Research on Assessment Index and Model of Road Safety Measures and Technical Means Effect Based on Trans-Departmental Information

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***Abstract*—This article on trans-departmental information, combines with specific field survey data, based on the principle of establishment of evaluation index, determines the specific indicators of comprehensive evaluation of road safety measures and technical means effect based on trans-departmental information, establishes the assessment model through the processing of indicators, and makes the foundation to the post safety assessment.**

***Index Terms*—Trans-department, safety measures, technical means, assessment index, assessment model**

I. Introduction

Road traffic safety measures are any technical equipments, means, procedures and so on, take improving road safety as the sole purpose or at least as one of the objectives of the unit. It is for the elements of road transport system, such as the use of the land, roads, and road equipment itself, and traffic control facilities, motor vehicles, policemen, road traffic participants and their traffic behavior, and main purpose is to reduce the number of traffic accidents, reduce the damage due to traffic accidents.

At present, not only our research results on road traffic safety measures of the quantitative evaluation are fewer, but also we do not have a systematic evaluation study on a variety of safety measures. Therefore, this paper through the classification research of road safety and technical instruments and their related traffic safety events, builds the assessment index system of road safety measures and technical means effect, and on this basis, establishes the comprehensive evaluation model of road safety measures and technical means effect combining with actual data.

II. He Creation of Evaluation Index

Establishment of the comprehensive assessment indicators of road safety measures and technical means effect: extract the relevant data of the transport sector on road safety facilities and the corresponding accident statistical data of public security department, and finish the comprehensive assessment of road safety measures and technical means effect. It is a very abstract issue to measure road safety measures and technical means effect. Therefore this paper has the research from three aspects . On the one hand, through obtaining the relevant data of the transport sector on road safety facilities, it evaluates the self-generated effects value of road safety measures ; on the other hand, by analyzing and comparing the accident statistical data and violation data of the public security departments that corresponding to safety measures, it measures the effects produced by improving and setting safety facilities ; finally, considering the above two aspects of the evaluation value, it gives the final safety facilities effective value[1].

Assessment index system of road safety measures and technical means effect as shown below:

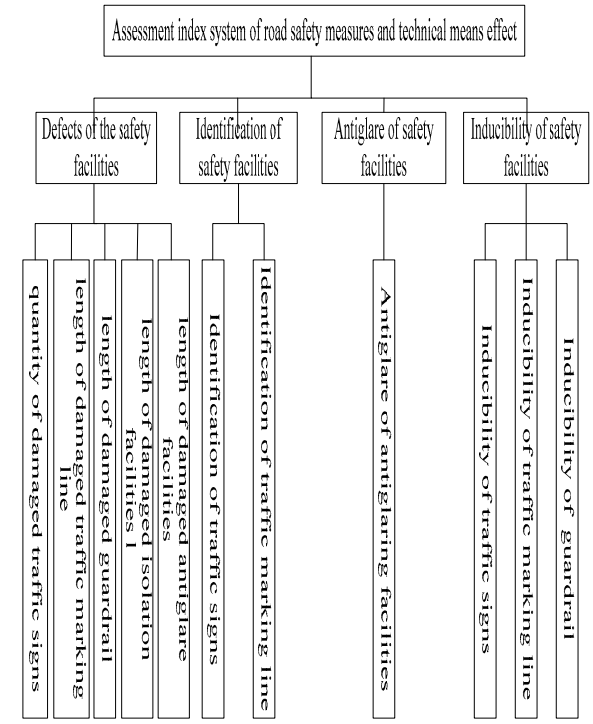

Fig. 1. Assessment index system of road safety measures and technical means effect

III. The Creation of Evaluation Model

A. Study On Dimensionless Indicators

1) Method selection[2]

Observe the defined index system and analyze their possible range, obtain that most of the indicators are showing the approximate linear transformation, so here it chooses linear undimensionalization.

2) Generalized linear efficacy coefficient method

The basic form of generalized linear efficacy coefficient method:

Dimensionless value of individual evaluation index:

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$$d = \frac{X_i - X_{i0}}{X_{il} - X_{i0}} \tag{1}$$

Or linear transformation:

$$Fd = d * a + b \tag{2}$$

$$d = \begin{cases} N & x < a \\ \dfrac{\ln x - \ln a}{\ln b - \ln a} * 40 + 60 & a \le x \le b \\ M & b < x < c \\ \dfrac{\ln 1/x - \ln 1/d}{\ln 1/c - \ln 1/d} * 40 + 60 & c \le x \le d \\ N & x > d \end{cases} \tag{3}$$

Usually take a = 40, b = 60. X_i is the actual value of index i, X_{i0} and X_{i1} are two key points of index i. For the positive index, $X_{i0} < X_{i1}$,for the inverse index, $X_{i1} < X_{i0}$.

3) Dimensionless function

For the index system of road safety measures and technical means effect, according to the form, generally we can draw the following two classes of graphics.

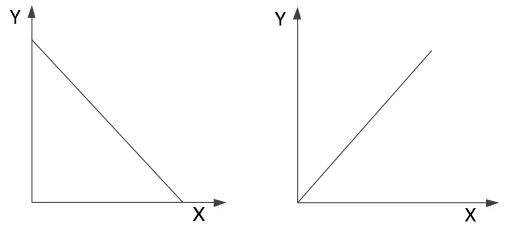

Fig. 2. Dimensionless function

It can be seen that defects of safety facilities belongs the first class graphic, identification and inducibility of safety facilities belong the second class graphic, here we define defects of safety facilities as the inverse index. In order to construct function better, we can integrate the two classes of graphics above to a graphic as shown below:

Dimensionless function constructed:

When $a \le x \le b$, a is "not allowed value", b is "satisfied value"; and when

$c \le x \le d$, d is "not allowed value", c is "satisfied value".

