

Source: SAARC Secretariat (2006).

Table 13. 8
Selected Maritime Gateways

	PRINCIPAL PORTS	BASIS OF SELECTION
India	JNPT	Potential to handle intra-SAARC traffic
	Kolkata / Haldia	Ability to provide access for landlocked countries to sea ports
	Kochi	Potential to handle intra-SAARC traffic
	Tuticorin	Potential to handle intra-SAARC traffic

Source: SAARC Secretariat (2006).

Table 13. 9
Selected Aviation Gateways

AIRPORT	RANK FOR CONSIDERATION
Delhi	2
Mumbai	6
Chennai	3
Kolkata	10
Thiruvananthapuram	9
Bengaluru	11
Tiruchirapalli	15
Cochin	12
Hyderabad	14

Source: SAARC Secretariat (2006).
Note: Colombo is 1. There is no rank 7 (Karachi and Mumbai both ranked 6) and there is no rank 13 (Lahore and Cochin both ranked 12).

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Figure 13. 8
SAARC Rail Corridors



Source: SAARC Secretariat (2006).

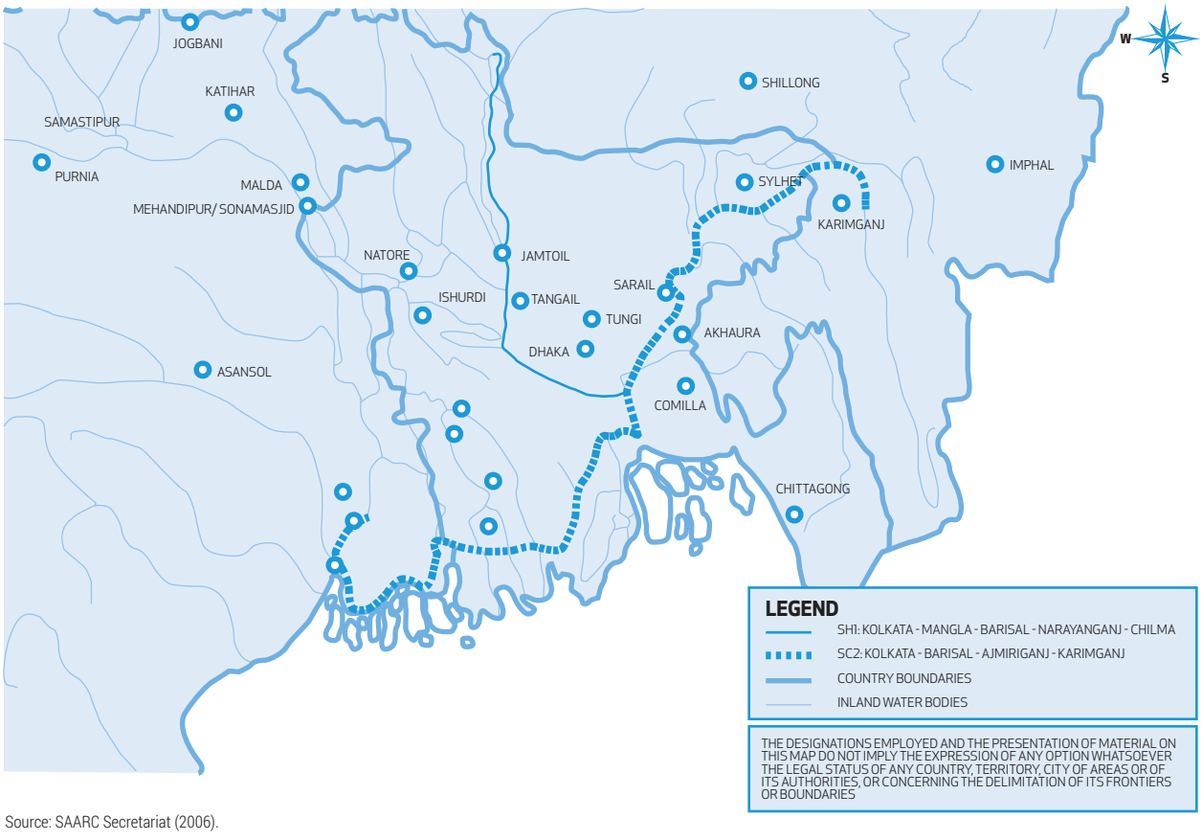
greater competition in service provision. Moreover, the region has not developed strong hub operations for efficient regional transfers. There is a clear need to adopt more liberal aviation policies and reduce regulatory barriers for seamless regional transfers.

Twenty airports within the SAARC region have flights to other regional destinations. These are considered as regional aviation gateways. In addition, five airports were considered as they could develop as gateways in the near future. Prioritisation criteria included:

- Weightage to current regional freight tonnage movements
- International passenger movements processed.
- Potential for regional tourism, and
- Fast development as industrial or commercial centres.

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Figure 13. 9
SAARC Inland Waterways



Source: SAARC Secretariat (2006).

Of the 16 aviation gateways that were prioritised, nine are in India.

TACKLING THE CONNECTIVITY CHALLENGES WITH SOUTH ASIA

An analysis of the major South Asia corridors, the current infrastructure, and actions required is detailed in Annex 13.2. A brief discussion is provided in this section.

ROAD

Road transport is the dominant mode and its importance keeps growing. Most of the trade between India and its neighbours takes place along the land routes.

FREIGHT

Freight in the SASEC region, India allows trucks from Nepal and Bhutan to operate on designated transit routes within India. Indian trucks are allowed anywhere into Nepal, but are given a limit of 72 hours to return. Nepalese trucks need permits for every trip to India with a validity of three months, but they are allowed to the nearest market towns and rail-heads in India. India allows Bhutan to use Phuntsholing (Bhutan)-Changrabandha (India)-Burimari (Bangladesh) for trade with Bangladesh, but this corridor is not allowed for third country trade.

The border between India and Bangladesh has 10 important road-based check posts. The facilities at Banglabandha (Bangladesh)/Fulbari (India)-Panitanki (India)/Kakarvita (Nepal) are exclusively for Bangladesh-Nepal bilateral trading. The Benapole (Bangladesh)/Petrapole (India) route carries the heaviest traffic by road, accounting for about 80 per cent in terms of value and 50 per cent by volume of India's exports to Bangladesh.

Between India and Pakistan, the commencement of the integrated check post (ICP) at the Attari (India) border in April 2012 will facilitate trade. Till now, 100-150 trucks could conveniently cross the border every day. The new ICP infrastructure can handle 10 times that number. Also, cargo movement between the two countries can take place for 12 hours daily against the eight hours earlier. This has started showing outstanding results. In the first quarter of the financial year 2012, imports grew by 106 per cent, while exports witnessed an increase of 39 per cent over the corresponding period in the previous year. According to a study released by the Associated Chambers

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of Commerce and Industry of India (ASSOCHAM), the ICP at the Attari-Wagah border and Pakistan's granting MFN status to India could increase bilateral trade to $8 billion a year in the next two years from the current level of $2.6 billion.

In another landmark development, truck services between Srinagar and Muzaffarabad and between Poonch and Rawalakote across the Line of Control between India and Pakistan-administrated Kashmir have been allowed. Trade is currently restricted to four days in a week.

The bilateral agreement between Myanmar and India limits the number of tradable items for the border trade to 40, and only in terms of barter. Trade imbalance needs to be settled by reverse trade within six months, instead of financial settlement, and there's no 'formal' foreign exchange facility in the border area. Consequently, official border trade has not been growing. According to the statistics of Moreh LCS, in FY 2010-11, India's export to Myanmar was Rs 2.6 million of cumin seed, and import was Rs 32 million of betel nuts and Rs 4 million of dry ginger. Meanwhile, informal border trade has been growing. As referred in De, the total trade at Moreh is estimated at Rs 2,800 million, which is far higher than the official trade statistics[14]. This obviously indicates a strong demand in the market.

PASSENGER

There are two established routes between Bangladesh and India for passenger movement. The Dhaka-Kolkata direct bus operation started in 1999 and Dhaka-Agartala in 2003. As for movement between Nepal, Bhutan and India, citizens are allowed to move freely by road without any visa and there are frequent bus services between the countries and between border points and key cities. Between Delhi and Lahore, a cross-border bus service began in 1999, got suspended in January 2002 and resumed operations from July 2003. Other bus services between Lahore and Amritsar, and between Nankana Shahib and Amritsar, have now commenced. All these go through the Wagah-Attari border crossing. Prior to opening truck services between India and Pakistan-administered Kashmir, two bus services between Srinagar and Muzaffarabad, and between Poonch and Rawalakote were launched in 2005 and 2006 respectively.

MAJOR BARRIERS AND REQUIRED ACTION

The physical and non-physical barriers across the identified priority corridors are similar in their lack of adequate infrastructure and facilities at the border areas which result in congestion and time delays. Specific problems vary in terms of narrow roads, lack of parking facilities and cumbersome procedures.

The complicated and cumbersome customs procedures at the India-Bangladesh border involve 22 documentations, over 55 signatures, and minimum 116 copies of paper for the final approval.

Physical barriers include narrow roads in India at Barasat-Petrapole (75 km 5.5m), Baharaich-Rupaidiha (25 km 3.5m), and Malda-Mohaddipur (13.5 km 5.5m) in India. Roads in poor condition are Barakar-Jharkhand and beyond in Bihar (180 km), Nanpara-Rupaidiha (15 km) and Maldah–Mohaddipur (13.5 km). Lack of facilities at the border include parking space at Dawki, Raxaul, Jaigon and Sunauli, and the immigration/customs at Phulbari. The check post and immigration offices at Agartala and Sunauli need to be shifting and the Central Warehousing Corporation at Petrapole needs protection from rain. Other issues include congestion along towns on the Petrapole-Kolkata road and weight restriction on the 80 year-old suspension bridge at Dawki. The ADB is financing a project to upgrade the road between Jaigaon and Chagrabandha, and Panitanki and Phulbari.

The non-physical barriers include lack of

- Bilateral and/or regional agreements for movement of vehicles across borders between Bangladesh, India and Pakistan
- EDI/IT system, and
- Through Bills of Lading

The cumbersome and complicated customs procedures at the India-Bangladesh border involve 22 documentations, over 55 signatures, and minimum 116 copies of papers for the final approval. There are also different documentation requirements at different border points. Working hours and weekly holidays need to be harmonised across the borders, restrictions on overloading of vehicles need to be enforced, security in some areas along the corridors has to be strengthened, and there needs to be greater transparency in inspection procedures.

RAIL

FREIGHT

Among mainland countries, India has no rail link with Bhutan and just a single link with Nepal. Bangladesh, India and Pakistan have extensive rail networks and before the partition of India in 1947, intra-sub-continental movements were mainly through the railways. Although these physical links are still there, only limited cross-border movement of freight by rail takes place between Bangladesh and India, Pakistan and India, and Nepal and India. The volumes are far less than the potential and projected growth of inter-country traffic.

14. De (2011).

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Since no South Asian port other than Colombo is able to accommodate fourth-generation container vessels, much of the intra-regional traffic is routed through this one port. This significantly increases transit times. In addition, all ports have capacity problems.

Currently, three broad gauge (BG) rail corridors are active between India and Bangladesh. Indian Railway (IR) wagons are pulled by Bangladesh Railway (BR) locomotives only over a short distance inside the country to a point where trans-shipment takes place. BR wagons do not cross the Indian border as the rolling stock is incompatible with the stock of IR.

Between Pakistan and India, there are currently two BG corridors, though one crossing is restricted to passengers only. There is limited freight movement by rail between India and Pakistan, partly due to lack of standardisation of infrastructure and rolling stock.

Between India and Nepal, rail movement is entirely via the broad gauge railway link connecting Kolkata port and other destinations in India through Birgunj Inland Container Depot (ICD).

It is important to note that the current railable traffic is almost entirely one-sided—from India to Bangladesh, Nepal and Pakistan. Wagons return to India empty. This is resulting in considerable under-utilisation of the existing transport capacity.

PASSENGER

The India-Pakistan Samjhauta Express resumed operations in January 2004, after more than two years of suspension of services. The twice-weekly train operates between Lahore and Delhi. Another train connection, Thar Express, was inaugurated in February 2006 to link Karachi via Khokhrapar and Munabao to Jodhpur.

The Maitree Express or Dhaka-Kolkata Express, a bi-weekly train, is the only passenger railway link between the two countries, and was started on 14 April 2008 after being closed for 43 years.

MAJOR BARRIERS AND REQUIRED ACTION

Physical barriers include missing links and the non-availability of air-braked fleet of rolling stock in Pakistan and Bangladesh. There is a missing 11.5 km link from Akaura (Bangladesh) to Agartala (India). Indian Railways has completed the final survey in August 2012 and the DPR is under preparation.

The main non-physical barrier is the absence of a Multilateral Rail Transport Agreement for intra-regional traffic. There are also restrictions on the movement of open wagons and oil tankers between India, Pakistan and Bangladesh. The turnaround time is too long, which affects trade requirements and causes problems like one-sided traffic and non-utilisation of wagon capacity. It is vital that issues such as manual documentation procedures, duplication of customs checks and restricted working hours are examined thoroughly.

INLAND WATERWAYS

Among South Asian countries, inland water transport links are available only between India and Bangladesh. Indian transit traffic and Indo-Bangladesh bilateral traffic move along these IWT routes under a protocol. This is the only transit facility for India through Bangladesh for serving the requirements of the North East. There is no inter-country passenger movement by IWT.

MAJOR BARRIERS AND REQUIRED ACTION

Physical barriers on the India side include navigational hazards such as shallow waters, narrow widths of channels in the rivers, siltation, bank erosions, shrinking of rivers in dry seasons; inadequate navigational aids; poor condition of wharves, jetties, platforms at the inland ports; lack of cargo handling equipment; insufficient spaces or sheds to store the cargo at almost all the inland ports and landing stations; poor hinterland connectivity; shortages of adequate vessels, and an old and obsolete fleet.

Non-physical barriers between Bangladesh and India include the lack of sufficient ports of call, shortage of skilled manpower, and labour unrest.

MARITIME TRANSPORT

FREIGHT

Since no South Asian port other than Colombo is able to accommodate fourth generation container vessels, much of the intra-regional traffic is routed through this one port. This significantly increases transit times. In addition, almost all ports have capacity problems in handling container traffic and require significant investment to handle projected demand.

It must be remembered that seaports being the gateways of a country play a significant role in its socio-economic development. Even after major development of roads and rail transport in recent decades, maritime transport continues to play a dominant role in carrying the external trade of most countries. Many great cities of the world grew around their ports. The Indian examples would be Chennai, Kolkata and Mumbai.

PASSENGER

There are currently no ferry services operating between South Asian countries. However, in SRMTS

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Phase 1, India and Sri Lanka agreed that the possibility of establishing regular ferry services between Colombo and either Kochi or Tuticorin had to be evaluated, as an alternative to Rail Corridor 5, which would have problems of restricted draft and adverse weather conditions during the monsoons.

