



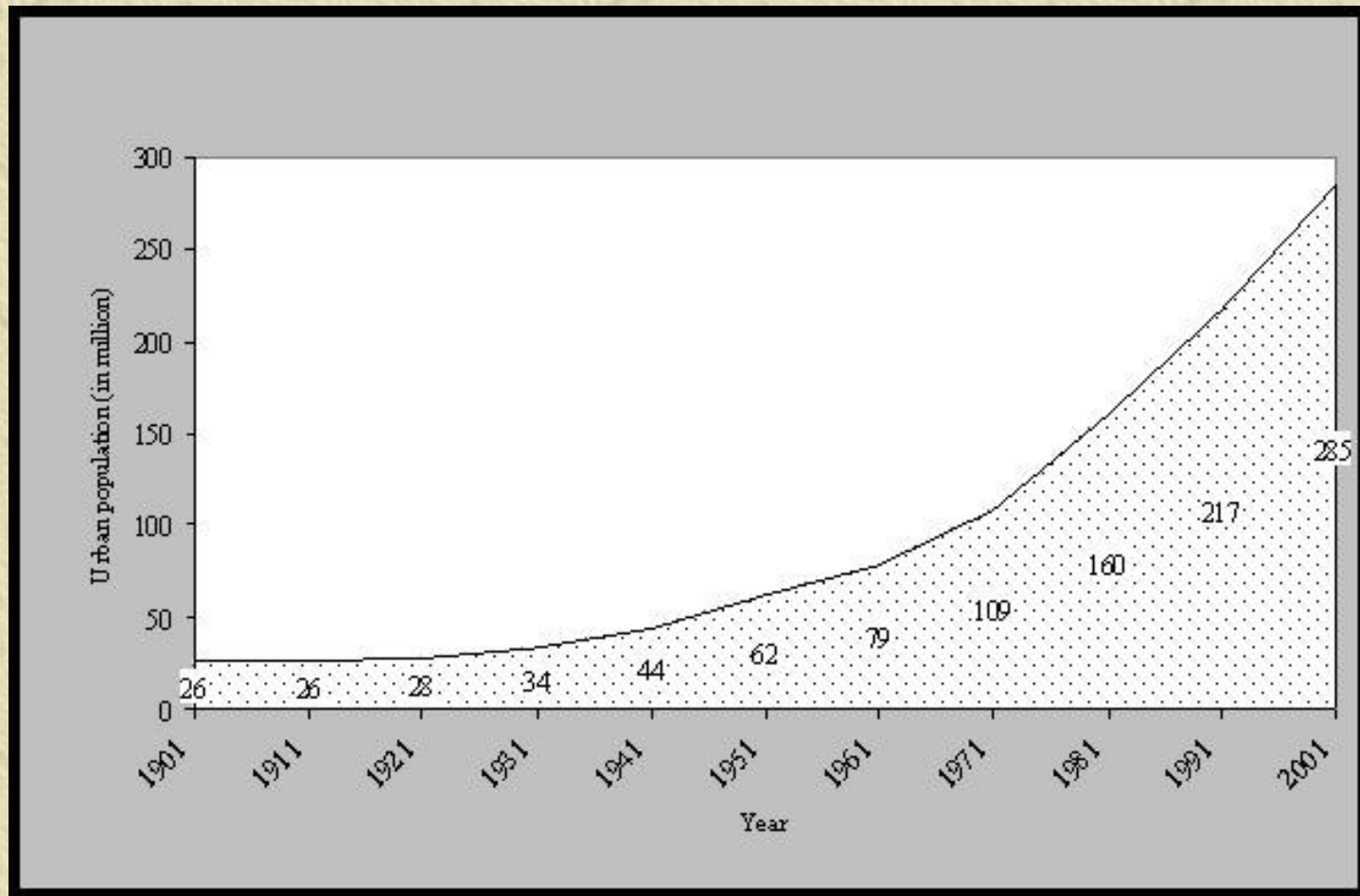
Urban Transport Planning and Development: Issues and Challenges for India

Dr. Sanjay K. Singh

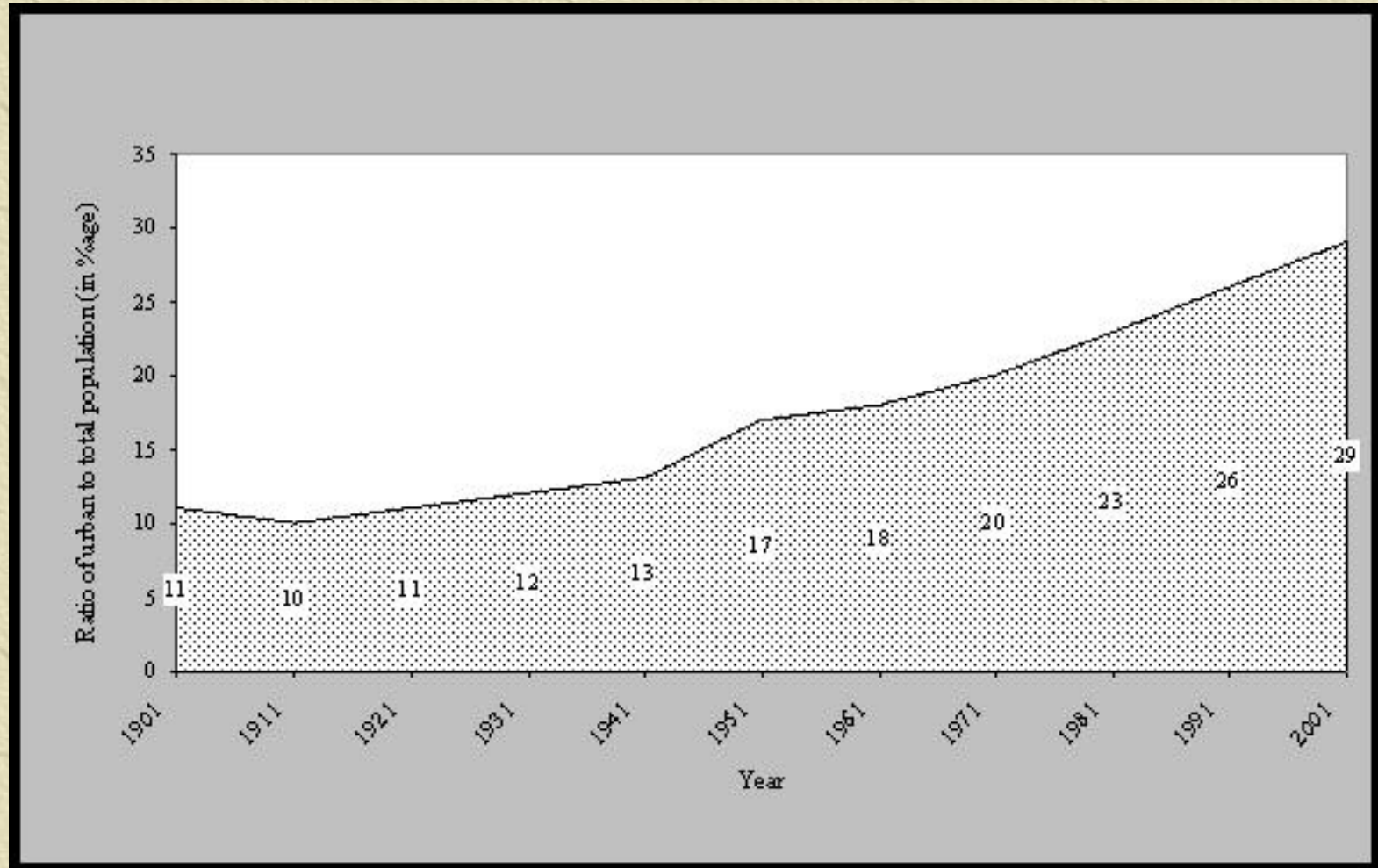
**Department of Humanities and Social Sciences
Indian Institute of Technology Kanpur**

Urbanization, vehicular growth and modal split

Urban population in 2001: 285 million (29% of total pop.);
Rate of growth in urban pop.: around 3 percent per annum;

