Research on Safety Factors of Transportation Vehicles in Yuntai Mountain Scenic Area Based on Hypothesis Test

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Abstract. The human factor has always been the main factor causing transportation safety. In order to prevent and reduce the occurrence of traffic accidents due to objective reasons, this paper adopts the one-way analysis of variance and two-factor analysis of variance in the hypothesis test, from the Yuntaishan intelligent 4G equipment It extracts the two dimensions of fatigue driving and distraction to alarm, and conducts data analysis and research on the relationship between time period, week, and vehicle speed and driving safety. Studies have shown that the P values of fatigue driving and distraction in different weeks, different speeds, and different time periods are far less than 0.05, and there is a significant difference.

1. INTRODUCTION

According to the FBI, 20% to 30% of traffic accidents are caused by fatigue driving, and the research on driver fatigue detection technology is of great significance for preventing traffic accidents. From 2010 to 2018, at least 180,000 traffic accidents occurred each year, of which at least 88% were motor vehicle accidents. Drivers of commercial vehicles have long-term driving in special environments (such as night and complicated road sections) and have low subjective risk awareness. Besides, to save time and improve efficiency, they will take risky behaviors such as congestion, speeding, and lane grabbing [1]. Due to the particularity of the scenic section, most of its sections are the winding roads in the scenic area, and the passenger capacity is relatively high. If an accident occurs, the casualty rate will be more serious. Therefore, there are stricter requirements on the driving behavior and speed of the driver. After analyzing the causes of traffic accidents, the traffic management department found that the low-risk awareness and serious violations of motor vehicle drivers are one of the most important reasons for the high incidence of traffic accidents and high mortality in my country. Early psychological warning for drivers and dispatchers is extremely important.

Scholars at home and abroad have carried out a lot of research on the factors affecting driving safety. Four factors constitute a road traffic safety system: drivers, cars, roads, and the environment. Each factor has a different degree of impact on road traffic safety. In terms of drivers, Li Lei et al. [2] analyzed the impact of different gender, occupation, age, education level, and driving experience on unsafe driving behavior based on the TPB theory. Su Fang et al. [3] used the Apriori algorithm to reveal the impact of the week, period, road conditions, weather, collision type, and vehicle involved as objective factors on urban road traffic accidents. Xu Wenli et al. [4] used factor analysis to study the impact of different risk awareness on driving behavior in risky driving situations and constructed a safety evaluation model for driving behavior. Zhuang Mingke [5] and others used exploratory factors to analyze the relationship...
between driving experience, personality, driving attitude, and driving skills, and the driver driving behavior. Feng Guo and Youjia Fang [6] studied the natural driving of 100 vehicles and found that age, personality, and driving accident rates have a significant impact on the risk of driving accidents for individual drivers. Zhang Huiling [7] et al. used questionnaire surveys to collect 155 valid samples in Heilongjiang, Shandong, Sichuan, Guizhou, and other provinces and cities, and explained the unsafe driving behavior of drivers in the urban and rural areas based on the theory of planned behavior. Attitudes and perceived behavior control factors have related influences on driving behavior. Jianqiang Wang [8] collected data from 364 drivers through questionnaires and analyzed the influence of typical driver behavior parameters such as speed, headway, and acceleration on driving risk. Ma Yong [9] et al. applied different stimuli to 13 drivers to study the influence of a combination of sight occlusion, conversation, recall, mathematical calculations, and some tasks on driver distraction. Distraction ranks. In terms of roads, Li Lingyu [10] pointed out that straight roads tend to make drivers feel irritable due to their monotony. Curved routes can cause drivers to panic and easily lead to vehicle driving errors. Teng Min [11] pointed out that road grades, roadside protection facilities, road signs, road speed limits, lighting conditions, and road design are all related to the occurrence of safety accidents. Mehdi Hosseinpour [12] et al. studied the case and found the influence of the horizontal curvature of the road, the width of the paved shoulder, the type of terrain, and the side friction on the safe driving of the car. In terms of environment, Li Sultan [13] and others found the relationship between weather, traffic flow, signs and markings, and driving safety risks by using an improved Logit model. Teng Min [11] pointed out that environmental factors do not directly affect road safety, but lead to traffic accidents through the combination of human, vehicle, and road factors. Mohamed M. Ahmed [14] and other graduate students studied the impact of weather information and road characteristics on driving safety. Research has shown that the collected real-time weather data can effectively predict the increase in road risks.

