



Urban Transport in India: Issues, Challenges, and the Way Forward

Sanjay Kumar Singh ^{1*}

¹ Associate Professor of Economics, Indian Institute of Management Lucknow, Lucknow – 226013, India.

Abstract

Cities and towns play a vital role in promoting economic growth and prosperity. Although less than one-third of India's people live in cities and towns, these areas generate over two-third of the country's income and account for 90% of government revenues. In the coming years, as India becomes more and more urbanized, urban areas will play a critical role in sustaining high rates of economic growth. But, economic growth momentum can be sustained if and only if cities function efficiently - that their resources are used to maximize the cities' contribution to national income. City efficiency largely depends upon the effectiveness of its transport systems, that is, efficacy with which people and goods are moved throughout the city. Poor transport systems stifle economic growth and development, and the net effect may be a loss of competitiveness in both domestic as well as international markets. Although Indian cities have lower vehicle ownership rate, number of vehicles per capita, than their counterparts in developed countries, they suffer from worse congestion, delay, pollution, and accidents than cities in the industrialized world. This paper provides an overview of urban transport issues and challenges in India. Rather than covering every aspect of urban transportation, it primarily focuses on those areas that are important from policy point of view. The paper first reviews the trends of vehicular growth and availability of transport infrastructure in Indian cities. This is followed by a discussion on the nature and magnitude of urban transport problems such as congestion, pollution and road accidents. Building on this background, the paper proposes policy measures to improve urban transportation in India.

Keywords: Urban Transport; Transport Policy; India.

1. Introduction

India is urbanising. Its urban population is growing at an average rate of around 3% per year. The average rate of growth of the urban population is not expected to change significantly during the next ten years or so. Assuming decadal increase of around 32%, India's urban population is expected to increase from 377 million in 2011 to 500 million in 2021. In terms of percentage of total population, the urban population has gone up from 17% in 1951 to 31.8% in 2011 and is expected to increase up to around 35% by the year 2021.

During the 2000s, 91 million people joined the ranks of urban dwellers – which implies that the growth rate in urban areas remains almost the same during the last

* Corresponding author: Sanjay Kumar Singh (sanjay@iiml.ac.in)

twenty years; urban population increased by 31.5% from 1991 to 2001 and 31.8% from 2001 to 2011. However, the number of metropolitan cities – those with a million plus population – has increased sharply over this period. From 35 in 2001, the number of metropolitan cities rose to 50 according to the Census of India, 2011. Out of these 50, eight cities – Mumbai, Delhi, Kolkata, Chennai, Hyderabad, Bangalore, Ahmedabad, and Pune – have population more than 5 million. India's big cities now account for a larger share of total urban population – a trend that has been observed since independence. In 2011, the share of metropolitan cities was 42.3%, up from 37.8% in 2001 and 27.7% in 1991.

The distribution of urban population by city size widely varies and is skewed towards larger cities. One specific feature of India's urbanization is the increasing metropolitanization, that is, growth in the number and size of cities with a million plus population. The trends indicate the continued urbanization and metropolitanization in the years to come. Often, there is a debate as to whether it is an index of development or distress. The very process of urbanization has sometimes been looked as something undesirable. While the objections used to be on social and moral grounds earlier, the criticism lately is more on economic grounds such as provision of requisite infrastructure and civic amenities at rapidly escalating per capita costs (Padam and Singh, 2004). Despite all the objections, the rate of urbanization has not even retarded, not to speak of its being halted. Certain inevitability about the process is being accepted steadily. It is now felt that urbanization is necessary for the benefits of sharing modern technology for the growth and development of the entire national economy. In India, urban areas contribute more than sixty percent of the national income. In the coming years, as India becomes more and more urbanized, urban areas will play a critical role in sustaining high rates of economic growth.

But, economic growth momentum can be sustained if and only if cities function efficiently - that their resources are used to maximize the cities' contribution to national income. Economic efficiency of cities and well-being of urban inhabitants are directly influenced by mobility or the lack of it. City efficiency largely depends upon the effectiveness of its transport systems, that is, efficacy with which people and goods are moved throughout the city. Poor transport systems stifle economic growth and development, and the net effect may be a loss of competitiveness in both domestic as well as international markets.

Although Indian cities have lower vehicle ownership rate than their counterparts in developed countries, they suffer from worse congestion, delay, pollution, and accidents than the cities in developed countries. In Kolkata, for example, average speed during peak hours in Central Business District (CBD) area goes down as low as around 10 Km/h. The problem of congestion and delays is not only faced by Kolkata but also by most of the big cities which indicates both the amount of time and energy that are wasted and the scale of opportunity for improvement. A high level of pollution is another undesirable feature of overloaded streets. The transport crisis also takes a human toll. Statistics indicate that traffic accidents are a primary cause of accidental deaths in the Indian cities.

The main reason for all these is the prevailing imbalance in modal split besides inadequate transport infrastructure and its sub-optimal use. Public transport systems in cities have not been able to keep pace with the rapid and substantial increases in demand over the past few years. As a result, people have turned towards personalized modes such as mopeds, scooters, motorcycles, and cars and intermediate public

transport modes such as auto-rickshaws, tempos, and taxis. Cities cannot afford to cater only to the private vehicles and there has to be a general recognition that policy should be designed in such a way that reduces the need to travel by personalized modes and boosts public transport particularly bus transport system. Much needs to be done if public transport is to play a significant role in the life of a city. Measures need to be taken to enhance the quality as well as quantity of public transport services and to impose constraints on the use of private vehicles. People should also be encouraged to use non-motorized transport and investments may be made to make it safer. It must not be forgotten that cities are the major contributors to economic growth, and movement in and between cities is crucial for improved quality of life (Singh, 2005).

2. Vehicular growth and availability of transport infrastructure in metropolitan cities

During the year 2009, 115 million vehicles were plying on Indian roads (Table 1). According to the statistics provided by the Ministry of Road Transport & Highways, Government of India, the annual rate of growth of motor vehicle population in India has been around 10% during last decade. The basic problem is not the number of vehicles in the country but their concentration in a few selected cities, particularly in metropolitan cities. From 1999 to 2009, number of vehicles per 1000 people in metropolitan cities has increased more than two-fold from 132 to 286 (Figure 1). Vehicle ownership rate, number of vehicles per 1000 people, in many big cities including Delhi has already crossed the mark of 400. There are at least 5 metropolitan cities having vehicle ownership rate in excess of 500. It is interesting to note that nearly 35% of the total vehicles in the country are plying in metropolitan cities alone, which constitute just around 11% of the total population. During the year 2009, nearly 15 million vehicles were plying in four big cities (Delhi, Bengaluru, Chennai, and Hyderabad) alone, which constitute 16.6% of all motor vehicles in the country (Table 2). Delhi, the capital of India, which contains around 1.4% of Indian population, accounts for nearly 7% of all motor vehicles in the country.

Traffic composition in Indian cities is of a mixed nature. There is a wide variety of about a dozen types of both slow and fast-moving vehicles. Two-wheelers¹ and cars account for over 85% of the vehicle population in most of the metropolitan cities. They account for at least 90% of total vehicles in Ahmedabad, Bhopal, Coimbatore, Delhi, Kanpur, Lucknow, Nagpur, Vadodara, Varanasi, and Vishakhapatnam. Two-wheelers alone account for more than 80% of the total vehicles in number of metropolitan cities. For example, during the year 2009, in Nagpur (84%), Varanasi (84%), Surat (83%), Coimbatore (83%), Madurai (82%), Bhopal (81%), Kanpur (81%), Vadodara (81%), Vishakhapatnam (81%), and Lucknow (80%), two-wheelers accounted for at least 80% of the total vehicles. Analysis of data presented in Table 3 reveals that, during the year 2009, the share of buses is negligible in most Indian cities as compared to personalized vehicles. For example, two-wheelers and cars together constitute at least 90% of the total vehicles in Ahmedabad (91%), Delhi (90%), Lucknow (93%), and Nagpur (91%) whereas in these cities buses constitute only 1%, 0.7%, 0.3%, and 0.4% respectively.

Table 1: Total number of registered motor vehicles in India: 1951-2009 (in thousands)

Year (as on 31 st March)	All vehicles	Two-wheelers	Cars	Buses	Goods vehicles	Others
1951	306	27	159	34	82	4
1961	665	88	310	57	168	42
1971	1865	576	682	94	343	170
1981	5391	2618	1160	162	554	897
1991	21374	14200	2954	331	1356	2533
2001	54991	38556	7058	634	2948	5795
2002	58924	41581	7613	635	2974	6121
2003	67007	47519	8599	721	3492	6676
2004	72718	51922	9451	768	3749	6828
2005	81501	58799	10320	892	4031	7457
2006	89618	64743	11526	992	4436	7921
2007	96707	69129	12649	1350	5119	8460
2008	105353	75336	13950	1427	5601	9039
2009 (P)	114951	82402	15313	1486	6041	9710

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. *Road Transport Year Book (2007-09)*.

