SUSTAINABLE TRANSPORT STRATEGIES: AN APPROACH TOWARDS LOW CARBON CITIES

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ABSTRACT

Rapidly growing urban population and changing morphologies of the urban settlements coupled with higher expectations of the global economy are placing unprecedented stress on the urban transportation system. A world class urban transportation which is innovative, effective, integrated, sustainable, intermodal, safer, secure, reliable and cost effective will improve the transportation scenario in cities dramatically. The developments of cities largely depend upon their physical, social and institutional infrastructure. In this context, the importance of intra-urban transportation is paramount. The aim of the study is to provide an overview of urban transport issues and strategies towards sustainable transport in India. The Paper first reviews the growth of urbanisation, vehicular growth and availability of transport infrastructure in Indian cities. These are followed by the nature and magnitude of urban transport problems such as congestion, pollution and road accidents and finally review the possible measures and strategies.

Key Words: Dynamics of urbanization, Urban transportation issues, Challenges, Sustainable strategies for urban transportation, Pollution

INTRODUCTION

Although circumstances differ across cities in India, certain basic trends which determine transport demand (such as substantial increase in urban population, household incomes and industrial and commercial activities) are the same. These changes have exacerbated the demand for transport—a demand that most Indian cities have been unable to meet. The prevailing imbalance in modal split besides inadequate transport infrastructure and its suboptimal use. Public transport systems have not been able to keep pace with the rapid and substantial increases in demand over the past few decades. Bus services in particular have deteriorated and their relative output has been further reduced as passengers have turned to personalized modes and intermediate public transport (such as three-wheelers and taxis), adding to traffic congestion which has had its impact on bus operations. Realization of issues and challenges of urban transportation and counter measures for them will increasingly rely on the development and deployment of new technologies and cutting edge solution. A world class urban transportation which is innovative, effective, integrated, sustainable, intermodal, safer, secure, reliable and cost effective will improve the transportation scenario in cities dramatically.

Dynamics of urbanization

Global urbanization

The global urban population has more than tripled to reach 2.86 billion.¹ More people are residing in urban areas than in rural areas today. While urbanization has considerably slowed down in developed countries, developing cities are getting urbanized the most; accounting for 68% of the urban population in 2000. By 2020, 77% of the global urban population (3.26 billion) is expected to be in developing countries.¹

Urbanization in India

India is world’s second largest urban system. Its urban population has grown by about six times during last six decades’ 1951-2011.
(Fig. 1). There has been 3-fold increase in the % of urban population to total population over the century. The vitality of urban settlement is evident from the fact that 31.15% live in town and cities in 2011 compared to 17.29% in 1951. India’s urban system is skewed towards bigger cities as evident from Table 1. The number of mega cities (>5m) and metro cities (1m) is rising very fast. The number of mega cities and metropolitan cities has grown up to 3 times during 1981-2011. Concentration of population in bigger cities reveals imbalance in the Indian urban system. Cities likely to house 40% of India’s population by 2030. (Fig. 2).

![Urban population in India](image1.jpg)

Table 1: Number of large cities in India

<table>
<thead>
<tr>
<th>Year</th>
<th>&gt;5m</th>
<th>&gt;1m</th>
<th>&gt;0.5m</th>
</tr>
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<tbody>
<tr>
<td>1981</td>
<td>3</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>1991</td>
<td>4</td>
<td>23</td>
<td>55</td>
</tr>
<tr>
<td>2001</td>
<td>6</td>
<td>35</td>
<td>74</td>
</tr>
<tr>
<td>2011</td>
<td>9</td>
<td>50</td>
<td>94</td>
</tr>
</tbody>
</table>

Source: Asia Economics ANALYST, GSER Issue no: 07/13, July 6, 2007

![Urbanisation growth](image2.jpg)

Fig. 1: Urban population in India

Fig. 2: Urbanization growth
Need of sustainable urban transport
A sustainable transport is one that is safe, economically viable and socially acceptable access to people, places, goods and services and meets the objectives for health and environmental quality. With the growth of population and urbanization, more natural resources and energy is consumed, which results in increased environmental pollution. Growth of urban transport along a sustainable path in cities is the foremost need of the hour; local pollution is a health hazard and Green House Gas (GHG) emissions are a global issue.

