Sustainable Transport Environment in Indian Megalopolis Cities: Challenges and Options

by

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ABSTRACT

India is becoming increasingly urbanized in which the dynamics of population growth, coupled with the current trends of urbanization are highly debilitating. Presently, approximately 30 percent of Indian population is living in cities, out of which about one fifth is residing in six megalopolis cities. Coupled with rapid urbanization each city consists of a number of supporting systems. Transport is one of them, which provides mobility, flexibility and accessibility to urban people. For all practical purposes, a sustainable transport system must offer mobility and approachability to all urban residents in safe, risk-free and eco-friendly mode of transport.

This paper deals with the idea and challenge of creating a "sustainable transport environment" in Indian megalopolis-cities, along with a comprehensive discussion on the existing problems of air and noise pollution and poor motorized system of transport. The scheme of this paper is to examine the extent of problems and suggest remedial measures.

Keywords: Population and urban growth, air and noise pollution, sustainable transport system.

INTRODUCTION

The world is becoming increasingly urbanized. The urban population of the world as a whole has been expanding at the rate of nearly 3 percent per year, presumably faster than the existing world population growth rate. Roughly, half of the global population lives in cities (Peterson, J., 1984). Presently approximately 30 percent India's population lives in urban areas. The current trends of urbanization inspired by better quality of life are posing multiple stresses on our environment. Coupled with rapid urbanization, each city consists of a large number of constituent systems. Transport is one of them, which provides mobility, flexibility and accessibility to people. A sustainable transport system must offer mobility and approachability to all urban residents in a secure and eco-friendly mode of transport.

Indian cities are faced with the challenge of power, resources and trained personnel to provide their rapidly growing population with clean drinking water, sanitation, sustainable transport system and other facilities.

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The result is mushrooming illegal settlements and slums, increased overcrowding, poor transport and inadequate facilities, pollution, and rampant diseases linked to an unhealthy environment. The proportion is significantly higher in cities like Mumbai, Chennai, Kolkata and Delhi. Along with over-crowding, Indian cities are filled with automobiles like scooters and private cars, buses and inappropriate industrialization. It is to be realized, in general, that there are neither resources nor-given rapid technological change- the time to allow the damage to environment now and clean up later.

In such a complex situation, linkages between environmental issues, public transport, non-motorized transport and safety must be given proper and adequate attention. If a large portion of population cannot afford to avail motorized transport-private vehicles or public buses- then they have to either walk as pedestrians or use bicycles to work. Secure infrastructure for bicyclists and pedestrians may require segregation of road space or reduction of speeds of moving vehicles. In both the cases, restriction of mobility on vehicle users in bound to take place.

Similarly, measures to reduce air and noise pollution may at times confront with those required for reduction in road accidents, For Example, on an average, increases in vehicular speeds may reduce emissions of pollutants but they can accelerate the rate of road accidents. My own study of literature pertaining to transportation and health reveals the fact that most public discussions and policy documents in India focus only on air pollution as a matter of prime concern. It is relatively simple to co-relate and quantify the relationship between the numbers of vehicles, exhaust fumes and morbidity due to increased pollution. Health problems due to pollution are considered as worthy of public action whereas those caused by accidents as due to personal mistakes. Hence, unless the requirements of non-motorized modes of transport are fulfilled, it will be almost implausible to procure any sustainable transport environment for India's urban areas in general and in megacities in particular. Options regarding mode of transport by individuals are based on economic factor, convenience and safety. Of all these concerns the one involving safety is the most challenging for any person. An essential aspect in the consideration of advantage of mobility versus perception of accidental risk is that the road user's sense of time saved by driving faster exceeds that in reality. The safety advantages are realized only by a relatively smaller segment of people who save many years of their lives without falling prey to pre-mature accidental deaths. A major problem in articulating a sustainable transport strategy aimed at increasing mobility of motorized vehicles is that pedestrians and non-motorized road users who do not benefit from increased mobility are largely open to increased accident risk. This requires a constant bearing on planning for public transport, and the safety on the roads.