Note: (1) P indicates provisional. (2) Cars include jeeps and taxis. (3) Others include tractors, trailers, three wheelers (passenger vehicles)/LMV and other miscellaneous vehicles which are not separately classified.

Table 2: Total number of registered motor vehicles in selected metropolitan cities in India: 1999-2009 (year as on 31st March and no. of vehicles in thousands)

Metropolitan cities	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	CAGR (%) 1999-2009
Ahmedabad	739	799	846	899	978	1075	1632	1780	1451	1586	1691	8.6
Bengaluru	1332	1550	1593	1680	1771	1891	2232	2617	2179	2640	3016	8.5
Chennai	1056	1150	1257	1356	1895	2015	2167	2338	2518	2701	2919	10.7
Delhi	3277	3423	3635	36899	3971	4237	4186	4487	5492	5899	6302	6.8
Hyderabad	951	N.A.	N.A.	1241	1319	1356	1433	1522	2181	2444	2682	10.9
Jaipur	542	598	644	693	753	824	923	1051	1177	1289	1387	9.9
Kolkata	N.A.	N.A.	N.A.	801	842	875	911	948	987	573	581	9.5
Lucknow	N.A.	N.A.	465	556	615	N.A.	N.A.	N.A.	801	962	1025	9.0
Mumbai	911	970	1030	1069	1124	1199	1295	1394	1503	1605	1674	6.3
Nagpur	298	331	416	459	503	543	770	824	884	946	1009	13.0
Pune	568	593	620	658	697	755	827	874	930	1141	1153	7.3

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India and Road Transport Year Book*.

Note: (1) N.A. indicates unavailability of data. (2) CAGR indicates compound annual growth rate. (3) From 2007 to 2008, there is a sudden drop in no. of vehicles registered in Kolkata because the Calcutta High Court in July 2008 ordered a ban on commercial vehicles registered before January 1, 1993 from Kolkata and its outskirts.

Table 3A: Private transport vehicles in selected metropolitan cities in India (as on 31st March 2000 and 2009)

Metropolitan cities	Two-wheelers (2000)	Two-wheelers (2009)	Two-wheelers CAGR (%)	Cars (2000)	Cars (2009)	Cars CAGR (%)
Ahmedabad	616738	1312601	8.75	104179	233320	9.37
Bengaluru	1164204	1946767	5.88	238374	586639	10.52
Chennai	848118	2017816	10.11	207860	511457	10.52
Delhi	2184581	3846721	6.49	869820	1881135	8.95
Hyderabad	757684	1836549	10.34	99314	426733	17.58
Jaipur	444889	1035999	9.85	76133	204871	11.63
Kolkata	298959	173891	-5.84	238560	313900	3.10
Lucknow	344268	825088	10.20	53069	142861	11.63
Mumbai	407306	909993	9.34	325473	509246	5.10
Nagpur	272734	850276	13.47	27573	94823	14.71
Pune	443266	831029	7.23	62885	147108	9.90

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India* and *Road Transport Year Book*.

Note: (1) CAGR indicates compound annual growth rate. (2) Cars include jeeps.

Table 3B: Public transport vehicles in selected metropolitan cities in India (as on 31st March 2000 and 2009)

Metropolitan cities	Taxis (2000)	Taxis (2009)	Taxis CAGR (%) (2000-2009)	Buses (2000)	Buses (2009)	Buses CAGR (%) (2000-2009)
Ahmedabad	43865	94264	8.87	14993	17407	1.67
Bengaluru	77375	235525	13.17	6380	18176	12.34
Chennai	45016	136635	13.13	4409	34491	25.68
Delhi	104747	229991	9.13	37733	41142	0.97
Hyderabad	48898	110772	9.51	2539	22725	27.57
Jaipur	12513	33344	11.51	14362	18873	3.08
Kolkata	41946	49571	1.87	8586	6938	-2.34
Lucknow	15454	16010	0.39	2816	2794	-0.09
Mumbai	156261	161674	0.38	15414	13061	-1.82
Nagpur	10666	17436	5.61	2788	4160	4.55
Pune	44590	17533	-9.85	7827	12800	5.62

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India* and *Road Transport Year Book*.

Note: (1) CAGR indicates compound annual growth rate. (2) Taxis include auto-rickshaws.

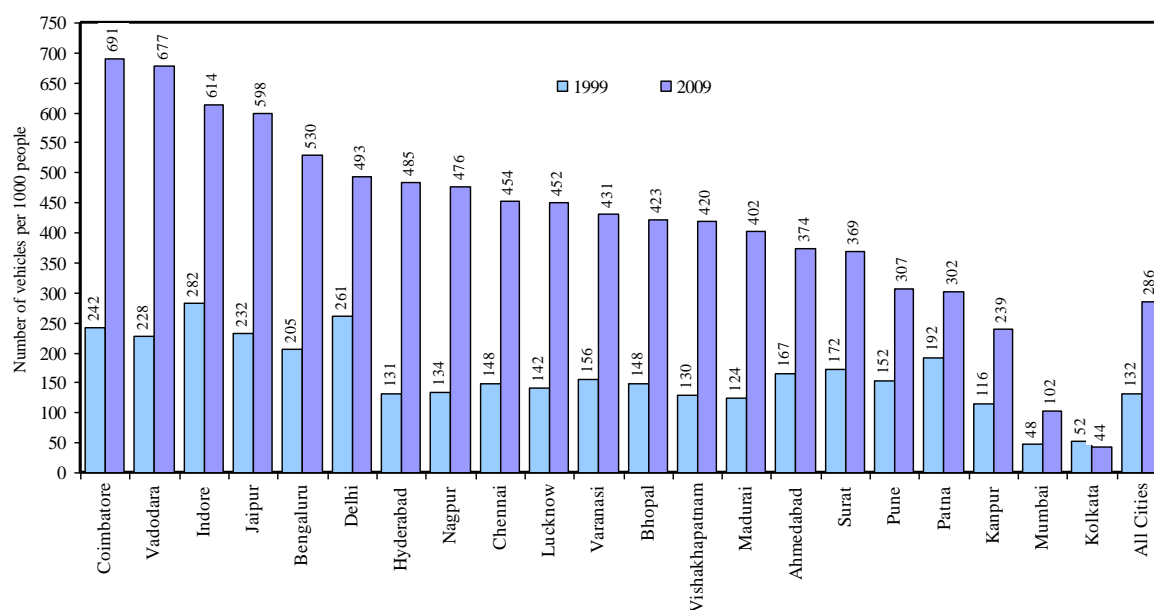


Figure 1: Vehicle ownership rate in selected metropolitan cities in India: 1999-2009

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India* and *Road Transport Year Book*.

Table 4 presents existing modal split in terms of percentage of trips made on different modes including walking and bicycling across Indian cities. When compared with desirable level of modal split (Table 5), it was found that the share of mass transport is well below the desired range whereas the share of personalized transport and para transit is already above the optimal range in most of the Indian cities. What is worse is that the modal split does not appear to be moving in the right direction. Table 3 reveals that, from 2000 to 2009, the growth in two-wheelers and cars is significantly higher than the growth in buses across metropolitan cities. For example, in Delhi, from 2000 to 2009, number of cars increased at the rate of 9% per year whereas number of buses grew only at the rate of 1% per year.

Moreover, availability of transport infrastructure is not only inadequate but also used suboptimally in Indian cities. The area occupied by roads and streets in Class – I cities (population more than 100,000) in India is only 16.1% of the total developed area while the corresponding figure for the United States of America is 28.19% (Singh, 2005). In general, the road space in Indian cities is grossly insufficient. To make the situation worse, most of the major roads and junctions are heavily encroached by parked vehicles, roadside hawkers, and pavement dwellers. As a consequence of these factors, already deficient space for movement of vehicles is further reduced.

The present urban rail services in India are extremely limited. Only four cities - Mumbai, Delhi, Kolkata and Chennai are served by suburban rail systems. The rail services in these four main cities together carry more than 7 million trips per day. Interestingly, the Mumbai Suburban Rail System alone carries about 5.5 million trips per day. A few other cities also have limited suburban rail systems but they hardly meet the large transport demand existing in these cities.

Although, few years back, bus transport services were available mainly in the cities located in southern and western regions of India, but they are now available in most of the metropolitan cities, thanks to the Government of India's Jawaharlal Nehru National Urban Renewal Mission (JNNURM). Services are mostly run by publicly owned State Transport Undertakings (STUs) or Municipal Transport Undertakings (MTUs). Most of the passenger buses use the standard truck engine and chassis and hence are not economical for city use. There are very few buses in India specifically designed for urban conditions. Qualitatively, the available urban mass transport services are overcrowded, unreliable, and involve long waiting periods. Over-crowding in the public transport system is more pronounced in large cities where buses, which are designed to carry 40-50 passengers generally, carry double the capacity during peak hours. As a result, there is a massive shift towards personalized transport, specially two-wheelers and proliferation of various types of intermediate public transport modes such as auto-rickshaws, tempos, and taxis.

