Professional Driver Suitability Evaluation

CHEN Xue-meia, WEI Zhong-huab, GAO Liab, a*

a. School of Mechanical and vehicular Engineering, Beijing Institute of Technology, Beijing 100081, China
b. Traffic Engineering Key Lab of Beijing, Beijing University of Technology, Beijing 100022, China

Abstract

In order to study professional driver suitability, driving ability, driving attitude and driving behavior are considered, electrocardiograph, Frecord data collecting system and dynamics GPS are utilized and the experimental are carried out in the Communications Ministry Trail. Fuzzy logical and AHP are utilized, professional driver suitability evaluation method is established and the test results are obtained. This research offers theory for driver management.

© 2011 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of [CEIS 2011]

Open access under CC BY-NC-ND license.

Keywords: professional driver; emergency; evaluation; selection; fuzzy logical; AHP; traffic safety

In the process of driving, drivers often come across an emergency, such as the pedestrian crosses roads suddenly, vehicles turn fiercely, etc. Literature[1-2] pointed out: in the complicated traffic conditions, due to the emergence information, the driver is easy to be in stress state, and driving control is easy to make a mistake, and it is the important traffic safety hidden trouble. Therefore, it has important meaning to enhance professional driver selection suitable assessment under emergency to improve traffic safety conditions. In the early 1920s, it had carried out a lot road traffic safety analysis studies about people factor abroad, such as the United States, especially in California, professional driver was been put forward higher request, and strengthen the test evaluation[3]. Since 1980s, it has also carried out the driving adaptive research in China. But the domestic existing driver suitable evaluation usually only starts from basic physical quality of driver to judge. This review or evaluation can only explain whether it has safe driving ability in the general road condition, and it has differences with practical safety operation of
driver. In fact, in a complex driving environment, driving behavior also relevant with drivers’ psychological status and safety attitude\[4-6\]. This study analysis driver's suitability based on the actual road test results\[b\].

1. **The suitability research content and the test results**

Professional suitability (occupational aptitude) is physiological and psychological quality characteristics which the one who engaged in a work must have. It formats and develops on the basis of the interaction of the innate factors and the environment\[7\]. Driving process is an process of information processing, and the physiological and psychological quality, safety attitude, driver reaction time and manipulation of the information processing all can affect driving suitability \[4-7\]. Based on this, the professional driver selects suitable assessment which build up in this study includes three areas:

1) Safety travel must have physiological and psychological conditions, that is the safe driving ability. it is evaluated based on "motor vehicle driver body condition and assessment requirements" which promulgated and implemented on the January 1, 2000. It includes eye examination, speed estimation, disposal judgment examination check (wrong operation expressed as S, number of mistakes expressed as D), attention check (A), the brain activity check (B), sports agility check (P), feel inspection (R).2) security attitude: driving safety score rates by safety attitude rating table\[6\].

3) Another is the driver's operation in the actual test environment, that is, the safe driving behavior. Let the driver operate in the representative test scene of Communications Ministry Trail, and then assess the quality of the safe driving behavior under actual operation. Table 1 is the test results in evaluation indices.

| Driver | Safe driving ability | Safe driving behavior |
|--------|----------------------|-----------------------|
| Numbers | Move vision | Dark adaptation time / s | Distant object recognition time / s | Speed estimation deviation / % | S /time | D /time | A /Hz | B /Hz |
| 1 | 0.80 | 12.70 | 11.90 | 71.30 | 7.00 | 4.00 | 2.75 | 5.55 |
| 2 | 0.70 | 7.90 | 13.90 | 61.60 | 4.00 | 4.00 | 2.71 | 7.26 |
| 3 | 0.40 | 6.20 | 7.50 | 19.60 | 5.00 | 2.00 | 1.64 | 5.63 |
| 4 | 0.40 | 10.80 | 13.00 | 10.80 | 6.00 | 4.00 | 2.29 | 5.46 |
| 5 | 0.40 | 7.60 | 4.20 | 72.60 | 7.00 | 1.00 | 2.27 | 6.96 |
| 6 | 0.60 | 7.20 | 14.20 | 23.90 | 6.00 | 2.00 | 2.11 | 5.83 |
| 7 | 0.70 | 10.70 | 5.40 | 30.90 | 2.00 | 3.00 | 1.76 | 4.70 |
| 8 | 0.40 | 9.70 | 5.10 | 56.30 | 4.00 | 1.00 | 2.68 | 6.35 |

