

12 INDIAN CITIES: TRANSPORT INDICATORS

ABSTRACT

This study compares basic transport and air quality indicators for 12 Indian cities. These indicators are reported in city development plans, comprehensive mobility plans, comprehensive traffic and transport studies and detailed project reports submitted to the Ministry of Urban Development between 2005 and 2007. The list was created with an intention to include, metropolitan cities, cities with ongoing or future BRT projects. We divided the 12 cities into three categories, “metro” cities (Chennai, Mumbai, and Delhi), “millennium bloomers” (Ahmedabad, Bangalore and Pune) and “now exploding” (Bhopal, Indore, Jaipur, Mysore, Rajkot and Surat).

Some significant observations from the transport indicators are as follow:

1. All cities classified as “now exploding” will double in size by 2021.
2. Average travel distances for the metropolitan cities and Bangalore is over eight kilometers. For the rest of the cities it is currently at six kilometers or below.
3. At current median household levels in these cities the rate of growth for two wheelers has slowed down and rate of growth of cars is increasing rapidly.

There was no consistent methodology or format to measure and present air quality indicators in CDP’s or CMP’s. The reported data is from the central pollution control board (CPCB) report.



INTRODUCTION

India has underway an ambitious, globally unique attempt to renew its urban infrastructure and reform the political, institutional and financial relationships between national, state, and city levels of government that have impeded sustainable city development heretofore. The Jawaharlal Nehru National Urban Renewal Mission (JnNURM) combines an offer of financial support for infrastructure projects, under a cost-sharing arrangement with the states and local governments, linked to a carefully structured governance model, that includes both central assistance and mandatory and optional reforms.

As per JnNURM regulations the Ministry of Urban Development (MoUD) requires cities to develop citywide development plans (CDP's), comprehensive mobility plans (CMP's) and detailed project reports (DPR's) to become eligible to receive financial support.

This study was conceived with an aim to build a database of transport and air-quality indicators from the projects sent to MoUD for approval under JnNURM and to perform preliminary comparative analysis of these indicators. The report will also indicate possible gaps in data collection and analysis and address opportunities for sustainable urban transportation.

JnNURM and NUTP

The JnNURM was launched in 2005 with a focus on efficiency of urban infrastructure and service delivery mechanisms, including community participation and accountability of urban local bodies (ULBs)/ parastatal agencies towards citizens. The duration of the mission is seven years beginning from the year 2005-06 and it identifies a requirement of 1,20,536 crore INR (28 billion USD) of investment in urban infrastructure in 63 cities across the nation. The ambitious program has two sub-missions: one focused on services for urban poor and the other focused on infrastructure development. The latter is administered by Ministry of Urban Development (MoUD) and includes projects in water supply and sanitation, sewerage, solid waste management, road network, urban transport and redevelopment of old areas in the cities (2). The JnNURM window is open until 2011.

The National Urban Transport Policy (NUTP) was launched in mid-2006 by the MoUD. The NUTP was created to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to jobs, education, recreation and such other needs within our cities (1). The underlying aim is to create a policy that would lead to building people centric urban transport instead of being focused on improving conditions for private motor vehicles. To realize its objective it recommends: integrated land use and transport planning, equitable allocation of road space, priority to



public transport, priority to non-motorized transport, discourage use of personal motor vehicles, coordinated planning and association with private sector (I). After the launch of the NUTP a crucial decision was made for all urban transport projects to receive financial assistance under JnNURM to conform to the NUTP. These reforms and the related National Urban Transport Policy (NUTP) guidelines provide an unprecedented *pull* from the center, motivating states and cities across India to attempt to design and implement BRT and other sustainable transport solutions, all at the same time.

