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ANALYSIS OF FACTORS AFFECTING THE SEVERITY OF TWO WHEELED VEHICLE ACCIDENTS

Qian Cao[*1], Qingyin Li[2], Aimei Sun[3], Shuncai Luo[4] & Xin Zhou[5]
[*1,2,3,4&4]School of Transportation and Vehicle Engineering, Shandong University of Technology, Zibo 255000, China

ABSTRACT
In order to analyze the influencing factors of the severity of two wheeled vehicle collision accidents, through the descriptive statistics of the traffic accident data involving two wheeled vehicles in Zibo City from 2015 to 2021, nine important influencing factors are selected for analysis, a hybrid logit model is established, and the Monte Carlo Markov chain algorithm is used to estimate the parameter distribution of the model. The results show that visibility, week, drunk driving, retrograde and weather have a significant impact on the severity of the accident, while gender has no significant impact.

Keywords: *traffic safety, mixed logit model, influence factor, Accident severity.*

1. INTRODUCTION

Two wheeled vehicles have become an important means of transportation for residents' commuting, entertainment and other travel needs because of their flexibility, low price and suitability for short distance travel. However, the two wheeled vehicle also has the characteristics of difficult control and lack of safety measures, and when it collides with a car, it is very easy to cause two wheeled vehicle drivers and passengers to be injured or even die. Due to the characteristics of urban road planning, the intersection has become the high incidence place of two wheeled vehicle and car collision accidents. Therefore, it is of great significance to study the influencing factors of two wheeled vehicle and car collision accidents at the intersection for traffic control.

With the rapid development of transportation, the problem of traffic safety has also attracted people's attention. Analyzing the influencing factors of accidents is of great significance to road design and traffic control. Domestic and foreign experts and scholars analyze historical accident data, establish accident models, and analyze and mine the occurrence mechanism of accidents. At present, there are rich research achievements in the analysis of influencing factors and analysis methods of traffic safety. Many experts and scholars have proposed a variety of optimization models to analyze the accident mechanism in depth according to the discrete and heterogeneous characteristics of accident data. At present, the theoretical system has been relatively perfect [1-2]. According to the differences and emphasis of different regions, experts and scholars have different research focuses, which can be mainly divided into two categories: Objective influencing factors [3-6] and subjective influencing factors [7-8].

Various factors of the external environment have a great impact on the severity of the two wheeled vehicle accident, and the influence of environmental factors in different regions is also quite different. Athanasios theofilatos[9] and others used Greek accident data to study the influencing factors of traffic accidents inside and outside the urban area, and found that the impact of 18-30-year-old people on the severity of accidents in the urban area is significantly higher than that outside the urban area, but frontal collision outside the urban area is more likely to increase the risk of accidents. Lin hu[10] et al. Analyzed the historical data of the collision between two wheelers and cars in Yinzhou District of Ningbo and found five significant influencing factors. Due to reduced visibility and other reasons, rainy, cloudy and foggy days have the highest risk of serious injury. In addition, the risk of male casualties at intersections is as high as 3.31 times that of women. Younshik chung[11] and others used on-board records to analyze the severity of injuries suffered by two wheeled cyclists in the

collision with taxis, and found seven significant influence variables. In addition, the behavior of taxi drivers can effectively reduce the occurrence of serious injuries. Laura ebol[12] et al. Distinguished different collision types (scratch, frontal impact) and studied the factors affecting the severity of the accident respectively. The research shows that the road factor is the main factor affecting the nature of the accident, the location (intersection / road section) variable is the most significant, and the accident occurring at the intersection is more serious. In addition, regardless of the severity of the accident, the impact of gender variables is the least significant.