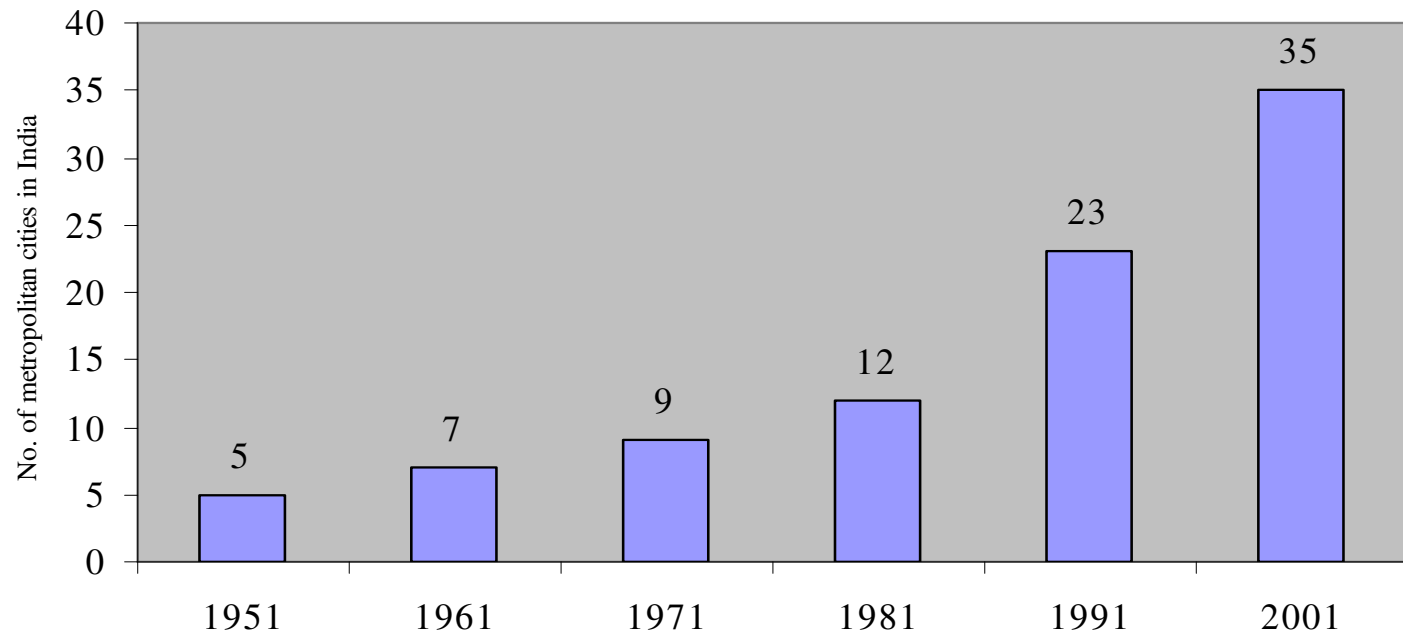


Share of urban population in India



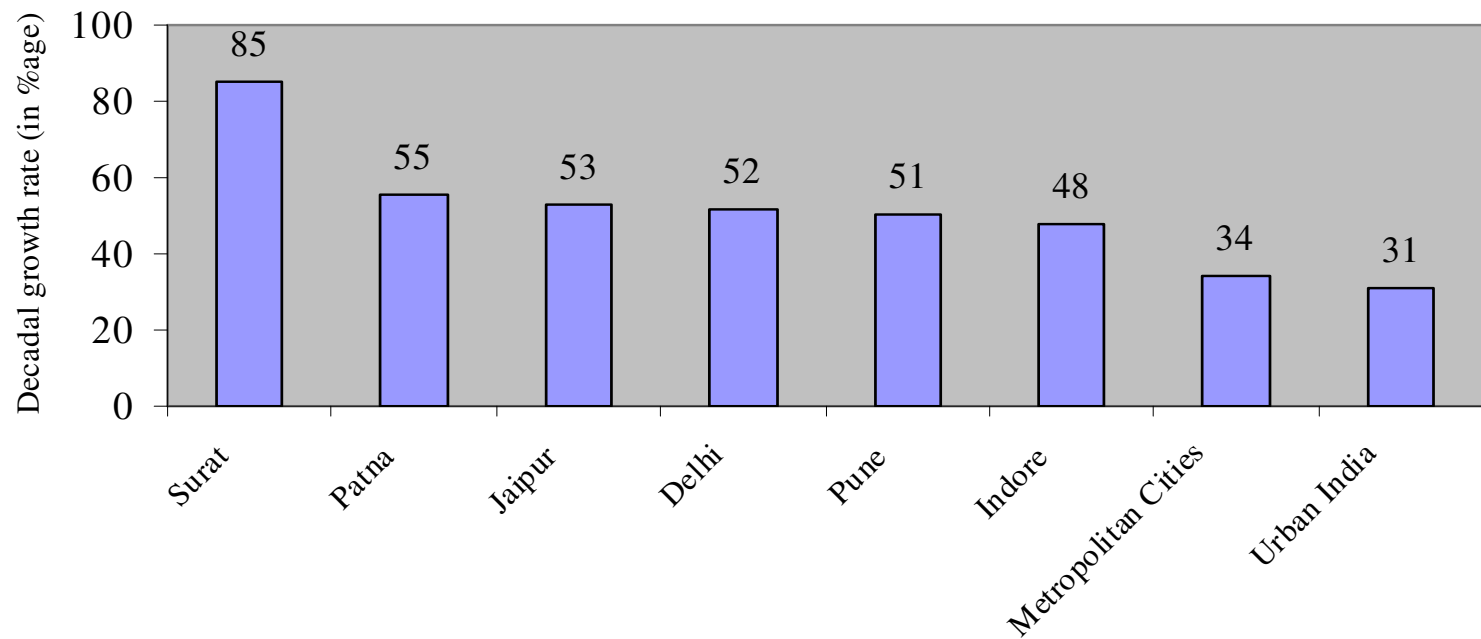
No. of metropolitan cities (million plus cities): increased from 23 in 1991 to 35 in 2001

Growth of metropolitan cities in India



In general, India's metropolitan cities experienced higher growth than their smaller counterparts during 1990s

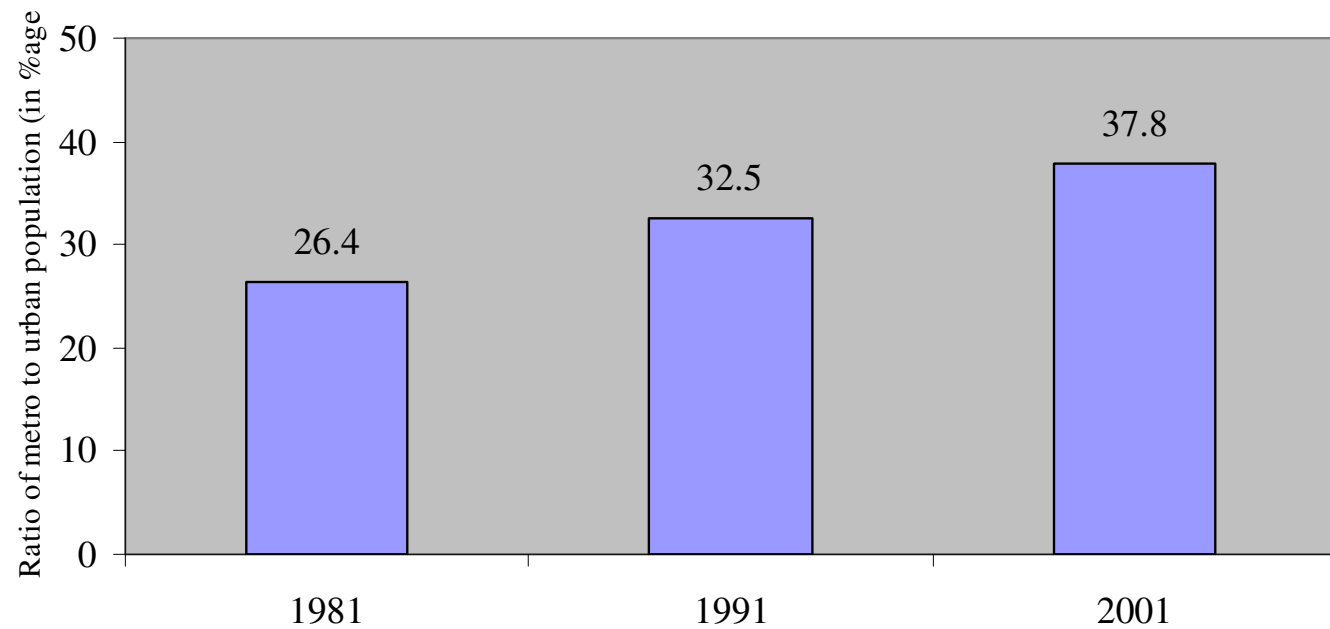
Growth in selected metropolitan cities during 1990s




India's big cities now account for a larger share of total urban population – a trend that has been observed since independence and

The trends indicate the continued urbanization and metropolitanization in the years to come

Share of metro population in urban India





Less than 1/3rd of Indians living in Urban areas contributes 2/3rd of National Income. Moreover, increase in household income in urban areas is far higher than that in the rural areas.

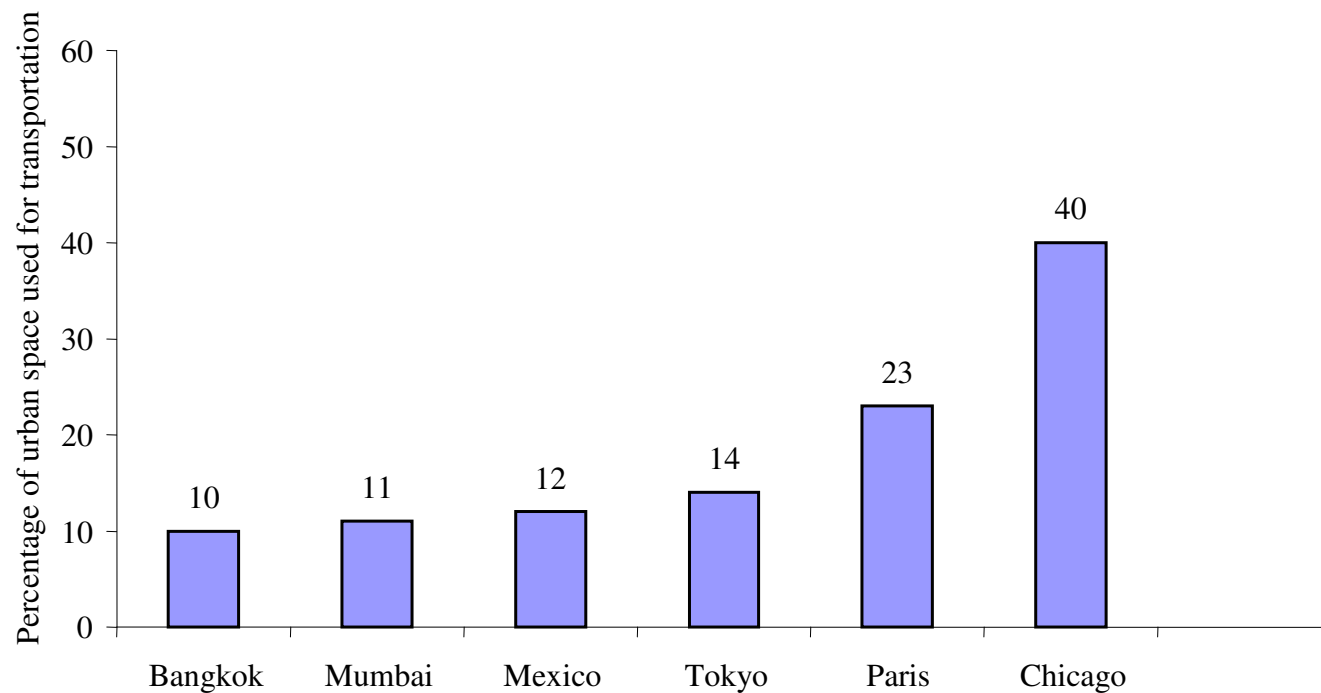
Population growth, increases in household income, and increase in commercial and industrial activities have placed heavy demands on urban transport systems, demand that many Indian cities have not been able to meet.

