

RISK ATTITUDE, PERCEPTION, BEHAVIOR AND PERSONALITY AS INDICATORS OF A DRIVER'S RISK AWARENESS IN CHINA

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ABSTRACT

As the driver is the information recipient and primary decision maker in the driving process, this research aims to investigate a driver's risk awareness to assess a driver's safety. We developed a scale for assessing a driver's risk awareness, which consists of four scales: Risk Attitude (48 items), Risk Perception (22 items) and Risk Behavior (27 items) scale, and the Sensation Seeking Scale (SSS) (14 items). The first three scales together cover 14 indicators, and the same 14 indicators are dealt with in the sensation seeking scale. The 14 indicators are named second class indices, such as the general attitude towards obeying rules, aggressive violations and awareness of safe driving, etc. In this study, in order to develop a risk awareness model, a survey was conducted in China. Based on the survey, exploratory factor analysis of the scale revealed three risk awareness factors (risk attitude, risk perception and risk behavior), also named first class indices. The respective weights of the 14 second class indices and the 3 first class indices were calculated. Results of statistically analyzing the survey showed that some drivers in our study have a high risk awareness. In addition, a diagram was constructed based on the regression analysis of a driver's sensation seeking and risk awareness indices. It appeared that the higher the driver's SSS, the lower the driver's risk awareness.

Keywords: driver, risk awareness, scale, attitude, behavior, perception, personality.

INTRODUCTION

From the World Health Organization website, we see that road traffic injuries kill nearly 1.3 million people annually and if current trends continue, road crashes are predicted to become the fifth leading cause of death by 2030. The traffic safety situation in China is no better than that in other parts of the world. China is now in the process of large-scale industrialization and rapid motorization which will result in greater occurrences of traffic accidents. In 2010, there were 3,906,164 traffic accidents all over China, which caused 65,225 fatalities, 254,075 injuries and the direct economic loss reached 930 million Yuan (about 144 million USD).

Analysis of driving environments, including the four elements connected with road accidents (namely, driver, vehicle, road and traffic), has become a focal issue around the world. Reports and related data from various organizations have pointed out that the main reason is the drivers' fault, followed by improper maintenance of vehicles and vehicle breakdown. According to statistics from *The Blue Book of Road Safety in China 2007*, many countries hold the opinion that drivers take the main responsibility for traffic accidents, Italy 41%, United States 57%, Brazil and the former Soviet Union 75%, 82% of the former Federal Republic of Germany, Hungary 74%, Poland 96%, about 90% in China. Based on a study of 2041 traffic accidents, Sabey and Taylor (1980) concluded that human factors were contributing elements in 95% of the accidents. In 2009, 94.62% of traffic accidents in China were caused by drivers.

So, the driver is not only the information recipient and primary decision maker, but also the main factor in traffic accidents. As most road traffic accidents can be attributed to human error (West et al. 1993), we suggest that accidents are mainly due to a driver's weak risk awareness. In order to know whether the driver is safety or not and where the weak aspects are, this research investigates drivers' risk awareness in relation to safety assessment. Risk awareness is related to

personal responsibility, attitude, perception, driving ethics, skills, knowledge of traffic safety, etc. Risk attitude, risk perception and risk behavior, to some extent, can show the level of a driver's risk awareness.

With the increase in traffic accidents, risk attitude and perception have widely become an area of concern. A considerable amount of scholars have studied this area, developing a number of scales. Malfetti et al. (1989) developed a Young Driver Attitude Scale (YDAS), which had 70 items and measured 7 attitude dimensions, such as, speeding, safe driving, riding with an unsafe driver, concern for others, concern for oneself, drinking and driving, and safety belts. Drivers were required to answer whether they agreed with the statements and a high reading implied a high risk based on driving attitude. Assum (1997) studied the relationship between attitudes and accident risk, and found that accident risk was affected by driver attitudes. In his study, 56 statements from a questionnaire concerned important aspects of road safety and violations of the traffic code. Attitudes were divided into general attitudes towards traffic safety and four special attitudes: speed, drinking and driving, consideration for other road users and responsibility. Based on the YDAS Malfetti et al. (1989) and 46 other items used by Rundmo (1992, 1996; 1998) which measured attitudes towards violating traffic rules in general, accident causation and risk of traffic accidents, Ulleberg and Rundmo (2002) developed 87 statements to measure traffic safety attitudes and divided these into 11 factors. 5 of these factors: riding with an unsafe driver, speeding, concern about hurting others, drinking and driving, showing off driving skills to others were taken from YDAS. The other 6 factors are: traffic flow vs. rule obedience, joyriding, dare to speak up to an unsafe driver, risk of accidents, fatalism, violation of traffic rules. Attitude towards traffic safety issues are identified as predictors for future risk behavior in traffic situations (Iversen 2004). From the survey, drivers who took more risks when driving were involved in more traffic accidents or crashes. Research shows, YILMAZ and ÇELİK (2006) selected five assessment criteria of risky driver attitudes: risky driver attitudes, obedience to speed rules, caring about traffic accidents, risk taking tendency in traffic and violations of basic traffic rules. They developed a risky driver attitude model to show risky drivers attitude tendencies. Tuokko et al. (2007) found that the perceptions of risk, attitudes and beliefs acted as mediators between knowledge and behavior factors,

