Available online at www.sciencedirect.com
ScienceDirect
Procedia - Social and Behavioral Sciences 160 (2014) 332 – 341
Procedia
Social and Behavioral Sciences

XI Congreso de Ingenieria del Transporte (CIT 2014)

Using Decision Trees for Comparing Different Consistency Models

Laura Garach Morcillo[a]*, Francisco Javier Calvo Poyo[a], Griselda López Maldonado[a]
[a]*TRYSE Research Group, University of Granada, ETSI Caminos, Canales y Puertos, c/Severo Ochoa, s/n, 18071 Granada, Spain*

Abstract

One technique used to improve highway safety from the point of view of the infrastructure is to examine the consistency of the design. Design consistency refers to if highway geometry is conformance to driver expectancy. When the consistency of the road is inadequate, the more likely it is that drivers will be startled and a crash will occur. The consistency, based on operating speed, has been calculated in Spanish two-lane rural highways. This consistency has been evaluated using a local method, to measure the consistency of each element of the road and using a global method, to measure the consistency of a segment of the road. Different models of consistency have been compared using Decision Trees (DTs). DTs are a Data Mining Techniques which can be used to solve classification problems. The results show that DTs are a suitable technique to compare consistence models and they permit to establish limits between the different models analyzed.

Peer-review under responsibility of CIT 2014.
*Keywords:*consistency; crashes; new global model; comparison consistency model; decision trees; CART.

1. Introduction

Design consistency is understood as the conformance of highway geometry with driver expectancy, or the relationship between the geometric characteristics of a highway and the conditions the driver expects to encounter (Castro et al., 2008). Many authors agree that operating speed is the form most commonly used to evaluate consistency, as it reflects driver behavior (Gibreel et al., 1999; Fitzpatrick et al. 2000; Ng and Sayed, 2004; Camacho-Torregosa et al., 2013). Operating speed is the most representative parameter of real driving performance (Dell`Acqua et al., 2013). The operating speed is defined as the 85th percentile of the distribution (V_{85}) of speeds by drivers under free-flow conditions on a particular location of the road alignment (Bella, 2007).

* Corresponding author. Tel.: +34 958 249455.
E-mail address: lgarach@ugr.es

Peer-review under responsibility of CIT 2014.
doi:10.1016/j.sbspro.2014.12.145

Models based on operating speed to calculate road consistency can be local, applied to a specific geometric element of one road segment; or global, producing a consistency value for the whole road segment. Different local models have been used for several authors. Babkov (1968) concluded that consistent and safe designs could be produced when the difference in the operating speed between two consecutive elements did not exceed 15% of the speed in the preceding element. Leisch and Leisch (1977) recommended a revised design speed concept that included guidelines on V_{85} reductions and differentials between the design speed (V_d) and V_{85}. Kanellaidis et al. (1990) suggested that a good design is achieved when the difference between V_{85} on the tangent and the following curve does not exceed 10 km/h. However, of all the local methods based on operating speed to determine the degree of consistency, the best known local criterion is that by Lamm et al. (1999) based on mean crash rates. They presented two design consistency criteria related to operating speed, consisting of the difference between V_d and V_{85} (criterion I) and the difference in V_{85} of successive elements (criterion II, named C_1 in this paper). Table 1 shows the consistency thresholds for both criteria:

Table 1.Thersholds for a determination of design consistency quality. (Lamm et al., 1999)

Consistency	Criterion I (km/h)	Criterion II (km/h):C_1
Good	$\|V_{85} - V_d\| \leq 10$	$\|V_{85i} - V_{85i+1}\| \leq 10$
Acceptable	$10 < \|V_{85} - V_d\| \leq 20$	$10 < \|V_{85i} - V_{85i+1}\| \leq 20$
Poor	$\|V_{85} - V_d\| > 20$	$\|V_{85i} - V_{85i+1}\| > 20$

As regards global models, Polus and Mattar-Habib (2004) developed a consistency model C_2 (Eq 1) to assess the consistency of whole road segments. Their model is based on two new consistency measures. The first is the relative area bounded between the operating speed profile (representing the V_{85} for each element of the road segment) and the average weighted operating speed (Ra) (Eq 2). The second one is the standard deviation of the operating speeds at every element of the road segment (σ) (Eq 3).

$$C_2 = 2.808 \cdot e^{-0.278 \cdot [R_a \cdot (\sigma/3.6)]} \tag{1}$$

where:

C_2 = Global consistency model according Polus and Mattar-Habib (2004) (m/s)

R_a= Relative area measure of consistency (m/s)(Eq 2)

σ = Standard deviation of operating speed (km/h) (Eq 3)

$$R_a = \frac{\sum_{i=1}^{n} a_i}{L} \tag{2}$$

where:

a_i= Area, between the speed in each element of profile and average speed (m^2/s)

L = Road segment lenght (km)

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (V_{85i} - \bar{V}_{85})^2}{n}} \tag{3}$$

where:

n = Numberof elements along a road segment

V_{85i} = Operating speed on each element i (tangent or curve) (km/h)

$\bar{V}_{85}$= Average operating speed (km/h):