CITY SELECTION

The city selection was done with an intention to include, metropolitan cities, cities with ongoing or future BRT projects. We divided the cities into three categories, metropolitan cities (Chennai, Mumbai, and Delhi), millenium bloomers (Ahmedabad, Bangalore and Pune) and now exploding (Bhopal, Indore, Jaipur, Mysore, Rajkot and Surat). Based on the available budget we were limited to 12 cities. We made a decision to leave out “metropolitan city” Kolkata and “millennium bloomer” Hyderabad to include more cities in the “now exploding” category. Figure 1 shows the cities on an India map and Table I below lists them.

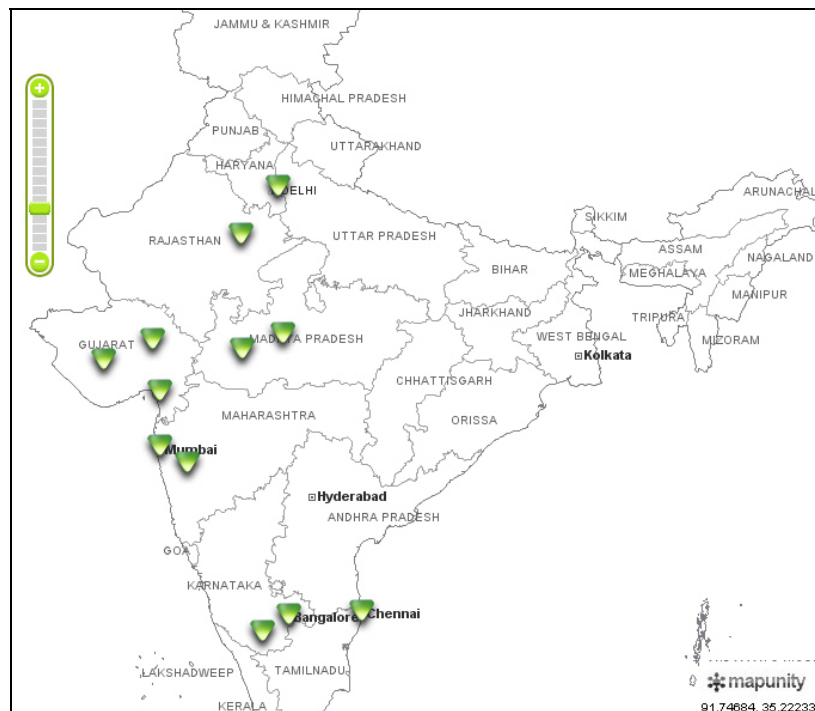


Figure I – Surveyed cities



Sr.No	City	State	Area	Population	Median Monthly HH Income
			km ²	million persons (2001 census)	in USD
1	Ahmedabad	Gujurat	466	4.5	114
2	Bangalore	Karnataka	1279	8.6	96
3	Bhopal	Madhya Pradesh	285	1.4	152
4	Chennai	Tamil Nadu	1189	7.0	90
5	New Delhi	Delhi	1483	13.8	221
6	Indore	Madhya Pradesh	134	1.8	64
7	Jaipur	Rajasthan	288	2.0	71
8	Mumbai	Maharashtra	4355	17.7	56
9	Mysore	Karnataka	128	0.8	96
10	Pune	Maharashtra	700	4.2	124
11	Rajkot	Gujurat	105	1.0	151
12	Surat	Gujurat	312	2.4	52

Table I – List of cities

INDICATORS SELECTION

The indicator selection was done based on a paper developed the *EMBARQ*²⁸ network joined to develop an indicators suite, with an aim to build a comprehensive framework for developing and applying sustainable transportation indicators. The indicators provide key information that summarizes the overall performance of projects with respect to their goals and the broader literature on sustainable development.

The following criteria were used to select the metropolitan-level short list of indicators from the pool:

- The indicator addresses a critical element of transportation sustainability;
- The indicator efficiently communicates compelling information;
- The indicator is feasible to develop and maintain; and
- The indicator has a clear direction of preference.

Figure I shows a snapshot of the database. The full database can be found in Appendix I. The indicators can be divided broadly into four categories, transport, energy and environment, social and economic.