The main reason for this is inadequate transport infrastructure and its sub-optimal use besides prevailing imbalance in modal split.

Existing transport infrastructure

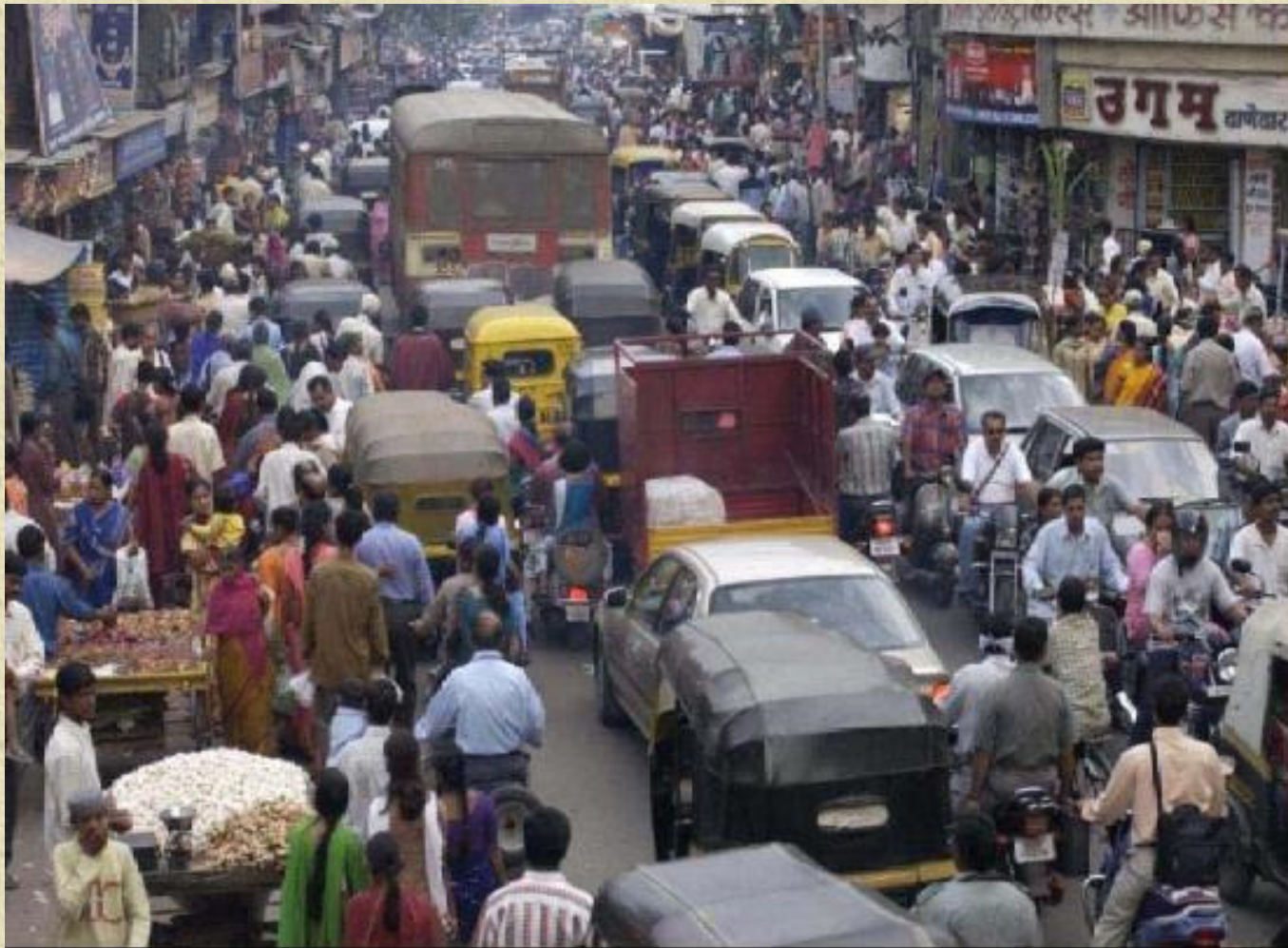
- Growth in road length is significantly less than the growth in vehicular population particularly in urban areas.
- Only 16.1% of the total developed area in Class – I cities is allocated for roads and streets.

Allocation of urban space for transportation in city centres



Existing transport infrastructure ... contd.

- Heavy encroachment at major roads and junctions.



Existing transport infrastructure ... contd.

- Inadequate availability of public and private transport.

Vehicle profile in selected countries

	Cars to buses ratio	Buses per Mn pop.	Cars per Mn pop.
Australia	171	2850	486787
Germany	454	1095	497615
France	311	1411	438898
Egypt	36	629	22421
India	13	553	7300

Existing transport infrastructure ... contd.

- Extremely limited rail services (only to Mumbai, Delhi, Kolkata, and Chennai).
- Well-organized bus services are mainly run by MTUs/STUs and confined only to few metropolitan cities whereas rail services are available only in few mega cities.
- The share of buses is negligible in most Indian cities as compared to personalized vehicles. For example, two-wheelers and cars together constitute more than 95% in Kanpur and 90% in both Hyderabad and Nagpur whereas in these cities buses constitute 0.1, 0.3, and 0.8 percent respectively.

Existing transport infrastructure ... contd.

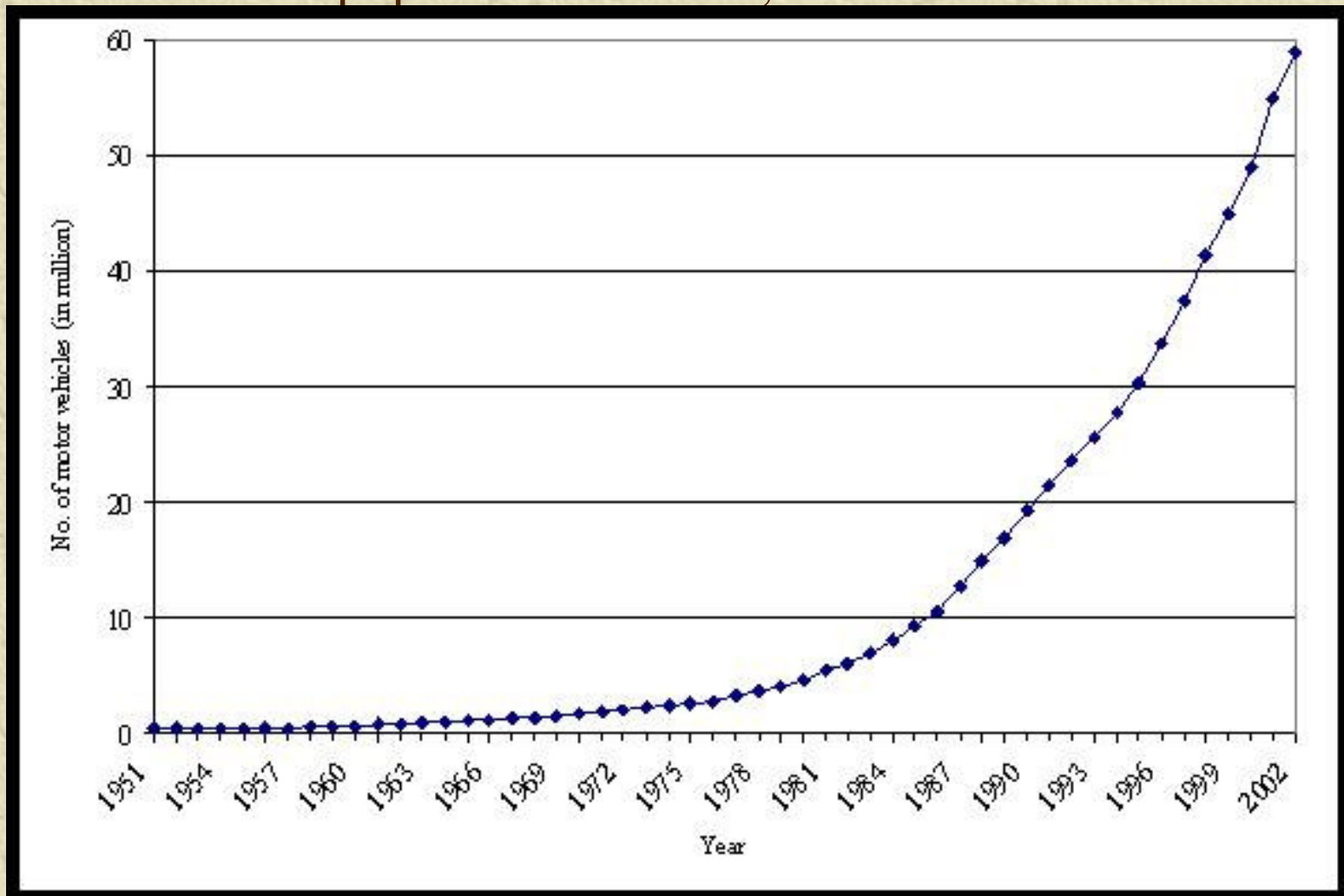
- Overall, quality of existing public transport services is poor.



Existing transport infrastructure ... contd.

