# Research of Method of Propensity Prediction for Road Traffic Safety Based on Trans-Department Information

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***Abstract*—Through the establishment of highway road accident causation model, combined with trans-department sources of information, this paper analyses the data requirements and forecasting processes of the road traffic safety propensity. Introduces AID-one of the commonly used accident prediction methods, and build the model of accidents prediction, also analyses the model fitting workflow.**

***Index Terms*—Traffic safety, propensity prediction, trans-department, road safety, model fitting workflow.**

## I. Introduction

On the highway, change of traffic flow, weather and other dynamic factors is an important factor in causing the accident. For example, rain and snow would slippery the surfaces of road, easy to cause rear-end accidents. In foggy weather, road accident rates increase because of the low visibility.

In advanced traffic management systems, if predicting the probability of the accident in this state based on dynamic traffic flow, weather and other factors is realizable, and take timely measures to reduce accidents and casualties. In addition, the accurate prediction of accident is able to ensure the unimpeded road traffic running, and reduce unnecessary administrative measures. And the dynamic predictions can provide strong support for the decision-making of the road.

Propensity prediction for road traffic safety is based on accident rates of the past, combined with the current traffic safety status to predict the security status of next stage of the road. Occurring of traffic accidents is an ever-changing dynamic process with a lot of randomness and contingency, but also with coherence and correlation. Therefore, occurring of the accident is closely related to its past and present safety status, propensity prediction for road traffic safety build the foundation of predicting traffic incidents and take timely preventive measures. [3]

## II. Propensity Prediction for Road Traffic Safety

Road accident causation analyzing is prerequisite for prediction of propensity prediction for road traffic safety and before all these begin, we should first in-depth analysis of the cause of the incident.

First of all build road accident causation model. Based on the analyzing of existing accident causation models, we can build a road traffic accident analysis of existing accident, road traffic accidents are caused by a variety of factors, including reasons of vehicles, persons and the road environment which interplay and influence each other cause traffic accidents, as shown in Fig. 1:

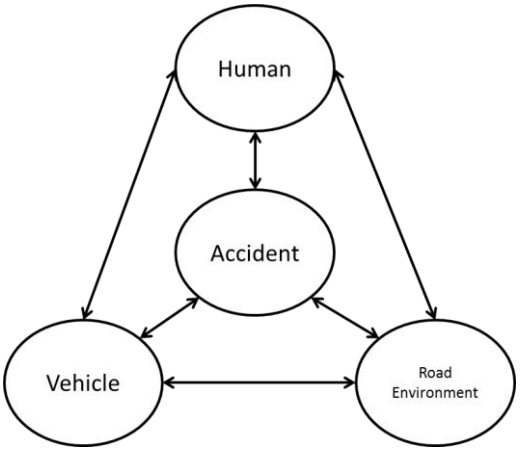


Fig. 1. Road accident causation model.

Various factors in the model can be summarized into the following broad categories:

### A. Vehicles Reasons

The reason of the so-called vehicle reasons is that the existing vehicle's road performance cannot match design of the road. In recent years the highway construction developed rapidly, but the level of vehicle manufacturers did not further enhance as well. Performance degradation of vehicle in the process of moving caused traffic accidents. Vehicle technical problems existing are as following:

1) Dynamic performance;
2) Reliability;
3) Poor braking performance;
4) Quality of tires can not match high-speed driving;
5) Poor stability of manipulation;
6) Poor passenger comfort;

### B. Human Reasons

The people of the main reasons include driver's education, driver's physiological and psychological reasons.

1) Driver education
2) Physiological and psychological reasons

### C. Road Environment Reasons

Manuscript received July 21, 2012; revised September 1, 2012. This work was supported by grants from the National Key Technology R&D Program in the 11th Five year Plan —Traffic Safety Information Integration, Analysis, Building Technology and Application of the Platf ‖ (NO.2009BAG13A01).

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## III. Analysis of Data Requirements and Prediction Process of Propensity Prediction for Road Traffic Safety

### A. Data requirements of accident prediction

All of the information collection point is the specific location of the accident in a period of time (one to three years) with the dynamic information, the time is when the accident occurred, and all accident-related information can be combined. The data requirements of accident prediction and providing departments are as shown in Table I.

