

Strategies and Policy Frameworks for Low Carbon Mobility in Indian Cities

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Abstract:

This paper endeavours to illuminate the challenges and issues that need to be addressed to achieve sustainable urban transportation system in Indian cities. This paper will try to trace pattern of urbanization, motorization and their impact on mobility, environment, health and road safety. Further, the paper will explain various efforts taken by government authorities to address the transportation issues and their outcomes. The paper also explains various strategies which if be adopted will ensure low carbon growth of urban areas. Low carbon cities will help in enhancing India's energy security and lower its carbon footprint.

Introduction:

India is experiencing the phenomenon of rapid urbanization as it is transforming from traditional rural economies to modern industrial one. Level of urbanization has increased from 27.81% in 2001 to 31.16% in 2011 (Census of India, 2011). Urbanization has an overall positive impact on growth rate of economy. The top 100 largest cities are estimated to produce about 43% of the GDP, with 16% of the population and just 0.24% of the land area (Indian Institute for Human Settlements, 2011).

The pattern of urbanization in India is characterized by continuous concentration of population and higher order activities in large cities (Kundu, 1983). Indian urbanization is often termed as pseudo urbanization (Breese, 1969) or over-urbanization (Kingsley & Golden, 1954) where in people arrives in cities not due to urban pull but due to rural push.

Indian urbanization has displayed remarkable and selective growth of cities. This fast-paced growth has also produced an urban crisis, which is marked by the lack of growth management and adequate infrastructure. The economic prosperity of cities has far outstripped its urban infrastructure. The poverty led migration (Sen & Ghosh, 1993) has induced very poor quality of urbanization and has resulted in urban sprawl.

Urban Sprawl has led to horizontal expansion of cities leading to wild land - urban interface. The wild land - urban interface has caused large scale deforestation leading to reduction in rain water absorption, loss of traditional land practices, agricultural and forestry jobs. The horizontal expansion of cities is exerting tremendous pressure on existing transportation system leading to frequent congestion, increase in travel time, traffic accident, and sound & air pollution.

Carbon emissions from the transport sector, particularly from vehicles burning fossil fuels, contribute significantly to air pollution and have various health impacts. According to the World Health Organization

(WHO), outdoor air pollution contributes to an estimated 4.2 million premature deaths worldwide each year. (WHO Health impacts fact sheet, 2018)

Fine particulate matter (PM_{2.5}) from transport emissions can penetrate deep into the lungs and cause respiratory problems. Studies have linked PM_{2.5} exposure to increased mortality rates and respiratory diseases. (DW Dockery, et al. 1993, New England Journal of Medicine)

Transport-related noise pollution can lead to various health issues. Prolonged exposure to noise levels above 55 decibels can increase the risk of cardiovascular diseases, stress, sleep disturbances, and cognitive impairment. (WHO - Environmental Noise Guidelines for the European Region, 2018)

Transportation System in Indian cities

The road networks in most of the Indian cities are based on notional hierarchy of roads, ranging from arterial roads designed to carry long distance and fast through traffic to local streets providing access to properties.

Unfortunately, the existing road systems do not cater to the needs of bicycles, pedestrians or any other slow-moving traffic. The contribution of the NMV (Non-Motorized Vehicles) to the transportation system of the city is ignored therefore no provision has been made for their dedicated lane and parking. As a result, slow and fast mode users have to share the same carriageway.

The intermixing of modes of different speeds causes traffic accidents, congestion and reduction in travel speed. Though de facto segregation, NMV uses the left side of the road which otherwise is used by buses and hence buses are compelled to stop in the middle lane at bus stops, disrupting the smooth flow of traffic in other lanes and rendering NMV vulnerable.

Pedestrians have to contend with narrow pavements which are often made narrower for road widening to reduce the congestion for motorized traffic. The presence of utilities poles, illegal car parking, litter bins and commercial waste creates obstruction for pedestrian movements and causes spillover of pedestrians over carriage way forcing them to interact with fast moving motorized traffic.

Traffic generally crawls during the peak hours at major inter-sections but during non-peak hours when streets are relatively empty mid-block speeds tend to be much higher ranging from 50-90 km/h for motorized vehicles (Tiwari G., 2002) leading to higher fatality rates.

