Hindawi
Journal of Advanced Transportation
Volume 2019, Article ID 8675318, 9 pages
https://doi.org/10.1155/2019/8675318

Research Article

A Study on the Differences in Driving Skills of Chinese Bus and Taxi Drivers

Zuobo Zhang,[1] **Xuxin Zhang**,[2] **Nuoya Ji**,[2] **Shanshan Lin**,[2] **Kun Wang**,[3] **Tianshan Ma**,[1] **and Wenying Zhu**[1]

[1]*School of Economics and Management, Chang'an University, 710064 Xi'an, Shaanxi, China*
[2]*School of Automobile and Traffic Engineering, Hefei University of Technology, 230009 Hefei, Anhui, China*
[3]*College of Civil Engineering, Hefei University of Technology, 230009 Hefei, Anhui, China*

Correspondence should be addressed to Zuobo Zhang; zzbime@chd.edu.cn

Received 26 March 2019; Revised 10 June 2019; Accepted 5 September 2019; Published 9 December 2019

Academic Editor: Eleonora Papadimitriou

Professional drivers constitute an important group of drivers who shoulder the responsibility of safely transporting passengers and cargo. Bus drivers and taxi drivers are an important part of the urban public transport system, and their driving safety affects road traffic safety. Therefore, the purpose of this paper is to explore the differences between bus drivers and taxi drivers in their driving behaviors and driving skills and to predict their traffic accident involvement based on these behaviors and skills. We conducted a field survey of 274 bus drivers and 178 taxi drivers in Hefei, China. The results revealed significant differences between bus drivers and taxi drivers in terms of violations, lack of concentration and technical driving skills. Aggression and violations had significant predictive effects on bus drivers' traffic accident involvement, and memory lapses and a lack of safety consciousness had significant predictive effects on taxi drivers' accident involvement.

1. Introduction

The urban public transportation system is an important part of the urban passenger transportation system, and its main means of transport include subways, buses, taxis, and public bicycles. Among these means, buses and taxis are important parts of road passenger transportation, and they are also the most common modes of transport in the urban passenger transportation system. By the end of 2018, China had 673,400 buses that completed 61.7 billion city passenger trips, accounting for 55% of the total passenger traffic, and it had 1,380,900 taxis that completed 35.167 billion city passenger trips, accounting for 28% of the total passenger traffic [1]. The driving safety of bus and taxi drivers is crucial to the road traffic safety of millions of passengers. Compared with bus transport in developing countries, bus transport in developed countries is relatively safe [2]. However, bus accident rates in India, Nepal [3] and Sri Lanka [4] are higher than the accident rates of other vehicle types. In a Japanese taxi company, 25% of drivers contributed to 50% of total traffic accidents, and only 14% of drivers had never had an accident [5]. A survey in Xi'an, China, revealed that the average number of taxi crashes per month was 8,500 over the period of 2006–2011 [6]. According to statistical data, human factors are the main cause of traffic accidents, with 91% of accidents caused by drivers' dangerous driving behaviors and improper operation behaviors [7]. Since bus drivers and taxi drivers are important types of drivers, their driving behavior is an important factor affecting road traffic safety. Therefore, this paper explores the driving behaviors and driving skills of bus drivers and taxi drivers, which is of great significance to ensuring road traffic safety.

Research on bus drivers mainly explores the risk factors related to accidents, bus drivers' driving behaviors and fatigue driving, and the influence of drivers' occupational health. Studying the risk factors related to accidents, Shahla et al. [8] found that the probability of accidents at signalized intersections depends on the annual average daily traffic volume, pedestrian traffic volume, traffic signal priority, parking position and restriction conditions in Canada. Guo et al. conducted a similar study in 2018. The research of Chimba et al. [9] in America showed that the location of bus lines, the presence of parking spaces at the roadside, lane width and other

factors related to the linear design of the road also affect the occurrence of accidents. A Danish study used an ordered logistic model to explore the risk factors influencing fatal bus accidents, and the results showed that age, gender, speed, intersection, distraction and risky driving significantly increase the severity of bus accidents [10]. A Chinese study used the same method and found slightly different results, namely, that the season, the accident time, the speed limit and other risk factors have a significant influence on the severity of fatal accidents for different drivers [11]. In terms of the driving behaviors of bus drivers, some Swedish studies use bus drivers' accelerating behavior and absence behavior to predict traffic accidents [12, 13]. In the United States, the frequency of bus accidents is correlated with driver demographics and behavioral characteristics [14]. Shi and Zhang [15] explored the influence of bus drivers' personality traits on their driving behaviors, and the results showed that drivers' altruistic traits were negatively correlated with job burnout and were significantly negatively correlated with abnormal driving behaviors, such as aggressive violations, common violations, error behaviors and lapse behaviors. Useche et al. [16] surveyed 524 Bus Rapid Transit (BRT) drivers in Colombia, and the results of suggest that stress-related working conditions (job strain, social support and ERI) are relevant predictors of risky driving in BRT operators and that fatigue is the mechanism that links another type of stress related to working conditions (job strain and low social support) with risky driving. Tan et al. [17] proposed a comprehensive steering system design aimed at changing bus drivers' fatigue driving behaviors, and the survey results showed that the system was feasible and could effectively reduce the accident rate. Davidović et al. [18] explored the influence of sleep, work and health factors on the fatigue driving of bus drivers and truck drivers. According to van Amelsvoort et al. [19], job strain in public transport drivers is be associated with negative physical (e.g., musculoskeletal and cardiovascular diseases and physical fatigue in general) and mental (e.g., psychological discomfort, sleep problems, and mental fatigue) health outcomes [20, 21].

