International Journal of Data Analysis and Information Systems
Volume 11 • Number 1 • June 2019

Cause Analysis of Accident Black Spot on Urban Expressway Based on Rough Set Theory

Qingqing Shao[1], Xu Xu*[,2]
[1]*College of Transport & Communications, Shanghai Maritime University, Shanghai, China*
[2]*Business School, Shanghai Dianji University, Shanghai, China*

ABSTRACT

Urban expressway is the main framework of urban road, it can relieve traffic congestion pressure and improve the overall traffic efficiency of urban roads to a certain extent. However, the number of traffic accidents on urban expressways is increasing with the increase of motor vehicles. Therefore, it is necessary to identify accident black spots on urban expressways and analyze the causes, so as to provide theoretical basis for relevant management departments. First of all, the paper analyzed the factors that affect the occurrence of accidents from the four levels of human, vehicle, road and environment. Secondly, according to the definition of accident black spots at home and abroad, the paper determined the black spot criterion and used the cumulative frequency method to get the black spot of the studied section. Then, the paper used rough set theory to analyze the importance of the cause of black spots and obtained the main and secondary factors. Finally, we put forward the corresponding rectification suggestions from the perspective of improving road conditions.

Key Words: Traffic Safety, Influence Factor, Accident Black-spot Identification, Rough Set Theory

INTRODUCTION

With the sustained development of economy, people's traffic demand is increasing, and traffic problems are becoming more and more serious. Facing the increasingly prominent contradiction between traffic demand and road, traffic managers are also trying to find various solutions. Identifying black spots and analyzing the causes of accidents are the main research directions of road problems nowadays, which can implement remedial measures to solve the problems existing in roads.

Urban Expressway refers to a two-way lane with more than four lanes. The entrance and exit are partially or totally controlled by a three-dimensional intersection with a central partition zone, which enables vehicles to move quickly(Peng Xinlin,2008).Because the expressway has the advantages of fast driving speed, it can effectively relieve traffic congestion pressure and improve traffic efficiency. Therefore, the smooth and efficient operation of expressways will have an impact on the overall situation of urban road traffic. Once an accident happens on the expressway, the traffic capacity of the road will be reduced and the overall traffic situation of the city will be affected to a certain extent. Therefore, it is necessary to find out the black spots of the accident on the expressway and analyze the causes so as to carry out the corresponding rectification.

It is of great practical significance to identify black spots and analyze their causes.

1) Accident black spot itself occupies a shorter mileage but gathers most traffic accidents, which is harmful. Judging the accident black spot and carrying out targeted renovation can achieve the greatest renovation effect with less personnel and capital investment, and maximize economic and social benefits.
2) After identifying the causes of black spots, we can find out the main and secondary factors, which can provide a theoretical basis for the relevant management departments to formulate remedial measures.

Traffic safety problem has always been the focus of researchers all over the world. According to the actual situation, using reasonable and scientific methods to identify the black spots of road accidents, and comparative analysis of the causes of frequent accidents, study its mechanism, which has great significance for solving traffic problems.

LITERATURE REVIEW

The level of economic development of each country is different from that of laws and regulations, there must be differences in the understanding of black spots in road traffic accidents. The criteria for judging black spots in accidents and the analysis of factors affecting accidents are also different, but the idea of studying black spots in accidents is the same.So far, researchers at home and abroad have made a lot of research results, including various methods of identifying accident black spots and cause analysis methods. These methods have their own advantages and disadvantages and scope of application, which must be carefully considered in the application. There are many methods to identify black spots in accidents, as follows:

1) Accident number method

According to the actual situation to determine a standard, when the number of accidents in a certain period of time on a road section exceeds that value, it is a black spot(Jiang Huaping&Xu Hongguo,2001).The advantage is simple that the black spot can be obtained only by statistics of accident number.But only the number of accidents is taken as the identification index, and the influence of other factors is ignored.

2) Accident rate method

According to the actual situation to determine a standard, when the accident rate of the studied section exceeds that value, it is a black spot(Guan Manquan&Li Qiangwei,2012).It is suitable and convenient for sections with similar traffic volume and road conditions. But it is possible to get the illusion that the accident rate is very high in the section with very small traffic volume.

