NON-STATIONARY MODELING OF ROAD-CURVE CRASH FREQUENCY WITH GEOGRAPHICALLY WEIGHTED REGRESSION

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Abstract

Vehicle crashes on roads are caused by many factors. However, the influence of these factors is not necessarily homogenous across locations, which is a challenge for non-stationary modeling approaches. To address this problem, this thesis not only evaluated the safety performance of high friction surface treatment (HFST) installations throughout Indiana using empirical Bayes (EB) analysis, but also adopted two types of methods that allowed the parameters to fluctuate among observations (the random parameter approach and the geographically weighted regression or GWR approach). With road curvature, curve length, pavement friction, and traffic volume as the independent variables, this thesis modeled vehicle crash frequencies using two non-spatial models (the negative binomial (NB) model and the random parameter negative binomial (RPNB)), as well as three spatial models (the GWR approach including geographically weighted Poisson regression (GWPR), the geographically weighted negative binomial regression (GWNBR), and the global geographically weighted negative binomial regression (GWNBRg). These models then were calibrated at the macro-level and micro-level using a dataset of 9,415 horizontal curve segments with a total length of 1,545 kilometers for a period of three years (2016-2018) throughout Indiana. The results revealed that the GWR approach successfully captured spatial heterogeneity and thereby significantly outperformed the conventional non-spatial

approach. Among the GWR models, the GWNBR model performed better for the Akaike Information Criterion (AICc) and the spatial distribution of the coefficients. This thesis also found that pavement friction and curve length had less influence on crash frequency in forest areas than in plain areas. Furthermore, pavement friction tended to have the most considerable impact on crash frequency in unpopulated areas with sparse curve distributions. It is expected the findings of the thesis can be adopted for Indiana highway curve safety improvement and other spatial heterogeneity problems application.