Research on taxi drivers can be broadly divided into driver decision-making behavior, bad driving behavior, accident rates and risk factors, and driver occupational health. Regarding research on taxi drivers' decision-making behavior, Li et al. [22] analyzed taxi drivers' behavioral preferences in route selection by using taxi track record data. Zhang et al. [23] used evolutionary game theory to explore the influence of passengers on taxi drivers' carpooling detour behavior. In research on taxi drivers' bad driving behavior, risky driving behavior, angry driving, and fatigue driving have been widely studied. In Wuhan, China, a survey among taxi drivers revealed that their attitudes towards traffic law violations affected their risky driving behavior [24]. Sullman et al. [25] found that taxi drivers who exhibited more passive-aggressive driving behaviors were easily distracted and had an increased crash risk. Cheng et al. [26] used an event-related potential (ERP) experiment to explore the differences in risk behaviors caused by impulsion between taxi drivers with traffic violations and those without. Vahedi et al. [27] explored the influence of the social economy, personal attributes and abnormal driving behavior on traffic accidents and traffic penalties. Bao et al. [28] investigated large-scale taxi GPS data to understand the impact of drivers' travel mode on spatial aggregation collision. Sullman et al. [25] used the Driving Anger Expression (DAX) Inventory to explore forms of anger expression in Turkish taxi drivers and their relationship with the drivers' personal characteristics, the results showed that verbal aggressive expression, personal physical aggressive expression, and use of a vehicle to express anger are the three most common forms of anger expression, which are related to age, driving experience, average annual mileage and other factors. Taxi drivers primarily drive in urban road environments with long driving hours and a high mental workload. A survey in Australia found that 67% of taxi drivers drove at least 50 h per week, and the time off in long shifts (up to 12 h) was often as short as 37 min [29]. Many factors contributed to driving fatigue for taxi drivers, among which prolonged driving time was likely to be the most common and important [30]. Meng et al. [31] found that the reason for the engagement in prolonged driving was neither a lack of awareness concerning the serious outcomes of fatigue driving nor poor detection of fatigue. The most probable reason was optimism bias, which led these professional drivers to think that fatigue was more serious for other drivers than for themselves and that they were effective in counteracting the effect of fatigue on their driving performance. A study of accident rates and risks for taxi drivers, [32] found that in Hanoi, Vietnam, approximately 22.7% of taxi drivers had accidents and that age, the type of driver's license, satisfaction with income, use of a seat belt and past traffic violations all had significant effects on traffic accidents. Ba et al. [33] found that taxi drivers' dangerous driving behaviors were significantly positively correlated with personal injury and collision risk. Estimates of the hybrid bivariate model reveal that increasing levels of fatigue, reckless behavior and aggressive behavior are positively related to a higher propensity for crash involvement [34]. In terms of occupational health, taxi drivers have a higher body mass index (BMI) and more unhealthy eating habits due to the extended hours of driving, this finding confirms previous findings that musculoskeletal problems are common in this occupation [35]. Taxi drivers are vulnerable to other occupational exposures that affect their risk of being involved in road crashes, these exposures include vision defects [36], mental stress [37], irregular shifts [38], lower income [39], and traffic congestion conditions [40].

Bus travel and taxi travel are the two most common modes of urban public transport. In general, in urban bus enterprises, bus drivers need to perform driving tasks according to the requirements of the scheduled departure schedule. Driving a bus is a repetitive and intense task. Drivers need to drive the same route for a long period of time every day, which increases the risk of driver burnout. In the Chinese taxi industry, taxi drivers can flexibly arrange their working hours according to their preferences, and drivers can take breaks to relieve fatigue when they feel tired. However, due to the constantly changing road traffic environment and the large number of potential risks, drivers' driving skills must improve. Therefore, four hypotheses are proposed in this paper: (1) Demographic variables have a significant impact on the driving behaviors and driving skills of bus drivers and taxi drivers. (2) Bus drivers and taxi drivers differ significantly in their driving behaviors

Table 1: Participant demographics.

	Bus drivers (N = 274)		Taxi drivers (N = 178)		F	Sig.
	Mean	S.D.	Mean	S.D.		
Age	39.37	8.41	43.16	6.17	26.70	0.000**
Driving experience	14.96	8.11	16.09	5.59	2.64	0.105
Average annual mileage ($\times 10^4$ km)	4.38	2.65	9.07	2.58	344.75	0.000**
Number of accidents in the past three years	1.44	2.66	0.61	0.96	15.98	0.000**
Penalty points in the last year	0.50	1.77	3.39	4.53	90.59	0.000**

**$p < 0.01$.

and driving skills. (3) The demographic variables, driving behaviors and driving skills of bus drivers and taxi drivers have a direct impact on their number of accidents. (4) The driving skills of bus drivers and taxi drivers can influence their number of accidents through their driving behaviors.

At present, research on professional drivers mainly focuses on the accident situation as well as drivers' driving behavior and health conditions in the professional driving context. Additionally, research on different types of driver behavior mostly consists of comparisons between professional drivers and nonprofessional drivers; there is less research on the differences in driving behaviors and driving skills among different types of professional drivers. Since bus drivers and taxi drivers comprise the two largest proportions of professional drivers in the urban public traffic system, their driving behaviors affect residents' travel safety. Therefore, this study focuses on bus drivers and taxi drivers to examine the differences in their driving behaviors and driving skills and to explore the influence of these behaviors and skills on their traffic accidents.

