Achieving Sustainable Transportation System for Indian Cities – Issues and Strategies





By

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Transportation Discipline

- **Traditionally supply centric**
  - Focus only on addition of physical infrastructure
- **Gradual realization of constraints**
  - Land
  - Resources
  - Energy
  - Environment

Indian Conditions – Adding to the Problem

- Heterogeneous
- Non-lane based
- Driver behaviour
- Poor integration between land-use and transportation etc.
- Population growth
- High density growth in cities
- Exponential growth in vehicles etc.

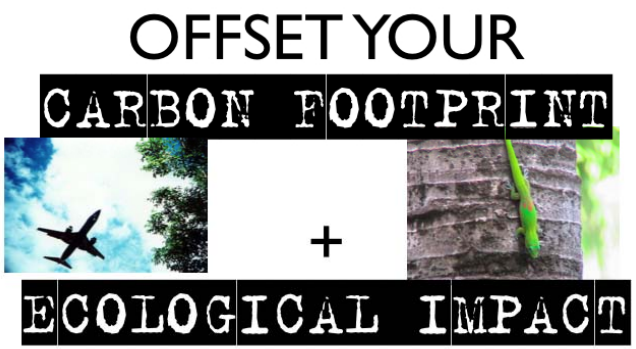
High transport externalities - *Focus on Sustainability*

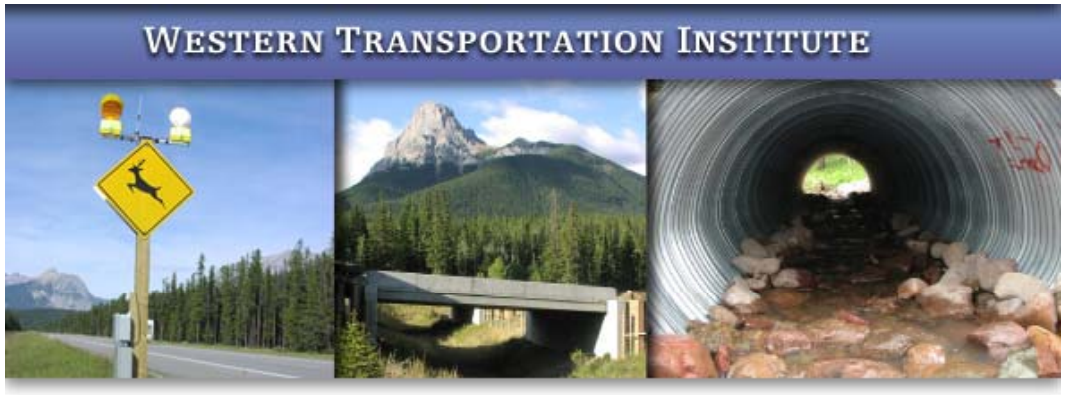
Transportation – Externalities

- Transportation Planning Effects

Transportation – Externalities

- Transportation – Environment Interaction





Key Issues

- Access, not Mobility
  - Activities tend to spread out in car-oriented cities
  - People have to travel more for the same level of accessibility

- Moving People, not Cars
  - Purposeful mobility
  - Need to nurture public transport, giving priority to them over cars

Shift in Approach

- **Supply centric to Demand centric** – Optimize

- Traffic management
- Demand management
- Travel behaviour

Often too complex and beyond manual interventions by humans - **Technology intervention is necessary to succeed.**

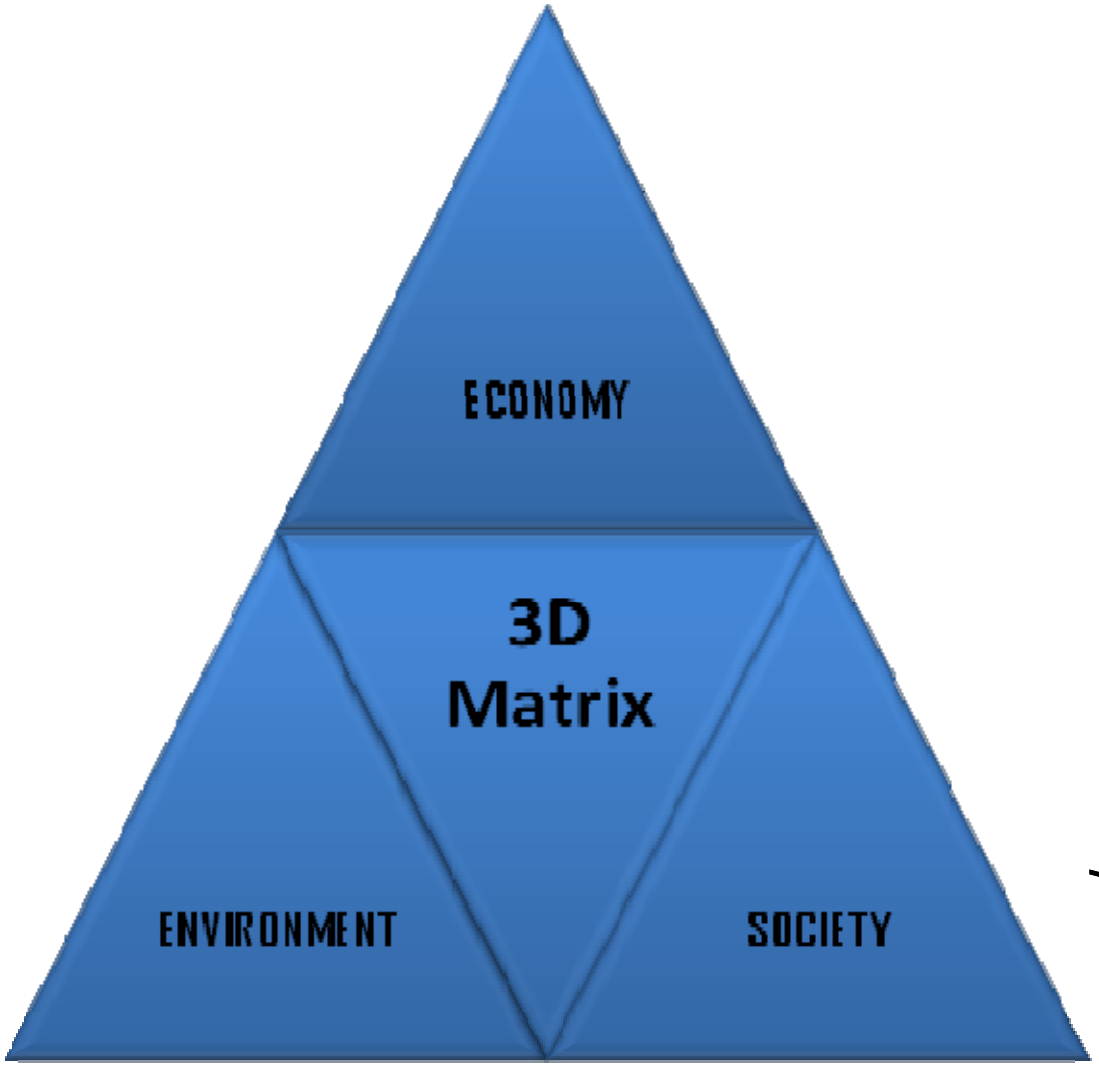
Emergence of Vehicle Telematics and ITS

- Positioning
- Mapping
- Remote Sensing etc.
- Communications
- Electronics
- IT
- Image processing etc.

Sustainability?

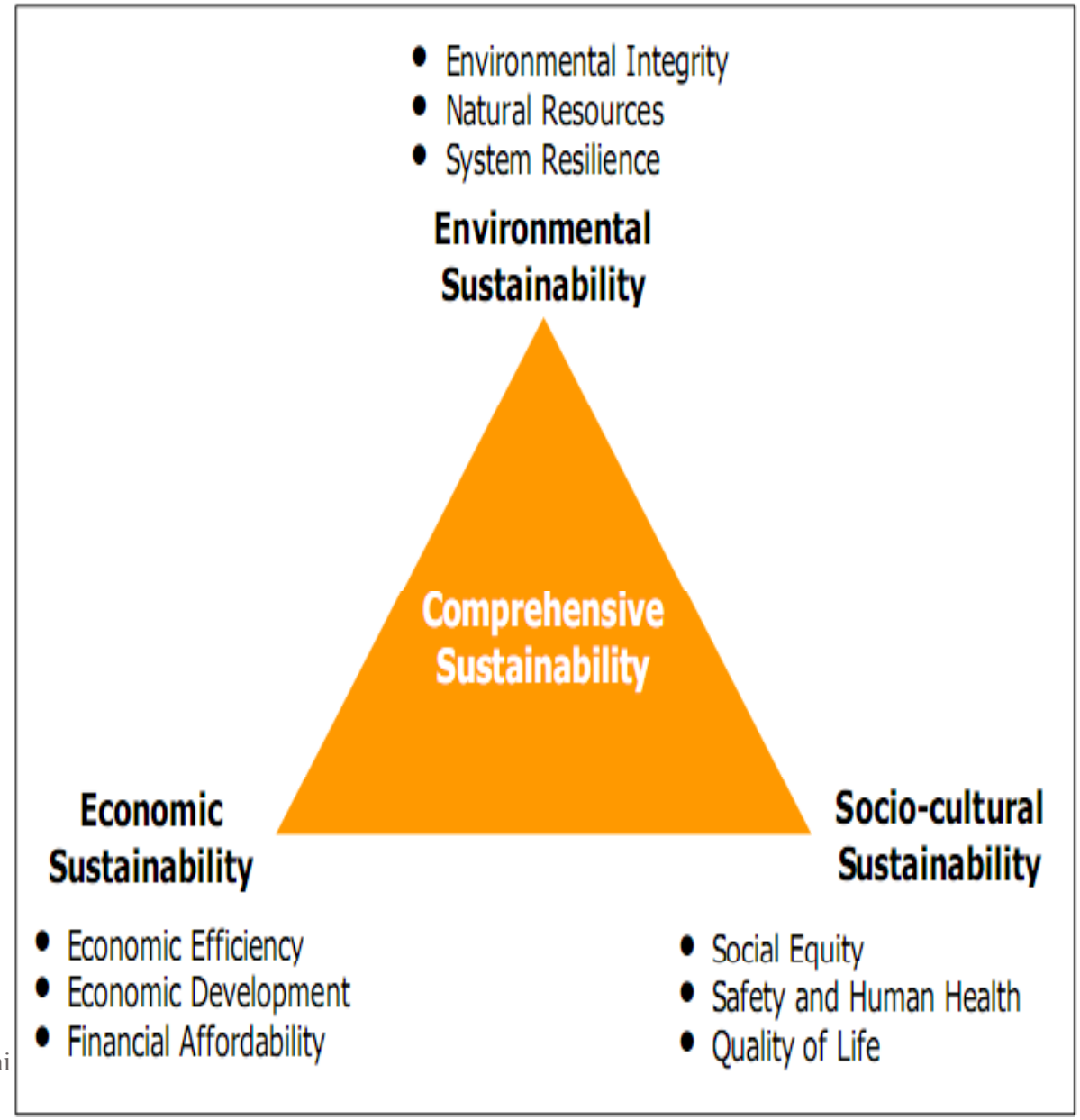
- **Development that meets the needs of the present without compromising the ability of future generations to meet their needs.**

SUSTAINABILITY



3D Matrix of Sustainability

WHAT IS SUSTAINABLE TRANSPORT ??