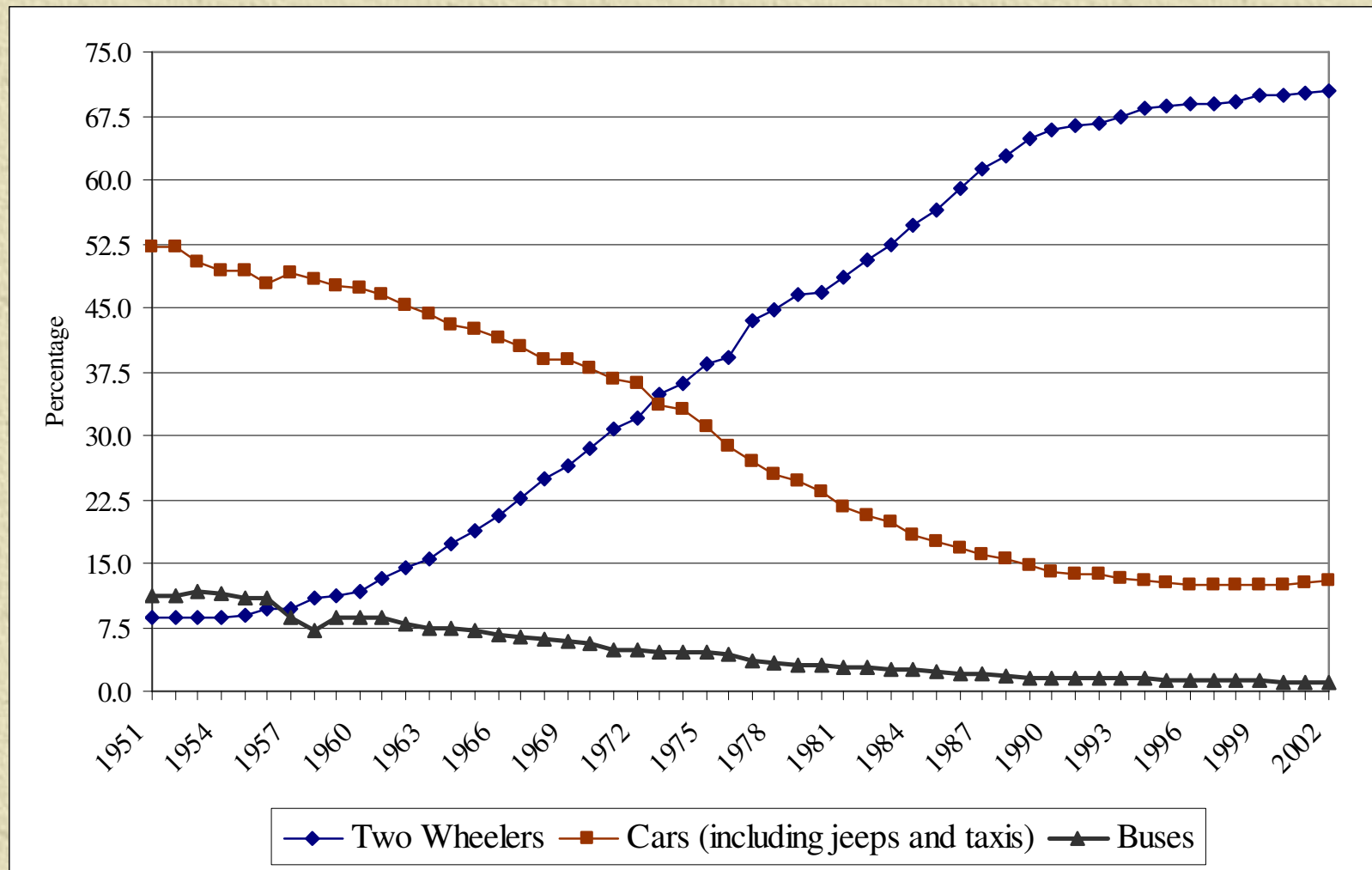
- In the absence of an adequate and efficient public transport, a large number of private and para-transit modes have entered into the market to meet the travel demand.
- The annual rate of growth of vehicle pop.: around 10% during last decade.
- In 2004, total no. of Vehicles = 72.7 M; TW = 52 M; Cars (including jeeps and taxis) = 9.45 M; Buses = 0.77 M; and Goods Vehicles = 3.75 M.
- Expected veh. pop. in India in 2010: 125 million.
- Excess concentration of vehicles in metropolitan cities.
- 32% of vehicles are plying in metropolitan cities alone, which constitute just 11% of the total human population.

Motor vehicle population in India; 1951 to 2002



Around 13% of all motor vehicles in the country are plying in mega cities (Mumbai, Delhi, Kolkata and Chennai) alone. It is interesting to note that Delhi, which contains around 1.4% of Indian population, accounts for nearly 7% of all motor vehicles in India.

Share of two wheelers, cars, and buses in total motor vehicle population in India



From 1993 to 2003, avg. annual growth rate of total vehicle – 10.1%, two-wheeler – 10.7%, car – 9.9%, bus – 4.8%, PCI – 4%, and Pop. – 1.9%.

Trends in rail and road share in passenger movement

	BPKm Rail	BPKm Road	Rail Share (%)	Road Share (%)
1950-51	67	36	65	35
1970-71	118	240	33	67
1990-91	296	1487	16.6	83.4
2000-01	457	3078	12.9	87.1
2020-21	1078	11909	8.3	91.7

Trends in rail and road share in freight movement

	BTKm Rail	BTKm Road	Rail Share (%)	Road Share (%)
1950-51	44	12	78.6	21.4
1970-71	127	82	60.8	39.2
1990-91	243	567	30.0	70.0
2000-01	312	899	25.8	74.2
2020-21	750	4250	15.0	85.0

**Desirable modal split for Indian cities of various sizes
(as a %age of total trips by mechanical modes)**

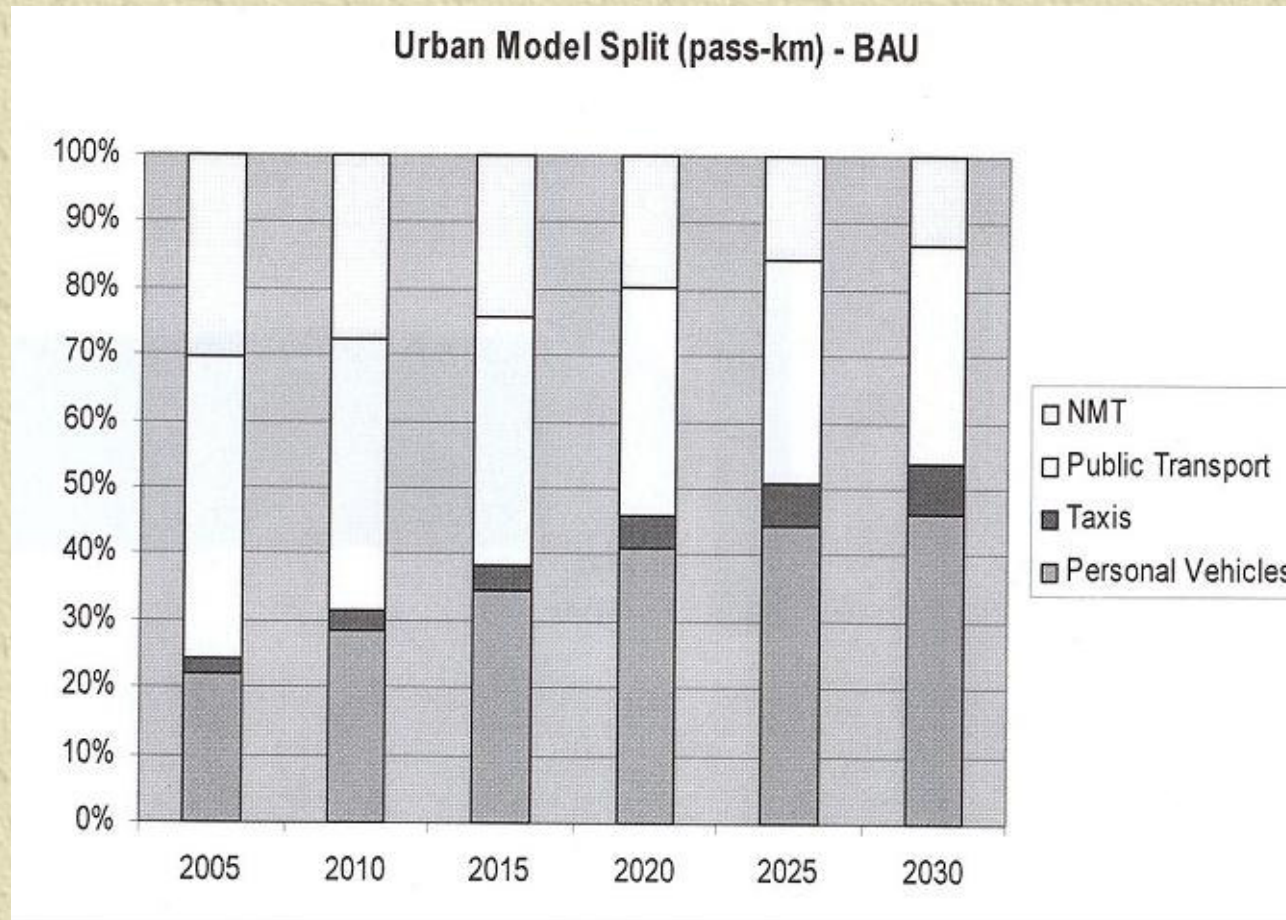
City size (pop. in Mn)	Mass transport	Bicycle	Other modes
0.1 – 0.5	30 – 40	30 – 40	25 – 35
0.5 – 1.0	40 – 50	25 – 35	20 – 30
1.0 – 2.0	50 – 60	20 – 30	15 – 25
2.0 – 5.0	60 – 70	15 – 25	10 – 20
5.0 plus	70 – 85	15 – 20	10 – 15

Existing modal split in Indian cities (in %age of total trips)

City population (in million)	Walk	Mass transport	IPT Fast Slow		Car	Two wheeler	Bicycle	Total
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

Note: Total denotes Mass transport plus Fast IPT plus Slow IPT plus Car plus Two wheeler plus Bicycle.