Scholars at home and abroad have studied the impact of different human factors on the severity of accidents from the perspective of human characteristics. Van elslande[13] and others studied the existing results of the analysis and Research on the influencing factors of two wheeled vehicle accidents, and found that human factors are common in two wheeled vehicle collision accidents, external environmental factors more affect the severity of the accident, and the accidents are mostly caused by human factors. Marissa B. esser[14] and others used Indian accident data to analyze the impact of alcohol on traffic safety. The study found that compared with car drivers, the probability of serious accidents after drinking alcohol by two wheeled cyclists was reduced by 90%. Drinking alcohol at night was the most in a day, and visibility was reduced. Therefore, the probability of serious accidents caused by drinking alcohol at night was nearly tripled. Laurie brown[15] and others analyzed the accident data involving two wheelers in European countries and found that the attention of Two Wheeler riders is easy to be distracted. At this time, when other vehicles turn and cross in front of the two wheeler, the risk of serious or fatal injury to two wheeler riders will increase. George yannis[16] and others used the data of the Greek National accident database to study the impact of driver age and engine size on the injury degree of two wheeled cyclists. The research showed that driver age had a significant impact on the severity of the accident, while engine size had no significant impact. Jiang Liang [17] and others collected six influencing factors through questionnaires. Through analysis, they found that risky driving behavior and adventurous spirit are important factors affecting traffic safety.

Experts and scholars at home and abroad have laid a systematic theoretical foundation for future generations' research in the process of traffic safety research. However, due to the spatiotemporal heterogeneity of traffic accidents, regional characteristics should be included in the analysis model for the study of different regions. Therefore, this paper uses the two wheeled vehicle accident data of a province to establish a mixed logit model to analyze the main influencing factors of the accident, so as to provide reference for regional traffic control.

2. DATA ANALYSIS AND PROCESSING

The data of two wheeled vehicle collision accidents in a province from 2014 to 2019 are selected as the sample data. Start with the four elements of people, vehicles, roads and environment, preprocess the data, delete the seriously missing variables, and retain the variables related to the four elements of traffic. After processing, each accident information record contains the specific date, time, type of accident, road conditions, weather conditions, visibility, and whether there is drinking, retrograde behavior and other variables, and finally 4777 two wheeled vehicle accident data are obtained. In all samples, only property damage accidents account for only 2% of the total accidents, and injuries and fatal accidents account for 61% and 37% respectively. It can be seen that there is a great possibility of injury or even death in the collision between two wheeled vehicles and cars. The specific distribution is shown in Figure 1:
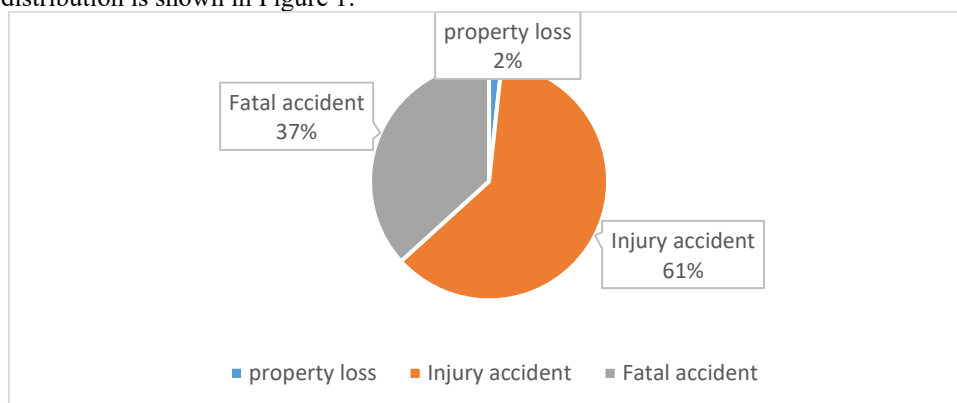