Public buses often remain overcrowded and poorly maintained providing a low level of comfort and service. Even if buses carry significant number of passengers, they get no privileged treatment in terms of traffic management or dedicated lanes.

Pedestrians, bus commuters and NMV users form the majority of road users. But their need for a convenient and safe infrastructure remains ignored. In the name of development, authorities plan infrastructure for fast movement of motorized traffic at the cost of NMV's and pedestrians. Police and traffic management experts often propose time and area restrictions on the movement of NMV's. If the urban design does not meet the requirements of the road users, then all modes of transport function in sub-optimal conditions.

Efforts taken by authorities to address urban issues

Indian cities have been preparing various Master plans to effectively manage and guide future physical development of the cities. These Master plans are based on the rigid concept of zoning and had weak land use transportation integration. Land use zoning compels people to commute longer distance for every trip

purpose because educational, recreational, commercial zones are located away from each other. The net result has led to horizontal expansion of cities and increased commuting distance.

Increasing commuting distance has made people dependent upon motorized mode of transportation. Rising cost of transportation has seriously impacted the mobility of poor and has restricted their job opportunity. The job opportunity majorly located at city centre act as urban pull attracting people at city centre but higher cost of housing pushes them at peri urban areas for living. Increased travel cost and long working hours has compelled works to live next to the factories majorly on roads making them venerable. Violating the law has becomes pre condition for survival in a city (Tiwari G., 2001).

The unreliable and suboptimal supply of public transport has led to the proliferation of personalized automobiles especially two wheelers. The total motor population in India has increased from 0.30 million in 1951 to about 73 million in 2004 (Tiwari G. , 2011) and 326.3 million in fiscal year 2022 (Statista, June 2023). The infrastructure development could not commensurate with the increasing number of automobiles. There has been a staggering 1000-fold increase in the population of motorized vehicles between 1951 to 2022, while the road network has expanded only sixteen times (MoRTH - Year end review report, 2022).

The net effect of inadequate infrastructure resulted in frequent traffic accidents, congestion, traffic grid lock and increasing travel time. In the city traffic environment, the automotive modes are often subjected to frequent acceleration and deceleration in quick succession. The contribution of CO (Carbon Monoxide) from automobiles is significantly higher in accelerating and decelerating condition of the automotive modes, during winter the automobile exhaust forms heavy smog, leads to accidents, respiratory diseases and mass flight cancellations.

India Imports a large share of its petroleum requirements which has increased to 87.3 per cent of domestic consumption in 2022-23, from 85.5 per cent in 2021-22 and 83.8 per cent in 2018-19 (Petroleum Planning & Analysis Cell, 2023), a significant amount of which is used for transportation (Planning Commission, 2011). The transport sector of India is the third most greenhouse gas (GHG) emitting sector and accounted for 14 per cent of our energy-related CO₂ emissions. These emissions have more than tripled since 1990, and with India's urban population expected to double by 2050, they are likely to increase further. (NITI Aayog, 2021).

Given the condition that petroleum prices are increasing in international markets, importing of petroleum can cause serious damping to the economic growth. In the oil-constrained future, there is need to reduce transport's dependence on petroleum in order to enhance India's energy security and lower its carbon footprint.

Proposals

Various proposals which should be adopted to ensure low carbon growth are mentioned below:

Strategy such as Transit Oriented Development (TOD) should be adopted to ensure Low carbon growth. TOD refers to high rise, high density residential and commercial development around transit stops, designed to maximize access by public transit and Non-Motorized Transportation (NMT), and with other features to encourage transit ridership (Renne, 2009). TOD promotes efficient use of land and transportation Infrastructure.

Location efficient neighbourhoods is an area which has compact development with walkable streets, access to transit, and a variety of amenities and have lower transportation costs than inefficient ones. People who live in location Inefficient places are auto-dependent, have high transportation costs, and are

more susceptible to fluctuations in fuel prices. The Housing + Transportation (H+T) Affordability Index is an innovative tool that measures the true affordability of housing based on its location. The H+T Index enables planners and policy makers to distinguish between location-efficient and inefficient areas (Centre for Neighbourhood Technology, 2012).

