



## Activity based travel demand models as a tool for evaluating sustainable transportation policies

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### ABSTRACT

India is in the course of an economic transition. The economic growth nurtured the life in the cities and cities have become a major livelihood destination for everyone. This migration of people contributed to the increased urbanization of Indian cities. The booming economy fostered the well-being and shaped the lifestyle of people in such a way that the dependency on private vehicle has become an unavoidable affair. Along with population growth, the increased vehicle ownership gave rise to overall spurt in travel demand. But the supply side lagged behind the demand adding to many of the transport related externalities such as accidents, congestion, pollution, inequity etc. The importance of sustainability is understood in the current urban transport scenario leading to the development and promotion of sustainable transport policies. The core agenda of these policies is to target the travel behavior of people and change the way they travel by creating a different travel environment. However, the impacts of many such policies are either unknown or complex. Hence, before adopting and implementing such policies, it is important for the decision makers to be aware of the impacts of them. The role of travel demand models comes here as they predict the future travel demand under different policy scenarios. This paper reviews the ability of travel demand models applied in India in analyzing the sustainable transport policies. The study found that the conventional model system in India, which is trip based four step aggregate methodology, is inadequate in analyzing the sustainable transport policies. A review of alternative approach, known as activity based travel demand modeling found that they are capable of handling such policies better than conventional models and are assistive to the decision makers in arriving at right mix of policies specific to the situations. Since there is no operational activity based travel demand model system developed in India, the study at the end envisaged a conceptual framework of an integrated activity based travel demand model based on the requirements identified from the review. This can potentially replace the existing travel demand models and can be used for planning applications once the modification & validation have been done according to the existing activity-travel behavior of individuals.

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### 1. Introduction

India is in the course of an economic growth. This growth mainly depends on industrial and service sectors of the economy, which are located mainly in the cities (National Urban Transport Policy (NUTP), 2006). The cities have become the engines of

economic growth as their major share in the Gross Domestic Product (GDP) grew from 50 percent in early 1990s to 60 percent in 2001 (Ministry of Urban Development (MoUD), 2001). The growing economy nurtured the industrial, business, and other activities in the cities; offered more job opportunities & higher income, and generated wealth & general welfare. This realm of possibility of well-being attracted many into the urban area. Along with the natural population explosion, the migration of people into urban areas due to rural push resulted in increased urbanization (Datta, 2006). The overall growth in income, changes in the lifestyle and household characteristics, availability of various facilities in hand, travel environment changes etc. affect the travel behavior of people (Srinivasan, Bhargavi, Ramadurai, Muthuram, & Sreenivasan, 2007).

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A major impact of this is the increased personal vehicle ownership and use. "When the population of six major metropolises in India increased 1.9 times from 1981 to 2001, the motor vehicle ownership went up by 7.75 times" (Lohia, 2008; NUTP, 2006). The increased urbanization and vehicular growth escalated the overall travel demand, and in many cities it even exceeded the existing capacity of infrastructure facilities (Padam & Singh, 2004). The limited availability of space (Singh, 2005; World Bank, 2005) and limited resources caused the supply side to lag behind the shooting demand. Aftermath of this scenario is the urban transport crisis in the form of congestion, accidents, environment pollution, public transportation issues, urban transport inequality etc. With the prevailing scenario, there is a growing concern on the future population who are yet to join the current population as the total target population estimated as 1399.4 million in 2026 (Office of the Registrar General & Census Commissioner, India, 2001a). Hence, sustainable development is considered to be the solution for meeting the travel requirements of present population and for satisfying the needs of those who are yet to join the urban population. Many researchers have discussed various policies for achieving sustainability in transport sector (for instance: Pucher, Korattyswaroopam, Mittal, & Ittyerah, 2005) Government of India launched Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in the year 2005 and allocated substantial resources for comprehensive changes in urban sector (including urban transport) (Jawaharlal Nehru National Urban Renewal Mission, 2005). This initiative was guided and motivated by the launch of National Urban Transport Policy (NUTP) around the same time. The objectives of these policies are to manage the demand in such a way that the mobility needs of present and future generation can be met in sustainable way while reducing the transport related externalities. The fundamental tenet of these policies is to change the way by which people travel, and then, satisfy the objectives of sustainability. Considering the scarcity of resources, the policy makers should be informed about the impacts of policies likely to be adopted. This will ensure whether the investment is worthwhile or not. The role of travel demand model comes here, as it is a decision support tool to forecast travel demand and its effects under various circumstances (Bowman, 1995).