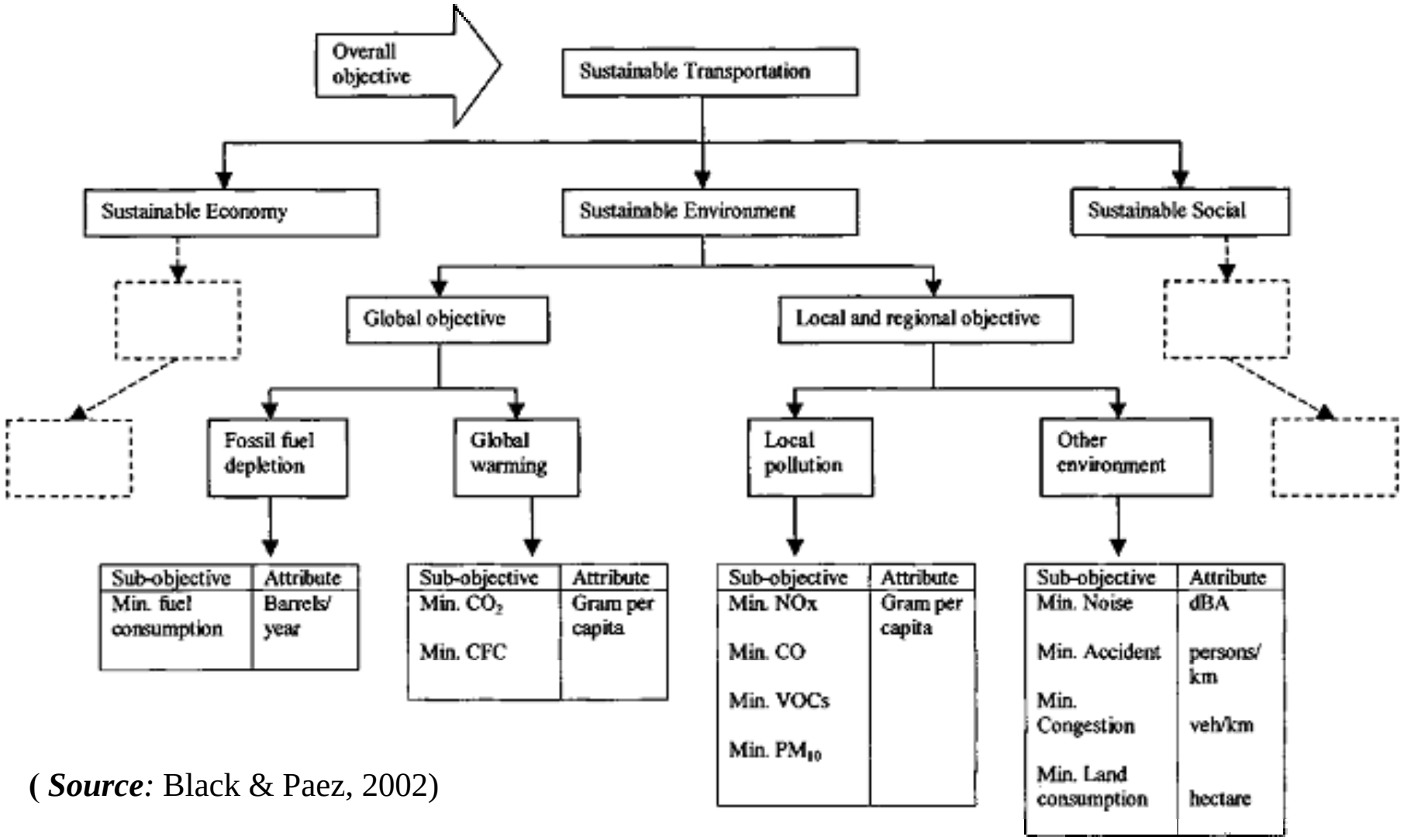


***Source**:* Jeon and Amekudzi , 2005

Goal for Sustainable Transportation

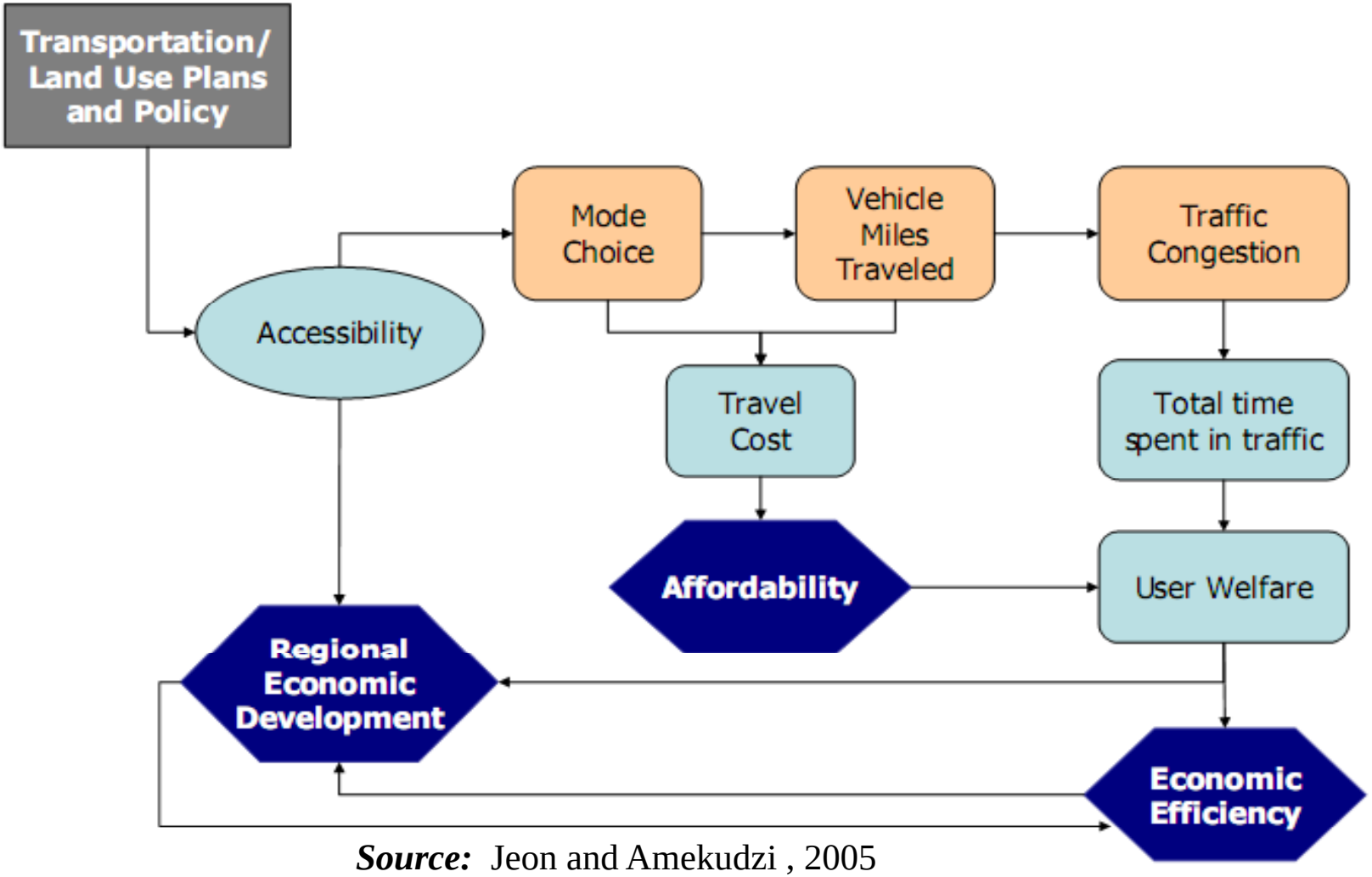
- **Develop better transportation systems, options, and expectations consistent with the objective of securing future social and economic development within a sustainable environment that ensures community well-being.**

Hierarchical Diagram for Sustainable Transportation



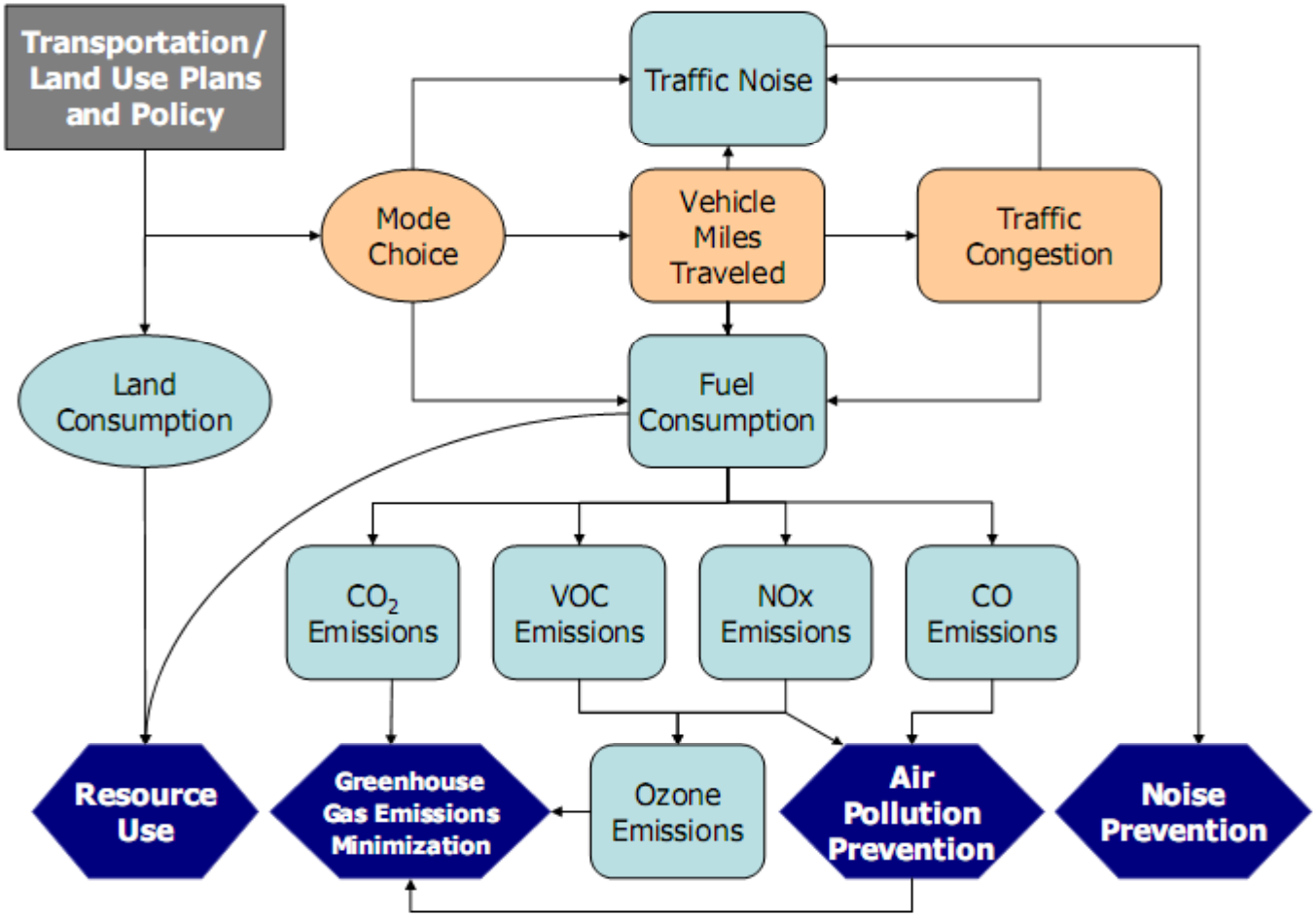
(***Source:*** Black & Paez, 2002)