Figure 1 Accident severity distribution

Due to the influence of people's work and life, electric vehicle travel is also affected by it, which has certain time distribution characteristics. In terms of the time of the accident, the number of accidents during the day from 10:00 to 16:00 is the largest, accounting for 28.55% of the total number of accidents. The main reason may be caused by the long peak period during the day. Secondly, the morning and evening peak accidents occurred most, accounting for 9.15% of the total number of accidents. Due to the influence of light factors, the evening peak was slightly higher than the morning peak, accounting for 15.05% of the total number of accidents. Because the peak period was shorter than the peak period, the total amount of the story was slightly lower than the peak period. However, in the whole day distribution of accidents, the number of accidents in the peak period is significantly higher than that in other periods. The change trend of accident volume in time is basically consistent with the traffic volume, showing a saddle shape, which indicates that there is a certain correlation between accident volume and traffic volume.
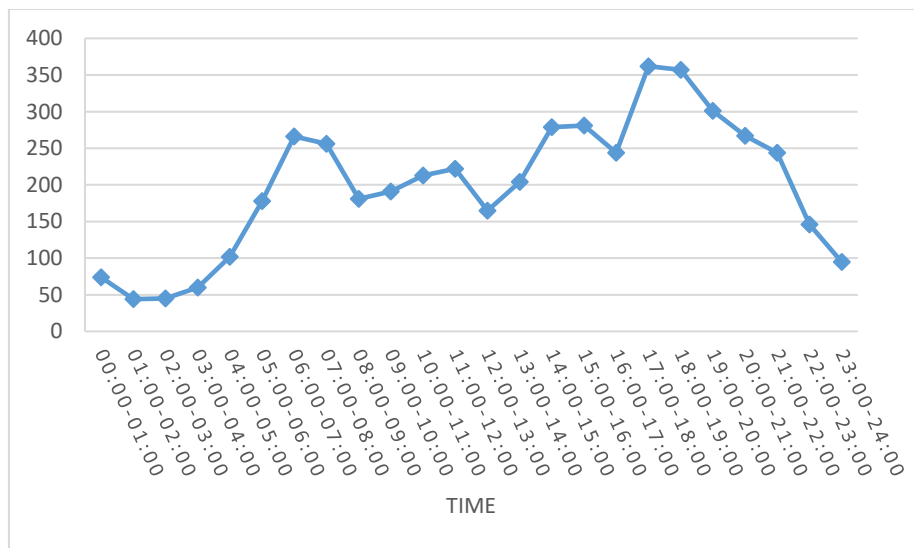

Figure 2 Distribution characteristics of accident period

The average number of accidents of two wheeled vehicles on weekends is slightly higher than the average number of accidents on weekdays. In terms of the number of accidents on a single day, the total number of accidents on Wednesday is the largest. Mainly because people's travel demand on weekends is not concentrated on commuting, and the travel rise caused by shopping, entertainment, education and other needs, the total travel volume increased compared with the working day.
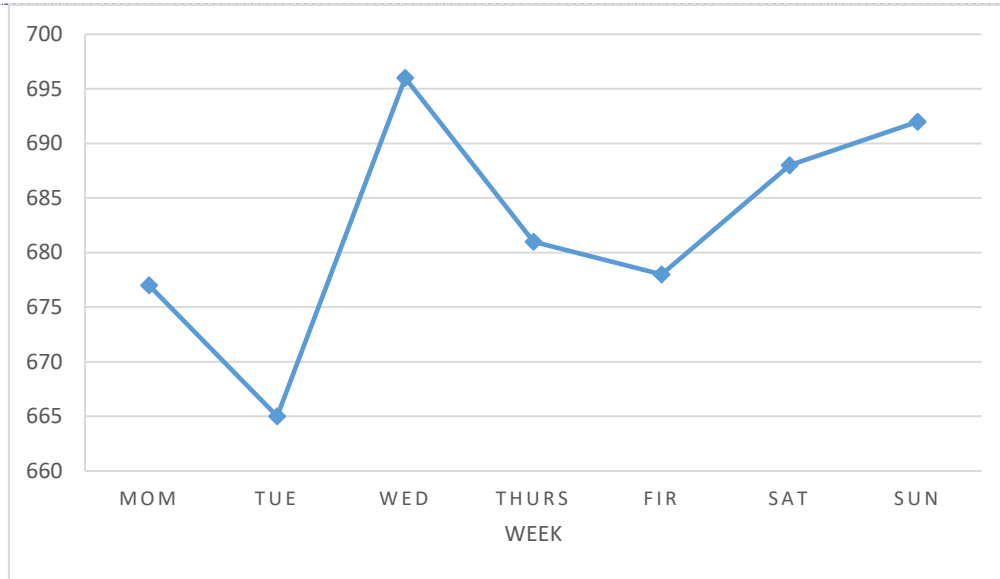
Figure 3 Distribution of accidents in each day of the week