There is other research focusing on human factors in driving and traffic safety. The main emphasis of Naatanen and Summala (1976) was on drivers' motives and the importance of risk perception in relation to bad driving practices. When analysing the relationship between driving behavior and traffic accidents, many researchers have developed questionnaires to measure driving behavior, of which the Driving Behavior Questionnaire (DBQ) has the highest rate of usage. Parker et al. (1995) and Reason et al. (1990) first studied DBQ and divided it into three factors: violations, dangerous errors, and relatively harmless lapses. Lapses are absent-minded behaviors with consequences mainly for the perpetrator (posing no threat to other road users), errors are typically misjudgments and failures of observation that may be hazardous to others, and violations involve deliberate contraventions of safe driving practice. Lawton et al. (1997) extended the violations scale by adding new items and divided violations into aggressive violations and highway code violations, the former one containing an interpersonally aggressive component while the latter one had no specific link to aggression. Blockey and Hartley (1995) replicated the research of Reason et al. (1990) to confirm the distinction between driving errors and violations in a Western Australian driving population. Their study also extracted three factors: general errors, dangerous errors, and dangerous violations, the content of the factors being a little

different from those of Reason et al. (1990). Åberg and Rimmö (1998) surveyed over 1400 Swedish drivers and four dimensions were found. Violations and dangerous errors correspond to previous research, but harmless lapse was split into two new factors: inattention errors and inexperience errors. Sullman et al. (2000) studied the DBQ in New Zealand drivers of heavy vehicles, and found four factors, which they named: errors, lapses, violations and aggressive violations. Mesken et al. (2002) found DBQ to have a four-factor structure, which they named: errors, lapses, speeding violations and interpersonal violations. Lajunen et al. (2004) carried out a postal questionnaire survey in Britain, Finland and The Netherlands. There were 27 items in the questionnaire and 4 factors: aggressive violations, “ordinary” violations, errors, and lapses. In China, Mingke et al. (2008) studied the structure of risky driving behavior and found out that highway code violations, aggressive violations, general errors, and dangerous errors were the four factors of risky behavior. In addition to this, the authors researched the correlations between risky driving behavior and the four areas of driving experience, personality, risky driving attitude, and driving skill.

Although personality traits are not a decisive factor when determining affects upon driving safety, it is something that can not be ignored. There are many studies on the relationship between personality traits and traffic accidents. Elander et al. (1993) pointed out that a driver's behavior is associated with certain personality characteristics and is also influenced by attitudes and beliefs. The role of personality in driving behavior and crashes has a connection with driving style, and high levels of personality traits predispose drivers to a higher risk in driving (Beirness 1993). Personality influences risky driving behavior in-directly through affecting the attitudinal determinants of the behavior (Ulleberg 2003). Sümer (2003) established a contextual mediated model to distinguish the distal factors (personality factors) and proximal factors in predicting traffic accident involvement. Further analyses revealed that personality factors had an impact on road accidents via their effects on actual driving-related behaviors. Xueyan (2007) revealed the relationship between personality, attitude and behavior by using questionnaires and put forward that a driver's personality is the distal factor and attitude is the proximal factor of the driving behavior.

METHODS

Questionnaires

The questionnaire used in this study consisted of four main sections: Risk Attitude Scale, Risk Perception Scale, Risk Behavior Scale, Sensation Seeking Scale (SSS).