2. Method

2.1. Participants. A total of 452 drivers, including 274 bus drivers and 178 taxi drivers, participated in this survey in Hefei, China. Hefei, the capital of Anhui province, is one of the typical large cities in eastern China. By 2018, the city had a permanent population of 8.087 million and a total area of 11,445.1 square kilometers. In recent years, Hefei has achieved rapid economic development. Its GDP reached 782.291 billion yuan in 2018, representing an 8.5% year-on-year increase. The urban road public passenger transport system in Hefei is well developed and can meet people's road traffic needs. Hefei has 4,427 operating buses and 170 routes. In 2015, the bus system covered a driving distance of 205 million kilometers and completed 617 million passenger trips. There are 9,402 taxis in Hefei. Of these, 2,001 taxis from Herui Taxi Company had 1,063 accidents in 2018. Thus far in 2019, taxis have been involved in 747 traffic accidents in which they were equally or primarily responsible, and buses have been involved in 402 traffic accidents in which they were equally or primarily responsible. The above accident data were obtained from the Hefei transportation management department. Among the participants in this survey, the average age of the bus drivers was 39.37 years (S.D. = 8.41), with an average of 14.96 years of driving experience and an average annual mileage of 43,800 km. The average age of the taxi drivers was 43.16 years (S.D. = 6.17), with an average of 16.09 years of driving experience and an average annual mileage of 90,700 km. In addition, the total number of accidents in the past three years was significantly higher for bus drivers than for taxi drivers, but bus drivers had significantly fewer driver's license penalty points than taxi drivers in the last year. The basic statistical information on the drivers is shown in Table 1.

2.2. Materials. The data used in this study were obtained from field surveys of bus drivers and taxi drivers. The bus driver survey was conducted at the weekly meeting of drivers from six bus companies belonging to the Hefei Bus Group. The questionnaire included questions on the basic statistical information of the drivers, such as their gender, age, driving experience, annual average mileage, number of accidents, penalty points and working hours. In addition, to assess the drivers' driving behaviors and driving skills, the Driving Behavior Questionnaire (DBQ) (Cronbach's $\alpha = 0.852$) and the Driving Skill Inventory (DSI) (Cronbach's $\alpha = 0.750$) in Zhang et al. [41], which were translated and revised, were selected, as shown in Tables 2 and 3, respectively. The DBQ contains 17 items, which are divided into four different dimensions: aggression ($\alpha = 0.763$), violations ($\alpha = 0.731$), lack of concentration ($\alpha = 0.669$) and memory lapses ($\alpha = 0.644$). The DSI contains 15 items, which are divided into three dimensions: safety consciousness ($\alpha = 0.819$), technical driving skills ($\alpha = 0.674$) and risk perception ($\alpha = 0.700$). Before the subjects completed the questionnaire, the experimenters informed them that the survey was completely anonymous, that their personal information would not be collected and that the results of the survey would be used for academic research purposes only. In the process of completing the questionnaire, the drivers could ask questions at any time if there was something that they did not understand, and experimenters provided clarification.

The questionnaire data on the taxi drivers' driving behaviors and driving skills come from the study by Zhang et al. [41] on taxi drivers. All participants were randomly sampled from three dining centers for taxi drivers (where taxi drivers can stop to rest and have lunch or dinner) in Hefei, China. These data include self-reported basic personal characteristics, driving behavior scores and driving skill scores. The items used to investigate each driver's behavior and driving skills were chosen from the 27-item DBQ [42] and 29-item DSI scales [43].

Table 2: DBQ used in this study.

DBQ-Items ($\alpha = 0.852$)
Factor 1-Aggression ($\alpha = 0.763$)
DBQ-6 Become angered by a certain type of driver and indicate your hostility by whatever means are at your disposal
DBQ-12 Sound your horn to indicate your annoyance to another road user
DBQ-15 Overtake a slow driver on the inside
DBQ-10 Become angered by another driver and chase after the driver with the intention of giving him/her a piece of your mind
DBQ-11 Race away from traffic lights with the intention of beating the driver next to you
Factor 2-Violations ($\alpha = 0.731$)
DBQ-16 Disregard the speed limit on a motorway
DBQ-2 Disregard the speed limit on a residential road
DBQ-5 Miss "Give Way" signs and narrowly avoid colliding with traffic that has the right of way
DBQ-1 Stay in a motorway lane that you know will be closed ahead until the last minute before forcing your way into the other lane
Factor 3-Lack of concentration ($\alpha = 0.669$)
DBQ-13 Misread the signs and exit a roundabout onto the wrong road
DBQ-14 Drive so closely to the car in front of you that it would be difficult to stop in an emergency
DBQ-17 Get into the wrong lane when approaching a roundabout or a junction
DBQ-3 Attempt to overtake someone whom you did not notice was signaling a right turn
Factor 4-Memory lapses ($\alpha = 0.644$)
DBQ-8 Realize that you have no clear recollection of the road along which you have just been travelling
DBQ-9 Hit something that you had not previously seen when reversing
DBQ-7 Forget where you left your car in a parking lot
DBQ-4 Intending to drive to destination A, you "wake up" to find yourself on the road to destination B

Table 3: DSI used in this study.