According to statistics, the human factor has always been the main factor causing road traffic accidents. About 95% of accidents are related to the deliberate violations and faults of drivers [15]. Many scholars have done a lot of work on road traffic safety. Research and most of the in-depth research focus on driver behavior. However, there are relatively few studies on the analysis of driver’s warning behavior based on objective factors, and most of the previous studies have used questionnaires to organize, analyze, and mine data. Due to the limitations of the questionnaire method, the analysis results are highly distorted with the real situation. Therefore, this article is based on the analysis of the original alarm data of buses in Yuntai Mountain Scenic Area, to more accurately and truly reflect the laws of vehicle alarms and driver behavior, and provide a better decision-making basis for enterprise managers.

2. DATA COLLECTION AND ORGANIZATION

2.1. Data Collection

The data comes from 160 scenic buses in Yuntai Mountain, each of which is equipped with D5X-SSD-ADK DSM (Driver Driving Behavior Monitoring and Analysis System) equipment produced by Shenzhen Ruiming Video Technology Co., Ltd.

The data collection vehicle uses the driver’s driving behavior monitoring and analysis system. The system is mainly composed of a dedicated fatigue detection camera and a fatigue detection terminal host. The camera installed on the driving dashboard directly captures the driver’s face and accurately locates the driver’s eyes. The system will automatically determine and analyze the close of the human eye. The frequency of state and closing, the judgment of the driver’s face orientation, combined with the current speed of the vehicle, and according to the pre-set detection logic rules, a variety of parameters are used as the basis for analysis to determine the fatigue state of the driver. For example: when the vehicle is at a certain speed and the length of time the eyes are closed reaches the alarm value, or when the driver’s face is not facing forward for a certain period (such as lowering the head for 3 seconds), the system will automatically sound an alarm to remind the driver Misoperation and fatigue driving, when the situation is serious, the system will also notify the background monitoring center of the alarm information through the network, and the driver will be supervised by manual intervention.
2.2. Organize Data
The data in this article was extracted from April 1, 2020, to July 30, 2020, in Yuntai Mountain Scenic Area. Drivers’ distraction alarm and fatigue driving alarm were reported for 12 consecutive weeks. The alarm records the alarm data that is automatically detected and recorded by the DSM (Driver Behavior Monitoring and Analysis System) monitoring equipment. The data was collected in Yuntai Mountain Scenic Area from April 2020 to mid-July 2020 for 12 consecutive weeks. Divide into one group every 3 consecutive weeks, a total of 4 groups. There are 5888 distraction alarms and 2,996 fatigue driving alarms.

3. DATA ANALYSIS
The analysis of variance mainly judges whether there are significant differences between the groups by comparing the size of the F value. The between-group variance is used to reflect the degree of difference between groups, and the within-group variance is used to reflect the degree of difference in data within each group. This paper uses the single-dimensional analysis of variance for the week, vehicle speed, and the period and the two-dimensional analysis of variance for the week and period to study.

3.1. Fatigue Driving Analysis
For the analysis of fatigue driving, because the analyzed week, speed, and period options are all diversified, a one-way analysis of variance is used. By comparing the P-value, test whether there is a significant difference. The analysis results are shown in Table 1.

| Types   | Source of difference | SS         | df  | MS          | F          | P-value      | F crit     |
|---------|----------------------|------------|-----|-------------|------------|--------------|------------|
| week    | Between groups       | 168335.5   | 6   | 28055.92    | 5.709578   | 0.001189994 | 2.572712   |
|         | Within group         | 103190.5   | 21  | 4913.833    |            |              |            |
|         | total                | 271526     | 27  |             |            |              |            |
| Speed   | Between groups       | 29204.41   | 58  | 503.5243    | 4.687552   | 2.26577E-13 | 1.42878    |
|         | Within group         | 13534.58   | 126 | 107.4173    |            |              |            |
|         | total                | 42738.99   | 184 |             |            |              |            |
| period  | Between groups       | 54049.03   | 18  | 3002.724    | 4.286944   | 2.11947E-05 | 1.809919   |
|         | Within group         | 35722.17   | 51  | 700.4346    |            |              |            |
|         | total                | 89771.2    | 69  |             |            |              |            |

Fig.1 Fatigue driving alarm times of different weeks
It can be seen from Table 2 that the P values of the week, vehicle speed, and period are respectively 0.00119, 2.266E-13, and 2.119E-05 are all less than 0.05. It shows that in terms of fatigue driving alarm, fatigue alarms have great differences in different weeks, different vehicle speeds, and different periods, and the differences in fatigue alarms for different vehicle speeds and different periods are more significant.

