

Analysis on the bad driving behavior of urban bus drivers: an example of Hohhot in China

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Abstract. Improving the safety level of bus operation is not only the important content of public safety management, but also the basic requirement of implementing the bus priority policy in China. In this paper, 300 Hohhot bus drivers were surveyed on the spot, then the factor analysis method was used to classify the bad driving behavior, and the influencing factors of two kinds of bad driving behavior were analyzed from the aspects of personal characteristics, education and training, safety awareness. Finally, the effect of bad driving behavior on operational accident was analyzed. The results show that the bus driver's bad driving behavior can be classified as risky behavior and habitual dangerous behavior; age, license holding time and lengths of service as bus driver are associated positively with two types driving behaviors; age, license holding time, the number of safety education and training, understanding of the harm of violation behavior, the familiarity of traffic laws and regulations, two types of bad driving behavior have an impact on the occurrence of traffic accidents, and the two types of driving behavior have great impacts on the occurrence of traffic accidents. Finally, according to the survey and analysis, the countermeasures of bus safety management are put forward.

Key words. Bad Driving Behavior, Urban Bus Drivers, traffic accidents.

1. Introduction

Urban bus is an important part of urban public transport system, and the safety level of its operation is closely related to the security of most urban residents' life and property. As a result, both of administrative departments and people pay a lot attention to the safety of bus operation. Therefore, preventing and controlling traffic accident are the main content of safety management of bus operation.

According to "China Traffic Yearbook 2009", among all the factors causing traffic accidents, human related factors accounted for 95.63%, while the factors of motor drivers accounted for 90.68% [1]. Road traffic accidents are mainly caused by human factors.

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According to domestic researches [2, 3], The driver's risky behavior and aggressive behavior are the crucial factors that influence the traffic accident. Pei [4] extracts 8 typical bad driving behaviors by video observation, which have a certain dangerous nature. The studies [5, 6] also show that the factors leading to vehicle drivers' abnormal behavior and risk driving behavior include driving skill, gender, license holding time, fatigue driving, drinking index, driving age, level of education and etc. Feng [7] established the MNL model of aggressive driving behavior, and analyzed the influence degree and process sensitivity of various factors on aggressive driving selective behavior by using the elastic value theory.

Foreign scholars have abundant research results on driving behavior too. Reason et al constructed the Driver Behavior Questionnaire (DBQ) [8]. Lamm revealed the relationship among road design, driver's driving behavior, driving dynamic characteristics and traffic safety. [9] Lajunen et al. conducted a questionnaire survey on driving characteristics in drivers from several countries, which reveals that the driving characteristics of drivers from different areas have a different influence on road traffic security. Claret found that the age at which the probability of accident is minimal for different gender were not the same, and the increase of age had a positive correlation with the probability of accident.

The observation shows that there are differences in bad driving behaviors among drivers driving different types of vehicles. [4] Buses belong to large vehicles, and they need to stop many times on the city road in accordance with the fixed route. The behavior and influence of bad driving behavior of buses are different from those of other types of vehicles. However, few studies have been conducted on the driving behavior of bus drivers in the existing literature. Yi[12] analyzed the influencing factors of bad driving behavior of bus driving using statistical method. According to the Zhu et al [13], the legal awareness of drivers, driving attitude, drivers' personality characteristics and driving habits have different effects on the driving behavior of bus drivers. Moreover, gender, driving years etc. could influence the behavior of bus drivers too. Shi and Zhang [14] showed that altruism and job burnout have some influence on bus traffic accidents, and altruism has a positive impact on reducing job burnout. Sun [15] analyzed the relationship between type A personality, driving behavior and accident, and the result of which indicates that the main factors that affect bus accident are driving behavior, driving years, gender, marriage and smoke, while personality is not the main factor. Mallia et al [16] suggested that bus drivers' attitudes toward others and personality traits related to emotions have an impact on the driving behavior of bus drivers and the incidence rate of traffic accidents.

In conclusion, existing studies have explored the classification and influencing factors of bad driving behavior of bus drivers, but few research results have been done on the impact of bus drivers' driving behavior on traffic accidents. In this paper, there is a questionnaire to investigate driving behavior of bus drivers referring to Manchester's DB. Through the factor analysis, this paper classifies the bad driving behavior of bus, and then analyzes the influence of personal characteristics, safety awareness, education and training on bad driving behavior. On this basis, the influence of driving behavior on bus accidents is studied. Its purpose is to provide the basis for scientific management of bus drivers, thereby reducing the occurrence of bus accidents.