There is also an imbalance in the distribution of the number of two wheeled vehicle accidents in the month. The number of accidents in January and February is the smallest, which is different from the conventional cognition. Although there is more snow in January and February and the road is wet and slippery, people are often unwilling to choose two wheeled vehicles without heating performance when traveling in January and February due to the cold weather. Coupled with the impact of migrant workers returning home during the Spring Festival, the number of two wheeled vehicle trips is reduced, resulting in a small decline in the number of accidents.
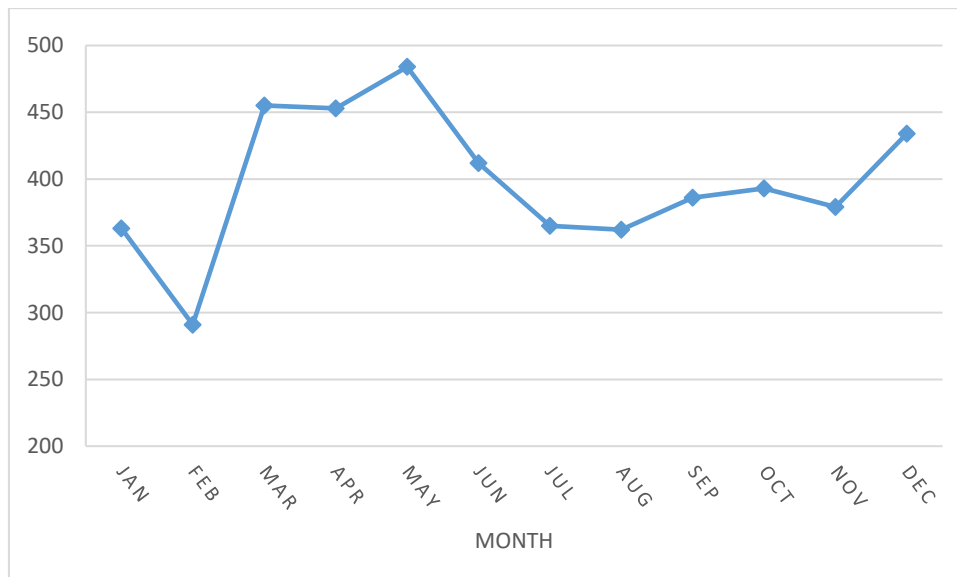

Figure 4 Distribution of accidents in each month

Under the influence of weather, sunny days have the largest number of accidents, accounting for 87.61%. Some studies have shown that the accident rate increases significantly with the decrease of visibility and the deterioration of road conditions in bad weather. However, due to the large proportion of sunny days in a year, there is a large number of sunny accidents. The number of accidents with visibility above 200 meters is the largest, accounting for 43.31%, and the number of accidents below 50 meters is the smallest, accounting for 19.91% of the total number of accidents. There is no big difference between the number of accidents between 50-100 meters and 100-200 meters, but the death probability of accident personnel with visibility below 50

meters is as high as 42.00%, which is much higher than the death rate under other visibility conditions. Under the influence of weather conditions, the road condition is generally dry. In terms of gender, there is no significant difference in the accident data. Women account for 50.91% of the accidents and men account for 49.09%.

In order to facilitate modeling research, variables are coded. All variables are coded beginning with 1, and all variables coded as 1 are taken as the benchmark variables of this influencing factor.