Short List of Indicators for the Metropolitan Level		1	2	3	4
		Ahmedabad Gujarat	Bangalore Karnataka	Chennai Tamil Nadu	Indore Madhya Pradesh
How Big and How Many?					
1 Area	km ²				
2 Population	persons (2001 census) persons (projection)				
3 Density	population/km ²				
4 per capita trip rate	(All Modes) (only motorized)				
How Rich and How Equitable?					
4 GDP per capita	\$				
5 Gini coefficient	index				
6 Median household income	\$				
How Far and How Fast?					
7 Average distance traveled	(km/person/day)				
8 Average travel time	(min/trip)				
How Traveled and How Motorized?					
9 Modal splits	% trips by mode walk				

Table II: Snapshot of the indicators database

INDICATOR DATABASE

The indicator database was populated with data from the various reports submitted to MoUD. The reports include, CMP's, CDP's, comprehensive traffic and transport study, detailed project reports (DPR's), central pollution control board (CPCB) report, data on city websites, Delhi Statistical handbook, Indian journal on transport management (IJTM) and others.

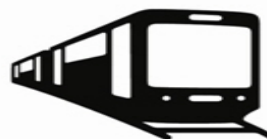
Transport Indicators: Data for transport indicators was readily available in the reports. Data was based on travel surveys. Demographic data, mobility data, modal splits and trip rate data was available for all cities.

Economic Indicators: Median household income was the only economic indicator available at the city level. Information about GDP per capita and Gini coefficient was available only at the national level.

Social Indicators: Data about average household expenditure for transport was not available for all cities. Cities implementing BRT projects had this data in their DPR's.

Energy Indicators: There is no consistent methodology or format to measure and present air quality indicators in CDP's or CMP's. The reported data is from the central pollution control board (CPCB) report. No reports had any estimation for GHG emissions. Ton CO₂ was computed using the following formulae

$$tCO_2 = \%mode * \%vehicle\ share * trips\ per\ day * trip\ length * g\ CO_2/km$$

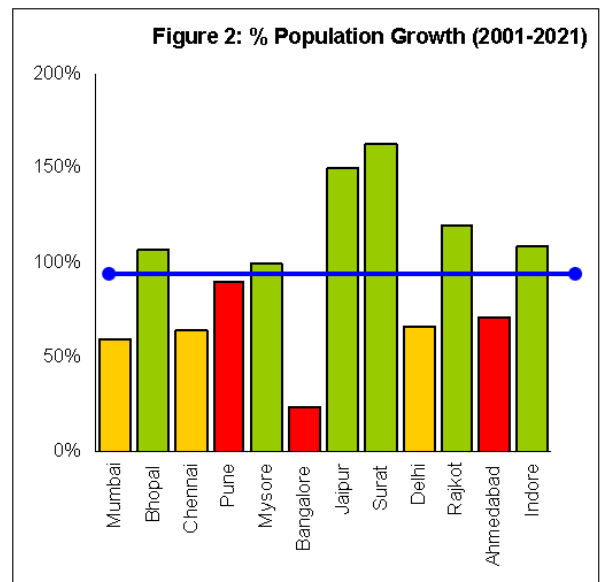
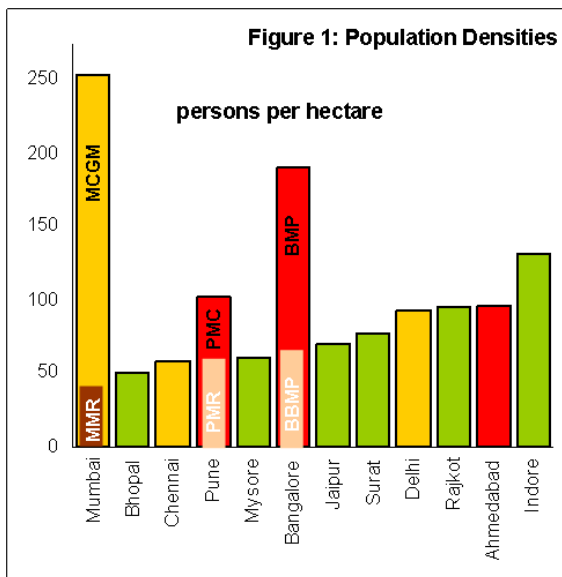


INDICATORS

Indicator 1: Population, population density and growth.