The risk attitude and perception scales were selected based on research from a large amount of literature and covered important aspects of drivers' risk awareness, including: 56 statements regarding attitude (Assum 1997), 70 items from Young Driver Attitude Scale (Malfetti et al. 1989), 45 attitude items measuring young drivers' risk-taking attitude (Ulleberg and Rundmo 2002), 16 attitudinal questions (Iversen 2004), 15 items from a driving questionnaire on perception of risk and attitudes (Tuokko et al. 2007). All questionnaire items from previous studies were firstly translated into Chinese, secondly we discussed how to reclassify them based on their content. Then, items that expressed the same thing and those that did not conform to the situation in China were dropped. Lastly, a questionnaire about risk attitude and perception containing 64 items was formed, which was then divided into 10 different areas: consideration

for road users, awareness of safe driving, responsibility and fatalism, safety belts, accident causation and risk of accidents, general attitude towards obeying rules, speed, drinking and driving, riding with an unsafe driver, and joyriding. The respondents judged on a five-point evaluation scale how much they agreed with the 64 statements, where 1 = "strongly disagree", 2 = "disagree," 3 = "neutral", 4 = "agree", 5 = "strongly agree."

The risk behavior scale also came from a review of literature. Although there are several different versions of driving behavior questionnaires, most of them were developed based on Reason et al. (1990). DBQ, developed by Reason, has been studied in many countries and a cross-cultural study (Lajunen et al. 2004) showed that the DBQ has a good reliability and validity, and can be used to measure risky driving behavior. Considering all of these, we chose DBQ as the risk behavior scale. It has 4 dimensions covering a total of 27 items from Lajunen et al. (2004). After translating the 27 items into Chinese, we adjusted some items to fit the situation in China. Respondents were asked to indicate how often they themselves committed each of the violations and errors when driving. Responses were recorded on a five-point scale from 1 = "Never" to 5 = "Nearly all the time".

In our study, personality is not considered as a main factor, but only as a potential indicator of degree of risk awareness. When considering the Personality scale, the first question was whether the scale had been standardized in Chinese, then we took note of the number of items, because having too many would affect the mood of the responder. There is a Chinese simplified version of the Sensation Seeking Scale translated by Chunxing (1994). Under the advice of a psychology expert, we selected this version which included 14 items for our study.

Background variables were recorded: age, sex, how long you've had a license, total driving mileage, driving mileage per week, number of accidents in last 3 years, points deducted from license in the last year, and whether they were private car drivers or company car drivers.

Participants

If a professional driver involves in a traffic accident, it would cause more injures and fatalities and economic losses than a private driver. So when a company selects a professional driver, the most important and the first thing they are considered is whether the candidate is a safe driver. This study was carried out on 240 healthy drivers from Guangdong and Shaanxi Province in China. Most of the drivers participated in our survey were professional drivers. Printed copies of the questionnaire were distributed in spring 2010. Respondents had been encouraged to answer the questions frankly and honestly before the survey began. A total of 196 respondents returned effective questionnaires, yielding a recovery rate of 81.7%. 19% of the respondents were private car drivers and 81% were company car drivers (including bus driver, taxi driver, coach driver, commuter car driver, and truck driver). Of these, 3.8% were 18-30 years old, 42.8% were 31-40, 46.5% were 41-50, 6.9% of them were 51 years old and above. There were 163 male drivers among the respondents, comprising 95.9% of the sample. 8.7% of the drivers had had a driver's license for less than five years, 12.8% for 6-10 years, 58.7% for 11-20 years, 15.1% for 21-30 years and 4.7% for more than 30 years.

Statistical Analysis

When preparing the data for analysis, we first computed the average readings of the 14 second class indices from the risk attitude, perception, and behavior scales and standardized the raw data. Cronbach's alpha reliability coefficient was calculated to evaluate the internal consistency of the risk attitude, perception and behavior scales. Using all of the items for the reliability analysis, we found that an internal consistency $\alpha=0.909$ was acceptable. Exploratory factor analysis was carried out to examine the structure of the questionnaires and to get the respective weights of the indices. To investigate the relationship between sensation seeking traits and traffic accidents, regression analysis was used to discover the relationship between the SSS results and each of the 14 indices.

RESULTS

Exploratory Factor Analysis

In the correlation test, as can be seen in Table 1, we put all items from the risk attitude, perception and behavior scales together, $KMO = 0.904$, $\chi^2 = 1600.249$. We found that using principal component analysis to extract factors from the 14 second class indices is feasible. Without the limitation of extraction conditions, in accordance with the extraction method of eigenvalue greater than one, three main factors were extracted from the 14 indices. As Table 2 shows, the characteristics of the first principal factor is 6.579, the second main factor is 1.697, and the third main factor is 1.146. The three main factors can explain the variance in cumulative 67.3%.