Table 1. Data coding results

Variable name	assignment
Severity	1= property loss ; 2= injured ; 3= death
Occurrence period	1=[00 : 00, 07:00) ; 2=[07:00,10:00) ; 3=[10:00-16:00) ; 4=[16:00-19:00);5=[19:00-00:00)
Week	1= weekdays ; 2= weekend
Season	1= spring ; 2= summer ; 3= autumn ; 4= winter ;
Weather	1= sunny ; 2= overcast ; 3= rain ; 4= fog ; 5= snow
Visibility	1=below 50 meters ; 2=50-100m ; 3=100-200m ; 4=more than 200 meters
Pavement condition	1= dry ; 2= damp ; 3= ponding ; 4= ice and snow
Drunk driving	1= not drinking ; 2= drink wine
Retrograde	1=not retrograde ; 2= retrograde
Gender	1= female ; 2= male

3. MODEL BUILDING

The occurrence and severity of accidents are jointly affected by many factors. When recording accidents, some factors are often omitted, resulting in certain heterogeneity of accident data. In order to reduce the impact of data heterogeneity on the analysis results, this study introduces random parameters and establishes a mixed logit model to analyze the factors affecting the severity of the accident.
mixed logit model

The mixed logit model is also called random parameter model. It introduces random parameters on the basis of the standard multinomial logit model, allowing parameters to change randomly among individuals, and characterizes individual heterogeneity through the distribution (mean, standard deviation) of model parameters, so it can better adapt to the impact of data heterogeneity.
The probability distribution of the mixed logit model is shown in formula (i):

$$P_i(j) = \frac{\exp{(\alpha_{ij}+\bar{\beta}_j^T x_i)}}{\sum_{j\in J}\exp{(\alpha_{ij}+\bar{\beta}_j^T)}} \qquad (i)$$

$\bar{\beta}_j$ is the model parameter, and its value is random and follows a certain distribution, that is $\bar{\beta}_j \sim f(\bar{\beta}_j|\theta)$ .Where vector $\bar{\beta}_j$ The k component of is

$$\bar{\bar{\beta}}_{ijk} = \mu_{kj} + \sigma_{kj}v_{ijk} \qquad (ii)$$

Among them, μ_{kj} refers to the average parameter of the kth independent variable when the accident severity is j, σ_{kj} refers to the parameter standard deviation of the kth independent variable when the accident severity is j, v_{ijk} is the unobservable random effect of the ith accident, and its mean and variance are 0 and 1 respectively.

Construction of mixed logit model
Take the injury severity as the dependent variable, the type "1" in the injury severity as the reference variable, seven influencing factors as the independent variable, and the independent variable coded as "1" as the benchmark variable of the influencing factor. The maximum likelihood method is used to estimate the parameters of the model, and Monte Carlo Markov chain (MCMC) generation is used to estimate the probability distribution of the parameters of the model, and then the parameters of the model are solved. The results of the model show that the Monte Carlo Markov chain (MCMC) iterates 12500 times in total. When the model iterates

to 25000 times, it begins to converge. In order to ensure the accuracy of the estimation of the model parameter distribution, the 25000 iterations before convergence are discarded. Finally, the parameter estimation results of the mixed logit model are obtained, as shown in Table 2.

Table 2. Parameter estimation results

Variable name	Classification statement	Injured			Death		
		Coef.	OR	p	Coef.	OR.	p
Week	weekend	.098	1.06	0.037*	.071	1.05	0.013*
Season	summer	.154	1.11	0.039*	-	-	-
	autumn	.180	1.13	0.039*	-	-	-
	winter	-	-	-	-.032	0.97	0.016*
Weather	overcast	.124	1.10	0.035*	-	-	-
	rain	-	-	-	.134	1.11	0.026*
	fog	-	-	-	-.101	-.984	0.047*
	snow	.396	1.25	0.047*	.030	1.019	0.021*
Visibility	50-100m	-.051	0.97	0.005**	-.126	0.913	0.009**
	100-200m	-.283	0.861	0.021*	-.235	0.871	0.017*
	more than 200 meters	-.315	0. 82	0.036*	-.431	0.77	0.007**
Pavement condition	damp	-	-	-	-	-	-
	ponding	-	-	-	-.012	0.991	0.047
	ice and snow	-	-	-	-	-	-
Occurrence period	07:00-10:00	-	-	-	-.288	1.165	0.017*
	10:00-16:00	-.435	0.79	0.016*	-.349	0.84	0.005**
	16:00-19:00	-.443	0.76	0.031*	-.484	0.721	0.022*
	19:00-00:00	-.452	0.752	0.029*	-.481	0.722	0.045*
Gender	Male	-	-	-	-	-	-
Drunk driving	drink wine	0.362	1.23	0.009**	0.392	1.272	0.019*
Retrograde	retrograde	0.191	1.18	0.017*	0.198	1.19	0.002**

Note: in the p value, * means the significance level is less than 0.05, * * means the significance level is less than 0.01.

