Overview of Planning and designing for sustainable urban transport systems and services

30th October - 2017

Prof. Sanjay Gupta, Ph. D
Head, Transport Planning Department
School of Planning and Architecture
( an institute of National Importance by Act of Parliament)
New Delhi, India
Importance of Urban Transport

- Urban transport is probably the most important single component instrumental in shaping urban development and urban living (NCU).
- The urban form and structure affects the need for and selection of appropriate transport systems.

![Diagram showing the relationship between transportation, activity patterns, accessibility, and land use.](image_url)
India’s Urbanization Pattern

- India’s population size of 1.21 billion (2011)
- 2nd largest country after China (19.4%) followed by USA (4.5%)
- Urban population of 377 million (2011) with 30% share
- Presently there are 8000 towns and cities
- 468 Class I towns (0.1 million plus size) account for 70% of urban population

- 53 million plus size cities (43%)
  - 3 megacities (10 million plus size)
  - 5 cities between 5-10 million size
  - 2 cities between 3-5 millions
  - 43 cities between 1-3 million

- Urban population set to rise to 814 million by 2050
Motorisation Trends in India

Vehicles Growth in India, 1951-2011 (in Millions)

- Two Wheelers
- Cars, Jeeps and Taxis
- Buses
- Goods Vehicles
- Others

Two wheelers account for 72% share

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Two Wheelers</td>
<td>28.64</td>
<td>31.33</td>
<td>34.12</td>
<td>38.56</td>
<td>41.58</td>
<td>47.52</td>
<td>51.92</td>
<td>58.80</td>
<td>64.74</td>
<td>69.13</td>
<td>75.34</td>
<td>82.40</td>
<td>91.60</td>
<td>101.87</td>
<td>115.42</td>
</tr>
<tr>
<td>Cars, Jeeps and Taxis</td>
<td>5.14</td>
<td>5.56</td>
<td>6.14</td>
<td>7.06</td>
<td>7.61</td>
<td>8.60</td>
<td>9.45</td>
<td>10.32</td>
<td>11.53</td>
<td>12.65</td>
<td>13.95</td>
<td>15.31</td>
<td>17.11</td>
<td>19.23</td>
<td>21.57</td>
</tr>
<tr>
<td>Buses</td>
<td>0.54</td>
<td>0.54</td>
<td>0.56</td>
<td>0.63</td>
<td>0.64</td>
<td>0.72</td>
<td>0.77</td>
<td>0.89</td>
<td>0.99</td>
<td>1.35</td>
<td>1.43</td>
<td>1.49</td>
<td>1.53</td>
<td>1.60</td>
<td>1.68</td>
</tr>
<tr>
<td>Goods Vehicles</td>
<td>2.54</td>
<td>2.55</td>
<td>2.72</td>
<td>2.95</td>
<td>2.97</td>
<td>3.49</td>
<td>3.75</td>
<td>4.03</td>
<td>4.44</td>
<td>5.12</td>
<td>5.60</td>
<td>6.04</td>
<td>6.43</td>
<td>7.06</td>
<td>7.66</td>
</tr>
<tr>
<td>All Vehicles</td>
<td>41.37</td>
<td>44.88</td>
<td>48.86</td>
<td>54.99</td>
<td>58.92</td>
<td>67.01</td>
<td>72.72</td>
<td>81.50</td>
<td>89.62</td>
<td>96.71</td>
<td>105.35</td>
<td>114.95</td>
<td>127.75</td>
<td>141.87</td>
<td>159.49</td>
</tr>
</tbody>
</table>

Source: Ministry of Road Transport and Highway 2015; Wilbur Smith 2008
### Urban Sprawl Trends in Mega Cities