Table 1 KMO and Bartlett's Test

	All questionnaires	Risk attitude	Risk behavior	Risk perception
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.904	.898	.829	.630
Bartlett's Test of Sphericity	Approx. Chi-Square	1600.249	666.672	567.025
	df	91	21	6
	Sig.	.000	.000	.000

Table 2 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total % of Variance	Cumulative %	Total % of Variance	Cumulative %	Total % of Variance	Cumulative %	Total % of Variance	Cumulative %	
1	6.579	46.995	6.579	46.995	4.098	29.270	4.098	29.270	
2	1.697	12.120	1.697	12.120	3.464	24.741	3.464	24.741	
3	1.146	8.185	1.146	8.185	1.860	13.289	1.860	13.289	
4	.866	6.186							
5	.738	5.273							
6	.522	3.732							
7	.457	3.267							
8	.436	3.111							
9	.341	2.439							
10	.318	2.268							
11	.289	2.062							
12	.245	1.750							
13	.205	1.463							
14	.161	1.149							

Extraction Method: Principal Component Analysis.

Varimax rotation was applied, because it is difficult to use the indices in their initial form. The rotated component matrix for all data is presented in Table 3. The first principal factor has a larger correlation coefficient with seven indices: riding with an unsafe driver, general attitude towards obeying rules, speed, accident causation and risk of accidents, joyriding, drinking and driving, and safety belts. These four indices: errors, lapses, “ordinary” violations, and aggressive violations, have a greater correlation coefficient with the second principal factor while consideration for road users, responsibility and fatalism, and awareness of safe driving have a correlation coefficient with the third factor. According to the original meaning of these three main factors, we can name them risk attitude, risk behavior and risk perception. They are considered as first class indices. The statistical results are consistent with our initial construction framework of assessment, and therefore validate our scales.

Table 3 Rotated Component Matrix ^a

	Component		
	1	2	3
Riding with an unsafe driver	.854	.112	.116
General attitude towards obeying rules	.757	.336	.168
Speed	.738	.360	.191
Accident causation and risk of accidents	.722	.104	.288
Joyriding	.681	.372	-.098
Drinking and driving	.660	.075	.275
Safety belts	.529	.241	.430
Errors	.121	.893	.188
Lapses	.152	.865	.224
“Ordinary” violations	.282	.842	.179
Aggressive violations	.389	.783	-.013
Consideration for road users	.076	.139	.839
Responsibility and fatalism	.195	.080	.587
Awareness of safe driving	.486	.321	.512

a. Rotation converged in 4 iterations.

Risk Awareness Model

In order to quantify the assessment of a driver’s risk awareness, the most critical step is to confirm the weight coefficient of each index. Three factors were successfully extracted using exploratory factor analysis and data in Table 3 show factor loadings after the rotation. We added the squares of the factor loadings to the same factor shown in Table 3 to get the eigenvalue of corresponding factor; we normalized the eigenvalue to get the weight coefficients of the first class indices. As the weight coefficients of the first class indices show in Table 5, we can see that risk attitude has the greatest impact on a driver’s risk awareness, followed by risk behavior, and finally the risk perception.

From Table 1, where risk attitude scale KMO=0.898, risk behavior scale KMO=0.829, and risk perception scale KMO=0.630, we can see that principal component analysis is suitable not only for the 14 dimensions of the risk awareness scales, but also for the risk attitude scale, risk behavior scale, and risk perception scale. In regard to the three sub-scales, according to the same

method, one main factor was extracted from every scale, which can explain the variance in cumulative 59.865%, 79.893%, and 55.784% respectively. Using varimax rotation, score coefficients were recorded in Table 4. In order to get the weight coefficients of the 14 second class indices, we normalized the score coefficients in Table 4. The results were recorded in Table 5.