OBJECTIVES

The broad objectives of this paper are as under:

- To examine trends in the level of pollution in metropolitan cities in terms of three major pollutants: Sulphur Dioxide (SO_2); Nitrogen Oxide (NO_x); Suspended Particulate Matter (SPM); and to elucidate the main causes and effect our pollutions on health due to vehicular growth.
- To analyse the effects of noise pollution on health.
- To suggest remedial measures for a sustainable transport environment in Indian megalopolis-cities on selective basis

DATABASE

During the course of this study, secondary sources of data have been largely used for analysis. The data on air and noise pollution have been taken from the Compendium of Environment Statistics, Central Statistical Organization (CSO), Ministry of statistics and programme implementation, Government of India and from the publications of the Central Pollution Control Board. Data on the vehicular mode of transport have been obtained from Motor Transport Statistics of India. Data on population growth and urban growth have been obtained from Census of India (2001).

METHODOLOGY

The paper makes an absorbing quest for the creation of a sustainable transport environment in Indian megacities along with a detailed investigation of the existing problems of air and noise pollution and poor motorized transport system. Thus, the scheme of this paper is to examine the extent of the problem and to suggest remedial measures. Analytical and statistical techniques have been used for interpretation and data representation.

FINDINGS

Trends of Urban Growth in India

The current trends of population growth coupled with urban growth are highly debilitating in India. Over the last ten decades, India has experienced more than two-fold increase in its level of urbanization during 1901 and 2001. One-fifth of the urban population of India lives in six megacities (Shukla, at. el; 1996). The classic urban nightmare has already gained ground in the cities of India. Table 1 indicated that the numbers of cities have more than doubled over the hundred years from ten decades.

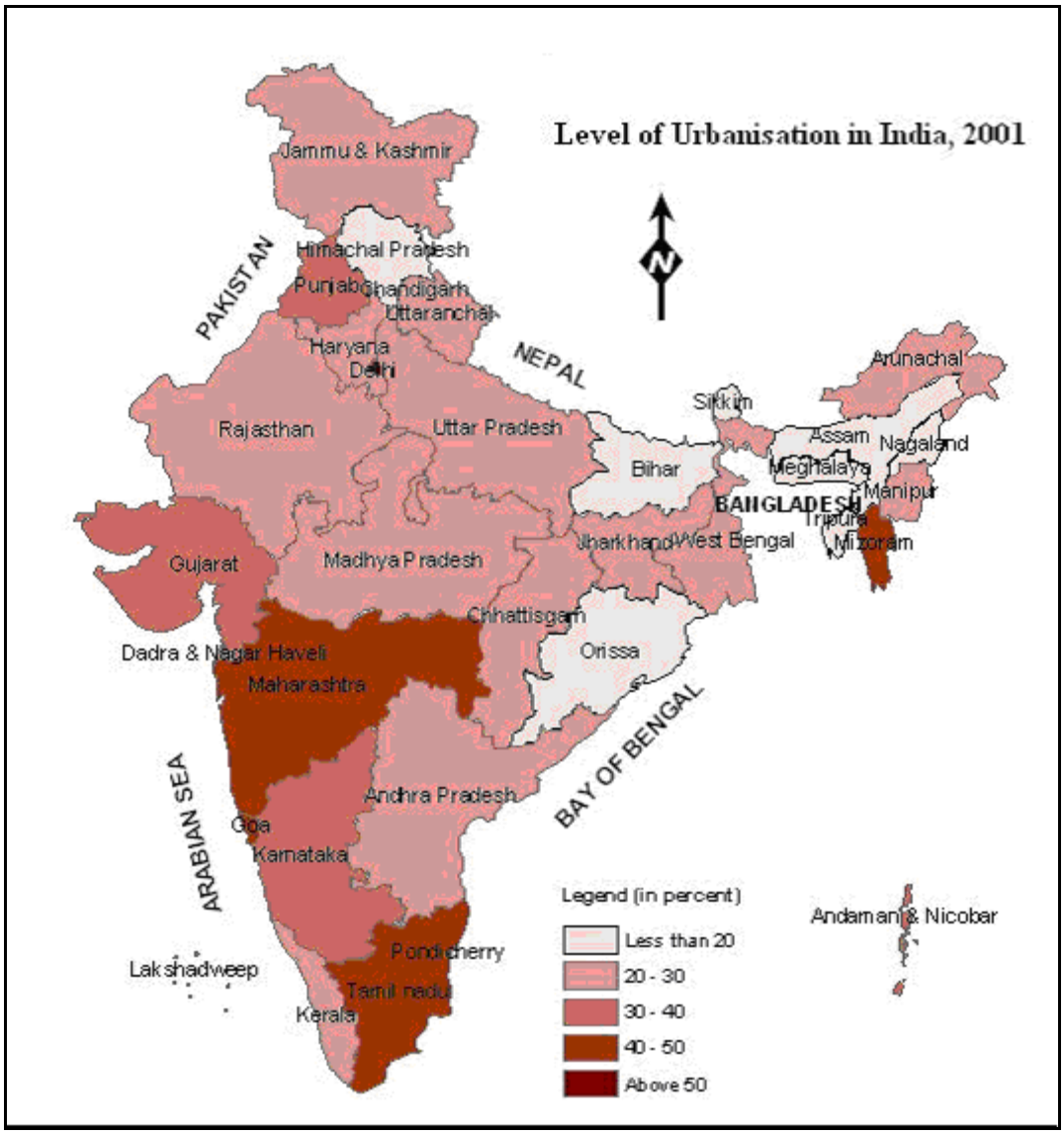
Table 1: Trends in Urbanisation, India, 1901 to 2001