3) Accident Number-Accident Rate Method

First, the section with lower accident rate is excluded by accident rate method, and then the remaining sections are identified by accident number method(Xiao Shen, Guo Xiucheng, Song Junmin,2003).It overcomes the shortcomings of accident number method and accident rate method, and the calculation results are accurate.But the requirement of data quantity is very high, so a large amount of data is necessary to ensure the accuracy.

4) Accident coefficient method

By multiplying the relative safety factor of road condition factors, the risk factor is obtained. If the risk factor exceeds the standard, it will be a black spot(Lufeng,2003).Its advantage is that there is no need for statistical accident data.But the judgment of relative safety factor of each factor is subjective.

5) Quality control method

Firstly, it is assumed that the number of accidents in the study section obeys Poisson distribution, and then compared with the average accident rate of other similar sections, and then statistical analysis is carried out(Pei Yulong,2006).The results obtained under satisfying conditions are more accurate and reliable.However, the roads studied do not necessarily satisfy the hypothetical conditions, and need similar sections of road conditions as a reference, the use conditions are harsh.

6) Traffic simulation method

The decision model of accident-prone sections is used to segment roads, count the number of accidents, vehicle status and other parameters, and then carry out computer simulation(Lian Peikun,2016).Its advantages are convenience, reproducible, economy, and the key parameters such as speed can be obtained.However, its modeling is difficult, data demand is large, and parameter calibration is affected by other factors.

7) Safety factor method

Judging by the speed change, the section where the speed often changes sharply is the black spot(Xiang Haifeng,2004).The analysis of road conditions is omitted.But we can't analysis the cause of black spots.

In addition to the identification of black spots, many achievements have been made in the cause analysis of black spots in accidents.

J.A.Stoop obtained basic data by investigating the scene of the accident and analyzed it systematically[9].But he did not classify and compare the causes of the accident.

Gregoriades Andreas(2018) used SOM to analyze accident data and mine knowledge.But the scope of application is not wide.

Flahaut(2004) proposed a spatial integration model and used logarithmic regression to analyze the impact of road and environment characteristics on spatial integration of accidents.However, he only considered the impact of road and environment on accident integration, without analyzing other factors.

Wei Qingyao(2005) constructed some accident databases in China and proposed a hierarchical correlation analysis method to analyze the weight of each factor.But he only analyzed a single factor and did not consider it systematically.

Chen Yanmei(2008) used multiple correspondence analysis to analyze the main causes of black spots in accidents.But the amount of accident data needed is large, otherwise the result is not accurate.

Lin Zhong(2006) used the principal component analysis theory to analyze the main factors causing black spots in accidents.But he only analyzed the main causes of the accident, not the mechanism of the factors.

INFLUENCING FACTORS OF TRAFFIC ACCIDENTS

Road traffic system is a dynamic system composed of four elements: human, vehicle, road and environment. Road safety is closely related to these four elements.Any factor change will have an impact on road safety. Serious factors will easily lead to traffic accidents.Therefore, it is necessary to elaborate how these factors affect the occurrence of accidents.This paper is based on the basic traffic accident data of K10+500-K42+872 Expressway in a city from 2016 to 2017.

3.1 Human Factors

Human factors include driver's violation and pedestrian's violation. Comparatively speaking, the proportion of driver's violation and the damage caused by driver's violation are larger. Speeding and fatigue driving are the most common violations. Pedestrian violations are generally not walking in accordance with traffic rules and crossing the road indiscriminately.

1) Speeding

Drivers usually choose to drive at high speed when they think the conditions permit, so speeding is very common, and speeding will increase the probability of accidents and aggravate the severity of accidents. The reasons are as follows:

(1) It is easy to cause mechanical faults such as tire burst and braking failure.

(2) When speeding, the driver can't take effective measures in case of emergency.

(3) The braking distance is elongated. Once the deceleration is too late, it is easy to catch up with the rear end.