Table 4 Component Score Coefficient Matrix

Risk Attitude		Risk Behavior		Risk Perception	
Safety belts	0.165	Aggressive violations	0.267	Responsibility and fatalism	0.415
General attitude towards obeying rules	0.203	“Ordinary” violations	0.285	Consideration for road users	0.462
Riding with an unsafe driver	0.199	Errors	0.286	Awareness of safe driving	0.460
Joyriding	0.170	Lapses	0.280		
Speed	0.201				
Drinking and driving	0.167				
Accident causation and risk of accidents	0.183				

Table 5 Weight coefficient of each index

First class indices	Weight coefficient of first class indices	Second class indices	Weight coefficient of second class indices
Risk Attitude	0.435	Safety belts	0.128
		Accident causation and risk of accidents	0.142
		General attitude towards obeying rules	0.158
		Speed	0.156
		Drinking and driving	0.13
		Riding with an unsafe driver	0.154
		Joyriding	0.132
Risk Behavior	0.368	Aggressive violations	0.239
		“Ordinary” violations	0.255
		Errors	0.256
		Lapses	0.25
Risk Perception	0.197	Consideration for road users	0.346
		Awareness of safe driving	0.344
		Responsibility and fatalism	0.31

According to the weight coefficient of each index in Table 5, a risk awareness model was built (see Equation 1). Firstly, we calculated the mean reading of the 14 second class indices, then we found the sum of all the mean readings multiplied by their respective weight coefficients to get the readings of the first class indices. For example, “risk behavior” = $0.239 \times$ “aggressive violations” + $0.255 \times$ ““Ordinary” violations” + $0.256 \times$ “errors” + $0.25 \times$ “lapses”. After getting the reading of the first class indices, a driver’s risk awareness can be obtained by the equation: “risk awareness” = $0.435 \times$ “risk attitude” + $0.368 \times$ “risk behavior” + $0.197 \times$ “risk perception”.

$$Y = \sum_{i=1}^3 [a_i \sum_{j=1}^n (a_{ij} X_{ij})] \quad (1)$$

$$X_i = \sum_{j=1}^n (a_{ij} X_{ij})$$

subject to

$$\begin{aligned} i=1, n=7 \\ i=2, n=4 \\ i=3, n=3 \end{aligned} \quad (2)$$

where:

- Y: reading of driver's risk awareness
- X_i: reading of first class index
- a_i: weight coefficient of first class index
- a_{ij}: weight coefficient of second class index
- X_{ij}: mean reading of second class index

According to the risk awareness model established, we can assess a driver's risk awareness through answering questionnaires. The number of items and mean readings for all questionnaires in our survey are listed in Table 6. Average readings are from 0-4, 0 represents a poor performance in corresponding aspect and unsafe driving, while 4 represents being safe in the corresponding driving aspect. In accordance with Table 5 and 6, and Equation 1, we calculated the mean reading of respondents' risk awareness in the survey to be 3.29. By statistically analyzing the survey results, we found that the samples in our study had a high risk awareness. This is mainly because 81% of the respondents were company car drivers, who have to attend a safety conference held by their company once a week.

Table 6 Number of items, mean readings for all questionnaires

Questionnaires	Number of items	Mean (range 0-4)	S.D.
Risk Attitude Scale	46	3.2174	.49556
Safety belts	5	3.3143	.64562
Accident causation and risk of accidents	4	3.3342	.66211
General attitude towards obeying rules	10	3.1051	.52043
Speed	15	2.9384	.60508
Drinking and driving	4	3.3610	.61872
Riding with an unsafe driver	6	3.0638	.69269
Joyriding	2	3.5000	.75955
Risk Behavior Scale	27	3.3839	.53771
Aggressive violations	3	3.3010	.70130
"Ordinary" violations	7	3.4380	.63048
Errors	9	3.5102	.55352
Lapses	8	3.2787	.52811
Risk Perception Scale	18	3.2701	.39071
Consideration for road users	9	3.2421	.43061
Awareness of safe driving	6	3.3393	.52226
Responsibility and fatalism	3	3.2245	.62843

Regression Analysis

Sensation seeking personality traits have a correlation with traffic safety. For SSS, the lower the reading, the lower the level of sensation seeking; the higher the reading, the higher the level of sensation seeking. According to the norm of the scale (Chunxing 1994): 0-3 very low, 4-5 low, 6-9 middle, 10-11 high, 12-14 very high. Stepwise linear regression analysis was used to verify that personality traits had an affect on the indicators of risk awareness. In the analysis, we took the SSS reading as an independent variable and the average readings of the fourteen second class indices as dependent variables.