The 17th SAARC Summit held in 2012 at Addu in the Maldives declared the implementation of the Indian Ocean Cargo and Passenger Ferry Services as a priority. A feasibility study has been completed. The study has recommended ferry routings between the Maldives, Sri Lanka and India, scheduling, and investments required in terminals and berths. A public-private partnership model has been suggested, and procedural changes in customs and immigration clearance. It is expected that this project will get completed faster than some of the other regional connectivity initiatives in the pipeline, and has the potential to significantly facilitate passenger movement and trade between the Maldives, Sri Lanka and India.

MAJOR BARRIERS AND REQUIRED ACTION

The main constraint for the identified Indian ports is that their capacities have almost reached their maximum limits and congestion is routine. Adequate channel depth is not available and it fluctuates considerably with tides and over seasons at Haldia and Kolkata. Cargo and ship handling equipment, and floating craft are old and insufficient at Kolkata, Haldia and Tuticorin. Haldia has very poor rail connectivity with the hinterland. Road connectivity is also poor at Haldia and Tuticorin for container carrying. Every port suffers from insufficient harbour area and channel depths to accommodate new generation larger vessels.

Non-physical barriers include poor port administration and management; limited implementation of EDI/IT systems to link up customs, ports and stakeholders, and no computerisation for port operations at Kolkata and Haldia. Customs procedures are complicated and time consuming at all ports. Labour unrest is a problem at Kolkata and Haldia, and there is no bilateral agreement between Colombo and Tuticorin/Kochi.

Ports need to be constructed on the basis of trends of existing traffic and the potential to carry future traffic; as also the ability to provide direct connectivity by enabling through movement across the region. The maritime gateways in India are mostly located on the west coast. Construction of new ports need to facilitate uninterrupted movement and bring major transport cost savings.

AIR TRANSPORT

As passenger and freight travel by air is expected to increase rapidly, there will be a capacity problem at airports for both passengers and cargo. There is low use of air travel when compared to population and economic conditions in the region. Presently, travel within the region, due to the paucity of direct links, often requires many transfers, sometimes having to go outside the region. These are the physical barriers.

The current non-physical barriers include air fares and airport charges, which are high when compared with other regions. Visa restrictions also discourage travel.

Physical barriers to air travel within the region include paucity of direct links, often requiring many transfers and having to go outside the region. Non-physical barriers include high air fares and airport charges, and visa restrictions.

BORDER CROSSINGS

As detailed previously, besides physical links, considerable difficulties exist at the land border crossings between South Asian countries, from documentation and bureaucratic procedures, to parking space and lack of IT connectivity.

Good measures have been taken up under Government of India's ICP project, under the Land Port Authority of India identified 13 border check posts and the Ministry of Commerce has further identified several Land Customs Stations[15]. However, some are still far from adequate and the lack of transport agreements allowing the direct movement of freight vehicle across the borders results in border congestion due to the need for transhipment. This process not only increases transport costs considerably, but results in increased damage to products, pilferage and incidences of unauthorised payments.

THE WAY FORWARD

Due to its strategic geographic location and size, India needs to play a central role in taking forward regional cooperation initiatives. It is in a position to provide key support for establishing an effective Asian institutional architecture. India is also at a center of a web of dynamic bilateral and regional FTAs within South Asia and between South Asia and East Asia and Southeast Asia. India will reap large benefits from Asian integration. The overall forward strategy needs to link the soft and hard aspects of transport infrastructure development. This is only possible through a combination of initiatives are all levels. The various actions and measures indicated need to be elaborated and appropriate legislative procedures need to be adopted and an impact assessment of each of the proposals will need to be undertaken. A summary of action points along the key identified corridors to be taken up are in Annex 13.2.

15. http://mha.nic.in/pdfs/BM_IntCheck(E).pdf (accessed 19 August 2013).

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Box 13. 4

Transport Agreements and Lessons from International Experiences

Some of the key issues with respect to trade and transport infrastructure include the harmonisation of technical and operational standards and requirements of international routes under various modes, as well as user charges for such infrastructure.

For vehicles, the key issues include commercial operating rights, vehicle registration, vehicle technical standards, traffic rules and signage, driving licenses, third party liability, and temporary importation of vehicles for the purpose of carrying goods and people across national frontiers. While adjustment in and development of transport infrastructure in a coordinated manner is critical to ensure technical compatibility and inter-operability of national transport systems, coordination in the management and control of traffic and user information is key to optimising the use of such infrastructure. The gains in efficiency from technical measures can however be offset in the absence of streamlined legal and administrative systems for international border-crossings. Discriminatory road charging, restrictive traffic quotas, restrictions on the use of foreign trucks on territory of particular countries and, last but not the least, the amount of time needed for police, customs and security clearance of vehicles and drivers are some of the factors that influence directly the transport operator's choice of the traffic route. When these and other factors are not adequately dealt with, traffic will be lost to alternative routes, involving waste on the side of the transit country which loses potential income from transit traffic and the shipper who takes a less efficient or more expensive route (UNESCAP report).

Agreements aimed at developing and operationalising a transport routes and corridors need to be developed directly or by invoking other related agreements. South Asia is the least legalised region in Asia in transport and trade facilitation agreements, which are two priority areas of ADB's support. EU is the most legalised region with more than 30 regional transport and trade facilitation agreements. ASEAN ranks at second with five regional agreements and strategic frameworks to handle trade facilitation and transport.

There are a number of international conventions that govern transport. UNESCAP issued Resolution 48/11 in 1992, which recommended seven key international conventions—and later three more—related to transport for countries in Asia and the Pacific. These conventions include Convention and Statute on Freedom of Transit; Convention on Transit Trade of Landlocked States, Convention on the Law of the Sea, WTO GATT (Article V, Transit); and various conventions on road traffic, road signs and signals The international conventions set standards to facilitate the harmonisation of transport laws and regulations and the adaptation of unified transport documents for regional transit and/or inter-state transport. More importantly, these international conventions help the streamlining of border-crossing formalities and procedures, including visa procedures for professional drivers, in order to reduce delivery time and transport costs. However, the conventions are difficult to implement at the country level for several reasons, including high cost of adjustment to meet the requirements; and lack of institutional structures at the country level.

Given these issues, except for India that acceded to Convention on Road Signs and Signals, none of countries in South Asia have acceded or signed any of the 10 important international conventions on transport.

Subregional Transport Agreements: Given the difficulties in implementing the international conventions, some subregional transport facilitation agreements have been or are being formulated.

The advantages of these subregional transport agreements are threefold. One, they play an important role in opening up regional road traffic, promoting international conventions, harmonising and simplifying formalities and procedures of bilateral transport agreements, and establishing standards not covered by international conventions. Two, the subregional transport agreements also can greatly facilitate trade as most of them have built-in trade facilitation measures. And three, subregional transport agreements can be a powerful showcase politically for regional cooperation and integration.

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The disadvantage of subregional transport agreements is that they often take years to conclude the negotiations and particularly to complete the legal process domestically for entry into force. The ASEAN Agreement on transit transport was signed in 1998 and its protocols have not been fully finalised till now. The ECO agreement on transit transport was signed in 1998 and took 9 years to enter into force. The implementation of these agreements at the country level is also facing complicated coordination issues as it involves many government ministries and authorities. Most of these agreements are under the purview of transport and thus customs authorities are not always active in implementing these agreements. Most importantly as these agreements often require reforms and adjustment of domestic legislations, many of them were signed and but never been fully ratified and/or implemented.

Bilateral Transport Agreements: Currently, Asian countries primarily rely on bilateral agreements for international road transport. However, there is no unified database for the bilateral transport agreements in Asia and the Pacific. According to UNESCAP, during 2006-07 there are more than 30 bilateral transport agreements signed. These often define specific routes rather than focusing on the transport network as a whole and provide designated designations and ports for transport carriers. They focus on issues such as traffic rights, conditions for transport, technical requirements for vehicles, compulsory issuance of vehicles, driving permits, safety and security, temporary importation duties, taxes and transit charges. Some bilateral agreements also bring in trade facilitation measures such as transit custom and other custom controls

The biggest benefit of bilateral transport agreements is that they provide direct access for the landlocked countries to the sea and immediate connectivity with neighbouring countries. This explains why a large number of bilateral transport agreements have been signed over the last two decades.

But these agreements also have limitations. Often they are not consistent with international standards. Hence it is difficult to harmonise the bilateral transport agreements. Freight forwarders and transport carriers find it difficult to comply to different transport requirements, especially if they have to bring goods across several countries with different transport agreements. Second, managing a growing number bilateral transport agreements will be a major burden for a developing country. Third, due to restrictions of routes in these agreements, carriers are often permitted to deliver goods only to pre-determined destinations, and as a result economic efficiency is significantly reduced because of empty return of trucks.

Other Legal Instruments There are also other types of legal instruments which are frequently used such as memorandum of understanding, strategic framework, and action plan for transport cooperation. Although these documents do not have strong binding effect as international conventions or bilateral and subregional transport agreements, they serve as important means to implement, monitor and coordinate collective efforts of a group of countries in facilitating regional transport cooperation.

Source: NTDPC Research.

LOWERING THE PHYSICAL BARRIERS

India's connectivity with its neighbours needs to involve all modes of transportation, namely, land (including road and railways), maritime (including inland waterway transport), and air. Cross-border multimodal transport has been identified as an efficient way of transporting international cargo. In this system of transportation with one transport document, one tariff rate and a single through-liability are applied.

ROADS

The reclassification of the last few km of all road corridors up to international borders along identified corridors is needed so they are treated as part of National Highways. This will promote upgrades to these often minor roads and thereby improve access to the border posts, as well as reduce transport costs. The development of modern border crossing facilities (on both sides), including immigration, parking and cargo handling facilities, will facilitate the smooth movement of both passengers and freight.

A major impediment to smooth flow of international transport is the existence of conflicting national laws and regulations. The modification of these domestic laws and regulations to the needs of international traffic is a challenging task, particularly since international traffic in general constitutes a small proportion of the total traffic within a country.

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Table 13.10
Summary of the Key Road Corridors

ROAD	STRETCH	BORDERS	SECTION OF INDIAN ROADS
AH1 and AH2	Asian Highways 1 and 2 through Northeastern states Moreh-Imphal-Kohima-Dimapur-Nagaon-Jorabat-Guwahati-Shillong-Dawki Land link Mekong-India Economic Corridor (MIEC) Kaladan Multimodal Transport Project Thailand Trilateral Highway project India-Myanmar Friendship Road	India-Myanmar (and ASEAN)	Moreh in Manipur/ Tamu in Sagaing (NH 39) including Imphal–Moreh (NH 39)
	Tiddim-Rhi-Falam Road	India-Myanmar (and ASEAN)	Zolkawtar in Mizoram (NH 54)/ Rihkhawdar (Chin)
		Bangladesh-India-Myanmar	Avakhung in Nagaland/ Layshi in Sagaing
SHC 1	Lahore-New Delhi-Kolkata-Petrapole/ Benapole-Dhaka-Akhaura/ Agartala	Pakistan, India, and Bangladesh	Wagah/ Attari in Punjab (NH 1) Petrapole/ Benapole in West Bengal (NH 35) Akaura/ Agartala in Tripura (SH connection NH 44)
SHC 2	Kathmandu-Birgunj/ Raxaul-Kolkata/Haldia	Nepal and India	Birgunj/ Raxaul in Bihar (NH 28A)
SHC 3	Thimphu-Phuentsholing-Jaigon-Kolkata/ Haldia	Bhutan and India	Phuentsholing/ Jaigon in West Bengal (state highways near NH 31 C and D)
SHC 4	Kathmandu-Kakarvitta-Panitanki-Phulbari-Banglabandha-Mongla/ Chittagong	Nepal, India, and Bangladesh	Kakarvitta/ Panitanki in West Bengal Phulbari/ Banglabandha in West Bengal (state highways near NH 31 C and D)
SHC 5	Samdrup Jongkhar-Guwahati-Shillong-Sylhet-Dhaka-Kolkata	Bhutan, India and Bangladesh	Dadgiri in Assam/ Gelephu Dawki in Assam (NH 40, 44)/ Tamabil
SHC 6	Agartala-Akhaura-Chittagong	India and Bangladesh	Agartala in Tripura/ Akahura
SHC 7	Kathmandu-Nepalganj-New Delhi-Lahore-Karachi	Nepal, India and Pakistan	Wagah/ Attari in Punjab
SHC 8	Thimphu-Phuentsholing-Jaigaon-Burimari-Mongla/ Chittagong	Bhutan, India and Bangladesh	Phuentsholing/ Jaigon in West Bengal Chagrabandha in West Bengal / Burimari (state highways near NH 31 C and D)
SHC 9	Maldha-Shibganj-Jamuna Bridge (Bangladesh)	India and Bangladesh	Malda in West Benal / Shibganj
SHC10	Kathmandu-Bhairahawa-Sunauli-Lucknow	Nepal and India	Bhairawa-Sunauli in Uttar Pradesh

Source: http://www.unescap.org/ttdw/common/Meetings/TFS/2011Regional-Road-Tx/Countries/India.pdf (accessed 17 May 2013).

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Table 13.11
Priority Rail Corridors

ROAD	STRETCH	BORDERS
SRC 1	Lahore (Pakistan)-Delhi/ Kolkata (India)-Dhaka (Bangladesh)-Mahishasan-Imphal (India)	Pakistan, India and Bangladesh
SRC 2	Karachi (Pakistan)-Hyderabad-Khokrapar-Munabao-Barmer-Jodhpur (India).	Pakistan and India
SRC 3	Birgunj (Nepal)-Raxaul-Haldia/ Kolkata (India)	Nepal and India
SRC 4	Birgunj (Nepal)-Raxaul-Katihar (India)-Rohanpur-Chittagong (Bangladesh) with links to Jogbani (Nepal) and Agartala (India)	Nepal, India and Bangladesh
SRC 5	Colombo (Sri Lanka)-Chennai (India)	Sri Lanka and India

Source: SAARC Secretariat (2006).

A greater understanding of the domestic regulatory regimes affecting international transport is essential to create a harmonised regulatory regime at the regional level. Formalisation of AH and TAR Agreements can set the stage for more collaborative efforts in bringing greater uniformity in national transport laws, regulations and practices. Internationally agreed technical standards have a strong symbolic value, and can potentially exert a strong influence on national transport planning, particularly when these standards are an integral part of formal, legally binding international agreements. A coordinated effort in the medium term to develop agreements along important identified corridors is required as a next step. For roads, the development and adoption of bilateral transport agreements between Bangladesh and India, as well as India and Pakistan, will enable through transport to travel directly between the countries, thus eliminating the costly and time-consuming process of transshipment at the borders on all of the SAARC road corridors.