Table 4: Existing modal split in Indian cities (as a %age of total trips)

City population (in million)	Walk	Mass transport	IPT		Car	Two wheeler	Bicycle	Total
			Fast	Slow				
0.10 – 0.25	37.1	16.4	10.4	20.1	3.3	24.1	25.7	100.0
0.25 – 0.50	37.8	20.6	8.9	17.2	2.6	29.8	20.9	100.0
0.50 – 1.0	30.7	25.4	8.2	12.0	9.5	29.1	15.9	100.0
1.0 – 2.0	29.6	30.6	6.4	8.1	3.3	39.6	12.1	100.0
2.0 – 5.0	28.7	42.3	4.9	3.0	5.0	28.9	15.9	100.0
5.0 plus	28.4	62.8	3.3	3.7	6.1	14.8	9.4	100.0

Source: Singh (2005)

Table 5: Desirable modal split for Indian cities (as a %age of total trips)

City population (in million)	Mass transport	Bicycle	Other modes
0.1 – 0.5	30 – 40	30 – 40	25 – 35
0.5 – 1.0	40 – 50	25 – 35	20 – 30
1.0 – 2.0	50 – 60	20 – 30	15 – 25
2.0 – 5.0	60 – 70	15 – 25	10 – 20
5.0 plus	70 – 85	15 – 20	10 – 15

Source: Singh (2005)

3. Vehicular emission, congestion, and road safety issues

The Indian metropolitan cities are facing serious environmental problem due to growing air pollution caused by fuels used in vehicles. Atmospheric pollutants commonly associated with motor vehicles are nitrogen oxides, hydrocarbons, carbon monoxide, sulfur oxides, and Suspended Particulate Matters (SPM). Pollutants from vehicular emission have various adverse health effects (see Table 6 for details). One of the main pollutants, SPM particularly fine PM, has serious health effects.ⁱⁱ The ambient air pollution in terms of SPM in many metropolitan cities in India exceeds the limit set by World Health Organization (Singh, 2008). Of a total of 127 cities monitored under the National Air Quality Monitoring Programme, only 3 have low air pollution, and 101

cities report at least one pollutant exceeding the annual average air quality standard (Central Pollution Control Board, 2009). In fact, air pollution in many of India's cities has become atrocious, and has already had serious health effects, especially in the form of respiratory diseases.

There is a direct relationship between transport system and air pollution in a city. Vehicular emissions depend on vehicle speed, vehicle-km, age of vehicle, and emission rate. In general, the average peak hour speed in Indian cities is far less than the optimum one. Growing traffic and limited road space have reduced peak-hour speeds to 5-10 Km/h in the central areas of many major cities. The quantity of all the three major air pollutants (namely, nitrogen oxides, hydrocarbons, and carbon monoxide) drastically increases with reduction in motor vehicle speeds. For example, at a speed of 75 Km/h, emission of carbon monoxides is 6.4 gm/veh.-km, which increases by five times to 33.0 gm/veh.-km at a speed of 10 Km/h. Similarly, emission of other pollutants increases with the reduction in vehicle speed. Thus, prevalent traffic congestion in Indian cities particularly during peak-hour not only increases the delay but also increases the pollution level. Problem is aggravated due to high average age and poor maintenance of vehicles (see Table 7 for age profile of on road vehicles in India). With inadequate availability of mass transport services and increasing use of personalized motor vehicles, vehicular emission is assuming serious dimensions in most of the Indian cities (see also Table 8). It is amply clear that among various modes of road based passenger transport, bus occupies less road space and causes less pollution per passenger-km than personalized modes (Table 9). This reveals the importance of bus transport in improving the air quality in urban areas.

India is also facing serious road accident problems. In 2009, latest year for which data is available, 126,900 people died and 466,600 people got injured due to road accidents. In a dubious distinction, India is the only country in the world which faces more than 14 fatalities and 53 injuries every hour as a consequence of road crashes. While in many developed and developing countries, including China, the situation is generally improving, India faces a worsening situation. During the last ten years, road accidental fatalities in India have increased at the rate of 4.6% per year while the population of the country has increased only at the rate of 1.6% per year. Consequently, fatality risk, road accidental deaths per 100,000 people, has increased from 8.2 in 1999 to 10.9 in 2009. Fatality risk in India is not only twice than that in some of the developed countries such as Sweden, United Kingdom, and Japan but also still increasing rapidly. If the trend continues, the total number of road traffic deaths in India would increase by 100% between 2009 and 2025.

Moreover, the burden of road traffic accidents in India is relatively high in its metropolitan cities (Singh, 2009). On an average, fatality risk in metropolitan cities is 11.6 fatalities per 100,000 people, higher than all India average of 10.9 fatalities per 100,000 people. Also, there is a huge variation in fatality risk across cities of India, ranging from 3.2 fatalities per 100,000 people for Kolkata to 34.4 fatalities per 100,000 people for Vishakhapatnam in 2009 (see Figure 2). During the same year, Vishakhapatnam (34.4), Kanpur (25.7), Lucknow (23.3), Jaipur (22.8), Varanasi (20.6), Coimbatore (19.4), and Bhopal (18.6) faced more than 50% higher fatality risk than the metropolitan city average (11.6). From 1999 to 2009, fatality risk in 8 out of 21 selected metropolitan cities increased at higher rate than that in the country. Vishakhapatnam faced the highest increase in fatality risk (11.2 to 34.4) followed by Varanasi (5.5 to 20.6), Lucknow (8.9 to 23.3), Bhopal (10.6 to 18.6), Coimbatore (12.1 to 19.4), Kanpur

(19.6 to 25.7), Jaipur (17.6 to 22.8), and Pune (10.0 to 13.9). However, there are nine cities which experienced decrease in fatality risk from 1999 to 2009; out of these, only two cities Indore (20.4 to 15.9) and Delhi (15.0 to 12.3) experienced significant decline whereas decline in others was only marginal.

The nature of road accident problem in Indian cities is different in many ways from that in their counterparts in the developed countries. Pedestrians, bicyclists, motorcyclists, and non-motorized vehicle occupants are often the most vulnerable in Indian cities, unlike cities from developed world where car and public transport users are the most vulnerable (see Table 10). Since pedestrians, cyclists, and non-motorized transport users are often from the lower socio-economic groups, road accidents in Indian cities have a disproportionate impact on the poor and vulnerable in society (Singh, 2009).

Why is the road safety situation so bad in so many cities of India? The main reason for this appears to be the prevailing imbalance in modal split, inadequate transport infrastructure and its sub-optimal use, and the lack of effective road-safety policies. Very few cities of India have an adequate public transport system. People rely primarily on personalized modes such as cars and two-wheelers, para-transit modes such as auto-rickshaws and tempos, and non-motorized transport modes such as tricycles, bicycles, and walking. In most of the cities, two-wheelers and cars account for over 90% of the motorized vehicle population whereas the share of buses is negligible in comparison to personalized vehicles. In general, the road space in cities is grossly insufficient. There is hardly any provision for pedestrians and cyclists to safely use the road. Lane marking and traffic signs are usually missing and the intersections often require geometric correction. To make the situation worse, most of the major roads and junctions are heavily encroached by parked vehicles, roadside hawkers, and pavement dwellers. As a consequence of these factors, already deficient space for movement of vehicles is further reduced. The problem of traffic accidents gets aggravated because of mixed nature of traffic composition. Busy roads often carry a mix of fast moving motor vehicles along with cyclists, pedestrians, and other non-motorized transport users. The experience shows that fatalities are concentrated around roads that are not fit for their purpose of carrying mixed streams of traffic safely. Many cities have somewhat dysfunctional roads with all the features that aggravate the traffic injuries and fatalities. Features such as roads with traffic volumes and speeds that they were not designed for, high proportion of young and inexperienced drivers, and high proportion of non-motorized transport users in the same road space are prevalent in number of cities.

Also, there is a lack of effective road-safety policies in India. Even simple measures like use of seat-belts and helmets, mandatory according to the Motor Vehicle Act 1988, are not properly enforced. One can get not only a driving license without having an adequate driving skill, but also drive the vehicle under the influence of alcohol particularly in smaller cities and towns. It is not uncommon to see over speed and rash driving on city roads. Some of the city authorities are even unable to tackle the problem of stray cattle on the roads, which often jeopardize the safety of road users.