**City Parameters**

<table>
<thead>
<tr>
<th>City Parameters</th>
<th>Hyderabad</th>
<th>Bangalore</th>
<th>Ahmedabad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Density (Urban Built in Persons/Sq.km)</td>
<td>10,526</td>
<td>9,378</td>
<td>17,441</td>
</tr>
<tr>
<td>Population Density (Urban Sprawl in Persons/Sq.km)</td>
<td>6,265</td>
<td>5,869</td>
<td>15,574</td>
</tr>
<tr>
<td>Compactness Index</td>
<td>0.60</td>
<td>0.63</td>
<td>0.90</td>
</tr>
<tr>
<td>Public Transport Use</td>
<td>48%</td>
<td>51%</td>
<td>24%</td>
</tr>
<tr>
<td>NMV Use</td>
<td>21%</td>
<td>24%</td>
<td>32%</td>
</tr>
<tr>
<td>Trip Length (Total) km</td>
<td>10.5</td>
<td>11</td>
<td>5.7</td>
</tr>
<tr>
<td>Vehicle km/capita</td>
<td>10.81</td>
<td>8.90</td>
<td>6.4</td>
</tr>
<tr>
<td>Population (Million)</td>
<td>8.5</td>
<td>8.5</td>
<td>6.0</td>
</tr>
</tbody>
</table>
Urban Density Patterns and Impact on Vehicle ownerships

- US cities
- EU cities
- Developed Asian
- Developing Asian

\[ y = -177.06 \ln(x) + 1111.2 \]

\[ R^2 = 0.7643 \]

- Urbanized density: key factor for car ownership rate!
- Importance of urban form!

Source: Literature Review

Dr Sanjay Gupta, SPA
Travel Patterns of Indian Cities

- **Cycle trips** are higher in medium towns
- **Public Transport** share is higher in mega cities
- **Two wheeler** trips are higher in medium towns

- Trip rate increases with city size.

- Trip length increases with the city

- Vehicular concentration increases with city size

**Travel demand grown faster than population**

11/15/2017

Dr Sanjay Gupta, SPA

Source: Wilbur Smith study 2007
Perspectives of Urban Transport Challenges

- **Growing Economy**
  - Increased Car Ownership
  - Increased Traffic Volumes
  - Increased congestion

- **Urban Sprawl**
  - More car dependency
  - Increased trip lengths
  - High costs for extending infrastructure and services

- **Climate Change**
  - Global warming
  - Higher emission levels
  - Air and noise pollution

- **Road Safety**
  - Increased speed
  - Increased conflicts among modes
  - Increased accidents and fatalities

- **Energy Consumption**
  - Transport consumes 30% of total energy
  - Increased demand for fossil fuel
  - Increased GHG emissions

To address the dynamic complexities of urban systems, a multi-disciplinary Planning Process is needed.

11/15/2017 Dr Sanjay Gupta, SPA
Urban Transport Issues

• Absence of Land use transport integration
• Inadequate public transport systems
• Inequities in delivery of transport services, for disadvantaged groups
• Inadequate attention to non- motorized transport (NMT’s)
• Inadequate attention to road safety
• Energy and environment related problems
• Multiplicity of authorities with no defined responsibilities and accountabilities, lack of coordination and absence of appropriate strategy
• Non availability of adequate financial resources
• lack of systematic traffic data and information
Urban Transport Planning Approaches

Traditional Approach

Automobile Approach

Known as

Sustainable Approach

Contemporary Approach
Definition

- Process seeking to satisfy or modify the demand for movement of people and goods by devising plans for the form and functioning of transport systems taking account of their impact on community.

Process

- A survey and analysis stage
  - establishes the present demand and develops relationships

- A prediction and plan formulation stage
  - projects the likely demand and puts forward transport proposals

- An evaluation stage
  - Assesses whether the proposals enhances safety, capacity and levels of service, and provide the maximum benefits to the community for minimum costs
Primary Surveys
1. Road Network Inventory
2. Speed and Delay Study
3. Classified Traffic Volume Survey
4. Origin and Destination Survey
5. Household Survey
6. Parking Survey
7. Public Transport System Study
8. Terminal Studies
9. Intersection Studies

Secondary Data
1. Physical and Land Use Characteristics
2. Demographic and Socio-Economic Characteristics
3. Transport System Characteristics
4. Past relevant data, reports, plans etc.

