

## Highway Design and Road Safety

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New paradigms in roadway design are focused on enhancing road user safety, convenience and comfort while meeting the societal mobility, health, safety needs. For example, one recent trend in designing and adopting complete streets had greatly increased the demand for reduced lane widths. Traffic lane widths are often reduced to make space for extra lanes, parking, bike lanes, and wider sidewalks on the existing right of way. The impact of this trend is more evident in urban areas where the right of way is often in short supply. This trend is likely to continue with the increasing demand for more active modes of transport.

This special issue of Journal of Transportation Safety & Security incorporates a collection of research articles examining urban and sub-urban roadway design. The six research articles contribute to integrated transportation safety solutions by (1) identifying new design approaches for improving safety, (2) evaluating new design approaches using driver simulation and (3) developing statistical approaches to evaluate the proposed safety solutions.

Strawderman et al. conducted a high fidelity driver simulation experiment with thirty seven participants to evaluate the effectiveness of in-vehicle warning systems and roadway environment (such as pedestrian crossing signs, marked crosswalks and sidewalks) on improving pedestrian safety at multi-modal interchanges. The driving simulation experimental design involved a repeated-measures mixed design. The participants drove through 4 multimodal transfer facilities with different designs and in-vehicle warnings. The participant behavior in the simulation was evaluated based on driver speed and lane position. The study offered interesting results. Specifically, the authors observed that in-vehicle warning systems resulted in reduced driver speed while moving closer to shoulder. In the presence of sidewalks, drivers exhibited more risky behavior by increasing speed and driving closer to shoulders. Overall, the results from the research effort contributed to our understanding of pedestrian and driver interactions for multimodal transfer locations. The analysis of in-vehicle warning systems can serve as a prelude to future research on autonomous and connected vehicles for driver behavior in general.

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With increasing emphasis on non-motorized transportation, there is growing interest in examining pedestrian vehicle conflicts at urban intersections. Iasmin et al designed a study to evaluate the impact of alternate pavement designs on safety. Specifically, the authors examined how driver turning speed at pedestrian crosswalks altered under three different pavement designs: (1) traditional design, (2) brick pavement and (3) red colored pavement. The authors conducted real-life video data collection at three intersections to evaluate the interaction of turning vehicles and pedestrians using the crosswalk. The driver speed was measured under three situations: (1) free flow condition, (2) at yellow onset and (3) when accepting the gap with pedestrian. The authors' analysis of data using multiple linear regression indicated that presence of brick and red-colored pavements affected driver turn speed. For left turning drivers, brick and red-colored pavement offered similar benefits. On the other hand, for right turning drivers, the brick pavement was found to be more effective in reducing driver turn speed. The authors recommend a larger study with more intersections and pedestrian traffic to generalize the findings.

Operation and safety performance of roadway facilities is influenced by various roadway design elements including number of lanes, presence of on-street parking, or shoulders or median. Rista et al. examined the impact of urban and sub-urban arterial lane width on safety. The authors employed multi-year crash data from state of Nebraska to evaluate the factors affecting side-swipe and rear-end crashes. The data included for the analysis contained roadway facilities with lane width ranging from 10 to 12 feet. The authors employed a random parameter negative binomial model that recognizes the panel nature of the dataset while also allowing for the consideration of site-specific unobserved factors affecting crash occurrence. The model results indicated that with reducing lane width (from 12 feet to 10 feet) the probability of side-swipe and rear-end crashes increases. For 11 feet lane width, the model results highlighted the presence of significant variability in crash occurrence due to unobserved factors. The authors recommend expanding on their research to incorporate additional advances in model estimation and data collection.

Rahman et al employed the same crash data from Nebraska to study the impact of lane width on crash frequency and severity. The authors contribute to our understanding of the role of lane width on traffic safety by developing classification and regression tree (CART) models. CART models partition the exogenous variable space into sub-populations to enhance our understanding of the response variables. For instance, CART approach enables the authors to account for heterogeneity associated with important factors such as traffic volumes, speed limits

and number of lanes. Using the CART based regression model results, the authors provide customized recommendations on lane width based on AADT, speed limit and number of lanes.

Zhao et al. study intersection-approach crashes in an effort to improve intersection associated safety. The authors specifically highlight how crash factors affecting safety at intersection approaches could vary compared to the crash factors affecting safety in the center area of an intersection. The study was conducted based on 10 years of data from signalized intersections on urban arterials and collector roads in Nebraska. The authors employed a multivariate Poisson log-normal model structure to simultaneously consider crash counts for light, moderate and severe crashes. Interestingly, the authors found that crash frequency reduced perceptibly in the presence of narrow lanes widths. Other factors affecting crash frequency include speed limit of the roadway, and AADT. The authors recommend future research to examine crash frequency by collision type to shed further light on the impact of various geometric and traffic characteristics.

In summary, these research articles provide us with exciting new approaches to influence urban roadway design and thus improve roadway safety. In terms of design, the research articles provide alternative design solutions to improving safety such as new pavement markings and lane width recommendations. In terms of research analysis methods, several advanced statistical approaches (including random parameters negative binomial model and multivariate Poisson-lognormal model) and driver simulation techniques (for in-vehicle warning systems) are evaluated.