| Driver Numbers | P / min | R / s | Score of the safety | Heart rate changes / (time.min\(^{-1}\) ) | Steering wheel speed / (°.s\(^{-1}\) ) | Foot pedals speed / (10\(^{-3}\).ms\(^{-1}\) ) | Obstacle avoidance time / s |
|----------------|---------|-------|---------------------|------------------------------------------|-----------------------------------------|-----------------------------------------|------------------------------|
| 1 | 27.73 | 24.10 | 4.00 | 17.50 | 460.60 | 246.82 | 9.07 |

\[b\]
2 Professional driver selection suitable assessment system

The professional driver select suitable assessment system build up based on the fuzzy analytical hierarchy process in this paper.

2.1 Driver behavior evaluation system under emergency

There is a question existing in the boundary of driver evaluation. If in the division of driver's move vision, it is rigid regulation 0.8 and above is "good", 0.7 is "bad", this perverse. This uncertainty of concept extension called fuzzy. Common set in express this concept has its limitations. In this paper, the fuzzy set is used to evaluate various index of the driver. Driver suitability quality is divided into five levels by using the fuzzy comprehensive evaluation-excellent, good, middle, pass, fail, respected with 5,4,3,2,1. Based on the systematic, scientific, comparability and availability principles, the professional driver select suitable assessment index system is established, as shown in table 2.

Table 2  Professional driver suitability evaluation system under emergency

| Target layer | Rule layer | Index layer |
|--------------|------------|-------------|
| The professional driver select suitable assessment index system C | Drive ability B21 | Move vision R31. 1  
Dark vision R31. 2  
Deep vision R31. 3  
Speed estimation R31. 4  
Disposal judgment check R31. 5  
Disposal judgment check R31. 6  
Attention check R31. 7  
The brain activity inspection R31. 8  
Sports agility inspection R31. 9  
Feel inspection check R31. 10 |
| Safety attitude B22 | Safety attitude score R32. 1  
Heart rate changes R33. 1  
Steering wheel speed R33. 2  
Foot pedals speed R33. 3  
Obstacle avoidance time R33. 4 |
| Drive behavior B23 |

2.2 Membership functions of the evaluation index

Some of evaluation index membership functions have been given[7].
3 The evaluation results of driver behavior quality under emergency

3.1 Evaluation results of single factor in index layer

The evaluation results of each driver's single factor in index layer shown as in table 3.

| Evaluation index | Numb | Fail | Pass | middle | good | excellent |
|------------------|------|------|------|--------|------|-----------|
| Move vision      | 1    | 0.000| 0.000| 0.500  | 0.500| 0.000     |
| Dark vision      | 2    | 0.000| 0.925| 0.075  | 0.000| 0.000     |
|                  | 3    | 0.000| 0.000| 0.000  | 1.000| 0.000     |
|                  | 4    | 0.000| 0.000| 0.000  | 0.000| 0.000     |
|                  | 5    | 0.000| 0.000| 0.000  | 0.000| 0.000     |
|                  | 6    | 0.000| 0.000| 0.000  | 0.000| 0.000     |
|                  | 7    | 0.000| 0.000| 0.000  | 0.000| 0.000     |
|                  | 8    | 0.000| 0.000| 0.000  | 0.000| 0.000     |

