Research Report Summary

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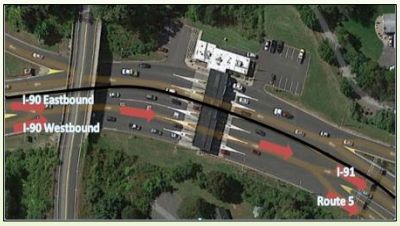
Safety and Lane Configuration at Toll Plazas

The objective of this study is to investigate the effect of toll plaza lane configuration design and traffic conditions on drivers' behavior and level of safety. The term *lane configuration* means placing lanes with different toll-collection technologies in a specific order at a toll plaza [1]. There is a hypothesis that introducing electronic toll collection (ETC) technology, while improving the throughput capacity of toll plazas and helping reduce congestion and emissions, might increase the probability and severity of collisions when used in combination with cash lanes and combo lanes (i.e., lanes that serve both cash and EZPass customers), due to the speed variance between cash and EZPass customers [2]. This study contains two approaches: a microsimulation study through VISSIM and Surrogate Safety Assessment Model (SSAM) and a driving simulation study.

This study proved the feasibility of modeling traffic conditions at a toll plaza and evaluating its safety using VISSIM and SSAM.

A microsimulation model was calibrated and validated using traffic data from a recorded video at the West Springfield toll plaza in Massachusetts, which connects Interstate 90 to Interstate 91 and Route 5. Among the lane configuration designs studied, all-ETC lanes were found to be the safest design. The second-safest condition was the clustered or grouped design in which the same lane types (i.e., EZPass or cash lanes) are grouped together versus having alternate lane types, or in other words, sparse design.



West Springfield toll plaza. An off-ramp plaza with a short distance (about 500 feet) between merging and diverging ramps, which causes a lot of weaving maneuvers and gives less longitudinal space for the drivers to switch lanes.

Driving simulator at Human Performance Laboratory, UMass Amherst. A full-cab fixed-base simulator with a Saturn sedan in front of three screens with three overhead projectors that provide 150 degrees of horizontal view and 30 degrees of vertical view.

The combo lane design (i.e., a lane that serves EZPass and cash) results in fewer conflicts, but the severity of the conflicts is high. There is a hypothesis that high severity could be due to the large difference in velocity of the cash and EZPass costumers that share the same lane. The results of this study could enable a safer transition if a traditional cash-lane toll plaza is going to be modified to serve ETC customers in the future.

The data used to validate and calibrate this model were from a limited period of time taken from only one toll plaza. To validate the results of this study and extend the results to other toll plaza conditions, more data should be collected. Different conditions, such as in/out ramp distance and number of lanes, could affect the results. The road surface and weather conditions may play a role in drivers' lane choice. The video used for analysis was collected during clear, dry conditions, but drivers may drive more conservatively in more hazardous conditions.

In the second part of the study, a driving simulation model of the same toll plaza was created to be used in the Realtime Technologies Inc. (RTI) full-cab fixed-base driving simulator to investigate drivers' behavior when they are exposed to different lane configurations and traffic and environmental conditions at toll plazas. The independent variables of this study were lane configuration, origin/destination of the subject vehicle, traffic queue, traffic composition, and customer type. The results show that having a queue (a queue of five vehicles in the cash lane closest to the subject's origin and with a transaction time of 3 seconds at the toll booth) and a slow leading heavy vehicle both significantly statistically affect the driver's lane choice in cash and EZPass scenarios, respectively. With EZPass drivers, origin-destination also affects their lane choice. According to the results, drivers are more prone to choose the right lane than the left lane. In scenarios without any queue or lead vehicle and with left-to-left origin-destination, 5 to 10 percent of drivers, depending on the lane configuration of the plaza, still switched from the left ramp to the right lane at the toll booth and went back to the left ramp after the plaza. It cost them between two to three lane crossings before the plaza and two to three lane crossings after the plaza, depending on the lane configuration. Further investigations with different plaza geometries and designs can provide a better understanding of this behavior and drivers' lane-decision-making approaches.

References

[1] Mohamed, A, Abdel-Aty, M., & Klodzinski, J. (2001). Safety considerations in designing electronic toll plazas: Case study. *ITE Journal, 71*(3), 20-33.

[2] Ding, J., Ye, F., & Lu, J. (2007). Impact of ETC on traffic safety at toll plaza. In R. Lui, D. Yang, & J. Lu (Eds.). *Plan, Build, and manage transportation infrastructure in China* (pp. 695-701). Reston, VA: ASCE.