2) Fatigue driving

When the driver is tired due to lack of sleep or driving for a long time, he will feel dull and his ability to process information will be weakened, which will reduce the accuracy of the action, especially in the aspects of braking and steering, such as increasing deceleration time and untimely steering.So fatigue driving is also an important factor causing accidents.

3) Pedestrian violation

Walking is an important part of traffic mode, so pedestrian traffic behavior will also have a certain impact on road traffic.Once pedestrians have psychological characteristics such as luck and conformity, they are liable to violate traffic rules, cross the road and rush with motor vehicles, which easily lead to traffic disorder and affect traffic safety.

3.2 Vehicle Factors

Vehicle factor refers to the performance and technical condition of the vehicle. If the vehicle keeps good technical condition in the course of driving, it can avoid the accident or reduce the loss of the accident in some cases.

Automobile safety technology includes active and passive parts. Active safety technology includes brake anti-lock, automatic anti-collision, drive anti-skid control and so on.Passive safety technology refers to the performance of automobiles that can alleviate injuries after accidents, such as seat belts, bumper airbags, etc.When these safety technologies are insufficient, the incidence and severity of accidents will increase. Similarly, when a vehicle breaks down or goes on the road with its own illness, the accident rate will increase significantly.

3.3 Road Factors

Road is the basis and carrier of traffic, which has an important impact on traffic safety. Road factors mainly include geometric alignment, cross-section, road condition, etc.

1) Road geometric alignment

The quality of alignment is related to the safety and smoothness of traffic flow. Plane, vertical and cross-section alignment should be considered in design. Straight line is the most common plane alignment, which has the advantages of clear direction and short distance.But the long straight line section easily makes the driver driving monotonous, distracted, fatigue increased, affecting driving safety.As for the longitudinal alignment, if the steep slope is too long, the car will climb slowly and

powerlessly, and even the engine will stall, causing traffic accidents.In addition, the sight distance is also an important factor in geometric design. Enough safety sight distance is an important guarantee for driving safety.

2) Pavement evenness

Flatness is one of the important indicators of pavement quality. When the pavement flatness is low (such as pits, bulges or waves), the driving resistance increases and the vehicle is prone to bump, which directly affects the driving stability and comfort, reduces the driving efficiency and easily leads to accidents.

3) Skid resistance

Road materials and surface characteristics (fine and rough) will affect the anti-skid performance of pavement. When the anti-skid performance of pavement is insufficient, vehicle braking is prone to side slip and out of control, especially in bends, slopes and intersections, which is prone to skid accidents.

3.4 Environmental Factors

Traffic environment is the basic condition and key element of traffic activities, which has a significant impact on traffic safety. Traffic environment factors mainly include traffic conditions, traffic facilities and road landscape.

1) Weather conditions

Different climatic conditions will have an impact on road safety. For example, in rainy and snow weather, the anti-skid performance of roads is poor, and the sight is blocked; in foggy weather, the sight is blocked more seriously; when the temperature is too high, the tires are explosive; when the temperature is too low, the engine power is insufficient. These climatic factors are prone to traffic accidents.

2) Lighting conditions

The main reason for the high severity of night accidents is that the visual information provided to drivers is insufficient.Road lighting facilities are the most effective measures to deal with this problem. Reasonable lighting facilities can provide drivers with information about the direction and alignment of the road ahead, which has a good inductive effect. When set up improperly, it is easy to cause traffic accidents.

3) Road landscape

Scientific and rational road landscape can not only beautify the traffic environment, but also play a positive role in assisting the road safety environment. For example: alleviate driver fatigue and tension, play the role of line of sight guidance, clear road linearity and so on.However, unreasonable road scenery may inhibit road safety, such as distracting drivers, blocking sight, visual misleading and so on.

4) Traffic signs and markings

The setting of traffic signs and markings must be reasonable so that drivers can get correct information and operate according to instructions to ensure traffic order, improve traffic efficiency and reduce traffic accidents.

IDENTIFICATION OF ACCIDENT BLACK SPOTS

4.1 Definition of Accident Black Spot

Every country in the world is studying accident black spot, but up to now, there is no uniform definition of traffic accident black spot. This is because different countries and different regions have different road conditions, so the criteria for judging black spot are also different.In fact, there is no need for a completely consistent standard. It should be judged according to the local road traffic conditions.This paper also defines the accident black spot before identifying it. It is generally believed that accident black spot is commonly referred to as the accident-prone point and dangerous zone, which means that there is a significant dense distribution in a statistical sense,it is the road space with certain consequences and quantity in a certain time range.