In order to show the influence more clearly, a diagram was produced, see Figure 1. The diagram reflects the causal relationship between sensation and indicators. Arrows were used to show the causal relationship, from the cause (independent variable) to the effect (dependent variable), while the path coefficients are the standardized regression coefficient (Beta value) discovered from the regression equation. As can be seen in Figure 1, only the responsibility and fatalism index did not pass the tolerance criterion and can not establish a regression equation. Beta coefficients of sensation seeking in relation to the other 13 indicators were all negative, showing that sensation seeking traits had a negative impact on the indicators of risk awareness. When the driver received a higher reading for sensation seeking, the lower index reading he would get. In psychology, the high sensation seekers generally prefer to participate in adventurous activities, these drivers are more prone to violate the traffic code and get low readings in risk awareness assessment.

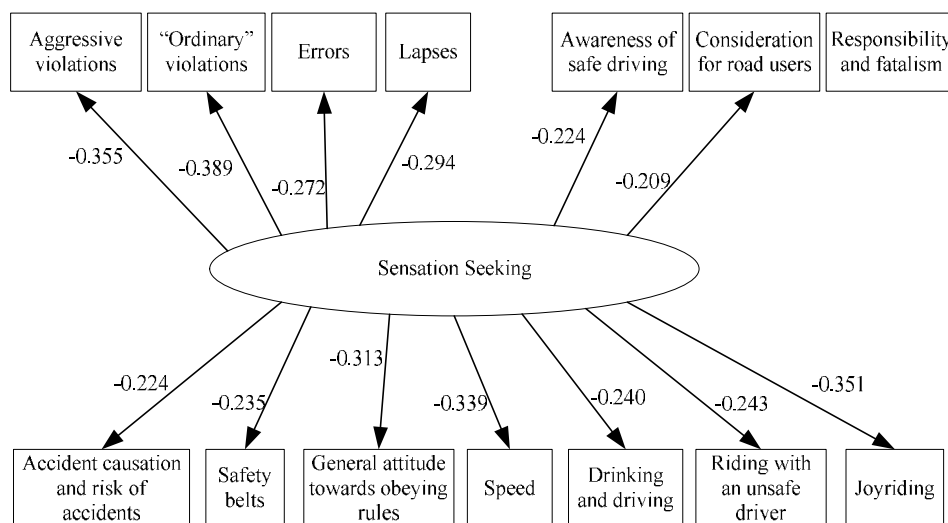


Figure 1 Diagram of sensation seeking as an indicator of a driver's risk awareness

CONCLUSIONS

At present, China ranks first in the road traffic accident death rate all over the world. Driver error is the main cause of accidents, especially the driver's weak risk awareness. Doing research into a driver's risk awareness helps us to know the issues in regard to driving safety and provides technical guidance that can be used for intervention into improving drivers' performance.

Questionnaires were used as tools to evaluate aspects of a driver's risk awareness. After reviewing a great deal of literature, an evaluation index system of a driver's risk awareness with an appropriate scale was established. The index system contained three first class indices: risk attitude, risk behavior, and risk perception. It also contained fourteen second class indices (general attitude towards obeying rules, aggressive violations and awareness of safe driving, etc). As is shown in Table 6, we can see that there are 91 items in all questionnaires, where the risk attitude scale has 46 items, risk behavior scale has 27, and risk perception scale has 18. In addition to this, there are 14 items in SSS to test the sensation seeking traits of respondents. Using a factor analysis method of evaluation, we can make full use of survey data to get the respective weight coefficient of indices (see Table 4) and establish a risk awareness model (see Equation 1).

In the risk awareness model, risk attitude, risk behavior, and risk perception can be used to assess a driver's risk awareness. In order to find the relationship between personality traits and risk awareness, stepwise linear regression analysis was used. As is shown in Figure 1, sensation seeking traits have a negative impact on most indicators of risk awareness. If the respondent has a high sensation seeking reading, he will have a low reading for risk awareness evaluation. Personality traits can also be considered as a simple indicator of a driver's risk awareness.

Taking into account the professional drivers play an important role in serious traffic accidents, most of the drivers surveyed were professional drivers who attended safety conferences regularly. By the way, only 3.8% of the samples were young driver (<30 years old) and about 78.5% of them had had a driver's license more than 10 years. They are relatively safe drivers as the findings of high risk awareness can validate the model we built to some extent. But, this sample bias will cause some limitations in the results and the model may not be generalized in application now. Based on this study, we should increase our samples, including more female drivers, private drivers, young drivers, etc. to verify or modify the driver's risk awareness model in our further studies.

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