Efficient locations can be used to target investments, incentivize development that will be more sustainable over the long term. The decision makers could expedite permitting and approvals for new construction on vacant lots, permit denser and mixed-use development "by right" in location-efficient areas (Centre for Neighbourhood Technology, 2012) Denser and compact development will help in reducing VMT and emissions (Benner, 2009). The data base for H+T index should be developed and maintained for all Indian cities.

Concepts such as walkable cities, sector planning, 10-minute neighbourhood should be applied in urban planning to enhance livability, promote sustainable transportation options, reduce congestion and carbon emissions, improve public health, and foster vibrant, connected communities. By incorporating these concepts into its planning, Chandigarh has achieved remarkable results. The city boasts an impressive walkability index of 0.91, the highest in the country according to a report by CSE Delhi (2009). Additionally, Chandigarh has achieved the highest transport performance index, as reported by the Ministry of Urban Development (MOUD, 2008).

Pedestrians are most vulnerable road users and this issue has never been properly addressed by civic authorities and policy makers. The existing infrastructure to support pedestrian movement, the most natural sustainable and cheapest mode of transportation is consistently overlooked by both state and central government. Therefore, main focus should be stressed on more equitable allocation of road space to people, rather than vehicles by improving walking and cycling infrastructure. The Government should guarantee "right to walk" to safeguard the interest of pedestrians. Street vendors should be given a valid and legal place in the road environment as they foster and provide services to pedestrians, bicyclists and bus users.

Multi-Modal Level of Service (MMLOS) approach can be adopted to improve the overall quality and efficiency of transportation systems. It gives valuable insights into the performance and user experience across various transportation modes within a network. This comprehensive assessment takes into account factors such as travel time, comfort, safety, accessibility, and reliability. It can lead to a more seamless, efficient, and user-centric transportation system that encourages the use of multiple modes of transport, reduces congestion, and promotes sustainable mobility options.

Construction of infrastructure such as roads, highways, buildings/places/transportation systems for public use should comply with the norms laid down by National policy for people with Disabilities (2006). In addition to it discrimination on the basis of disability in public transportation services, such as city buses and public rail (subways, commuter trains, etc.) should be prohibited (Americans with Disabilities Act of 1990) to encourage people with Disabilities to travel by public transport instead of using personal motor vehicles.

Battery operated auto rickshaw should be encouraged and polluting rickshaws should be put off the roads. Buses complying with Bharat Stage III norms and below should be phased out and replaced with Buses complying Bharat Stage IV norms as Buses complying with Bharat Stage III norms are polluting as compare to Buses complying Bharat Stage IV norms.

Use of Electric Vehicles (EVs) can be promoted in the Indian cities by offering incentives, subsidies, and establishing an accessible charging infrastructure. Continued advancements in battery technology and

decreasing costs make EVs a viable option for reducing carbon emissions. Additionally, alternative fuels like hydrogen fuel cells and biofuels should be explored for specific transportation needs, such as heavy-duty transport and long-range travel.

Public Transportation systems can be enhanced with energy-efficient and eco-friendly options such as electric buses, bus rapid transit (BRT) systems, and integrating renewable energy sources to power transit networks.

To meet ever increasing transportation demand of urban population and provide easily accessible, safe and fast mode of transportation, Mass Rapid Transit System (MRTS) projects should be undertaken. Such projects will help in significantly reducing vehicular pollution and travelling time. The MRTS corridor should be densified and mix land use should be promoted along the MRTS corridor. The mix land use and high-density development will generate transit ridership/throughput in both the direction throughout the day.

Intelligent transportation system (ITS) is defined as the application of advanced and emerging technologies (computers, sensors, control, communications, and electronic devices) in transportation to save lives, time, money, energy and the environment (ITS Canada, 2009). ITS should be installed in all the Indian Cities as it will help in achieving fully integrated transportation demand management system, improving safety, efficiency, general mobility and productivity, at the same time reducing threats to travel security and safety as well as the negative effects to the environment such as pollution.