As can be seen from Figure 1, in each group of alarms, the number of fatigue driving alarms on Saturday and Sunday is higher. This shows that drivers are more prone to fatigue during weekends. It can be seen from Figure 2 that when the vehicle speed is 0km/h, there is a certain fatigue alarm. When the vehicle speed is 20km/h, the alarming phenomenon will suddenly rise sharply, and most of the fatigue alarms are concentrated at the vehicle speed of 30km/h-40km/h. When the vehicle speed exceeds 43km/h, the number of alarms is greatly reduced. This shows that the driver is prone to fatigue when the car starts or stops. When the car starts, this phenomenon will disappear quickly. When the speed is 30km/h-40km/h, the driver is most prone to fatigue. When the car is driving at low speed and high speed, the driver fatigue state appears lower. It can be seen from Figure 3 that the number of daily fatigue driving alarms began to gradually increase over time and reached a peak at 9 am, then began to fall, and began to rebound after reaching a trough at 11 am, and the second appeared at noon. The peak of the wave, then a small fall, the third peak at 3 p.m., and it has been falling since then. This shows that every day at 9 o'clock, 12 o'clock, and 15 o'clock, drivers are prone to fatigue, and compared to the afternoon, drivers are more prone to fatigue in the morning.

For the analysis of fatigue driving, considering the influence of the two dimensions of the week and the period on the driver's fatigue driving factors, two-factor analysis of variance is adopted. The analysis results are shown in Table 2.
Tab.2 Analysis results of the influence of two factors on fatigue driving during the week and time

| Types       | Source of difference | SS     | df  | MS       | F      | P-value          | F crit  |
|-------------|----------------------|--------|-----|----------|--------|------------------|---------|
| week and period | Row                  | 36534.3| 18  | 2029.683| 4.685506| 1.64644E-07     | 1.700134|
|             | Column               | 35439.05| 6   | 5906.509| 13.63512| 1.79016E-11     | 2.183657|
|             | error                | 46783.8| 108 | 433.1834|         |                  |         |
|             | total                | 118757.2| 132 |         |         |                  |         |

Fig.4 Fatigue driving alarm times in different time and week

By comparing the P-value, test whether there is a significant difference. It can be seen from Table 2 that the P values of the week (row) and period (column) are 1.65E-07, and 1.79E-11 are all less than 0.05, which indicates that the driver fatigue driving alarm is affected by the week and the period. There are significant differences in the number of alarms in different periods of the same week and the same period in different weeks.

It can be seen from Figure 4 that the number of fatigue driving alarms on Sunday is higher than that on Saturday, and at almost any period, the fatigue alarms for drivers on Saturday and Sunday are higher than Monday to Friday. At 9 o'clock, 12 o'clock, and 15 o'clock on Sunday, there will be a peak of fatigue alarm throughout the week. The fatigue alarm phenomenon is particularly significant at 9 o'clock and 15 o'clock every day, and there will be a trough of fatigue alarm phenomenon at 11 o'clock.

3.2. Distraction Analysis

For the analysis of distraction, because the analysis week, speed, and period are all diversified, a one-way analysis of variance is used. By comparing the P-value, test whether there is a significant difference. The analysis results are shown in Table 3.

Tab.3 Analysis results of factors influencing distraction

| Types       | Source of difference | SS     | df  | MS       | F      | P-value          | F crit  |
|-------------|----------------------|--------|-----|----------|--------|------------------|---------|
| week        | Between groups       | 283424.2| 6   | 47237.37| 4.854496| 0.002963        | 2.572712|
|             | Within group         | 204343.5| 21  | 9730.643|         |                  |         |
|             | total                | 487767.7| 27  |         |         |                  |         |
| Speed       | Between groups       | 161435 | 62  | 2603.791| 8.558402| 1.54E-26        | 1.405099|
|             | Within group         | 44418.75| 146 | 304.238 |         |                  |         |
|             | total                | 205853.8| 208 |         |         |                  |         |
| period      | Between groups       | 205375.2| 18  | 11409.73| 9.23148 | 1.85E-10        | 1.809919|
|             | Within group         | 63033.92| 51  | 1235.959|         |                  |         |
|             | total                | 268409.1| 69  |         |         |                  |         |
It can be seen from Table 3 that the P values of the week, vehicle speed, and period are 0.002963, 1.54E-26, and 1.85E-10, respectively, which are all less than 0.05. It shows that the distraction alarm has great differences in different weeks, different vehicle speeds, and different periods, and the difference in the number of alarms between different vehicle speeds and different periods is more significant.