Population data is from the 2001 census. 2021 population projections used for analysis of growth trends are from comprehensive mobility plans submitted by cities. City limits are defined as per latest municipal jurisdiction boundaries. Three cities Mumbai, Pune and Bangalore show two values for density due a recent trend to annex adjoining villages into the municipal jurisdiction. This data was available only for 3 cities. This is done to allow planned comprehensive development.

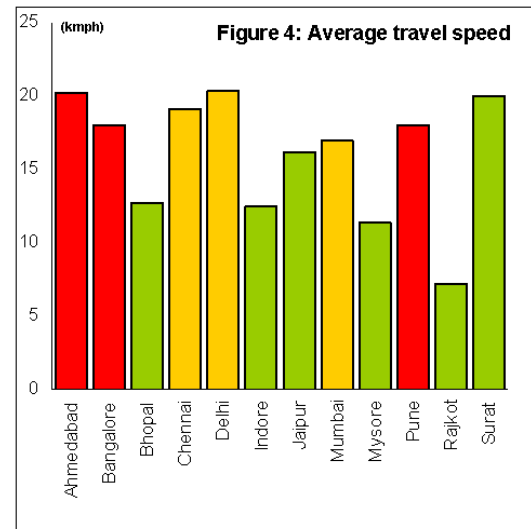
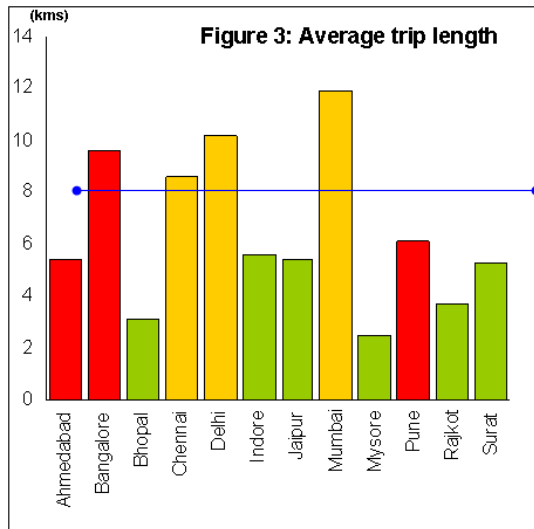
Bangalore is the only city projected to grow less than 50% in the next 20 years. All cities classified as now exploding are projected to double their population by 2021.



Indicator 2: Travel Characteristics

Average daily trip lengths for metro cities and Bangalore are over 8 km. All other cities are at 6 kms or less. These cities will see an increase in trip lengths in the coming year. Based on literature from around the world shows an increase in per capita trip making and trip lengths with 1) increasing income; 2) increased participation of women in the labor force; 3) industrial restructuring towards a service oriented economy. All cities are showing a propensity for all three.

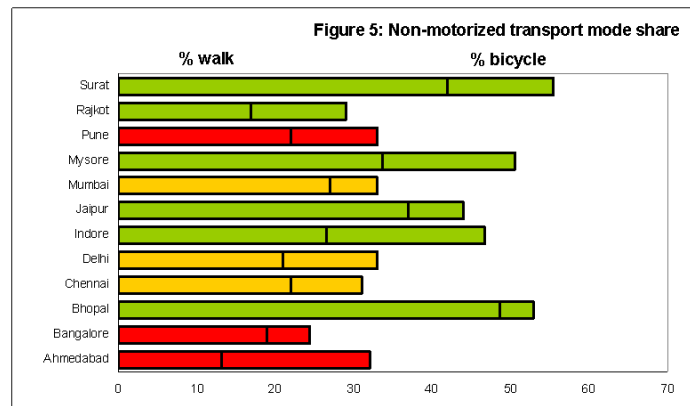




This data is from 2-3 years ago and recent studies in certain cities already report higher trip lengths.