More worrisome trends



Source: Ke Fang, India: Sustainable Urban Transport Program, March 2007
(South Asia Transport Unit, World Bank)

Relatively, there is a greater reliance on roads and within roads there is far greater reliance on private and para-transit modes. Reliance on public transport and NMT modes is declining.

What are the consequences?

- Acute traffic congestion resulting in inordinate delays,
- High-energy consumption,
- Intense pollution of the environment, and
- High rate of road accident (e.g., from 1993 to 2003, avg. annual growth rate of total road accidents – 3.8%, fatality – 3.5%, and injury – 4.2%). *Economic loss due to road accidents in India is of the order of at least one percent of its GDP (GDP of India at current prices in 2004-05 was Rs. 28439 billion).*

Traffic Congestion in Indian cities

Average vehicle speed during peak hour in CBD area in many Indian cities is as low as 10 Km per hour.

What China did to tackle the congestion problem?

- ✦ Urban roadway network more than doubled between 1990 and 2003 (95,000 KM to 208,000 KM)
 - While Beijing's roadway network expanded by 24% between 1996 and 2003 (from 11,682 KM to 14,462 KM), most of this has been in the form of new construction in suburban areas.
 - Shanghai's road network has more than doubled between 1991 and 2004 (from 4,818 KM to 11,825 KM), of which urban road length has more than tripled.
 - In Beijing, the roadway expansion has already cost over USD 5 billion and the City is planning to spend another USD 4 billion on additional expressways and arterial roads.
- ✦ Most road improvements in the city centers have been in the form of road widening.

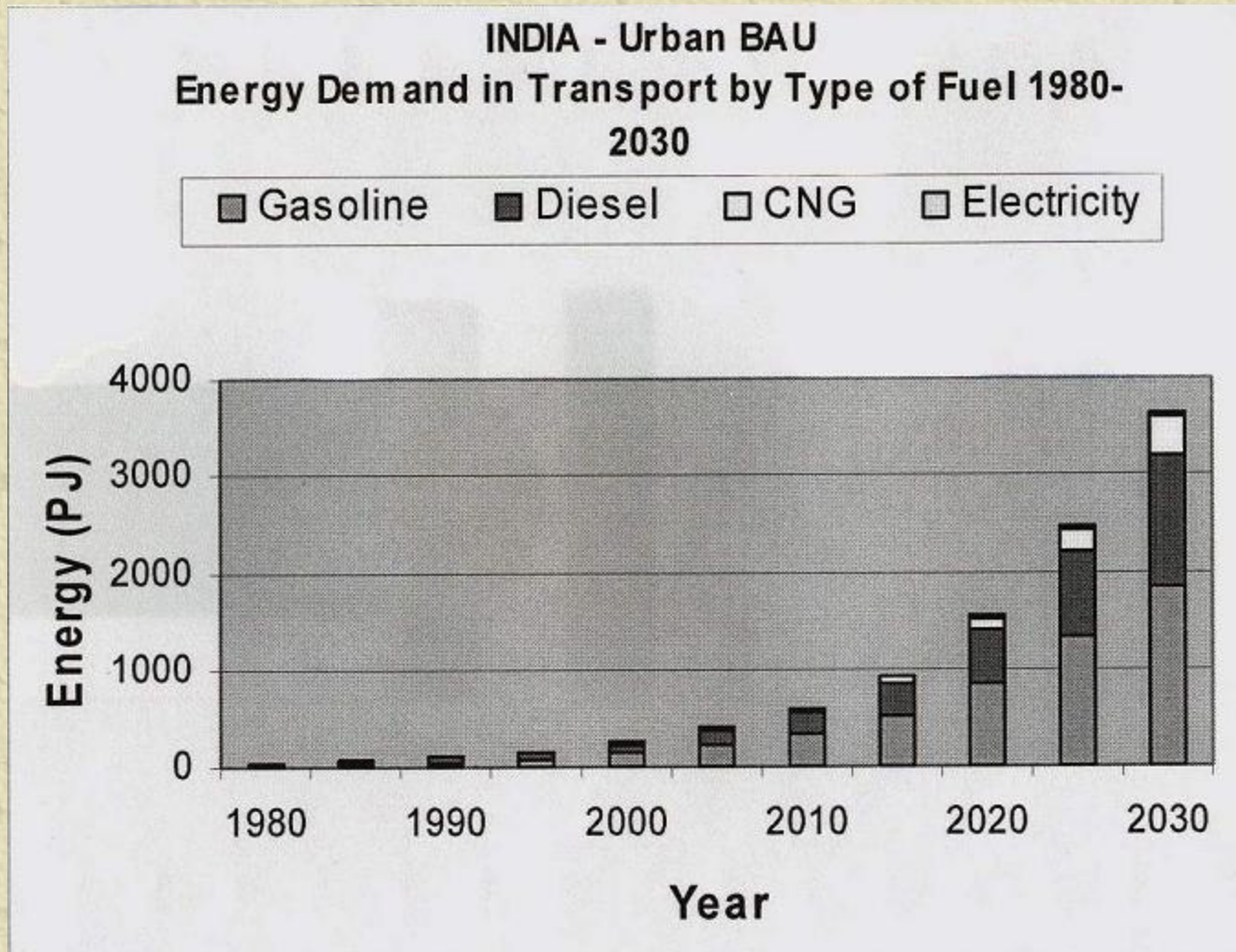
What are the consequences?

- ✦ Average peak-hour vehicle speeds in Beijing on the arterial roads have declined from 45 KMPH in 1994 to 33 in 1995, 20 in 1996, 12 in 2003 and less than 10 KMPH in 2005!
- ✦ Peak-hour vehicle speeds in Shanghai's center roads range from 9 to 18 KMPH.
- ✦ In Shenzhen, traffic accidents have been the top killer over the past three years, with forty percent of those killed aged between 20 and 40.
- ✦ The amount of carbon monoxide and hydrocarbons from auto emissions accounts for 79% of the total in all of China.

What are the lessons?

Cities can not afford to cater only to private modes. There is a need to make more investment in public transport. Public transport should be made good enough to attract people away from cars and two-wheelers.

Energy demand in transport (Urban India)




Source: Ke Fang, India: Sustainable Urban Transport Program, March 2007
(South Asia Transport Unit, World Bank)

Energy efficiency of various modes

Energy efficiency of various modes of passenger transport

Mode	Fuel type	Fuel efficiency (Km/litre)	Operating energy intensity (litre/PKm)	Relative energy efficiency
Bus	Diesel	4.30	0.006	1.00
Two-wheeler	Petrol	44.40	0.015	2.50
Three-wheeler	Petrol	20.00	0.028	4.70
Car	Petrol	10.90	0.038	6.30

On an average, a car consumes nearly six times more energy than an average bus, while two-wheelers consume about 2.5 times and three-wheelers 4.7 times more energy.



In terms of fuel cost per pass.-km, a two-wheeler is 6 times, three-wheeler 7 times, and a car is 12 times costlier than a bus.

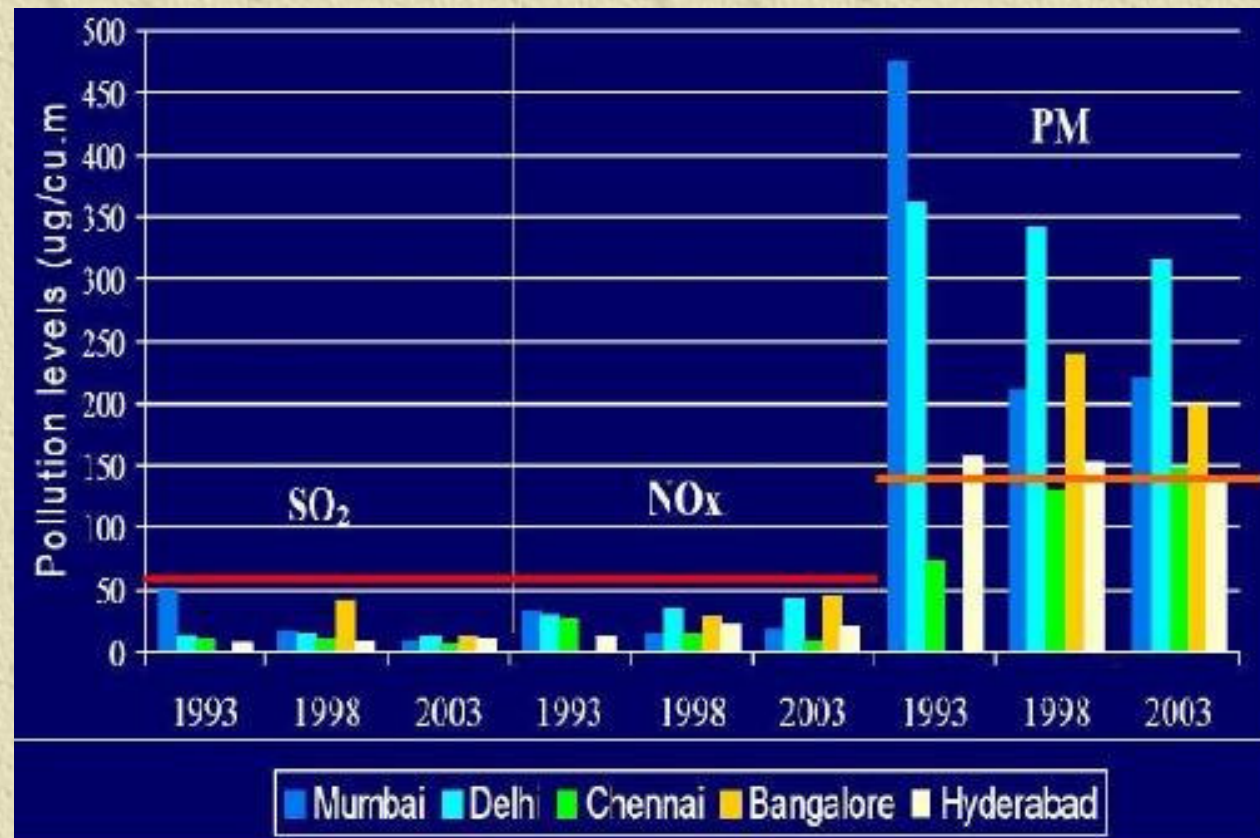
Furthermore, a car occupies over 38 times more road space in comparison to a bus to provide same level of passenger mobility (in terms of pass.-kms). The corresponding figures for two- and three-wheelers are 54 and 15 respectively.

