CiSTUP

A Framework for Achieving Sustainable Urban Mobility

Prof. T. G. SITHARAM
Chairman, Centre for infrastructure, Sustainable Transport and Urban Planning (CiSTUP),
Indian Institute of Science, Bangalore – 560012
Email: sitharam@civil.iisc.ernet.in

Janmarg Ahmedabad, India
**URBAN MOBILITY**

- Traditional transport planning aims to improve mobility, especially for vehicles, and may fail to adequately consider wider impacts.
- The real purpose of transport is to provide access for the citizens to work, education, friends and family, and goods and services.
- A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable.
- Cities should improve the sustainability of their transport networks to create more vibrant, livable, sustainable cities.
Why Urban Mobility Matters?

- Citizens expect high levels of mobility.
- Sustainable urban mobility is essential for:
  - Guaranteeing citizens a high quality of accessibility and life
  - Facilitating economic development of cities, thus helping growth and employment
  - Respecting the environment and ensuring sustainable development
Congestion and Motorization – Sao Paulo, Brazil
Bangalore, India
Where’s this?

Seoul, South Korea the Cheonggye Cheong Expressway
- Centre of the CBD carrying 168,000 cars a day
- Replaced by public park and one way streets on either side and a BRT (Improved bus service)

Seoul city invested in public transportation, including creating bus-only lanes and pedestrian bridges, reforming parking policies, etc. Dr. Lee, Seoul embraced a “paradigm shift… from car to human-oriented street.”
**Growth of the Urban Population**

- The United Nations projected that more than half of the world's population would live in urban areas at the end of 2015.
- Urbanization will be mainly in less developed regions of the world; Very slow in the more developed regions.
- With an estimated population of 1.2 billion, India’s urban population is growing at >30%.

**More Mega Cities**

MegaCities Mean Huge Infrastructure and transport problems.
GROWTH OF URBAN REGIONS IN THE LAST HALF CENTURY

Figure 1 - Here the growth of the urban regions over half a century is depicted.
This map shows the geographic distribution of cities. It clearly shows that cities are concentrated in Europe, the eastern United States, Japan, China and India. It is a better map for showing the geography of night time electricity consumption for outdoor lighting than it is for showing the geography of population. For example: the eastern United States is very bright but the more densely populated areas of China and India are not nearly as bright in this image. NASA Image.
How many cities in India? The big picture

✓ About a quarter of India's population is urban
✓ Atleast 53 Indian cities have over million residents.
✓ 3 cities have > 10 million residents
✓ 5 more cities are becoming Mega cities
✓ 497 cities with > 100000 population

2011 Census data

Mega Cities Mean Huge Infrastructure and transport problems

Density of population – Mumbai, Kolkata, Chennai, Delhi, Bangalore, Hyderabad – higher density - 10000 people per sq km

Mass rapid transit system is very essential
INDIA – AUTOMOTIVE INDUSTRY

- Motor vehicles: 12 motor vehicles per 100 persons.
- In Automotive industry, India is one of the largest in the world and one of the fastest growing globally– Sale of cars 25 to 30% increasing every year
- India manufactures over 11 million 2 and 4-wheeled vehicles and exports about 1.5 million every year.
- Tata Motors began selling its cheapest car "one-lakh car" in March, 2009– will increase the car ownership- thought the Nano would expand the nation's car market by 65%
- In 2009, more than 2.6 million cars were sold in India (an increase of 26%),

<table>
<thead>
<tr>
<th>Number of cars sold</th>
<th>2300s t (1975)</th>
<th>26,00,000 (2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of car models</td>
<td>3 (1975)</td>
<td>50+ (2011)</td>
</tr>
</tbody>
</table>

| Price of Petrol | Rs 3.39 per liter (1975) | Rs 65 per liter (2011) |
CHALLENGES FACED BY CITIES

- **Congestion**
  - Increase of traffic in urban areas is causing congestion - this costs to citizens and businesses
  - Parking – Major problem – Portion of road is occupied by Parking

- **Energy consumption**
  - Urban mobility - faced by the domination of oil as a transport fuel.

- **Climate change**
  - Urban mobility accounts for 40% of all CO2 emissions of road transport.

- **Health issues**
  - towns and cities face increasing air pollution and noise problems, which impact on citizens health.

