ABSTRACT

Over the last few decades, rapid urbanization along with the sustained economic growth and increase in disposable income has triggered a steep rise in urban travel demand in India. The noteworthy growth of vehicle population has outstripped the uneven increase in urban road length and capacity, and thus, resulting in a sheer imbalance between demand and supply of road transport in urban India. In recent times, various externalities such as traffic congestion, vehicle emission, roadside air pollution, increase in fuel consumption, vehicle crashes etc. have reached an alarming state. In such situations, an improved traffic control measure could be used efficiently. As signalized intersections are the major bottlenecks in an urban road network, measures such as retiming, activation, progression, actuated control, etc. are found instrumental in enhancing the roadway capacity. For a corridor or network level traffic operation, area traffic control is significantly aided by signal coordination. It promotes a smooth flow of traffic resulting into the reduction in delay, number of stops, and harmonizes the speed profile. It is also found to be effective to mitigate congestion, reduce vehicle emission and fuel consumption. Therefore, from mobility point of view, coordinated operation of closely spaced traffic signals is often desirable.

Investigations on signal coordination have been carried out in several facets such as identifying the benefits from various stakeholders point of view, assessing users' perception about the system, understanding the vehicle progression and mutual interaction of roadway and traffic conditions, etc. Giving due consideration to the various findings from past works, it is now necessary to carry out further investigations on vehicle progression and develop nuggets of wisdom for successful implementation of signal coordination in urban India. Limited right of way, impedance due to the interaction of roadway and abutting land-use, road encroachment and several other pertaining issues dent the mobility in urban India. Moreover, non-lane based mixed traffic conditions are predominant in urban India making the urban roadway system in India different from the roadway systems in several other countries. Findings of past studies on several elementary aspects of signal coordination are yet to be validated in non-lane based mixed traffic environment. Therefore, the present thesis aims to carry out an investigation on vehicle progression and arterial signal coordination in the backdrop of urban India.

The workflow of the present study comprises of seven major work components which were carried out to accomplish the study objectives. The major work components were determined as (a) development of database (b) modelling of vehicle progression along arterial links, (c) configuring a micro-simulation model, (d) design of a coordinated traffic signal system, (e) field evaluation of an arterial signal coordination plan, and (f) field validation of the micro simulation model, and (g) assessment on likely benefits from signal coordination. A new performance measure, namely *Homogeneity in Speed Profile* (HISP) was suggested to evaluate the motorist's driving experience while moving along the set of coordinated links.

The key contributions of the present research work are as follows.

(a) An alternate measure to characterize non-lane based vehicle discharge, namely Vehicle Passing Intervals (VPI) at a stop-line is proposed and successfully used to identify vehicle platoon.

(b) Various empirical models were formulated using the proposed generalised functional form for various arterial width and alignment. These models provide a ready reckoner to practitioners to estimate α while carrying the design of arterial signal coordination using TRANSYT-7F.

(c) The proposed new approach for calibrating Robertson's model is found to be superior to traditional approach of calibration for providing realistic input to develop an efficient signal coordination plan.

(d) A rational approach is formulated to calibrate a micro-simulation model. The proposed calibration approach considered a number of discrete measures as measures of effectiveness (MoE) parameter. In lieu of an aggregate measure, use of multiple discrete measures enables the proposed approach of calibration for the micro-simulation model to improve the consistency of the simulation model.

(e) The key aspect of proposed signal design approaches lies in the use of micro-simulation model which is equipped to analyse the site-specific aspects more rationally than a macroscopic/mesoscopic signal design tool. The utility of such design approaches is profound for non-lane based mixed traffic system prevailing in India.

(f) Assessment of the benefits from signal coordination reveals that corridor level arterial signal coordination provides benefits to motorists of non-lane based mixed traffic system by significantly improving their arterial travel time in the direction of coordination.

(g) The proposed performance measure of signal coordination, namely 'homogeneity in speed profile' (HISP) accomplishes to rationally assess the motorists' driving experience while moving along a set of coordinated links.

(h) From network level coordination point of view, findings from the assessment on link level signal coordination can be used advantageously to decide a set of coordinated links.