DSI-Items ($\alpha = 0.750$)
Factor 1-Safety consciousness ($\alpha = 0.819$)
DSI-14 Following traffic lights carefully
DSI-11 Conforming to speed limits
DSI-7 Conforming to traffic rules
DSI-8 Keeping a sufficient following distance
DSI-15 Parking in legal places only
DSI-10 Relinquishing one's rights
Factor 2-Technical driving skills ($\alpha = 0.674$)
DSI-12 Fluent lane-changing in heavy traffic
DSI-9 Overtaking
DSI-1 Driving fast if necessary
DSI-5 Avoiding competition in traffic
DSI-13 Fast reactions
Factor 3-Risk perception ($\alpha = 0.700$)
DSI-4 Driving in a strange city
DSI-3 Perceiving hazards in traffic
DSI-6 Driving on slippery roads
DSI-2 Driving in the dark

3. Results

3.1. Binary Correlation Analysis. Pearson correlation analysis was used to test the correlation between the personal characteristics of the bus drivers and taxi drivers (age, driving experience, annual average mileage, total number of accidents in the past three years and total penalty points in the last year) and their driving behaviors and driving skills. The results, shown in Table 4, show that among the taxi drivers, the total number of accidents in the past three years and the total penalty points in the last year are positively correlated with aggression, violations and memory lapses but negatively correlated with safety consciousness [44]. Among the bus drivers, their personal characteristics are significantly correlated with their driving behaviors and driving skills. Among their personal characteristics, age and driving experience are significantly positively correlated with the bus drivers' safety consciousness, while driving experience is significantly negatively correlated with memory lapses. The average annual mileage is significantly positively correlated with aggression ($r = 0.124$, $p < 0.05$) and risk perception ($r = 0.129$, $p < 0.05$). The total number of accidents in the past three years is significantly positively correlated with aggression ($r = 0.217$, $p < 0.01$) but negatively correlated with safety consciousness ($r = -0.123$, $p < 0.05$). Thus, hypothesis 1 is supported.

3.2. Variance Analysis (Differences in Driving Behaviors and Skills between the Two Types of Drivers). One-way ANOVA was conducted, and the differences in driving behaviors and driving skills between the two different types of professional drivers were evaluated. The results, shown in Table 5, indicate significant differences between the two different types of drivers in violations ($F = 6.540$, $p < 0.05$), lack of concentration ($F = 6.371$, $p < 0.05$) and technical driving skills ($F = 8.517$, $p < 0.01$). Moreover, the average violation and lack of concentration scores of the taxi drivers are higher than those of the bus drivers. At the same time, the technical driving skills of the taxi drivers are also higher than those of the bus drivers. Thus, hypothesis 2 is supported.

3.3. Accident Prediction of Bus Drivers and Taxi Drivers. To explore the influence of the driving performance of taxi drivers and bus drivers on accident prediction, structural equation model analysis is conducted for the two types of drivers. Combined with the above assumptions and analysis, the number of traffic accidents is taken as the dependent variable of the model, and demographic variables, driving behaviors and driving skills are taken as the independent variables included in the model. The corresponding model path is set, and the accuracy of the model is tested by the following evaluation indexes: root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), incremental fit index (IFI) and comparative fit index (CFI). The statistical summary of the goodness of fit of the SEM model is shown in Table 6. The GFI, AGFI, IFI, and CFI values of this model are all greater than 0.90, and the

Table 4: Correlation analysis of personal characteristics, driving behaviors and driving skills of drivers.

Independent variable	Driver category	F1 Aggression	F2 Violations	F3 Lack of concentration	F4 Memory lapse	F1 Safety consciousness	F2 Technical driving skills	F3 Risk perception
Age	Bus	−0.086	−0.043	0.079	−0.097	0.251**	0.020	−0.024
	Taxi	−0.131	−0.111	−0.076	0.000	0.104	−0.034	−0.100
Driving experience	Bus	−0.075	−0.043	0.042	−0.125*	0.251**	0.070	0.056
	Taxi	−0.063	0.006	−0.076	0.043	0.068	0.095	0.017
Average annual mileage	Bus	0.124*	−0.040	0.029	−0.062	0.050	0.025	0.129*
	Taxi	−0.076	−0.131	−0.103	−0.071	0.062	0.015	0.029
Number of accidents in the past three years	Bus	0.217**	0.097	−0.003	0.017	−0.123**	0.037	0.053
	Taxi	0.194**	0.168*	0.132	0.234**	−0.209**	−0.071	−0.001
Penalty points in the last year	Bus	0.016	−0.016	0.052	0.048	−0.010	0.009	−0.012
	Taxi	0.242**	0.163*	0.106	0.198**	−0.245**	0.002	−0.045

*$p < 0.05$, **$p < 0.01$.

Table 5: Differences in driving behaviors and driving skills between bus drivers and taxi drivers.

Variable	Bus drivers		Taxi drivers		F	p value
	Mean	S.D.	Mean	S.D.		
F1 Aggression	10.27	3.41	10.27	3.38	0.000	0.990
F2 Violations	5.97	1.86	6.48	2.35	6.540	0.011*
F3 Lack of concentration	6.56	2.16	7.10	2.25	6.371	0.012*
F4 Memory lapse	6.94	2.39	6.52	2.10	3.737	0.054
F1 Safety consciousness	24.25	3.59	24.12	3.95	0.130	0.718
F2 Technical driving skills	16.91	3.02	17.80	3.37	8.517	0.004**
F3 Risk perception	12.82	2.73	12.86	3.10	0.020	0.888

*$p < 0.05$, **$p < 0.01$.

RMSEA value is less than 0.05, indicating that the structural equation model constructed is acceptable.

Figure 1 shows that bus drivers' penalty points in the last year and violations have a significant impact on their number of accidents, which confirms hypothesis 3. The beta coefficient shows that violations are more significant than the number of accidents caused by penalty points in the last year. The beta coefficient between safety consciousness and violations is 0.34, indicating that safety consciousness can affect the number of accidents through violations, thus, hypothesis 4 is supported. Figure 2 shows that bus drivers' driving experience, penalty points in the last year and memory lapse have a significant impact on their number of accidents, which confirms hypothesis 3. The beta coefficient shows that memory lapse is more significant than driving experience and penalty points in the last year. The beta coefficient between safety consciousness and memory lapse is not significant, indicating that safety consciousness cannot affect the number of accidents through memory lapse, this finding is contrary to hypothesis 4.

