Developing Safety Performance Functions for Urban Intersections in Sri Lanka

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Declaration

I hereby declare that to the best of my knowledge, this submission is my own work and it neither contains direct material previously published nor written by another person or material, which to substantial extent, has been accepted for the award of any other academic qualification of a university or other institute of higher learning except where acknowledgement is made in the text.

Certified by

Signature : ………………

Date :…………..18/02/2022………….

Name of Supervisor :……Prof. Niranga Amarasingha..

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Date :…………18/02/2022…………

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Abstract

Crash frequency modeling is a good approach in identifying factors that influence on crash frequency at road ways or intersections. This research study aimed at developing Safety Performance Functions (SPFs) for urban intersections in Sri Lanka based on crash frequency modeling. This is a novel approach in the local context. The study accommodated 369 urban intersections. For each intersection, crash data, geometric data and traffic related data were collected. Out of 369 urban intersections, 107 intersections were located in Colombo district. An intersection was the unit of analysis in crash frequency modeling. Data were obtained for the period from 2015 to 2019. Police reported crash data under all severity levels were considered for the study. Geometric variables included width of lanes, shoulder, median, side walk and existence of geometric features at an intersection. Vehicle Kilometers of Travel (VKT) data were considered in terms of traffic data. VKT data were collected through an island-wide paper-based travel survey. As timely VKT data are not available with the relevant authorities in the country, estimating VKT is one of key contributions to the existing literature.

Count data modeling methods; Poisson and Negative Binomial regression models were adopted to develop crash frequency models. In the study, two different SPFs were developed for Colombo district and the entire country. Out of 36 independent variables that related to geometry and traffic characteristics of urban intersections, few variables were remained statistically significant in the developed crash frequency models. Existence of left turn lanes on major leg, bus halting places, traffic signal lights, illegal road side parking, roads connected to minor leg and average shoulder width of major road variables were remained statistically significant in the Colombo district crash frequency model. In the model that was developed for urban intersections in Sri Lanka, VKT, existence of left turn lanes in minor leg, right turn lanes in major leg, traffic signal lights, road hand rails, presence of approach lanes in the minor leg, existence of kerbs in the minor leg, existence of roads connected to the minor leg, road signs and width of median in the major road variables were found statistically significant. Those variables were recommended to appear in the SPFs. Identifying influencing traffic and geometric variables on crash frequency at urban intersections in Sri Lanka is another key contribution from this study.

SPFs illustrated crash frequency at urban intersections in terms of statistically significant variables with a link function. This is the ultimate output of the research study that allowed to propose and compare the most suitable countermeasures in improving safety at urban intersections. Also, limitations and recommendations of the study were discussed that can effectively be adopted in future research studies for a better approach in determining crash frequency at urban intersections in Sri Lanka.

Key words: Crash frequency models, Safety performance functions, Urban intersections, Count data modeling methods, Significant variables.

Table of Contents

List of Tables

List of Figures

Abbreviations

WHO	: World Health Organization
NCRS	: National Council for Road Safety
DMT	: Department of Motor Traffic
DCS	: Department of Census and Statistics
FHWA	: Federal Highway Administration
TPHQ	: Traffic Police Headquarters
USA	: United States of America
SPMs	: Safety Performance Models
SPFs	: Safety Performance Functions
AADT	: Annual Average Daily Traffic
HSM	: Highway Safety Manual
NB	: Negative Binomial
GLMs	: Generalized Linear Models
GAMs	: Generalized Additive Models
AIC	: Akaike Information Criteria
VMT	: Vehicle Miles of Travel
MSNB	: Markov Switching Negative Binomial
MLE	: Maximum Likelihood Estimation
MCMC	: Markov Chain Monte Carlo
MVPLN	: Multi Variate Poisson Log-Normal
ANN	: Artificial Neural Network
SVMM	: Support Vector Machine Models
KNNR	: K-Nearest Neighbor Regression
IAZs	: Intersection Analysis Zones
MAZs	: Middle Analysis Zones
PDO	: Property Damage Only
VKT	: Vehicle Kilometers of Travel
AVGLWMJ	: Average Lane Width-Major
AVGLWMN	: Average Lane Width-Minor
AVGSWMJ	: Average Shoulder Width-Major
AVGSWMN	: Average Shoulder Width-Minor

SWWMJ	: Side Walk Width-Major
SWWMN	: Side Walk Width-Minor
MWMJ	: Median Width-Major
MWMN	: Median Width-Minor
OWL	: One-Way Legs
LLMJ	: Left turn Lanes-Major
LLMN	: Left turn Lanes-Minor
RLMJ	: Right turn Lanes-Major
RLMN	: Right turn Lanes-Minor
CCWMJ	: Conventional Cross Walks-Major
CCWMN	: Conventional Cross Walks-Minor
CCWRIMJ	: Conventional Cross Walks with Refuge Islands-Major
CCWRIMN	: Conventional Cross Walks with Refuge Islands-Minor
BH	: Bus Halts
TC	: Traffic Controlling
RR	: Road hand Rails
IRSP	: Illegal Road Side Parking
ALMJ	: Approach Lanes-Major
DLMJ	: Departure Lanes-Major
LBMJ	: Lane Balance-Major
ALMN	: Approach Lanes-Minor
DLMN	: Departure Lanes-Minor
LBMN	: Lane Balance-Minor
CI	: Central Islands
SI	: Splitter Islands
CHN	: Channelization
KBSMJ	: Kerbs-Major
KBSMN	: Kerbs-Minor
RS	: Road Signs
EXRMJ	: Existence of Roads connected to Major
EXRMN	: Existence of Roads connected to Minor
VIFs	: Variance Inflation Factors
MSE	: Mean Square Error
RMSE	: Root Mean Square Error