Urban transport issues and challenges

Vehicular growth
No. of registered motor vehicles plying on Indian roads has increased from 0.31 million in 1951 to about 90 million in 2005-06. Amongst different type of motor vehicles % of two wheelers has shown rapidly and constitute 70% of motor vehicles of India. There is a significant shift from share of slow moving vehicles to fast moving vehicles and public transport to private transport. Table 2, shows, between 1994 and 2021, the average two wheeler and car ownership levels per 1,000 of population and vehicle trips in metropolitan cities are estimated to grow more than three-fold. A recent study by India’s Ministry Of Urban Development (MOUD) indicates that daily trips in the top 87 urban centres are anticipated to more than double from 228 to 482 in 24 years (2007–2031).

Table 2 : Growth of vehicle ownership in India

<table>
<thead>
<tr>
<th>Year</th>
<th>2W/1,000</th>
<th>Car/1,000</th>
<th>Vehicle trips(million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>112</td>
<td>14</td>
<td>67</td>
</tr>
<tr>
<td>2021</td>
<td>393</td>
<td>48</td>
<td>216</td>
</tr>
</tbody>
</table>

Rising traffic densities and congestion
The effect of Increase no. of vehicles and disproportionate Increase in the road network is increased traffic densities on urban roads. (no of vehicles/km length of road.) The consequent result of rising traffic densities has been reduces journey speed rising Traffic congestion and loss of energy and productive time.

Inadequacy of public transport system
Except the bigger cities mass public transport system either absent or awfully inadequate resulting in serving the transportation needs by para transit modes or private vehicles. Due to inadequate public transport nearly 60%-70% of the travel needs are met by the private modes. Inadequate mass transport facility is one of the causes for traffic congestion. City buses run as the principle mode in many cities while some metro cities have other public transport modes such as suburban rail or metro rail. Many cities do not have standard bus services. Public transport need in these cities is met with mini-buses and by IPT

Unpredictable and unreliable public transport system
• Due to unscientific route planning and location of depot the amount of dead mileage is quiet high leading to energy and financial losses.
• Due to less passenger ridership in busses, their performance index is on lower side.
• No provision for physically challenged people.
• Lack of cleanliness and unreliability of mass public transport system results in shift to private transport modes to cater the travel need of the passenger

Lack of inter modal integration
Lack of integration of public transport system which results in loss of productive time and energy on the one hand and fuel and environment inefficiency on the other hand. Except for some scanty efforts in bigger cities hardly any efforts is made to establish integration amongst different components of transportation.

Deteriorating environment condition
The deterioration of the environment due to traffic has been causing serious concern. Some environmental issues of traffic are:
Safety of road users has been seriously endangered by the motor vehicles. An inevitable result of growth of traffic has been the increase in road accident which takes a
great toll of human life every year. Children and aged is another group that receives severe punishment. Pedestrian, cyclist and slow moving vehicles account for 60-70% of fatalities.

Noise in the street and adjoining areas has been growing up to intolerable levels. It can cause discomfort, annoyance, interference in sleep, speech and general task and can cause physiological effect like deafness. Air pollution in atmosphere is fumes and gases emitted from vehicles create unpleasant environment and cause effect on health. Traffic induced vibration cause impact on building and adjacent structure. Visual intrusion and severance are some of the other ill effects.