Table 6: Adverse health effects from vehicular emissions

Pollutant	Health effect
Carbon monoxide (CO)	This gas is created when fuels containing carbon are burned incompletely. Fetuses and persons afflicted with heart disease are at greater risk. CO hinders oxygen transport from the blood into the tissues. Therefore, more blood is required to be pumped to deliver the same amount of oxygen. Healthy individuals are also affected at higher levels of CO exposure. Large dose of CO can be fatal.
Sulfur dioxide (SO ₂)	This gas is created when fuel containing sulfur is burnt. High concentration of SO ₂ can result in temporary breathing impairment for asthmatic children and adults who are active outdoors. This gas mainly affects the functions of lungs.
Suspended particulate matter (SPM)	At high concentration, particulate matter can adversely affect human health. There are two classifications for particulate matter, PM ₁₀ and PM _{2.5} . All particles smaller than 10 microns in diameter are classified as PM ₁₀ or coarse size particles. Fine size particles or PM _{2.5} , are those particles less than or equal to 2.5 microns in diameter. Diesel vehicle exhaust is the main source of PM in urban areas. These particles penetrate deeply into the lungs and are captured by lung tissue. The most dangerous aspect of PM pollution from diesel vehicles is the hundreds of different chemicals that are adsorbed to the particle. Exposure to PM pollution has been associated with respiratory and cardiac problems, infections, asthma attacks, lung cancer and decreased life expectancy. Fine particulate (<2.5 microns) is thought to be more dangerous because of its ability to penetrate deeper into lung tissue.
Nitrogen oxides (NO _x)	Nitrogen oxides contribute to the formation of ozone, production of particulate matter pollution, and acid deposition. Diesel engines produce a disproportionately large amount of NO _x when compared to gasoline engines because of their high temperature combustion process. Nitrogen dioxide has been shown to irritate lung tissue, cause bronchitis and pneumonia, and reduce resistance to respiratory infections. The health effects of ozone are magnified in the presence of nitrogen dioxide. Frequent or long-term exposure to high levels of nitrogen oxides can increase the incidence of acute respiratory illness in children.
Hydrocarbons (HC)	Hydrocarbons are a class of reactive organic gases which are formed solely of hydrogen and carbon. The incomplete burning of any organic matter such as oil produces hydrocarbons. They contribute to the formation of ozone and the resulting smog problem. The primary health effect of hydrocarbons results from the formation of ozone and its related health effects.
Air Toxics	Air toxics are generally organic chemicals, including some hydrocarbons that are highly evaporative in nature. Benzene, formaldehyde, acetaldehyde, 1,3-butadiene, and acrolein are typical examples of air toxics. Air toxics are pollutants that cause or are suspected of causing cancer in those exposed to them. Benzene has been shown to cause aplastic anemia and acute myelogenous leukemia. Known health concerns related to aldehydes include cancer, asthma, and respiratory tract irritation. It is also believed that these air toxics have impacts on the reproductive system by causing chromosomal aberrations or mutations. The health effects of particulate matter from diesel exhaust are thought to be attributable to the many air toxics that are adsorbed to the particles. These small particles penetrate deeply into the lungs, and are the perfect vehicle for delivering air toxics into the body.

Source: Singh (2008).

Table 7: Age profile of on road vehicles in India

Vehicle Type	< 5 Yrs (%)	6-10 Yrs (%)	11-15 Yrs (%)	16-20 Yrs (%)	20-25 Yrs (%)	>25 Yrs (%)
Two-wheelers	48.7	27.2	14.3	7.8	1.8	0.3
Cars	50.3	29.5	12.9	6	1.1	0.2
LCV	36.8	21.5	26.5	11.3	3.2	0.8

Source: Status of the vehicular pollution control programme in India (March, 2010). Central Pollution control Board, Ministry of Environment & Forests, Govt. of India.

Table 8: Estimated vehicular emission load in selected metropolitan cities in India

Name of the city	Vehicular pollution load (tons per day)				
	Particulates	Oxide of the Nitrogen	Hydrocarbons	Carbon monoxide	Total
Agra	0.9	3.3	10.3	17.9	32.4
Bengaluru	8.1	29.7	117.4	207.0	362.2
Chennai	7.3	27.3	95.6	177.0	307.2
Delhi	12.8	110.5	184.4	421.8	729.4
Hyderabad	8.0	36.9	90.1	164.0	298.9
Kanpur	1.9	7.3	11.7	28.7	49.6
Kolkata	10.8	54.1	47.6	137.5	250.0
Mumbai	10.6	46.4	89.9	189.6	336.4
Grand total	60.4	315.4	647.0	1343.5	2366.3

Source: Status of the vehicular pollution control programme in India (March, 2010). Central Pollution control Board, Ministry of Environment & Forests, Govt. of India.

Table 9: Pollution rate and congestion effect of private and public transport vehicles

Type of vehicle	Average passenger per vehicle	Pollution load in gm/pass.-km	Congestion effect in PCU/Pass.
Two-stroke two-wheeler petrol engine	2	7.13	0.375
Four-stroke two-wheeler petrol engine	2	4.76	0.375
Car with catalytic converter petrol engine	4	0.93	0.25
Bus with diesel engine	40	1.00	0.075

Source: Singh (2008).

Note: PCU = Passenger Car Unit where 1 car = 1 PCU, 1 bus = 2.5 PCU, 1 scooter = 0.75 PCU, etc.

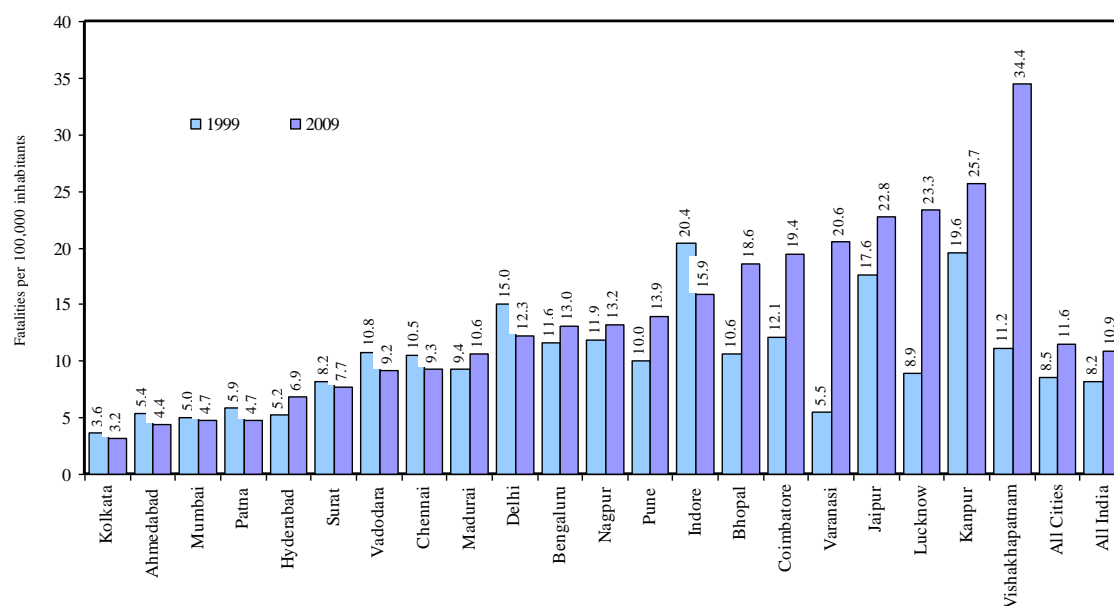


Figure 2: Road accident fatality risk in selected Indian metropolitan cities in 1999 and 2009

Source: National Crime Record Bureau, Ministry of Home Affairs, Government of India, New Delhi. Accidental Deaths and Suicides in India, 1999 and 2009.

Table 10: Pedestrian and motorized two-wheeler fatalities as a percentage of total road accident fatalities

City/Country	Pedestrian	Motorized two-wheeler
Delhi, India (2009)*	23	34
Kolkata, India (2009)*	58	15
Mumbai, India (2009)*	29	22
Australia (2009)#	13	15
European Union (2009)\$	18	17
Japan (2004)@	26	15
Singapore(2005)@	24	55
USA (2009)€	12	13

Sources: (1) * Accidental Deaths and Suicides in India, 2009. National Crime Record Bureau, Ministry of Home Affairs, Government of India, New Delhi. (2) # Road Deaths Australia 2009 Statistical Summary published by Department of Infrastructure, Transport, Regional Development and Local Government, Australian Government. (3) \$ European status report on road safety: towards safer roads and healthier transport choices. Copenhagen, WHO Regional Office for Europe, 2009. (4) @ Road Safety in Asia and the Pacific published by Economic and Social commission for Asia and the Pacific on 26th United Nations Economic and Social Council. (5) € Traffic Safety Facts 2009, U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC.

4. Policy measures to improve urban transportation in India

4.1 Promoting regional economies and compact townships

There is a need to promote not only regional economies in such a way that reduces the need for long-distance travel but also self sufficient compact townships which would reduce the need for short-distance travel within the cities. The promotion of regional economies should be complemented by the creation of compact settlement structures with the provision of shopping, services and recreational facilities and work opportunities close to where people live, so that the trip distance is kept short. In other words, wherever possible, “towns of short distances” should be promoted (Singh, 2006). There are many benefits of the compact township over urban sprawl, which include less car and two-wheeler dependency thus lower emissions, reduced energy consumption, better public transport services, better accessibility, less traffic accidents, and better quality of life.

4.2 Focusing on public transport particularly bus transport

Passenger mobility in urban India relies heavily on its roads. Although rail based transport services are available in few mega cities, they hardly play any role in meeting the transport demand in rest of the million plus cities. The time has indeed come to plan rail based mass transport system in all the cities having population more than 2 million. However, considering the financial health of various levels of governments (central, state, and local governments) and investment requirement to introduce and improve rail based public transport system, it is evident that bus transport will have to play a major role in providing passenger transport services in all million plus cities. Therefore, urban transport plans should specially emphasize on bus transport system.