The definition of black spot in this paper is that in a certain statistical period (1-3 years), the number or characteristics of traffic accidents on a certain section are obviously prominent compared with other sections.

4.2 Selection of Identification Methods

Through the introduction of various methods for identifying black spots at home and abroad, we have a basic understanding of the research results at home and abroad, and will use the cumulative frequency curve method to identify black spots, mainly for two reasons. Firstly, there is no standard reference value for the study of road accidents in China, such as accident number method or accident rate method. In addition, foreign research methods are aimed at their own countries, and their parameters and standards may not be applicable to our research. Secondly, the level of economic

development in different regions of China is different and the road conditions are different. It is not realistic to formulate unified standards.According to the above two points, the cumulative frequency curve method can avoid the above drawbacks, and adapt to the actual situation of our country, can identify the road sections with high accident rate, so as to achieve better governance effect with less capital investment.

The cumulative frequency curve method is a method based on mathematical statistics(Wang Longjian,2015).The steps are as follows:

1) The study section is divided into many sections of unit length (usually 1 km).
2) Statistics the number of accidents per unit length section, find out the same number of accidents section and summarize.
3) Find out the frequency and cumulative frequency of the total number of road sections with the same number of accidents.
4) Taking the number of accidents per unit length as the abscissa and the cumulative frequency of accidents as the ordinate, the chart is drawn for analysis.

4.3 Example Analysis

This paper takes the urban Expressway K10+500-K42+872 as an example.

1) Section division and statistics

Firstly, starting from researching the starting position of the section K10+500, it divides each section according to the length of 1 km, and counts the number of accidents happened on each section.

The total length of K10+500-K42+872 is 32.372 km, which is divided into 33 sections according to the length of each section being 1 km. A total of 81 traffic accidents occurred in the studied sections in the statistical time.Among them, K15+500-K16+500 and K16+500-K17+500 have the highest number of accidents, which are 8 and 13 respectively. In addition to these two sections, K18+500-K19+500, K21+500-K22+500 and K27+500-K28+500 also have more accidents, which are 7 accidents.

2) Calculate cumulative frequency and plot

After dividing sections and counting the number of accidents one by one, it is necessary to find out the sections with the same number of accidents and sum them up, and find out the corresponding accident frequency and the accumulative accident frequency of different accident incidents.Accident frequency refers to the ratio of the number of sections corresponding to the number of accidents to the total number of sections. The cumulative frequency is the sum of frequencies below or above a certain value. Accumulation from one direction with small variable value to the one with large variable value is called upward accumulation, and conversely is called downward accumulation.

(1) Upward cumulative frequency

The upward accumulative accident frequency refers to the accumulative frequency less than or equal to the number of accidents. For example, the accumulative accident frequency of 2 accidents is equal to the sum of accident frequencies of 0, 1 and 2 accidents.In order to make the identification result more realistic and improve the standard of black spot identification, the section corresponding to the number of accidents whose cumulative frequency is more than 0.95 upward is selected as the black spot.According to the calculation results, the upward cumulative frequency curve is drawn as shown in Figure 1.

According to Figure 1, it can be seen that the number of accidents corresponding to the cumulative frequency of 0.95 is 8, so the section with the number of accidents greater than or equal to 8 is the accident black spot.