4. Discussion

In this paper, the driving behaviors and driving skills of bus drivers and taxi drivers were investigated by means of questionnaires with the purpose of exploring the behavioral differences between these two types of professional drivers.

The results of the binary correlation analysis of bus drivers' and taxi drivers' personal characteristics and driving behaviors and driving skills show that the average annual mileage of bus drivers is significantly positively correlated with aggression. Bus drivers tend to be bored and listless due to their fixed work routes and long-term, long-distance, repetitive work, which may lead to more aggression, such as frequent honking. Taxi drivers' total number of accidents in the past three years is significantly correlated with violations; however, in this regard, bus drivers do not show a significant correlation. Compared with buses, taxis are smaller in size; thus, it is easier for drivers to change lanes, overtake other vehicles and perform other operations, resulting in an increased frequency of speeding, illegal lane changes and other behaviors. Regarding safety consciousness, with increases in age and driving experience, bus drivers' consciousness of laws and regulations also improves. At the same time, the total number of accidents in the past three years of both bus drivers and taxi drivers is significantly negatively correlated with safety consciousness, indicating that drivers with traffic accidents may have worse safety consciousness. Therefore, management and training should focus on cultivating the safety consciousness of drivers in their daily driving process to further reduce the accident rate.

ANOVA of the two types of professional drivers found that the violations, lack of concentration and technical driving skills of taxi drivers were significantly different from those of bus drivers, and taxi drivers' scores were all higher than bus

Table 6: Model fit indexes.

Index		CMIN/DF	RMSEA	GFI	AGFI	IFI	CFI
Measured value	Bus driver	1.256	0.030	0.957	0.937	0.977	0.976
	Taxi driver	1.348	0.044	0.976	0.943	0.972	0.970
Evaluative criteria		1~3	<0.05	>0.90	>0.90	>0.90	>0.90

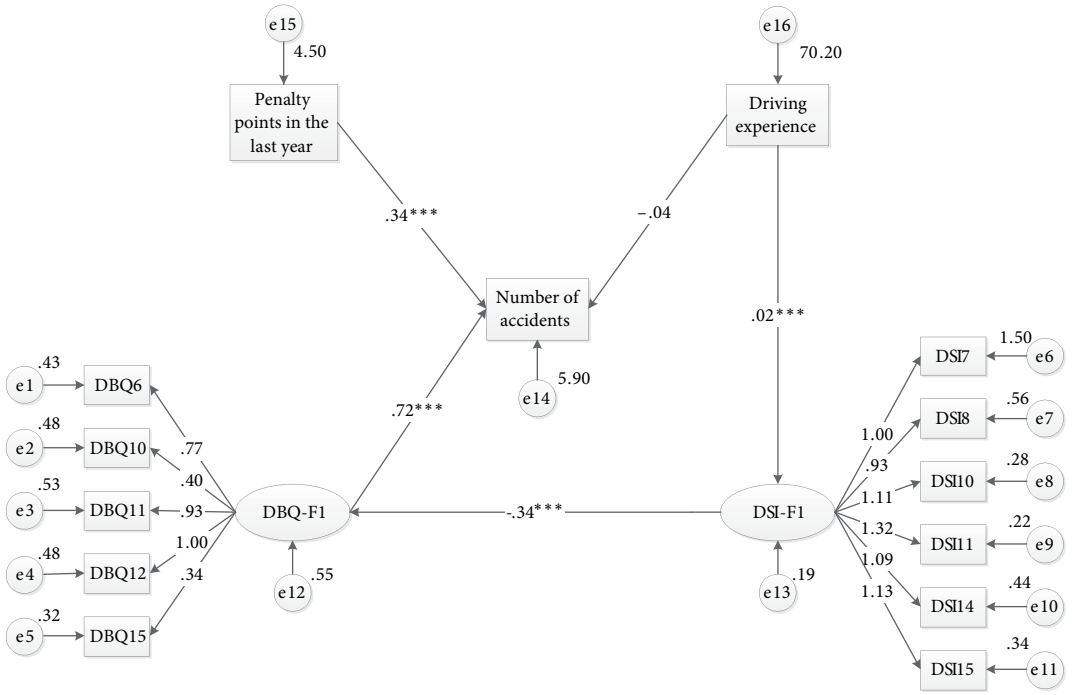

Figure 1: Bus driver structural equation model path coefficient.

drivers' scores. The results show that taxi drivers have a higher frequency of violations and a lack of concentration than do bus drivers, and their technical driving skills, such as overtaking other vehicles and reacting rapidly, are better than those of bus drivers. Bus drivers drive larger vehicles with more passengers, and buses are equipped with more sophisticated monitoring equipment; these factors may play a supervisory role in drivers' behaviors and decrease the frequency of their violations and lack of concentration. Taxi drivers navigate more diverse daily driving routes and more complex road conditions; thus, they are more experienced in dealing with different traffic environments, which may improve their technical driving skills.

The accident prediction model results of the two types of professional drivers show that for bus drivers, penalty points in the last year and violations play a significant role in predicting the occurrence of traffic accidents, with violations having the most serious impact on traffic accidents. Due to the large size of buses, bad bus-driving behavior has a serious impact on surrounding vehicles. For example, when forcibly changing lanes or illegally overtaking other vehicles, drivers' vision behind the bus is blocked. A reaction that is not made in time can easily cause a collision or rear-ending. For taxi drivers, memory lapses, driving experience and penalty points in the last year can significantly predict the occurrence of traffic accidents. The results show that drivers who have been more frequently involved in traffic accidents have less awareness of laws and regulations and more memory lapses.