- **Safety and security**
  - road fatalities take place in urban areas - pedestrians and cyclists are the most vulnerable victims.
Impact of Global Economic Change

Urbanization, More cars & other vehicles, pollution, congestion, infrastructure development
Problems of Transport

- Increasing Traffic intensity
- Road Congestion
- Parking
- Accidents
- Increasing Traffic intensity
Other Urban Issues

- Urban Flooding
- Air Pollution
- Garbage Disposal
- Urban Sprawl
- Water
### Total Emission Load Tonnes Per Day
(source apportionment study for Bangalore, 2007)

<table>
<thead>
<tr>
<th>Source</th>
<th>PM$_{10}$</th>
<th>NO$_x$</th>
<th>SO$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>22.4</td>
<td>146.36</td>
<td>2.31</td>
</tr>
<tr>
<td>Road Dust</td>
<td>10.9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Domestic</td>
<td>1.8</td>
<td>2.73</td>
<td>0.68</td>
</tr>
<tr>
<td>DG Set</td>
<td>3.6</td>
<td>50.96</td>
<td>3.35</td>
</tr>
<tr>
<td>Industry</td>
<td>7.8</td>
<td>17.19</td>
<td>8.21</td>
</tr>
<tr>
<td>Hotel</td>
<td>0.1</td>
<td>0.2</td>
<td>0.02</td>
</tr>
<tr>
<td>Construction</td>
<td>7.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>54.4</td>
<td>217.4</td>
<td>14.6</td>
</tr>
</tbody>
</table>
The image contains a page from a document discussing urban mobility and its evolution, as well as the implications for megacities. The key points are as follows:

**MEGACITIES**

1. **POPULATION INCREASE**
2. **GROWTH**
3. **TRAFFIC DEMAND**
4. **POLLUTION**

Cities are locations having a high level of **accumulation** and **concentration** of economic activities and are complex spatial structures that are supported by transport systems.

**Urban Mobility and its Evolution**

- Collective Transportation (public transit)
- Individual Transportation
- Freight Transportation.

Urban mobility accounts for 40% of all CO2 emissions of road transport and up to 70% of other pollutants from transport.
Reasons for Unsustainable Transport

- Absence of a integrated city development strategies – Need for Integrated Metropolitan Land transport authority
- Unsustainable transport policies driven by meeting demand by creating additional infrastructures (construction of underpasses, flyovers, road widening works, etc.)
- Governance problems where politics won over technocratic advice.
- Ineffective Integrated transport planning and modal connectivity's
- Little data about the success or failure of implementation in achieving policy goals
Framework for Achieving Sustainable Urban Transport

- **Planning**
  - Vision for a livable city and city master plan
    - Land use planning
    - Transport master plan

- **Design Integrated Transport Systems**
  - Public transport – commuter rail, metro rail, mono rail, commuter rail, city buses, taxis, autos
  - Intermodal Transportation Hubs to connect different modes
  - Promotion of Walking and cycling
  - Private vehicles
  - Trucks and freight movement

- **Analyses**
  - Political
  - Economic
  - Social
  - Technical
  - Environmental

- **Implementation and Monitoring**
  - Technical support
  - Stakeholder involvement
  - Institutional setup
  - Capacity
  - Policies
  - Financing
NEW CULTURE FOR URBAN MOBILITY

● SMARTER URBAN TRANSPORT
  – Cyber communication, computation and sensing
  – Use of Cyber physical Systems in urban transportation system
    - Vehicles embeds electronic components and control systems to improve performance and safety - vehicle centric
  – High quality information with space and time along with scenario simulations for better mobility
  – Intelligent transport systems and traffic management
  – Smart charging/ fare collection

● ACCESSIBLE URBAN TRANSPORT
  – Collective transport accessible and affordable for all citizens
  – Interconnection of urban and sub-urban networks
  – Co-modality: optimization and integration of transport modes

● Better organized freight transport

● SHARED CARS / NMT POLICIES
  – Shared taxis/autos
  – Optimization of the use of private cars – car sharing/car pools
  – Promotion of walking and cycling

● SAFETY AND SECURITY IN URBAN TRANSPORT - CPS
  – Safer behaviour, infrastructures and vehicles
  – Cross-border enforcement of traffic sanctions
  – Facing security as a growing threat

● GREENER TOWNS AND CITIES
  – New technologies to increase energy efficiency - CPS, increased use of alternative fuels
  – Green procurement
  – Traffic restrictions and green zones
  – Eco-driving