Economic Factors for Transportation System Sustainability



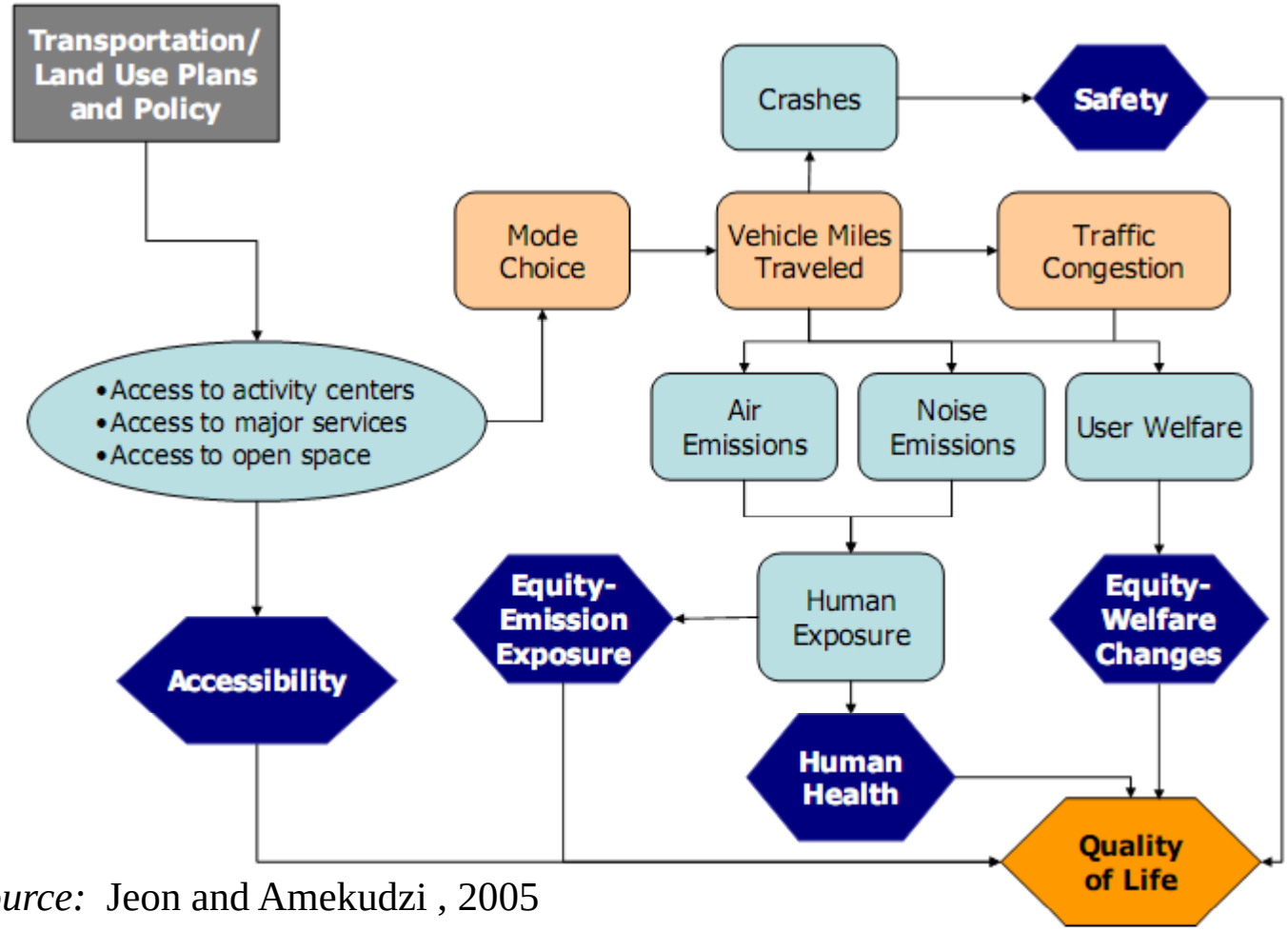
Source: Jeon and Amekudzi , 2005

Environmental Factors for Transportation System Sustainability



Source: Jeon and Amekudzi , 2005

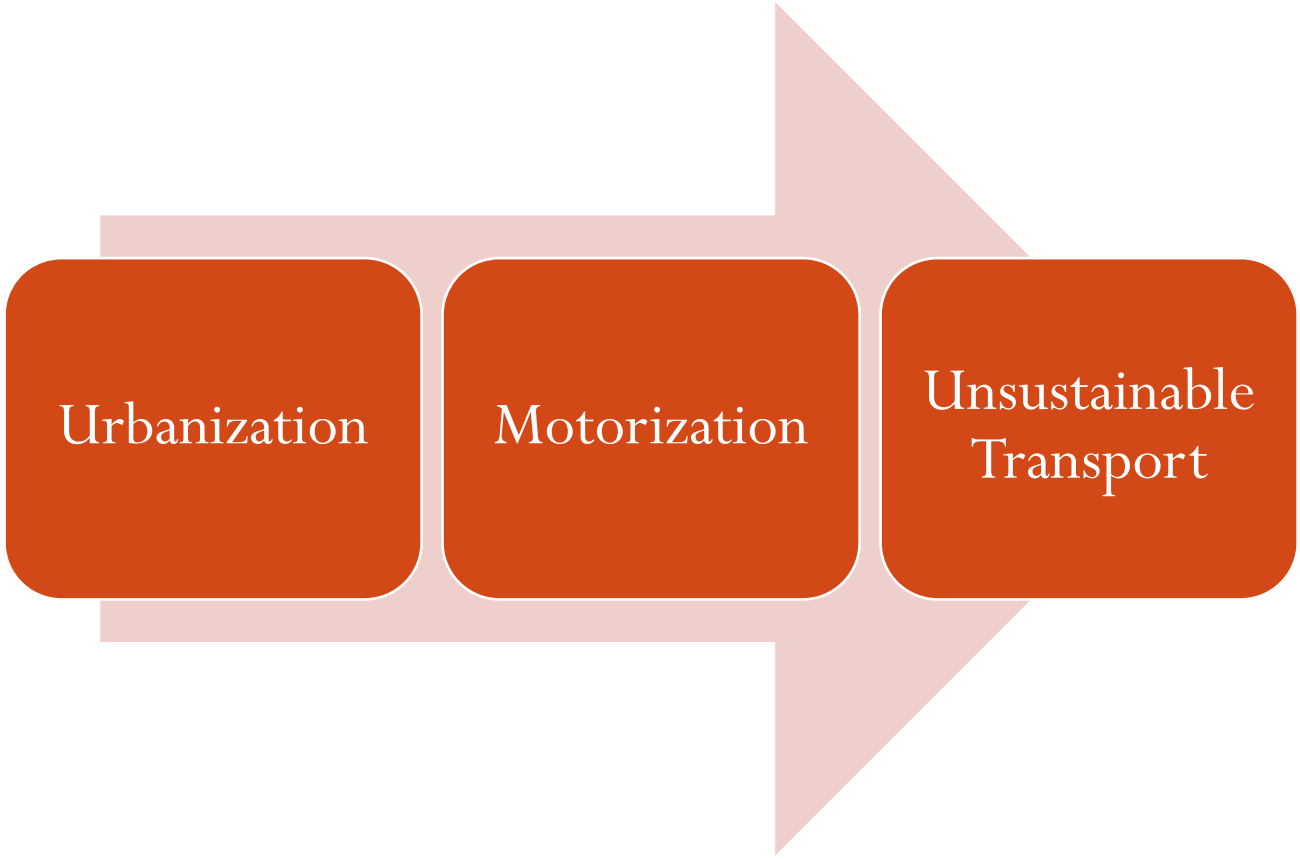
Social Factors for Transportation System Sustainability



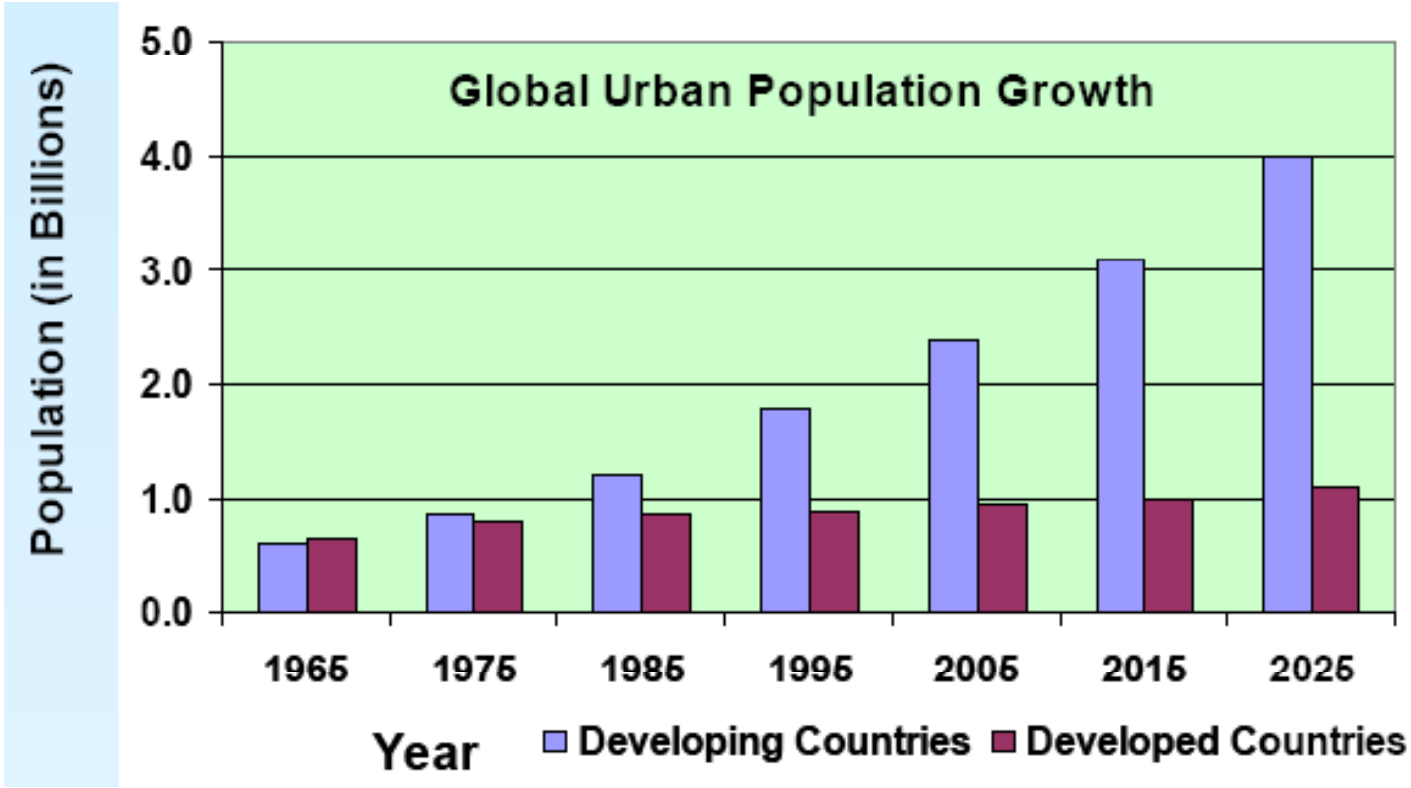
Source: Jeon and Amekudzi , 2005

Are current systems and trends in Indian cities sustainable?