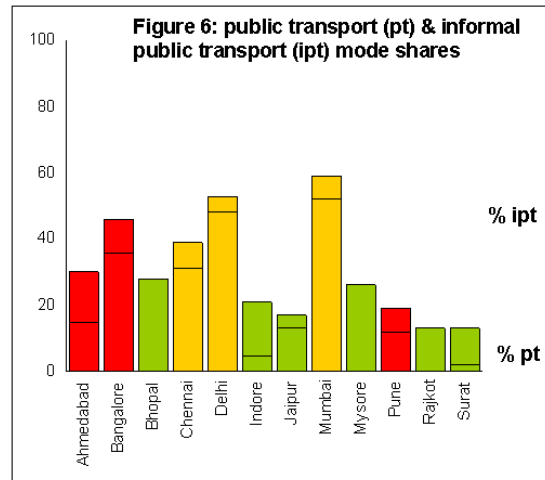
Indicator 3: Non-motorized transport

All cities show an extremely high use of non-motorized transport. The data is from 2-3 years ago and some recent reports suggest these shares have decreased in this duration. Except for the 5.6 km busway in Delhi and 10 km exclusive bikeways in Pune there is no dedicated infrastructure for bicyclists in any of the cities. Wherever provided footpaths are not continuous and encroached upon. Indore is a good example for a city with no footpaths. Most cities in the “now exploding” category have no footpaths at all.



Indicator 4: Public transport & intermediate public transport

Public transport and informal public transport are presented on the same indicator. In some cities it is very difficult to differentiate between the services. Buses operate under the state carriage way contracts, operations are irregular, unorganized and of poor quality. Informal public transport includes mini-buses, Maruti vans, tempos and shared auto rickshaws (3, 4, 6 and 8 seater). Mumbai shows the highest share of public transport (pt) 52%. Mumbai (319 kms) and Chennai (27 kms) have heavy rail system and Delhi (68 kms) has a Metro system. Bangalore is building a metro. Delhi inaugurated a 5.6 km BRT corridor in May of 2008. Ahmedabad, Pune, Jaipur, Indore, Surat, and Rajkot have approved BRT projects under JnNURM and are in implementation stage. Bhopal and Mysore have BRT projects in planning stage. It will be interesting to see how public transport mode shares react to these new public transport systems.



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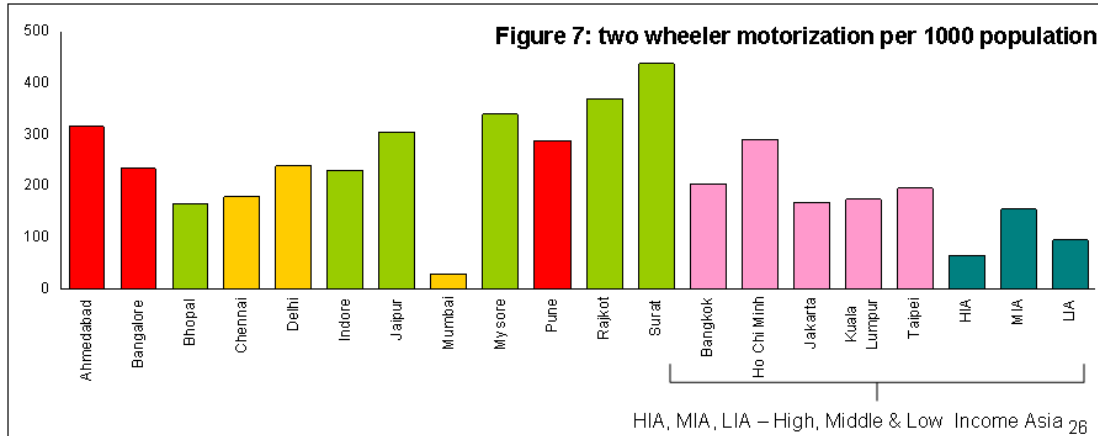
Indicator 5: Motorization

Two wheelers - A regression of two-wheelers per 1000 population and median household income do not show good statistics for the given sample. Monthly median household incomes are in a range of 50 USD and 220 USD. At these levels two wheeler ownership and monthly household income level are not correlated.