● A NEW CULTURE FOR URBAN MOBILITY
  – ITS Supported by larger sensor networks for sensing, cyber communication data, and information, computation and simulation models for achieving better urban mobility
  – Change of behaviour by Education, training and awareness raising
Urban Mobility in India - Needs

- Increase average speed of public transport buses - Bus priority Lanes, Direction oriented services and BRT systems
- Transit planning / transportation hubs
- NMT policy and cycling routes (intermodal connectivity)
- Additional parking and development of parking policy
- Use of railways to move large section of urban population - Metro rail, mono rail and commuter rail services to suburban areas
- Use of ITS to optimize the services and occupancy of vehicles
- Strategies to handle Traffic chaos of heterogeneous mix of bullock carts to Volvo buses
- Need for integrated study for city’s traffic and transportation needs - Creation of Traffic Engineering Cell to collect necessary data
- Increase awareness about Safety on roads to common public
- Improvement of side walks - Integrating Hawkers and Vendors who have occupied the side walks
- Trees on Roads / pavements - for better visibility and mobility ??
- Driver education, safety and awareness programmes
The Relationship between the Urbanization and its Underground Space

Immediate underground level or sub-surface

EVERYTHING IS JUST BELOW THE ROAD!!

REF: International Tunnelling Association - Association Internationale des Travaux en Souterrain
The Relationship between the Urbanisation (city) and its Underground Space

Deep level or underground
The principal resources (potentials) of underground

Space - urban infrastructure development.
Energy - heating and cooling buildings
Ground water - drinking purposes
Geomaterials - used for construction purposes

Aerial view of Shinjuku, Tokyo
Near MG Road
Outskirts
Aerial View of Bangalore
Benefits of Underground

- Land use and location problems
- Isolation
- Safety – Earthquakes
- Environmental preservation

The Underground is Ideal for:

- Improving the environment
- Supporting Sustainable development

Develop Underground Space in Urban areas

TO PROTECT THE ENVIRONMENT

We need move from Urban Underground Space Use towards Urban Underground Space Development
The elevated highway structure will soon be replaced by approximately 30 acres of open space along the Artery corridor. Three quarters of the new corridor space will be designated as open space, with the rest planned for modest buildings. 250 acres in all will be reserved for parks and open space throughout the project area.
The « Central Artery » - Boston - USA
Underground Construction in Urban Areas - Bangalore

Every ring drilled in the Metro tunnel 60 feet below KG - TOI – Jan 22, 12
Rapid urbanisation - Bangalore

9 million already live in the city. An additional 200,000 people move into the metropolitan area each year.
Population will grow rapidly

- Within city population will remain stable.
- Growth mainly in the outskirts.

<table>
<thead>
<tr>
<th>Region</th>
<th>2011</th>
<th>2021</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within City</td>
<td>5143426</td>
<td>5356491</td>
<td>5356541</td>
</tr>
<tr>
<td>Extended BBMP</td>
<td>2710665</td>
<td>4882307</td>
<td>7938274</td>
</tr>
<tr>
<td>Rest of BMR</td>
<td>2964564</td>
<td>3647142</td>
<td>4518082</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10818655</td>
<td>13885941</td>
<td>17812897</td>
</tr>
</tbody>
</table>

Source: Wilbur Smith
Bangalore: Development of Vehicular Population

- Rapid growth of motorized vehicles.
- Increasing share of mot. vehicles
- Drastic extension of jams will be the result.

Source: Wilbur Smith
TRAVEL CHARACTERISTICS OF COMMUTERS USING 2-WHEELERS

- NEED FOR STUDY
  One of the main observations from vehicular growth trends in Bangalore is the tremendous use of 2-wheelers. Between 2005-2008 nearly 7.5 lakh new 2-wheelers were added. As per vehicle registration figures (2008), 2-wheelers account for 71% of the share.

- OBJECTIVE
  To understand the travel patterns of 2-wheeler users, their reasons for not using public transport and evaluate their willingness to shift towards public transport under pre-conditions.