Year	No. of UAs/ Towns	% of Urban Pop^{n} / Total Pop^{n}	Growth Rate	Annual Exponential Growth Rate (%)	Annual gain in percent Urban
1901	1827	10.84	-	-	-
1911	1815	10.29	0.35	0.03	-0.60
1921	1949	11.18	8.27	0.79	0.09
1931	2072	11.99	19.12	1.76	0.08
1941	2250	13.86	31.97	2.77	0.19
1951	2843	17.29	41.42	3.47	0.34
1961	2365	17.97	26.41	2.34	0.07
1971	2590	19.21	38.23	3.24	0.19
1981	3378	23.34	46.14	3.79	0.34
1991	3768	25.74	36.19	3.09	0.24
2001	4378	27.86	31.74	2.76	0.21

Source: Figures up to 1991 are taken from Census of India 1991, Paper 1 of 1993; Census of India 2001, Final Population Totals, Office of the Registrar General and Census Commissioner, India, New Delhi.

Notes. As the 1981 Census was not conducted in Assam, the 1981 population figures for India include interpolated figures for Assam. The 1991 Census was not been held in Jammu and Kashmir. The 1991 population figures for India include projected figures for Jammu and Kashmir as projected by the Standing Committee of Experts on Population Projections (October, 1989). 3.The total urban figures of 2001 include the estimated urban figures for Kachchh district, Morvi, Maliya-Miyana and Wankaner talukas of Rajkot district, Jodiya taluka of Jamnagar district of the Gujarat where the population enumeration of census 2001 could not be conducted due to natural calamity.

Map1. Level of Urbanisation in India 2001.