TABLE I: Data Requirements of Accident Prediction and Providing Departments

| Data types | Data sources |
|---|---|
| Meteorological information | Department of Transportation |
| Traffic facilities | Department of Transportation |
| Traffic flow information (flow rate, speed) | Department of Transportation |
| Accident information (time, location, type) | Department of Public Security |

### B. Prediction Process of Accident Prediction

Road traffic accident prediction is generally divided into three stages.

The first stage is the design phase to determine the predicted target, through collecting, analyzing relevant information, initially select prediction techniques. The second stage is the modeling stage, build the prediction model and validate if the model is reasonable. The third stage is the evaluation stage which predict and have the predicted values validated, evaluated. At this stage we should consider all factors in a variety of ways to study and correct the method.

Flow chart of road traffic accident prediction is shown as Fig. 2.

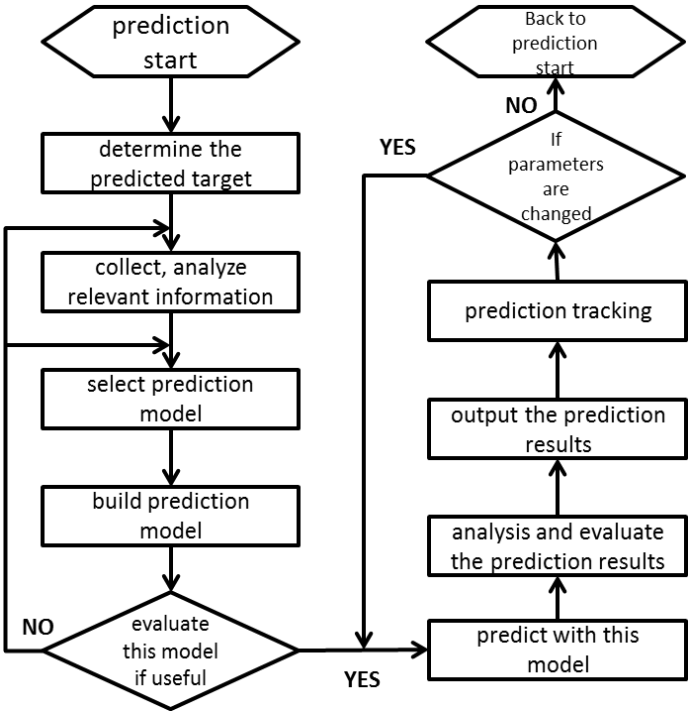


Fig. 2. Prediction process of accident prediction.

## IV. Analysis of Data Requirements and Prediction Process of Propensity Prediction for Road Traffic Safety

Highways accidents caused the decline of road capacity, and it's the main reason leading highway sporadic crowded. More and more traffic incident in sporadic crowded not only have a serious impact in the normal operation of the highway, but also reduces traffic safety. Sporadic congestion need to be determined by event detection, event detection techniques can be divided into Non-auto-incident of Detection technology and Automatic Incident of Detection (AID). Driver using the telephone booth or a cellular phone, highway patrol, closed circuit television is a Non-auto-incident of Detection technology, which requires witnesses at that time and location. But AID technology based on changes in parameters of traffic flow works all day and whole road while an eyewitness is unnecessary which demonstrates huge potential, is now becoming a very important content of the ITS research, and main direction in the research of event detection

AID algorithm is usually building algorithm model based on theoretical analysis, assumptions and simplifications of the relationship and variation between the traffic flow parameters which is tested by traffic data from simulation or collected in real traffic environment. These models can give a good description to the state of traffic flow to a certain extent.

### A. The AID Algorithm Performance Evaluation Indicators

*False Alarm Rate，FAR:* The false alarm rate refers that

while using time detection algorithm, within a certain time, the ratio of the number detected of events that not happened to the total number of events that actually happen.

$$FAR=NFDR/（NDR+NFDR）*100\% \quad (1)$$

The NFDR for false alarms number; NDR is the total number of decisions made before the detected events.

*Detection rate，DR:* The detection rate refers that while using time detection algorithm, within a certain time, the ratio of the number detected of events and also happened to the total number of events that actually happen.

$$DR= NDR/（NDR+DT-NDR) *100\% \quad (2)$$

The DR refers detection rate; DT is number of detected events; the NDR is number of the actual event.