**Rising vehicular emission**

According to 2007 estimates; Indian transport sector is responsible for 12.9 % of the country’s GHS emissions impacting air quality, public health, Sustainable urban development. According to the study by CPCB (Central Pollution Control Board) New Delhi reveals that vehicles contribute about 56-71% CO2 emission Every day. According to CSE the quantity of all three major component (CO, NO2 and hydrocarbon) Drastically increase with reduction in motor vehicles Speed. eg. At the speed of 75kmph emission of CO2 is 6.4grm/vehicles which increase by five times at the speed of 10km/hours. Large cities (> 8 mill.) have 15% population and contribute 64% of CO2 emissions, Medium size cities (2-4 mill.) have 14% population, CO2 emission 3-4 times less, high growth rate in private motorized trips and Small cities (.5-2 mill) are dependent on Para transit modes (motorized and non motorized)

**Energy inefficient transportation system**

Heterogeneity of traffic and traffic congestion of city roads make the transport system energy inefficient. According to an estimate, bus transport consumes about 5-15% of fuel energy and 85-95% is consumed by other vehicles.

In large cities 50-60% by private modes, 17.33% by bus and about 4% is by auto rickshaw. Large amount of energy is consumed by private automobiles due to their rising number.

**Poor parking facilities**

About one fourth of valuable road space in our cities is being taken away by parked vehicles. There is lesser parking on major roads in bigger cities. The parking is pushed into minor or interior roads. There is need to revise car parking set out. According to a study at least 40 % of the commercial vehicles entering in the city have no business in the city. Parking of truck bound from/to city at city fringe due to restriction in the city is concern.

**Poor mobility**

Hardly any serious effort is made to make provision for elderly, physically challenged, children and females. Except for low floor busses recently introduced in few bigger cities like Bangalore and Delhi metro.

**Lack of inter agency coordination**

Many agencies are working in different area of traffic and transportation, be it transport system, roads, rail, terminals or traffic control and regulation. But all these agencies work independently and hardly any coordination is visible amongst them. Lack of coordination amongst different agencies is responsible for absence of an integrated approach to urban transportation planning and development.

**Inadequate funding and financing option**

Lack of finance is one of the most significant causes for slow progress in improving the urban transportation scenario. Funding and financing of urban transportation is still in an ambiguous state of affairs. Though some efforts have started in bigger cities but a longer path is yet to be travelled.

**Sustainable transport strategies**

**Land use and city planning control**

Traffic is the function of activities that take place in a city and closely related to land use. The most obvious method of dealing with the deteriorating traffic situation is to impose land use and city planning control, calculated to have an impact on traffic generation.

**Transit Oriented Development (TOD)**

Transit oriented development is walkable, mixed use form of development focused around a transit station. Concentrating higher density development around the station makes transit convenient and encourages ridership (Fig. 3).
Decentralized distribution of work areas will reduce the transport demand to a large extent as the trip length will reduce remarkably. Transit oriented development is suggested for improving accessibility and usability of mass public transport facility. Location of major center of housings, shopping, employment and recreation should be close to the mass transport route alignment to minimize the number and length of trips.

![Concept of decentralization](image)

**Fig. 3 : Concept of decentralization**

Higher density development around MRTs and LRT. Or BRTS. So that transportation system is convenient and economically efficient. The distance that a person is willing to walk to take the transit defines the primary area within which transits will occurs. Distance should roughly a 5 minute walk approx. 400-600 m. at these radii there is potential for 125-250 acre of land for TOD.

**Improvement in vehicle design and fuel technology**

Improvement in engine design technology in two wheeler.i.e changing the 2 stroke engines with 4 strokes will make the automobile environmentally clearer and energy efficient as well.

Use of catalytic converters should be made mandatory in the petrol driven vehicles. As it can reduce CO₂ and HC levels by more than 70%.

Alternative fuel like electricity, solar energy, CNG,LPG, synthetic liquid fuels derived from hydrogenation of coal, synthetic liquid, which has been proved to be less air polluting and energy efficient.