Map not to scale

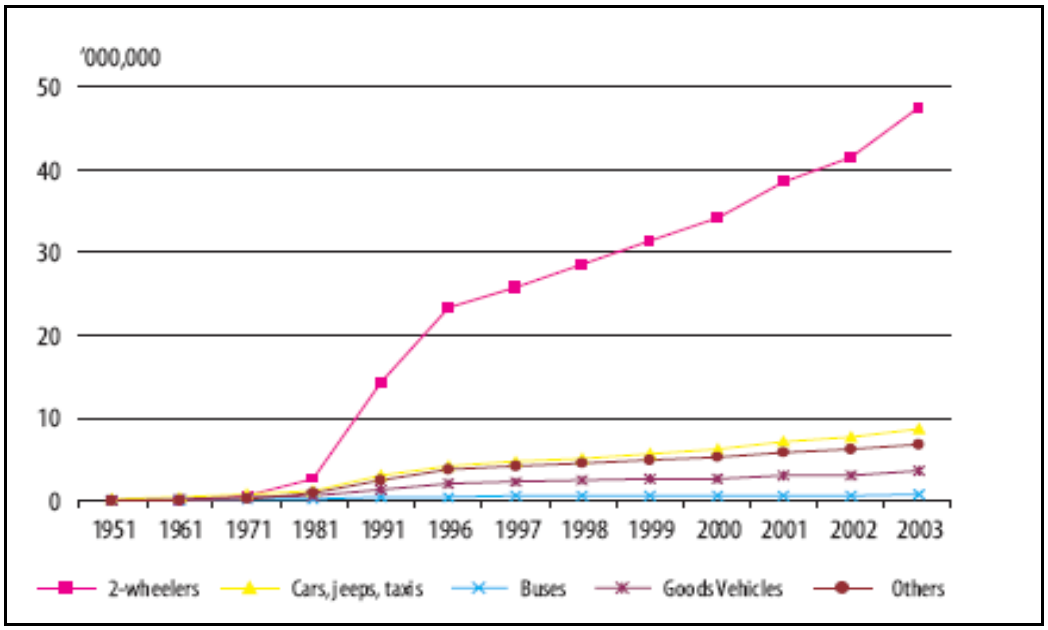
The number of metropolitan cities in India has reached the figure of 40 in 2001. Delhi's population in 1991 stood at 9.4 millions, showing an increase of 3.2 millions over the 1981 figure. According to census of India (2001), Delhi's population has reached the figure of 137,82,976. The city of Chennai has reached a growth rate of 41.05 percent and the population has reached the figure of 42,16,268 (Census, 2001). Kolkata and Mumbai on the other have marked the entire domain, range and scope of problems arising out of unbridled urban growth

Population growth coupled with urbanization causes over-crowding, environmental pollutions, health problems and civil amenities and transportation, etc stretched to almost disrupting edge.

Vehicular Growth and Air and Noise Pollution

The problems of air and noise pollution have been increasing by leaps and bounds over the past few decades as a result of urbanization and faster rate of motorization, particularly due to enormous increase in personal mode of transport. Figure 1, indicates that vehicular growth in India as a leading manufacture in the region, India has also seen a rapid rise motorization especially in two wheeler 40% of total vehicle population (Bose, 2006) over the year- particularly in its major urban areas. The total number of registered motor vehicles in India has increased from 1.86 million in 1971 to 67 million in 2003. Motorized two-wheelers (motorcycles, scooters, mopeds) account for over 70% of the total registered fleet that will clearly impact on Carbon monoxide (CO) and hydrocarbon (HC) emissions.