- METHODOLOGY
  - Over 1000 surveys completed in different study zones

<table>
<thead>
<tr>
<th>Disadvantages of 2-wheeler Growth</th>
<th>User Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prone To More Accidents</td>
<td>Personal Freedom &amp; Flexibility</td>
</tr>
<tr>
<td>Higher GHG Emissions &amp; Pollution</td>
<td>Door-to-Door Connectivity</td>
</tr>
<tr>
<td>Traffic Congestion</td>
<td>Lesser Travel Time</td>
</tr>
<tr>
<td>Irregular Traffic &amp; Parking Problems</td>
<td>Economical for Short Distances</td>
</tr>
<tr>
<td></td>
<td>Comfort</td>
</tr>
</tbody>
</table>

Study area is divided into 23 zones

Random sampling method adopted - from each zone the minimum samples about 50

Data collection - COMPLETED

Analysis - UNDER PROGRESS

CiSTUP team: MANJULA ; assisted by Ashrita, Shruti ; Guided By: Prof. Ramanayya
### Actual Average Fuel Consumption (TW, Cars)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Total</th>
<th>km/Liter</th>
<th>Fuel consumption l/100km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scooters</td>
<td>35%</td>
<td>35</td>
<td>2,9</td>
</tr>
<tr>
<td>Motor Cycles</td>
<td>40%</td>
<td>50</td>
<td>2,0</td>
</tr>
<tr>
<td>Mopeds</td>
<td>35%</td>
<td>60</td>
<td>1,7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cars</th>
<th>Total</th>
<th>km/Liter</th>
<th>Petrol</th>
<th>Diesel</th>
<th>Fuel consumption l/100km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Cars</td>
<td>55%</td>
<td>16</td>
<td>35%</td>
<td>20%</td>
<td>6.3</td>
</tr>
<tr>
<td>Big Cars</td>
<td>30%</td>
<td>10</td>
<td>20%</td>
<td>10%</td>
<td>10.0</td>
</tr>
<tr>
<td>Others</td>
<td>15%</td>
<td>8</td>
<td>5%</td>
<td>10%</td>
<td>12.5</td>
</tr>
</tbody>
</table>

- Fuel consumption of TW is low: If change to car will happen, fuel consumption will increase.
- Fuel consumption for cars and trucks is higher as in Europe due to less restrictive regulations. This will lead to problems in the future, for the car owner as well as for the environment and public budget.

Source: CiSTUP
Trip lengths show typical structure for emerging cities

- Trip lengths are still beneath trip lengths in western megacities.
- The population growth in the outskirts will lead to increasing trip lengths.
- Average walking distance is high and will decrease in the future, dependent on individual motorization.

<table>
<thead>
<tr>
<th>Travel Mode</th>
<th>Average Trip Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>1.4</td>
</tr>
<tr>
<td>Bicycle</td>
<td>3.02</td>
</tr>
<tr>
<td>Auto rickshaw</td>
<td>5.90</td>
</tr>
<tr>
<td>Taxi</td>
<td>20.9</td>
</tr>
<tr>
<td>Two Wheeler</td>
<td>8.0</td>
</tr>
<tr>
<td>Car/Van /Jeep</td>
<td>9.1</td>
</tr>
<tr>
<td>Public Transport</td>
<td>10.8</td>
</tr>
</tbody>
</table>
Bangalore city has spatially developed in a concentric manner.

The economic activities have been growing at an unprecedented pace locating themselves in a sporadic manner with limited plan intervention covering an area of 1307 Sq. Kms.

### Table 1.8  Existing and Proposed Land Use for BMA

<table>
<thead>
<tr>
<th>Land Use</th>
<th>2003</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sq. Kms</td>
<td>% age distribution</td>
<td>Sq. Kms</td>
</tr>
<tr>
<td>Residential</td>
<td>159.76</td>
<td>37.91</td>
</tr>
<tr>
<td>Commercial</td>
<td>12.83</td>
<td>3.04</td>
</tr>
<tr>
<td>Industrial</td>
<td>58.83</td>
<td>13.96</td>
</tr>
<tr>
<td>Open spaces</td>
<td>13.10</td>
<td>3.11</td>
</tr>
<tr>
<td>Public &amp; Semi-public</td>
<td>46.56</td>
<td>11.05</td>
</tr>
<tr>
<td>Public Utilities</td>
<td>2.49</td>
<td>0.59</td>
</tr>
<tr>
<td>Offices and Services</td>
<td>4.27</td>
<td>1.01</td>
</tr>
<tr>
<td>Traffic &amp; Transportation</td>
<td>88.31</td>
<td>20.96</td>
</tr>
<tr>
<td>Un-classified</td>
<td>35.26</td>
<td>8.37</td>
</tr>
<tr>
<td>Total</td>
<td>421.41</td>
<td>100</td>
</tr>
<tr>
<td>Agriculture land</td>
<td>649.24</td>
<td></td>
</tr>
<tr>
<td>Lakes &amp; Tanks</td>
<td>39.02</td>
<td></td>
</tr>
<tr>
<td>Quarry</td>
<td>9.61</td>
<td></td>
</tr>
<tr>
<td>Vacant</td>
<td>187.72</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1307.00</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Revised Master Plan-2015
Urban Development and Hypergrowth