**Control of car population and usage**

- Control of vehicle population has been achieved through two main measures: car ownership restraints and car usage restriction measures.
- Restrict vehicle usage by road pricing and parking fee and registration fee and fuel tax.etc, as practiced in Singapore
- Vehicle Quota System (VQS)
  Controls vehicle population
  Number of new vehicles predetermined
  Owners bid for Certificates of Entitlement (COEs)

**Provision of non motorized transport and bicycles**

- Planning and development of dedicated bikeways, NMV streets and Lanes. Which should be adequate direct, shortest, safe and attractive.
- Develop underpass on major roads and signal control lock system as prevalent in west countries.
- Development of network of cycle’s rental and parking centers.
- Cycle design improvement. like: multigear, batteries, computer chip and music system.

**Improving public transport**

- Introducing world class transportation system like LRT, MRT and BRT in the cities to make it attractive or the private
vehicle users. Providing a high quality public transport system that satisfies the transport need of all sections of commuters and offer an attractive alternative to motor car is the need of the hour in most of the urban settlement. Such a shift will reduce the energy requirement and vehicular emission to a great extent.  

- Instead of competition, different public transport should complement each other.
- Bus priority lanes and junctions should be planned to make it more attractive and faster alternative of cars.
- Intelligent traffic lights should be erected to detect approaching buses and turn green automatically at the junction. Make use of GPS system to locate the buses.
- Prioritization of bus traffic at signalized intersection will supplement the efforts made for dedicated bus lanes, which will tempt the passenger to use such vehicles in place of operation in the city.
- Special care should be taken while planning and providing facilities for elderly, physically challenged, children and woman at the terminal to make them more mobile.

**Transport System Management (TSM)**

TSM techniques offer low cost solution to urban transport problems are:

**Road widening/traffic free zones and TDR**

Wherever feasible take up road widening by acquiring land but it is difficult in cities. So the novel solution is TDR (transferable development rights) wherein owner of the property on either side of the road to be widened have to compulsorily relinquish the required extent of land needed to widen the street free of charges in lieu of increased FARs. The TDR can also be sold like share.

**Traffic signals management**

Computer controlled traffic signals management system provides flexible time traffic signaling, depending upon the volume of traffic and area-wise traffic signal coordination. Priority can be accorded to Public transport vehicles at traffic crossing.

**Parking policy**

Parking policy should be critical consideration which should be evolved keeping in view the following:

- Review of parking norms and parking charges for various land uses
- Optimizing parking spaces.
- Multilevel parking provision at the venues of public concentration in commercial areas/metro station.
- Review mixed land use policy

**Car pooling**

Car pooling can reduce vehicle emission drastically. Off peak our and weak end car schemes to allow more car primarily during off timing resulting less congestion and reducing energy requirement.

**Park and ride facilities**

Provision of park and ride facility particularly at suburban railway stations in and around the metro cities can greatly help in reducing the number of private vehicles on the urban roads. This facility can be easily privatized.

**Peak hour congestion**

Use of trucks and private cars should be banned on all major roads and CBD (Central Business District) in mega cities during peak hours. Where individual still wish to ply their vehicles during peak hours, they should be required to obtain a permit on payment of a fee i.e. Cordon Pricing System.

Staggering of office hours is a simple and effective way to spread the duration of the peak hour and lessen the pressure on the road space. School hour can be very conveniently planned to be sufficiently away from the office hours. Even the office and industrial working hours can be staggered.

The system of minimum occupancy vehicles can be introduced during rush hours in all millions plus cities along specified roads to reduce congestion in peak hours.

**Pedestrianisation**

Complete banning of the motor vehicles from certain areas and declaring the same as pedestrian precincts has a salutary effect on the traffic situation. It increases the safety of the pedestrians .it gives them the freedom to move about and shop leisurely. It frees the area from noise, fumes and smell. It may affect the shopping turnover also.