RAILWAYS

A standardisation of technologies, including track, signaling and rolling stock, in order to introduce commodity specific freight wagons capable of hauling longer and heavier axle load freight trains will eliminate avoidable marshaling, lower speeds and longer transit times is required. The development of additional container terminals connecting major commercial centres and ports along the corridors will enable movement of containerised cargo via the shorter routes in the region compared to the much longer road/rail/sea routes at present and thereby bringing down the unit transport costs. Stress should also be laid on development of the railway network of India with Bangladesh and Nepal. Coordination of the standardisation/rationalisation of the gauge conversion programmes of Indian and Bangladesh Railways will achieve seamless operations of intra-regional freight and passenger trains without the need for transshipment due to gauge differences. The uniformity of prevailing systems and procedures at interchange points, simplification of documentation, elimination of double customs checks, introduction of IT enabled data transfer facilities and introduction of round-the-clock working for trade facilitation will enhance the performance of the international rail freight services throughout the SAARC region.

IWT

A joint assessment needs to be undertaken by Bangladesh and India of the future role that inland waterways can play in regional connectivity and whether this would justify investment in dredging and vessels replacement. To make inter-country traffic movement by IWT attractive, more ports of call in Bangladesh should be allowed under the bilateral agreement. Further, installation and maintaining navigational aids to provide 24 hour travel to enhance transit times and attract new traffic; and upgrading jetties and replace old cargo handling equipment and craft needs to be undertaken.

MARITIME GATEWAYS

Improvement of port and trade facilitation measures though simplification of procedures and introduction more EDI/IT to reduce dwell times at all ports has to be surveyed and undertaken.

AVIATION

For enhanced aviation connectivity, bilateral agreements with emphasis on direct capital-to-capital air connections; and development of low cost carrier operations to actually reduce the cost of air transport for those unable to afford the benefits of schedules services will encourage regional traffic.

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Before entering into any regional transport agreement, countries in South Asia have to consider the required reform and adjustment of domestic legislations that are enforced by the signed regional agreements. This domestic legal process can be very lengthy.

NORTH EAST INDIA

The development strategies for Myanmar and Northeast India can be the core of the regional strategy to enhance ASEAN-India connectivity.

EFFICIENT LOGISTICS SYSTEMS

Among others, an efficient logistic system includes a network of inland container depot (ICDs) and container freight stations (CFSs). First, the development of ICDs is of critical for India. ICDs/CFSs are interfaces between connecting different modes of cross border transports and offer a total package of activities to handle export and import containers and general cargo flows between road, rail and waterways in a cost effective manner with logistic services such as storage, grading, sorting, packaging, repair, and clearing activities, including custom clearance.

Benefits of connectivity are limited if India does not have a functional ICD network. This is largely because a major amount of India's exports is generated in the northern states which are located far away from sea port gateways. Second, these ICDs and CFSs have to be connected by rail and road networks to the sea ports to enable smooth and seamless movement of containers. India's Container Corporation (CONCOR) has developed a number of ICDs and CFSs, which are connected with the broad rail network. However, there is still a need for development and strengthening of more ICDs, and CFSs, especially in the Northeast region to connect with ASEAN.

Second, freight forwarders and shipping lines play important roles as multimodal transport operators. Indian shipping companies are, however, relatively small both in terms of vessels and in terms of cargo transported with the sole exception of the state owned. Despite support from India's government, Indian shipping companies carry less than 10 per cent of total Indian container trade (Indian Port Association).

DEVELOPMENT OF INDUSTRIAL CLUSTERS

ASEAN economies show a high level of integration with the global supply chain, and this has significantly driven the development of physical connectivity, particularly maritime trade with East Asian countries. For ASEAN India connectivity becomes more commercially and economically viable, it is important to development industrial clusters/production networks along the main road, rail, maritime, and inland water ways of ASEAN and India. For example Bangkok-Chennai can develop industrial agglomerations to lead the regional economy by providing large markets of final and intermediate goods and raw materials. Other potential regional production networks such as Chiang Mai-Kolkata-Dhaka-Kunming; Yangon-Mandalay; and Dawei-Kyaukphyu-Guwahati can be developed.

SUB-REGIONAL APPROACH

A three-level approach is proposed, where, at the national level, it is led by individual countries; at the bilateral/sub-regional level, by two or more countries, and regionally by the entire group of countries. In the longer run, smooth flows between countries will come with development and adoption of regional transport and transit agreements to allow through movement of vehicles, goods and passengers across the region on a door-to-door basis; widening the existing visa exemption schemes to promote regional travel by citizens; undertaking a study to identify gateways that have potential to become regional aviation hubs and finally move towards a regional aviation agreement for open skies for passengers and freight transport to promote more air services.

LOWERING NON-PHYSICAL BARRIERS

Institutional connectivity refers to linking various international or regional agreements and protocols to facilitate international transactions of goods and services as well as the movement of natural persons across borders. Most of the costs and delays along India's main economic corridors with South Asia and ASAEN are due to complex trade documents and procedures. Complicated documents and procedures in custom clearance, quarantine certification, import and export licenses, transshipment, physical inspection, terminal handling and transit causes trade delays and increase costs. Trade and transport facilitation measures therefore play a crucial role for cost and time reduction for trade.

POLITICAL COMMITMENT FOR REFORM AND ADJUSTMENT OF DOMESTIC LEGISLATIONS

Before entering into any regional transport agreement, countries in South Asia have to consider the required reform and adjustment of domestic legislations that are enforced by the signed regional agreements. The lessons from ASEAN and CAREC have clearly demonstrated that the negotiation and the domestic legal process to bring a regional transport agreement into force can be very lengthy. This can be counterproductive as it may trigger a retreat to bilateral agreements if countries are frustrated with the regional process. The SAFTA is a good example. Exhausted by the sluggish process of

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Box 13. 5

A Comprehensive Approach: The European Union

I. CHALLENGES TO EU TRANSPORT

- **Unequal growth** in the different modes of transport. While this reflects the fact that some modes have adapted better to the needs of a modern economy, it is also a sign that not all external costs have been included in the price of transport and certain social and safety regulations have not been respected, notably in road transport. Consequently, road now makes up 44 per cent of the goods transport market compared with 41 per cent for short sea shipping, 8 per cent for rail and 4 per cent for inland waterways. The predominance of road is even more marked in passenger transport, road accounting for 79 per cent of the market, while air with 5 per cent is about to overtake railways, which have reached a ceiling of 6 per cent.

- **Congestion** on the main road and rail routes, in towns, and at airports; if most of the congestion affects urban areas, the trans-European transport network itself suffers increasingly from chronic congestion: some 7 500 km, i.e., 10 per cent of the road network, is affected daily by traffic jams. And 16,000 km of railways, 20 per cent of the network, are classed as bottlenecks. Sixteen of the Union's main airports recorded delays of more than a quarter of an hour on more than 30 per cent of their flights. Altogether these delays result in consumption of an extra 1.9 billion litres of fuel, which is some 6 per cent of annual consumption.

- **Increasing labour mobility** due to economic growth was also putting heavy load on the EU transport network. As far as goods transport is concerned, growth is due to a large extent to changes in the European economy and its system of production. In the last 30 years, EU moved from a 'stock' economy to a 'flow' economy. This phenomenon has been emphasised by the relocation of some industries—particularly for goods with a high labour input—which are trying to reduce production costs, even though the production site is hundreds or even thousands of kilometres away from the final assembly plant or away from users. The abolition of frontiers within the Community has resulted in the establishment of a 'just-in-time' or 'revolving stock' production system which required a more seamless EU transport network than ever before.

- **Mobilising capital** remains a key challenge EU transport development, apart from technical or environmental considerations. Traditionally, transport infrastructure has been built on the basis of public funding, whether regional, national or Community. Most of the road or rail projects currently underway follow this pattern. However, due to limited public funding, a number of EU transport projects were delayed. For example, the funds needed to develop the trans-European transport network exceed 110 billion euros for the major priority projects alone, which meant that some projects had to be delayed.

II. EU TRANSPORT POLICY TO ADDRESS THE CHALLENGES

- **Shifting the Balance between Modes of Transport:** There was a growing imbalance between modes of transport in EU. The increasing success of road and air transport is resulting in ever worsening congestion as explained above, while, paradoxically, failure to exploit the full potential of rail and short sea shipping is impeding the development of real alternatives to road haulage. To solve this problem, the EU adopted five priority policies need to be attained, which include: (i) revitalising the railways; (ii) improving quality of road sector; (iii) controlling growth in air transport; (iv) developing maritime and inland waterway transport system; and (iv) liking up the modes of transport.

- **Eliminating Bottlenecks:** The EU revised the trans-European network guidelines to eliminate bottlenecks by encouraging corridors with priority to freight, a rapid passenger network rail and traffic management plans for major roads with flagship transport projects such as a high capacity railway route through the Pyrenees for freight, East European high-speed train/combined transport Paris-Stuttgart-Vienna, Fehmarn bridge/tunnel between Germany and Denmark, and the Galileo satellite navigation project.

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- **Innovative Approach for Infrastructure Financing:** The EU launched a consultation process in 1995-97 aimed at encouraging the development of public/private partnerships. Some major projects—the Øresund bridge/tunnel for example—have been funded by this partnership mechanism. The guarantees are such that almost the entire risk is borne by the State. One important lesson for any innovative approach for infrastructure financing is that new infrastructure projects should benefit from an 'income' even before the first operating revenue is generated. The income from charges on competing routes—once these have been amortised—could provide a reserve of surplus financial resources. Some of this income could therefore be used to make up the shortfall in funds needed to complete other infrastructure projects, particularly rail, in the region in question. In other words, the toll or charge is applied to the area as a whole to finance any future infrastructure. The EU can no longer expect, as with the Channel Tunnel, to repay investment by charging users once the infrastructure has been opened to traffic. When this approach were applied to the Alpine crossings, the Alpine motorways and tunnels contributed to the funding of construction work on new crossings before they opened. Switzerland has adopted the radical solution of funding this type of major work almost entirely through charges on heavy goods vehicles, starting with EU lorries.

- **A Comprehensive Approach beyond European Transport Policy:** Transport policy cannot stand isolated and has to be integrated with a broad range of other policies. The EU adopted an integrated approach beyond transport policy to ensure a sustainable transport development. These include, among others, (i) economic policy to be formulated to take account of certain factors which contribute to increasing demand for transport services, particularly factors connected with the just-in time production model and stock rotation; (ii) urban and land-use planning policy to avoid unnecessary increases in the need for mobility caused by unbalanced planning of the distances between home and work; (iii) social and education policy, with better organisation of working patterns and school hours to avoid overcrowding roads, particularly by traffic departing and returning at weekends, when the greatest number of road accidents occur; (iii) urban transport policy in major conurbations, to strike a balance between modernisation of public services and more rational use of the car, since compliance with international commitments to curb CO_2 emissions will be decided in the cities and on the roads; (iv) budget and fiscal policy to achieve full internalisation of external-in particular environmental-costs and completion of a trans-European network worthy of the name; (v) competition policy to ensure that opening-up of the transport market, especially in the rail sector, is not held back by dominant companies already operating on the market and does not translate into poorer quality public services; (vi) transport research policy to make the various efforts made at Community, national and private level more consistent, along the lines of the European research area.

Source: NTDPC Research.

the SAFTA, South Asian countries have entered into various bilateral trade agreements.

WELL-DEFINED RELATION BETWEEN TRANSPORT AND TRADE FACILITATION

It is important to define the scope of a transport agreement if it should also cover trade facilitation measures or it will only be confined to transport facilitation. The CBTAs of GMS and CAREC have built-in trade facilitation measures such as transit custom, temporary admission regime for containers, custom insurance, transshipment, joint sections and quarantine. The advantage of this is that the CBTAs are comprehensive. However, problems arise at the implementation level due to a lack of a national body that can bring together national transport, custom, and quarantine authorities. Because of this, custom cooperation in the GMS is moving slowly. Therefore, it is crucial to define at the design stage of any bilateral or regional transport agreement how trade facilitation measures will be covered; and if trade facilitation measures have to be addressed, these should be directly related to supporting transport facilitation rather than applying across-the-board trade facilitation measures.

CONSISTENCY WITH INTERNATIONAL CONVENTIONS

Regardless of what form that a legal instrument for transport cooperation may take in South Asia, it is important to ensure the consistency of the legal

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Box 13. 6
The ASEAN Experience

ASEAN endorsed the Master Plan on ASEAN Connectivity (MPAC) at the 17th ASEAN Summit held on 28 October 2010 in Ha Noi, Vietnam. In 2010, ASEAN endorsed a Work Plan of the Transit Transport Coordinating Board (TTCB) for implementation of the ASEAN Framework Agreement on the Facilitation of Goods in Transit (AFAFGIT), ASEAN Framework Agreement on Multimodal Transport (AFAMT), and ASEAN Framework Agreement on the Facilitation of Inter-State Transport (AFAFIST). In completing all Protocols to support the implementation of the ASEAN transport facilitation agreements, ASEAN encouraged the ASEAN Customs Directors-General to conclude the Protocol 2 (Designation of Frontier Posts) and Protocol 7 (Customs Transit System) of the AFAFGIT as soon as possible. ASEAN restarted the discussion on the draft Protocol 6-Railway borders and interchange stations under AFAFGIT for eventual signing. A stock-taking of road inventory of all national route sections/components of the ASEAN Highway Network (AHN) was completed and the upgrading of the ASEAN Transit Transport Routes (TTR) below Class III as a high priority of implementation was prioritised. In upgrading AHN, ASEAN agreed to install common road signs in all designated routes, with a specific priority on the TTR. ASEAN is now preparing ASEAN Regional Road Safety Strategy Plan 2011-20 covering the strategic framework for cooperation among ASEAN Member States in this area and its policy guidelines. The Strategy Plan will be aligned with the UN Resolution on the Decade of Action on Road Safety and the Moscow Declaration of the first Global Ministerial Conference on Road Safety, Enhancing transport connectivity with Dialogue Partners. A summary of the ASEAN agreements is in Annex 13.1.

ASEAN Open Skies: To facilitate and enhance air services as well as complement the transport facilitation and liberalisation efforts in ASEAN, the Ministers signed the ASEAN Multilateral Agreement in 2010 on the Full Liberalisation of Passenger Air Services (MAFLPAS) and its two Protocols, which would further expand the scope of the ASEAN Multilateral Agreement on Air Services (MAAS) to include other ASEAN cities. This Agreement and its Protocols would allow designated airlines of a Member State to provide air services from any city with international airport in its territory to any city with international airport in the territory of the other Member States and vice versa with full third, fourth and fifth freedom traffic rights. ASEAN signed Multilateral Agreement on the Full Liberalisation of Air Freight Services, which aims to ensure an efficient and competitive international air freight service in a move to promote economic growth; the ASEAN Multilateral Agreement on Air Services which will lead to the gradual removal of restrictions for greater flexibility and capacity in air freight services in the region; and the ASEAN Framework Agreement on the Facilitation of Inter-State Transport, which will pave the way for the implementation of integrated air transport services.

