Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 54(11) (2023) 859-862
DOI: 10.22060/ceej.2022.20546.7457

Rural Road Safety Monitoring Using Crash Severity Predictive Models: A Case Study of Khorasan Razavi Province in Iran

A. H. Taheri, A. Rasaizadi, S. H. Seyedabrishami*

School of Civil and Environmental Engineering, Tarbiat Modares University, Tehran, Iran

ABSTRACT: The high severity of crashes caused by high-speed vehicles is one of the drawbacks of intercity transportation. Heavy costs are linked to severe crashes, including death, injuries, and damage to the road, road equipment, and vehicles, as well as major psychological effects. This study uses predictable traffic characteristics to forecast the severity of crashes on suburban highways using logit family models. As a result, the traffic data from the traffic detectors on the roadways is integrated with the crash data in the first stage before being evaluated and modeled. Spatial-temporal scenarios are combined with these two datasets. In this investigation, the ordered logit (OL) and multinominal logit (MNL) models were used. The data, which refers to the roads in Iran's north-eastern province of Khorasan Razavi, was collected over a four-year period. Results indicate that the MNL model performs better than the OL model with more significant traffic parameters

Review History:

Received: Sep. 13, 2021
Revised: Apr. 26, 2022
Accepted: Aug. 06, 2022
Available Online:Aug. 29, 2022

Keywords:

Crash severity
Ordered logit
Multinominal logit
Descriptive modelling
Predictive models

1- Introduction

Due to population growth and urbanization in developing nations like Iran, the need for transportation has obviously increased during the past few years. Challenges including traffic congestion, environmental pollution, and an increase in the frequency and severity of crashes can be anticipated as a result of the rise in transportation demand [1]. As a result, it is crucial to have a thorough understanding of the numerous contributing elements to road traffic crashes to be able to forecast hazardous conditions and make the roads safer. The modeling approach makes use of independent descriptive factors including traffic parameters. For short-term prediction, these variables are verifiable. In this study, the suggested method for utilizing independent variables provides the basis for estimating crash severity. Additionally, it is anticipated that the predicted traffic factors will be accessible in the future. A wide variety of variables are also useful in generating reliable and valid results. The primary contributions of this study are the integration of various spatio-temporal scenarios based on the application of data fusion approaches and probabilistic models to assess the severity of crashes.

2- Data and methodology

The data used was gathered over a four-year period on all roads in Iran's northeastern province of Khorasan Razavi. Models from the logit family, including OL and MNL models, are used to predict the severity of crashes [2]. The three levels of analysis for the crash severity examined in this study are damage, injuries, and fatalities. The distribution of the different crash severities is shown in Table 1.Circles with a radius of 500 m are drawn in the center of each detector to integrate the data collected by the detectors on crashes and traffic parameters like traffic volume and average speed. The traffic data obtained from the detectors and the related crashes in the zones are merged.

Table 1. Summary of crash severity

Variable Description	Damage		Injury		Fatal		All
	Count	%	Count	%	Count	%	
Crash Severity	175	38.21	253	55.24	30	6.55	485

*Corresponding author's email: seyedabrishami@modares.ac.ir

Table 2. The fitness of models

Model	Ordered logit	Multinomial logit
ρ^2	0.017	0.019

Table 3. Calibration result of multinominal logit model

Choice	Variable	Coefficient	t-value
Damage	Minimum headway	-0.011	-2.38
Injury	Constant	-1.113	-4.29
	Heavy vehicle flow	0.163	1.74
	Dummy variable, if the maximum speed above 85 km/h = 1, otherwise = 0	0.510	2.09
Fatal	Constant	-2.815	-9.09
	Dummy variable, if the maximum speed above 85 km/h = 1, otherwise = 0	0.510	2.09

3- Results and discussion

After calibrating ordered and multinomial logit models, in terms of p^2, the highest fitness is achieved by multinominal logit model. Table 2 shows the fitness of models.

Table 3 shows the output of the MNL model.