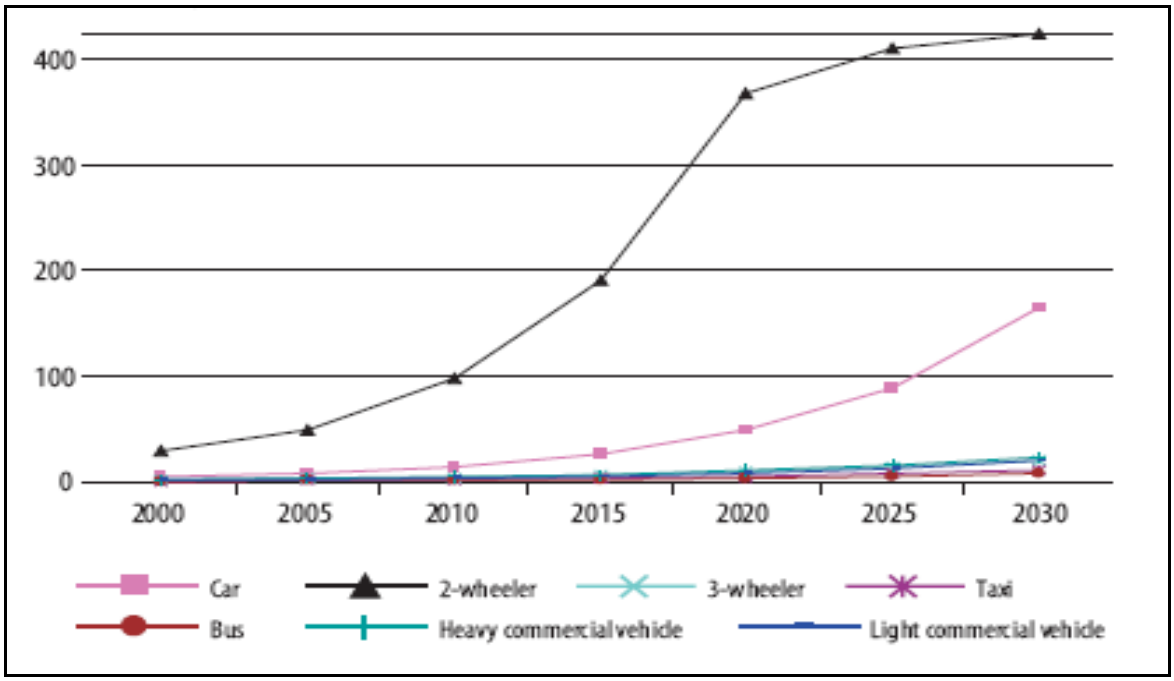
Figure1: Types of Vehicular Growth in India (1951-2003)