In summary, this study used a self-reported questionnaire to investigate the differences in driving behaviors and driving skills between bus drivers and taxi drivers. The results show that the violations and lack of concentration of bus drivers are significantly lower than those of taxi drivers, while the technical driving skills of taxi drivers are significantly better than those of bus drivers. In terms of accidents, aggression and violations significantly predict the occurrence of bus driver accidents. For taxi drivers, both memory lapses and safety consciousness can predict accidents, and safety consciousness can significantly predict the results of accidents.

With regard to bus driver management, to avoid aggression and violations, more effective management measures should be taken to improve drivers' driving safety consciousness. First, it is important to strengthen the regular training and education of drivers and driving behavior interventions and to enhance their awareness of safe operation. For example, when individual passengers attack bus drivers through verbal abuse, physical assault and other serious actions that cause harm to public safety, bus drivers should cease driving and notify the police. This is a painful lesson learned from accidents in China. Second, it is important to regularly adjust bus

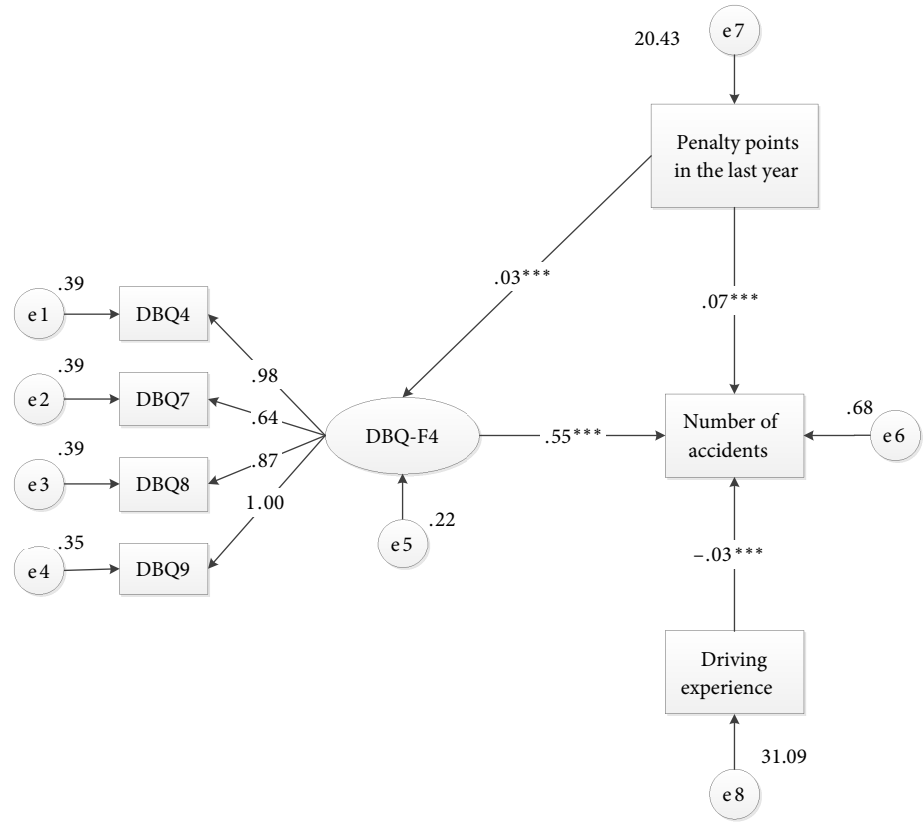

Figure 2: Taxi driver structural equation model path coefficient.

drivers' working routes to avoid the boredom and burnout caused by fixed working routes; doing so has the same effect as the road design concept of specially setting turning curves in the case of long straight lines to improve drivers' attention. Third, it is important to establish measures for passengers to supervise and report the dangerous driving behaviors of drivers, such as violations and aggression, and to implement certain reward and punishment measures to jointly maintain bus driving safety.

With regard to taxi driver management, taxi drivers have a high degree of autonomy in production and operation, creating certain difficulties for the management of taxi enterprises. It is necessary to strengthen management in the following ways. First, it is important to implement an access system for taxi drivers. Obtaining a driver's license should require taxi drivers to demonstrate proficiency through an exam covering the layout of main urban roads, the position of main urban landmarks and other aspects related to common sense. This exam should be organized by taxi management agencies so that drivers can be familiar with the conditions of the city before driving and improve the accuracy of their memory, which is a fundamental intervention for memory lapses. Second, it is important to strengthen the assessment of taxi drivers' violations and to implement scoring management. After reaching a certain score, drivers should be required to undergo education and training at taxi management institutions and taxi enterprises; they can resume operating as professional drivers after showing that they can meet basic standards. Third, we should strengthen the installation of video surveillance in taxis and adopt information technologies to prevent taxi drivers from using mobile phones and engaging in other risk behaviors while driving so that they can concentrate on driving and improve their safety awareness.

For the safety management of the urban public transportation system, the strength that comes from drivers' families is also very important. Chinese people focus strongly on family harmony. Illegal driving behavior not only endangers traffic safety but also negatively affects family harmony. Family members can play a crucial role in urging bus drivers to take adequate rest, maintain a good working mood and stay in good physical condition, which is a neglected part of driver management.

This study contains some limitations. Because there may be a certain level of social desirability bias in the drivers' self-report surveys, there may be some discrepancies between the drivers' responses to the questionnaire items and reality. Future studies may consider incorporating driving simulators to further measure driver behavior and to evaluate the differences between bus drivers and taxi drivers in their driving behaviors and driving skills. In addition, the subjects of this study were limited to bus and taxi drivers in Hefei; thus, the results may not fully represent the driving behavior of all professional drivers in China. Future research may further expand the sample size to explore the behavioral differences of professional drivers in a manner that is more in line with Chinese national conditions.

