Evaluation System for Evaluating the VMS Guidance Effect

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***Abstract*—With the VMS (Variable Message Signs) gradually and extensively used in major cities, it is necessary to develop a related evaluation system to evaluate its guidance effect systematically and efficiently. This paper primarily studies on developing a system to make the evaluation work more simply and quickly, and it chiefly contains the following five aspects: Firstly, conducting the system requirement analysis. Secondly, designing the overall system framework; Thirdly, designing and achieving every module's function; Fourthly, study on the main models used in the system; Finally, applying the evaluation system to practice by taking one road network of Beijing as an example. As a result, it indicates that the system can be successfully applied in practice. In addition, it can also save time and money.**

***Index Terms*—VMS, Guidance Effect, System Development, System Application**

I. Introduction

In recent years, the traffic jam becomes much heavier in many big cities, and it causes other problems such as economic losses, traffic safety and environmental pollution. As a part of Intelligent Transportation System, VMS plays an important role in relieving traffic jam. So it is significant to develop a system to evaluate the guidance effect.

So far, many researchers have conducted related work. Baofeng Sun (2005) [1] evaluated the effect of highway VMS projects on social economy, giving out the appraisal of VMS's guiding result from the point of benefit. Hui Zhang (2009) [2] compare the condition of before building VMS to it of after building it from three aspects: economic benefits, traffic benefits and public benefits. Srinivas Peeta(2000) [3] evaluated the AIS' (Advanced Information Systems) effect, which include fluency, safety and air quality. Nevertheless, few of researchers gave the VMS's guidance an integrated evaluation. Although the research on VMS's guiding result is carried out for a few years, the evaluation system has not been developed. In addition, evaluation is long-term work, and it may be carried out during the whole process. So far, the VMS evaluation system has not been studied, but a related traffic evaluation system has been developed, Mingzheng Sun (2003) [4] developed a system to evaluate the traffic design of intersection; Fugui Chen (2007) [5] also developed an urban rail transit economic evaluation system. This paper will borrow ideas from above systems and mainly develops a system to evaluate the VMS's guidance effect more comprehensively, simply and quickly.

The structure of the paper is as follows: Section 1 shows the study background, related work and structure of the paper; Section 2 conducts the system requirement analysis to find out that the system has to meet demand of transport management and research; Section 3 designs the overall system framework which includes traffic condition display module, evaluation index calculation module, comprehensive evaluation module, system parameter settings module and other auxiliary module;

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Section 4 designs and achieves every module's function; Section 5 studies the models used in the system; Section 6 applies the evaluation system to practice by taking one road network of Beijing as an example.

II. System Requirement

The evaluation system mainly serves two types of users: Transport Management Department and Transport Research Department. To Transport Management Department, the system can make them comprehensively master VMS guidance result, thus can lay a sound foundation on making related traffic decision; To Transport Research Department, the system will help them acquire VMS guidance effect on different aspects so that they can put forward effective solutions to transport.

III. System Framework

The system should achieve several objectives: The VMS evaluation system should not only make the guiding effect evaluation visual, but also meet different users' demand. In addition, the software can be used in different stages (include VMS planning stage, VMS trial stage, VMS running stage).

Based on above objectives, the system framework is designed as Fig. 1 showed. The system includes five parts: Traffic Condition Display Module, Index Calculation Module, Comprehensive Evaluation Module, Parameter Settings Module, and Other Auxiliary Module. The core function of the system is realized by Traffic Condition Display Module, Index Calculation Module, and Comprehensive Evaluation Module. Parameter Settings Module makes the evaluation work can meet different users' individual demand. Other Auxiliary Module can make users manage the system much more convenient.

According to the system's framework, the evaluation process can be determined, which is shown by Fig. 2.