2. Data survey

Based on the Manchester DBQ, this study selects the items that have a significant impact on the bad driving behavior of the bus drivers in Hohhot, and makes a preliminary formulation of the questionnaire. And these can be got through the pre-survey to understand whether the respondents can successfully understand the questionnaire. Then, feedback and modification are necessary before the final questionnaire forming.

The site random sampling is adopted to do this survey. On June 30, 2016, at the three original and terminal stations of Hohhot city bus company, 300 drivers were randomly selected and accepted the interview and did the questionnaire during their rest time. Successfully, 300 valid questionnaires were received.

The investigated bus drivers are anonymous in order to avoid the driver's anxiety and ensure the objectivity of the answer. And the content of the questionnaire includes bus drivers' basic information(such as gender, age, license holding time, lengths of service as bus driver, degree of education and etc.), education and training(times of receiving safety education, the familiarity of traffic laws and regulations), drivers' attitude to risk, self-evaluation about driving skill, fatigue driving, experience about traffic accident and etc.

3. Bad driving behaviors of bus drivers

3.1. Descriptive statistics

Among the 300 bus drivers investigated, 258 were male, accounting for 86% of the total number, and 42 were female, accounting for 14% of the total number. The age of bus drivers investigated is between 22~48 years old, and the average age is 35.35 years old. The license holding time of them is between 1~26 years, and the average is 11.98 years.

Among all the bus drivers surveyed, there were 21 people having experienced accidents in the last year, including 2 women, accounting for 4.76% of the female drivers surveyed; 19 males, accounting for 7.36% of the male drivers surveyed. These bus drivers who have met accident are mainly 33~45 years old.

The literature has screened out 8 typical bad driving behaviors of motor vehicle drivers. And the probability of occurrence of each behavior was described using video survey. Combined with the characteristics of bus operation, this paper mainly studies the following 8 types bad driving behavior. As shown in table 1, through the questionnaire survey, the Likert scale 1-9 was used to describe the frequent occurrence of various bad behaviors, that is, from the absence of this behavior to the very frequent occurrence of this behavior. Calculate the frequent occurrence of each behavior, calculate its mean and standard deviation, and sort.

According to Table 1, Q1, Q2 and Q3 are most likely to occur during bus driving among these eight bad driving behaviors.

Table 1. Frequency of Bad Driving Behavior of Buses

| Code | Description of Bad driving behavior | Mean value | standard deviation |
|------|---|------------|--------------------|
| Q1 | Make use of every single space when encountering traffic jams | 5.727 | 2.092 |
| Q2 | Speed up in bad mood or expressing hostility to dissatisfied drivers | 5.614 | 1.714 |
| Q3 | Jump the queue or occupy other lanes when the vehicle is queuing in the station | 4.028 | 1.680 |
| Q4 | Find every opportunity to overtake when driving | 3.460 | 1.917 |
| Q5 | Not give precedence to pedestrians without traffic lights | 3.120 | 1.633 |
| Q6 | Ignore the warning signs or signal lights on the road | 3.073 | 1.904 |
| Q7 | Not pay special attention to passengers when getting in and pulling out | 2.470 | 1.478 |
| Q8 | Start the vehicle when passengers fail to get on and off safely | 2.255 | 1.478 |

3.2. Classification of bad driving behavior based on factor analysis

In order to analyze the influencing factors of adverse driving behavior of buses and the impact on traffic accidents, it is not easy to get the ideal results by directly using these eight behaviors. It is usually classified by factor analysis. [3, 5, 6, 12]

Firstly, Bartlett sphericity test and Kaiser-Meyer-Olkin (KMO) test were used to determine the suitability of factor analysis using SPSS software. The approximate chi square value of the Bartlett sphericity test statistic is 240.222, corresponding to a significance level of 0.000 and less than 0.050, so the test result is significant, indicating that there is a factorial structure. The MSA of KMO test is 0.740, so according to the literature [17], factor analysis can be performed. Reliability test of driving behavior scale showed that the Cronbach's alpha coefficient was 0.740. According to the judgment standard [17], the credibility of the questionnaire was considered as credible.

In this paper, the principal component method is used to extract the factors. According to the Kaiser criterion, the number of factors extracted is the number of factors whose factor eigenvalues are greater than 1. As shown in Table 2, there are two factors with eigenvalues greater than 1. Combined with the gravel map (Figure 1), select the first two as the main factor, each factor explained more than 5% of the variance, and the cumulative explained variance of 50.453%.