3.2 Evaluation results Based on the fuzzy and hierarchical analysis

Take the evaluation of the first driver as the example, introduces professional driver selection suitable assessment process. First the evaluation results of the index layer of driver was calculated by using the membership functions, and then calculate the evaluation of rule layer by using fuzzy reasoning, finally get the evaluation results of target layer. The calculation process of evaluation of the first driver rule layer is:

\[ B_{21} = A_{31} \cdot R_{31} = (0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1) \cdot \begin{bmatrix} 0 & 0 & 0 & 0 & 0.5 & 0.5 \\ 0 & 0.925 & 0.075 & 0 & 0 \\ 0 & 0.725 & 0.275 & 0 & 0 \\ 0.015 & 0.985 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0.5 & 0.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0.95 & 0.05 & 0 \\ 0 & 0 & 0 & 0.5675 & 0.4325 \\ 0 & 0 & 0.32 & 0.68 & 0 \end{bmatrix} \]

\[ = (0.0515, 0.4135, 0.162, 0.27975, 0.09325) \]

\[ B_{23} = A_{33} \cdot R_{33} = (0.25, 0.25, 0.25, 0.25, 0.25) \cdot \begin{bmatrix} 0 & 0 & 0.5 & 0.5 & 0 \\ 0 & 0 & 0 & 0.894 & 0.106 \\ 0.0317 & 0.9683 & 0 & 0 & 0 \\ 0 & 0 & 0.535 & 0.465 & 0 \end{bmatrix} \]

\[ = (0.007925, 0.242075, 0.25875, 0.46475, 0.0265) \]

The calculation process of evaluation of the first driver target layer is:
The test scores of the first drive $D = (55, 65, 75, 85, 95) \cdot C' = 73.024$

Using similar methods to obtain the other driver suitable assessment score. The driver's test results show in table 4. The relevant departments of driver management set talent employ standard, and the suitability scores more than 75 points are hired, then eliminate the substandard drivers, and ensure the operation safety of professional drivers.

Table 4 Professional driver suitability evaluation results

| Driver Numbers | No.1     | No.2     | No.3     | No.4     | No.5     | No.6     | No.7     | No.8     |
|----------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Test score     | 73.024   | 74.881   | 69.603   | 84.575   | 79.537   | 73.860   | 77.696   | 73.864   |

Through the above assessment, the quality order of the eight drivers is: 4, 5, 7, 2, 8, 6, 1, 3.

4 Conclusion

In order to study professional driver suitability evaluation, driving ability, driving attitude and driving behavior under emergency are considered, electrocardiograph, Frecord data collecting system and dynamics GPS are utilized and the experimental are carried out in the Communications Ministry Trail. First of all, take the vision, speed estimation, disposal judgment, attention, the brain activity, sports agility and feeling degrees as driving ability measure index; Drive safety score is obtained through the safety attitude table; take the heart rate changes, the steering wheel speed, foot pedals speed, obstacle avoidance time to examine the stand or fall of driver's actual operation. Again, based on fuzzy inference and hierarchical analysis, the professional driver selection suitable assessment system is established to study the selection of suitable assessment, and then obtain the final eight drivers' suitability score.

Reference:

[1] WANG Jun-guo,PANG Guo-qiang, JIA Zhi-xuan. Drivers’ stress and driving safety[J]. Shan’xi Science &Technology of Communications. 2002. 2(1): 61-62 (in Chinese)

[2] KOU Xue-zhi. Research on the psychological training of automobile drivers[J]. Journal of Highway and Transportation Research and Development. 1998. 15(2): 61-64 (in Chinese)

[3] ZHANG Hong, WANG Li, LI Wei. Effect of driver physical quality on traffic accident[J]. Occupation and Health, 2001. 17 (8) : 9-11 (in Chinese)

[4] YUZURU M.. A study of evaluation based on physiological response of a driver’s task and stress level while maneuvering a vehicle[J]. SAE Paper, 1997. 19 (2) :137

[5] LI Bai-chuan. Safety personalities and safety attitude examination [J]. Automobile drivers 1998. 14(1): 22-23 (in Chinese)

[6] LIU Zhi-hong, GUAN Lian-rong. Study on evaluating method of the occupational suitability in military automobile drivers[J]. Journal of Preventive Medicine of Chinese People's Liberation Army, 1994, 12 (4) : 267-270. (in Chinese)

[7] Chen Xuemei. Synthesis Driver Behavior Model under Multi-factors Stimulation of Emergency and Professional Driver Suitability Evaluation[D]. Beijing: Beijing Institute of Technology, 2006.