The variable "minimum headway" is significant with the t -value -2.38 in damage crashes. The coefficient of this explanatory variable for traffic is -0.011; In other words, if the minimum headway decreases, the probability of crashes occurring increases. It is also important to note that decreasing the distance between the two vehicles increases the driver's caution, that is, slows down and, consequently, deceleration is one of the effective factors in reducing the severity of crashes [3]. The variable "heavy vehicle flow" with a t-value of 1.74 is significant for fatal crashes. The coefficient of 0.163 indicates that this variable is an effective factor in causing crashes with injury and that it seems reasonable; because increased heavy vehicle flow is one of the most effective factors in the occurrence of more severe crashes on suburban roads [4]. The variable "maximum speed above 85 km / h" with a t-value of 2/09 was significant for both injuries and fatal crashes. A positive coefficient of 0.510 indicates the effect of this variable on the occurrence of more severe crashes, which also seems logically correct; because speeding is one of the main reasons why accidents with greater severity occur [5].

4- Conclusion

Similar to previous studies in modeling the severity of accidents and their results [2, 6, 7], in this study, an acceptable range of independent variables with a traffic nature has become significant. In both OL and MNL, a number of independent factors are significant. The importance of these factors reveals the importance of their impact on the accidents with various degrees of severity. The volume of heavy vehicles and the maximum speed exceeding 85 km/h are two examples of these variables. One of the strengths of the MNL model over the OL model is the significance of the "minimum headway" variable, which significantly enhances the model in terms of statistics and interpretation. The models forecasting the severity of accidents will be able to evaluate the safety state of suburban roads if the values utilized in the models are accessible for the near future. When the situation for road safety is determined to be severe, actions including alerting passengers via smart signage along the route, employing traffic enforcement tools like speed control, and reducing traffic flow can be taken to improve the situation before any crashes happen [8, 9, 10].

References

[1] E. Rahimi, A. Shamshiripour, A. Samimi, A.K. Mohammadian, Investigating the injury severity of single-vehicle truck crashes in a developing country, Accid Anal Prev, 1(137) (2020) 105444.

[2] A.Taheri, A. Rasaizadi, S. Seyedabrishami, Temporal Analysis of Crash Severity: Multisource Data Fusion Approach. Discrete Dyn Nat Soc (2022).

[3] M. Zhu, X. Wang, J. Hu, Impact on car following behavior of a forward collision warning system with headway monitoring, Transp. Res. Part C Emerg, 1(111) (2020) 226-244.

[4] C. Chen, j. Zhang, exploring background risk factors for fatigue crashes involving truck drivers on regional roadway networks: a case control study in Jiangxi and Shaanxi, China, Springerplus, 5(1) (2016) 1–12.

[5] A.j. Khattak, R.J. Schneider, F. Taga, Risk factors in large truck rollovers and injury severity: analysis of single-vehicle collisions, Transp Res Rec, 40 (2003) 1–22.

[6] M. Rezapour, S.S. Wulff, K. Ksaibati, Examination of the severity of two-lane highway traffic barrier crashes using the mixed logit model, J Safety Res, 70 (2019) 223-232.

[7] F. Chen, S. Chen, X. Ma, Analysis of hourly crash likelihood using unbalanced panel data mixed logit model and real-time driving environmental big data, J Safety Res, 65 (2018) 153-159.

[8] N.A. Khan, N. Jhanjhi, R.S.A. Brohi, U.A. Nayyar, Smart traffic monitoring system using unmanned aerial vehicles (UAVs), Comput, 1(157) (2020) 434-443.

[9] L.S. Iyer, AI enabled applications towards intelligent transportation, Transp. Eng., 1(5) (2021) 100083.

[10] F. Afshar, S. Seyedabrishami, S. Moridpour, Application of Extremely Randomised Trees for exploring influential factors on variant crash severity data, Sci, 12(1) (2022) 1-19.

HOW TO CITE THIS ARTICLE

A. H. Taheri, A. Rasaizadi, S. H. Seyedabrishami, Rural Road Safety Monitoring Using Crash Severity Predictive Models: A Case Study of Khorasan Razavi Province in Iran , Amirkabir J. Civil Eng., 54(11) (2023) 859-862.

DOI: 10.22060/ceej.2022.20546.7457