The purpose of this paper is to examine the ability of current travel demand modeling approaches in India in analyzing the sustainable transportation policies and to suggest any further improvements are required in the modeling approach. The paper is organized as follows. The second section briefly reviews the typical urban transport problems in Indian cities. Third section reviews the sustainable transport policy intervention in urban transportation context. Fourth section focuses on the travel demand modeling approach in India and their ability in analyzing sustainable transportation policies. Fifth section focus on an alternative approach called activity based approach in travel demand modeling. Sixth section reviews the travel demand modeling approaches developed based on activity approach with focus on the basic inputs, model components, and outputs. Seventh section describes the key features of activity based travel demand models and some case studies related to their policy applications. Eighth section focuses on travel behavior and activity based studies in Indian context and envisages a conceptual activity based travel demand modeling framework based on requirements identified from the review. The final section summarizes and concludes our study.

## 2. The present urban transportation scenario in Indian cities

As mentioned in the previous section, cities are the engines of growth. This is one of the reasons behind increased urbanization of Indian Cities. As per the statistics given by Ministry of Urban

**Table 1**  
Existing modal split in Indian cities (as a percentage of total trips).

City population in millions	Walk	Mass transport	IPT		Car	Two wheeler	Bicycle	Total
			Fast	Slow				
0.10–0.25	37.1	16.4	10.4	20.1	3.3	24.1	25.7	100
0.25–0.50	37.8	20.6	8.9	17.2	2.6	29.8	20.9	100
0.50–1.0	30.7	25.4	8.2	12.0	9.5	29.1	15.9	100
1.0–2.0	29.6	30.6	6.4	8.1	3.3	39.6	12.1	100
2.0–5.0	28.7	42.3	4.9	3.0	5.0	28.9	15.9	100
5.0+	28.4	62.8	3.3	3.7	6.1	14.8	9.4	100

Source: Singh, 2005.

Development (MoUD, 2001), the percentage of urban population to total population of the country is 27.8, and 35 metropolitan cities are having million plus population. The population growth from 238.4 million in the year 1901 to 1028.7 million in the year 2001 (Office of the Registrar General & Census Commissioner, India, 2001b) and the private vehicle ownership and use [the projected share of private modes is expected to be 84% in 2031, (MoUD, 2008)] stimulated by the flourishing economy let the travel demand to rise alarmingly. Along with the population growth, the cities started sprawling outward (Pucher et al., 2005; Tiwari, 2001). Most of the Indian cities are evolved from old main centers of activities and are developed along the major arterials and highways (Tiwari, 2001). Tiwari (2001) in her paper mentioned that only planned high-income residential areas in Delhi city have good quality roads. She also observed that unplanned sections, consisting of middle and low-income groups and other settlements, are widespread in the city. Moreover, industrial and manufacturing activities are also lying dispersed in the city (Tiwari, 2001). Over all the sub-urban condition in cities is an "uncontrolled mix of industrial development, dumps and obnoxious uses" (Ramachandran (1989), cited in Pucher et al., 2005).

These prevailing conditions along with higher income, changes in the lifestyle, available facilities, sociodemographics etc. influence the travel pattern of individuals (Srinivasan et al., 2007). According to Srinivasan et al. (2007), income, presence of female drivers, presence of children, young workers, distance to the work place etc. influence the vehicle ownership and usage. These factors point out to the reason behind the imbalance in modal split in many of the Indian cities (see Tables 1 and 2). The reliance on private modes, which fill the roadways, also affects the public transport operations. With the inadequate supply of infrastructure facilities, the increased vehicle ownership and travel demand give rise to various transport related externalities, which are discussed below.

Road accidents and fatalities are one of the major problems in Indian cities. The spurt in the number of vehicles, higher speed, mixed traffic conditions, lack of safety measures etc. play major role in road accidents. The statistics given by Ministry of Road Transport and Highways (MoRTH) (MoRTH, 2008) indicates that there is an increase of 32 percent in death toll related to road accidents from year 2001 to 2008 and every year 80000 people die on an average due to the same. Motor cyclists, cyclists and pedestrians are the main victims of road accidents (Tiwari and Mohan (1999), cited in

**Table 2**  
Desired modal split for Indian cities (as % of total trips).

City population in millions	Bicycle	Mass transport	Other modes
0.10–0.5	30–40	30–40	25–35
0.50–1.0	25–35	40–50	20–30
1.0–2.0	20–30	50–60	15–25
2.0–5.0	15–25	60–70	10–20
5.0+	15–20	70–85	10–15

Source: Singh, 2005.

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