GROWTH
POLLUTION
POPULATION INCREASE
URBAN SPRAWL
TRAFFIC DEMAND
RISING COMFORT

Some major problems of cities:

✓ Separation of functions among urban bodies
✓ Increasing traffic demand
✓ High fossil energy consumption
✓ Unlimited population increase
✓ High-speed urban growth & sprawl
✓ Rising income & rising comfort

It’s necessary to enhance the mobility for our cities.
Transportation Systems in Bangalore

- **Vehicle Population:**
  - 3.89 million as on March 2010

<table>
<thead>
<tr>
<th>Travel Mode</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>34.0%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>4.5%</td>
</tr>
<tr>
<td>Taxi</td>
<td>0.5%</td>
</tr>
<tr>
<td>Auto</td>
<td>4.6%</td>
</tr>
<tr>
<td>Maxi Cab</td>
<td>0.5%</td>
</tr>
<tr>
<td>TW</td>
<td>21.4%</td>
</tr>
<tr>
<td>Car/Van</td>
<td>4.5%</td>
</tr>
<tr>
<td>PT</td>
<td>30.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

*Table 8: Shares of different traffic means 2009 (source: Wilbur Smith 2010)*

- **BMTC:**
  - Buses: 7000, Routes operated: 6000
  - Total Trip Lengths: 13 lakhs km
  - Total Trips: 80,000
  - Passengers carried: **4.2 million passengers/day.**
  - 583 city and 1785 sub urban routes, running 13 lakhs kilometers and making 76266 trips

- **Metro Rail:** about 8 km is in operation
  - 42 Kms under construction at the cost of Rs 11000 Crores.
  - Estimated passengers per day: 16.1 lakh (2021)

- **Mono Rail:** Feasibility study - 54.2 Kms

- **Commuter rail:** Under discussion with Indian railways

- Number of Auto rickshaw’s - about 100,000
- Radio taxis / cabs
- Car Pool / Car Sharing [http://www.carpooling.in/city/Bangalore](http://www.carpooling.in/city/Bangalore)
- [http://www.commuteeasy.com](http://www.commuteeasy.com)
- Shared Taxis/ Autos

- One of the few public sector undertakings (public transport) which is making profits

- Figure 24: Bus fleet development of BMTC
Facilities at BMTC’s T T M Cs

- **Bus terminal**
  - Bus bays
  - Platforms
  - Seating & lighting
  - Public conveniences
  - Information systems
  - Safety and security

- **Bus maintenance depot**
  - Maintenance bays,
  - washing platform
  - Bus parking
  - Services and Utilities
  - Fuel filling station
  - Amenities for crew

- **Passenger amenities**
  - Bangalore One centers
  - Other citizen amenity centers
  - ATMs
  - Daily needs shopping

- **Park and Ride facilities**
Direction-based bus services
along with significant fleet expansion
STUDY OF BUS STOPS AND BUS BAYS IN BANGALORE CITY

- **OBJECTIVES**
  - Where are the bus stops?
  - What is the present status?
  - Integration with para-transit modes
  - Appropriateness of location relative to surrounding uses/activity centers/ junctions
  - Scientific design

- **Works & Findings**
  - 6108 buses, traveling 13,04,000 km
  - 5886 schedules, 78616 trips
  - 4.2M commuters, 3.5 crore daily revenue
  - 35 depot, 47 stations
  - 583 city routes, 1785 sub-urban routes, over
  - > 2300 bus stops, status not known
  - Survey of 165 stops carried out, spatially marked, photographs taken
  - Not for physically disabled and for 60+