Table 2. the Explained Total Variance

| Ingredients | Initial eigenvalue | | | Extract square and load | | |
|-------------|--------------------|------------|----------------|-------------------------|------------|----------------|
| | Total | Variance % | Accumulation % | Total | Variance % | Accumulation % |
| 1 | 2.350 | 29.371 | 29.371 | 2.350 | 29.371 | 29.371 |
| 2 | 1.109 | 13.862 | 43.233 | 1.109 | 13.862 | 43.233 |
| 3 | .914 | 11.431 | 54.664 | | | |
| 4 | .870 | 10.874 | 65.538 | | | |
| 5 | .839 | 10.492 | 76.030 | | | |
| 6 | .733 | 9.162 | 85.192 | | | |
| 7 | .638 | 7.974 | 93.166 | | | |
| 8 | .547 | 6.834 | 100.000 | | | |

Extraction method: principal component analysis.

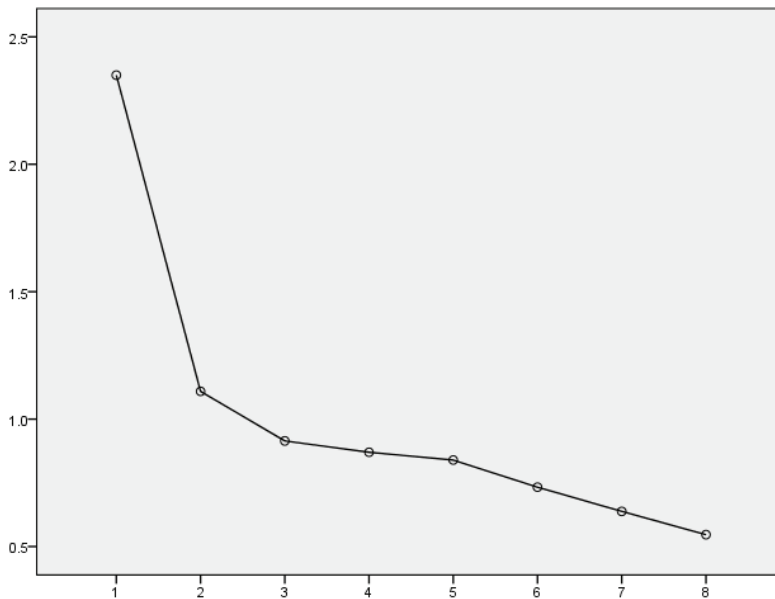


Fig. 1. Gravel Diagram of Factor Analysis

Factor rotation is performed by the maximum variance method to obtain a factor rotation matrix. As shown in Table 3, eight observation behaviors are assigned to two factors.

Factor 1 explained the variance of 29.371%, including four types of behavior, belonging to adventurous bad driving behavior, which have a greater probability of causing traffic accidents, classified as “risky dangerous behavior.”

Table 3. Factor Rotation Matrix

| Description of behavior | Factor | |
|-------------------------|--------|-------|
| | 1 | 2 |
| Q1 | | 0.515 |
| Q2 | | 0.615 |
| Q3 | | 0.719 |
| Q4 | 0.578 | |
| Q5 | 0.673 | |
| Q6 | | 0.580 |
| Q7 | 0.737 | |
| Q8 | 0.631 | |

Factor 2 accounts for 13.825% of the variance and includes four types of behavior, which are habitual, potentially dangerous, subconscious behaviors classified as “habitual hazardous behaviors.”

3.3. Factors affecting bad driving behavior

Pearson correlation analysis was used to analyze the influence of each factor on the two types of adverse driving behaviors. The influencing factors with significant influence were sorted into tables. The results are shown in Table 4, and the values of each variable in addition to the license holding time refer to table 5. The license holding time take the true value.