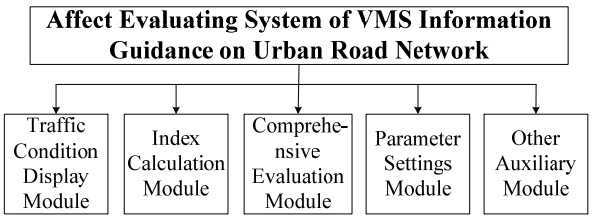

Figure 1. Note how the caption is centered in the column

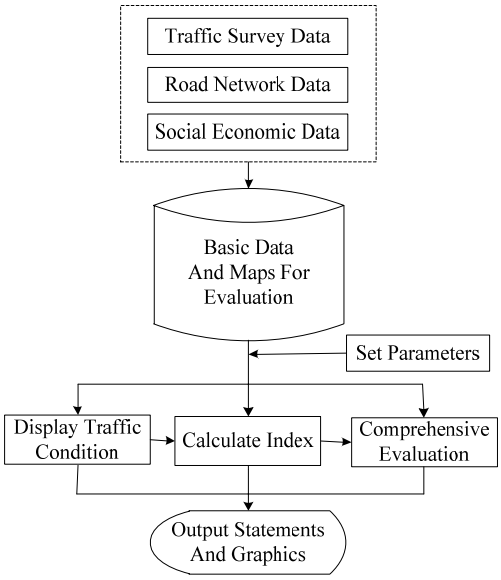

Figure 2. Evaluation process of the system

IV. System Function

The system function can be divided into five parts, which are shown by Fig.1. A brief introduction to each part will be presented as follows.

A. Traffic Condition Display Module

Traffic condition display module includes three parts: traffic condition without VMS, traffic condition with VMS and flow variation with and without VMS. The interface of flow variation with and without VMS is shown by Fig.3. The meaning of the color line in Fig. 3 and Fig. 4 is shown by legends at each figures' bottom right. By using of this module, users can have a visual feeling about VMS guidance effect.

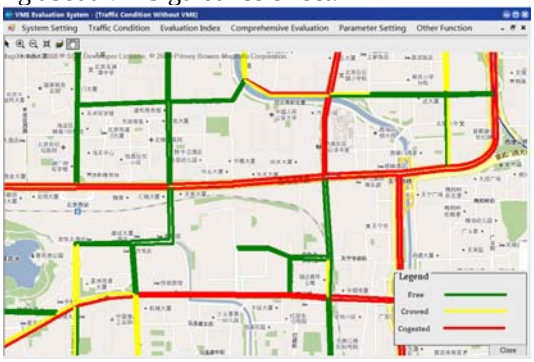

Figure 3. Interface of the traffic condition without VMS

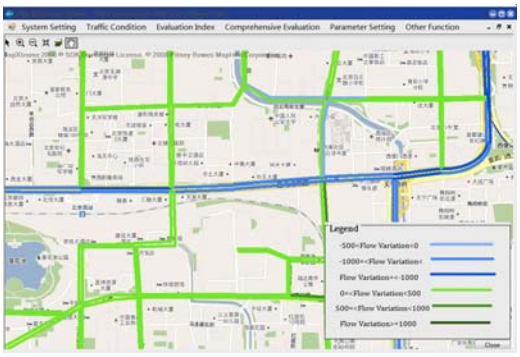

Figure 4. Interface of the traffic condition without VMS

B. Index Calculation Module

Index calculation module, which can supply users with VMS guidance effect on different aspects, mainly includes network child module, economic child module, environment child module, safety child module and driver child module [6][7]. Every child module has its own indexes. The content of it is shown by Fig.5. And the operation interface is shown by Fig. 5.