CiSTUP study By: GURURAJA, DEEPAK; assisted by Dilip, Jay
BRT - URBAN BUS TRANSPORT IS IMPORTANT AND HAS TO BE TRANSFORMED TO A LEVEL THAT IT CAN BE SOLD TO PUBLIC AS A “BRANDED PRODUCT”

- Hebbal to Bannerghatta Road along eastern crescent of outer ring road (33.0 km)
- Benniganahalli (ORR) to PRR along old Madras Road (7.0 km)
- From ORR to Hosur Rd along Hi-tech Corridor (8.0 km)
- Hosur Road to Tumkur Road along PRR (western part) (41.0 km)

BRTS - With dedicated infrastructure along the route, specialized vehicles, dedicated road width for Buses – Real time traffic information to public can be delivered

AIM TO REPLICATE DELHI METRO EXPERIENCE ON THE URBAN BUSES
STUDY OF AUTORICKSHAW SERVICE SYSTEM IN BANGALORE

NEED FOR STUDY

PARA-TRANSIT SYSTEMS
Autos and Taxis; Informal Public Transport – Matadors, Tempos, etc

PRIVATE TRANSPORT
2-wheelers, Cars

Growing public frustration regarding the service!
Integral part of a city’s transport system - needs to be streamlined and incorporated!

OBJECTIVE

To assess the system of autorickshaw services in Bangalore, identify key areas/ issues for improvement and put forward some suggestions/

CiSTUP study By: FAGUN, RADHA ; assisted by Shreyas, Arjun, Arshita & Shruti
STUDY OF AUTORICKSHAW SERVICE SYSTEM IN BANGALORE

Works & Findings
Primary Surveys, Interviews and consolidation of information from the Literature Review/Secondary Data, is in progress…
Presented here is not the final analysis or conclusions, but the consolidated findings of information being collected/collected so far.

AUTO NUMBERS
- Registered and Actual Numbers – number of new autos sold per month in city
- Nature of illegal auto operations
- Regulations regarding green tax and scrapping old vehicles over 15 years old

VEHICLE DESIGN & TECHNOLOGY
- Regulations regarding vehicle design and technology, environmental and noise pollution, safety norms, etc.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Responses</th>
<th>Summary/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Drivers</td>
<td>Number varies from 0.8 to 2 lakhs</td>
<td>Responses differ considerably from person to person</td>
</tr>
<tr>
<td></td>
<td>In their perception about 30-50% autos are illegal</td>
<td>Many auto drivers think there are enough or more than required autos in the city</td>
</tr>
<tr>
<td>Manufacturers</td>
<td>About 1 lakh autos, of which 20-25,000 are illegal (25%)</td>
<td>Figures from Transport Dept. GoK Jan 2007: close to 92,000 autos registered and kept for use</td>
</tr>
<tr>
<td>Easy Auto</td>
<td>About 3 lakh on Bangalore’s roads (!!!)</td>
<td></td>
</tr>
</tbody>
</table>

CiSTUP study by: FAGUN, RADHA; assisted by Shreyas, Arjun, Arshita & Shruti
India’s first Traffic Management Centre

Bangalore Traffic Improvement Project-B-TRAC 2010

**B-TRAC 2010:** This 5-year programme will cost about Rs. 350 crores. For the financial year 2007-08, 2008-09 and 2009-10, the Government has released Rs. 44 crores, 35 crores and 40 crores respectively. In the year 2010-11, Rs. 5 crores is planned to be released. The implementation will be done by the Govt. owned Karnataka Road Development Corporation (KRDCL).
Traffic Management Centre in Bangalore

- Traffic management centre
  - 330 signals operational in the city of Bangalore – vehicle actuated signals, direction boards, pedestrian components, disable friendly auditory signals.
  - All of the signals are centrally controlled from traffic management centre (TMC) with IP based network
  - Optimization of timing of signals and pattern
  - Surveillance cameras and enforcement cameras
  - Real time traffic information to public
  - Parking information system

- Traffic helpline

- A High end software application ‘Traffic Silverlight’ provides sophisticated GUI for monitoring and managing signals.

- Signal timings can be changed from the Traffic Management Centre as and when desired.

- Virtual loops with the help of CCTV cameras are also used for traffic control and monitoring.

- Moving enforcement /Surveillance
Emergency service

• GVK EMRI handles medical, police and fire emergencies through the "1-0-8 Emergency service".