- Can be understood through issues of urbanization and motorization :



Global Urban Population Growth



Source - MOUD (2008), "Study on Traffic and Transportation Policies and Strategies in Urban Areas in India"

Increase in population over the last two decades

City	1991	2001	2011	Increase in the last two decade
Delhi	8.41	12.88	16.31	94%
Bangalore	4.13	5.70	8.50	106%
Hyderabad	4.34	5.74	7.75	78%
Lucknow	1.67	2.25	2.90	74%
Indore	1.11	1.52	2.17	95%
Guwahati	0.65	0.89	1.30	105%

Source : Census of India, 2011

Cities are seeing an increase in the Working Age population in the last two decades

City	Age Group	1981	1991	2001
Bangalore	0-14	35.6%	31.1%	25.9%
	14-60	58.9%	62.7%	67.3%
	60+	5.3%	5.6%	6.7%
Hyderabad	0-14	-	35.9%	31.1%
	14-60	-	58.9%	63.0%
	60+	-	5.2%	5.9%
Lucknow	0-14	45.0%	42.5%	35.0%
	14-60	49.9%	57.5%	58.6%
	60+	5.2%		6.5%
Indore	0-14	35.9%	34.2%	34.5%
	14-60	58.3%	59.6%	61.0%
	60+	5.8%	6.2%	4.5%
Guwahati	0-14	-	29.3%	26.1%
	14-60	-	65.6%	67.6%
	60+	-	4.1%	5.1%

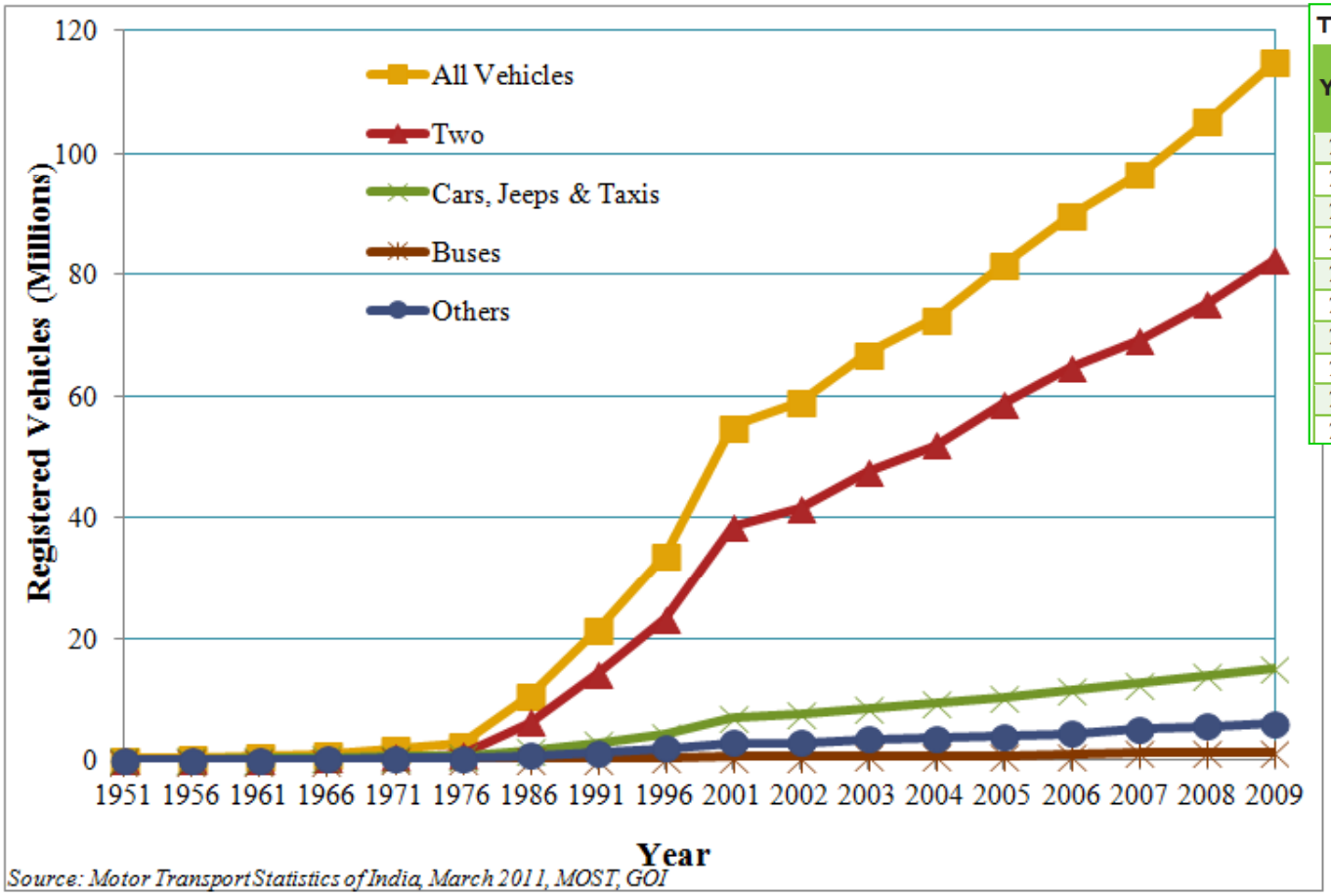
Source : Census of India, 2011

Percentage of Population Working – There has been a substantial increase in % working women in all the cities

City	Gender	1981	1991	2001	% Increase since 1991
Delhi	Both	-	31.64%	32.82%	4%
	Male	-	51.72%	52.06%	1%
	Female	**-**	**7.36%**	**9.37%**	**27%**
Bangalore	Both	30.3%	33.2%	38.5%	16%
	Male	49.4%	52.8%	57.6%	9%
	Female	**8.8%**	**11.5%**	**17.5%**	**52%**
Hyderabad	Both	27.86%	27.36%	29.20%	7%
	Male	47.47%	46.02%	47.30%	3%
	Female	**6.55%**	**7.33%**	**9.9%**	**35%**
Lucknow	Both	29.13%	27.56%	27.60%	0%
	Male	50.77%	47.24%	45.70%	-3%
	Female	**3.84%**	**5.01%**	**7.20%**	**44%**
Indore	Both	28.98%	30.03%	32.10%	7%
	Male	48.38%	49.73%	51.20%	3%
	Female	**7.06%**	**8.15%**	**11.10%**	**36%**
Guwahati	**Both**	**-**	**32.20%**	**35.10%**	**9%**
	Male	**-**	**52.40%**	**54.10%**	**3%**
	Female	**-**	**8.70%**	**12.50%**	**44%**

Source :Census of India data for various years

Vehicle Growth in India



Source: Motor Transport Statistics of India, March 2011, MOST, GOI

Table 1-1: Vehicles Registration trends – India

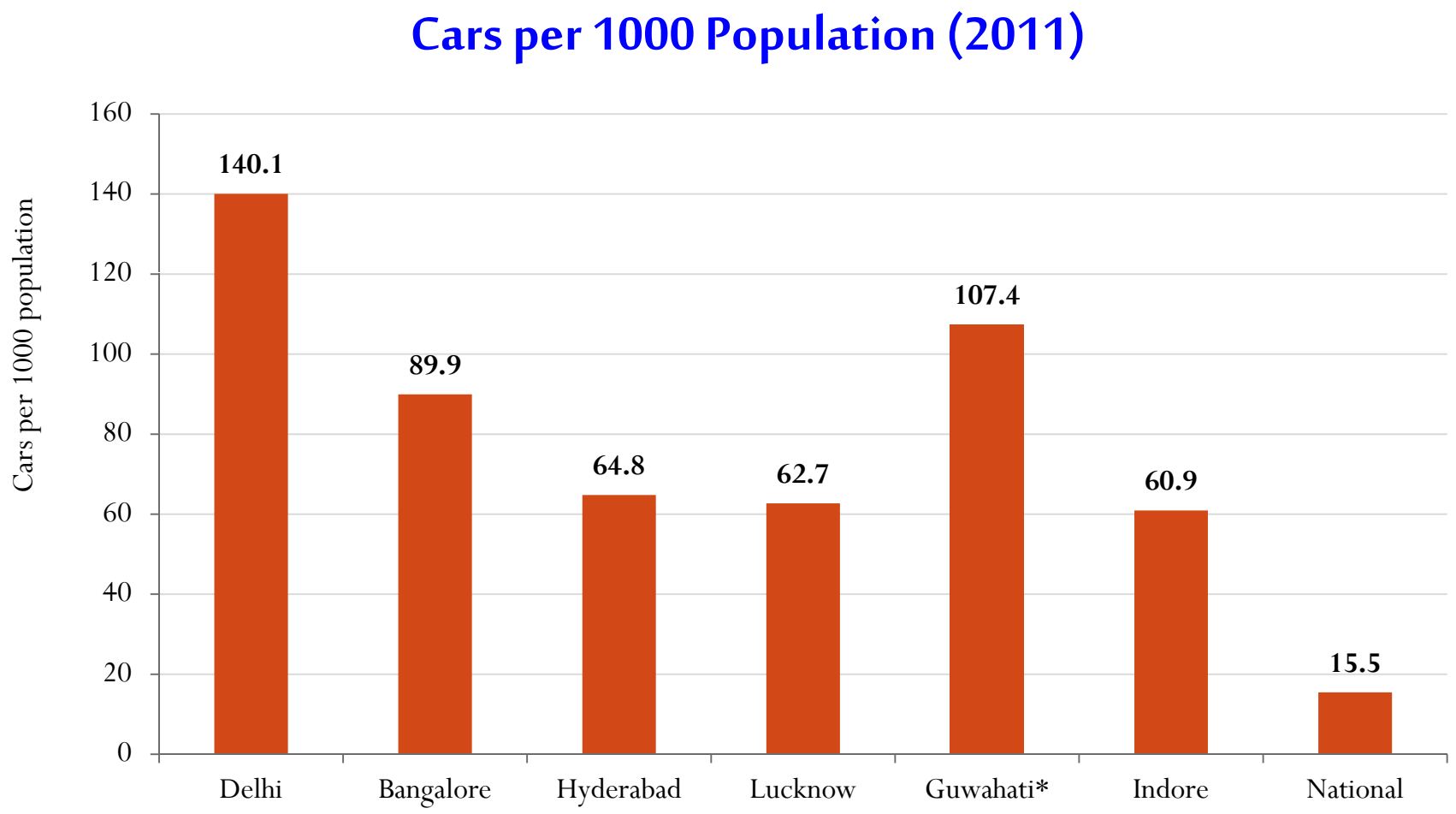
YEAR	NO. OF REGISTERED VEHICLES	ANNUAL GROWTH RATE
2001	54,991,026	
2002	58,924,337	7.2
2003	67,007,284	13.7
2004	72,717,935	8.5
2005	81,501,719	12.1
2006	89,618,267	10.0
2007	100,683,409	12.3
2008	111,537,339	10.8
2009	122,709,614	10.0
2010	136,759,444	11.4