**Improve traffic monitoring and information**

The information includes, motorist location, prevailing traffic condition, road works,
parking facility etc. Even the optimal route. To allow every motorist to access a wide variety of information while travelling

**Financing**

Some measures to overcome the finance problem are:

- More avenues should be worked out to introduce PPP mode in the urban transportation sector. Private sector should be convinced to their social responsibilities apart from the economic return.
- Levy on petrol for mass transport projects
- Wiping off indirect subsidy given in allotment of land to petrol pumps.
- Generating international funding
- Leasing and issue of bond to mass transport projects.
- Rationalizations of passenger/vehicle taxes.
- Surcharge on property tax.
- Excess condemnation in construction of highways / MRTS.

**Environmental concern measures**

- Some techniques and measures to reduce the environmental impact like noise pollution, air pollution and traffic induced vibration and visual intrusion are as follows:
  - Change in design of vehicles, in tiers or road surfaces and Elimination of nosier vehicles and create barrier to reduce noise pollution.
  - Modification in traffic operation
  - Use small car instead of big cars and alternative fuels
  - Controlling idling engines
  - Construction of by pass and ring road to reduce traffic in mid town.
- Provision of wider roads and enforcing a certain minimum distance between adjacent buildings to reduce vibration
- Suitable off street parking and enforcing measures for on street parking
- Control unsightly bill boards by suitable regulatory measures IRC policy on control of road side advertisement act
- Access control and Provision of service road

**Nodal authority**

- It is high time that a single transportation agency (Nodal Authority) should be established in cities which will act as coordinator to all other agencies responsible for planning development and maintenance of urban transportation facilities. No plan of any agency should be implemented without the recommendation of this nodal authority.
- Innovative technologies should be introduced in the existing agencies involved in urban transportation planning, development and maintenance process to make better equipped to solve the existing and upcoming solution

**Best practices**

**Singapore**

Singapore is an urban and densely populated city of 4 million which has over 700,000 motor vehicles in land area of 700 km². There is 20% increase in vehicle population over last decade. To ensure a sustainable economic growth, Singapore has taken some measures towards EST (Environment sustainable transport)Table 3

<table>
<thead>
<tr>
<th>Table 3 : Some measure towards EST taken by Singapore for environment sustainable economic growth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicle emission standard</strong></td>
</tr>
</tbody>
</table>
| **Legislation /enforcement** | -Video cameras are installed to capture smoky vehicles. Smoke test carried out on chassis dynamometers since Sep 2000  
-Periodic mandatory inspection  
-Encourage alternative fuel like CNG and electric cars.  
-Cleaner Fuel- Reduced sulphur content in diesel. |
| **Education** | Educate the fleet owner and drivers about common causes of excessive emission, proper and regular maintenance. proper driving habits etc. |
| **Government initiatives** | Vehicle Quota System  
Road pricing  
Effective public transport system |
Control of vehicle ownership and vehicle usage

Two major forms of car ownership restraints are in use in Singapore to suppress the growth of vehicles to within a tolerable level. Fiscal measures to increase the costs of owning, operating and maintaining motor vehicles. These costs include import duties, vehicle registration fees, fuel and road taxes and compulsory vehicle inspection fees. (b) The Vehicle Quota System (VQS) that requires anyone intending to purchase a car to first acquire a Certificate of Entitlement (COE) through an open bidding system.

Vehicle usage control

Singapore’s vehicle usage control policy includes road pricing, parking fee, fuel tax, inspection fee. There are some policies which stimulate the travelers to optimize the usage of car are: car pooling, park and ride system, weekend or off week end cars, car sharing and Taxis*. All fitted with meters, all air conditioned, about 90% of taxis have radiophones, *call booking is done via GPS or digital voice dispatch.