Mobility as a Service (MaaS) can be implemented by developing user-friendly platforms that integrate various transportation modes, including public transit, ride-sharing, and bike-sharing. This can provide seamless mobility options to reduce the overall carbon footprint. (UITP, 2019)

Car-sharing and ride-sharing services should be promoted as alternatives to private car ownership. These platforms optimize vehicle use, reduce the number of cars on the road, and contribute to lower emissions. In a bid to reduce traffic during peak hours strategies such as 'congestion pricing' should be introduced in cities. The congestion pricing would encourage people to use public transport and deter them from taking private vehicles to congested areas of cities. This would result in lesser number of vehicles on roads. After levying congestion pricing, traffic in Central London, went down by about 21 per cent and the traffic speed went up by about 10 per cent (The New Indian Express, 2014).

Technologies such as Dedicated Short-Range Communications (DSRC) should be deployed to pay Congestion Pricing fee electronically, DSRC provide communications between a vehicle and the roadside in specific locations, for example toll plazas. In case if DSRC system is not in place or if it is not possible to implement congestion pricing then probably be a better option would be to increase tax on fuel in the city to reduce the use of personalized automobiles and invest the funds generated in public transport.

Due to non-availability of parking space, automobiles are generally parked road side reducing effective Right of Way (ROW). Therefore, automobile sale should be permitted only if the customer has access to parking slots. The Proof of Parking (PoP) system in Japan has been helpful in efficiently utilizing parking spaces and addressing parking challenges in densely populated urban areas. It reduced instances of illegal parking, improved traffic flow, and minimized congestion. It also promotes the consideration of alternative transportation options.

A trial can be conducted for Indian cities, as is being done in Cheju Island, South Korea before implementing the proof of parking policy.

Additionally, commercial parking should be charged higher to discourage people from using private mode of transportation and force them to prefer public transportation.

Strategies such as staggering of school and office timings should be adopted to help assist with a safe and orderly commuting. This strategy will reduce traffic congestion and travel time during peak periods hours. The timings of all public mode of transport such as bus, trains, air planes and para transit should be synchronized to provide hassle free seamless travel.

With the rise of e-commerce and supply chain management, finding sustainable last-mile delivery solutions has become crucial. Options like electric delivery vehicles, cargo bikes, and even drone deliveries (subject to approval from Directorate General of Civil Aviation, DGCA) may prove to be beneficial alternatives to traditional ways of last-mile delivery.

Unmanned Aerial Vehicles (UAVs) or Drones have the potential to significantly accelerate delivery times and reduce human costs and carbon emissions associated with deliveries. Amazon, one of the pioneers in drone delivery, introduced its drone delivery service called "Prime Air." The company has conducted rigorous testing of drone delivery operations, aiming to achieve faster delivery services and has effectively executed 100 successful drone deliveries in California and Texas. Small consumer drones used for last-mile delivery typically have a payload capacity of a few kilograms, while larger industrial drones can carry heavier loads, ranging from 10 kilograms to even several hundred kilograms.

CONCLUSIONS:

Achieving a sustainable urban transportation system in Indian cities requires comprehensive strategies. This includes transit-oriented development, prioritizing pedestrians and non-motorized transportation, promoting electric vehicles, and implementing intelligent transportation systems.

If existing roads are redesigned by providing equitable allocation of road space to people and Transport Demand Management (TDM) strategies are adopted then safe and convenient environment for pedestrians and non-motorized modes can be ensured. It will also help in reducing dependency on fossil fuel and transportation crises, improve efficiency of public vehicles and enhanced capacity of the corridor. In addition to it, the mobility of socially and economically weaker sections will be greatly enhanced and a sustainable faster inclusive urbanization can be ensured.

Future research should focus on housing and transportation integration, assessing the impacts of innovative policies like proof of parking. It requires collaborative efforts from policymakers, urban planners, transportation experts, and citizens to create cities that prioritize sustainable transportation options and prioritize the well-being of all road users.

REFERENCE

1. APTA. (2009). Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit
2. Article on Amazon website, Amazon prime Air prepares for drone delivery, <https://www.aboutamazon.com/news/transportation/amazon-prime-air-prepares-for-drone-deliveries>
3. Benner, R. (2009). Portland Metropolitan Region Turns a Climate Change Corner Portland: ISOCARP
4. Breese, G. (1969). Urbanisation in Newly Developing Countries. New Delhi.
5. Business, Transportation and Housing Agency. (2002). Statewide Transit-Oriented Development at Study: Factors for Success in California.
6. Census of India (2011).
7. Center for Neighborhood Technology. (2012). The H+T Toolkit: Using the H+T Index to Improve Location Efficiency. Chicago. Center for Neighbourhood Technology.