B. Dimensionless Indicators

After dimensionless method and function are determined, we make the index dimensionless.

1) Defects of safety facilities dimensionless

The index of defects of safety facilities is an inverse. Here define its satisfied value as 0.1, its not allowed value as 3, that is when the value of defects is less than 0.1,the dimensionless values are the maximum, and when the value of defects is larger than 3, the dimensionless values are the minimum. As the following Table I.

2) Identification and inducibility of safety facilities dimensionless

The indexes of identification and inducibility of safety facilities are the positive. Here define satisfied value of identification and inducibility as 100, their not allowed value as 40, that is when the value of identification and inducibility is less than 40,the dimensionless values are the minimum of 60, and the value of identification and inducibility can be as large as 100.As the following table II

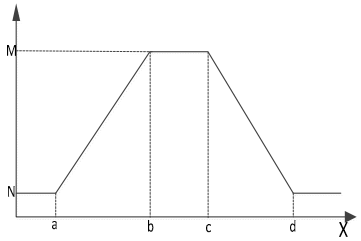

Fig. 3. Combined dimensionless function

C. Index Weighting Method

1) Determine order relation[3]

If the important degree of index x_i is greater (or not less) than x_j to an evaluation criteria (target), then denote $x_i > x_j$.

And if the indexes of X_1 , X_2 , … , X_m have the relation of $X_1 > X_2 > \ldots > X_m$ to an evaluation criteria (target), then we say X_1 , X_2 , … , X_m determine the order relationship according to ">". Here x_i represent the scheduled order index i according to ">". (i=1 , 2 , … , m).

2) Compare the relative importance of X_{k-1} and X_k

Assume the rational judgment of W_{k-1}/W_k about the importance of the evaluation index X_{k-1} and X_k that experts give is:

$$W_{k-1}/W_k = r_k \quad (k = m, m-1, m-2, ..., 3, 2) \tag{4}$$

When m is larger, then take $r_m = 1$ according to order relation above.

Values of a as the following table III:

TABLE I: THE DIMENSIONLESS VALUES OF DEFECTS OF SAFETY FACILITIES

Key point						
value of T_1			.1			
dimensionless value of U_1		00	00	0		

TABLE II: THE DIMENSIONLESS VALUES OF IDENTIFICATION AND INDUCIBILITY OF SAFETY FACILITIES

Key point						
value of T_2、T_3	0	00				
dimensionless value of u_2、u_3	0	00				

TABLE III: VALUES OF r_k

	explanation
1.0	index X_{k-1} and index X_k has the same importance
1.2	Index X_{k-1} is slightly important than index X_k
1.4	Index X_{k-1} is obvious important than index X_k
1.6	Index X_{k-1} is strongly important than index X_k
1.8	Index X_{k-1} is extremely important than index X_k

TABLE IV: CLASSIFICATION OF THE EVALUATION LEVEL

Evaluation Level	Value Range	Remark
Level 1	$[0,0.25]$	excellent traffic safety state, traffic management measures and road service level have reached a very high level, the extremely low probability of traffic accidents
Level 2	$(0.25,0.45]$	good traffic safety state, traffic management measures and road service level have reached a high level, the low probability of traffic accidents
Level 3	$(0.45,0.65]$	medium traffic safety state, traffic management measures and road service level have reached a middle level, the medium probability of traffic accidents
Level 4	$(0.65,0.85]$	ordinary traffic safety state, traffic management measures and road service level have reached a low level, the high probability of traffic accidents
Level 5	$(0.85,1]$	bad traffic safety state, traffic management measures and road service level have reached a very low level, the extremely high probability of traffic accidents

If X_1 , X_2 , … , X_m have the relation of $X_1 > X_2 > \ldots > X_m$ then $r_{k-1} > 1/r_k$, $(k = m, m-1, m-2, ..., 3, 2)$

D. The Calculation of the Weight Coefficients W_k

If the rational values of r_k that experts give have the relation of $r_{k-1} > 1/r_k$, then

$$W_m = \left(1 + \sum_{k=2}^{m} \prod_{i=k}^{m} r_i\right)^{-1} \tag{5}$$

E. Calculation and Classification of Evaluation Value

After having the dimensionless index and determining the weights of them, we can get the comprehensive assessment value by the multiplied product of them[4].

In evaluation of road traffic safety, considering experts' opinion and the distribution of evaluation results , the results of the micro-evaluation and macro-evaluation are divided into five levels, which called the traffic safety state level, and we give each level a corresponding value range. As the following table IV :

IV. CONCLUSION

Relying on the national road traffic safety science and technology action plan, through specific field survey data of trans-department, this paper has put forward the assessment index system of road safety measures and technical means effect based on trans-departmental information, and finishes the process of dimensionless indicators and weighting indexes, and then gets the classification of the evaluation level, finally build the assessment model of road safety measures and technical means effect based on trans-departmental information, which provides a theoretical support for the next comprehensive assessment.

REFERENCES

[1] W. Yanhui, Z. Han, Z. Ke, and Z. Chenchen, "Study of evaluation method of road safety measures and technical means effect based on inter-departmental information," *Highway*, 2011, vol. 10, pp. 145-150.

[2] L. Guoqi, Z. Jin, and L. Sijing, "Determination of urban emergency logistics needs region and method of level classification," *Chinese security science journal*, 2012, vol. 1, pp. 157-164.

[3] G. Yajun, "Comprehensive evaluation theory," *method and application*, Beijing: Science Press, 2007.

[4] Z. Chenchen, W. Yanhui, and J. Limin, "Evaluation method of regional traffic safety condition based on the inter-department information," *Chinese security science journal*, 2010, vol. 10, pp. 152-158.