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Empirical estimation of the variability of travel time

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Abstract

This paper provides simple explanatory models for variability of road travel times with the aim to include reliability benefits in transport projects appraisal based on mean-dispersion models. It consists in an empirical investigation of the travel time distribution on urban roads in the metropolitan region of Paris, France. The analysis is based on accidents, major road works and detection loop data collected over a year on 23 urban highways. Explanatory models for several reliability indicators based on average travel time and road characteristics have been established and should allow to conduct rough estimations of reliability benefits of transport projects.

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Keywords: reliability; travel time variability; travel time distribution; travel time quantiles; forecasting; appraisal

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1. Introduction and literature review

Reductions in travel times are generally the main benefits of road infrastructure projects. In many countries, the focus of road transport policies is shifting from expanding road networks towards optimising road operation and quality of service. Transport projects usually reduce not only expected travel times but also the variability of travel times; this reduction of variability is valuable to travellers, insofar as they help them better organise their daily and non-daily activities, synchronize their schedules with other peoples', and so on. Moreover an increasing range of investments are specifically purported to reduce travel time variability: ITS investments, road renewal, dedicated lanes, etc. These projects aim at reducing the spread of the distribution of travel times but not its expected value, and therefore their benefits fall outside the perimeter of traditional cost–benefit analysis (CBA). For example, in France, the current appraisal guidelines allow including the valuation of variability in CBA, but do not require it. Therefore, following the publication of the new appraisal guidelines in 2014, studies have been started on defining a practical methodology to calculate travel time variability benefits.

Basically, there are three main ways to introduce the valuation of travel time reliability in appraisal practices. In order of increasing complexity, these methods are:

- keep reliability indicators out of traffic models, and use a mean-dispersion valuation formulation in the CBA in which the indicator of reliability and its marginal valuation coefficient are tutelary, e.g. defined in evaluation guidelines. This indicator can be estimated as a function of road and traffic flow characteristics, typically using a regression model. These regression models can be calibrated on a few road and traffic types with traffic loop detectors data;
- include reliability in static traffic models, for example with a mean-dispersion approach;
- use dynamic scheduling traffic models which make explicit both the dispersion of travel times and its costs for road users (reliability and scheduling).

The first type of method can be achieved by including a mean-dispersion valuation of reliability in the CBA, as a post-process of the outputs of traffic models which do not make travel times dispersion explicit. Practically, the objective is to develop a method which works with classic static road assignment models, and with currently available data (e.g. traffic loop detectors data).

In order to implement this approach, three tasks need to be achieved:

- choose the reliability indicator which will be used: time-frame, nature (percentile of the distribution of travel times, probability of being late, buffer index, etc.);
- estimate a model to forecast this indicator for various types of projects;
- give a monetary value to this indicator in the CBA.

This paper focuses on the second task: estimating and forecasting reliability. To find an explanatory model for reliability indicators, this paper describes an empirical analysis of the distribution of travel times on urban roads in the metropolitan region of Paris, France. The analysis is based on detection loop data. It was collected over a year, in a 6-minutes period on 23 urban highways. The analysis focuses on road transport, which has also been the topic for most of the available literature on modelling and valuing transport travel time reliability.

The shape of the travel time distribution is modelled in a simple way, with relationships between the average travel time and various indicators of the shape of the distribution (several percentiles, standard deviation). Then some road characteristics, accidents and road works data are added, which would prove useful to evaluate the impact of some ITS measures like automatic accidents detection. An other question is the time-frame on which the distribution is calculated: do road users differentiate Monday from Tuesday and 11 am from 12 am? It seems they are able to do so, partly because travel time distributions vastly differ from one day to another and from one hour to another.

Several linear models were run in order to obtain an explanatory model based on average travel time for several reliability indicators and check their stability over time of day and day of week. Models have been tested with various levels of details in order to allow a proportionate evaluation of the impacts of a project on travel time variability.

Two case studies of valuation of travel time reliability using the results of the regression models are presented at the end of the paper in order to assess the feasibility of the method and to get an estimate of the relative value of reliability benefits compared to traditional costs and benefits.