ABSTRACT

Sharma, Anuj, PhD, Purdue University, August, 2008. Integrated Behavioral Economic Framework for Improving Dilemma Zone Protection Systems. Major Professors: Dr. Darcy Bullock and Dr. Srinivas Peeta, School of Civil Engineering.

There are approximately 68 million instances of signal change to yellow phase at high speed isolated intersections where an erroneous decision to stop or go can often lead to a crash. Dilemma zone protection systems are typically used to control these intersections to ensure safe and efficient movement of vehicles. This dissertation introduces a economic and behavioral framework to model the safety and efficiency of isolated high speed signalized intersections. The economic framework allows us to compare the safety benefits accrued by the main street traffic with the delay cost accrued by the cross street traffic. A behavioral-based measure is proposed to quantify the probability of crash, which is used to estimate the safety benefits accrued by extending the main street green.

A total of 446 drivers were observed at the intersection of State Route 32 @ State Route 37 to develop a behavioral decision model for the drivers on the onset of yellow. It was found that driver uses perceived acceleration to the stop bar as the decision variable for the choice to stop or go. If a driver perceive a need for acceleration to cross the stop bar within the yellow interval they typical decide to stop instead.

Dilemma hazard function can then be developed using the above described behavioral model and along with the critical acceleration and deceleration thresholds. Data collected at Noblesville, IN showed that 85 percent vehicle use rate of deceleration less than 14.41

ft/sec^2 for stopping and rate of acceleration of 3.19 ft/sec^2 for going. Any vehicle requiring a greater rate of deceleration or acceleration than threshold value faces a severe traffic conflict.

The probability of having a severe traffic conflict is used as dilemma hazard function to quantify the benefits of safety. The delay cost can be obtained by counting the number of vehicles in queue. The dilemma zone design can then be casted as marginal cost and benefits problem and an intersection can be operated so as to minimize the total cost of operation of the system.