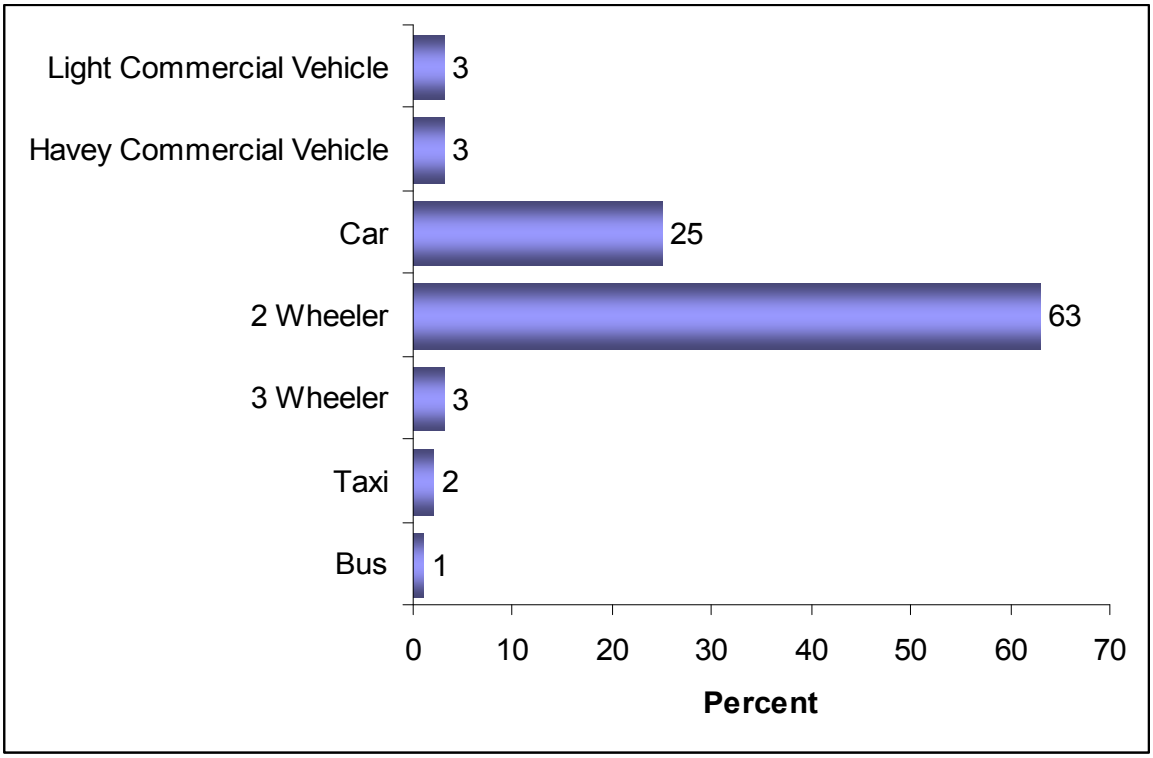


Sources: Department of Road Transport and Highway and Clean Air Initiative for Asian Cities (CAI-Asia)

The proportion of buses to the total registered fleet has fallen from 5% in 1971 to 1.1% in 2003. Correspondingly, the proportion of private vehicles (two-wheelers and cars) to the total number of registered vehicle population in India has increased from 65% in 1971 to 2003. In 2003, 23 out of 35 metropolitan cities accounted for about 1/3 of the total 67 million vehicles registered in the country. About 45 % of the total cats in India are confined to these metropolitan cities.

Figure 2a & 2b: Projected Number and Percentage Distribution per Type of Vehicle in India by 2030





Source: Bose 2006 and CIA-Asia

Table 3: Total Registered Motor Vehicles in Four Megalopolis City of India.

S.No	Category	Total no. of all Vehicles
1	Delhi	2629645
2	Mumbai	723632
3	Kolkata	911921*
4	Chennai	81196
All India Total		**9315093**

Source: Motor Transport Statistics of India 1997, * 2005

The table 3 indicates the total number of vehicles in 4 Indian megacities as on 31 March 1996. As investigated, the number of vehicle increased from about 11 million in 1986 to more than 33 million in 1996 of which about 28 percent remained concentrated in 23 metropolitan cities (Motor Transport Statistics of India, 1997 & 2005). Urban transport is expected to grow by 2.6 times by the year 2016 in the large and medium-size cities of India, thus culminating into increased and compound vehicular pollution. The different pollution-centric factors are the types of engines, the age of vehicles, poor roads and over-crowded traffic. The main vehicular pollutants are carbon monoxide, Nitrogen Oxide, a varying amount of sulphurdioxide depending on the sulphur contents of the fuel and lead compounds. Table 4 shows daily vehicle emission loads in Delhi, Mumbai, Kolkata and Chennai.

Table 4: Daily Vehicle Emission Loads in Four Metropolitan cities in India (Tonnes/Day)

City	SPM	SO_2	NO_2	HC	CO	Total
Delhi	10.3	8.96	126.46	249.57	651.01	1046.30
Mumbai	5.59	4.03	70.82	108.71	469.92	659.57
Kolkata	3.25	3.65	54.69	43.88	188.24	293.71
Chennai	2.34	2.02	28.21	50.46	143.22	226.25

Source: Central Pollution Control Board 2000.

According to the Transport Department, Government of National Capital Region of Delhi, in 2000, the estimated vehicular emission load in Delhi has shown tremendous rise. Table 5 shows the trends.

Table 5: Estimated Vehicular Emission Load in Delhi

Pollutants	Pollution Load in thousand tonnes			% reduction as compared to
	1990-91	1995-96	1998-99	1995-96
SO_2	10	15	11	27
NO_x	139	207	182	12
SPM	19	28	21	25
Pb	0.19	0.362	0.007	97
CO	243	351	337	4
HC	0.83	113	45	12
Total Pollution load	493	714	666	-
Emission lead in tonnes / day	1351	1947	1825	11

Source: Transport Department, Govt. of National Capital Region of Delhi, 2000

Some of the main factors identified as reasons for increasing vehicular pollution in the Indian megacities can be put together as follows:

(i) High volumes of traffic and urban population dynamics.