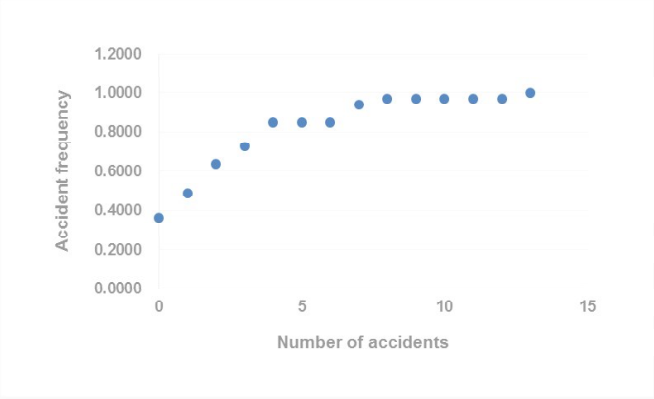

Figure 1: Cumulative upward frequency curve

(1) Downward cumulative frequency

Downward cumulative accident frequency refers to the cumulative frequency greater than a certain number of accidents. For example, the cumulative accident

frequency of 11 accidents is equal to the sum of the accident frequency of 12 and 13 accidents.Accident black spot identification standard is generally the corresponding section of the accident frequency between 15% and 20%.According to the calculation results, the downward cumulative frequency curve is drawn as shown in Figure 2.

According to Figure 2, we can see that the curve fitting function is:,the fitting degree is 0.9878.It can be seen that it is relatively high.Accumulative frequency between 15% and 20% of the "sudden change point" of the number of accidents is 4, so the number of accidents greater than or equal to 4 is the accident black spot.

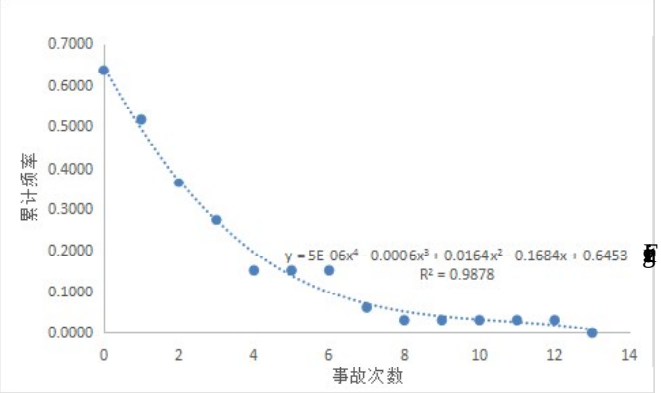

Figure 2: Downward Cumulative Frequency Curve

3) Identification results and analysis of black spots

Comparing the results of the two kinds of accumulative frequencies mentioned above, because there are too many black points of accidents calculated by the downward accumulative frequencies, which do not meet the actual needs very well, we choose the sections that can be identified by both methods as black spots of accidents.

Through the above analysis, we can know that the black spots of accidents are K15+500-K16+500 and K16+500-K17+500, the total length of which is 2 km, accounting for 6.18% of the total length of the section, while the number of accidents at the black spots accounts for 25.93% of the total. It can be concluded that black spots do great harm to roads, and the influencing factors need to be analyzed to improve road safety.

CAUSE ANALYSIS

The occurrence of traffic accidents is accidental and uncertain, but within a certain period of time, the occurrence of accidents at black spots is regular.Accidents are caused by many factors, such as weather, road, traffic environment, etc. These factors have different effects on accidents. How to distinguish the main and secondary factors from these factors is the primary problem of black spot remediation.In the past, expert consultation was often used to judge the main factors and put forward remediation proposals. However, there is obvious randomness and subjectivity. Once the subjective judgment is wrong, it will result in the loss of personnel and funds invested. Therefore, it is necessary to explore a new objective and accurate method of cause analysis.

5.1 The Concept and Algorithms of Rough Set Theory

Rough Sets Theory, originally proposed by Polish mathematician Z. Pawlak in 1982, is a mathematical theory for dealing with incomplete and uncertain data(Yao Zhisheng, Shao Chunfu, Long Delu,2005).The advantage of Rough Set Theory is that it does not need prior knowledge and can get decision rules only from existing data.