Government regulation and control have exacerbated the poor operational and financial performance of publicly owned urban transport undertakings, which are the main provider of bus transport services in Indian cities. As cost of operation rises, transport system comes under financial pressure to raise fares, but politicians are under pressure to keep fares at existing levels. Unless the system is subsidized, it has to eliminate some of its less profitable or loss making services. In democracy, politicians are bound to yield to pressure from those whose services are threatened and to insist on maintaining money-losing operations. Due to this, transport undertakings find it difficult to raise their revenue sufficient enough to meet the cost of operation.ⁱⁱⁱ In addition, they have to provide concessional travel facilities to various groups such as freedom fighters, journalists, students, etc. besides paying a high level of different kinds of taxes. The total tax burden for public transport vehicles per vehicles-km is 2.6 times higher than that for private vehicles (Table 11). It is increasingly becoming very difficult for loss making urban transport undertakings to augment and manage their fleet, which in turn leading to poor operational performance and deterioration in quality of services.

With few exceptions, publicly owned urban transport undertakings in India operate at higher unit costs than comparable transport operations controlled by the private sector. Kolkata provides an opportunity to make a direct comparison between privately owned and publicly owned bus system. Public buses are operated by the Calcutta State Transport Corporation (CSTC), with fleet size of almost 1,000 buses and staffing ratio per operational bus of around 11. CSTC’s bus productivity is hardly 112 kilometers per

bus per day and its fuel productivity is less than 3.5 bus-kilometers per litre of diesel. As a result of low productivity, CSTC requires a huge subsidy since revenues cover less than three-fourths of the costs.^{iv} On the other side, there are nearly 2,000 private buses in the city. These buses are operated mainly by small companies or individual owners grouped into a number of route associations. Fares for private and public bus services are the same. Despite the similarity in fare rates, private operators have been able to survive financially without any subsidy. Their success is attributed to high level of productivity, which is reflected in low staffing ratios and high fleet availability. The private bus operators in Kolkata, who hold almost two-third of the market, play a major role in meeting the demand and thus substantially reduce the financial burden on the state government. Furthermore, publicly owned urban transport undertakings often lack the flexibility of organization, the ability to hire and fire staff, or the financial discretion needed to adapt to changing conditions. In such circumstances, a policy which encourages private participation in the provision of bus transport services should be welcomed. One should note that there is an urgent need for restructuring of public transport system in Indian cities to enhance both quantity as well as quality of services.

Private participation in the provision of bus transport services has been very successful in Indore and Surat. Indore, which did not have a public transportation system until 2006, now has a city bus service with 104 buses run by a special purpose vehicle (SPV), the Indore City Transport Services Ltd. (ICTSL). ICTSL was set up in December 2005 by the Indore Municipal Corporation and the Indore Development Authority to operate and manage the public transport system through Public Private Partnership (PPP). It runs buses on 24 routes with 300 bus stops built on Build-Operate-Transfer (BOT) basis. The marketing of bus services is done by a vendor who issues at least 15,000 monthly and daily passes at agreed rates every month, ensuring a monthly income of Rs. 4 million for the ICTSL. ICTSL has been making profits since its inception and its profit has increased from Rs. 3.4 million in 2006-07 to Rs. 10 million in 2009-10. Surat is another successful example of private participation in the provision of bus transport services. Surat has 125 buses running on 44 routes, carrying 70,000 passengers daily. There are 87 bus stops on BOT basis, each earning a revenue of Rs. 40,000 per year. The urban local body gets a premium of Rs. 20,000 per bus from the operator for the contract period of five years. All city buses run on CNG and are owned, operated, and maintained by private operators. In both the cases, Indore and Surat, operation of the bus services has been outsourced to the private sector, while the Municipal Corporations have found innovative ways of investing in public transport infrastructure and traffic monitoring systems of regulation and enforcement (Ahluwalia et al., 2011). This model of bus transport system may be adopted by all those cities where there is poor availability of public transport services.

Table 11: Vehicle taxation in Indian cities

Vehicle tax (Rs. per year)	Lucknow	Delhi	Bangalore	Hyderabad	Ahmedabad
For a car priced at Rs. 4 lakh	667	533	2400	2400	1333-2000
For a public transport bus	7880	13675	108000	5% of the gross traffic earnings	7092

Source: Centre for Science and Environment (2009).

4.3 Introducing variety of bus transport services

There is a need for variety of bus transport services. Given the opportunity, people reveal widely divergent transport preferences, but in many places authorities favor a basic standard of bus transport services. Presently, it is increasingly difficult to achieve good market acceptance with a single type of product. Bus transport operators operating in Indian cities still believe that the vast majority of its users make the same type of commuting trips everyday, and so promote package that essentially assume this regularity. It may be possible that the current users of bus transport services have such regular pattern of use, but certainly many of those that have left it had varying mobility needs that they felt poorly satisfied either by the services themselves or by the price deals available. Therefore, it is required to segment the supply of bus transport system to provide different services for different people and even to the same person at different occasions.

4.4 Improving the efficiency of bus transport operation

A serious effort should be made to improve the productive efficiency of bus transport operators so that they can enhance both quality as well as quantity of bus transport services. It is recognized that some form of competitive pressure is needed to ensure that a serious effort is made towards productive efficiency. This competitive pressure may be obtained either through direct competition for the market or through some form of systematic comparison with similar operators. Direct competition for the market, for example through periodic tenders for the right to supply the service in a partly or totally protected environment, is more appropriate for cities where presently there is no bus transport operation. In this case, private operators may be encouraged to provide the service where a negative result will mean loss of business for the incumbent operator. This will have a competitive pressure on the operator to improve productive efficiency. Benchmarking i.e., systematic comparison with similar operators can effectively be used to improve the productive efficiency of publicly owned urban transport undertakings where a negative result will mean loss of job for the managers and some of the staff. This will improve productive efficiency of bus transport operation in those cities which are served by publicly owned transport undertakings.

4.5 Adopting optimal pricing strategies for transport services

Pricing of transport is another key issue which should be addressed properly. Pricing policy could effectively be used to encourage the public transport and restrict the usage of private vehicles. So far, in India, operating cost of using the private vehicles is far less than the marginal social costs which encourage people to use private modes. Over the years, government policies have been very supportive towards automobile industry. Motorcycle and car ownership is seen as desirable and to be promoted at all costs. Coupled with this perception is the common view that development and support of the car and two-wheeler manufacturing industry is good for the economic development. For these reasons, government often implements policies that artificially lower not only the cost of vehicle ownership (through very low one time registration fee, low sales tax, etc.) but also the usage of the same. There is no doubt that government should

encourage automobile industry for overall economic development, it should find ways to restrict the usage of cars and two-wheelers. Private vehicles should pay their full external costs. Government should use market based instruments such as annual registration fee, parking fee, road tax, fuel tax, congestion charges, etc. to increase the (actual) marginal cost of private vehicle use to a level where it is equal to the marginal social costs of the same. At the same time, government should promote public transport by abolishing annual motor vehicle tax and passenger tax levied on public transport vehicles.^v

There is a need to have optimal pricing strategy for public transport services as well. Price of transport services must be seen not only as an instrument for cost recovery but also for driving consumers' behavior. Although, there is no such thing as the 'right' price but rather there are optimal pricing strategies, which facilitate attainment of specific goals. The optimum price to achieve profit maximization may differ from the one needed to maximize welfare or to ensure the highest traffic revenue. Many economists recommend adoption of prices based on marginal costs particularly in case of public enterprises. The driving force behind the argument in favor of marginal cost pricing for public enterprises is the assertion that they ought to maximize welfare rather than profits. The adoption of marginal cost pricing may, however, in certain circumstances, result in an undertaking making a financial loss. The classic example of this is the decreasing cost industry where, because of high initial capital costs, the setting of charges equal to marginal cost will result in a financial deficit. This deficit may not be necessarily indicative of mismanagement. Most of the urban transport undertakings in India appear to operate on increasing returns to scale and consequently marginal cost pricing will result in a financial deficit. When they are restricted to meet a revenue-cost constraint, it is required to find the second-best set of prices which could be based on inverse elasticity rule^{vi}. The price and output combinations that it computes minimize the deadweight loss due to unavoidable deviation of price from marginal cost. Since this pricing rule takes into account price elasticity of demand, it is superior to the average-cost pricing rule that most urban transport undertakings tend to adopt.

Publicly owned urban transport undertakings can think of charging different (optimal) prices for different quality of services. Assuming that shift of consumers between different qualities of services is negligible, the availability of the range of services means that total potential consumer surplus will exceed that generated if only a single price and service package were available. Operator stands to gain as a result of this pricing strategy since costs of servicing each customer group are not drastically different.