This shows that bus transportation is not only favorable in terms of energy efficiency but also in terms of best possible use of scarce road space.

Environmental impact of urban transport

Local Level Concerns

The ambient air pollution in terms of Suspended Particulate Matter (SPM) in many metropolitan cities in India exceeds the limit set by World Health Organization (WHO).

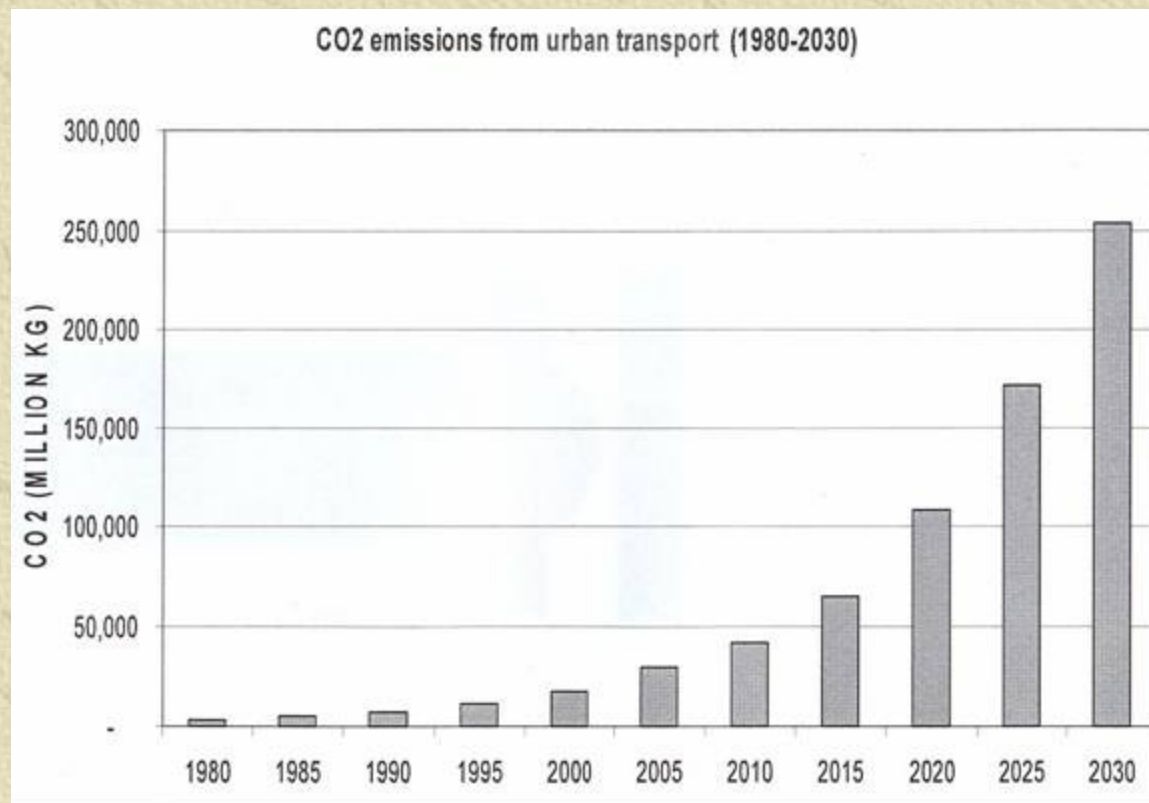


Pollution level in selected Indian cities (in micrograms per m³)

Environmental impact contd.

Global Level Concerns

- Increased GHG emissions – impacting global efforts to address climate change.
- Increased consumption of fossil fuels – impacting price at world oil market.



Source: Ke Fang, India: Sustainable Urban Transport Program, March 2007
(South Asia Transport Unit, World Bank)

Environmental impact contd.

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.

Estimates of annual episodes of illness and premature deaths due to ambient SPM in the air in mega cities of India

Mega cities	Annual episodes of illness			Annual premature deaths		
	1991-92	1995	%age increase	1991-92	1995	%age increase
Kolkata	3022786	5446225	80	5726	10647	86
Chennai	462966	680241	47	863	1291	50
Delhi	3990012	5197018	30	7491	9859	32
Mumbai	2579210	4005538	55	4477	7023	57

Source: Nagdeve, D. A., (2002).

It has been estimated that 2.0 million Indians die annually due to air pollution. India is spending Rs. 4,550 crore per year to treat health problems caused by air pollution.
(<http://www.indianngos.com/issue/environment/overview.htm>)

Environmental impact contd.

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.

Prevalent traffic congestion, high avg. age of vehicles and poor maintenance of vehicles aggravate the problem of air pollution.

Emission rate of different vehicles in a typical Indian city (in gms/km)

Vehicle	CO	HC	NO_x	SO₂	Pb	TSP
Two-wheeler	8.30	5.18	-	0.013	0.004	-
Car	24.03	3.57	1.57	0.053	0.012	-
Three-wheeler	12.25	7.77	-	0.029	0.009	-
Bus	4.38	1.33	8.28	1.441	-	0.275
Truck	3.43	1.33	6.48	1.127	-	0.450
LCV	1.30	0.50	2.50	0.400	-	0.100

Note: (-) indicates negligible quantity.

Environmental impact contd.

The average peak hour speed in Indian cities is far less than the optimum one. According to Centre for Science and Environment (CSE), the quantity of all the three major air pollutants (namely, CO, hydrocarbons, and nitrogen oxides) drastically increases with reduction in motor vehicle speeds.

For example, at a speed of 75 kmph, emission of CO is 6.4 gm/veh.-km, which increases by five times to 33.0 gm/veh.-km at a speed of 10 kmph. Similarly, emission of hydrocarbons, at the same speeds, increases by 4.8 times from 0.93 to 4.47 gm/veh.-km. Thus, traffic congestion not only increases delay but also the pollution level.

Environmental impact contd.

It is clear that among various modes of road based passenger transport, bus occupies less road space and causes less pollution per passenger-km. Therefore, urban transport plans should specially emphasize on bus transport system.

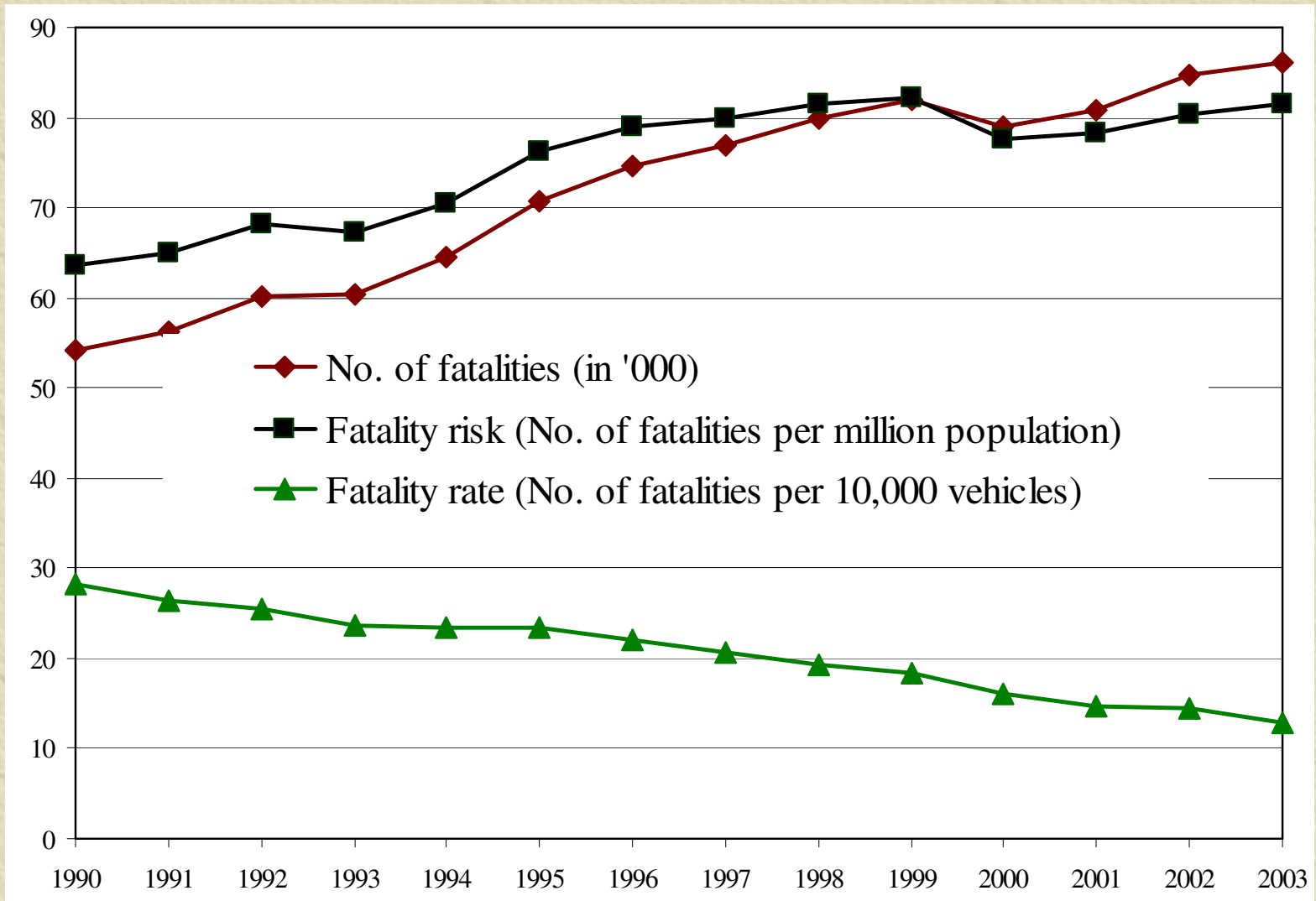
Pollution rate and congestion effect of private and public transport vehicles

Type of vehicle	Average passenger per vehicle	Pollution load in gm/pass.-km	Congestion effect in PCU/Pass.
Two-stroke petrol engine two-wheeler	2	7.13	0.375
Four-stroke petrol engine two-wheeler	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: Agarwal (2001).