4. CONCLUSION

In order to analyze the influence degree of the influencing factors on the severity of the accident, a hybrid logit model considering heterogeneity is established, and the parameters, or values and P values of each factor are calculated. The or values are used to evaluate the influence of the factors on the severity of the accident, and suggestions for improvement are put forward for traffic safety problems.

Analysis of influencing factors of two wheeled vehicle accident

After modeling and analysis, it is found that week, time period, visibility, weather, drunk driving, retrograde, season and other factors are significantly related to the severity of the accident, while gender is not significantly related. As shown in Table 2, the probability of injury accidents and fatal accidents on weekends is 1.06 times and 1.04 times higher than that on weekdays respectively, which may be mainly caused by the fact that people no longer focus on commuting on weekends, the demand for travel is large, and travel does not gather in morning and evening peak hours.

The probability of injury and death accidents is the highest when the visibility is below 50 meters. With the increase of visibility, the accident risk decreases. When the visibility is above 200 meters, the probability of injury and death accidents will be reduced to 0.82 and 0.77 times that of visibility below 50 meters.

Both drunk driving and retrograde driving will increase the risk of accidents. The probability of injury and death accidents during drunk driving is 1.23 and 1.27 times that without drunk driving, and the probability of injury and death accidents during retrograde driving is 1.18 and 1.19 times that without retrograde driving. It can be seen that eliminating dangerous driving behavior is an effective measure to improve traffic safety.

From the modeling results of seasons and weather, autumn has the greatest impact on the severity of accidents, and the probability of injury accidents is 1.13 times that of spring. This may be caused by the relatively stable weather in autumn, less severe weather, higher travel speed of people, and the increase in the total volume of two wheeled vehicle travel. The probability of fatal accidents in rainy days is 1.11 times that in sunny days. The important reasons for the increase of the probability of death are the reduced visibility and slippery roads.
Gender has no significant impact on the severity of the accident, indicating that gender is not an important factor affecting traffic safety in the province. Although there are slightly more female drivers of two wheeled vehicles, women are more conservative and careful in riding, and the possibility of serious accidents is small.

Suggestions on regulatory measures
Through the above analysis of the modeling results, it is found that drunk driving, retrograde, visibility, week and weather have the greatest impact on the severity of the accident. Some suggestions on traffic control measures are put forward for these factors.

On weekends, the travel demand of residents due to life, entertainment, education and other aspects increases, and the total daily travel volume is higher than that on weekdays. Therefore, measures such as strengthening traffic control on weekends and setting travel reminders at residents' travel gathering points are of great significance to reduce accidents.

The probability of injury or death accidents increases in low visibility, and high speed, distraction and other behaviors will greatly increase the risk of accidents. Eye catching traffic warning slogans can wake up drivers and improve their attention. Setting fluorescent or flashing slogans within a certain distance can wake up drivers.

The sample size of accidents in sunny days is large, but bad weather will increase the probability of accidents. Rainy and snowy weather will not only reduce visibility, but also cause wet and slippery roads. In rainy and snowy weather, warning signs can be set up on waterlogged and icy roads to remind drivers to be careful and slow down.

Dangerous driving behaviors, such as drinking alcohol and going retrograde, will increase the risk of accidents. Therefore, it is very important to strengthen traffic safety publicity and improve residents' awareness of traffic safety. At the same time, we should also strengthen traffic control and supervision, and put an end to dangerous behaviors such as drinking, drunk driving and retrograde driving, which can effectively reduce the risk of accidents.

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