Apart from this one could also envisage differential pricing mechanism such as peak period, off-peak period, peak-direction, off-peak direction, etc. based pricing strategy. The problem of the peak is peculiar to transport sector. The problem here arises from systematic variation in demand, frequently over a relatively short period. The problem is further aggravated due to the fact that transport can not be stored to reconcile the systematic changes in demand with smooth, even production. Reconciliation can only be through price. Justification of differential pricing for peak and off-peak passengers stems from the fact that marginal cost of production during peak exceeds that during off-peak. Charging peak and off-peak passengers prices that are equal to their respective marginal costs not only maximizes social welfare but also has potential to augment traffic revenue. Even after adopting such pricing strategy if traffic revenue is not sufficient to cover costs, then one may have to adopt second best pricing where price

charged to a particular group of passengers equals marginal cost plus mark-up. The mark-up over marginal cost would be inversely proportional to the price elasticity of demand. For example, peak travelers whose demand is relatively inelastic could be charged a price substantially higher than the marginal cost as compared to off-peak passengers.

4.6 Enhancing transport coordination

To encourage people to use public transport, there is a need to have transportation system which is seamlessly integrated across all modes. The various modes of public transport including intermediate public transport have to work in tandem. Presently, different agencies, independent of each other, are operating different services in Indian cities. For example, in Delhi, metro rail is operated by Delhi Metro Rail Corporation Ltd, sub-urban rail service by Northern Railway, bus transport service by Delhi Transport Corporation, and taxi and auto-rickshaw by private operators. There is a lack of coordination among these agencies. Since the ultimate objective is to provide adequate and efficient transport system, there is a need to have a coordinating authority with the assigned role of coordinating the operations of various modes. This coordinating authority may be appointed by the central or state government and may have representatives from various stakeholders such as private taxi operators, bus operators, railways, state government, etc. The key objective should be to attain the integration of different modes of transport to improve the efficiency of service delivery and comfort for commuters. At the same time, a single ticket system, where commuters can buy a transport ticket that is valid throughout the public transport network within the coordinating authority's jurisdiction, should also be developed and promoted. Integration between different modes of public transport provides quicker, easier, convenient, and more reliable journeys which are essential to promote the usage of public transport. Integrated transport system has potential to attract people away from the private cars and two-wheelers and thus can contribute for congestion relief and environmental preservation.

4.7 Promoting car sharing

Car sharing, also known as car pooling, is when two or more people share a car and travel together. It allows people to have the convenience of the car, but at the same time helps to reduce congestion and pollution through reduction in vehicle kilometers. Car sharing may be organized through affinity groups, large employers, transit operators, neighborhood groups, or large car-sharing businesses (Singh, 2006). Car sharing provides the potential to reduce the costs of vehicle travel to the individual as well as society. In order to promote car sharing, it is important to ensure that sufficient parking places are allocated to vehicles belonging to car sharing groups at nominal or no parking fee.

4.8 Restraining the use of polluting vehicles and fuels

More than 50% of motor vehicles in India are more than five years old. In general, emission performance of older vehicles is significantly inferior to newer vehicles because of poor maintenance and lax emission standards for in-use vehicles. The large

number of three-wheelers and many two-wheelers still operate with two stroke engines, which emit a high volume of unburnt particles due to incomplete combustion. Diesel cars now account about 40% of total car sales in India, compared with less than 20% few years ago. Diesel cars are becoming more popular because diesel price in India is significantly less than the petrol price. Government encourages this price differential primarily to help farmers and bus and truck operators. This price benefit is not meant to be available for personal cars. Although diesel cars emit less greenhouse gases, there are serious concerns about the public health effects of their NO_x and particulate matter emissions particularly in densely populated metropolitan cities.

Therefore, government needs to check the use of polluting vehicles and fuels and promote cleaner technology and better fuels. Government may use the market based instruments to do the same. For example, a relatively high annual motor vehicle tax, which may be increasing with the age of vehicle, may be imposed on two stroke two-wheelers and three-wheelers and all vehicles that are more than ten years old. Similarly, cars that use diesel could be discouraged in million plus cities by levying cess on diesel in those cities.

4.9 Tightening vehicle emissions standards and inspection and maintenance programs

Appropriate vehicle emissions standards for new and in-use vehicles and a well-designed and operated Inspection and Maintenance (I/M) program are important elements of an overall strategy to reduce vehicle emissions and air pollution in urban areas. Stringent emission regulations and their effective implementation have produced good results in many developed countries (Asian Development Bank, 2003). However, emission standards in India are relatively lax compared to current Euro standards. At the present time, India lags behind the European new vehicle standards and fuels requirements by 7-8 years (Table 12). Hence, there is a need to review the emission standards of India and make them more stringent. It is required to set a goal to achieve parity with Europe, United States or Japan by the year 2015 at the latest.

It has been estimated that at any point of time, new vehicles comprise only 8 to 10% of the total vehicle population in India. Currently, only transport vehicles, that is, vehicles used for hire or reward are required to undergo periodic fitness certification (see Figure 3 for existing inspection and maintenance system in India). The large population of personalized vehicles is not yet covered by any such mandatory requirement. Modern vehicles equipped with advanced pollution controls are even more dependent on proper functioning of components to keep pollution level low. Minor malfunctions in the air, fuel, or spark management system can increase the emissions significantly. Therefore, tightening of new vehicle emissions standards should be followed by a similar tightening of in-use vehicle emission standards.

The inspection and maintenance system, comprising inspection, maintenance, and certification of vehicles, is crucial for regulating pollution for the large fleet of in-use vehicles. At present in India, there is no regular fitness checking program for in-use private vehicles. Simple Pollution Under Control (PUC) checks came into existence in 1991 for all on road vehicles. Commercial vehicles are required to undergo simple fitness checks in addition to PUC checks. However, these are isolated checks and are grossly inadequate. There is an urgent need to strengthen the existing inspection and maintenance program in the country.

Government needs to consider (i) whether it has adopted the appropriate in-use vehicle emissions standards and test procedures on which to base I/M, (ii) whether the institutional capacity and willingness to enforce an I/M program exists, and (iii) whether the repair sector is sufficiently trained to carry out repair work on vehicles which fail the tests. If any of these aspects are found to be deficient, government should take appropriate measures to rectify the problems. To ensure the public acceptance and their participation in I/M program, public awareness campaign should be strengthened. Particular emphasis should be placed on the health benefits that can result from a successful I/M program.

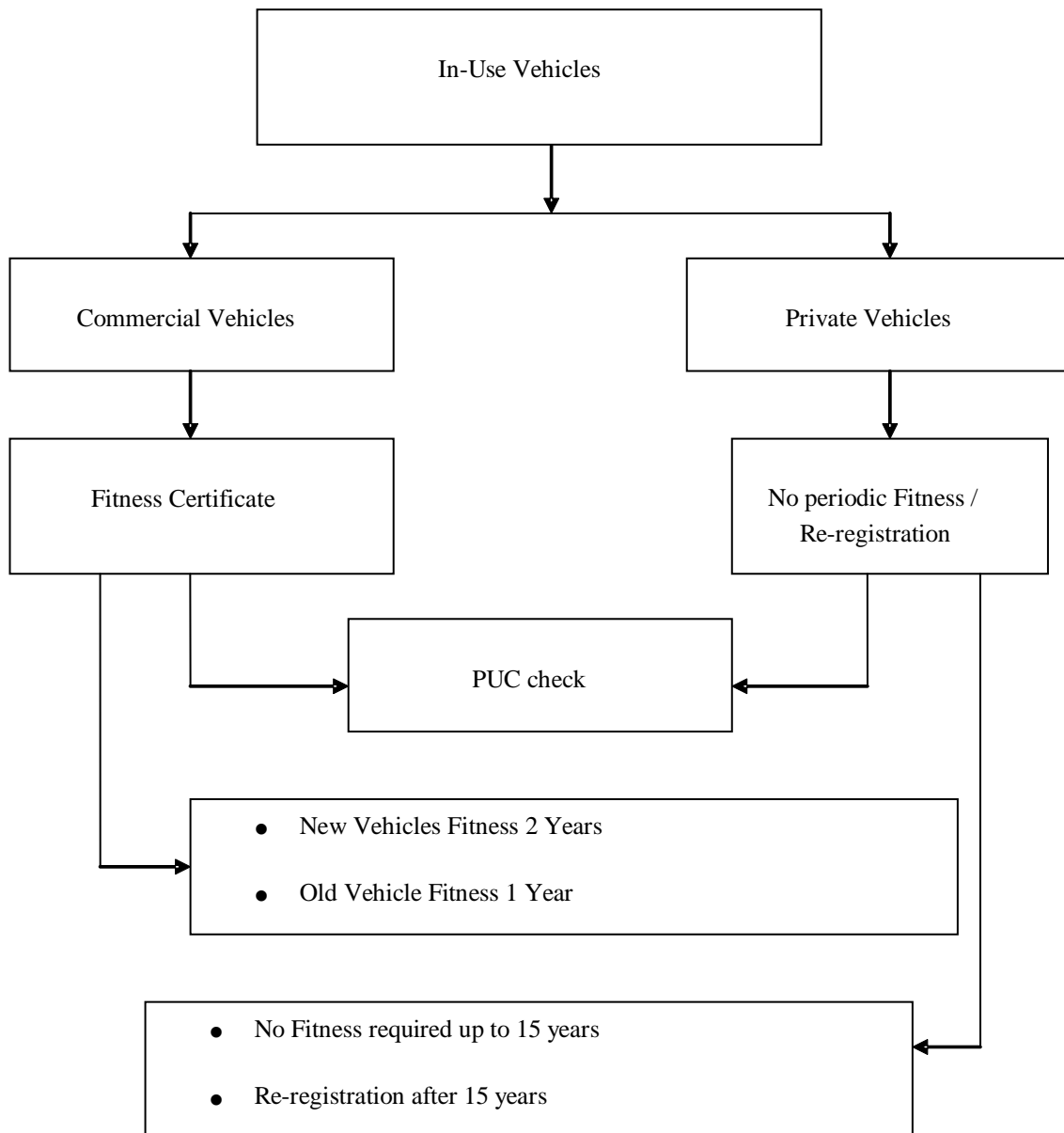


Figure 3: Existing inspection and maintenance system

Source: Status of the vehicular pollution control programme in India (March, 2010). Central Pollution control Board, Ministry of Environment & Forests, Govt. of India.