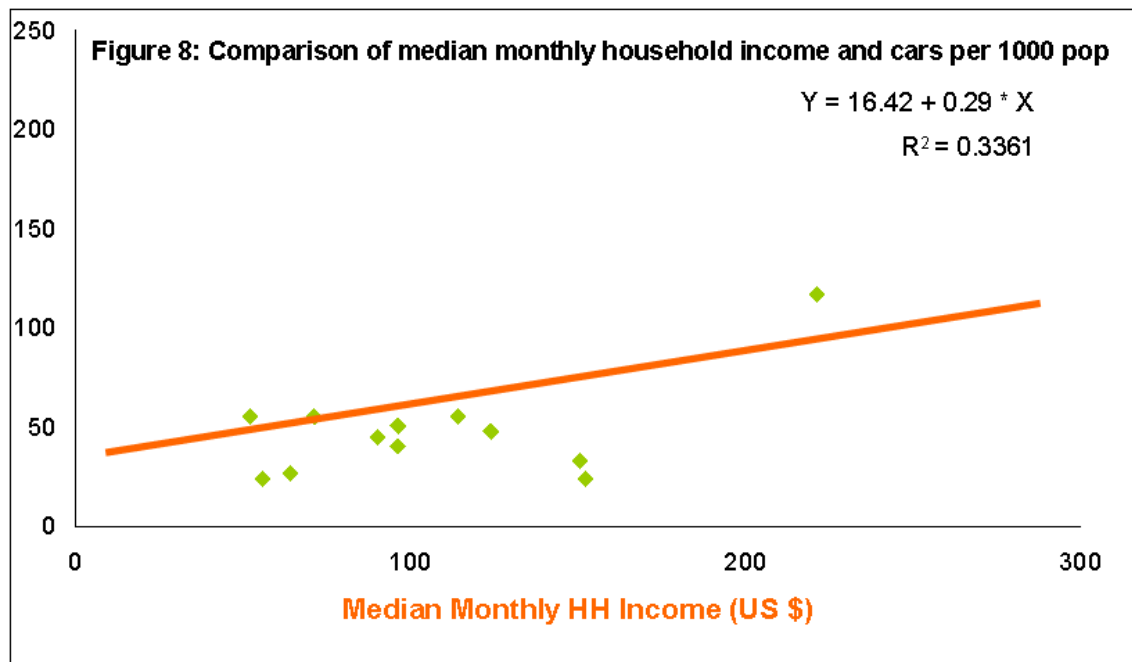
11 of the 12 cities have higher motorization than the average for middle income Asian (MIA) cities. Indian cities have one of the highest two wheelers motorizations in the world. It will be interesting to see if it stabilizes at the current 300-400 per 1000 population mark or continue to grow. Literature from around the world suggests a trend to move from two wheelers to cars as income grows.

The Indian policy makers face a big dilemma, to provide facilities to improve travel conditions, to improve safety for two wheelers, to create more stringent emission standards or not enhanced conditions for two wheelers in any way and hope that they stabilize at these levels. i.e. new two wheeler users are about the same as the people moving from two wheeler to cars.