55 million vehicles were plying on Indian roads in 2001

100 million vehicles were plying on Indian roads in 2011

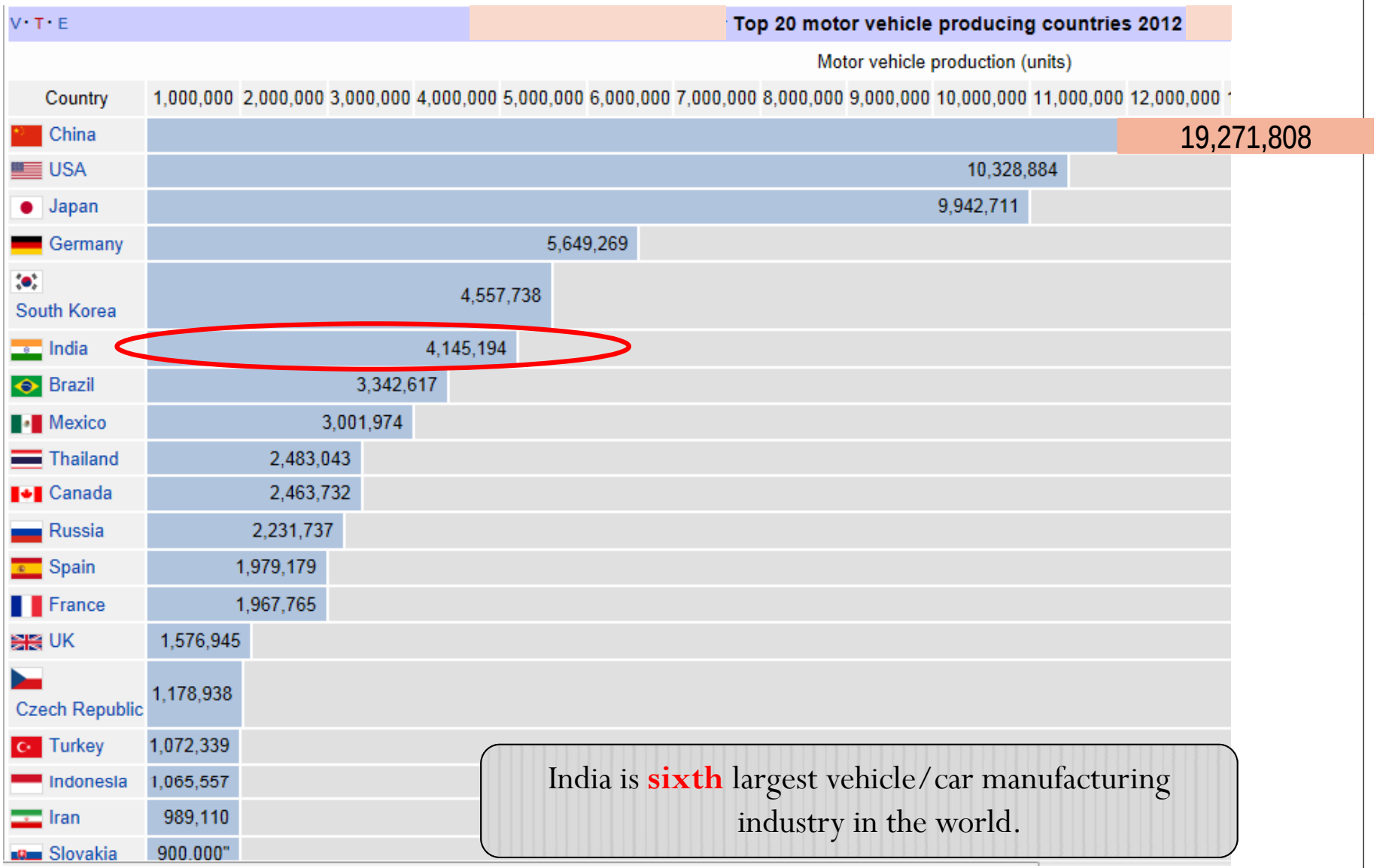
10% growth during 1991-2001, 12.3% (2001-05), 16 to18% (2005-2011)

Number of Registered Cars per 1000 population



*Estimated

Vehicle Production



India is **sixth** largest vehicle/car manufacturing industry in the world.

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Desired Modal Shares for Indian City

City Population (in millions)	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+	70–85	15–20	10–15

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Percentage share of trips by Modes

Delhi

Mode	2011
Car/Taxi	8.9
2 Wheeler	14
Auto	2.3
Bus	26.9
Cycle	10.7
Metro/ Train	2.8
Walk	34.3

Bangalore

Mode	2011
PT	41.91%
Car	6.62%
2-Wheeler	29.36%
IPT	11.56%
Cycle	2.22%
Walk	8.33%

Guwahati

Mode	2008
Car	36%
2 Wheeler	36%
Auto	10%
Bus	18%
Total	100%

Lucknow

Mode	2011
Walk	17%
Bicycle	16%
Cycle Rickshaw	8%
Auto Rickshaw	8%
Two wheeler	42%
Car/Van	5%
Public Transport/ Shared Auto	4%

Indore

Mode	2011
Car	5.58%
2 Wheeler	39.49%
Contract Van	2.19%
Auto	2.27%
Tata Magic	4.67%
City Bus	8.56%
Chartered Bus	0.15%
School Bus	10.35%
Cycle	11.93%
Train	0.12%
Walk	14.69%

Source : Comprehensive Traffic and Transportation Plan, 2011

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Change in Public Transport Share

City Category	City Population Range in lakhs	WSA, 2007 (%)	RITES, 1994 (%)
1	< 5.0	0.0 -15.6	14.9-22.7
2	5.0 -10.0	0.0 - 22.5	22.7-29.1
3	10.0 -20.0	0.0 - 50.8	28.1-35.6
4	20.0 - 40.0	0.2 - 22.2	35.6-45.8
5	40.0 - 80.0	11.2 - 32.1	45.8-59.7
6	Above 80.0	35.2 - 54.0	59.7-78.7

Source - MOUD (2008), "Study on Traffic and Transportation Policies and Strategies in Urban Areas in India"

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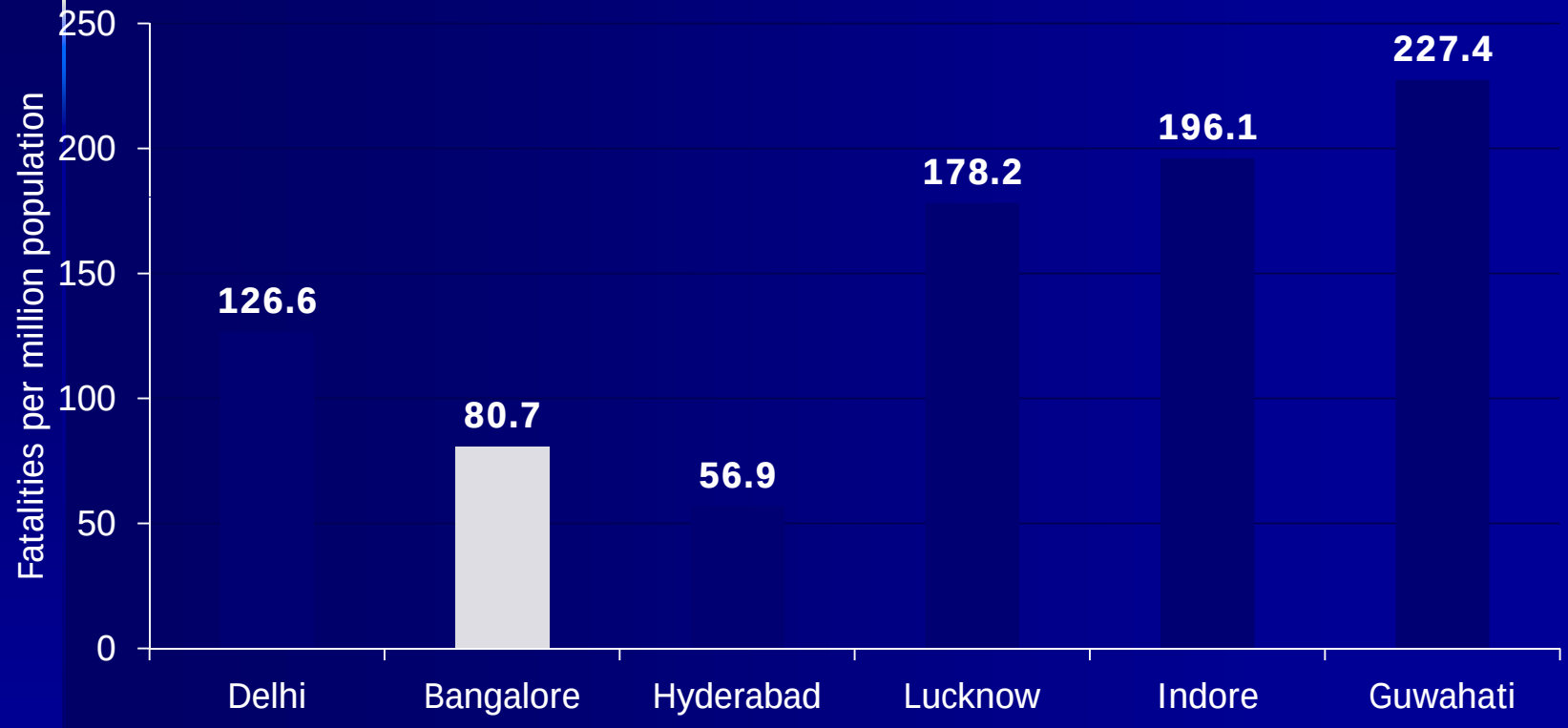
Number of fatalities due to transport accidents per million population –Highest fatalities recorded in smaller cities

Number of fatalities per million population



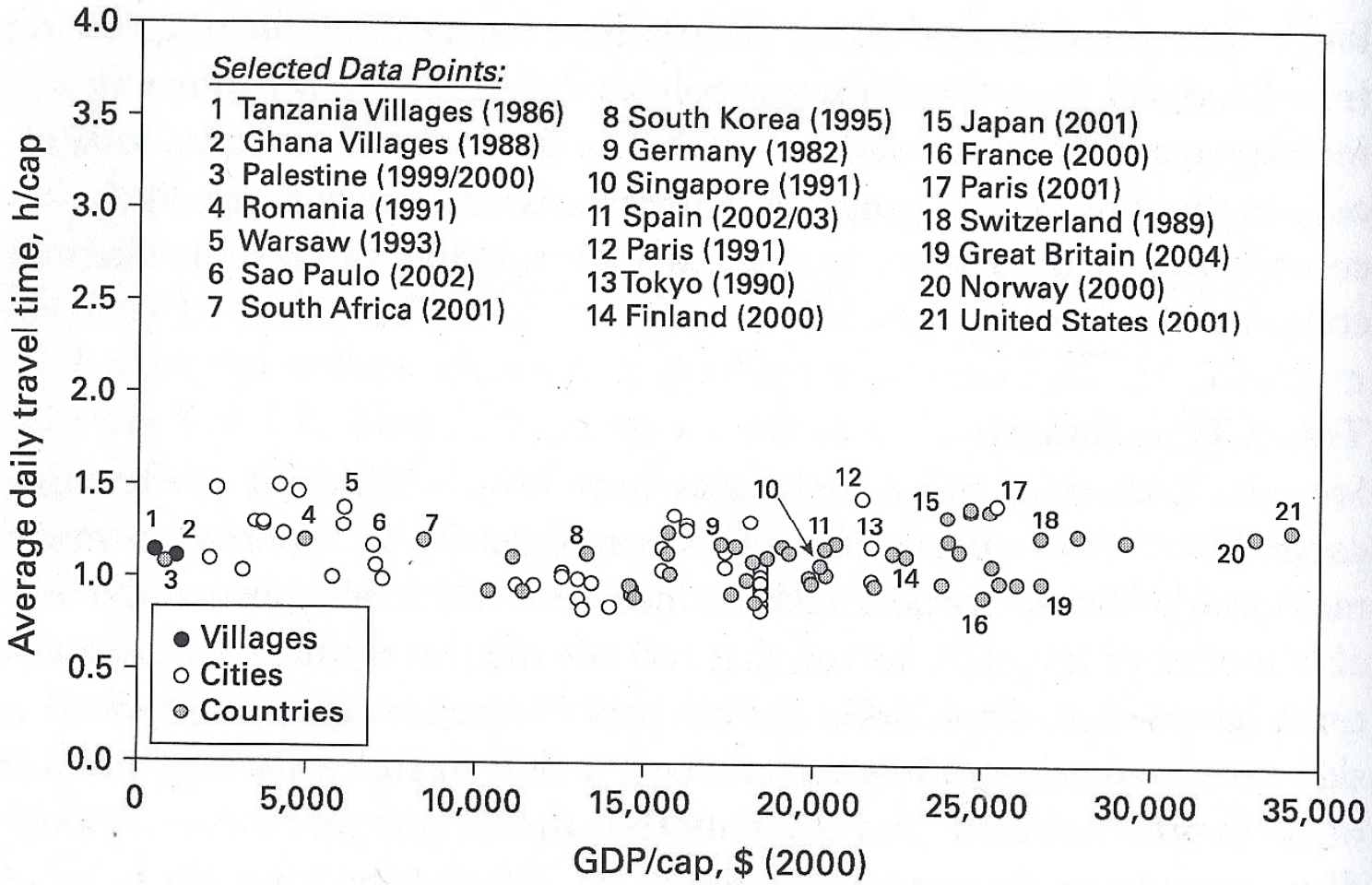


Figure 2.2
Average daily travel time in hours per person as a function of GDP per capita. Source: updated dataset of Schäfer, A., D.G. Victor, 2000. The Future Mobility of the World Population, *Transportation Research A*, 34(3): 171–205.