ASEAN Maritime Integration: The Roadmap Towards an Integrated and Competitive Maritime Transport in ASEAN (RICMT) aims to further the goals enunciated in the Vientiane Action Programme (VAP) 2004-10 and ASEAN Transport Action Plan (ATAP) 2005-10, and the ASEAN Leaders' call to institute new mechanisms and measures to strengthen the implementation of its existing economic initiatives.

ASEAN Trade Facilitation: ASEAN Single Window (ASW) is another trade facilitating platform, which is designed to expedite customs clearance and release of shipments coming to and departing from ASEAN. The Roadmap for Integration of Logistics Services (RILS) was endorsed in August 2008 to strengthen ASEAN as a single market and production base, and enhance its competitiveness through trade and transport facilitation. Under the liberalisation of logistics services which is an important element in achieving connectivity, the RILS calls for liberalisation of cargo handling services, storage and warehousing services, freight transport agency services, courier services, packaging services, custom clearance services, international freight transportation excluding cabotage, international rail freight transport services, and international road freight transport services, as stipulated in the RILS.

The Institutional mechanisms to work at and later endorse each of the agreements included holding: (i) ASEAN Transport Ministers Meeting annually; (ii) ASEAN Transport Working Group meetings, i.e., Secretary-level meeting that reports to the Transport Ministers; and (iii) ASEAN Sub-Committees, one for Land Transport, one for Maritime and one for Civil Aviation at Joint Secretary level, meeting every year reporting to the second rung.

Source: NTDPC Research.

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Box 13. 7
Institutional Arrangements in the Trans-European Networks

Due to the early identification of needs for transport facilitation in Europe, the United Nations Economic Commission for Europe (UNECE) became a focal point for regulatory and technical intergovernmental development in the transport facilitation for inland transport modes. In particular, UNECE has developed and administers many international legal instruments in this area, including the TIR Convention (1975) and Harmonisation Convention (1982) and many of them have become truly global. The Inland Transport Committee (ITC) is the highest policy-making body of the UNECE in the field of transport. In the course of the last 60 years, together with its subsidiary bodies, the ITC has provided a pan-European intergovernmental forum, where UNECE member countries come together to forge tools for economic cooperation and negotiate and adopt international legal instruments on inland transport. These legal instruments are considered indispensable for developing efficient, harmonised and integrated, safe and sustainable pan-European transport systems.

The Trans-European Networks (TEN) were created by the European Union by Articles 154-156 of the Treaty of Rome (1957), with the stated goals of the creation of an internal market and the reinforcement of economic and social cohesion. The Treaty establishing the European Union provides a sound legal basis for the TENs. According to these objectives, the European Commission developed guidelines covering the objectives, priorities, identification of projects of common interest and broad lines of measures for the three sectors concerned (Transports, Energy and Telecommunications). The European Parliament and the Council approved these guidelines after consultation with the Economic and Social Committee and the Committee of the Regions.

The Trans-European Transport Networks (TEN-T) are a planned set of road, rail, air and water transport networks in Europe. In the case of transport, decisions covering combined transport, road and inland waterways were adopted on 29 October 1993. The original aim of TEN-T was to establish a series of interconnected and interoperable European transport networks that would remove bottlenecks and fill in missing links. The scope of the TEN-T network is defined in terms of the individual transport modes. TEN-T guidelines were initially adopted on 23 July 1996.

The Trans-European Transport Network Executive Agency (TEN-T EA) was established by the European Commission for managing the technical and financial implementation of the Trans-European Transport Network (TEN-T) Programme. Its mission is to support the European Commission and TEN-T project managers and promoters, by ensuring the technical and financial management of the projects and the successful implementation of the TEN-T Programme.

The TEN-T timeline

1990: Commission adopts first action plan on trans-European networks (transport, energy and telecommunications)
1993: TENs given legal base in Maastricht Treaty.
1994: Essen European Council endorses list of 14 TEN-T 'specific' projects, drawn up by a group chaired by then Commission Vice-President Henning Christophersen.
1995: Financial regulation for TEN-T support adopted.
1996: Adoption of TEN-T guidelines.
2001: Extension of TEN-T guidelines to port infrastructure (seaports, inland ports and intermodal terminals) adopted.
2003: A group chaired by former Commission Vice-President Karel Van Miert proposes new priority projects and calls for new means of funding.
2004: Revised guidelines and financial regulation adopted, with a list of 30 priority projects (including the original 14) and a higher maximum funding rate of 20 per cent in certain cases.
2005: Nomination of the first six European coordinators
2005: A group chaired by former Commission Vice-President Loyola de Palacio due to propose axes linking TEN-T to neighbouring countries outside the EU.

TEN-T EA

The TEN-T Executive Agency is a relatively new member in the EU family of institutions and agencies:

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December 2002: Executive agencies are officially born; the legal basis for executive agencies entrusted with certain tasks in the management of European Community programmes is formalised in Council Regulation (EC) No 58/2003
October 2006: The Trans-European Transport Network Executive Agency (TEN-T EA) is established for the management of Community Action in the field of TEN-T. Its mandate covers projects which have been financed from the 2000-06 Financial Perspective and its lifetime till 31 December 2008
July 2007: The TEN-T EA Director is nominated by the Commission
August 2007: The TEN-T EA Steering Committee is nominated by the Commission
November 2007: The Commission approves the delegation of powers to TEN-T EA to efficiently and effectively implement the TEN-T Programme within the boundaries of its mandate
April 2008: TEN-T EA becomes financially, legally and operationally autonomous
July 2008: TEN-T EA's mandate is extended until 31 December 2015 and its objectives and tasks redefined to take responsibility for the TEN-T budget linked to the 2007-13 Financial Perspective
October 2008: The Commission modifies and extends the act of delegation to TEN-T EA to take account of its new tasks
January 2009: TEN-T EA becomes fully responsible for the management of all open TEN-T projects from both the 2000-06 and 2007-13 Financial Perspectives
March 2009: TEN-T EA website officially launched
November 2010: TEN-T EA moves into its permanent headquarters at Chaussée de Wavre 910 (W910) in Brussels

Source: NTDPC Research.

instrument with the standards set forth in international conventions. It is particularly important for bilateral agreements to be consistent with international standards as it can facilitate a greater harmonization of bilateral transport agreements. The Annex 13.1 to this chapter details the various multilateral transport-related agreements and initiatives that ASEAN members have agreed on over the years.

THE ROUTE

India has played a central role in regional cooperation and integration in South Asia. It is also at the center of all regional trade facilitation and transit issues. In the past, India has strengthened bilateral links with its immediate neighbors through successful FTAs and through a preferential trade agreement with Afghanistan. A fresh impetus was given to the SAFTA process with the India-Pakistan trade talks. However, the current state of surface transport networks in South Asia imposes significant barriers to trade. The problems are accentuated by poor sea connectivity for intra-SAARC trade. In such a scenario, transport facilitation efforts by India would bring vast benefits to regional trade. Removing rigidities, which have existed for decades at the borders, to enable the movement of goods across at lower cost is part of the unfinished South Asia trade facilitation agenda. India has taken a series of trade integration measures since 2007 and it is important to keep up the momentum.

Road transport is the most dominant mode of transport for India's trade with its neighbours. Yet, it continues to be underdeveloped due to poor infrastructure and ineffective protocols. Multiple agencies are involved with no single agency responsible to ensure coordinated functioning. A limited number of road routes are open for trade and a limited number of goods are allowed to be traded. The customs procedures at land ports remain far less efficient than at seaports. Rail movement is constrained by technical problems and the absence of a regional agreement.

Operational efficiency and intermodal connectivity needs to be improved. South Asian countries need to collectively strive to make land ports as efficient as seaports and charge commensurately for the facilities. The modernisation of land ports should be completed within a targeted period of three to five years. Trade through all modes should be opened up so that there are enough options available to traders. Multimodal routes need to be identified and developed and institutional reform undertaken at the borders. Trading goods across borders is also currently severely restricted by the lack of transit agreements that would allow seamless movement of goods across the region. India actively engaged in capacity building with Nepal and Bangladesh to address technical barriers to trade (TBT) and sanitary and phyto-sanitary (SPS) measures. In order to address the issue of non-acceptance of testing and certification, India needs to enter into Equivalence Arrangements and Mutual Recognition Agreements with its trading partners. Further, testing facilities need to be made available at land borders so that consignments do not have to be sent across to other places for testing.

Providing transit to landlocked countries has remained a major concern for the region, although several steps have been initiated to address the issue since 2010. The revised Afghanistan-Pakistan tran-

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sit treaty will open up new transit corridors that will link Pakistan to the Central Asian countries. If Bhutan, India and Nepal are able to formulate and implement transit arrangements equally effectively, Bhutan and Nepal's dependence on India alone would be greatly reduced and the ground would be laid for a transit arrangement at a regional level. The regional agreement will eventually connect Nepal and Bhutan to Pakistan through India; and Afghanistan to Nepal and Bhutan through Pakistan and India.

The experience of EU and ASEAN will help India in moving forward transport and trade facilitation in the South Asia region and beyond.

Coordinated and focused commitment of countries is needed to resolve the various physical and non-physical barriers in order to put in place a regional multimodal transport system for South Asia and beyond. The investments requirements are nominal to achieve substantial improvements in regional transport connectivity are nominal. Many of the building blocks are in place and India needs to play a leading role in the process of promoting an environment where there blocks can be combined.

The implementation of recommendations made in this chapter will be difficult to achieve in a business-as-usual context. If there is general agreement with the kind of transport investments and agreements that have been proposed as desirable to be achieved over the next couple of decades, it will be necessary for the government to take up this task in a focused manner. The NTDPC therefore recommends that the Government of India initiate this process by forming a dedicated Joint Task Force to Promote International Transport Connectivity within the South Asia Region. Such a Task Force should have technical participation from all the neighboring countries, along with representation from agencies such as UNESCAP, ADB and SAARC which have already done extensive work in this area.

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Annex 13.1

ASEAN Agreements

NO.	AGREEMENT	YEAR SIGNED	MAIN FEATURES
1	AFAFGIT	Dec 1998	ASEAN Framework Agreement on the Facilitation of Goods in Transit
2	AFAMT	Nov 2005	ASEAN Framework Agreement on Multimodal Transport
3	AFAFIST	Dec 2009	ASEAN Framework Agreement on the Facilitation of Inter-State Transport To simplify and harmonise transport, trade and customs regulations and requirements for the purpose of facilitation of inter-state transport of goods
4	RIATS	2004	Roadmap for Integration of Air Travel Sector Guides multilateral air services liberalisation in ASEAN by way of a series of milestones, in particular unlimited 3rd, 4th and 5th freedom of traffic rights for air freight among all ASEAN cities, and unlimited 3rd, 4th and 5th freedom of traffic rights for passenger services between all ASEAN capitals, by December 2008 and December 2010 respectively Aims to achieve the ASEAN Leaders' vision of Open Sky in the ASEAN region.
5	RICMT		Roadmap Towards an Integrated and Competitive Maritime Transport in ASEAN A time-bound action plan for concrete actions that ASEAN Member States need to take in order to achieve a more open, efficient, and competitive ASEAN maritime transport system Covers both passengers and freight services. Implementation of the specific measures is subject to conformity with international conventions and/or the relevant national laws and regulations There is a critical element in the Roadmap calling for the implementation of an ASEAN Single Shipping Market. There are a number of issues that need to be addressed prior to the implementation stage
6	MAAS		ASEAN Multilateral Agreement on Air Services
7	MAFLAFS		ASEAN Multilateral Agreement on the Full Liberalisation of Air Freight Services
8	MAFLPAS		ASEAN Multilateral Agreement on the Full Liberalisation of Passenger Air Services
9	ATAP, 2005-2010		ASEAN Transport Action Plan
10	ASW		ASEAN Single Window The National Single Window is a prerequisite of the ASEAN Single Window ASEAN-6 countries are at various stages of implementation of their respective National Single Windows
11	RILS	Aug 2008	The Roadmap for Integration of Logistics Services

Source: Asian Development Bank.

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Annex 13. 2

Status of the SRMTS Roadmap for Developing Regional Corridors/Gateways as of July 2013

SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SHC 1	Road Corridor No 1: Lahore – Delhi – Kolkata – Dhaka – Agartala (2,453 kms)	(i) Absence of an agreement for transport movement across Benapole/Petrapole makes the border crossing extremely costly requiring transshipment of goods;	(i) Within a Regional Framework, a bilateral agreement between India and Bangladesh is needed for allowing reciprocal movement of vehicles and goods across the border;	(i) India Bangladesh bilateral Trade Agreement yet to be finalized. (ii) customs standard operating procedures (SOP) implemented at 8 land customs stations including Benapole-Petrapole, Akhaura-Agartala in 2012
		(ii) Border post at Benapole/ Petrapole works for limited hours in a day and does not work over week-ends. This causes delay in cargo clearance and leads to congestion. Again, only 300 trucks are cleared per day while several hundreds continue waiting to deliver goods. Such a working system has adverse impacts on transport costs;	(ii) Provision of 24 hours and 7 days customs service, with built in transparent inspection procedures; and strengthened security measures at the border crossing needed;	(ii) SOP includes rescheduling of working hours of the customs and simplified documentation (ii) A car pass system has been introduced at Petrapole in Jan 2012. (ii) From field study inputs, it is assessed that further improvement is required
		(iii) Slow clearance of goods at border crossing points (Wagha, Petrapole/Benapole, Akhaura/ Agartala) increases transport costs;	(iii) Introduction of EDI/IT system; simplification and harmonization of customs procedures, adoption of similar documentations at all border crossings, standardization of Indian Customs Declaration (CTD) and implementation of Automated Customs Clearance system essential;	Integrated Check Post commissioned at Wagah – Attari in April 2012 and ICPs are being constructed atBenapole-Petrapole and Akhaura-Agartala
		(iv) Acute traffic congestion along Barasat – Petrapole section leads to slow down of vehicles and increases transport costs;	(iv) Infrastructure investment is needed to widen Barasat – Petrapole road to 2-4 lanes, and build by-passes around a number of towns located along Petrapole-Kolkata portion of the corridor;	Delays over land acquisition; process to acquire land has started.
		(v) Poor road condition and narrow road along Brahmanbaria-Akhaura section, increase travel time and costs;	(v) Investment is needed to improve and widen to 2-lanes, the road section Brahmanbaria-Akhaura (Bangladesh);	Poor road condition; widening yet to start.
		(vi) Absence of facilities at Wagha (Pakistan) in terms of warehousing, loading/ unloading, and at Attari border (India), in terms of parking and space for unloading of goods;	(vi) Physical facilities at border crossing on both sides of Wagha, in terms of warehousing, parking and space for loading/unloading to be built;	Wagha and Attari ICP commissioned by Pakistan and India in April 2012. Containerized cargo is to be started to avoid examination. Joint examination and EDI is also under consideration.
		(vii) Roads in Bangladesh portion of the corridor have axle load limit of 8.2 tonnes;	(vii) Strict enforcement of restriction on overloading to be imposed when Bangladesh roads are opened to international traffic;	Administrative monitoring of implementation
SHC 2	Road Corridor No 2: Kathmandu – Birgunj - Kolkata/ Haldia (1,323 kms)	(i) About 180 km road in Bihar (India) is in poor condition, which reduces vehicles speed to 20 km/ hours and increases transport costs;	(i) About 180 km of road section in Bihar (India) to be improved immediately to reduce operating costs of vehicles and travel time;	This corridor still requires improvement, especially Motihari- Sagauli-Ramgarhwa-Raxaul section (50 km), a level crossing close to the check-post and the narrow 2-lane bridge over the River Sirsiya near the border are challenges. There is significant congestion at the border point at Raxaul.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(ii) Kathmandu - Birgunj section is a long detour road (276 kms) that adversely impacts on transportation costs;	(ii) A 'Fast Track Road' (about 120 km) between Kathmandu and Birgunj should be built to reduce travel distance and transport costs;	Kathmandu Terai Fast Track Road Project is yet to be implemented
		(iii) Over 36 km of length along Pathalaiya-Hetauda road (Nepal), there are a number of single lane bridges, which are hazardous and adversely impact vehicle speeds;	(iii) Narrow bridges to be replaced by 2-lane wide bridges along Pathalaiya-Hetaudo Road (Nepal);	Feasibility study in progress
		(iv) Customs yard at Birgunj is very small, as a result trucks are parked along main roads causing congestion;	(iv) A freight station at Birgunj (Nepal) to be build urgently under Indian Economic Cooperation Programme;	Birgunj ICD has Rail connectivity to Kolkata/Haldia port. Birgunj ICP project is underway but delayed.
		(v) Immigration office at Raxaul lacks in basic facilities and parking space for unloading, causing inconvenience to users;	(v) Infrastructure investment is needed to provide parking and other basic facilities at immigration office at Raxaul (India);	Raxaul ICP is under construction.
		(vi) Slow clearance of goods at Raxaul border crossing increase costs;	(vi) Introduction of EDI/IT system, simplification and harmonization of customs procedures, adoption of similar documentations at all border crossing, standardization of Indian Customs Declaration (CTD) and implementation of Automated Customs Clearance system;	Indian side ICES system is implemented; Nepal side ASYCUDA is to be upgraded.
		(vii) Lack of formal agreement for vehicular movement across Nepal/India border, which may create problems in the future;	(vii) Nepal and India should consider signing a formal agreement under which vehicles could move across the border and within each others' territory;	SAARC Motor Vehicles Agreement is being discussed; shown as a priority item in 17th SAARC Summit declaration
SHC 3	Road Corridor No 3: Thimphu - Phuentsholing / Jaigon – Kolkata / Haldia (1,039 km)	(i) Physical facilities in terms of parking, cranes, and fork lift trucks are insufficient at Phuentsholing (Bhutan) and there is lack of adequate parking at Jaigon (India). These cause inconvenience to road users and increase congestion on roads;	(i) Physical facilities in term of cranes and forklifts at Phuentsholing and parking on both sides of the border need to be provided urgently;	Physical facilities need to be improved Congestion at Phuentsholing due to industrial estate traffic of Pasakha - the route from Bulan will cut short the distance from Pasakha by 9 km and emerge at Manglabari on the Indian side, 6 kilometres from Phuentsholing Gate
		(ii) Slow clearance of goods at border crossing in Bhutan increase transport costs;	(ii) Introduction of EDI/IT system, simplification and harmonization of customs procedures, adoption of similar documentations at all border crossing, standardization of Indian Customs Declaration (CTD) and implementation of Automated Customs Clearance system;	Indian side ICES system is implemented; Bhutan side BCAS is implemented.
		(iii) About 172 km road from Thimphu to Phuentsholing is a single lane, which results in slow down of vehicles and increases transport costs;	(iii) Infrastructure investment for widening 172 km of road from Thimphu to Phuentsholing to 2-lane is needed;	Double laning completed in 2010
SHC 4	Road Corridor No 4: KTM – Kakarvita – Phulbari – Banglabandha - Mongla/ Chittagong (1,362 kms)	(i) Absence of an agreement for cross border movement of vehicles makes the border crossing extremely costly requiring transhipment of goods;	(i) Within a Regional Framework, a bilateral agreement between India and Bangladesh is needed for allowing reciprocal movement of vehicles and goods across the border;	(i) India Bangladesh bilateral Trade Agreeement yet to be finalized.
		(ii) Over 36 kms of length along Pathalaiya – Hetauda roads, there are a number of single lane bridges that are hazardous and adversely impact vehicle speed;	(ii) Narrow bridges to be replaced by 2-lane wide bridges along Pathalaiya-Hetauda Road (Nepal);	(ii) customs standard operating procedures (SOP) implemented at 8 land customs stations which includes Phulbari – Banglabandha Feasibility study in progress

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(iii) No permanent immigration and custom office at Phulbari and at Banglabadha, where telephone and postal facilities are also missing;	(iii) Permanent immigration and Customs offices need to be built at Phulbari (India) and Banglabandh (Bangladesh) together with support facilities;	Improving Phulbari land customs station being explored with ADB assistance Work of private operator developing Banglabandha land port to be expedited
		(iv) 2.5 km road in India, close to Phulbari border point is in poor condition, and could be a bottleneck when traffic increases;	(iv) Infrastructure investment needed to improve 2.5 kms road near Phulbari, when traffic increases;	Improvement being considered with ADB assistance; 1 alternate road section between Phulbari and Medical Road intersection (15 km) being considered
		(v) Roads in Bangladesh portion of the corridor have axle load limit of 8.2 tonnes;	(v) Overloading restriction should be strictly enforced, when Bangladesh roads are opened to international/ regional traffic;	Administrative monitoring of this implementation is required
SHC 5	Road Corridor No 5: Samdrup Jongkhar - Guwahati - Shillong – Sylhet – Dhaka - Kolkata (906 kms)	(i) Absence of an agreement for cross-border movement of vehicles at Dawki/Tamabil makes the border crossing extremely costly requiring transhipment of goods;	(i) Within a Regional Framework, a bilateral agreement between India and Bangladesh is needed for allowing reciprocal movement of vehicles and goods across the border;	(i) load restriction on 80 year old Dawki suspension bridge, coal carrying vehicles permitted up to distance of 3 km from the border after which it moves in smaller vehicles
		(ii) 74 years old bridge at Dawki has a load restriction of 6 tonnes, which adversely impacts transport cost;	(ii) Infrastructure investment is needed to build a new bridge at Dawki (India) to facilitate movement of intra-country traffic;	(ii) New 165-m RRC bridge construction project approved but execution delayed, increased investment required, bidding process is likely to be started afresh
		(iii) Lack of parking space at the Dawki border crossing point, causes inconvenience to users and create congestion on the road;	(iii) Investment is needed to provide parking space at Dawki (India) border post;	(iii) Land acquisition issues have delayed Dawki ICP project, DPR is now approved and detailed engineering is in progress
SHC 6	Road Corridor No 6: Agartalla – Akhaura – Chittagong (227 kms)	(i) Absence of an agreement for cross-border movement of vehicles makes border crossing costly requiring transhipment of goods;	(i) Within a Regional Framework, a bilateral agreement between India and Bangladesh is needed for allowing reciprocal movement of vehicles and goods across Akhaura border;	(i) India Bangladesh bilateral Trade Agreeement yet to be finalized. (ii) customs standard operating procedures (SOP) implemented at 8 land customs stations including Akhaura-Agartala
		(ii) Narrow road along Akhaura - Dharkhar (15 kms) and poor road condition along Dharkhar-Comilla (56 km) both in Bangladesh lead to slow down of vehicles and increase travel time and costs;	(ii) Infrastructure investment is needed for widening and improvement of two road sections, Akhaura-Dharkhar (15 km) and Dharkhar-Comilla (56 km) both in Bangladesh;	Poor road condition and widening to start within next 5 years
		(iii) Lack of proper physical facilities at Akhaura border crossing causes inconvenience to road users;	(iii) Proper physical facilities at border crossing to be established at Akhaura;	Agartala ICP project construction works is in progress
SHC 7	Road Corridor No 7: Kathmandu – Nepalganj – New Delhi – Lahore – Karachi (2,643 kms)	(i) 2-road sections, Nepalganj – Baharaich and Bahraich – Rupaidiha are one-lane and in poor condition. These adversely impact vehicle speed and increase travel time and costs;	(i) Infrastructure investment is needed for widening and improving two road sections namely, Nepalganj - Baharaich and Baharaich - Rupaidiha, both in India;	Baharaich – Rupaidiha road section improvement works to start . Rupaidiha ICP DPR approved. Detailed Engineering in progress.
		(ii) Lack of a formal agreement between Nepal and India for vehicle movement across the border, may create problems in the future;	(ii) It is desirable to get a formal agreement signed between Nepal and India for smooth vehicles movement across the border and within each others territories;	Trucks allowed upto nearest market and have to return on same day

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SHC 8	Road Corridor No 8: Thimphu – Phuentsholing – Jaigon – Burimari - Chittagong (966 kms) or (ii) Mongla (880 kms)	(i) Lack of physical facilities at Phuentsholing and Jaigon, border crossing, in terms of parking, cranes, forklift trucks, etc cause inconvenience to road users and truckers leading to congestion on the road;	(i) Infrastructure investment is needed to provide vehicle parking at Jaigon (India) and both parking and goods handling equipments like cranes, forklift trucks, etc, at Phuentsholing (Bhutan);	Phuentsholing physical facilities need to be improved. ADB is working on a plan. Congestion at Phuentsholing due to Pasakha industrial estate traffic. Alternate route from Bulan will cut short the distance from Pasakha by 9 km and emerge at Manglabari on the Indian side, 6 kilometres from Phuentsholing Gate. Possible to connect this to Jaigaon-Hasimara Road (India) through a road firstly along the river bank and then through a single surfaced lane of approximately 5 km once it leaves the river bank.
		(ii) Lack of warehousing, parking, open yard at Burimari (Bangladesh), causes damage to goods and inconvenience to users;	(ii) Infrastructure investment is needed to provide warehousing, parking and open yard at Burimari (Bangladesh);	Pre-feasibility study of Burimari Land Custom Station completed.
		(iii) Absence of an agreement for cross-border movement of vehicles, necessity for transhipment of goods at the border, which adversely impacts transport costs;	(iii) Within a Regional Framework, a bilateral agreement between India and Bangladesh is needed to facilitate smooth reciprocal movement of transport across Burimari border post;	This would be mainly Bhutan-Bangaldesh trade though India; agreement yet to be completed.
		(iv) About 172 kms road between Thimphu and Phuentsholing is one-lane, which results is slow-down of vehicles and increases transport cost;	(iv) Infrastructure investment needed to widen 172 kms of road between Thimphu - Phuentsholing (Bhutan) to 2-lanes;	Double laning completed in 2010
		(v) Roads in Bangladesh portion of the corridor have axle load limit of 8.2 tonnes;	(v) Strict enforcement of restriction on overloading to be imposed when Bangladesh roads are opened to international traffic;	Administrative monitoring of implementation
SHC 9	Road Corridor No 9: Maldha - Shibganj – Jamuna Bridge (252 kms)	(i) About 13.5 kms road from Maldah-Mehdipur (India) and another 82 kms from Sonamasjid to Rajshahi (B'desh) are narrow and in poor condition which cause slow down of vehicle speed and increase transport costs;	(i) Infrastructure investment is needed to widen to 2-lanes and improve riding condition of two road sections (a) Maldah-Mehdipur (13.5 kms) in India and (b) Sonamasjid-Rajshahi (82 kms) in Bangladesh;	Roads are yet to be widened & condition improved
		(ii) Lack of an agreement for cross-border movement of vehicles between India and B'desh necessities transhipment of goods at border, which adversely impacts transport cost;	(ii) Within a Regional Framework, a bilateral agreement between India and Bangladesh is needed to facilitate smooth reciprocal movement of transport across Sonamasjid border post;	(i) India Bangladesh bilateral Trade Agreeement yet to be finalized. (ii) customs standard operating procedures (SOP) implemented at 8 land customs stations including Sonamasjid-Mohaddipur border crossing in 2012
		(iii) Roads in Bangladesh have axle load limit of 8.2 tonnes;	(iii) Strict enforcement of restriction on overloading to be imposed when Bangladesh roads are opened to international traffic;	Administrative monitoring of implementation