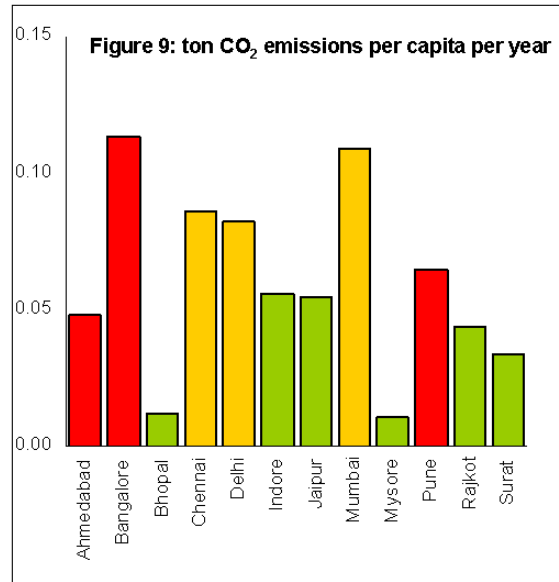


Comparison of median household income and car ownership - The relationship for personal cars per 1000 population and median household income is shown in figure 8. The regression shows a clear correlation between car ownership and monthly household income for the given sample. On the whole car ownership is likely to increase with an increase in income levels. All 12 cities are well below the average of 198 cars per 1000 population²⁶ for middle income Asian cities. Most cities are closer to the average of 38 cars per 1000 population²⁶ for low income Asian cities. Delhi is the only city with more than 100 cars per 1000 population.



Indicator 6: ton CO₂ emissions per capita per year

Figure 9 shows a comparison of annual CO₂ emissions from the transport sector in terms of ton per capita per year. The figures range from 0.01 ton CO₂ per capita per year for Mysore to 0.11 ton per capita per year for Mumbai. Mumbai despite a high public transport mode share shows more CO₂ emission due to longer trip lengths and higher share of cars versus two wheelers. Fuel use and CO₂ emissions are 3-4 times higher for cars in comparison with two-wheelers. We foresee a significant increase in emissions as people shift from non-motorized transport to two-wheelers and two wheelers to cars.



Assumptions for the emission calculations are provided in the appendix II. Trip lengths by mode are required to do more accurate analysis.

CONCLUSIONS

In all cities, incomes are growing rapidly; there is an increased participation of women in the labor force and industrial restructuring towards a service economy. Literature from other countries in this stage of development shows an increase in travel and average travel distances.

Tokyo, Osaka, Hong Kong, Singapore and Seoul all share a history of curtailing motorization for a significant period at an early stage of motorization. Much before it reached 150 vehicles per 1000 people. In Hong Kong, Singapore and Seoul, high-quality mass transit systems were not yet in operation when private vehicle restraint began. Slow motorization despite rapidly rising incomes allowed these cities a window of opportunity to invest in public transport and eventually provide substantial, high-quality public transport systems. They were able to maintain bus-based public transport usage at a high level until mass transit became affordable and was built. Public transport never became the mode of last resort or to be seen as only for the poor in these cities.

Indian cities are at this stage and are making investments to build mass transport systems. If the goal is to have transportation systems and motorization levels of high income Asian (HIA) countries two things are essential



- i. measures to curtail motorization
- ii. measures to ensure high quality for the mass transport systems in planning and implementation stage.

FUTURE DATA NEEDS

This database is a representation of the transport situation in India around 2005. Very little archived data is available for cities outside the metros. Given the growth stage a lot of our cities an exercise of this scale should be conducted every 5 years. There is a need to collect data beyond what has been used in the paper to get more accurate estimates of energy consumption and social impacts. The following additional data should be collected to enhance this research and for future research.

- 1) Data on trip lengths by mode and by trip purpose (work, shop, recreation, education and other)
- 2) Clearer understanding of supply of informal public transport systems and demand served by them.
- 3) Clearer understanding of travel patterns in the non-motorized segment.
- 4) Data to study travel characteristics at the household level
- 5) Data to assess the increase in participation of women in the labor force