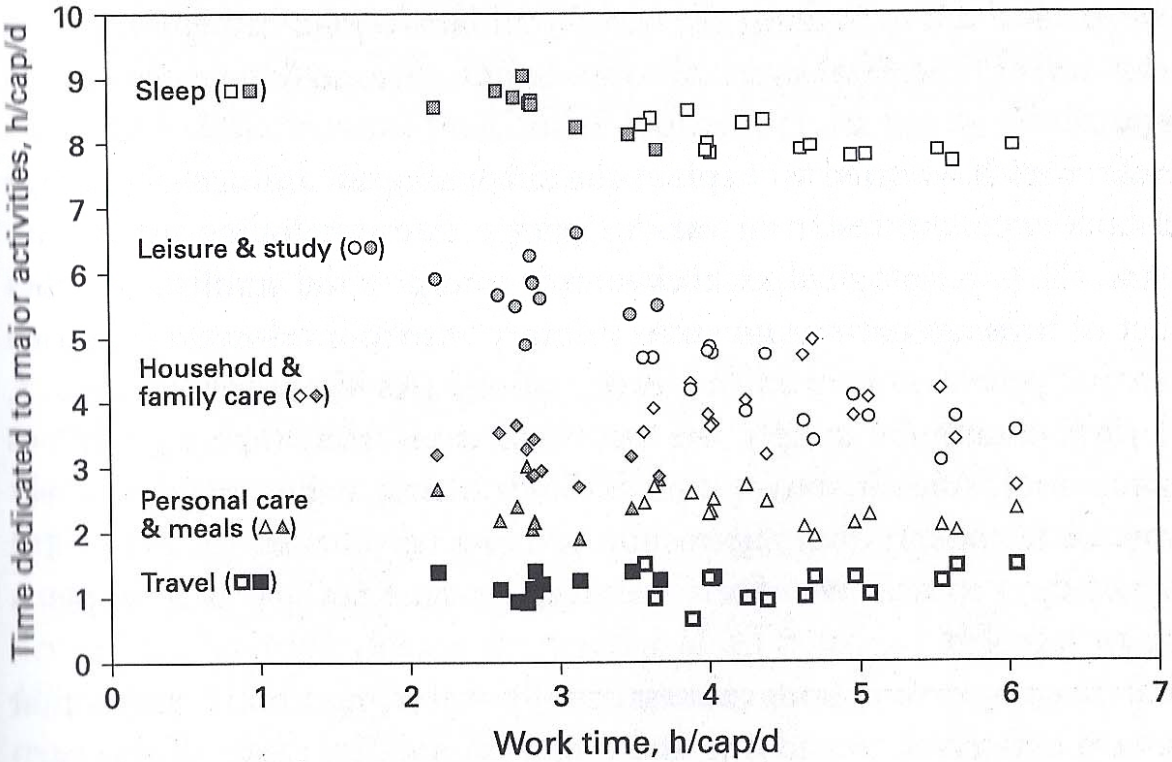


Figure 2.3
Time allocation to various activities as a function of work time in fifteen different settings within the Western Hemisphere in 1965–1966 (empty symbols) and in ten European countries at about 2000 (full symbols). Sources: Szalai, A., P.E. Converse, P. Feldheim, K.E. Scheuch, P.J. Stone, 1972. *The Use of Time: Daily Activities of Urban and Suburban Populations in 12 Countries*, Mouton, The Hague. European Commission, 2003. *Time Use of Different Stages of Life—Results from 13 European Countries*, Office for Official Publications of the European Communities, Luxembourg.

Basic Strategies

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Which role shall the different transport modes play?

Push-and-Pull concept:

Which modes need support, which modes need restrictions?

Push: parking management, access restrictions …

Pull: dense bus network, high quality bus services, …

Push and Pull: separate bus lanes, priority for buses at traffic signals etc.

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Public Transport Integration

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Physical Integration

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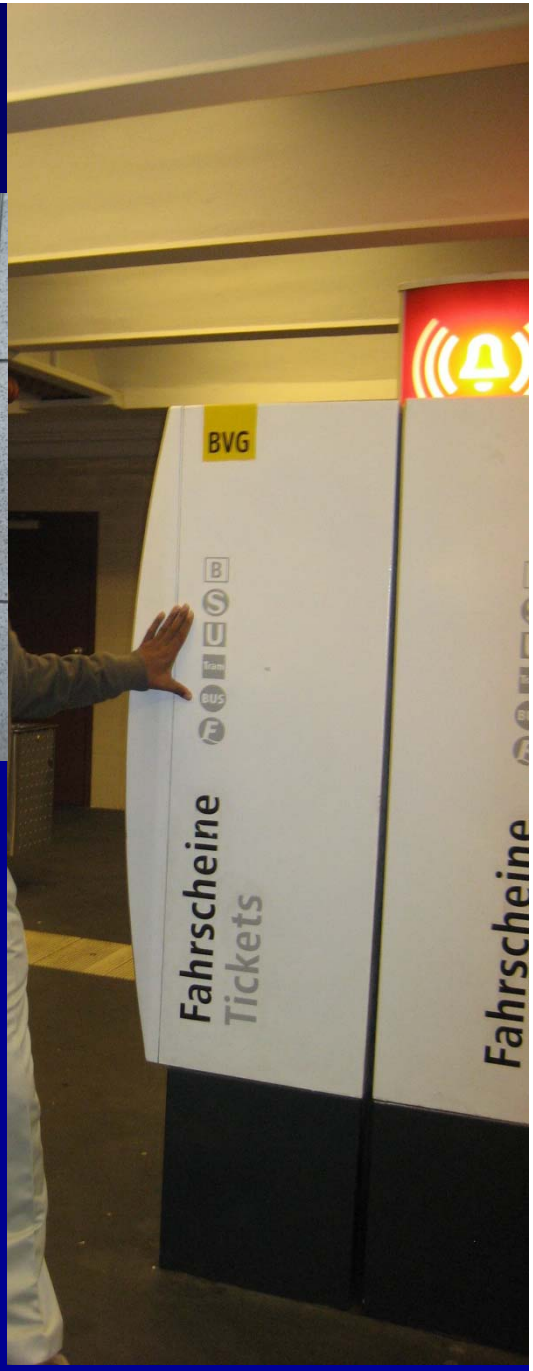
Fare Integration



Good Passenger Information System

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Good Passenger Information System

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Accessibility for Disabled

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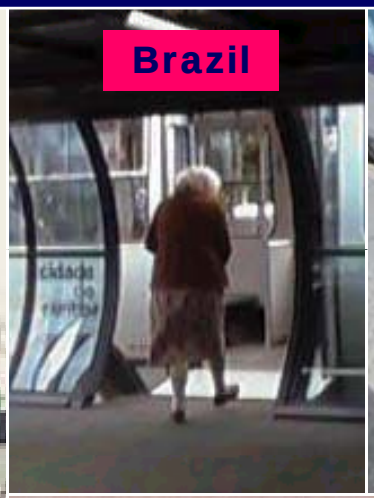
Accessibility for Disabled




Autofahren mit Erdgas
Autofahren mit Erdgas
Festival des Sports
70%


Kongresshaus
Altstadt


Kongresshaus
Altstadt

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Tee
TEA-
PAVILLON
APOLLO
OPTIK


SIAM
GOLDENER HECHT
ZONE
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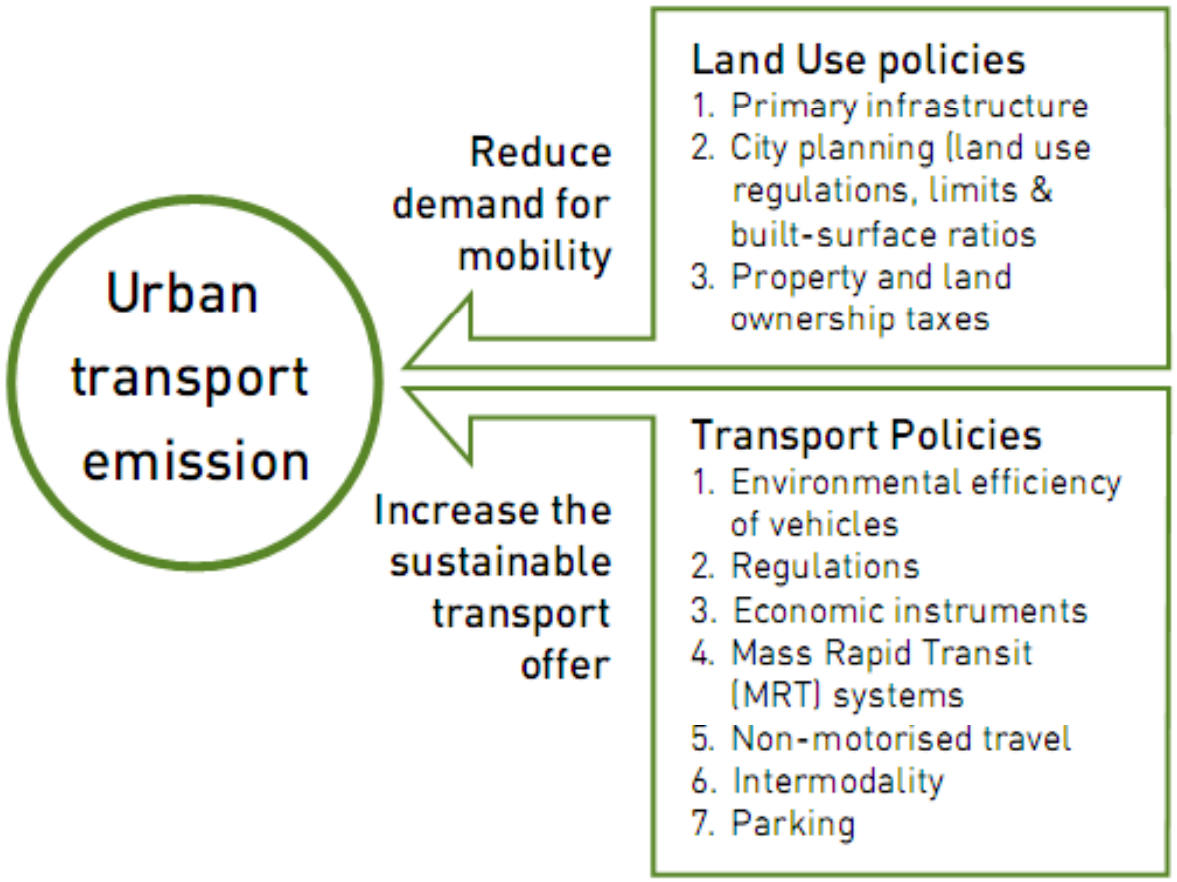
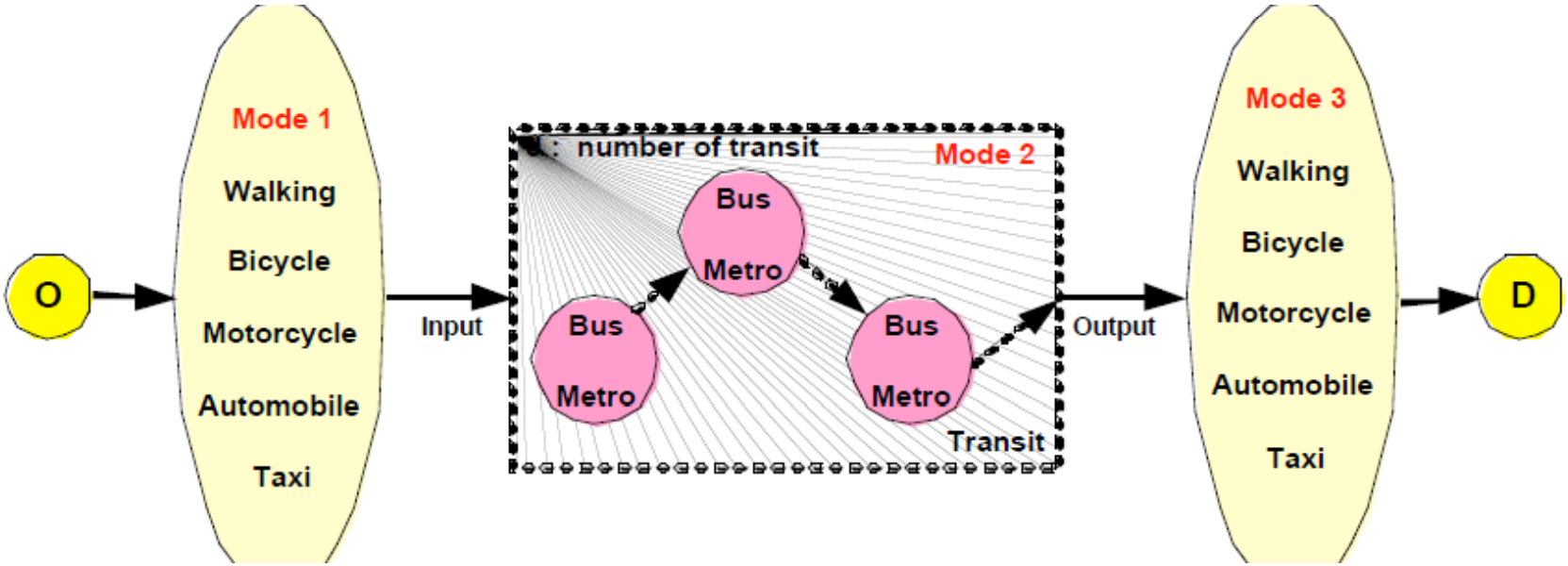