Road pricing in Singapore

There were 2 manual road pricing schemes:
- Area Licensing Scheme (ALS, 1975-1998)
- Road Pricing Scheme (RPS, 1995-1998), Expressways

In 1998, these 2 schemes were transformed to an electronic scheme called

Electronic Road pricing

Under the proposed system, the rate that the motorists to be charged for using each road section would be dependent on the congestion level of the road section. It is hoped that such a pricing system will help to reduce the congestion level of busy road sections. It is also anticipated that motorists would travel by private cars only when necessary and choose to use less congested road sections, thereby optimizing the utilized capacity of the road network.

DISCUSSION

The future transportation scene is bringing alarming challenges in the decades to come. A comprehensive vision is required to be developed to attain sustainable urban transport system for future. Sustainability emphasizes the integrated nature of human activities and therefore the need for coordinated planning among different sectors, groups and jurisdictions. It expands the objectives, impacts and options considered in a planning process. This helps insure that individual, short-term decisions are consistent with strategic, long-term goals. Sustainable transport planning recognizes that transport decisions affect people in many ways, so a variety objectives and impacts should be considered in the planning process. There are some goals and objectives to attain the sustainable transport (Table 4).

Table 4 : Sustainability goals and objectives

<table>
<thead>
<tr>
<th>Sustainability goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Economic</td>
<td></td>
</tr>
<tr>
<td>Economic productivity</td>
<td>Improving Transport system efficiency.</td>
</tr>
<tr>
<td></td>
<td>Transport system integration.</td>
</tr>
<tr>
<td></td>
<td>Maximize accessibility.</td>
</tr>
<tr>
<td></td>
<td>Efficient pricing and incentives. (road, parking, insurance, fuel, etc).</td>
</tr>
<tr>
<td>Economic development</td>
<td>Access to education and employment opportunities.</td>
</tr>
<tr>
<td></td>
<td>Support for local industries.</td>
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<tr>
<td>Energy efficiency</td>
<td>Reduce per capita transport energy consumption and per capita use of imported fuels.</td>
</tr>
<tr>
<td>Affordability</td>
<td>Availability and quality of affordable modes (walking, cycling, ridesharing and public transport). Especially for low-income households that spend more than 20% of budgets on transport.</td>
</tr>
<tr>
<td>Efficient transport operations</td>
<td>Efficient operations and asset management maximizes cost efficiency.</td>
</tr>
</tbody>
</table>
II. Social

<table>
<thead>
<tr>
<th>Equity / fairness</th>
<th>Transport system accommodates all users, including those with disabilities, low incomes and other constraints.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety, security and health</td>
<td>Minimize risk of crashes and assaults and support physical fitness.</td>
</tr>
<tr>
<td>Community development</td>
<td>Help create inclusive and attractive communities. Support community cohesion. Land use mix., walkability and bikability, quality of road and street environments</td>
</tr>
</tbody>
</table>

III. Environmental

<table>
<thead>
<tr>
<th>Climate stability</th>
<th>Reduce global warming emissions Mitigate climate change impacts</th>
</tr>
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<tbody>
<tr>
<td>Prevent noise pollution</td>
<td>Minimize traffic noise exposure By vehicle and road design</td>
</tr>
<tr>
<td>Open space and biodiversity protection</td>
<td>Minimize transport facility land use. Preserve high quality habitat. Encourage more compact development. TOD and land use planning</td>
</tr>
</tbody>
</table>

CONCLUSION

Rapid urbanization that too skewed towards bigger cities is a driving force to increased transport demand. Inadequacy of mass public transport system, inappropriate transport system management measures, inappropriate vehicle and fuel technologies, lack of inter agency coordination etc. have been making the urban transportation system unsustainable and inefficient. Mobility, safety, environment, energy, reliability, convenience etc. are the major issues striking the urban settlement in the current urban system in India. Corrective measures like Transit Oriented Development, Transport System Management and Transport Demand Management Improved Public Transport Planning and Operation and Fuel Technology Capacity Building Practices will minimize the above said issues to the large extent and make the urban travel seamless.

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