(ii) Excessive increase in private / personal vehicles.

(iii) Improper maintenance of vehicles.

(iv) Growing traffic bottlenecks.

(v) Less eco-friendly mode of transport and fuel technologies.

(vi) Lack of comprehensive fiscal strategies to check the increase of private/ personal vehicles

Harmful Effect of Vehicular Pollution and Health Hazards

The vehicular pollutants have varying effects on human health. Table 6 is self-explanatory in this regard.

Table 6: Main Pollutants and Health Effects

Pollutant	Health Effect
SPM	Damage of lungs, bronchitis and asthma
SO_2	Acid rain, damage to lungs, eyes and skin
NO_x	Form Smog damage to respiratory system and eye irritation
CO	Toxic causes blood poisoning
HC	Cancer
Pb	Nervous system slow down ad brain development is retarded; slow reaction time.

Source: Delhi Environmental Status Report: Pollution Monitoring and Technical Corporation Division, New Delhi, 1995.

As studied, following facts are worth-mentioning to grasp the health problems generated by air pollutants:

- A World Bank report underlines that more than 40,000 people die prematurely per year in India due to health problems caused by air pollution.
- Studies reveal that the cases of respiratory diseases and allergies have almost doubled since 1990.
- Nearly 80-90 percent lead in ambient air is attributed to the composition of leaded petrol (Compendium of Environment Statistics, 1999). Unleaded petrol in India contains a very high level of benzene, which may cause lung cancer.
- It is estimated that almost 50 percent population in Mumbai has absorbed 30 microgram of lead in 100 milliliter of blood, while simply 50 microgram is sufficient to culminate in brain damage and muscular problems.
- The levels of air pollution in large cities have been increasing with such a tremendous magnitude that the World Health Organisation has suggested the international tourists to limit their visits to the four megacities of India- Kolkata, Mumbai. Delhi and Chennai.

- By the year 2001, carbon monoxide levels were estimated to increase by seven times and that of hydrocarbons by 9 times. The levels of other pollutants are expected to rise by 5 times (Satyaramchandar, 1997).

Noise Pollution and Health

After vehicular emission, noise pollution is the second most hazardous pollutant of environment from the health point of view. Encyclopedia Britannica (1968) and Encyclopedia Americana (1973) define noise as 'undesired' and 'unwanted' sound respectively. The net effects of high traffic intensity in noise pollution in the city are well-known facts. As per record, Mumbai is the noisiest city of the world with average noise level of 75 dBA, which in Delhi it varies between 75-80 dBA. A study conducted jointly by Central Pollution Control Board and State Pollution Control Board, Kolkata in 1994-95 underlines that in most of the situations the traffic noise index contributes to 10 dBA to the noise pollution index in Kolkata. This study also reveals that the noise levels at the road crossings in Kolkata are much higher. The noise pollution levels are no good in other Indian megacities. The health hazards of noise pollution in terms of subjective, behavioral and physiological effects can be summarized as under:

Type of effect	Health Hazards
1. Subjective effects (below 40 dBA)	Disturbance, annoyance, disappointment, frustration.
2. Behavioral effects (up to 90 dBA)	Communication interference, sleep disturbance, irritation, reduced work efficiency.
3. Physiological effects	Fatigue, strain, deafness, headache, increases in blood pressure, abortion.

It is, therefore, urgently required to check the rising levels of noise pollution as a result of heavy traffic in the cities, particularly in Indian megacities.

CONFLICT BETWEEN SAFETY AND SUSTAINABLE TRANSPORT

It can be seen that:

- Non-motorised modes of transport is an integral component of all trips and are likely to remain so in the foreseeable future in all Indian cities, including mega cities.
- Any accretion in the use of public transport also causes an increase in walking/bicycling trips in these cities.
- In the prevailing situations, pedestrians and bicyclists are more prone to accidental risks per trip than the car users.
- It seems difficult to have sustainable bus transport systems with marked lanes for buses unless segregated lanes are provided for non-motorized modes of transport in these cities.

