NS 532: Evaluation of Metro Freeway System for Reliability and Resilience: Literature Search
Tuesday, July 03, 2018

Prepared for: Mitch Bartelt

Prepared by: Jim Byerly, Electronic Resources Librarian

Resources searched: ASCE Library, Library Catalog, Google, RiP, Transport Database

Summary: Results are compiled from the databases named above. Links are provided for full-text, if applicable, or to the full record citation. I completed my searches using the following terminology: resilient, resiliency, reliable, reliability, freeway system/network, travel time reliability, measure, performance, traffic management. The results are divided into most relevant and less relevant

Most Relevant Results

Travel time reliability study report
Call Number: HE336.T76 T73 2003

Guide to establishing monitoring programs for travel time reliability
"TRB's second Strategic Highway Research Program (SHRP 2) Report S2-L02-RR-2: Guide to Establishing Monitoring Programs for Travel Time Reliability describes how to develop and use a Travel Time Reliability Monitoring System (TTRMS). The report also explains why such a system is useful, how...
Call Number: SHRP2 L02-RR-2

Cost-effective performance measures for travel time delay, variation, and reliability
Call Number: NCHRP 618

Guide to incorporating reliability performance measures into the transportation planning and programming processes
Call Number: SHRP2 L05-RR-2

Methods for Improving the Reliability of Transportation Systems
Reliability in transportation systems is a measure of predictability and consistency in departure and arrival times. It may be measured as the probability of arriving (or possibly departing) within a specified time span (or “window”), the variance of arrival, departure or service times, or the generalized cost of the variability. Reliability is one of the key aspects of service quality and system performance to be considered in planning, designing and operating transportation systems. The reliability of transportation systems may be improved in various ways involving overall system design, the detailed design of facilities and vehicles, maintenance of facilities and equipment, routing, scheduling, traffic management, terminal operations, control of vehicle movements, provisions for reserves or slack in various system components, and preparations for contingencies. While seeking to develop general methods applicable to various kinds of transportation systems, the objective of the proposed study is to improve freight transportation reliability in road networks. Furthermore, this study will focus on three important aspects of transportation system reliability, namely (1) the development and maintenance of reliable networks, (2) real-time vehicle dispatching decisions, and (3) resulting resource requirements, especially fleet sizes. In analyzing the development and maintenance of transportation
networks, we will develop methods for evaluating candidate projects or alternatives based on their reliability effects, in addition to various effectiveness measures, including infrastructure costs, user costs and benefits, environmental impacts and some external economic impacts. The two major improvements over conventional methods for transportation investment planning and scheduling will be (a) their explicit consideration of reliability measures jointly with other effectiveness measures in the evaluation and optimization processes and (b) their consideration of quantifiable interrelations among alternatives. Interrelated alternatives are those whose benefits and/or costs depend on which other alternatives are implemented at what times. Consideration of interrelations is very important for transportation networks because changes in network components shift traffic and thus affect the benefits of improvements to other components. Temporary interruptions in resource availability for maintenance purposes may also shift traffic and their effects depend crucially on whether the closed elements are in parallel or in series. The costs, budgets and other resources available for various alternatives may also be interrelated. The currently available analysis methods are relatively well suited for dealing with mutually exclusive alternatives or independent alternatives but quite inadequate for dealing with realistic numbers and complexities of interrelated alternatives. By extending methods already developed by our team (Tao & Schonfeld 2005, 2006, 2007, Wang & Schonfeld 2005, 2008, 2012, Shayanfar & Schonfeld 2015, Yang et al 2015) we expect to develop methods that not only evaluate interrelated alternatives appropriately, but also optimize the selection, sequencing and scheduling of those alternatives, subject to constraints on reliability, continuity, budgets, various resources, implementation times, fairness and other factors.

- **Record URL:**
  http://ntc.umd.edu/node/158

### Impact of Traffic Incidents on Reliability of Freeway Travel Times

**Abstract**

Travel time reliability is a key measure of a freeway system’s performance. Traffic incidents are one of the more important factors affecting travel time reliability because they reduce the capacity of a freeway segment and generate a temporary bottleneck. In this study an empirical travel time reliability analysis was conducted with the use of 4 years of travel time and incident data collected on Interstate 5 and Interstate 405 in the Seattle, Washington, metropolitan area. The incident data used for this study are notable for their highly detailed information for each incident. Three incident types (i.e., shoulder, single-lane, and multiple-lane incidents) were considered in the data analysis. Travel time reliability was analyzed through several measures, including travel time variability, buffer index, and probability of freeway segment traffic breakdown. The results show that incidents result in higher values for all these measures. To be more specific, multiple-lane incidents induce the highest buffer index and variability in freeway route travel times, whereas shoulder incidents induce the lowest buffer index and variability. Travel time variability and buffer index during multiple-lane incidents increase by an average of 205% and 237%, respectively, compared with normal conditions (conditions with no incidents). Compared with normal conditions, shoulder incidents can significantly increase the probability of freeway segment traffic breakdown. In general, incidents can significantly reduce travel time reliability. The findings in this study can help shape incident mitigation and management policies for different incident types, especially when the aim is to improve freeway travel time reliability.

https://trrjournalonline.trb.org/doi/abs/10.3141/2484-10

### Applying Travel-Time Reliability Measures in Identifying and Ranking Recurrent Freeway Bottlenecks at the Network Level