Table 5. the Results of Pearson Correlation Analysis

| Driving behavior | Age | The license holding time | Lengths of service as bus driver | Degree of familiarity with traffic laws and regulations |
|--|---------|--------------------------|----------------------------------|---|
| 1 | 0.618** | 0.494** | 0.455** | 0.006 |
| 2 | 0.705** | 0.568** | 0.465** | -0.131* |
| **. Significant correlation was found at the 0.01 level (bilateral). | | | | |
| *. Significant correlation was found at the 0.05 level (bilateral). | | | | |

According to Table 4, we can see that age, the license holding time and lengths of service as bus driver have significant effects on two types of bad driving behaviors. The longer the age, the license holding time and lengths of service as bus driver, the more rigid the driver’s driving habits, and the harder it is for some bad driving habits to be changed. Therefore, they have a positive effect on the bad driving behaviors. However, the more familiar with the traffic laws and regulations, the clearer the drivers’ awareness of the harmful effects of such dangerous behaviors and be conscious of correction of these habits, thus it has a negative effect on habitual dangerous behavior. In addition, the effect of gender and education levels on two types of adverse behavior is not significant.

4. Influence of bad driving behavior on traffic accidents

4.1. Variable description and univariate analysis

Pearson correlation analysis [17] and univariate Logistic regression [18] were used to each factor and the accident experience. the variable descriptions are shown in Table 5. The parameters estimation and test results are shown in Table 6.

Table 6. Model Variables and Descriptions

| Variable description | | name | Description |
|---------------------------------------|---|-----------------|---|
| Traffic accident (Dependent variable) | | Y | 1 indicates that no accident experience, otherwise 2 |
| Individual characteristics | Gender | X ₁ | 1 for male, and 2 for female |
| | Age | X ₂ | The actual value |
| | The license holding time | X ₃ | 1 shows the license holding time less than 10 years, otherwise 2 |
| | Lengths of service as bus driver | X ₄ | The actual value |
| Education and training | Education level | X ₅ | 1 for primary school, 2 for junior high school, 3 for high school, 4 for secondary school, 5 for junior college, and 6 for college. |
| | Accept safety education and training times | X ₆ | 1 represents zero safety education and training; 2 represents less than 3times; otherwise 3 |
| Safety awareness | Cognition of the relationship between traffic illegal behavior and traffic accident | X ₇ | 1 represents closely related; 2 represents related, 3 represents little related, and with 4 represents irrelevant |
| | Familiarity with traffic laws and regulations | X ₈ | 1 represents very understanding; 2 represents understanding, 3 represents understanding a little |
| | Evaluation of your driving skills | X ₉ | 1 represents very skilled and professional, 2 represents in general, 3 represents not very good |
| Driving behavior | Adventurous dangerous behavior | X ₁₀ | The scores calculated by regression. |
| | Habitual dangerous behavior | X ₁₁ | |

Table 7. Pearson Correlation Analysis and Logistic Regression Analysis of Influencing Factors and Traffic Accidents

| variable name | Correlation coefficient(Pearson) | Regression coefficients(B) | EXP(B) | P value of the regression coefficient |
|---|----------------------------------|----------------------------|--------|---------------------------------------|
| X ₁ | -0.035 | -0.464 | 0.629 | 0.543 |
| X ₂ | 0.151** | 0.100 | 1.105 | 0.011* |
| X ₃ | 0.095 | -1.970 | 0.139 | 0.009** |
| X ₄ | 0.090 | 0.063 | 1.065 | 0.124 |
| X ₅ | 0.018 | -0.113 | 1.307 | 0.610 |
| X ₆ | -0.034 | -0.644 | 0.525 | 0.035* |
| X ₇ | 0.437** | 0.110 | 1.116 | 0.752 |
| X ₈ | 0.130* | 1.986 | 7.287 | 0.000** |
| X ₉ | 0.071 | 0.852 | 2.345 | 0.240 |
| X ₁₀ | 0.528** | 2.710 | 15.025 | 0.000** |
| X ₁₁ | 0.449** | 2.344 | 10.419 | 0.000** |
| **.Significantly correlated at 0.01 level (bilateral) | | | | |
| *. Significantly correlated at 0.05 level (bilateral) | | | | |

Results of the two methods shows that age, familiarity with traffic laws and regulations, adventurous dangerous behavior and habitual dangerous behavior are significantly associated with traffic accidents. In addition, Pearson correlation analysis showed that awareness of the harm of illegal behavior also had an impact on the occurrence of traffic accidents. The univariate Logistic regression analysis showed that the number of driving experience and safety education and training had a significant impact on the occurrence of traffic accidents.

4.2. Discussion

According to the result of univariate analysis, four factors are related to traffic accidents, including adventurous dangerous behavior, habitual dangerous behavior, familiarity with traffic laws and regulations, and age. It is worth mentioned that the regression coefficients and correlation coefficients for all variables are positive. This shows that the higher the frequency of the three types of adverse driving behavior is, and the older the driver is, the traffic accident can be more easily occur. What's more, the driver is less familiar with the traffic laws and regulations, the accidents can occur more easily too.