11/15/2017 Dr Sanjay Gupta, SPA
Family of Regular Transit modes

- Rail Rapid Transit
- Light Rail
- Fixed Route Bus

- Jitney
- / RTV

- Van Pool
- Subscription Bus
- Car Pool

- Taxi
- Auto rickshaws
- Cycle Rickshaw
- Dial-a-ride
- Auto Rental

Dr. Sanjay Gupta, SPA

Date: 11/15/2017
• City size, form and structure
• Travel Demand along corridor (phpdt)
  upto 5000 : Standard bus
  5000-15000 : Standard bus with exclusive lane/ETB/Trams
  15,000-25,000 : BRT/Mono Rail
  20,000-30,000 : Light Rail Transit
  30,000 + : Elevated BRTS
  30,000-80,000 : Heavy Rail

• Costs constraints and construction time

• Flexibility of expansion/upgradation in future
Sustainable Development and Sustainable Transport

**Sustainable Development**

- Livable Cities and Communication
- Better quality of life for all members of society
- Eco-development combined with sustainable transport system bringing economic growth
- Social inclusion bringing economic prosperity
- Business Practices with environ impacts

**Environment**

- Long Term Environ Practices

**Economy**

- Sustainable Transport: Efficient, Equitable and Environmentally friendly transport

11/15/2017 Dr Sanjay Gupta, SPA
## Principles for Transport in Urban Life

1. **Walk the walk**  
   Create great pedestrian environment

2. **Powered by people**  
   Create great environ for cycle and NMT

3. **Get on the bus**  
   Provide great cost effective PT

4. **Cruise control**  
   Provide access for clean part vehicle at safe speeds and insignificantly reduced nos.

5. **Deliver the goods**  
   Service the city in cleanest and safest manner

6. **Mix it up**  
   Mix people, buildings and spaces

7. **Fill it in**  
   Build dense people and transit oriented urban districts that are desirable

8. **Get real**  
   Preserve and enhance local natured cultural, social and historical assets

9. **Connect the Blocks**  
   Make trips more direct, interesting and productive with small size permeable buildings and block to.

10. **Make it last**  
    Build for long term (Sustainable cities bridge generation,
A sustainable transport system is one that:

• allows the **basic access needs of individuals and societies** to be met safely and in a manner **consistent with human and ecosystem health**, and with equity within and between generations.

• is **affordable, operates efficiently, offers choices** of transport mode, and **supports a vibrant economy**.

• **limits emissions and waste** within the planet’s ability to absorb them, **minimizes consumption of non-renewable resources**, **limits consumption of renewable resources** to the sustainable yield level, **reuses and recycles** its components, and **minimizes the use of land**.

*Source: TDM Encyclopedia, Victoria Transport Policy Institute*  
*http://www.vtpi.org/tdm/tdm67.htm*
Performance measures

- Transit Accessibility
- Cycle and Pedestrian modal share
- Vehicle miles per capita
- Carbon intensity
- Mixed land use
- Transportation affordability
- Benefits by income groups
- Land consumption
- Cycle and pedestrian safety
- Average vehicle occupancy
- Transit productivity
**Avoid Strategies**

- Integrated Landuse and Transport
- Mixed Use Development
- Information and Communication Technology

**Shift Strategies**

- Non Motorized Transport
- Public Transport
- Transportation Demand Management

**Improve Strategies**

- Cleaner Fuels and Technologies
- Inspection and Maintenance
- Intelligent Transportation System

Source: GIZ
Concept of Travel Demand Management

- It is the use of policies, programs, services and products to influence whether, why, when, where and how people travel.
- It is the implementation of programmes of measures which seek to change travel demand patterns by:
  - Trip reduction
  - Reduction in vehicle use
  - Increase in vehicle occupancy
  - Increased travel by alternative modes
  - Trip retiming
  - Offering alternative destinations
  - Reduction in trip length
Bicycles - Environment Friendly Transport Modes