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Appendix I

Short List of Indicators for the Metropolitan Level													
City	Unit	Ahmedabad	Bangalore	Bhopal	Chennai	Delhi	Indore	Jaipur	Mumbai	Mysore	Pune	Rajkot	Surat
How Big and How Many?													
1 Area	km ²	466	1,279	265	1,189	1,483	134	288	4,355	128	700	105	312
2 Population	lakh persons (2001 census)	45	86	14	70	138	18	20	177	8	42	10	24
	lakh persons (2021 - Projection)	77	107	30	116	230	37	51	282	16	80	22	64
3 Density	population/km ²	9,657	6,744	5,028	5,899	9,332	13,127	7,046	4,065	6,128	6,000	9,556	7,788
4 per capita trip rate	(all modes)	1.14	1.41	1.14	1.50	1.55	1.49	1.26	1.67	0.72	1.30	1.29	1.30
	(all modes excl walk)	0.77	1.05	0.73	1.05	1.00	1.09	0.90	1.15	0.48	0.88	0.92	0.80
How Rich and How Equitable?													
4 GDP per capita	\$					1661							
5 Gini coefficient	index												
6 Median household income	\$/month	114	96	152	90	221	64	71	66	96	124	151	52
How Far and How Fast?													
7 Average trip length	(km/person/day)	5.4	9.6	3.1	8.6	10.2	5.6	5.4	11.9	2.5	6.1	3.7	5.3
8 Average travel time	(min/trip)	16	32	15	27	30	27	20	42	13	20	31	16
How Traveled and How Motorized?													
9 Modal splits	% trips by mode												
	% walk	13	19	49	22	21	27	37	27	34	22	17	42
	% bicycle	19	6	4	9	12	20	7	6	17	11	12	13
	% public transport	30	36	28	39	48	16	17	62	26	12	66	13
	% private transport	38	39	19	30	19	37	39	15	23	54	5	31
10 Motorization	vehicles/1000 pop												
	2w/1000 pop	316	233	165	181	238	230	304	30	340	288	370	437
	3w/1000 pop	17	10	7	6	5	6	4	9	17	23	7	27
	4w/1000 pop	55	50	24	45	117	27	55	24	40	48	33	55
How Dangerous?													
11 Traffic Fatalities	fatalities/100,000 population	5.50	0.08	14.31	0.15	0.16	11.26	91.00	0.04	19.57	0.17	0.05	9.00
	injuries+fatalities/100,000 population	57.89		167.00	0.64	0.79	142.13	131.94	1.22	148.03		0.75	50.49
How Dirty?													
12 Total emissions from transportation	tons/year												
13 Average ambient concentration of air pollutants for 2003 in residential areas	ug/m ³												
	SO ₂	13	17	8	11	6	9	5	10	13	20	13	19
	NO ₂	22	39	14	17	50	17	28	39	18	38	18	26
	SPM	225	229	209	148	361	201	267	230	81	196	161	183
	RSPM	97	80	64	63	170	120	111	92	42	109	100	92
At What Cost?													
14 Average household expenditure on transport	% of income	5					8.12				9.9	8.87	10.31
	\$/month	5.70					15.28			3.25	13.23	13.38	5.37
15 Transport energy use per capita	MBtu												
16 Air pollution cost from transport	\$												
17 External cost of transport/city GDP	\$												
Source?													
18		CDP, BRTS, UTM	CTTP, CPCB	CMP, CDP, BRTS	CDP, MMTL, UTM, CPCB	commonwealth games, Delhi statistical handbook, CPCB	CMP, CDP, BRTS	CDP, BRTS	CDP, CPCB, MMRDA	DPR for BRTS 2007, CDP	CDP, BRTS phase 1 & commonwealth youth games, UTM	BRT DPR, CDP	CMP, CDP, BRTS



Appendix II

Assumptions for fuel efficiency (km/l) and emissions (gco₂/km) from each mode are presented in Table III. All public transport trips were assumed to be in buses, occupancy of 50 was used.

mode	km/l	l/km	gco ₂ e/km
2w	50	0.02	54
3w	25	0.04	108
car	11	0.09	245
bus	3	0.33	900

Table III: Assumptions for emissions (gco₂/km) for each mode