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SHC 10	Road Corridor No10: Kathmandu – Bhairahawa – Sunauli - Lucknow (663 kms)	(i) Lack of adequate physical facilities on Indian side at Sunauli border post in terms of parking, space for unloading of goods for checking and lack of baggage scanning and rest rooms at immigration office cause inconvenience to traders and passengers;	(i) Infrastructure investment is needed to provide parking, space for unloading of goods for inspection at Sunauli border post, and also the scanning facility and rest rooms at the immigration office;	ICP at Sunauli planned in Phase 2; DPR approved; proposal under preparation
		(ii) The Indian immigration office at Sunauli is located in a busy market place, which causes traffic congestion and inconvenience to travellers;	(ii) Immigration office at Sunauli (India) to be shifted to a convenient place;	
		(iii) On Nepalese side, lack of banking facility at Sunauli border point compels the traders to take their customs payments to City Bank office at Bhairahawa, causing delays;	(iii) HMGN needs to ensure that a banking facility is established at Sunauli border post;	
SRC 1	Rail Corridor No 1: Lahore – Delhi – Kolkata – Dhaka - Imphal (2,830 kms)	(i) Non-utilization of the available capacity of Indian Railway freight wagons by Pakistan and Bangladesh - trade being largely one sided;	(i) Promotion and development of intra-regional railable traffic to utilize the existing capacity of Indian Railway wagons which are being returned in empty condition from Bangladesh, Nepal and Pakistan resulting in wastage of transport capacity;	
		(ii) Restriction on movement of commodity specific rolling stock including open freight wagons, oil tanks and containers between India and Pakistan and India and Bangladesh;	(ii) Existing bilateral agreements to be suitably modified; (ii) A multilateral agreement permitting movement of commodity specific freight wagons between the SAARC member states is needed in order to meet the requirement of trade and industry be put in place	Regional Railway Services Agreement expected to be concluded soon
		(iii) Sectional capacity constraints for increasing the throughput on the corridor in view of the growth potential;	(iii) Investments are required on priority to augment the sectional capacity in the saturated sections on the corridor, including improvement of the permanent way, signalling, additional lines and by-passes etc; (iii) Identified major capacity augmentation /gauge conversion works to be completed;	Indian Dedicated Freight Corridor project is in progress; expected completion 2017
		(iv) Inadequate capacity of the holding, yard and terminals causing marshalling of rakes and consequent detention to the rolling stock;	(iv) Inadequate capacity of holding lines, loops and terminals for Indian Railway rakes results in marshalling and consequent detentions to the rolling stock. Capacity augmentation is required on an urgent basis on Bangladesh Railway network;	Capacity may be improved
		(v) Axle load restriction on Jamuna bridge prohibiting any through movement of BG freight trains across Jamuna bridge (Bangladesh);	(v) Strengthening of the existing bridge to facilitate movement of through BG freight and container trains or provision of a transhipment hub at Ishurdi, purely as an interim measure; (v) Reconstruction of Jamuna bridge to facilitate movement of broad gauge loaded freight and container trains;	Recent study says fully loaded ISO containers on low platform flat cars of Container Corporation of India can move over Jamuna Bridge, without any load restrictions.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(vi) Different gauges on the corridor requiring transhipment of goods;	(vi) Dual gauging between Joydebpur – Dhaka to be provided on priority;	Completed; Maitree Express runs directly between Dhaka and Kolkata
		(vii) Kulaura – Shahbazpur rail section is out of commission (Bangladesh);	(vii) The section should be restored and opened for traffic with dual gauge/broad gauge to facilitate intra-regional movement of freight and passenger trains; (vii) Metre gauge sections between Joydebpur – Akhaura – Shahbazpur (Bangladesh) and Mahishasan – Jiribam (India) to be undertaken and completed on priority;	(vii) Detailed Project Plan preparation of rehabilitation of Kulaura- Shahbazpur section of Bangaldesh Railways to start shortly; works to be taken up under line of credit from India (vii) Karimganj – Mahisasanguage conversion has been approved by India in 2011; work to commence (vii) Mahisasan-Shahbazpur MG route has not been operational since December 1996 due to lack of traffic
		viii) Missing rail link between Jiribam – Tupul (Imphal);	(viii) The ongoing work of a new broad gauge line connecting Jiribam with Tupul (Imphal) in India to be completed;	Jiribam-Tupul (98 km), work in progress, expected commissioning March 2014 Jiribam-Imphal (125 km), work started, expected commissioning March 2016
		(ix) Restricted working hours, multiple customs clearances at inter-change points;	ix) Round the clock working hours at Wagha and Gede-Darshana interchange points with simplified single custom checks should be ensured;	This is yet to be achieved.
SRC 2	Rail Corridor No 2: Karachi – Khokhrapar – Munabao – Jodhpur (707 kms)	(i) Restriction on movement of freight trains on this corridor;	(i) This being shorter route for bilateral traffic between central India and Pakistan, (currently opened only for passenger trains), should be opened for freight traffic also;	Restriction in Bilateral Trade Agreement
		(ii) Absence of infrastructure for handling freight traffic at Munabao (India) and Khokhrapar/ Zero Station (Pakistan);	(ii) Development of infrastructure for handling freight traffic including holding lines, yard lines with provisions of customs and rolling stock inspections should be taken up at Munabao and Khokhrapar/Zero Point station;	Can be commissioned in Trade Agreement removes restriction
		(iii) Single line sections and change of gauges	(iii) Gauge conversion work of Bhildi - Samdarimetre gauge line connecting ports of Gujarat from this corridor should be expedited; (iii) Hyderabad – Khokhrapar and Munabao – Jodhpur is a BG, single line section and may require doubling in view of the projected growth of traffic from ports;	Bhildi - Samdari (223 km) metre gauge conversion project completed. Expert Group meeting in July 2012 discussed the possibility of a dedicated rail route between Sindh (PAK) – Rajasthan (IND) through the Khokhrapar – Munabao border crossing point.
		(iv) Absence of bilateral agreement between India and Pakistan for running of freight trains;	(iv) Existing bilateral agreement should be expanded to incorporate movement of freight traffic via this corridor;	Restricted in Bilateral Trade Agreement
SRC 3	Rail Corridor No 3: Birgunj – Raxaul – Kolkata Port/ Haldia port (704/832 kms)	(i) Inadequate sectional capacity in different sections on this corridor affecting movement of traffic;	(i) Birgunj – Barauni section is oversaturated requiring augmentation of the capacity to handle the projected growth of traffic;	Congestion exists in this section
		(ii) Excessive transit time between Birgunj and Kolkata port;	(ii) The current transit time of over 72 hours should be brought down by minimizing en route detentions on account of change of traction and other capacity constraints in single line sections;	No significant reduction in transit time

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(iii) Lack of usage of through Bills of Lading and acceptance of a combined transport document cumbersome procedures and manual documentation at Kolkata port and Birgunj;	(iii) IT enabled customer facilitation services, streamlining of procedures and adoption of appropriate usage of through Bills of Lading should be undertaken on priority;	Documentation procedures can be considered for simplification.
SRC 4	Rail Corridor No 4: Birgunj – Katihar – Singhabad – Rohanpur – Chittagong with links to Jogbani (Nepal) and Agartala (India) (1,146 kms)	(i) Capacity constraints due to single line sections and poor condition of track and signalling;	(i) The corridor is largely on single line broad gauge/ metre gauge network with severe capacity constraints in Mansi – Katihar (India), Tungi - Akhaura (Bangladesh) and poor condition of track between Rohanpur – Rajshahi and Azimnagar – Ishurdi (Bangladesh). Immediate steps are required towards augmenting the sectional capacity which adversely affects the freight traffic on this corridor;	Track doubling work between Barauni – Mansi – Katihar (India) is expected to be completed soon. Work to remove constraints on Bangladesh side yet to pick up momentum.
		(ii) Inadequate infrastructure including loops holding lines causing avoidable marshalling and detention to the rolling stock;	(ii) Inadequate holding capacity of lines in Rohanpur yard (Bangladesh) necessitates load shedding and detention of wagons at Singhabad (India). Holding capacity of lines should be increased as a priority	Work to remove constraints on Bangladesh side yet to pick up momentum.
		(iii) Axle load restriction on Jamuna bridge prohibiting movement of loaded BG freight trains;	(iii) Strengthening of Jamuna Bridge to facilitate movement of broad gauge freight trains with higher axle loads; (iii) Reconstruction of Jamuna Bridge;	Recent study says fully loaded ISO containers on low platform flat cars of Container Corporation of India can move over Jamuna Bridge, without any load restrictions.
		(iv) Metre gauge sections - Joydebpur – Chittagong (Bangladesh) and Katihar – Jogbani (India);	(iv) Dual gauging of Joydebpur – Dhaka to be completed on priority. Ongoing gauge conversion work on Katihar – Jogbani section be expedited; (iv) Dual gauging of Joydebpur – Chittagong section or provision of broad gauge alongside metre gauge should be undertaken to enable running of trains without transhipment on this corridor;	(iv) Joydebpur – Dhaka (Bangladesh) dual guage completed; Katihar – Jogbani (India) broad guage completed (iv) Works for dual gauging of Joydebpur – Chittagong section or provision of broad gauge alongside metre gauge is to be undertaken to enable running of trains without transhipment.
		v) Missing link between Akhaura and Agartala;	(v) India and Bangladesh to undertake survey/feasibility study for construction of this short missing link connecting Akhaura with Agartala; (v) Provision of broad gauge line connecting Akhaura with Agartala to facilitate through movement of intra-regional traffic;	Final survey completed in 2012 and DPR is under preparation.
		(vi) Capacity constraints at Chittagong port;	(vi) Dredging, remodelling of railway yard and adequate supply of freight wagons should be ensured;	Work yet to be completed. Track and bridges between Dhaka ICD and Chittgong Port to be strengthened and wagon availabity increased.
		(vii) Missing link between Jogbani(India) and Biratnagar (Nepal);	(vii) Jogbani – Biratnagar BG link be constructed to operationalise the corridor link from Katihar;	DPR has been completed for Jogbani– Biratnagar 18 km BG link.
		(viii) Restriction on movement of air-braked rolling stock and commodity specific freight wagons;	(viii) Bilateral agreement should be expanded to permit movement of commodity specific open, air-braked and oil tanks wagons between India and Bangladesh;	This is yet to be done.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(ix) Restrictive bilateral rail transport agreement and absence of a multilateral transport agreement for third country and transit traffic;	(ix) To operationalise through movement of freight and passenger trains on this corridor with third country, transit and bilateral traffic, a multilateral transport agreement between the concerned SAARC member states needs to be put in place;	Regional Rail Service Agreement is being discussed for finalization
SRC 5	Rail Corridor No 5: Colombo – Talaimannar – Rameshwaram – Chennai (1,025 kms)	(i) Medawachchiya – Talaimannar pier railway line is currently non operational;	(i) Restoration of Medawachchiya to Talaimannar pier is required to provide connectivity between Colombo and Talaimannar pier;	Track will be constructed in two phases from Medawachchiya to Madhu and Madhu to Talaimannar Pier including pier construction. Contract has been awarded.
		(ii) Ferry link between Talaimannar and Rameshwaram is suspended for last more than 15 years;	(ii) Restoration of ferry link for transhipment of goods and passengers across the channel should be expedited;	Ferry link to be discussed between India – Sri Lanka; feasibility study being done by India for resumption of services.
		(iii) Metre gauge sections on Indian railways involving transhipment;	(iii) Rameshwaram – Madurai gauge conversion work should be completed on priority to enable through broad gauge connectivity on the corridor;	Rameshwaram – Madurai gauge conversion completed.
		(iv) Capacity constraints on Madurai – Dindigul section on Indian Railways;	(iv) Madurai – Dindigul section should be taken up for doubling to minimize the capacity constraints;	Madurai-Dindigul section has been doubled.
		v) Poor condition of permanent way and signalling in Medawachchiya – Polgahawela sections;	(v) Upgradation of permanent way and signalling should be taken up on priority on this section by Sri Lankan Railways;	Rehabilitation project of Signalling and Telecommunication System in the Northern and Talaimannar Lines of Sri Lanka Railway is in progress
		(vi) Old bilateral agreement;	(vi) Old bilateral agreement for rail-cum-ferry link connecting the island country of Sri Lanka with India should be expanded to include other ferry links and movement of containerized cargo;	Rail-cum-ferry link agreement under consideration between governments of two countries.
SIWC 1	Inland Waterways Corridor No 1: Kolkata – Haldia – Raimongal – Mongla – Kaukhali – Barisal – Hizla – Chandpur – Nerayanganj – Aricha – Sirajganj – Bahadurabad – Chilmari - Pandu (1,439 kms)	(i) Existing protocol between India and Bangladesh is currently being renewed only in amonthly basis;	(i) Existing protocol to be renewed for a longer period, say for a few years;	Protocol has been extended for longer period and is now valid till 2013.
		(ii) Lack of sufficient ports of call in Bangladesh for movement of inter-country trade;	(ii) Allow more ports of call within Bangladesh;	Silghat (India) and Ashuganj (Bangladesh under SIWC 2) included as a port of call.
		(iii) High rate of siltation in both Bangladesh and India;	(iii) Extensive and regular dredging needed to maintain safe navigability of the rivers;	Indian side dredging has improved draft to 3 m. Bangladesh side
		(iv) Navigational hazards like shallow waters, narrow width of channels and inadequate navigational aids;	(iv) Investment would be needed to install more navigational aids;	Improvements can be made; investment requirement based on business case
		(v) The vessels presently plying are old and unable to carry containers;	(v) Inland water transport operators to be encouraged to replace their vessels;	90 per cent of the vessels plying are from Bangladesh; adoption and degree of compliance to vessel building standards differ between Bangladesh and India

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(vi) Poor condition of piers, jetties and other infrastructures;	(vi) Improvement of the condition of piers, as well as jetties and replacement of the old and obsolete cargo handling gear, support craft and cargo carrying vessels are needed;	New RCC Jetty to be readied at Kolkata in 2013
		(vii) Lack of storage facilities, cargo handling equipment, pilot boats, etc.	(vii) New storage facilities to be built at inland ports and cargo handling facilities to be enhanced	New Transit Shed to be readied at Kolkata in 2013 Transhipment facility for container handling at Ashuganj not in place; inland water-cum-road transport connectivity with the north-eastern Indian States through Ashuganj is not possible
		viii) Shortage of skilled manpower;	(viii) Measures for human resource development to be undertaken;	Skills / vocation education standards and certification requirements differ between Bangladesh and India
SIWC 2	Inland Waterways Corridor No 2: Kolkata – Haldia – Raimongal – Mongla – Kaukhali – Barisal – Hizla – Chandpur – Nerayangang – Bhairabbazar – Anmirigang – Markulo – Sherpur – Fenchunganj – Zakiginj – Karimgang (1318 kms)	Same as above for Corridor No 1;	Same as above for Corridor No 1;	Silghat (India under SIWC 1) and Ashuganj (Bangladesh) included as a port of call.
SMG 1	Maritime Gateway No 1 Karachi (Pakistan)	(i) No room for expansion of existing container terminals after doubling the capacity;	(i) In order to meet the container growth rate, other sites for the container terminals need to be planned; (i) Development of 3rd container terminal at KeamariGroyne to handle 4th generation container vessels, redevelopment of existing berths and increasing the depths alongside and increase the capacities of existing container terminals by raising performance per sqmetre;	Pakistan Deep Water Container Terminal project at KeamariGroyne started from April 2009. It can handle 4th generation container vessels. Dredging, reclaimation, breakwater, sand dykes, basin, quay wall and other key contracts awards. Road and rail links have been worked out. Land planned to be reclaimed for containerized general & bulk cargo, EPZ, customs. Land for cargo village has been identified. Targeted to be commissioned by 2013.
		(ii) Dock labour problems of inefficiency and levies/ charges on each tonnage handled at the port;	(ii) Dock Labour Board needs to be dissolved and unions to be brought under Essential Services net;	KDLB cess still in place; labour productivity is an issue; training needed to handle containerized cargo
		(iii) Draft limitations that restricts size of the vessels;	(iii) High capacity dredgers to be procured to clear the arrears and maintain designed depths. There is a need for capital dredging to increase drafts for accommodating larger vessels. City refuse should be treated before it is discharged into adjacent creeks and back waters. The dredged material should be used for reclaiming land;	KPT has increased capability to accommodate and provide safe berthing to 12.5 m draught container vessels on 2 of its container terminals.
		(iv) Non-responsive attitude of railway for clearing port cargo and slow delivery of goods at the destinations;	(iv) Railway tracks to be strengthened, more wagons to be procured and fast track system for goods trains to be programmed;	1.87 km newly laid rail track to transport bulk coal inaugurated in 2010. More collaborative working required between Karachi Port Trust and Pakistan Railways.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(v) Congestion in port area and high dwell time due to lack of coordination and facilitation	v) In order to reduced dwell time and congestion of the port, port and custom clearance procedures to be simplified. Awareness of the customers for use of IT/EDI system is needed. Free storage for containers be reduced and customs should enlarge their CARE system to cover whole range of cargo not only containers;	Free period for cargo clearance reduced from 10 to 5 days, average dwell time is less than 7 days. Customs Administration Reform (CARE) and Pakistan Customs Computerized System (PACCS) have simplified container clearance procedures but Agility software has issues. New WEBOC system yet to stabilize.
		(iv)Access roads are congested which has created bottleneck for the port performance;	(iv) Access roads needs to be widened, strengthened. Construct bypasses and overhead corridors for smooth and fast exit of the port traffic;	Congestion yet to ease out; plans being put in place
SMG 2	Maritime Gateway No 2 Port Bin Qasim (Pakistan	(i) The leading channel and harbour basin are subjected to heavy siltation, especially during monsoon season. Accumulation of siltation compels the authority to reduce draft during monsoon period and carry on dredging rest of the period annually. The Port does not have its own dredging fleet; therefore, dredging is contracted out. The cost of dredging also very high, therefore, committed depths are difficult to maintain during non-monsoon period;	(i) The port should develop its own fleet to maintain committed depth and get away from annual decrease and increase of drafts. The trade feels that port must increase the draft so that large bulk carriers could be accommodated from economic operations perspective;	Port is spending around Rs 3.0 billion annually to clean its channel from 5 million cubic meters silt in order to maintain its 11 meter draught. The project to deepen navigation channel for all weather 14 meter draught vessels at a cost of US$ 200 million on Design, Construct and Finance basis has been approved by Government and is under implementation.
		(ii) There is restriction on night navigation through the channel. Vessels waiting time is increased;	(ii) The channel should be properly marked. Instead of buoys, fixed beacons may be installed to prevent thefts and drafting. Night navigation must be started to save waiting time;	Night berthing has started in November 2011 with a vessel of length of 292 meters and draft of 11.7 meters made possible by the induction of three ASD tugs and one fast pilot boat.
		(iii) Dwell time are high. Clearing system still tedious and time consuming;	(iii) EDI/IT system are needed to be installed and customs CARE system to be introduced for reducing dwell time. Container free storage period to be reduced;	PACCS system has issues. New WEBOC system at QICT is stabilizing. Dwell time can be reduced.
		(iv) Shortage of railway wagons. Traders suffer and storage time is increased;	(iv) Railway wagons to be increased for carriage of container and specialized cargo up country. The railway tracks to be replaced and strengthened to increase speed;	More collaborative working required between PQA and Pakistan Railways. Pakistan Int'l Bulk Terminal (PIBT) will be connected to the railway network at Port Qasim.
		(v) Port needs further expansion as the estimated growth rate is higher in Pakistan;	v) New berths and terminals to be added to increase the capacity of the port to meet the anticipated growth;	(v) Construction of LPG, crude oil and products terminal, development of rice and other bulk cargo berths and later on development of more container terminals and a dedicated fertilizer berth;