• This is a free service delivered through state-of-art emergency call response centres and has over 2858 ambulances across Andhra Pradesh, Gujarat, Uttarakhand, Goa, Tamil Nadu, Karnataka, Assam, Meghalaya, Madhya Pradesh, Himachal Pradesh and Chhattisgarh.

Opportunities for Emergency Vehicle Preemption in Bangalore: A case study

Dheep Kadambi, Deepak Baisah and T. G. Sitharam

A system that can allow the clearing of an intersection for Emergency Vehicles (EVs) to pass and to give right of way to an EV through an automated system integrating the Intelligent Transportation System (ITS) with the EV operations.
Bangalore Transport Information System

http://www.btis.info

TRAFFIC · DIRECTIONS · BUSES · FINES · RTO · AIRPORT · PUBLIC OFFICES · SAFETY · PARKING · TOURISM · METRO · CARPOOL · INDIBUS · TRACK YOUR FLEET

Dr. Ashwin Mahesh – CISTUP fellow
Bangalore Metro

- I Phase (2 corridors double lines) covers ~42.30 km
- N-S corridor will be 24.2 km
- The E-W corridor will be 18.10 km.
- Of the 42.3 km, 8.82 km will be **Underground** near City Centre & Railway Station and the rest will be elevated.
The Bangalore Elevated Tollway is a 9.985 kilometers (6.204 mi) long elevated, tolled, access-controlled expressway outside Central Silk Board at the Junction of Hosur Road with Outer Ring Road.

Bangalore – Mysore Infrastructure Corridor (BMIC) also called NICE road is a 4 to 6 lane private tolled expressway.

The Bangalore-Nelamangala expressway 19.5 km stretch, 4.3 km is fourlane elevated highway.

Elevated road to BIA in the making
Major road widening project around Bangalore - executed by the state PWD with a cost of about Rs 684 crores.

- a total of 39 key roads (884 kms) were widened.

ROAD NETWORK IN AND AROUND BANGALORE
Many cities have developed variations around the general approach of **Bus Rapid Transport (BRT)**. The concept of a **Bus Priority System (BPS)** is a collection of some (not all) of the practices from BRT to result in improved bus services and better performance.

- **Objective**
  - A pilot study for BPS on Old Madras Road

**BUS PRIORITY SYSTEM – Pilot Project**

**Dedicated bus lanes to be tested on old Airport Road**

CiSTUP study jointly with PRAJA
Project Features:

- Creation of the brand for the system which will lead to uniform expansion
- Working out details of cycle and station design to balance cost, durability and user friendliness
- Determining the operational details, maintenance and redistribution processes
- Designing, deploying and field-testing the technology required for system
- Rental process - mobile technology can aid these efforts

CiSTUP study jointly with PRAJA
An effort towards improved mobility in Bangalore

- Road Design
- Footpath Budget in BBMP
- Metro Zone
- Commuter Rail
- Transport Policy
- Junction improvements – BBMP and PPP projects
- Non-motorised transport – DULT
- Electric car

Ducting utilities on 14 arterial roads
A dedicated budget for footpaths
Metro-Zone footpaths – 30km this year

18th October 2011 at three locations in the CBD (Central Business District)

Figure 22: REVA electric car

Junction redesign
Real-time traffic information system

- Global Positioning Systems
- Weather information systems
- Bus Information System
- Airport arrivals/departures
- Metro Stations, Arrivals, Departures
- Trains – Stations, Arrivals, Departures
- Traffic and transit management
- Parking
- Incident management
- Emergency management
- Electronic toll collection
- Commercial vehicle operations

- Vehicular communication system

Integrating all the information and deliver it to public through PIS (mobiles, smart phones, TV, Radio, etc.)
SOLUTION TO TRAFFIC PROBLEM

- Improved Mobility of 'People' rather than 'Automobiles' should be the principle to reduce the traffic problem in the city.
- “Excellent Public transport is the only the solution for decongesting the traffic in cities. Thus the goal shall be to increase the modal share of public transport system to 70% or double it by 2020”
Challenges Facing Urban Transportation

- Traffic congestion and parking difficulties
- Longer commuting
- Public transport inadequacy
- Difficulties for non-motorized transport
- Loss of public space
- Environmental impacts and energy consumption
- Accidents and safety
- Land consumption
- Freight distribution
DISCUSSION ITEMS: SUGGESTIONS TO IMPROVE THE URBAN MOBILITY