- Correct framing of Policy could pave a identified path to monitor transport carbon footprint and hence sequester it effectively

- It could also help in expanding and redesigning future cities

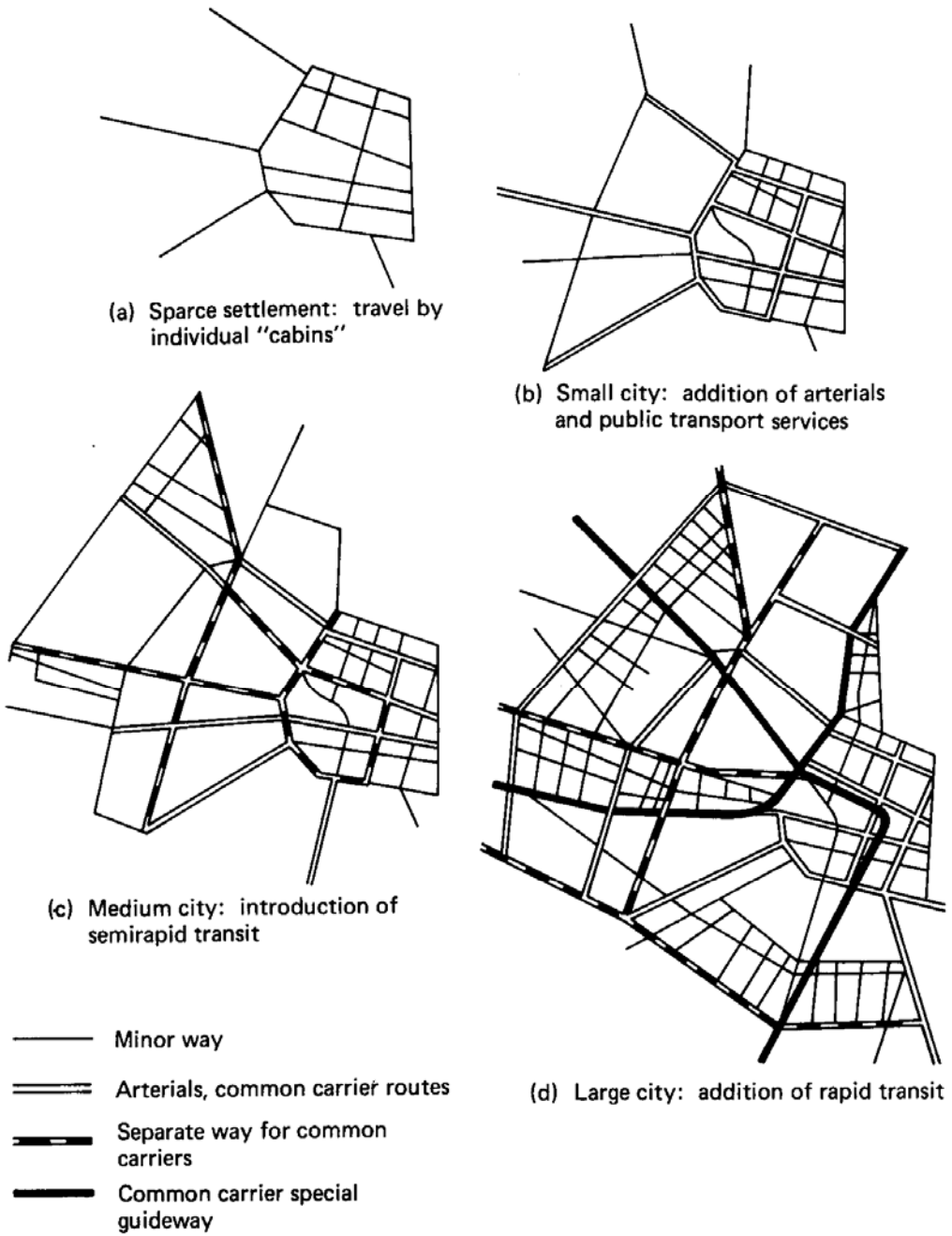
The Figure shows urban passenger transport emission reducing policies

An Inter-modal Trip

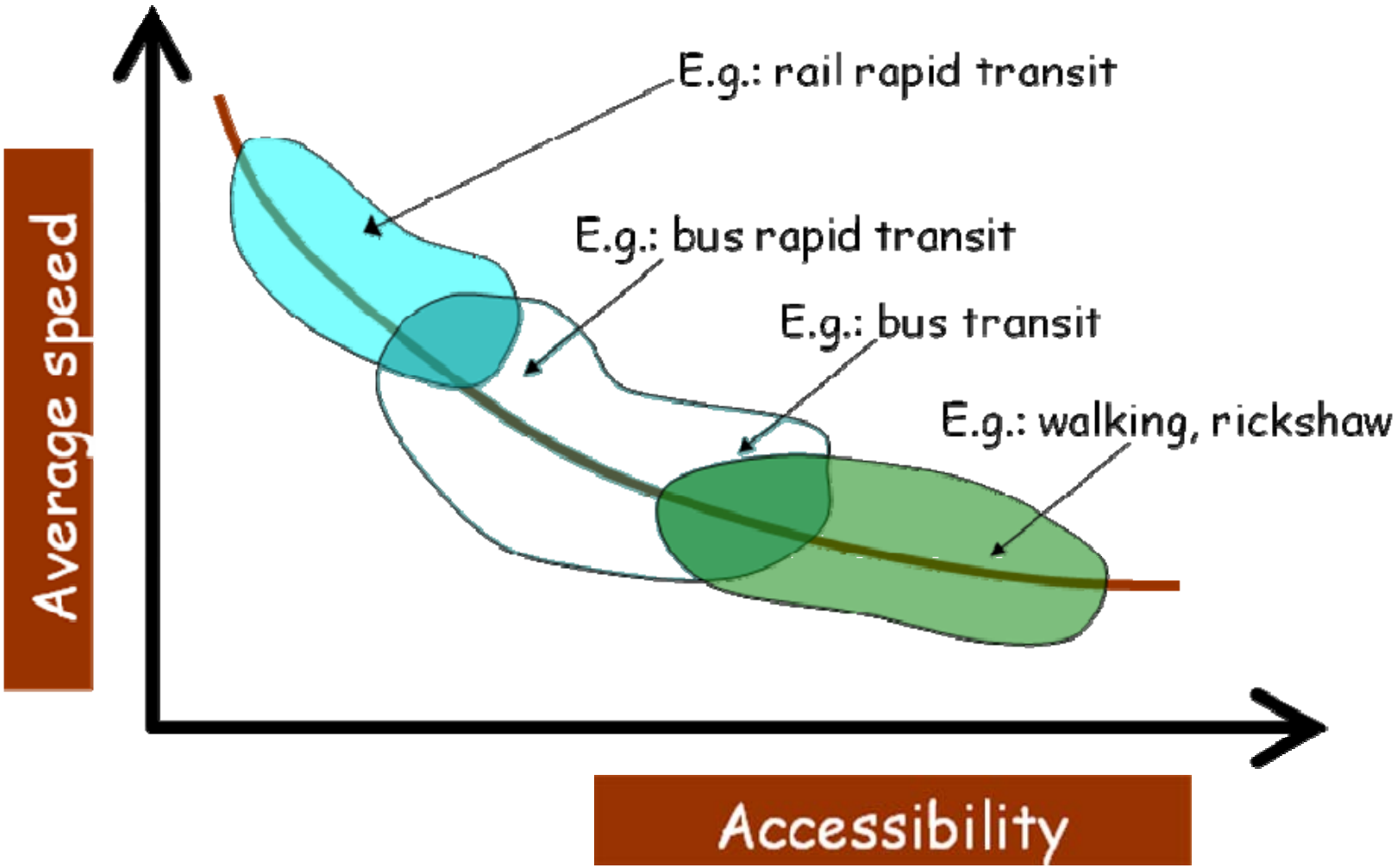


- it is important that we consider various scenarios consisting of combination of different modes and infrastructure options and adopt the one that is most sustainable in terms of both mobility/accessibility and safety.

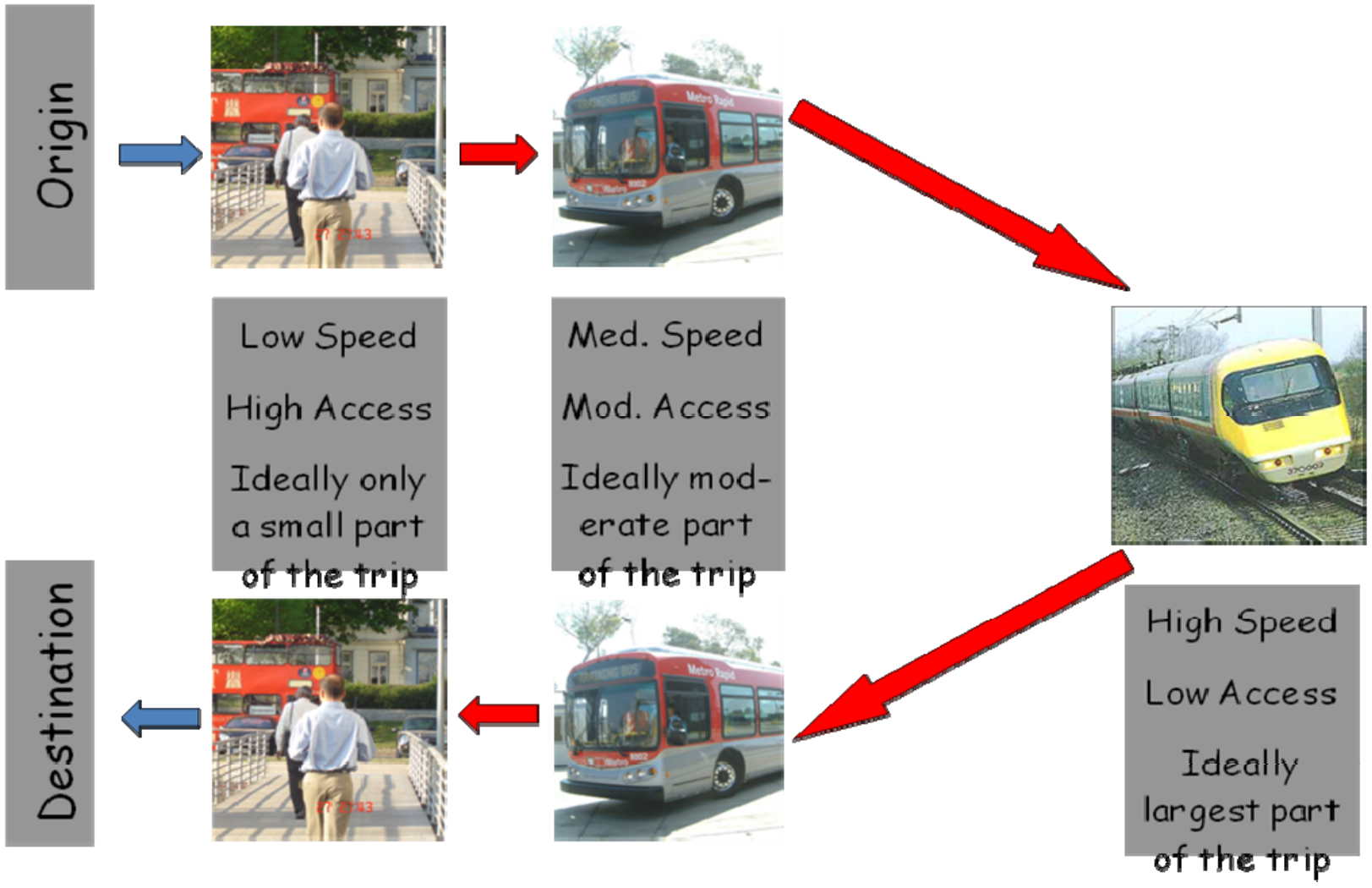
- Cities like, London, Zurich, Berlin, Paris, Munich, Hong-Kong, Bogota etc. provides good example of well integrated multi-modal transport system that provides seamless O-D connectivity through sustainable mode options