5. Conclusions

The results of the study show that (a) there are significant differences between bus drivers and taxi drivers in terms of violations, lack of concentration and technical driving skills, and (b) penalty points in the last year and violations can significantly predict the traffic accidents of bus drivers, while memory lapse and safety consciousness can significantly predict the accidents of taxi drivers.

Data Availability

The questionnaire data used to support the findings of this study have not been made available because a confidentiality agreement is signed with the participants during collection process. So the data that has been used is confidential.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] "China statistical bulletin on the development of the transportation industry. Ministry of Transport of the People's Republic of China," 2015.

[2] U. Barua and R. Tay, "Severity of urban transit bus crashes in Bangladesh," *Journal of Advanced Transportation*, vol. 44, no. 1, pp. 34–41, 2010.

[3] T. Pearce, D. A. C. Maunder, T. C. Mbara, D. M. Babu, and T. Rwebangira, "Bus accidents in India, Nepal, Tanzania, and Zimbabwe," *Transportation Research Record: Journal of the Transportation Research Board*, vol. 1726, no. 1, pp. 16–23, 2000.

[4] A. U. Jayatilleke, S. Nakahara, S. D. Dharmaratne, A. C. Jayatilleke, K. C. Poudel, and M. Jimba, "Working conditions of bus drivers in the private sector and bus crashes in Kandy district, Sri Lanka: a case-control study," *Injury Prevention*, vol. 15, no. 2, pp. 80–86, 2009.

[5] Z. Q. Liu, R. H. Ge, and B. Gong, *Road Traffic Safety Engineering*, Chemical Industry Press, Beijing, 2005.

[6] Y. Zhao, J. Zhang, and X. He, "Risk factors contributing to taxi involved crashes: a case study in Xi'an, China," *Periodica Polytechnica Transportation Engineering*, vol. 43, no. 4, pp. 189–198, 2015.

[7] China Road Traffic Incidents Statistics, "Beijing, China: Traffic Administration Bureau of China State Security Ministry," 2015.

[8] F. Shahla, A. S. Shalaby, B. N. Persaud, and A. Hadayeghi, "Analysis of transit safety at signalized intersections," *Transportation Research Record*, vol. 2102, pp. 108–114, 2009.

[9] D. Chimba, T. Sando, and V. Kwigizile, "Effect of bus size and operation to crash occurrences," *Accident Analysis & Prevention*, vol. 42, no. 6, pp. 2063–2067, 2010.

[10] S. Kaplan and C. G. Prato, "Risk factors associated with bus accident severity in the United States: a generalized ordered logit model," *Journal of Safety Research*, vol. 43, no. 3, pp. 171–180, 2012.

[11] S. Feng, Z. Li, Y. Ci, and G. Zhang, "Risk factors affecting fatal bus accident severity: their impact on different types of bus drivers," *Accident Analysis & Prevention*, vol. 86, pp. 29–39, 2016.

[12] A. E. af Wahlberg, "Long-term prediction of traffic accident record from bus driver celeration behavior," *International Journal of Occupational Safety and Ergonomics*, vol. 13, no. 2, pp. 159–171, 2007.

[13] A. E. af Wåhlberg and L. Dorn, "Absence behavior as traffic crash predictor in bus drivers," *Journal of Safety Research*, vol. 40, no. 3, pp. 197–201, 2009.

[14] D. Blower and P. E. Green, "Type of motor carrier and driver history in fatal bus crashes," *Transportation Research Record: Journal of the Transportation Research Board*, vol. 2194, no. 1, pp. 37–43, 2010.

[15] X. Shi and L. Zhang, "Effects of altruism and burnout on driving behavior of bus drivers," *Accident Analysis & Prevention*, vol. 102, pp. 110–115, 2017.

[16] S. A. Useche, V. Gómez, and B. E. Cendales, "Stress-related psychosocial factors at work, fatigue, and risky driving behavior in bus rapid transport (BRT) drivers," *Accident Analysis & Prevention*, vol. 104C, pp. 106–114, 2017.

[17] C. F. Tan, R. S. S. Singh, V. K. Kher, and B. T. Tan, "Integrated steering system design for bus driver drowsy behavior change," *Applied Mechanics and Materials*, vol. 315, pp. 231–235, 2013.

[18] J. Davidović, D. Pešić, and B. Antić, "Professional drivers' fatigue as a problem of the modern era," *Transportation Research Part F: Traffic Psychology and Behaviour*, vol. 55, pp. 199–209, 2018.

[19] L. G. van Amelsvoort, I. J. Kant, U. Bültmann, and G. M. Swaen, "Need for recovery after work and the subsequent risk of cardiovascular disease in a working population," *Occupational and Environmental Medicine*, vol. 60, 1pp. 83–87, 2003.

[20] V. Gómez, B. Cendales, S. A. Useche, and J. P. Bocarejo, "Working conditions, health indicators and psychological variables as predictors of accidents risk of bus operators of bus rapid transit," in *International Congress for Occupational Health and Work Organisation and Psychosocial Factors*, International Commission on Occupational Health (ICOH), Adelaide, 2014.

[21] P. T. Raggatt and S. A. Morrissey, "A field study of stress and fatigue in long-distance bus drivers," *Behavioral Medicine*, vol. 23, no. 3, pp. 122–129, 1997.

[22] L. Li, S. Wang, and F.-Y. Wang, "An analysis of taxi driver's route choice behavior using the trace records," *IEEE Transactions on Computational Social Systems*, vol. 5, no. 2, pp. 576–582, 2018.