Main concepts: Decision table is an important knowledge representation system in rough set theory. Suppose a knowledge representation system is represented by $S=(U,C\cup D,V,f)$, in which $U=\{x_1,x_2,\cdots,x_n\}$ represents the non-empty finite set of objects, called universe of discourse. $A=C\cup D$ represents a non-empty finite set of attributesÿsubsets C and D represent conditional attribute sets and decision attribute sets, respectively.And $C\cap D=\varnothing$;$V=\bigcup_{a\in A}V_a$ ÿWhere V_a represents the range of attribute values of attribute a. $f:U\times A\to V$ is an information function that assigns values to each attribute of each object, $\forall a\in A, x\in U$, $f(x,a)\in V_a$.Knowledge representation system can be expressed as a two-dimensional table. Each row is an element in the universe, and each column is an attribute value. This table is called a decision table(Zhang Wenxiu, Wu Weizhi, Liang Jiye, et al,2001).

Assuming a universe U, for any subset $X\subseteq U$, it can be called the concepts or categories in U. These concepts constitute the classification of the universe.

Generally, the concept of classification is replaced by equivalence relation.Now R is defined as an equivalence relation. When X can be expressed by the union of some basic categories of R, it is said that X can be defined by R, and vice versa, it can not be defined. R definable set is also called R exact set,undefinable set is called rough set. Rough set can be approximated by its upper approximation set and lower approximation set(Deng weibo&Liu Yuzeng, 2010).

$$R\_(X)=\left\{X\subset U:[X]_R\subset X\right\} \quad (1)$$

$$R^{-}(X)=\left\{X\subset U:[X]_R\cap X\neq\varnothing\right\} \quad (2)$$

Formula (1) represents the lower approximation set and Formula (2) represents the upper approximation set.

$POS_R(X)=R\_(X)$ is called the R-positive field of .Simply speaking, is the set of elements that can be totally classified into set in according to knowledge. is a set of elements based on knowledge that cannot exclude the possibility that they belong to set (Zhang Peng&Zhang Jing,2007).The measure of approximate classification is defined asÿ

$$r_R(F)=\frac{\sum_{i=1}^{n}card\left(R\_(X_i)\right)}{card(U)} \quad (3)$$

1) Data preprocessing

Completion, discretization and reduction. Sometimes the original data collected from traffic accidents can not be directly applied and need to be processed.The data selected in this paper are neat and need not be supplemented.As for discretization, because rough sets can not be applied to continuous values, it is necessary to divide the continuous values into a series of intervals, and the values of each interval are regarded as equal. In this paper, the discrete values are divided into three values: 0, 1 and 2.As for reduction, this paper only needs to calculate the importance of attributes, so it only needs to eliminate the reductive calculation of repeated rows.

2) Attribute Importance Calculation

Remove some attributes from the table. If the condition attributes change greatly in the support degree of decision attributes after removing, then the attribute is of high importance, and conversely, it is of little importance(Xi Jianfeng, Wang Xiaoyan, Wang Shuangwei et al,2009).Calculate classification and the dependence of attributeon attributeis obtained.Calculate classification ,and got the dependence of attribute on attribute .

5.2 Example Application and Result Analysis

Accident black spots have been obtained: K15(K15+500-K16+500) and K16 (K16+500-K17+500).Eight and thirteen groups of accident data were collected at the black spot K15 and K16 respectively, and their causes were preliminarily analyzed, including vehicle speed, road geometric alignment, weather conditions, lighting conditions and pavement conditions. These reasons can be regarded as conditional attributes in the decision table, and the severity of the accident as the decision attribute, and recorded as:

$$C=\left\{x_1,x_2,x_3,x_4,x_5\right\}\quad D=\left\{y\right\} \quad (4)$$

Settings:vehicle Speed (0 means no overspeed, 1 means overspeed);geometric alignment of the road (0 for straight, 1 for curved);weather conditions (0 indicates good, 1 indicates bad);illumination condition (0 means sufficient daylight, 1 means illumination at night, 2 means no illumination at night);road condition (0 means flat, 1 means uneven);the severity of the accident (0 for minor accidents, 1 for general accidents, 2 for serious accidents)(Wang Ling, 2011).

1) Cause Analysis of Black Point K15 Accident

Eight groups of accident data were collected at the black spot K15. The data were discretized according to the settings. The statistical results are shown in Table 1.

Table1 Decision Table for Cause Analysis of Black Point K15 Accident.