Sustainable transport systems can be optimized by the promotion of public transport and non-motorized modes of mobility and accessibility in Indian megacities.

Table 7: Potential annual savings per person in air pollution from using public transport instead of driving to work

	HC	CO	NO_2	SO_2	PM
Kg	13.47	99.50	7.05	0.14	0.12
Percent	98.6	97.3	85.1	46.1	27.6

Source: Rutter; et al- 1997.

However, in governmental response, some of these measures do not find adequate expression at the level of policy decisions. For example, the Government of India in 1997 drafted a White Paper on pollution in Delhi. There after, an Environmental Pollution Control Authority was set up for the city. Some of the options suggested to check vehicular pollution, both air and noise, are given as under:

- Construction of expressways and grade separated intersections.
- Introduction of one-way streets and introduction of synchronised signals and area traffic control systems.
- Construction of metro rail transport systems.
- Phasing out older buses and induction of new buses.

MEDICATION MEASURES FOR SUSTAINABLE TRANSPORT SYSTEMS

(A) Public Transport

- Shift from private / personal transport to mass public transport can lower the vehicular emission to large extent.
- Priority should be given for the design and development of modern and sophisticated bus transport systems to increase their use in the megacities of India. This will be an important step towards a sustainable public transport system.
- India must evaluate the cost-effectiveness of metro rail systems, specifically building of two or three lines at very high costs. Experiences from Chinese cities suggest that the construction of metro systems does not necessarily help in the reduction of private vehicle use, congestion or pollution.
- Introduction/acquisition of such engines and transmission technologies fitted with buses that ensure clean burning and combustion at the passenger loads and driving cycles in Indian megacities.
- Introduction of safe entry and exist modus operandi for bus passengers. This will require all buses to be fitted with closing doors, low floors and properly designed bus stops.
- Movement of buses with relatively safer speeds. This can be ensured by adjusting of trip times and introduction of speed limiting devices in buses.

(B) Segregated Lanes for Non-Motorized Transport and Safe Pedestrian Modes

Following arrangements are required for:

- Comprehensive adherence to urban and road design characteristics to ensure the safety of pedestrians and bicyclists.

- Construction/provision of segregated bicycle lanes on all arterial roads in megacities.
- Constructions of convenient under-street sub-ways and crossing facilities for pedestrians.

(C) Environmental Protection and Monitoring

- Increase in the distances between residential blocks, sensitive areas and the ring roads.
- Buildings sensitive to vibrations not to be constructed within a range of 40 m of the road.
- Strict control of speeds by all vehicles to prevent noise pollution.
- Elevated roads should be reduced and the use of double-layered or multi-layered roads should not be adhered to ensure sustainable transport environment.

  This indicates that any high traffic road in a megacity affects the land use around it and makes it less usable for people or user-friendly.
- We have to design and implement schemes that remain at a human scale and protect all aspects of human health.
- The safety and environmental dimensions of change in transport and land use should find adequate expression in technical and public analyses and estimates.
- In order to ensure a sustainable transport environment, it is irrevocably required to have a simultaneous evaluation of safety and environmental concerns by involving related department and agencies.

CONCLUSIONS

The increases in urban population, haphazard urban growth, industrialization and motorized transport have caused unbridled problems of air and noise pollution in all the cities of India in varying degrees. The levels of these pollutions in Indian megacities have risen to alarming proportions. It is, therefore, urgently required to develop a safe and eco-friendly transport environment. Adequate measures must be taken in terms of technological modifications in vehicles, introduction of new technologies fuel integrated land-use transportation planning, properly planned transport system management, public and non-motorized transport, etc. to cater to the need of people for a sustainable transport environment.

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