Transportation System Evolution with Urban Area Growth [Source: Vuchic (1981)]



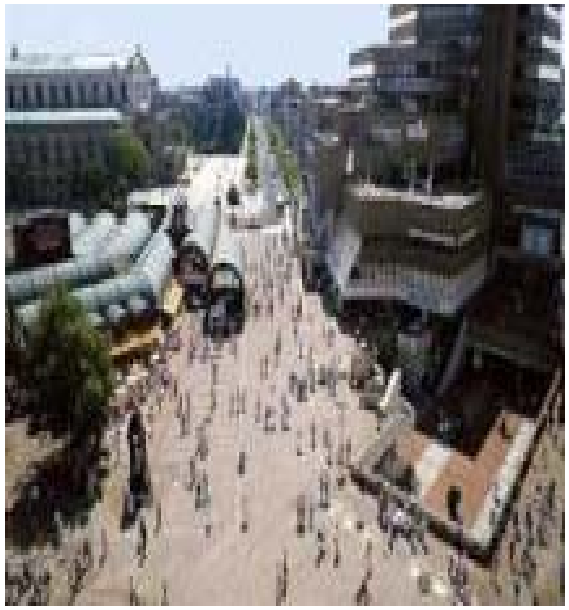
Mobility Vs. Accessibility for different Modes (Ref: Chakroborty, 2009)



Balancing Access and Speed (Ref: Chakroborty, 2009)

FIELD OF ACTION:: What can a local government do to reduce CO2

- **Residential development, Mobility in Proximity**
- **Public transit**
- **Street infrastructure, parking and transportation management**
- **Mobility management**



FIELD OF ACTION AS TAKEN IN GERMANY

- In light of above field of action, the following slides present a case study that highlights Strategic Transportation plan 2020 for the Region of Hanover/Germany (population 1 million), prepared by TU-Hamburg.

Field of Action: Residential development, Mobility in Proximity

- **Σ = -11% CO_2-reduction**

- **land use planning: Transportation-saving residential structures as a precondition for "Mobility in Proximity"**

- **Enhancement of bicycle Use and Walking**

Rental Bike System

Field of Action: Public Transit

- **Σ = -21% CO2-Reduction**
- **New lines (-1%), because of exellent existing system**
- **shorter headways (-3%)**
- **attractive fare system (-5%)**
- **Green Technology like Hybrid Vehicles (-12%)**

Field of Action: Street infrastructure, parking and transportation management

➢ Σ = -11% CO_2-reduction

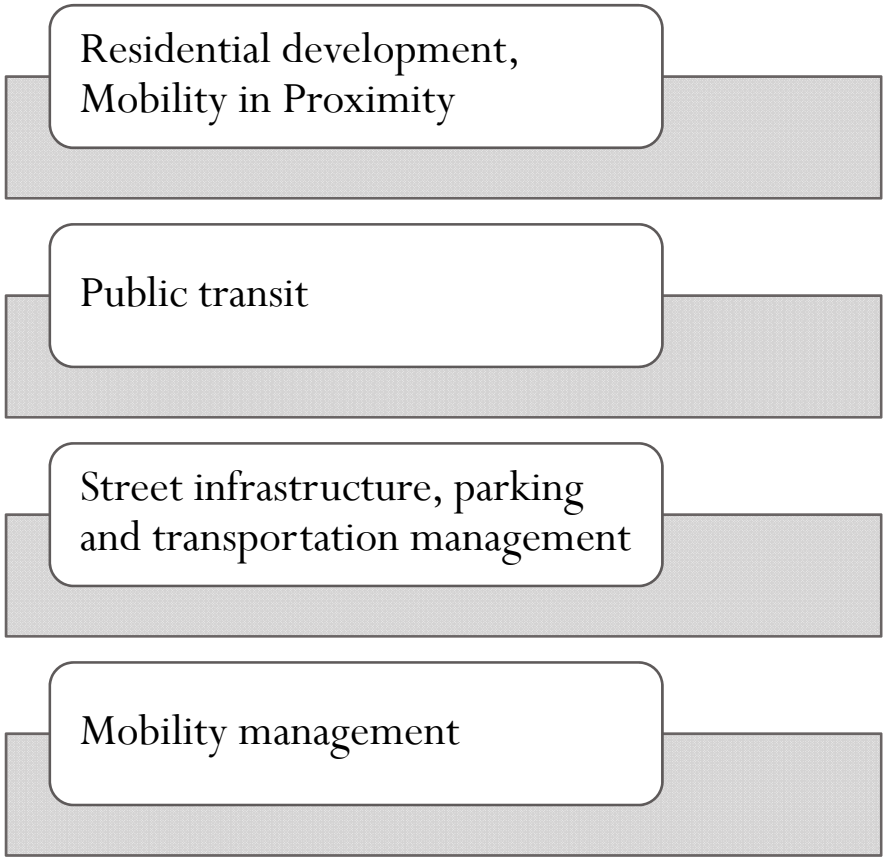
- **Improved Park+Ride System (-1%)**
- **Optimization of traffic lights (-3%)**
- **Introduction of 30,000 Electric Vehicles (-2%)**
- **Increase of Parking fees +1€ (-2%)**
- **Reduced speed limit (-3%)**

Field of Action: Mobility management, efficient vehicles

➢ **Σ = -8% CO_2-reduction**

- **Awareness Campaigns (-1%)**
- **Car Pooling etc. (-2%)**
- **Efficient driving (-5%)**
- **+2000 Car Sharing Cars (-1%)**

Summary of measures' impacts



If all measures would be applied the potenzial to reduce CO_2-Emissions of Road Transportation is - 45%

Comparison Annual CO_2-Emissions per person

Germany 2005: 13 metric tonnes

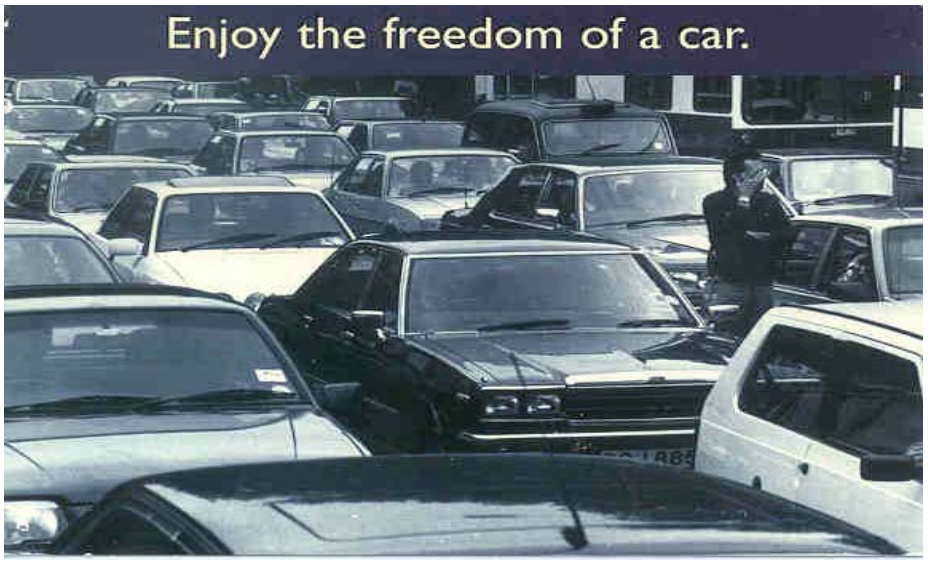
German Challenge: Dramatic Reduction of emissons necessary

Indian Challenge: Reduction of the increase of emissions necessary

To comply with the goal to reduce the worlwide heating to 2° Celsius, the average annual CO_2-Emission per person should not be bigger than approx. 2.4 metric tonnes per person until 2050

What can be learned from Countries that already experienced high car ownership rates?

Even the most car-oriented countries try to establish planning guidelines to reduce car use and try to enhance the use of alternative modes like bicycling.



The reason: planning that gives priority "only" to the car has not been successful in terms of sustainability.

Walking and Bicycle Integration with Transit

- Creating a walking influence zone around metro stations and create integrated and connected walking infrastructure. Develop social, cultural, or business hubs in the influence areas. It will promote both walking (as access/egress mode) and ridership on transit. For example, Bangalore metro network.
- Similarly, create cycling infrastrucutre around transit, particularly in sub-urban and residential areas, including park-and-ride at metro stations, bus stops etc.
- Cycle-on-transit to enable long distance travel using cycle.
- Pedestrianization of core city areas, while they are well served by Metro rail.
  - What are the hurdles?
  - Why not have occasional Car-free days to make people understand the benefits of pedestrianization?
- All this requires consideration and provision at the planning stage only.

Integration of Cycle Rickshaws, Battery Operated Vehicles With Transit and Policy Measures

- Cycle Rickshaws, battery operated vehicles like golf cart as feeder services in low demand or residential areas where running feeder buses is in-feasible. Provision of park-and-ride during planning stage of transit.
- Cycle Rickshaws and golf cart in congestion charging zones or on pedestrianized streets/zones.

Integration of Private Vehicles With Transit and Policy Measures

- Park-and-Ride facility at metro stations in sub-urban locations, so that people can travel even slightly longer distance from out-skirts areas to reach nearest metro station to park their vehicle and travel to city core by transit and thereby does not congest them by bringing cars all the way up to city centre.
- This will also complement policies like congestion charging, pedestrianization etc.

Specific Policy Strategies for Bangalore

While carrying out service and infrastructure improvements for an integrated public transport system in Bangalore, complimentary policy measures need to be introduced that can influence the mode choice behaviour of individuals towards public transport. Some such policy measures could be:-

a. A good Parking policy as a demand management measure rather than a supply side measure, including differential parking charges, strategizing the location (like park and ride) and availability of parking in such a way that, it discourages the use of personal vehicles in certain areas or during certain hours or days, and encourages use of public transport.

b. Creation of non-motorized transport (NMT) zones in CBD and other congested areas of Bangalore city.

c. Congestion charging for personal vehicles entering busy and congested areas during peak periods.

d. Giving priority to buses on corridors and at junctions.

e. Implementing CAR FREE DAY may be once or twice in a year to give a tangible feeling and understanding of what it means when streets are free of personal vehicles.

THANK YOU