Accident number	Condition Attributes					Decision Attribute
	x_1	x_2	x_3	x_4	x_5	y
a_1	1	0	0	0	0	1
a_2	1	1	0	0	1	2
a_3	0	0	1	0	0	0
a_4	1	0	0	1	0	1
a_5	0	0	0	2	0	1
a_6	0	0	0	1	0	0
a_7	0	1	1	0	1	1
a_8	1	1	1	0	1	2

Now calculate the importance of attributes in Table 1.The calculation process is as follows:

$$C=\{x_1,x_2,x_3,x_4,x_5\}\ D=\{y\}$$

$$U|C=\{\{a_1\},\{a_2\},\{a_3\},\{a_4\},\{a_5\},\{a_6\},\{a_7\},\{a_8\}\}$$

$$U\mid D=\{\{a_1,a_4,a_5,a_7\},\{a_2,a_8\},\{a_3,a_6\}\}$$

$$POS_C(D)=\{a_1,a_2,a_3,a_4,a_5,a_6,a_7,a_8\}$$

$$r_C(D)=8/8=1$$

$$U\mid(C\text{-}\{x_1\})=\{\{a_1\},\{a_2\},\{a_3\},\{a_4,a_6\},\{a_5\},\{a_7,a_8\}\}$$

$$POS_{C\text{-}x_1}(D)=\{a_1,a_2,a_3,a_5\}$$

$$r_{C\text{-}x_1}(D)=4/8=0.5$$

$$r_C(D)-r_{C\text{-}x_1}(D)=1-0.5=0.5$$

According to the same calculation steps, the influence degrees of the other factors are 0, 0, 0.25 and 0, respectively.From the results of calculation, it can be seen that at the black point K15, conditional attribute x_1 has the greatest influence on decision attribute y, and conditional attribute x_4 takes the second place. That is to say, at the black spot K15, the speed is the main factor affecting the severity of the accident, and the lighting condition is the secondary factor.

2) Cause Analysis of Black Point K16 Accident

According to the analysis process of black spot K15, we can know that at black spot K16,condition attribute x_5 has the greatest influence on decision attribute ,and condition attributeand attribute have the second influence.That is to say, at the black spot K16, the flatness of the road surface is the main factor affecting the severity of the accident,while the speed and geometric alignment of the road are the secondary factors.

REMEDIATION PROPOSALS

According to the cause analysis of the accident black spot, the factors that have great influence on the two accident black spots have been determined, which are vehicle speed, lighting conditions, road smoothness and road geometric alignment. In view of these factors, some suggestions are put forward for reference.

1) Speed

In view of speed, speed limit signs can be set to remind drivers to decelerate and set aside a certain operating time; speed reduction markings can be set to reduce the speed; roadside cameras can be increased, monitoring and punishment for speeding can be increased, and driver's safety awareness can be improved; traffic police can strengthen management and strict during peak traffic period. Pedestrians are forbidden to cross the road, especially at intersections, so as to prevent drivers from overtaking at Expressway entrances and exits.

2) Lighting conditions

In order to ensure that the driver can clearly identify the road condition ahead, the illumination required by road brightness should be given to avoid accidents. Lighting facilities are the most effective means to prevent night accidents. In lighting design, besides the illumination to be achieved, they should also have good lighting quality.For example, the brightness level of the roadway is appropriate; the brightness is uniform, the road surface does not appear bright spots; coordinates with the road landscape; saves power and so on.

3) Road alignment

As for the road linearity, warning signs such as accident prone should be set up; the road outside the bend should be widened to adjust superelevation and avoid inertia rollover; the guardrail should be reformed to increase its strength; the convex mirror should be installed at the bend so that the driver can observe the traffic coming from the opposite side**.**

CONCLUSION

The purpose of this paper is to find out the accident-prone points of the study section and analyze the causes of the accidents according to the collected accident data, find out the main factors affecting the accident black spots, and finally put forward some suggestions for policymakers to refer to.In this paper, the cumulative frequency method is used to find out the two accident-prone points in the study section, and then the rough set theory is used to analyze the causes of the two black spots, and then determine the main influencing factors of the two black spots respectively. Finally, some suggestions are put forward to remedy the main influencing factors.It is hoped that the conclusions drawn in this paper can bring practical help to decision makers, which can be summarized as follows:

1) Drivers and pedestrians'traffic behavior, vehicle condition, road alignment, road surface condition, lighting conditions and other factors will affect road safety, so improving road conditions and strengthening management can improve road safety.
2) According to the actual situation of the study section, the cumulative frequency curve method is chosen to identify the black spots. Finally, two accident black spots, K15 and K16, are identified.
3) Rough set theory is used to analyze the causes of the black spots, and the main influencing factors are obtained.
4) According to the actual situation, the corresponding remediation suggestions are put forward.

