International Co-operation on Theories and Concepts in Traffic Safety

Identifying Pedestrian Crosswalks for In-depth Safety Auditing

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Introduction

Pedestrians are vulnerable road users who suffer more severe injuries in collisions than occupants of vehicles. In recent years, a pedestrian was killed in one out of twelve pedestrian collisions in Indiana, which is twice the typical frequency experienced in the past. Identifying high-risk crosswalks must differ from the screening method established for vehicles. The current methods for vehicles rely on clusters of crashes that are sufficiently large to warrant safety auditing or even to select adequate safety countermeasures. On the other hand, pedestrian-vehicle crashes in the USA are typically strongly dispersed across roads. The number of collisions at a single location during a screening period of three years unlikely exceeds one. The problem is further complicated with the typically unknown pedestrian volumes. The presented research was focused on developing a practical method of screening large road networks for high-risk pedestrian crosswalks within intersection areas (Figure 1) under the general lack of pedestrian volume to narrow the location to a manageable number that could be further investigate by auditing. The presented method was developed for the state of Indiana in the USA.

Research Methodology

The pedestrian count data are scarce and their collection prohibitively expensive. A multinomial logit model was used to link the land use, vehicle traffic, and roadway characteristics with seven Crossing Activity Levels (CAL) based on 514 urban pedestrian crossings in Indiana (Figure 2) with known pedestrian AADTs. The developed model provided an unprecedented ability to obtain a sound estimate of pedestrian presence at any urban intersection in Indiana (Figure 3). The model was then applied to estimate the pedestrian crossing activity levels at a large number of Indiana urban crosswalks.

Then, the sequential binary logit framework was used to estimate the crash probabilities at four severity levels, namely property damage only, non-incapacitating, incapacitating, and fatal for 1,985 intersection segments with crosswalks with at least one pedestrian-vehicle crashes (2,456 such crashes in total) supplemented with randomly selected 10 times more segments with no pedestrian crashes.

Results and Implementation

The analysis confirmed the strong effect of speed limits on pedestrian safety together with other local conditions. The knowledge of the pedestrian activity level allowed the research team to separate the pedestrian exposure factor from other safety factors and to develop intuitive crash probability and severity models that include estimated effects of pedestrian traffic, vehicle traffic, built environment, speed limits, and traffic control. Since the available data included observations from 2020, the COVID-19 effect was estimated. Estimating this effect was helpful to adjust for its presence and to avoid bias in future safety analyses when this effect is not present.

A more practical and accurate estimation of crash probability was achieved by combining it with actual crash counts using the specialized probabilistic EB method. The EB method is widely used in current safety management practice to adjust crash counts. An Empirical Bayes (EB) method based on the beta distribution was proposed to improve the crash probability estimates with past crash occurrence and resulting injury severity.

The pedestrian safety model provided the basis to identify high-risk urban intersection segments for safety audits and improvements of pedestrian crossings. The screening criterion includes the crash cost calculated with the crash risk and severity models. A screening criterion alternative to the crash cost is the crash probability obtained for intersection legs with pedestrian crosswalks. The full research report is available at https://doi.org/10.5703/1288284317438 .

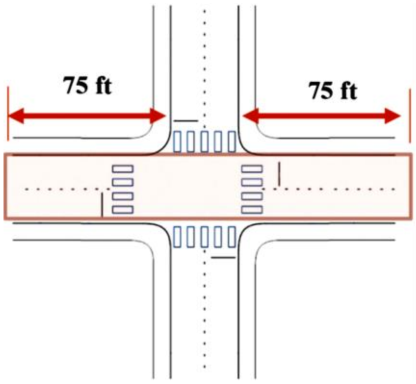

Figure 1 Intersection crosswalk area

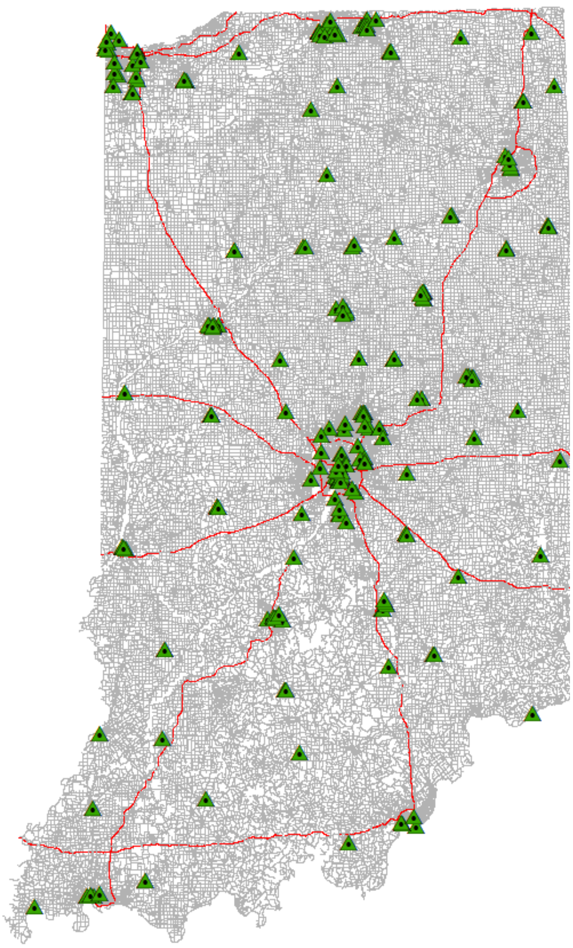

Figure 2 Locations with CAL values

Obs CAL	Pred CAL 1	2	3	4	5	6	7
1	11	3	16	6	0	0	0
2	3	3	53	21	0	0	0
3	2	5	77	53	0	0	0
4	0	2	54	91	2	5	0
5	0	1	13	46	4	1	0
6	0	0	3	15	0	6	4
7	0	0	0	1	0	2	11

Figure 3 Observed vs. predicted CAL values