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Modelling the impacts of transportation hazards on truck-involved crash frequency on cold region rural highways

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Abstract

The highway safety manual [1] provides guidance on predicting crash frequency (CF) based on safety performance functions (SPFs) — multiple linear regression models predicting CFs under a set of driving conditions — and crash modification factors (CMFs) — multiplicative factors applied to SPFs. The goal of this research is to mitigate crash risk to freight transport trucks travelling on rural highways located in cold regions such as the Canadian Prairies. The research objectives are twofold. First, this research attempts to develop (i) truck SPFs that predict truck-involved CFs, and (ii) hazard-specific CMFs reflecting the change in truck CFs due to transportation hazards for cold region rural highways. Second, this research intends to identify transportation hazards (hereinafter hazards) with significant crash risks.

The research methodology consists of three steps. First, police-reported truck-involved crash data on rural highway segments of Alberta, Canada, from 2015 to 2017 were used to develop truck SPFs for (i) four crash severity levels: total, fatal, personal injury (PI), and property damage only (PDO), and (ii) two highway segment types: rural two-lane two-way highways (R-TL-TWH) and rural multilane highways (RMH). In this research, each trucks SPF was developed as a negative binomial regression model — a multiple linear regression model in which the dependent variable is assumed to follow the negative binomial distribution. The dependent variable of all truck SPFs developed in this research represents the annual truck-involved CF on a rural highway segment in Alberta. The independent variables include (i) $AADT$: annual average daily traffic, (ii) Trp: percentage of trucks, (iii) N: number of lanes (for RMHs), (iv) L: highway segment length, (v) highway horizontal alignment, (vi) highway vertical alignment, and (vii) transportation hazard(s) present, for each highway segment considered. Second, the exponents of regression model coefficients of truck SPFs were used to estimate hazard-specific CMFs for each hazard for a specific highway type and a collision severity type. Third, hazards with significant crash risks were identified based on the (i) numerical value of each hazard-specific CMF, and (ii) statistical significance of regression model coefficients used to estimate hazard-specific CMFs.

According to the study results, most hazard-specific CMFs (e.g., snow, fog) were deemed statistically insignificant implying the absence of a statistically significant relationship between truck-involved CF and the presence of hazards. Of the statistically significant CMFs, the CMF for poor visibility (CMF=1.5) suggests that poor visibility increases PI type truck-involved crashes on R-TL-TW segments by 50% as compared to the frequency of such crashes attributed to crash causes other than transportation hazards. The impact of wildlife on truck-involved CF was also deemed statistically significant. Current research on this topic includes evaluating the effectiveness of Provincial Wildlife Sanctuary Corridors, a wildlife-vehicle collision mitigation measure, on reducing truck-involved wildlife-vehicle collisions in Alberta. Road safety researchers and practitioners may adapt the study methodology to effectively rank hazard risks to a highway freight transportation system, thus prioritizing safety countermeasures designed to mitigate truck crashes attributed to transportation hazards that intensify truck vulnerability.

Keywords: truck crash modelling, transportation hazards, safety performance functions, crash modification factors

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References

[1] American Association of State Highway and Transportation Officials (AASHTO), Highway Safety Manual (1st Edition) with Supplement, 2010