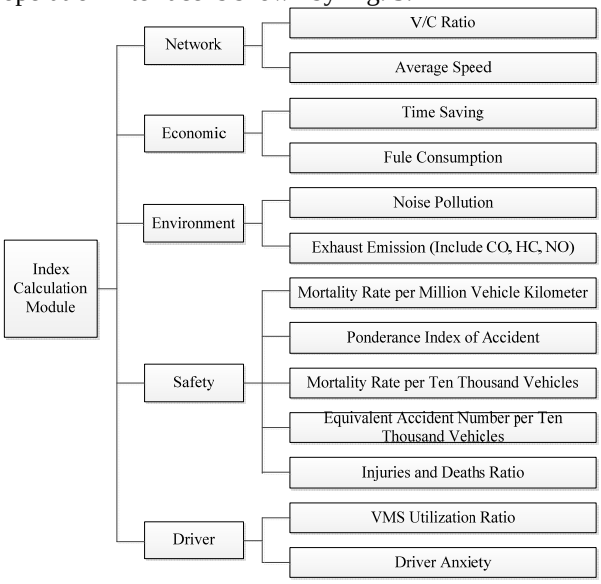

Figure 5. Content of Index Calculation Module

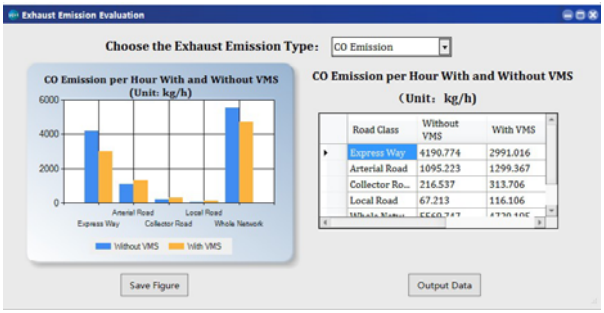

Figure 6. Operation interface of index calculation

C. Comprehensive Evaluation Module

Based on the index calculation module, comprehensive evaluation module can offer users a final evaluation about VMS guidance effect by use of the Grey Relational Analysis. The Comprehensive evaluation process is shown by Fig. 7. The system supply users with a method selection for calculating the index weight based on users' owe demand. The three index weight calculation methods are: 1) AHP (Analytic Hierarchy Process); 2) Entropy; 3) Custom weight. The operation interface is shown by Figure 8. The detailed comprehensive evaluation methods will be studied in Section 5.

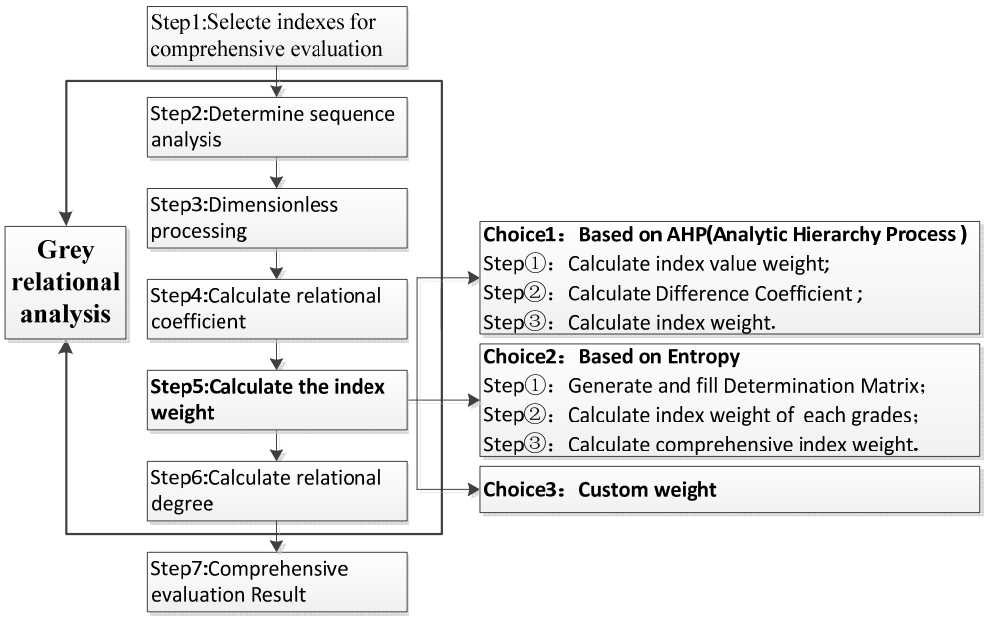

Figure 7. Comprehensive evaluation process of the system

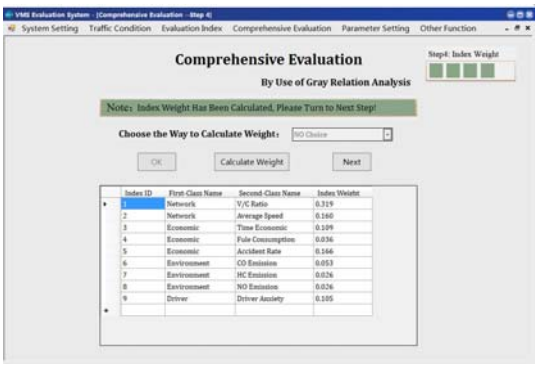

Figure 8. Operation interface of comprehensive evaluation

D. Parameter Setting Module

In order to meet individual persons' demand, parameter setting module is designed. Therefore, users can obtain the different evaluation results that they want by setting different parameters. The module refers to network, economic and environment. The operation interface of setting economic parameter is shown by Fig. 9.

