



Impact of public transport and non-motorized transport infrastructure on travel mode shares, energy, emissions and safety: Case of Indian cities



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ABSTRACT

Current modal share in Indian cities is in favor of non-motorized transport (NMT) and public transport (PT), however historical trends shows decline in its use. Existing NMT and PT infrastructure in Indian cities is of poor quality resulting in increasing risk from road traffic crashes to these users. It is therefore likely that the current NMT and PT users will shift to personal motorized vehicles (PMV) as and when they can afford it. Share of NMT and PT users can be retained and possibly increased if safe and convenient facilities for them are created. This shall also have impact on reducing environment impacts of transport system.

We have studied travel behavior of three medium size cities – Udaipur, Rajkot and Vishakhapatnam. Later the impact of improving built environment and infrastructure on travel mode shares, fuel consumption, emission levels and traffic safety in Rajkot and Vishakhapatnam are analyzed. For the purpose three scenarios are developed – improving only NMT infrastructure, improving only bus infrastructure and improving both NMT and bus infrastructure.

The study shows the strong role of NMT infrastructure in both cities despite geographical dissimilarities. The scenario analysis shows maximum reduction in CO₂ emissions is achieved when both PT and NMT infrastructure are improved. Improvement in safety indicator is highest in this scenario. Improving only PT infrastructure may have marginal effect on overall reduction of CO₂ emissions and adverse effects on traffic safety. NMT infrastructure is crucial for maintaining the travel mode shares in favor of PT and NMT in future.

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Introduction

India is the world's fourth largest consumer of oil and the third largest contributor to energy related CO₂ emissions (U.S. Energy Information Administration, 2015). However, per capita CO₂ emissions by transport sector of India are only one-sixth of the world's and one-third of China's per capita CO₂ emissions (U.S. Energy Information Administration, 2015). The relatively low level of per capita CO₂ emissions from the transport sector of India is associated with relatively high mode share of low carbon modes of transport (walk, bicycle and bus) (Wilbur Smith Associates, 2008).

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Historical trends shows constant decline in the use of NMT and PT. Existing NMT and PT infrastructure in Indian cities is in poor condition posing discomfort and high risk from traffic accident to these users (Ghate and Sundar, 2010; Tiwari and Jain, 2008). Majority of these users belong to low income groups and are therefore captive as they cannot afford PMV of transport. Most Indian cities are investing to ensure fast mobility of vehicles that includes road widening schemes and provision of flyovers and foot-over bridges (Jnnurm, 2009). While, there are minimal plans to invest in improving the basic transport infrastructure for pedestrians, bicyclists and bus users (Tiwari and Jain, 2013). Given the existing condition, the low carbon mode users are likely to shift to carbon intensive modes as and when they can afford it. The shift to PMV will result in higher emission levels (Dhar and Shukla, 2015).

Modal shift to NMT and PT has major impact on CO₂ emissions however; this modal shift is not possible without ensuring safety to NMT and PT users. Also CO₂ is a global pollution indicator, and traffic safety shows the local health impact. Therefore both are important for evaluating impacts of different scenarios.

Previous studies document the positive impacts of appropriate built environment and improving NMT and bus infrastructure on safety. This has resulted in modal shift from PMV to low carbon modes like PT and NMT (BUND and European Environmental Bureau, 2015; Tao et al., 2013; LTA Academy Singapore, 2011; Fietsberaad, 2010; Schiller et al., 2010; Lleras, 2003). Therefore a way to curb the increasing emission levels is by ensuring safety and comfort to both NMT and PT users such that captive users are transformed into choice users.

We aim to estimate the likely range of the impacts of appropriate built environment and NMT and bus infrastructure on energy consumption and equivalent CO₂ emissions in medium size Indian cities. Along with this, impact on safety under alternate scenarios is studied as it is a crucial factor to aggravate shift between modes. Three scenarios are developed for the study – improving only NMT infrastructure, improving only bus infrastructure and improving both NMT and bus infrastructure.

There are 4378 urban agglomerations and towns in India of which nearly 29% of the urban population lives in 77 medium size cities (Census of India, 2011). Medium size cities (0.5–2 million populations) are growing faster with higher rates of motorization (Indian Institute of Human Settlements, 2011). Appropriate built environment and infrastructure is necessary in these cities to ensure sustainable development and low carbon mobility. Travel characteristics vary with city size, city structure and available transport infrastructure. However, study by Wilbur Smith Associates (2008) shows that there is less variation in trip lengths and trip rates between cities of similar size. We have therefore conducted the study in medium size cities to understand the level of variation in travel behavior and type of infrastructure that needs to be improved in cities of similar size. For the purpose, three cities – Udaipur, Rajkot and Vishakhapatnam (Vizag) are selected belonging to different geographic locations but having similar population size. In the three cities primary surveys were conducted under the project “Promoting Low Carbon Transport in Indian cities” funded by UNEP. However detailed data was available for Rajkot and Vizag for which energy consumption and equivalent CO₂ emissions are estimated while safety indicators are estimated for Vizag only.

The paper is divided in three sections. First, travel trends of six Indian cities belonging to different population sizes are studied. Section ‘Existing travel modes in Indian cities and trends’ presents mobility and safety indicators for three cities – Udaipur, Rajkot and Vizag. In third section data from Rajkot and Vizag is used to develop three scenarios. The impact of change in built environment and infrastructure on mobility and emissions from passenger transport is analyzed. Impact of the three scenarios is analyzed on safety indicators for Vizag only as it requires detailed micro-level data for analysis.

Existing travel modes in Indian cities and trends

The NMT share is approximately 30% in cities with more than one million population and 60% in smaller cities (Wilbur Smith Associates, 2008). Approximately, 25% of the trips in cities with population more than 5 million are by PT while only 5–8% of the total trips are by PT in cities with population less than 0.5 million. Average trip length (ATL) in megacities of India (population > 8 million) is 10 km as compared to 6–7 km in medium size cities (population 4 million to 8 million).

The travel trends of three decades show a sharp decline in NMT trips while rise in motorized two wheeler (MTW) and car trips. Non-motorized travel modes include walk, bicycle and cycle rickshaw. Low income households are dependent on these modes to access employment, education and other essential services (Jain and Tiwari, 2009; Tiwari, 1999; Replogle, 1992). They are captive as they cannot afford motorized modes of transport. These users are dependent on walk and bicycle even for commuting longer distances (Mohan and Tiwari, 1999). Use of NMT has health benefits for all, however with rise in incomes and poor quality infrastructure, use of NMT has been declining.

City authorities and state governments have not invested in upgrading NMT infrastructure resulting in degrading level of service and increasing risk of road traffic crashes to pedestrians and bicyclists. This is one of the most important factors contributing to a decline in NMT trips in the past few years (Wilbur Smith Associates, 2008). Despite this, NMT dominates the travel mode share in Indian cities. This is also attributed to the dense mixed land use city structure enabling short trip lengths.

NMT is also used to access public transport system. Primarily, a PT user is a pedestrian for at least one part of the trip either during access or egress. Approximately 97% of the bus commuters surveyed in Delhi walk to access bus service (Advani and Tiwari, 2006). Provision of an appropriate well integrated infrastructure for NMT along with PT improves the utility of the public transport system and increases its catchment area. Though, dedicated infrastructure for pedestrians does

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