Investigation and analysis on traffic safety of low-speed electric vehicles

Yanhui Fan¹, Yan Wang²*, Lingyun Xiao², Wei Zhao¹ and Haiyun Sun³

¹Transportation and Logistics Engineering College, Shandong Jiao Tong University, Jinan, Shandong, 250357, China
²SAMR Defective Product Administrative Center, Beijing, 100101, China
³Zhejiang Geely Automobile Research Institute Co. LTD, Ningbo, Zhejiang, 315000, China

*Corresponding author’s e-mail: wangyan@dpac.gov.cn

Abstract. In recent years, China's low-speed electric vehicle industry has developed rapidly, and traffic safety of low-speed electric vehicles has attracted widespread attention. Classified surveys on the users, potential users and familiar users of low-speed electric vehicles have been conducted by means of questionnaires, and these statistical data obtained from the above surveys have been analyzed by using SPSS software in this paper. Moreover, traffic safety factors of low-speed electric vehicles involved in participants, vehicles and road traffic environment are in-depth analyzed, and corresponding suggestions and measures are put forward in this paper. The research results in the paper will have been certain guiding significance for further improving traffic safety of low-speed electric vehicles.

1. Introduction

In recent years, the low-speed electric vehicle industry has developed rapidly in China, and the number of low-speed electric vehicles has increased year by year[1]. On the one hand, low-speed electric vehicles are favored by people because of their low price, simple operation and low cost of use. On the other hand, under the background of environmental pollution control, the market demand and share of low-speed electric vehicles are gradually increasing. At the same time, the social issue caused by low-speed electric vehicles is becoming more serious. On the one hand, the automobile industry has certain doubts about the safety performance of low-speed electric vehicles[2]. On the other hand, low-speed electric vehicles have no license plate and frequent traffic violation, which bring great potential safety hazards to traffic safety[3]. Finally, the public security traffic management department has a blind spot for low-speed electric vehicle supervision. For example, the driver who drives this type of vehicle does not need a driver's license, and the vehicle does not have vehicle insurance. These problems seriously restrict and affect the healthy development of low-speed electric vehicles.

This paper investigates and analyses the factors affecting the traffic safety of low-speed electric vehicles from three aspects: people, vehicles and roads through a large sample survey and statistical analysis, and puts forward corresponding suggestions and measures, which have certain guiding significance for improving the traffic safety of low-speed electric vehicles and promoting the development of low-speed electric vehicle industry.
2. Investigation plan

This paper randomly selected traffic participants to conduct a questionnaire survey, during which a total of 600 valid questionnaires were collected. Among them, there are 100 valid questionnaires for Class A (users), 100 valid questionnaires for Class B (potential users), and 400 valid questionnaires for Class C (familiar users). The data of 600 valid questionnaires were analyzed by SPSS software, and the influencing factors of traffic safety of low-speed electric vehicles were determined.

2.1. Age distribution of respondents

The results show that the age distribution of different types of respondents is obviously different. For class A (users) respondents, the proportion of 41-50 years old is 26%, and the proportion of 51-60 years old is 28%; For class B (potential users) respondents, the 41-50 years old group has the largest proportion, accounting for 30%; for class C (familiar users) respondents, the proportion of those under the age of 30 is the highest, accounting for 70%. The specific distribution is shown in Table 1.

| Age group            | Class A (%) | Class B (%) | Class C (%) |
|----------------------|-------------|-------------|-------------|
| Under 30 years old   | 12          | 21          | 70          |
| 31-40 years old      | 12          | 17          | 11          |
| 41-50 years old      | 26          | 30          | 12          |
| 51-60 years old      | 28          | 19          | 4           |
| 60-70 years old      | 18          | 13          | 2           |
| Over 71 years old    | 4           | 0           | 1           |

2.2. Occupation and income distribution of respondents

Among the 600 respondents, men accounted for 76% and women accounted for 24%. The occupational distribution among the respondents is shown in Table 2, and the annual disposable income of the household is shown in Table 3. The respondents of class A (users) are mainly retirees, individual businessmen, and farmers, and the annual disposable income is concentrated below 80,000 RMB. While the annual disposable income of respondents with class B (potential users) is concentrated in Less than 60,000 RMB.

| Occupation            | Class A (%) | Class B (%) | Class C (%) |
|-----------------------|-------------|-------------|-------------|
| Retired personnel     | 20          | 17          | 6           |
| Individual businessmen| 19          | 10          | 6           |
| Farmer                | 18          | 20          | 8           |
| Worker                | 13          | 10          | 12          |
| Self-employed         | 13          | 29          | 11          |
| Institutional staff    | 10          | 7           | 5           |
| Civil servants        | 2           | 2           | 1           |
| Other                 | 5           | 5           | 51          |
Table 3. Distribution of annual disposable income of the household.