1. Improvement in footpaths
   - Integrated footpaths as per IRC recommendations
   - Obstructions of all kinds to be removed
   - Even in side roads, footpaths needs to be clearly demarcated and marked
   - OFC ducts for taking all the cables, electric wires, etc.
   - Pedestrian crossings – selection of location and appropriate marking needs to be done

2. Pavements
   - Pothole free pavements – new technologies needs to be adopted for smooth roads which increases the average speed of the vehicle
   - Pruning of trees which spread to the width of pavements – particularly on bus routes
   - Rainwater harvesting on the stretches where it is prone to flooding. – rainwater harvesting can be done below the road pavements
   - Milling of old pavement before laying new bitumen pavements needs to be recommended
   - Integrated road development (including road widening works) shall cover footpaths and it shall be part of the tender.
   - All the animals shall not be allowed on major urban roads (dogs, cattle, pigs, horses, etc.)

3. PUBLIC TRANSPORT – BUSES- BMTC
   - Creation of bus bays, Marking of bus stops, display of bus routes, information to passengers regarding frequency of buses and bus routes at each bus stops
   - Passenger information system
   - Pruning of trees for easy movement of buses on both lanes in different bus routes – BMTC shall create a separate team within their organization
   - Use of feeder buses in many residential areas (removal of long / conventional buses from the existing routes)
   - Development of direction orientated bus network like big circle, big10, etc. - hub and spoke model for bus transport system

4. Cycle paths
   - Development of integrated cycle paths and marking for cycle lanes wherever possible
   - Encourage cycle users by tax breaks
   - Creation of Rental bicycle system

5. autos
   - Conversion of all two stroke to four stroke autos
   - Registrations – free market, separate RTO for autos in the city for better control
   - Installation of GPS in autos
   - Clear marking of auto stands
   - Green autos – autos with LPG and CNG, electric autos
   - Complaint centre and encouragement for Autos association to get together on the format of “easy auto” for web booking and their availability through phones

6. METRO – BMRCL
   - Integration with other modes
   - Development of footpaths around metro stations

7. COMMUTER RAIL
   - Development of commuter rail services with more numbers of stations, higher frequency towards Ramanagar, tumkur, doddaballapura, chikaaballapura, hosur, whitefield, anekal – doubling of lines, EMU’s, AC cars, additional stations, higher...
Other measures

- **LONG DISTANCE TRAINS**
  - Develop final destination points At the outskirt of the city like beyond Yeshavantapur, Yelahanka, biappannahalli, kengeri, etc

- **OUT STATION BUSES (KSRTC, NWRTC, NERTC, OTHER STATE GOCT BUSES, PRIVATE)**
  - Develop large terminals in each direction like mysore (OTISDE CBD AREA) and integrate with metro, city buses, TTMC’s, autos, taxi cabs, etc.

- Taxi care cab systems – call taxis with GPS, receipts in the car like meru taxis within the city along with taxi stands

- **Reduce Travel Demand, Bring Destinations Closer and Improve Accessibility**

- Hierarchies – integrate the planning and design of Road Networks with Public Transportation Systems and the distribution of Land Uses and Densities. Establish well-formed road network hierarchies based on functional characteristics.

- Improve public open spaces in conjunction with public transport systems to transform the quality of life and experience of the city

- Discourage private motorized vehicle use through transport demand management measures like parking policies, congestion charging, higher taxes and fuel costs, etc. Encourage car pooling, prioritize HOV (high-occupancy vehicle and bus) lanes, explore innovative means of incentivizing public transport like discounts and subsidies

- **Use of ICT (information and communication technology) for efficient traffic management and operation services, passenger information systems, electronic payment services, road transport-related personal safety services, weather and environmental conditions monitoring services, disaster response management and co-ordination services, etc.**

- Cleaner, greener, more efficient fuels, vehicle design and technology – with a focus on fuel efficiency leading to lower air pollution and GHG emissions, alternate less polluting fuels (gas/electricity) based on renewable resources.
SUSTAINABLE Urban Transport

- Walking and biking
- Public transport –
  - rail and road based
- Transit oriented development
- Demand management
- Safety
- Environmental friendly –
  - alternative fuels,
  - hybrid vehicles, etc
Thank You for your attention !!!

Visit us at: http://cistup.iisc.ernet.in/