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

Road safety issues



Road safety issues .. contd.

Road accidental deaths in Indian cities

There are more than 30 deaths per week due to road accidents in Delhi alone.

Road accidental casualties in selected metropolitan cities in India

Metropolitan cities	1990			2003		
	Fatality	Accidents	ASI	Fatality	Accidents	ASI
Delhi	1670	7697	21.7	1620	7839	20.7
Mumbai	400	25331	1.6	748	3726	20.1
Chennai	507	5877	8.6	567	4243	13.4
Kolkata	463	10911	4.2	442	1941	22.8
Bangalore	562	6729	8.4	882	10678	8.3
Hyderabad	276	1412	19.5	488	3600	13.6
Pune	275	1387	19.8	319	1075	29.7
Jaipur	235	1062	22.1	369	2234	16.5

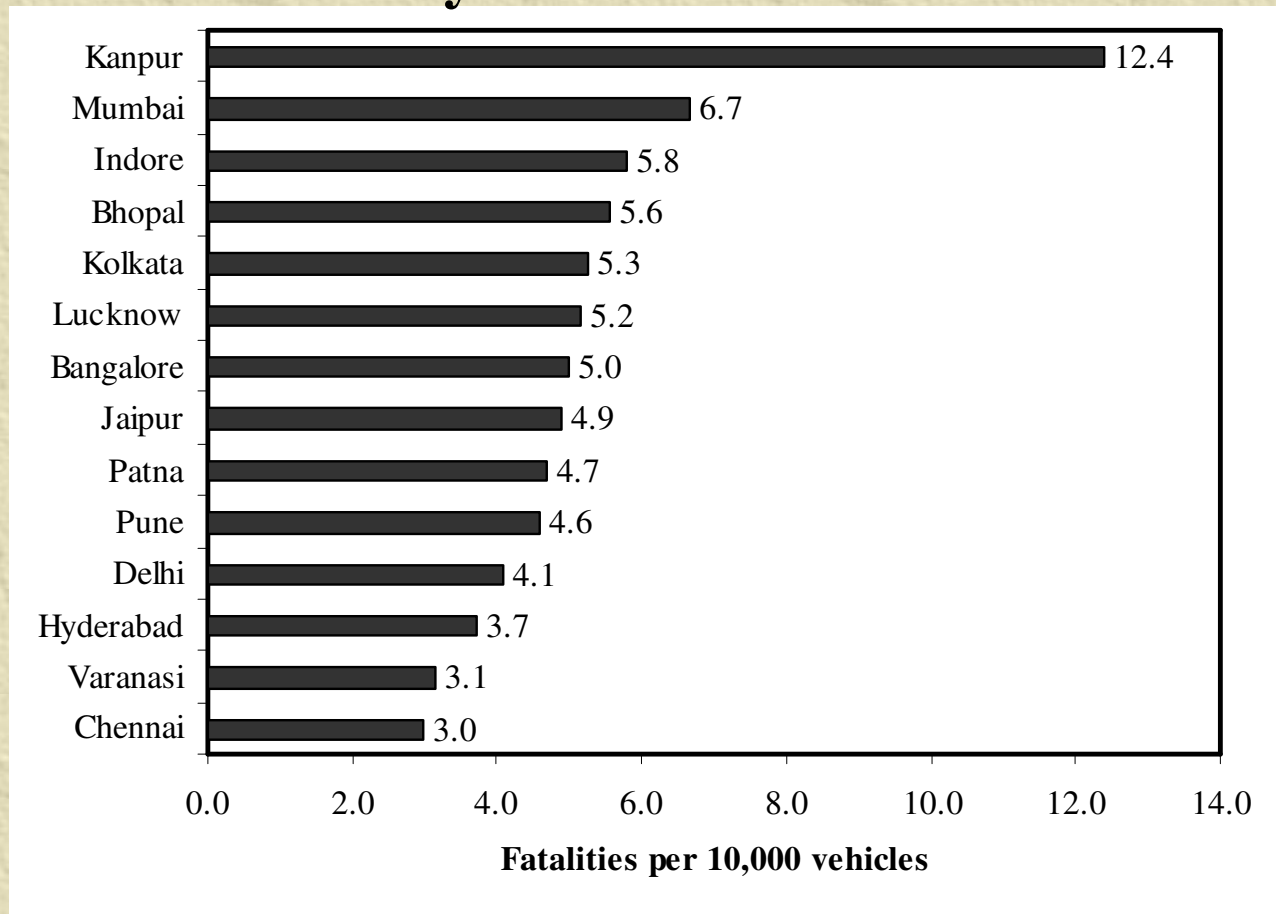
* ASI is accident severity index (defined as number of fatalities per 100 accidents)

Road safety issues .. contd.

Comparing road accidental problems across Indian cities

One way to compare road accident problems across Indian cities is to examine the fatality risk and fatality rate (during 2003).

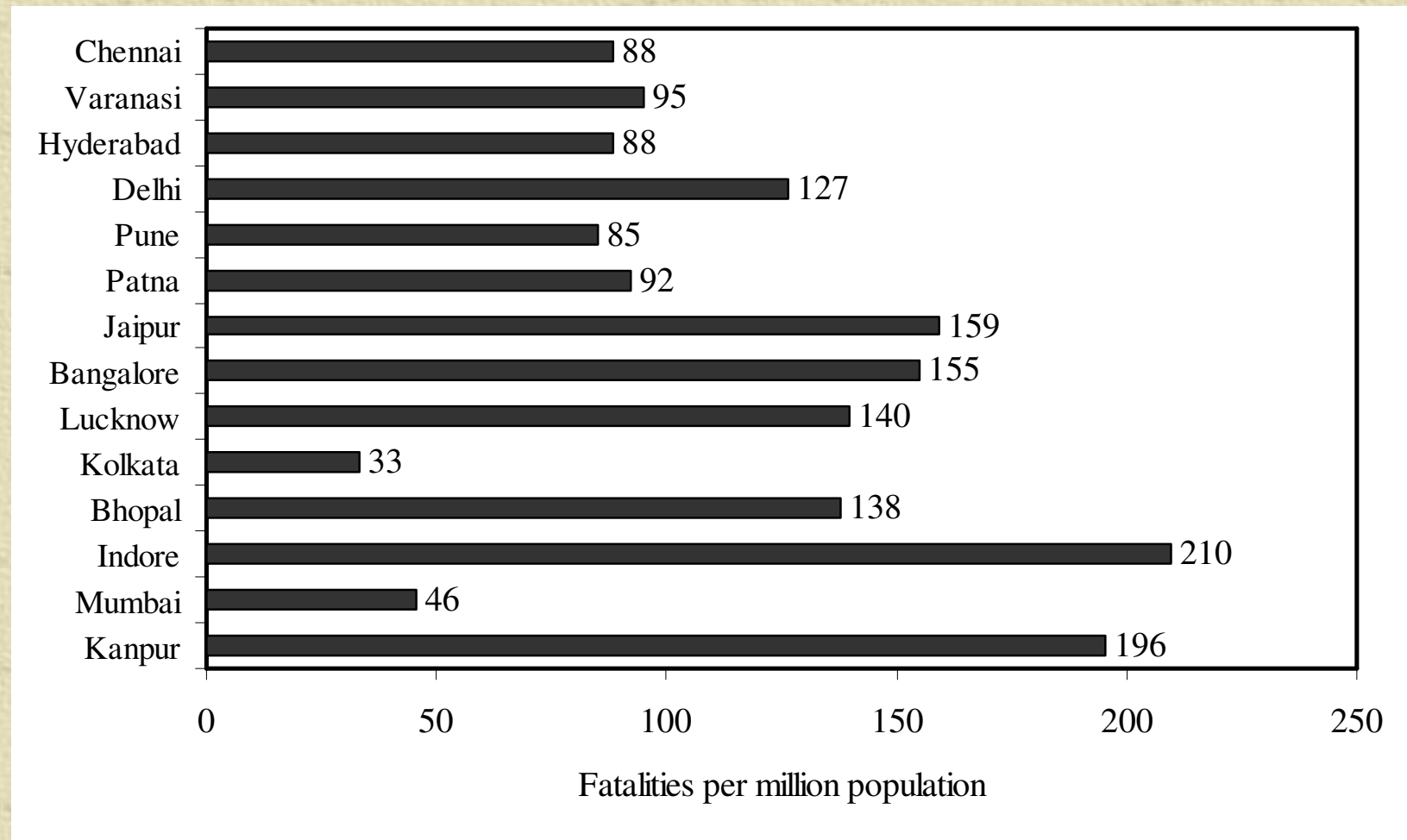
Fatality Rate in Indian Cities



Road safety issues .. contd.

Comparing road accidental problems ...

Fatality Risk in Indian Cities



How to predict fatality rate for an Indian city?

By using the Smeed (1968) equation:

$$\ln\left(\frac{F}{V}\right) = \alpha + \beta \ln\left(\frac{V}{P}\right)$$

where (F/V) is fatality rate and (V/P) is vehicle ownership per capita.