It can be seen from Figure 5 that the number of alarms and the number of alarms from Monday to Friday showed a downward trend, but the number of distracted alarms on Saturday and Sunday increased significantly. This shows that drivers are more prone to distraction during holidays. It can be seen from Figure 6 that when the vehicle speed is 0km/h, the distraction alarm is higher, the vehicle speed is
20km/h, and the number of distraction alarms rises rapidly to the maximum. When the vehicle speed exceeds 40km/h, the number of alarms significantly reduced. This shows that the driver has an obvious distraction when starting or parking. When the car starts, this phenomenon will disappear quickly. When the speed is about 20km/h, the driver is most likely to have attention analysis. When the car is driving at low speed and high speed, the driver's distraction appears low. It can be seen from Figure 7 that the number of daily distraction alarms began to rise gradually over time and reached a peak at 9 am, then fell back briefly until a high peak again appeared at 3 pm, and then continued to fall. This shows that 9 o'clock and 15 o'clock every day are the most distracting moments for drivers.

For the analysis of fatigue driving, considering the influence of the two dimensions of the week and the period on the driver's distraction factors, two-factor analysis of variance is adopted. By comparing the P-value, test whether there is a significant difference. The analysis results are shown in Table 4.

| Types          | Source of difference | SS       | df  | MS       | F        | P-value     | F crit    |
|----------------|----------------------|----------|-----|----------|----------|-------------|-----------|
| week and       | Row                  | 139674.3 | 18  | 7759.681 | 19.84021 | 2.44E-26    | 1.700134  |
| period         | Column               | 59668.26 | 6   | 9944.709 | 25.42697 | 1.2E-18     | 2.183657  |
| error          |                      | 42239.74 | 108 | 391.1087 |          |             |           |
| total          |                      | 241582.3 | 132 |          |          |             |           |

Fig.8 Different times of day and times of the week

It can be seen from Table 4 that the P values of the week (row) and period (column) are 2.44E-26, and 1.2E-18 are all less than 0.05. It shows that the driver's distraction alarm is affected by the week and the period, and there are significant differences in the number of alarms in different periods of the same week and the same period of different weeks.

It can be seen from Figure 8 that there are more driver distractions on Saturdays and Sundays, and the peak of distraction at 9 o'clock and 15 o'clock every day, and the distraction at 11 o'clock is relatively reduced.

4. CONCLUSION

By analyzing the distribution of fatigue driving and distraction in different weeks, different speeds, and different periods, it is found that there are significant differences.

For the influence of different week factors on the number of fatigue driving alarms and distraction alarms. The number of alarms increased significantly on Saturday and Sunday, but the number of distracted alarms showed a downward trend from Monday to Wednesday, and the number of fatigue driving alarms showed a slight upward trend from Monday to Friday. And regardless of the day of the week, the number of attention alarms is higher than the number of fatigue alarms. It shows that the driver is more likely to be distracted when driving. On Saturdays and Sundays, the driver's fatigue level increased significantly, and the level of attention decreased significantly.
For the influence of factors in different periods on the number of fatigue driving alarms and distraction alarms. There is a high number of alarms from 8 am to 17 am every day, and there are two peak periods at 9 am and 15 am, and there is a drop in the middle period. It shows that the driver is not able to maintain a good mental state throughout the day, even if there is a short break after each trip, there are regular fatigue and distraction.

For the influence of different vehicle speed factors on the times of fatigue driving alarm and distraction alarm. When the vehicle speed is 0km/h, there are a certain number of alarms. In the low-speed and high-speed driving phases, there are few alarms, and the alarms are concentrated at 20km/h-40km/h. When the vehicle speed is 20km/h, the alarms all have a sudden increase. It shows that the speed of 20-40km/h is the comfortable speed for the driver, which is easy to cause the driver to lose concentration, relax mentally, and easily lead to fatigue.

This study also has some shortcomings. First, the operating status of the DSM equipment, such as equipment damage or lack of return information, is not considered; second, this experiment believes that the increase in the number of alarms in different weeks is due to the interference of the week, and the characteristics of the time distribution of the flow of people in the scenic area are not considered.

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