8. Cervero, R. (2000). Transport and Land Use: Key Issues in Metropolitan Planning and Smart Growth. |CSE-Centre for Science and Environment, New Delhi. Footfalls: Obstacle Course To Livable Cities, Right To Clean Air Campaign (2009)
9. DW Dockery, et al - An Association between Air Pollution and Mortality in Six U.S. Cities (1993), published in New England Journal of Medicine
10. Figliozzi, M., Tucker, C., Polikakhina, P. (2018). Proceedings 7th International Conference on Information Systems, Logistics and Supply Chain, ILS Conference, Lyon, France.
11. Hess, B. D. & Ong M. P. (2002). Traditional neighbourhoods and automobile ownership. Transportation Research Record, 35-44.
12. Indian Institute for Human Settlements. (2011). Urban India 2011: Evidence. India Urban Conference, (p. 11). Delhi.
13. India's Greenhouse Gas Emissions 2007. New Delhi. Ministry of Environment and Forests.
14. ITS Canada. (2009), Intelligent Transportation. Retrieved May 18, 2014, from www.itscanada.ca: <https://www.itscanada.ca/it/index.html>
15. Kingsley, D., & Golden, H. H. (1954), Urbanisation and development in pre-Industrial Areas. Economic Development and Cultural Change.
16. Kundu, A. (1983). Theories of City Size Distribution and Indian Urban Structure - A Reappraisal. Economic and Political weekly.
17. McKinsey & Company. (2010), India's urban awakening: Building inclusive cities, sustaining economic growth. Mumbai: McKinsey Global Institute.
18. MoUD - Ministry of Urban Development. Study on Traffic and Transportation Policies and Strategies in Urban Areas in India (2008) | MoRTH- Ministry of Road Transport and Highway – Year End review report (2022) | NCHRP. Multimodal Level of Service Analysis for Urban Streets: Users Guide (2009)
19. Oil Ministry's Petroleum Planning & Analysis Cell (PPAC), (2023) | Planning Commission. (2011). Low Carbon Strategies for Inclusive Growth. New Delhi.
20. Renne, J. (2009). From Transit Adjacent to Transit Oriented Development. Local Environment, 1-15.
21. Sen, A., & Ghosh, J. (1993). Trends in Rural Employment and Poverty Employment Linkage. ILO-ARTEP
22. Siddharth Sinha and Madhav Sharma. Decarbonising Transport: Redefining Mobility Policies in India, published by NITI Aayog (2021) | Statista, June 2023
23. The New Indian Express. (2014, May 18). Get ready to pay for congestion on city roads. Retrieved May 18, 2014, from <http://www.newindianexpress.com>: <http://www.newindianexpress.com/nation/article1486065.ece>
24. Tiwari, G. (2001). Urban Transport Priorities Meeting the Challenge of Socio-Economic Diversity in Cities - Case Study Delhi, India. Meeting the Transport Challenges in Southern Africa.
25. Tiwari, G. (2002). Urban Transport for Growing Cities. In G. Tiwari, Urban Transport for Growing Cities: High-Capacity Bus Systems (pp. 200-222). New Delhi: Macmillan India Ltd.
26. Tiwari, G. (2002). Urban Transport Priorities Meeting the Challenge Of Socio-Economic Diversity In Cities- Case Study Delhi, India.
27. Tiwari, G. (2011). Key Mobility Challenges in Indian Cities. Leipzig: International Transport Forum.
28. UITP - Report on Mobility as A service (2019) | Waykule, Jyoti. Smart Drone Delivery System (2020)
29. WHO health impacts fact sheet (2008)
30. WHO – Environmental Noise Guidelines for the European Region (2018)

31. World Bank. (2005). Global Purchasing Power Parities and Real Expenditures. Washington.
32. World Bank (2014). Global Purchasing Power Parities and Real Expenditures. Washington.