REFERENCES

[1] Peng Xinlin. Research on traffic state prediction of urban expressway [D]. Shanghai: Shanghai Jiaotong University,2008.

[2] Jiang Huaping, Xu Hongguo. Identification of traffic accident-prone points based on mathematical statistics [J]. Journal of Jinan Communications College, 2001, 9 (3): 15-17.

[3] Guan Manquan, Li Qiangwei. Application of Equivalent Total Accident Rate Method in Some Sections of Jinliwen Expressway [J]. Highway, 2012, 3(8): 164-170.

[4] Xiao Shen, Guo Xiucheng, Song Junmin. Research on identification method of black spots in road traffic accidents [J]. Road traffic technology, 2003, 3(2): 70-73.

[5] Lufeng. Method of checking traffic accident-prone points and sections [J].Journal of Chang'an University (Natural Science Edition), 2003, 23 (1): 87-90.

[6] Pei Yulong. Improvement of Quality Control Identification Method for Road Traffic Accident Frequent Points [J]. Journal of Harbin University of Technology, 2006, 38 (1): 97-100.

[7] Lian Peikun. Non-conflict cellular automata model of diversion Island machine based on VISSIM

micro-traffic simulation software [J]. Computer application, 2016, 36 (6): 1745-1750.

[8] Xianghaifeng. Identification and Improvement of Highway Dangerous Places [J]. Journal of Hubei Police Academy, 2004, 12(4): 51-54.

[9] Gregoriades Andreas, Chrystodoulide Andreas. Extracting Traffic Safety Knowledge from Historical Accident Data[J]. Applied Mechanics and Materials, 2018, 2155(253): 109-114.

[10] Wei Qingyao.Analysis of accident road factors based on hierarchical correlation analysis[J].Journal of Changsha Jiaotong University,2005,21(1):82-86.

[11] Chen Yanmei. Study on the Causes of Black Spots in Highway Traffic Accidents by Correspondence Analysis Method [D]. Nanjing: Southeast University, 2008.

[12] Lin Zhong, Yu Rende. Study on the causes of traffic accidents based on principal component analysis [J]. Journal of Shandong Jiaotong College, 2006, 14 (1): 55-57.

[13] Wang Longjian. Limitation of Unit Sample Length in Identifying Road Accident Frequency Locations [J]. Highway and Motor Transportation, 2015, 24 (5): 36-39.

[14] Yao Zhisheng, Shao Chunfu, Long Delu. Cause analysis of road traffic accidents based on rough set theory [J]. Chinese Journal of Safety Sciences, 2005, 15 (12): 107-110.

[15] Zhang Wenxiu, Wu Weizhi, Liang Jiye, et al. Rough set theory and method [M]. Science Press, 2001, 1:123-131.

[16] Deng weibo, Liu Yuzeng. Cause analysis of traffic accident black spot based on Rough set [J]. Journal of Sichuan Police College, 2010, 22 (1): 91-96.

[17] Zhang Peng, Zhang Jing. Application of Rough Set in Cause Analysis of Black Spots in Traffic Accidents [J].Journal of University of Electronic Science and Technology, 2007, 36(2): 267-270.

[18] Xi Jianfeng, Wang Xiaoyan, Wang Shuangwei et al. Analytical Hierarchy Process of Road Traffic Accident Causes Based on Rough Set [J]. Journal of Changchun University of Technology (Natural Science Edition), 2009, 32 (2): 257-259.

[19] Wang Ling. Uncertain information discovery based on rough set and its application in urban traffic management [D]. Xi'an: Southwest Jiaotong University, 2011.