The greater the per capita level of vehicle ownership, the lower the per vehicle fatality rate.

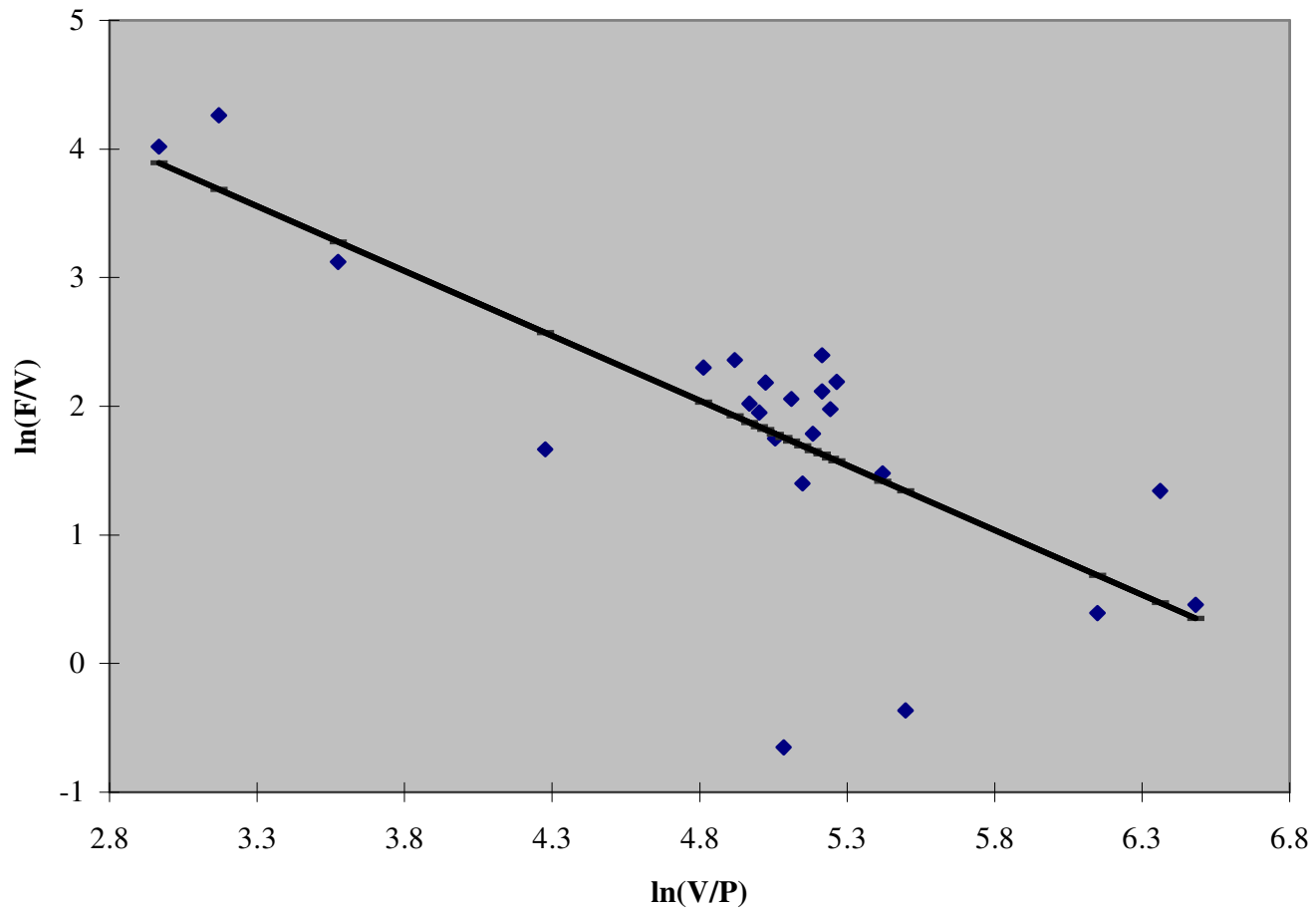
By using the data of 1997 for Indian cities, we estimated Smeed equation:

$$\ln(F/V) = 6.88 - 1.01 * \ln(V/P); R^2 = 0.56$$

where (F/V) is fatality per 10,000 vehicles and (V/P) is vehicle per thousand capita.

Smeed Analysis

Estimated elasticity is 1.01 \Rightarrow 10 percent increase in vehicle ownership in a typical Indian city will reduce the fatality rate by 10.1 percent in that city.






Nevertheless, road accidental fatality will continue to be a serious problem in Indian cities.

Some observations

- The most productive age group (31-45 years) is the most prone to road accident fatality. The adult working age group (18 to 60 years) accounts for more than 80 percent of all casualties in many cities.
- According to the Government's statistics, most of the accidents are caused by drivers' fault. Bad weather, bad roads, mechanical failures, and pedestrians' faults are other (minor) reasons for accidents. Data collection process needs improvement.
- Pedestrians, cyclists, and motor cyclists death as a percentage of all road fatalities are extremely high. Over 50% of all traffic fatalities are pedestrians.


Policy measures

- *Focusing on public transport particularly bus transport*
 - Public transport has lower external costs vis-à-vis private modes
 - Promoting rail-based transport system in high density corridors
 - Focusing on bus transport throughout the country (due to its cost effectiveness and flexibility)
 - Restructuring of tax policy to promote bus transport
 - Restructuring the STUs/MTUs
 - Rationalizing the fare and adopting a robust automatic fare revision formula
 - Optimize scale of operations
 - Introducing different variety of services
 - Improving passenger information system



- *Focusing on public ... contd.*

- Productivity enhancement measure
 - Reducing staff to bus ratio
 - Increasing bus utilization (bus-km per day)
 - Using smaller capacity vehicle along low-density routes
 - Hiring of buses
 - Increasing fuel efficiency through training to drivers
 - Learning lessons from success stories (such as BMTC)



• ***Focusing on public ... contd***

- Enhancing coordination between STUs and PBOs and encouraging PBOs in non-STU operated cities with adequate regulatory mechanism
- Improving efficiency of operation through competitive pressure (competitive pressure may be obtained either through direct competition for the market or through some form of systematic comparison with similar operators)
- Government initiative to reform the labor market so that actual wage in urban transport undertakings is equal to market rate (India's employment elasticity of output growth is declining, from 0.52 during 1983-94 to 0.16 during 1993-2000)



- ***Adopting optimal pricing strategies for transport services***

Government should use market based instruments 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.

Publicly owned urban transport undertakings can think of charging different (optimal) prices for different quality of services.

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.




- ***Enhancing transport coordination***

(e.g., buses should operate on main corridors whereas IPTs should serve on feeder routes)

To encourage people to use public transport, there is a need to have transportation system which is seamlessly integrated across all modes of public transport. There is a need to have a coordinating authority with the assigned role of coordinating the operations of various modes.

- ***Promoting car sharing***

Car sharing 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.



- *Restraining the use of polluting vehicles and fuels*

Government should use market based instruments to promote cleaner technology and fuel. 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 all vehicles that are more than say 10 years old. Similarly, cars that use diesel could be discouraged in million plus cities by levying cess on diesel in those cities (*Diesel cars generate not only higher CO₂ emission but also high level of particulate matter*).

•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. It is required to set a goal to achieve parity with Europe, United States or Japan by the year 2010 at the latest.

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

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
India (entire country)		Euro 1				Euro 2					Euro 3
India (Delhi and other cities)	Euro 2					Euro 3					
Thailand	Euro 1	Euro 2				Euro 3					Euro 4
Hong Kong, China	Euro 2	Euro 3					Euro 4				
European Union	Euro 3					Euro 4				Euro 5	

Source: Asian Development Bank, (2003), “Vehicular Emissions Standards and Inspection and Maintenance”, Asian Development Bank, Manila, Philippines.




- ***Demand side management measures***

Although policy measures that involve restraining the use of private cars and two-wheelers 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 greater acceptance. *Congestion pricing, parking fee, fuel tax*, etc. could effectively be used to restrain the usage of all personalized modes.




- ***Supply side management measures***

There is an urgent need to use supply side management measures also to tackle prevalent traffic congestion problem. *One way traffic system, improvement of signals, bus priority lane, etc.* could effectively be used as *short-term measures*. *Road infrastructure improvement measures* like *new road alignments, provision of service roads, bye passes, construction and repair of footpaths and roads, removal of encroachments, etc.* should be introduced at least in million plus cities. These can be considered as *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*.




- ***Encouraging “green” modes***

An urban transport strategy should encourage the need for developing ‘green’ modes like bicycles, cycle rickshaws, pedestrians etc. Safety concerns of cyclists and pedestrians must 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 improve traffic flow, increase the average speed of traffic and reduce emissions resulting from low speeds.



• ***Introducing public awareness program***

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 need to be better understood and communicated as a means of influencing public attitudes. Media, NGOs and research institutions should be encouraged to highlight the issues, conduct independent analysis, and advocate possible solutions to policy makers and implementing agencies.



- *Need to strengthen urban institutions*

Most Indian cities have failed to address 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 seems to be in charge of overall coordination.

There is a pressing need to empower the municipalities so that they can raise funds for developmental projects in urban areas by their own. Also, they may be authorized, through legislation, for overall coordination of activities relating to provision of transport infrastructure.

Can Government's new initiatives work?

- **National Urban Renewal Mission (NURM, Nov 2005)**
 - National government will finance up to 50% of capital costs for urban infrastructure (including urban transport) in 63 major cities.
 - Conditioned upon commitment to basic urban reforms.
- **National Urban Transport Policy (April 2006)**
 - Develop “safe, affordable, quick, comfortable, reliable, and sustainable urban transport systems”.
 - Through integrated planning, public transport and NMT, cleaner technologies, regulatory reform for public transport operations, and effective coordination.

No doubt, these are good initiatives, however, “implementation gap” is still there!



THANKS