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SMG 3	Maritime Gateway No 3 JNPT (India)	(i) The port is working at its designed capacity, whereas anticipated growth of containers by the year 2014 is 5.5 million TEUs. Port is also expected with existing space;	(i) There is need for enhancement of port capacity by developing new terminals to alleviate current problem and meet the future developments; (i) Area behind the service berth to be developed, reclamation of land for port expansion acquisition of super post Panamax RMQC and development of a tank farm;	Extension of berth by 330 mtrstowards North by DBFOT basis; 4th Container Terminal work progressing in 2 sequential phases: Phase I capacity 2.4 million TEUs, 12 RMQCs, 36 RTGCs, 4 RMGCs, 120 Tractors cum Trailors; Phase II capacity 2.4 million TEUs, 12 RMQCs, 36 RTGCs, 4 RMGCs, 120 Tractors cum Trailors; Other planned projects: Modernization and capacity addition for JNPT's self operated terminal JNPCT; Development of 5th Mega Container Terminal and other projects like ship repair yard at Nhava island; Port Based SEZ; Development of Marine Terminal for liquid cargo, tripling current capacity; Project for augmenting bulk handling.
		(ii) The road connectivity needs to be improved and there is congestion at Jawahar Customs point, waiting for export clearances;	(ii) Access roads need to be widened and repaired. There is a program underway to improve the connecting road network and this needs to be completed. A review should be undertaken of the export customs procedures to expedite their delivery into the port;	(ii) SPV created with CIDCO and NHAI with NHAI in the lead, 6-8 laning work in progress, construction of grade separators to improve connectivity
		(iii) Railway has capacity problem on Mumbai - Delhi link which slows the speed of container trains;	(iii) Additional train paths need to be provided between Mumbai and Delhi. Existing developments by IR need to be completed urgently;	(iii) Dedicated Freight Corridor (DFCC) project already taken up in 2 phases Delhi – Baroda and Mumbai – Baroda; project expected to be commissioned by 2017; will enable multi-modal high axle load freight movement
		(iv) The port lacks the modern and high performance container handling equipment;	(iv) Container handling equipment to be replaced gradually with high performance equipments and also the port should adopt modern maintenance practices that would lead to reduced equipment down time;	(iv) Orders placed for acquisition of 4 super-post Panamax RMQCs and 1 RMGC; to be commissioned by 2013
		(v) The approach channel and harbour basin is considered to be shallow and narrow for the latest large size vessels, thus effects the economic scale in the maritime transport;	(v) Plan the deepening the JNP Channel to 14 metres depth;	(v) JNPT and Mumbai harbour channel to be deepened to 14 mtr draft in 1st phase. (v) In 2nd phase, the channel is to be deepened to 17mtr; expected completion by Sept 2014
		(vi) High reliance on traditional paper work increases the dwell time and cost of the goods. There is lack of port facilitation, ICES automated clearance system at Jawaharlal Customs has not been reliable;	(vi) Efforts are needed to improve the trade facilitation by development of paperless system and adoption of revised Kyoto Convention;	(vi) ICES automated system implemented by Indian Customs; Cargo scanners and Risk Based cargo clearance system commissioned by Indian Customs, dwell time reduced by about 60 per cent

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SMG 4	Maritime Gateway No 4 Cochin (India)	(i) Cochin port is operating close to its designed capacity. This needs further capacity enhancement in line with projected traffic;	(i) Plans to be made to improve the existing infrastructure and related facilities and to expand the port by means of reclamation and development of South end Willington Island and further development at Vallarpadam The port may adopt 'Landlord' Concept to attract the investment; (i) Develop exclusive economic zone, construct bunkering terminals and further develop port area land;	Master Plan for development of Willingdon Island finalized in 2011; Vallarpadam Port Based SEZ notified and International Container Transhipment Terminal (ICTT) commissioned; Puthuvypeen PBSEZ Single Buoy Mooring facility commissioned by Bharat Petroleum; 5MMTPA LNG Terminal to be commissioned by PLL in 2013; Multi-user liquid terminal bidding in progress; Indian Oil storage tank farm development for LPG is in progress.
		(ii) The channel and basin are subject to heavy siltation due to long distance flow of river Periyar coupled with bank erosions. Round the clock dredging is needed to maintain committed depths;	(ii) Channels and harbour basins required continuous dredging. In order to reduce dredging expenditures, dredging should be contracted out on depth basis and not on dredged material basis; (ii) Dredging for ICTT project at Vallarpadam;	(ii) Channels deepened from 12.5 mtr draft to 14.5 mtr draft (ii) Berth basin dredging for ICTT undertaken (maintenance dredging)
		(iii) Progress made in computerisation in relations to customs, has not been matched by all other authorities, therefore, productivity is reduced and operational cost is increased;	(iii) Capacity building programme are required to be undertaken to improve the efficiency, operational profits and productivity as well;	Progress has been made in this direction.
SMG 5	Maritime Gateway No 5 Tuticorin Port (India)	(i) Due to draft constraints only feeder vessels are calling this port. Containers are therefore transhipped through Colombo or Singapore;	(i) There is need to increase the depths of channel and harbour basin up to 14.6 metres so that main line vessels could call directly;	In 2011, basin was deepened to 14.1 m and channel to 14.6 m.
		(ii) There is also need to expand the port capacity as its present designed capacity is 15.5 million whereas it handled 13.68 million tonnes in 2003-2004;	(ii) Berth No 9 to be constructed, the outer harbour and breakwater developed and an island breakwater constructed. With the projected traffic there is need for development of 2nd container terminal. Later there will be a need for construction of Berth No 10 and further expansion of container terminal and further studies should be undertaken for expansion of the port and enhancing the facilities;	Berth 9 constructed; Development of 2nd container terminal awarded on PPP scheme in August 2012; Feasibility Study for Outer Harbour is being processed and expected to be part of 13th Five Year Plan (2017 – 2022). Berth 10 will be part of this expansion.
		(iii) Access road and service roads are weak and narrow, therefore, remain highly congested, it is effecting efficiency of the port and difficulty to the traffic;	(iii) Condition of the access road and service roads needs to be improved through repairs. In addition the programme for widening and strengthening is also required to be expedited, preferably to provide 4-lanes for existing traffic;	Main roads have been made 4 lane to match with port connectivity with NH 7 and NH 45B. Interrior roads widened and strengthened; Plan for 6 laning during 12th Five Year Plan (2012 – 2017) with own funds and construction of 2 bridges.
		(iv) Ships handling craft are insufficient and existing are old, therefore, berthing problems are encountered;	(iv) Replace two tugs;	Proposal approved for hiring 1 tug (new) as replacement for the exisiting hired tug; Proposal for 1 new tag purchase is prepared and discussed, likely to be approved soon.
		(v) More berths are required;	(v) Construction of North Cargo Berth;	(v) The work is in progress.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SMG 6	Maritime Gateway No 6 Kolkata/ Haldia (India)	(i) The port has handled 9.95 million tones in the year 2004-2005 which is 14.4 per cent growth. Whereas, rated capacity of the port is 9.8 million tones, this necessitates for further enhancement of the capacity of KDS. On the HDC side its rated capacity is 34.10 million tones whereas it handled 32.57 million tones in the year 2003-2004;	(i) There is need to enhance the port capacity by developing more berths which seems to be not possible due to limitation of space and drafts of approaching channel, therefore, HDS to be developed for meeting the projected traffic of 7.43 per cent annually. There is also need to develop more infrastructure to facilitate the traffic and increase the throughput;	At HDC, 2 Berths commissioned in June and December 2007; 2 RMQC for improved container handling commissioned; Construction of 2 riverine jetties outside the impounded lock being taken up; At KDS 3 Mobile Harbour Cranes, 10 Reach Stackers, 5 RTG inducted; additional RTG cranes, Reach Stackers, Hydraulic Cranes, Tractor-Trailer combination etc. are being procured / hired; IT systems to improve efficiency being implemented
		(ii) The container handling equipments are inadequate and old, that effects the performance of the port;	(ii) Both ports are required to replace certain amount of cargo handling equipment especially container handling cranes (RTGS);	
		(iii)Access road and service roads are congested which effects the flow of port traffic;	(iii) There is a need to develop road infrastructure inside and outside the docks and back up area;	4 laning of Kolaghat - Haldia section (53 km) in progress; 14 km Kona Junction on NH-6 to NS Dock (in KDS) to be taken up
		(iv) Too much siltation is accumulated which creates difficulties of the traffic, navigating through Hooghly River. Draft limitations restrict the entry of main line vessels into the ports. Therefore, the port is confined to serve only feeder vessels;	(iv) Although it is near to impossible to dredge the whole length of 226 kms the channel used for navigation needs to be maintained at least for the committed depths. The accumulation of siltation is natural phenomena, but minimum dredging required keeping the ports operational needs to be ensured;	Kolkata/Haldia Port draught is reducing further due to silting; KDS is planning to construct cargo handling jetties at Diamond Harbour, 70 km downstream from Kolkata; Plan for floating storage dock being developed in common port zone with Orissa
SMG 7	Maritime Gateway No 7 Chittagong Port (Bangladesh)	(i) The river Karnaphuli suffers from heavy siltation, which often change depths of navigation channel considerably, so at times it becomes difficult for the management to control the depths;	(i) The authorities are required to acquire high capacity dredgers to maintain committed depths;	6th FYP states capital and maintenance dredging as objective of CPA Measures to salvage sunken vessels need to be initiated.
		(ii) No night navigation due to lack of pilotage services and marking of navigable channel. Vessels have to wait for day break;	(ii) Proper marking of the navigable channel is needed to commence night navigation and save time;	Night navigation is still not permitted; measures have to be initiated
		(iii) The port is working beyond its rated capacity and remains highly congested;	(iii) Port expansion programmes needs to be undertaken to increase the capacity to cater for present and future projected traffic;	(iii) Construct another container terminal with storage area and high performance equipment, build CFS at Pangaon with capacity of 30,000 TEUs, construct LNG handling facilities in the port, enhance oil products and chemicals handling facilities;
		(iv) Cargo equipment is insufficient for both conventional and specialised cargo handling;	(iv) The port must acquire modern cargo handling equipments to improve its productivity. More container freight stations to be built to relieve congestion for the port area;	Improvements need to be done.
		(v) Dwell time is too high due to poor trade and facilitation. Port and Customs procedures are manual with significant amounts of paper work;	(v) Customs reforms are essentially needed for better service, removal of congestion and reduction in dwell time. IT/ EDI system to be installed to facilitate the port users and improve clearing system;	Dwell time can be reduced.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(vi) Hinterland connectively is poor. Container movements are not properly developed by road. Railway is not fully equipped to handle the port traffic. Inland Water Transport is also not equipped for container transport;	(vi) Roads need to be improved. Access road to be strengthened widened and low load bridges to be redesigned Railway tracks to be strengthened and container carrier wagons and other specialized cargo wagons to be added in the fleet;	Railway link between Pubail and Dhrasram Railway Stations; only 10 per cent of containerized cargo can be sent by rail to Dhaka ICD.
		(vii) Labour unrest, restrictive practices has resulted in poor productivity, congestion and high operational costs. Therefore, charges are high as compared to services provided;	(vii). Labour reforms are required by addressing their social and economic problems, developing human resources and capacity building programmes;	(vii) Deregularise the dock labour and create incentives to improve labour efficiency;
		(viii) Management also lacks the knowledge of modern port practices therefore it adds to problems, quality of services and port performance;	(viii) The port needs its operational efficiency for which experienced professional at top tiers to be appointed Port is needed to adopt privatization policy and landlord concept so that investments are attracted and operational efficiency is achieved;	Operational efficiency of Port can be increased; people related matters kept out side the purview of this study.
SMG 8	Maritime Gateway No 8 Mongla Port (Bangladesh)	(i) The port is working under capacity about 50 per cent. The port has high potential for growth, but due to many deficient constraints, it has not yet attracted the traffic, particularly the container traffic It is due to non-connectivity of railway and improper road net work and many more reasons;	(i) The Mongla Port Authority should launch marketing campaign together with improving and facilities and offer incentives to the trade; (i) Link the railway system with the port;	Khulna – Mongla rail link (53 km) to be established as part of 6th FYP ending 2015
		(ii) The river Paussur and Mongla Canal are subject to heavily siltation therefore, depths are always unpredictable as such vessel are always put on risk while approaching this port;	(ii) River channel and Mongla channel require extensive dredging for which either acquire high capacity dredger or contract out dredging on depth basis to achieve better result with proper monitoring;	Removal of wrecks from Pussur channel planned;
		(iii) The port lacks proper infrastructure, including container handling facilities despite having ports of Kolkata/ Haldia and Chittagong in the vicinity;	(iii) Administrative and operational plans to be made for the port to compete with regional ports;	Included as part of 6th FYP of Bangaldesh; Improved navigational aids and procurement of harbor crafts planned
		(iv) Lighters and tug-boats used for midstream cargo operations are inadequate, old and uneconomical therefore, port becomes expensive and inefficient;	(iv) This is the era of container cargo, therefore, emphasis to be given to improve container handling facilities on the shore as well as midstream operations. Adequate equipments and container lightering barges to be acquired. The best approach should be to invite private investments if paucity of funds is felt. The port must gear up its resources to install modern facilities;	Tugs, lighters and vessel for carriage of container to inland water destinations; Crane, straddle carrier; forklifts and other handling equipment planned; equipment for handling general cargo and containers will be procured for smooth operation.
		(v) Too much paperwork, exhaustive rules and regulations create difficulties for port users;	(v) Customs reforms are essential in this port. Installation of IT system would reduce paper work. The port needs to adopt trade and transport facilitation standards so that it attracts the traffic;	Improvements need to be done.
		(vi) Labour unrest and poor management of port operation affects the productivity performance;	(vi) Labour reforms are necessary for bringing improvements in the port. Experienced professionals to be appointed to manage the port on modern lines with market oriented methodology;	(vi) Deregularise the labour and offer incentives to improve efficiency;