| Annual income            | Class A (%) | Class B (%) | Class C (%) |
|--------------------------|-------------|-------------|-------------|
| Less than 20,000 RMB     | 17          | 26          | 24          |
| 20,000-40,000 RMB        | 35          | 37          | 29          |
| 40,000-60,000 RMB        | 23          | 20          | 20          |
| 60,000-80,000 RMB        | 13          | 11          | 13          |
| 80,000-100,000 RMB       | 8           | 5           | 7           |
| 100,000-150,000 RMB      | 3           | 1           | 5           |
| More than 150,000 RMB    | 1           | 0           | 2           |

3. Traffic safety issue of low-speed electric vehicles

3.1. Driver’s traffic violation
The driving habits of low-speed electric vehicle users are shown in Table 4. Up to 75% of drivers said they are used to driving on motorway; only 23% of drivers said they are driving on non-motorized vehicle lanes; and 17% of drivers said they will drive between the motorway and the non-motorized vehicle lanes.

Table 4. Driving habits of drivers of low-speed electric vehicles.

| Driving habits                                      | Probability (%) |
|----------------------------------------------------|-----------------|
| Driving on the right side of the motorway          | 49              |
| Driving on a motorway like a car                   | 26              |
| Driving on non-motorized vehicle lanes             | 23              |
| Driving between the motorway and the non-motorized vehicle lanes | 17              |

In the 600 questionnaires, 95% of the respondents believe that low-speed electric vehicle drivers have poor driving behavior during the use of low-speed electric vehicles. According to the statistical results of the questionnaire, the three traffic safety violations, which are free to park, run a red light, change lanes, turn and u-turn randomly, have the highest probability of occurrence, and are also common in life, as shown in Table 5.

Table 5. Probability distribution of driver traffic safety violations.

| Traffic safety violations                       | Users (%) | Potential users (%) | Familiar users (%) |
|------------------------------------------------|-----------|---------------------|--------------------|
| Free to park                                   | 67        | 55                  | 54                 |
| Run a red light                                | 44        | 52                  | 47                 |
| Change lanes, turn and u-turn randomly         | 31        | 31                  | 34                 |
| Illegal occupation of the urban fast lane      | 25        | 32                  | 24                 |
| Driver lacks traffic law knowledge             | 22        | 34                  | 26                 |
| Driving without a license                      | 27        | 30                  | 22                 |
| Driving on non-motorized vehicle lanes         | 11        | 16                  | 18                 |
| Turning without turning on the turning light   | 13        | 15                  | 11                 |
| No whistle when overtaking                     | 15        | 6                   | 9                  |
| Driving reaction and speed slowly              | 21        | 10                  | 14                 |
| Driving fast and jumping the queue forcibly    | 8         | 9                   | 19                 |
| Driver has a bad temper                        | 4         | 4                   | 3                  |

The attitude of respondents to the reasons for poor driving behavior of low-speed electric vehicles is shown in Table 6. According to the analysis data of the questionnaire survey, more than 50% of the respondents believe that drivers lack driving training, small vehicle size and flexible driving, lack of traffic management are the causes of traffic safety violations and bad behavior of low-speed electric vehicle drivers.
Table 6. Distribution of attitudes caused by bad driving behavior of low-speed electric vehicles.

| Reasons | No clear distinction between Motorway, non-motor vehicle lanes and sidewalks | Lack of traffic signs and traffic markings | Too many vehicles on the motorway | Small vehicle size and flexible driving | Lack of traffic management | Drivers lack driving training |
|---------|---------------------------------------------------------------------------------|--------------------------------------------|-----------------------------------|----------------------------------------|--------------------------|-----------------------------|
| Users   | Agree 47% 35% 51% 63% 49% 54%                                                  | Neutral 27% 29% 31% 20% 31% 35%           | Disagree 26% 36% 18% 17% 20% 11%    |                                        |                          |                             |
|         | Neutral 27% 29% 31% 20% 31% 35%                                                | Disagree 26% 36% 18% 17% 20% 11%         |                                   |                                        |                          |                             |
|         | Disagree 26% 36% 18% 17% 20% 11%                                                |                                        |                                   |                                        |                          |                             |
| Potential users | Agree 37% 31% 49% 52% 44% 63%                                                  | Neutral 30% 45% 36% 32% 42% 22%          | Disagree 33% 24% 15% 16% 14% 15%    |                                        |                          |                             |
|         | Neutral 30% 45% 36% 32% 42% 22%                                                 | Disagree 33% 24% 15% 16% 14% 15%         |                                   |                                        |                          |                             |
|         | Disagree 33% 24% 15% 16% 14% 15%                                                |                                        |                                   |                                        |                          |                             |
| Familiar users | Agree 49% 34% 56% 55% 54% 65%                                                  | Neutral 31% 43% 33% 36% 367% 27%        | Disagree 20% 23% 11% 9% 9% 8%       |                                        |                          |                             |
|         | Neutral 31% 43% 33% 36% 367% 27%                                                 | Disagree 20% 23% 11% 9% 9% 8%           |                                   |                                        |                          |                             |
|         | Disagree 20% 23% 11% 9% 9% 8%                                                    |                                        |                                   |                                        |                          |                             |