Table 12: Emission standards for new vehicles (light duty) in selected countries

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
India (entire country)	Euro 1		Euro 2				Euro 3			Euro 4		
India (Delhi & other cities*)	Euro 2		Euro 3				Euro 4			Euro 5		
European Union	Euro 3		Euro 4			Euro 5				Euro 6		
Hong Kong, China	Euro 3			Euro 4			Euro 5					
South Korea				Euro 4			Euro 5					
Thailand	Euro 2		Euro 3						Euro 4			

Sources: (1) Vehicular Technology in India | Emission Norms. SIAM India. Retrieved on 2011-02-02 from <http://www.siamindia.com/scripts/emission-standards.aspx>. (2) Emission standards for new vehicles (light duty). CAI-Asia, 2008. Available at http://www.cleanairnet.org/caiasia/1412/articles-58969_resorurce_1.pdf

Note: * includes Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Lucknow, Sholapur, and Agra.

4.10 Implementing demand side management measures

In general, Indian cities have not made much progress in implementing the demand side management measures, such as parking fee, fuel tax, congestion pricing, etc. Although measures that involve restraining the use of private vehicles are likely to be unpopular, a gradualist approach of progressively introducing restraints on road use, while at the same time improving public transport, is more likely to lead to a greater acceptance. It is expected that improved public transport and more efficient management of demand would help to combat the trend away from public transport towards greater use of cars and two-wheelers.

There is no doubt that the public transport is desired but it can not be encouraged without the implementation of sound and comprehensive demand side management policies. Such policies should not be implemented in isolation, but in conjunction with other transport planning, supply side management, and transport pricing measures. Public needs and road safety should also be considered in design of the policies even when these are directed to improve the air quality.

4.11 Using supply side management measures

As discussed earlier, traffic congestion on roads increases the level of pollution dramatically. Hence, there is an urgent need to use supply side management measures to tackle prevalent traffic congestion problem. One way traffic system, improvement of signals, traffic engineering improvement measures for road network and inter-sections, bus priority lane, etc. could be used as short-term measures to ease traffic congestion. Road infrastructure improvement measures like new road alignments, hierarchy of roads, provision of service roads, bye passes, ring roads, bus bays, wide medians, intersection improvements, construction and repair of footpaths and roads, removal of

encroachments, etc. should also be introduced at least in million plus cities. These can be considered as medium-term measures. Besides short- and medium-term measures, there is a need to have long-term measures as well, involving technology upgradation and introduction of high speed, high capacity public transport system particularly along high-density traffic corridors. However, capital-intensive projects should be considered if and only if they are absolutely necessary. In many cases, instead of building underground railways or elevated highways, government would have done better to have increased the capacity of existing bus transport services. There should be careful appraisal of capital-intensive projects before implementing them in metropolitan cities.

4.12 Encouraging green modes

Transport policy should also encourage the need for developing *green* modes like bicycles, cycle rickshaws, pedestrians, etc. The potential of *green* modes is often underestimated since they are used primarily for short distances. But, large fraction of journeys made by cars and two-wheelers are mainly for short distances say less than 6 km, a distance over which use of motor vehicle does not provide significant time advantage (Singh, 2006). Moreover, motor vehicle emissions are high for short distance travel because fuel consumption is high due to cold engine and because the catalyst is not yet working at full efficiency. Due to this reason, the use of *green* modes in place of motor vehicles for short distances has huge potential for pollution reduction. Green modes particularly walking and cycling have huge health benefits as well. However, to promote *green* modes, the safety concerns of cyclists and pedestrians have to be addressed adequately. For this purpose, there has to be a segregated right of way for bicycles and pedestrians. Apart from improving safety, this will help to improve traffic flow, increase the average speed of traffic, and reduce emissions resulting from low vehicle speed.

4.13 Introducing public awareness programs

Public attitudes influence politicians and policy makers and increase the political will to tackle problems. The adverse health effect of air pollution due to vehicular emission needs to be communicated to people as a means of influencing public attitudes. Deaths and injuries resulting from road traffic crashes are also a major and growing public health problem. Media, NGOs, and research institutions should be encouraged to highlight these issues, conduct independent analysis, and advocate possible solutions to policy makers and implementing agencies. At the same time, fair and equitable procedures for public complaints should be instituted. These can enhance awareness and understanding, influence public attitudes and public support, and create the necessary political will to tackle the problem of congestion, air pollution, and road safety.

At the same time, public awareness programs should also be initiated to communicate the benefits of public transportation, efficient vehicles and fuels, car pooling, green modes, economical driving, etc. One should note that an economical driving alone can bring about fuel savings of up to 10-15% per vehicle (Singh, 2006). The fact that fuel consumption can be influenced by economical driving is not widely communicated to the public. The public should be given better information about the same. To promote economical driver training for individuals as well as companies, government should positively think to provide financial subsidies to driver training schools.

4.14 Strengthening urban institutions

Most Indian cities are struggling to address the transportation problem mainly because they are not equipped with the appropriate institutional capacity and required financial resources. This is because functional responsibilities for urban transport are fragmented among central, state and local level governments where no one is in charge of overall coordination (see Table 13 for institutional arrangements for urban transport in India). Management of urban areas is primarily a responsibility of the state governments in India. However, several key agencies those play an important role in urban transport planning work under the central government, with no accountability to the state or local government. Central government is directly involved in the provision of suburban rail service through Indian Railways in four mega cities. Ministry of Road Transport & Highways, Government of India, is responsible for the national highways, including the stretches within urban areas, and local governments have no role in the operations and management of these stretches though they are heavily used for urban transport (Singh, 2005).

State governments independently control local land use policies, motor vehicle and sales tax rates, bus transport systems, policies for private sector participation, etc. Most of the local governments at municipal level rely heavily on capital grants from the states for almost all infrastructure projects. Although, Urban Local Bodies (ULBs) in India have been empowered by the Constitution (74th Amendment) Act, 1992 to assume responsibilities for development of urban transport, but most of them do not have adequate power to raise financial resources. Their revenues mainly depend on property tax collection and inter-governmental transfer from the state. ULBs' revenues are barely sufficient for salaries and current expenditures, and most capital investments are funded through borrowing, often from the state Urban Infrastructure Development Corporations (UIDCs). Revenues from user charges imposed on publicly provided infrastructure services are minimal. Due to this, insufficient funds are available for operation and maintenance of existing assets which badly affects the service delivery.

Although 74th Amendment of the Constitution aimed to provide administrative and fiscal decentralization at the local government level, the progress in this regard has been slow primarily because local governments are still dependent on higher level of governments for funding. They do not have power to raise additional tax revenue and are still dependent on inter-governmental transfer arrangements. As long as this situation continues, most cities may not be able to improve their infrastructure. There is a pressing need to empower the ULBs in the true sense so that they can raise funds for developmental projects in urban areas by their own rather than being dependent on states. Also, they may be authorized, through legislation, for overall coordination of activities relating to provision of transport infrastructure by various government agencies in their respective urban areas. Only then, they can augment the infrastructure base, provide improved quality of services on a sustainable basis to their residents, and contribute to the growth momentum of the Indian economy.