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SMG 9	Maritime Gateway No 9 Male Commercial Harbour	(i) The port is handling traffic well in excess of its rated capacity whereas; projected growth rate is 9.8 per cent annual. It is impossible for the port in the existing conditions to match with the growth, due to limitation of land;	(i) There is great need to expand the capacity on a priority basis for which additional land will be required by reclaiming land from the inner harbour of the west side of the terminal to cater for growing traffic. Until port expansion is undertaken under a Masterplan, in the meantime interim actions are necessary to improve the current situation;	Major expansion work yet to be taken up
		(ii) Limitations of water depths, which restricts accommodating only small size vessels;	(ii) Extend the existing 101 m berth to accommodate larger and more vessels calling at the port;	Yet to be extended.
		(iii) Storage area is limited, therefore, port remains congested. Delays in berthing, high turn-around time and high berth occupancy are major factors affecting port users and with high operational cost;	(iii) Reducing free storage time on container cargo	No Ro-Ro berths. Containers and conventional cargo are being handled at Berth and at Anchorage.
		(iv) Custom and port have all manual system of documentation and examination which results in port congestion and very high clearance time. Customs also examine the containers in the port open storage/stacking areas, which further adds to the congestion; Lack of adequately trained staff in all the areas of port operation further reduces the port efficiency;	iv) Modernise customs and port procedures so that congestion is reduced and dwell time is controlled. This should include installation of IT/EDI systems and a dedicated cargo clearance area, supplemented by implementation of a needs-based human resource plan;	Improvements need to be done.
		(v) No container crane and inadequate handling equipment. Empties are returned, because there is no sufficient export. Therefore, Male is not ideal for containerisation;	(v) Acquire additional equipment to be able to introduce high density staking methods including a high capacity RTG for the container yard be procured and replace the old equipment;	Yet to be done.
		(vi) Lack of coordination between port management and port users. Lack of proper laws to regulate, develop and operate the port. Lack of autonomy for the port management to run the port efficiently;	(iv) Port authority also addresses the issues of management deficiencies and non-cooperative status of the shipping lines and other agencies working in the port. Restructuring the port management so that it has more autonomy by further commercialization or privatization of the port operations;	The regulatory functions of the port were transfered to the Ministry of Transport and Communication and the commercial functions was corporatized as Maldives Ports Limited on 31st July 2008. Maldives Port Limited is a State Owned Enterprise.
SMG 10	Maritime Gateway No 10 Colombo Port (Sri Lanka)	(i) The port is nearing to its rated capacity, occupancy has reached to 75-80 per cent level therefore, at times berthing delays are encountered;	(i) There is immediate need for expansion of JCT and UCT to reduce congestion; (i) Enhance capacity of JCT from 2 to 2.4 million TEUs;	(i) Detailed design has been completed and implementation of this projects will make it possible to berth two 8000 TEU Container ships simultaneously at JCT III and JCT IV.
		(ii) Area of harbour basin is limited, as such its is difficult to manoeuvre large size vessels;	(ii) Engineering solution to be sorted out for removing the limitations of harbour basin. Dredging is also essential for accommodating the new 5th generation vessels coming up on the high seas; (ii) Harbour Basin to be dredged up to 15 metres;	Current capacity at Colombo Port 4.1 million TEUs with dredged depth of 15 m. Hambantota Port minimum basin depth of 17 metres will ease congestion at Colombo Port. SLPA has already diverted trans-shipment traffic (automobiles) from Colombo to Hambantota.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
		(iii) Having high throughput and limited yard area, there is significant congestion within the container terminals;	(iii) To meet the future demand of the trade and traffic plans to be made to develop south harbour; (iii) Enhance yard capacity and create incentive schemes to improve port labour. Attract private sector to invest in port capacity and other facilities;	(iii) Capacity will be increased up to 13 million TEUs with the completion of three new terminals in the South Port by 2016
		(iv) Access roads are congested for inland transportation of domestic trade i.e. 30 per cent of the total traffic handled;	(iv) Though the port is mainly used for transhipment cargo but still about 30 per cent of the total handling is for the domestic consumption, therefore, the roads and railway need to be efficient to carry the cargo in and out of the port to reduce congestions. The port area should not be used by the trader as godowns are direct sell of cargo to other parties;	At present A2 Highway connects Colombo – Galle – Hambantota. The six-lane Expressway between Colombo and Matara scheduled for completion in 2013 is proposed to be extended to Hambantota.
		(v) Frequent changes in the management has an adverse effect on overall efficiency and continuity of policies;	(v) Consistency should be developed in decision making;	Studying this has been kept outside purview of this update
		(vi) The port suffers the same port and trade facilitation problem common in the region. It has significant effect on port traffic which leads to higher dwell times especially in relation to CFS activities;	(vi) There is major demand for development and implementation of trade and transport programme. This may be introduced based on automated customs clearance system with DTI capability. Linkage between port, custom and agents on the basis of community-type IT system to eliminate paper work and manual work;	ASYCUDA World with Direct Trader Input (DTI) implemented.
SAG 1	Aviation Gateway No 1: Dhaka (Bangladesh)	(i) There is scope for expansion by means of another runway at Dhaka;	(i) Need to construct a 2nd runway at Dhaka;	The renovation work of HazratShahjalal International Airport which includes building the second runway will need 21 months to be completed.
		(ii) The fleet of F-28 aircraft is old and spares are not available. Major complaints on flight delays and cancellations of intra-regional routes is due to this;	(ii) Need to upgrade the aircraft fleet, possibly by private sector investments;	Fleet modernization of BimanBangladesh remains a challenge. Private operators have increased their operations.
		(iii) No green channel for cargo inspection;	(iii) Investment in improved cargo facilities with improved facilitation measures.	May not be covered in renovation work of HazratShahjalal International Airport
SAG 2	Aviation Gateway No 2:Paro (Bhutan)	(i) Since Paro Airport is located in a narrow valley surrounded by mountains, it can handle only smaller aircraft;	(i) To build an alternative airport with ILS facilities and provisions for landing during the hours of darkness and to explore such locations in south central part of Bhutan	(i) Construction at the Gelephudomestic airport completed in 2012 and maybe capable of receiving international traffic in the future (i) Yongphula and Bapalathang domestic airports would also receive ADB funding.
		(ii) Due to the absence of ILS airport operates only in daylight hours and during favourable weather conditions;	(ii) To improve technical capabilities for the short term at Paro airport;	(ii) Work on modernization of the Voice communication system completed and improvement of power supply system through the procurement of UPS.
		(iii) Terminal passenger handling and baggage services capacity needs enhancement;	(iii) To Improve passenger handling capacities in the short term;	Construction of a second terminal building that would be used only for arrivals and domestic flights is expected to commence shortly and completed by 2015.
		(iv) Difficulties for passengers to purchase Druk Air tickets in other SAARC countries, except in India and Nepal;	(iv) Need to enhance ticketing arrangements;	ASA signed with Maldives; updated ASA signed with India, Bangladesh; flights to and from Nepal

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SAG 3-11	Aviation Gateways No 3 - 11: (India)	(i) Shortage of pilots and flight engineers to keep pace with the anticipated growth;	(i) Additional training capacity required and approaches to ensure that pilots and engineers stay in India;	Increasing pilots retirement age to 65 years - setting up of training institute in Maharashtra - upgradation and modernization of infrastructure at the India Gandhi RashtriyaUdaanAkademi to enhance its training capacity from 40 to 100 pilots and reduce the training period.
		(ii) The airport charges are high compared to nearby regions, especially for low-cost airlines;	(ii) Consider review of charges to promote sector and attract low cost carriers;	Kept outside purview of this study
		(iii) High import dwell time on international traffic with no green channel;	(iii) Improve trade facilitation measures with green channelling of known shippers;	Measures under consideration
		(iv) Shortage of capacity terminals, runways etc to handle future demand;	Delhi (i) New International Terminal Complex Phase II needs to be completed; (ii) Installation of automatic storage and retrieval systems for import handling required; (iii) New conveyor belt for cargo handling; Mumbai (i) International courier terminal required; (ii) New automatic storage and retrieval system for import handling required; (iii) Completion of 7 new parking stands; Chennai (i) New International Terminal Complex Phase II to be completed; (ii) Integrated Cargo terminal Phase III for imports required; (iii) Construction of a common user cargo terminal for domestic required; (iv) Completion of 3 parking stands; Kolkota (i) New International Departure building is required; (ii) Apron extension; (iii) Metro link over head corridor is to be constructed; (iv) New Integrated Cargo Terminal - Phase I under construction to be completed; (v) Perishable cargo centre to be constructed; (vi) New automatic storage and retrieval system for import handling; Trivandrum (i) New International building is required; Bangalore (i) Completion of expansion and modification of terminal building; Hyderabad (i) Extension of apron required; (ii) Extension of arrival terminal required; Cochin (i) New airport to be built by private sector;	Delhi and Mumbai: modernization done through PPP projects; both have been completed with new terminals and state of the art facilities. Chennai and Kolkata: the airports are being modernized and expanded by the Airport Authority of India (AAI). Trivandrum: new terminal constructed Bangalore: new airport commissioned Hyderabad: new airport commissioned Cochin: new international terminal to be constructed and the existing one would be converted to domestic terminal

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SAG 12	Aviation Gateway No 12: Male (Maldives)	(i) Passenger processing facilities at the present airport need to be expanded and the staff need to be trained in all the areas;	(i) Addition passenger processing facilities required and an effective human resource development programne needs to be implemented;	Male International Airport has been privatized. Maldives Airport Company (MACL) will only be responsible for Air Traffic Control, Aviation Security Command and some smaller offices. The agreement signed between the Maldives government and private operator included the upgrading and renovation of the airport up to the standard of a global airport by the year 2014. More than 1200 employees of MACL transferred to private operator as part of this agreement.
		(ii) Cargo handling area needs to be expanded with additional infrastructure as insufficient processing areas and cold store needed;	(ii) Addition cargo processing facilities required;	Private operator announced development plans including reclaiming more land at the northern end of the runway; where a new terminal is to be built. This terminal will consist of 3 separate bridged buildings and will consist of elements that reflect the traditional Maldivian resort. Plans for a separate cargo terminal have been announced.
		(iii) Service between Trivandrum and Male' needs an increase in the capacity flights;	(iii) ASA to be expanded to cover requirements for higher frequencies;	ASA with Bhutan signed in 2012 Revised ASA with India signed in 2008
SAG 13	Aviation Gateway No 13: Kathmandu (Nepal)	(i) Constraints in handling passengers and baggage;	(i) Improvements to baggage handling and passenger processing required;	is in the final stage of installing common user terminal equipment (CUTE) that will enable integrated passenger check-in and e-ticketing for all online airlines
		(ii) Inadequate passenger facilities;	(ii) Improved layout and facilities in passenger departures area;	Improvements need to be done.
SAG 14 -15	Aviation Gateways Nos 14 & 15: (Pakistan)	(i) Air terminal complex at both Karachi and Lahore lack cargo centres and modern cargo handling equipment;	(i) Cargo facilities should be upgraded as required;	Karachi has import, AFU, ICG and export terminals; a chiller facility; Dangerous Goods Storage; 2 cargo scanning machines; transactions are fully automated Lahore is first ever purpose built Air Cargo Complex, capable of handling almost 150,000 tons of cargo; latest cargo scanning machine, CCTV, Strong Rooms, and Cold Room, fitted with the latest fire fighting facilities. A separate room for DGR has been built and an exclusive area has been marked for explosives; has large number of docks for trucks/ transporters with wide open parking area.
		(ii) Modernization of security systems all airports with the state of the art equipment to ensure safety and security;	(ii) Improvements made in security systems;	SAPS Cargo maintains the international security standard.
		(iii) The Civil Aviation Authority of Pakistan has assumed a dual role being both service provider as well as regulator;	(iii) Regulator roles should be separated from operations;	Not done so far.

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SL NO.	CORRIDORS/ GATEWAYS	BARRIERS AND REASONS FOR ACTION (TAKEN FROM SRMTS 2006 REPORT)	SRMTS 2006 RECOMMENDATIONS	PRESENT STATUS AND FORWARD PLANS
SAG 16	Aviation Gateway No 16: Colombo (Sri Lanka)	(i) The facilities that will be inadequate by around 2010 especially the passenger terminal (building and apron), car parks, air navigation systems and utilities;	(i) Supporting infrastructure facilities required especially to promote BIA as a transit hub;	BIA 2nd Phase expansion will include the widening of the existing runway and taxiways, a new state-of-the-art passenger terminal is also being built with separate sections for arrivals and departures.
		(ii) Sri Lanka requires a 2nd international airport. Locations have been identified, but studies have not been finalized. BIA is 32 kms from Colombo and not in close proximity to any centre of tourist attraction limits transit potential;	(ii) Selection of second international airport required;	Construction of 2nd International Airport at Mattala, Hambantota started in November 2009.
		(iii) Problems in attracting major airlines due to lack of infrastructure and inadequate ancillary services, such as high cost bunkering services, poor road transportation and insufficient accommodation;	(iii) Passenger facilities need enhancement;	BIA expansion will double the airport's passenger handling capacity to 12 million, while also expanding cargo handling capacity to 500.000 m from existing 250.000 m

Source: ADB (2012).

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