According to the results of Logistic regression, after many tests, it was found that drivers holding the license more than 10 years were not prone to accident, compared to those holding the license less than 10 years. The higher the number of safety training received, the lower the probability of traffic accidents will be. The impact of this factor is also significant. It shows that ensuring the number of safety training, education and assessment for bus drivers has a positive effect on reducing traffic accidents. In addition, In the Pearson correlation analysis, the driver's understanding of the violation behavior is also positively related to the

occurrence of traffic accidents, indicating that drivers who consider that violation behavior is irrelevant to traffic accidents, are prone to more accidents experience.

In Li [3], the education level has a significant impact on the occurrence of accidents. Because there is not much difference in the education level of bus drivers in this study, this factor has no significant effect on the occurrence of traffic accidents. In Yi [12], gender has a significant effect on habitual driving behavior. In this study, gender had no significant effect on bad driving behavior and traffic accidents. The length of service as bus driver, the number of safety training sessions and the assessment of self-driving skills have no direct impact on the occurrence of traffic accidents.

5. Conclusion

(1) Driving behavior and other data were obtained through on-the-spot questionnaire survey, and factor analysis was used to classify bad driving behaviors as risky dangerous behavior and habitual dangerous behavior, and the statistical test was effective.

(2) Correlation analysis showed that age, the license holding time and the length of service as bus driver have significant impact on bad driving behavior, and familiarity with laws and regulations has a significant impact on habitual dangerous behavior.

(3) According to the univariate analysis, there are eight factors that have a significant impact on the traffic accidents. From the regression coefficient, risky dangerous behavior and habitual dangerous behavior are the most important factors that affect the traffic accident, and need to be effectively corrected in the management, which has a positive effect on reducing the occurrence of traffic accident.

In summary, this article can bring the following enlightenment for the bus company to strengthen the operation and management:

(1) The number of safety education and training is conducive to correcting habitual dangerous behavior, which has a positive effect on reducing traffic accidents. There are evaluation links in the safety education and training of public transport companies in general, so the problem is only measured by the number of training. In Hohhot City, the working mode of bus drivers is divided into two classes: full day class and half day class. Enterprises should arrange the working time of drivers reasonably, and ensure the effective safety training and education.

(2) The familiarity with traffic laws and regulations not only affects the bad driving behavior, but also directly affects the occurrence of traffic accidents. Therefore, it is necessary to strengthen the training and assessment of drivers' traffic laws and regulations.

(3) The degree of awareness of the danger of illegal behavior also has an impact on traffic accidents. According to the questionnaire survey, from the driver's point of view, the weak sense of personal safety is the most easily lead to illegal behavior, accounting for 42%, followed by the poor road environment accounted for 37%, illegal behavior accounted for 21% of others. Therefore, enterprises should strengthen the personal safety awareness of drivers through the safety training, safety knowledge

publicity activities, safety meetings and other ways, and correctly understand the harm of violation behavior.

(4) How to correct the habitual hazard behavior of drivers holding license for long time is a problem that enterprises should pay attention to.

In addition, this questionnaire also investigated the following two items:

(1) The questionnaire survey showed that 93% of drivers considered morning and evening rush hour as the most likely time for traffic accidents. Morning and evening peak road congestion is a big challenge to the driver's driving skills and psychology. Enterprises should be targeted to introduce management measures, such as properly handle delays, identify accidents prone sections, the peak prone accident summary communication.

(2) According to the questionnaire survey, the drivers considered that the six kinds of measures that can make bus drivers pay attention to driving safety are ordered according to their functions and sizes: family members' instructions, accident case reports, safety inspections, daily meeting education, unit leaders' instructions and colleagues' reminded. The families daily told will let the driver subconsciously pay attention to the traffic safety, and accident case notification played a wake-up call, safety checks to the driver can provide more constraints and supervision. These three methods are considered by the driver is the most effective way.

This study mainly relies on the data from the questionnaire survey. Although the anonymous investigation will make respondents relax and answer questions more objectively, they may be influenced by the expectation of social psychology. As a result, they may be unwilling to admit bad driving behaviors. In addition, the driver's technical evaluation scale and personality analysis scale cannot be merged, only the influence of driver's self-evaluation is considered, and the research on the factors affecting personality characteristics and aggressive behavior is insufficient, which is the direction to be further improved.

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