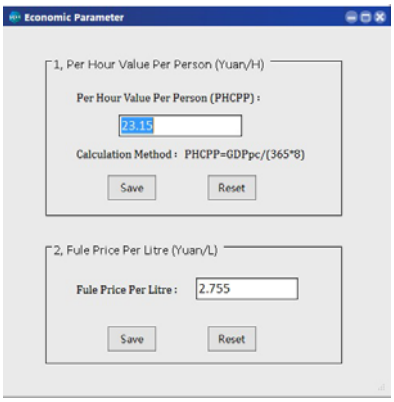

Figure 9. Operation interface of setting economic parameter

E. Other Auxiliary Module

Other auxiliary module includes login interface, evaluation process, system initial and system note. This module can make users use the system much more easily and safely.

V. System Function

In order to test whether the system is practical or not, this paper takes one road network of Beijing as an example. The network and the VMS location are showed by Fig. 10.

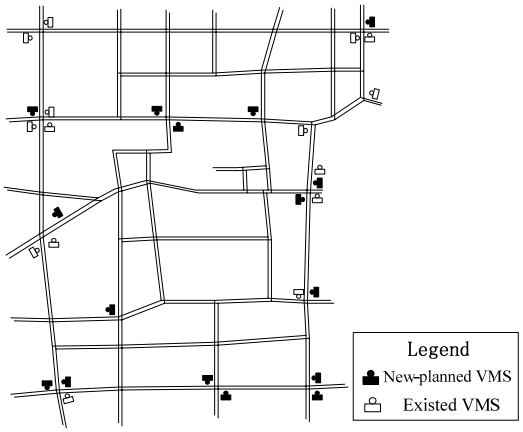

Figure 10. Road network and VMS location on it

Data, which is collected from the traffic survey and flow detection will be input and applied to the system in order to evaluate the VMS guidance effect. The evaluation result contains three parts:

(1) A direct look on traffic condition. The flow variation with and without VMS is represented by Fig. 11. According to the Fig. 11, we can roughly know the VMS guidance effect, which can lay a foundation on further evaluation.

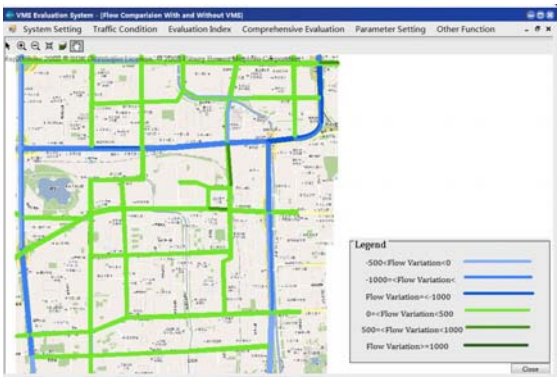

Figure 11. Flow variation with and without VMS

(2) Signal index calculation result, which can help the users obtain the VMS guidance effect on different aspects. Because the collected data is limited, the indexes calculated in this example are as follows: V/C ratio, average speed, time saving, fuel consumption, noise pollution, exhaust emission, injuries and deaths ratio, driver anxiety.

Take the result of fuel consumption for an example, which is showed by Fig.12. We can exactly know the variation of whole network and different levels road by the analysis of Figure12.

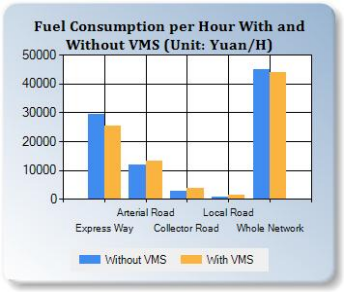

Figure 12. VMS guidance effect on fuel consumption

(3) Comprehensive evaluation result (AHP is used to calculate the weight index in this example). The result is showed by TABLE I, which indicates newly-planned VMS in Fig.8 can improve the traffic condition 5%.

TABLE I.
COMPREHENSIVE EVALUATION RESULT

Without VMS	With VMS	Variation Value	Variation Rate
0.952	0.999	0.047	4.98%

VI CONCLUSION

This paper's main achievement is as follow: (1) Based on system requirement analysis and overall framework design, the evaluation system of VMS's guiding effect is developed; (2) Apply this developed system to Beijing's road network, a region serviced by VMS is evaluated. In the future research, the system's function will be extended, like Real-time evaluation and micro-simulation of the VMS' guiding effect.

VII ACKNOWLEDGEMENT

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