Table 13: Institutional arrangements for urban transport in India

Function	Sub-functions	Agency Responsible
Strategic and Policy Functions	Strategic planning Policy formulation Capital financing	Ministry of Urban Development / State Transport Department / State Urban Development Department
Regulation of Commercial Issues	Fixation of fares / tariffs Monitoring quality of services	Ministry of Railways / State Road Transport Corporation / Regional Transport Office
Health and Safety Regulation	Setting standards Ensuring adherence to safety standards Ensuring adherence to environmental standards	Ministry of Road Transport & Highways / Central Pollution Control Board / State Pollution Control Board Ministry of Road Transport & Highways Central Pollution Control Board / State Pollution Control Board
Procurement and Provision of Public Transport	Network and route design Identification of demand Franchising/route allocation Planning and provisioning of services Contract monitoring	Municipal Corporation / State Road Transport Corporation Municipal Corporation State Road Transport Corporation Municipal Corporation / Public Works Department
Supply of Common Infrastructure and Other Services	Inter-modal coordination Passenger information systems Data collection and management Dispute resolution Management of common infrastructure Public relations Security services Management of common ticketing facilities Management of revenue-sharing arrangement between operators	State Road Transport Corporation / Municipal Corporation / State Transport Department Traffic Police Municipal Corporation / State Road Transport Corporation
Operation of Services	Operation of publicly owned bus services Operation of privately owned buses Operation of rail-based services	Municipal Corporation / State Road Transport Corporation Private Bus Operators Ministry of Railways

Source: Ahluwalia I. J. et al. (2011).

5. Concluding remarks

Transport demand in most of the Indian cities has increased substantially due to increase in population as a result of both natural increase and migration from rural areas and smaller towns. Availability of motorized transport, increase in household income, and increase in commercial and industrial activities has further added to it. Unfortunately, public transport systems in Indian cities have not been able to keep pace with the rapid and substantial increase in travel demand. Rail based public transport services and well-organized bus transport services are limited to few big cities only. Qualitatively, the available public transport services are overcrowded particularly during peak hours and involve long waiting periods. As a result, there is a massive shift towards personalized transport, specially cars and two-wheelers, and also proliferation of various types of intermediate public transport modes, such as auto-rickshaws and taxis.

The increasing use of private motor vehicles in cities has been rapidly changing their modal-split structure. Motorization may have brought a higher level of mobility to the high-income segments of urban population, but its adverse impact in the form of congestion, air pollution, and traffic accidents is also substantial. Although these impacts are inherent to motorization, the excessively high level of impact faced by many Indian cities has a lot to do with the lack of effective public policy. The city cannot afford to cater only to the private cars and two-wheelers and there has to be a general recognition that without public transport in general and bus transport in particular cities would be less viable. Although rising income of the people is one of the most important reasons for change in modal-split structure, the more important reasons are to be found in the public transport system itself. Speed, service quality, convenience, flexibility and availability favor adoption of private mode as the main mode of transport. Given the opportunity, people reveal widely divergent transport preferences, but in many places city authorities favor a basic standard of public transport services. It is often thought to be inegalitarian to provide special services such as premium or guaranteed seats in return for higher fares. As a consequence, those who can afford private vehicle are successively leaving public transport. Until recently the main function of public transport was to satisfy the individual needs of the less affluent members of society, but now it has to contribute for congestion relief and environmental preservation. This requires a fundamental change of emphasis to fulfill its new role of attracting enough people away from the cars, two-wheelers, auto-rickshaws, and taxis.

The problem of acute road congestion, rising air pollution, and a high level of accident risk faced by metropolitan cities of India is taking serious dimensions and worsening the people's quality of life. Without vigorous action, this problem would intensify, as rising population over the coming decades and the goal of growing economic prosperity put more pressure on the system. Reducing traffic congestion, vehicular emission, and accident risk requires a comprehensive strategy. The main objective of such strategy should be to provide and promote sustainable high quality links for people, goods, and services to, from and within the city. Strategy should be designed in such a way that it reduces the need to travel by personalized modes and boosts public transport system. This requires not only increasingly stringent emissions standards, specifications for clean fuels, proper maintenance of in-use vehicles, optimal pricing of transport services, demand as well as supply side management measures, but also a complete overhaul of public transport system. The time has come to act now.

References

- Ahluwalia, I.J., et al. (2011). Report on Indian Urban Infrastructure and Services. Ministry of Urban Development, Government of India, New Delhi. <http://niua.org/projects/hpec/finalreport-hpec.pdf>, (accessed on 2 December 2011).
- Asian Development Bank (2003). *Vehicular Emissions Standards and Inspection and Maintenance*. Asian Development Bank, Manila, Philippines.
- Central Pollution Control Board (2009). *Annual Report for 2008-09*. Ministry of Environment & Forest, Government of India, New Delhi. http://cpcb.nic.in/upload/AnnualReports/AnnualReport_37_ANNUAL_REPORT-08-09.pdf, (accessed on 9 December 2011).
- Centre for Science and Environment (2009). *Taxing the Public not the Private: An Analysis of the Current Vehicle Taxes*. Briefing Paper 2a. Centre for Science and Environment, New Delhi.
- Emission standards for new vehicles (light duty). CAI-Asia, 2008. http://www.cleanairnet.org/caiasia/1412/articles-58969_resorurce_1.pdf, (accessed on 4 October 2011).
- European status report on road safety: towards safer roads and healthier transport choices. World Health Organization Europe, 2009. WHO Regional Office for Europe, Copenhagen. http://www.euro.who.int/__data/assets/pdf_file/0015/43314/E92789.pdf, (accessed on 11 October 2011).
- National Crime Record Bureau, Ministry of Home Affairs, Government of India, New Delhi. *Accidental Deaths and Suicides in India, 1999 to 2009*. <http://ncrb.nic.in/adsi/main.htm>, (accessed on 4 October 2011).
- Padam, S. and Singh, S.K. (2004). Urbanization and Urban Transport in India: The Search for a Policy. *European Transport \ Trasporti Europei International Journal of Transport Economics, Engineering and Law*, vol. 27, pp. 26-44.
- Road Deaths Australia 2009 Statistical Summary. Department of Infrastructure, Transport, Regional Development and Local Government, Australian Government, Canberra, Australia. http://www.bitre.gov.au/publications/69/Files/Ann_Road_Deaths.pdf, (accessed on 11 October 2011).
- Road safety in Asia and the Pacific. Economic and Social Commission for Asia and the Pacific during 26th United Nations Economic and Social Council Meeting on 6-8 November 2006 in Busan, Republic of Korea. http://www.unescap.org/ttdw/roadsafety/files/MCT_SGO_9E.pdf, (accessed on 9 December 2011).
- Singh, S.K. (2009). Road Traffic Crashes: The Scourge of UP's Cities. *Economic and Political Weekly*, vol. 44, no. 48, pp. 22-24.
- Singh, S.K. (2008). Transport Policy for Better Air Quality in Urban India. In K. N. Bhatt, eds., *Population, Environment, and Health: Emerging Issues*; pp. 169-184. Rawat Publications, Jaipur, India.
- Singh, S.K. (2006). The Demand for Road-based Passenger Mobility in India: 1950-2030 and Relevance for Developing and Developed Countries. *European Journal of Transport and Infrastructure Research*, vol. 6, no. 3, pp. 247-274.
- Singh, S.K. (2005). Review of urban transportation in India. *Journal of Public Transportation*, vol. 8, no. 1, pp. 79-97.

Status of the vehicular pollution control programme in India (March, 2010). Central Pollution control Board, Ministry of Environment & Forests, Govt. of India, New Delhi.

<http://www.indiaenvironmentportal.org.in/files/status%20of%20the%20vehicular%20pollution.pdf>, (accessed on 4 October 2011).

Traffic Safety Facts (2009). U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC.

Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. *Road Transport Year Book (2007-09)*. <http://www.morth.nic.in/writereaddata/mainlinkFile/File420.pdf>, (accessed on 11 October 2011).

Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Various Issues. *Motor Transport Statistics of India* and *Road Transport Year Book*.

Vehicular Technology in India | Emission Norms. Society of Indian Automobile Manufacturers, New Delhi. <http://www.siamindia.com/scripts/emission-standards.aspx>, (accessed on 11 October 2011).

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ⁱ Two-wheelers include motorcycles, scooters and mopeds. They are usually petrol driven vehicles and available in both two- as well as four-stroke engines. Although engine capacity of two-wheelers in India varies from 60 cc for mopeds to 535 cc for motor cycles, most of them operate with an engine capacity of around 100 cc.

ⁱⁱ Finer Particulate Matter (PM) is usually characterized as less than 10, 2.5 and 1.0 microns and referred as PM₁₀, PM_{2.5} and PM_{1.0} respectively.

ⁱⁱⁱ During the year 2009-10, publicly owned urban bus transport undertakings in India incurred an accumulated loss of about Rs. 27,279 million which is equivalent to a loss of Rs. 18.82 per bus-km.

^{iv} CSTC incurred total cost of Rs. 2215 million whereas its total revenue was only Rs. 1631 million during the year 2008-09, latest year for which the data is available.

^v During the year 2009-10, urban transport undertakings in India operated with around 20,000 buses and paid Rs. 1,600 million to the government in different form of taxes such as motor vehicle tax, passenger tax, special road tax, etc. Therefore, on an average, every bus operated by urban bus transport undertakings in India faces a tax burden of almost Rs. 80,000 per year.

^{vi} Inverse elasticity rule asserts that the optimal percentage deviation of the price of any goods or service from its marginal cost should be inversely proportional to its own price elasticity of demand.