[23] W. Zhang, R. He, C. Ma, and M. Gao, "Research on taxi driver strategy game evolution with carpooling detour," *Journal of Advanced Transportation*, vol. 2018, pp. 1–8, 2018.

[24] M. Ma, X. Yan, H. Huang, and M. Abdel-Aty, "Safety of public transportation occupational drivers risk perception, attitudes, and driving behavior," *Transportation Research Record: Journal of the Transportation Research Board*, vol. 2145, no. 1, pp. 72–79, 2010.

[25] M. J. Sullman, A. N. Stephens, and D. Kuzu, "The expression of anger amongst Turkish taxi drivers," *Accident Analysis & Prevention*, vol. 56, pp. 42–50, 2013.

[26] A. S. Cheng, K. H. Ting, K. P. Liu, and Y. Ba, "Impulsivity and risky decision making among taxi drivers in Hong Kong: an event-related potential study," *Accident Analysis & Prevention*, vol. 95, pp. 387–394, 2016.

[27] J. Vahedi, A. Shariat Mohaymany, Z. Tabibi, and M. Mehdizadeh, "Aberrant driving behaviour, risk involvement, and their related factors among taxi drivers," *International Journal of*

Environmental Research and Public Health, vol. 15, no. 8, p. 1626, 2018.

[28] B. Jie, L. Pan, Q. Xiao, and Z. Huaguo, "Understanding the effects of trip patterns on spatially aggregated crashes with large-scale taxi gps data," *Accident Analysis & Prevention*, vol. 120, pp. 281–294, 2018.

[29] J. R. Dalziel and R. F. S. Job, "Motor vehicle accidents, fatigue and optimism bias in taxi drivers," *Accident Analysis & Prevention*, vol. 29, no. 4, pp. 489–494, 1997.

[30] R. Friswell and A. Williamson, "Comparison of the fatigue experiences of short haul light and long distance heavy vehicle drivers," *Safety Science*, vol. 57, no. Complete, pp. 203–213, 2013.

[31] F. Meng, S. Li, L. Cao et al., "Driving fatigue in professional drivers: a survey of truck and taxi drivers," *Journal of Crash Prevention and Injury Control*, vol. 16, no. 5, pp. 474–483, 2015.

[32] Q. N. La, A. H. Lee, L. B. Meuleners, and D. Van Duong, "Prevalence and factors associated with road traffic crash among taxi drivers in Hanoi Vietnam," *Accident Analysis & Prevention*, vol. 50, pp. 451–455, 2013.

[33] X. Ba, F. Zhou, and Y. Wang, "Predicting personal injury crash risk through working conditions, job strain, and risky driving behaviors among taxi drivers," *European Transport Research Review*, vol. 10, no. 2, p. 48, 2018.

[34] Y. Wang, L. Li, and C. G. Prato, "The relation between working conditions, aberrant driving behaviour and crash propensity among taxi drivers in china," *Accident Analysis & Prevention*, vol. 126, pp. 17–24, 2018.

[35] R. K. Raanaas and D. Anderson, "A questionnaire survey of Norwegian taxi drivers' musculoskeletal health, and work-related risk factors," *International Journal of Industrial Ergonomics*, vol. 38, no. 3–4, pp. 280–290, 2008.

[36] U. Maag, C. Vanasse, G. Dionne, and C. Laberge-Nadeau, "Taxi drivers' accidents: how binocular vision problems are related to their rate and severity in terms of the number of victims," *Accident Analysis & Prevention*, vol. 29, no. 2, pp. 217–224, 1997.

[37] R. E. Mann, G. Stoduto, A. Ialomiteanu, M. Asbridge, R. G. Smart, and C. M. Wickens, "Self-reported collision risk associated with cannabis use and driving after cannabis use among Ontario adults," *Traffic Injury Prevention*, vol. 11, no. 2, pp. 115–122, 2010.

[38] Y. Wang, M. Li, J. Du, and C. Mao, "Prevention of taxi accidents in Xi'an, China: what matters most?" *Central European Journal of Public Health*, vol. 23, no. 1, pp. 77–83, 2015.

[39] S. M. Lim and S. E. Chia, "The prevalence of fatigue and associated health and safety risk factors among taxi drivers in singapore," *Singapore Medical Journal*, vol. 56, no. 2, pp. 92–97, 2015.

[40] P. Vayalamkuzhi and V. Amirthalingam, "Influence of geometric design characteristics on safety under heterogeneous traffic flow," *Journal of Traffic and Transportation Engineering (English Edition)*, no. 6, pp. 559–570, 2016.

[41] W. Zhang, X. Zhang, Z. Feng, J. Liu, M. Zhou, and K. Wang, "The fitness-to-drive of shift-work taxi drivers with obstructive sleep apnea: an investigation of self-reported driver behavior and skill," *Transportation Research Part F: Traffic Psychology and Behaviour*, pp. 545–554, 2018.

[42] T. Lajunen, D. Parker, and H. Summala, "The Manchester driver behaviour questionnaire: a cross-cultural study," *Accident Analysis & Prevention*, vol. 36, no. 2, pp. 231–238, 2004.

[43] T. Lajunen and H. Summala, "Driving experience, personality, and skill and safety-motive dimensions in drivers' self-assessments," *Personality & Individual Differences*, vol. 19, no. 3, pp. 307–318, 1995.

[44] Y. Guo, Z. Li, Y. Wu, and C. Xu, "Exploring unobserved heterogeneity in bicyclists' red-light running behaviors at different crossing facilities," *Accident Analysis & Prevention*, vol. 115, pp. 118–127, 2015.