*Mean Time To Detection，MTTD:* The average detection time refers that while using time detection algorithm, within a certain time, the average time difference from the incident to being detected.

$$MTTD = \frac{1}{n}\sum[TI(i) - AT(i)] \quad (3)$$

MTTD for the average detection time; TI (i) the actual happening-time of event i; AT (i) the time being detected of event i.

These indicators of assessments are interdependent. Usually, improving the performance of the detection rate would raise the false alarm rate. Similarly, reducing the false alarm rate would lower sensitivity of the algorithm and the detection rate also fell. Under normal circumstances, the longer the detection time of the algorithm takes the result of detecting the better. But with the increasing of the detection time, detection rate and false alarm rate will drop.

### *B. The Classification of the AID Algorithm*

The presence of the AID algorithm can be divided into the following categories: pattern recognition, statistics, catastrophe theory, and advanced event detection techniques.

### *C. Accident Prediction Fitting Model*

The total number of accidents of highway traffic is positively correlated with the road length, traffic flow, urban or rural variable, whether it is the interchange variable and the average rotation of the horizontal curve, but not correlated with the speed and some other variable. Model selects the form of the negative binomial distribution. The independent variables of the model are the average angle of a flat curve, whether it is urban and rural areas, whether it is the interchange, trucks proportion.

A high degree fitting model of accident prediction is as below.

$\mu$ = EXPO×EXP（-2.737629 + 1.119211×City-rural + 0.4733442 × Interchange + 0.0112781 × Ave-angle + 1.375432Truck% + 0.0588885×Spe=stan-truck）

where: $\mu$ - sections to predict the number of accidents;

EXPO-exposure variables, the annual million vehicle kilometers,

EXPO = hour traffic × 365L × y;

y - Sustained year predicted;

L - Length of section;

City-rural - urban and rural variables;

Interchange - interchange variables;

Ave - average corner angle of the horizontal curve in-section;

Truck - The proportion of truck within one section, %;

Spe = Stan-truck - The standard deviation of the cart speed.

Using prediction model to predict traffic accidents on highway is as following steps:

1) Determine conditions of the highway sections to be to predict, collection of road information, the establishment of the plane, longitudinal cross-sectional data, including: the level curves of the corner, whether interchange;
2) For historical accident data, use sequential clustering to divided road into sections; If no accident use fixed-length method;
3) Collect other factors that affects, including road level, traffic composition, the carts percentage, speed;
4) Determine length, hours of traffic and other factors of the road to be predict;
5) Specific annual traffic accidents forecast for this section of road;
6) Using hour traffic variable model to predict traffic accidents for a particular year;
7) Using millions of vehicle kilometers as the unit to calculate the exposure variable;
8) Calculate the standard deviation of carts speed and carts proportion, take Spe-Stan-Truck and the Truck% into the equation to have the accident prediction;
9) If you need to predict traffic accidents in other years, go to 5) step, otherwise go 10) step.
10) Come to the result of highway accident predictions.

Flow chart is shown as Fig. 3.

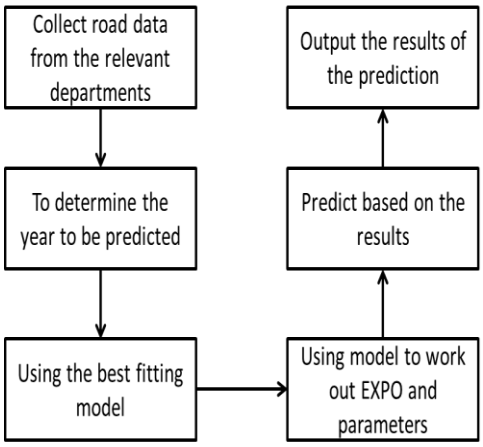


Fig. 3. Process of model fitting workflow.

## V. Conclusion

Trans—department information has been challenge for the prediction road traffic safety, but help it to self-improvement at the same time. Appropriate use of trans-department information and accident prediction fitting model to make accurate prediction of accident is able to ensure the unimpeded road traffic running, and reduce unnecessary administrative measures. And the dynamic predictions can provide strong support for the decision-making of the road.

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