Bike Sharing Systems

System for Bike Sharing

Cycle sharing system to encourage people to use cycles

Cycle sharing station: Card punching mechanism with route and station map

Cycle sharing stations are often placed near public transport systems to provide last-mile connectivity

Integrated system for bike sharing is connected through mobility cards

Bike Sharing, Santiago

Bus Rapid Transit (km)- 92
BRT Passengers /day- 50,000
Bike Share Stations- 175

Total Bike Share Bikes- 2600
Total Cyclist (per day) - 40,000
Cycling Infrastructure (km)- 36
Public Bike Sharing Guidelines

Key Imperatives

- A dense network of stations across the coverage area, with a spacing of approximately 300 m between stations
- Cycles with specially designed parts and sizes to discourage theft
- A fully automated locking system at stations that allows users to check cycles in or out without the need for staffing at the station
- Electronic tags to track where a cycle is picked up, the identity of the user, and the station where it is returned.
- Redistribution of cycles to ensure availability of cycles and empty docking points
- Real-time monitoring of station occupancy rates through information technology (IT) systems, used to guide the redistribution and provide user information through the web, mobile phones, etc.
- Pricing structures that incentivise short trips, helping to maximize the number of trips per cycle per day

Source: Public Bike Sharing System – A Planning toolkit for Indian Cities, MoUD, GoI (2012)
Cycle Rickshaws – Environment Friendly Transport Modes

Case Study: Eco Cabs, Fazilka (North India)

Innovative features

• Light Weight: Reduced to 65 kg instead of existing 90 kg
• More Luggage Space
• Better Safety: Reflectors
• Comfort for both commuter and traction men
• Facilities like Water Cooler, Magazine
• More advertisement space for more revenue
• Micro credit schemes
• Rickshaw drivers and the coordinator provided with digital communication services

11/15/2017 Dr Sanjay Gupta, SPA
Case Study: Eco Cabs, Fazilka

Operational Scheme

City divided into 9 zones. Each zone comprising 1km x 1km

- **Five Ecocab call centers** are established within the city mainly north, south, east, west and central to provide dial-a-rickshaw facility.

- Each centre is serving almost **1500 households**.

- Centers are strategically placed so that after a phone call **within 10 minutes** Ecocab shall reach to desired location.

- At present fleet of **500 registered traction** men are self employed under Fazilka Ecocab project.
Case Study: Eco Cabs, Fazilka

- Tea vendor acted as a coordinator, responsible for answering calls and dispatching rickshaws.
- BSNL sponsor all the calls under a closed user group scheme, where all the calls within the group are.

Communication System

How it works

1. Make a phone call
2. Ask for Ecocab
3. Message conveyed to Ecocab operator
4. Ecocab reaches home

Figures 8a, b: Fazilka Ecocabs- Dial-a-Rickshaw: How it works.
© Vedant S. Goyal, Original Source: Navdeep Asija
E- Rickshaws utilizes batteries as the sole source of power for vehicle movement and other auxiliary uses.

**Brief Characteristics in Delhi (2014)**
- Average passengers carried per Rickshaw = 60
- Average route length = 7 km
- Average round trips = 10
- Majority use for work and education
- Majority use as first/last mile mode
Electric Cars

A Battery Electric Vehicle is a vehicle that utilizes batteries as the sole source of power for vehicle movement and other auxiliary uses.
Suggested Transport Planning Strategies

1. Integrated Land use and transport strategy
   - TOD
2. Network Development and Mobility Corridor Strategy
3. Public Transport Strategy
   - Bus augmentation, MRTS
   - Intermodal Integration
4. Non Motorised Strategy
5. Freight Management Strategy
6. Parking Strategy
7. IPT Strategy
8. Traffic Management
9. Travel Demand Management Strategy
• Encourage movement of “people” rather than “vehicles”
• Ensure an integrated land use transport development in urban areas
• Ensure inclusive mobility environment
• Encourage environment friendly modes in urban areas including pedestrianisation
• Evolve transit systems based on urban form, city size and corridor travel demand which are economically and financially sustainable to operate
• Comprehensive Mobility Planning approach needs to be promoted