3.2. Vehicle failures
Among the 100 respondents, the respondents indicated that they found failures or safety hazards during the use of low-speed electric vehicles. 51% of the respondents had battery problems during the use of low-speed electric vehicles and 22% of the users had parts damage, and other failures are shown in Figure 1. It can be seen that there are some problems in the quality of low-speed electric vehicles, which have a great impact on the safety of low-speed electric vehicles, and also need to be improved as soon as possible in the long-term development of the low-speed electric vehicle industry.

![Figure 1. Distribution of vehicle failures.](image)

3.3. Road traffic environment
The questionnaire data shows that low-speed electric vehicle users often travel on township roads, urban motorway and non-motorized vehicle lanes, with the probability of 48%, 32% and 32% respectively. The specific driving road conditions are shown in Figure 2.
According to the survey results of the road traffic environment, more than 50% of the respondents believe that local public transportation needs to be improved; About 30% of respondents believe that driver traffic violations are serious; less than 20% of respondents are very satisfied with local road traffic conditions.

Table 7. Attitude distribution of road traffic environmental satisfaction.

| Traffic environment                  | Users Agreement | Users Uncertain | Users Disagree | Potential Users Agreement | Potential Users Uncertain | Potential Users Disagree | Familiar Users Agreement | Familiar Users Uncertain | Familiar Users Disagree |
|--------------------------------------|-----------------|-----------------|----------------|---------------------------|----------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Narrow roads and poor road conditions | Agree 44%       | 56%             | 39%            | 70%                       | 45%                        | 30%                      | 62%                      | 20%                      |
| Reasonable setting of traffic signs and lines | 25%             | 35%             | 35%            | 20%                       | 32%                        | 50%                      | 23%                      | 48%                      |
| Lack of traffic management           | 31%             | 9%              | 26%            | 10%                       | 23%                        | 20%                      | 15%                      | 32%                      |
| Public transport needs to be improved | 32%             | 47%             | 36%            | 69%                       | 38%                        | 32%                      | 46%                      | 29%                      |
| A lot of trucks on the road          | 32%             | 40%             | 39%            | 25%                       | 27%                        | 35%                      | 41%                      | 49%                      |
| Frequent traffic violations          | 36%             | 13%             | 25%            | 6%                        | 35%                        | 33%                      | 13%                      | 22%                      |
| A lot of electric bicycles on the road | 39%             | 48%             | 38%            | 65%                       | 50%                        | 41%                      | 61%                      | 13%                      |
| Very satisfied with the local traffic conditions | 18%             | 9%              | 18%            | 5%                        | 15%                        | 21%                      | 7%                       | 34%                      |

4. Suggestions and measures for traffic safety of low-speed electric vehicles
According to the survey data of low-speed electric vehicles, it can be seen that the traffic safety of low-speed electric vehicles can be improved by taking corresponding safety measures from three aspects including driver management, vehicle management and road traffic environment.

1) To incorporate low-speed electric vehicles into motor vehicle management, drivers must hold corresponding driving licenses and be familiar with traffic safety laws and regulations.

2) Vehicle management of low-speed electric vehicles is carried out from the following aspects: formulating safety technical standards for low-speed electric vehicles; all low-speed electric vehicle manufacturers must adopt automobile parts that meet 3C certification (national compulsory product certification); and formulating registration and inspection standards for low-speed electric vehicles, so that vehicles can go on the road only after passing the inspection.
(3) Improve the traffic environment of low-speed electric vehicles from the following aspects: rationally planning the driving range of low-speed electric vehicles, prohibiting traffic in sections with large traffic flow and high speed; recommending adding special lanes for low-speed electric vehicles and setting up corresponding traffic signs; prohibiting low-speed electric vehicles from stopping at random in places with dense traffic flow.

5. Conclusion
The random surveys on the users, potential users and familiar users of low-speed electric vehicles have been conducted in this paper. According to the statistical data analyses on these surveys, traffic safety issue of low-speed electric vehicles has been analyzed from three aspects involved in participants, vehicles and road traffic environment; moreover, the corresponding traffic safety measures have been put forward. The research work in this paper will have been certain guiding significance for improving traffic safety of low-speed electric vehicles in China.

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