**Abstract**

The primary purpose of this study is to develop a systematic approach to effectively identifying and ranking recurrent freeway bottlenecks using travel-time reliability (TTR) measures. To achieve this goal, three subtasks are undertaken: (1) to identify recurrent freeway bottlenecks at the network level, (2) to rank discerned freeway bottlenecks, and (3) to examine the impacts of different threshold values used in defining TTR measures. Research results suggest that two TTR measures, namely the frequency of congestion (FOC) and planning time index (PTI), are suited to identify and rank
recurrent freeway bottlenecks at the network level. A case study is performed to validate the feasibility of the proposed methodology using vehicle probe data collected on four interstate freeways in Mecklenburg County, North Carolina, in 2015. Suggestions about the selection of threshold values in defining FOC and PTI for freeway bottleneck and congestion analysis are also provided. The findings of this study can provide insightful and useful information for traffic engineers and decision makers in identifying recurrent freeway bottlenecks and in developing effective congestion mitigation strategies for planning applications.

https://ascelibrary.org/doi/abs/10.1061/JTEPBS.0000072

**Freeway Capacity Estimation Method for Planning Applications**

Abstract

The capacity of a freeway segment is a critical factor for the planning, design, and analysis of freeway facilities. The Highway Capacity Manual (HCM) is considered to be one of the authoritative sources on capacity values for a variety of roadway types in the United States, particularly for planning purposes. For basic freeway segments, a single set of capacity values are provided as a function of free-flow speed. Although these values are considered to be reasonably representative values for freeways located throughout the United States, the HCM does not provide any guidance on how its recommended values can be adjusted to reflect significant differences in capacity due to local conditions, nor how to directly measure or estimate capacity values. With the recent development of a statewide freeway traffic data archive in Florida, the Florida Department of Transportation (FDOT) desired to use these data to determine if the freeway capacity values in the HCM were appropriate for Florida freeway level of service analyses for planning and preliminary engineering applications. This study evaluated two previously published methods for estimating freeway capacity, identified their advantages and disadvantages for use in planning applications, and ultimately recommended a method for use by FDOT. One of the chosen methods determines capacity from a mathematical function generated from speed-flow data points and the other chosen method uses the concept of breakdown probability distribution to determine capacity. Neither of these methods proved desirable for planning applications due to computational burden; thus, an alternate, simplified approach was developed that used a simple averaging method of highest flow rates to determine capacity.

https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29TE.1943-5436.0000699
Search Strategy: 1

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**Title**  
Travel Time Reliability for Urban Networks: Modelling and Empirics.

**Source**  

**URL**  
http://dx.doi.org/10.1155/2017/9147356

**Abstract**  
The importance of travel time reliability in traffic management, control, and network design has received a lot of attention in the past decade. In this paper, a network travel time distribution model based on the Johnson curve system is proposed. The model is applied to field travel time data collected by Automated Number Plate Recognition (ANPR) cameras. The authors further investigate the network-level travel time reliability by connecting the network reliability measures such as the weighted standard deviation of travel time rate and the weighted skewness of travel time rate distributions with network traffic characteristics (e.g., the network density). The weighting is done with respect to the number of signalized intersections on a trip. A clear linear relation between the weighted average travel time rate and the weighted standard deviation of travel time rate can be observed for different time periods with time-varying demand. Furthermore, both the weighted average travel time rate and the weighted standard deviation of travel time rate increase monotonically with network density. The empirical findings of the relation between network travel time reliability and network traffic characteristics can be possibly applied to assess traffic management and control measures to improve network travel time reliability.

**Publication Year**  
2017
Title Pattern Recognition Using Clustering Algorithm for Scenario Definition in Traffic Simulation-Based Decision Support Systems.

Source Conference Title: 17th International IEEE Conference on Intelligent Transportation Systems (ITSC14)Institute of Electrical and Electronics Engineers (IEEE)China Association of AutomationQingdao Academy of Intelligent IndustriesState Key Laboratory of Management and Control for Complex SystemsXi'an Jiaotong University, ChinaInstitute of Automation,Chinese Academy of Sciences. Location: Qingdao.Sponsored by: Institute of Electrical and Electronics Engineers (IEEE).Held: 20141008-20141011. 2014/10. pp 798-803 (Refs.)

URL http://dx.doi.org/10.1109/ITSC.2014.6957787

Abstract This paper presents a scenario clustering approach intended to mine historical data warehouses to identify appropriate scenarios for simulation as a part of an evaluation of transportation projects or operational measures. As such, it provides a systematic and efficient approach to select and prepare effective input scenarios to a given traffic simulation model. The scenario clustering procedure has two main applications: travel time reliability analysis, and traffic estimation and prediction systems. The ability to systematically identify similarity and dissimilarity among weather scenarios can facilitate the selection of critical scenarios for reliability studies. It can also support real-time weather-responsive traffic management (WRTM) by quickly classifying a current or predicted weather condition into pre-defined categories and suggesting relevant WRTM strategies that can be tested via real-time traffic simulation before deployment. A detailed method for clustering weather time series data is presented and demonstrated using historical data. Two clustering algorithms with different similarity measures are compared. Clustering results using a K-means clustering algorithm with squared Euclidean distance are illustrated in an application to travel time reliability.

Publication Year 2014

Title Analysis of Weather Impact on Travel Speed and Travel Time Reliability.


URL http://dx.doi.org/10.1061/9780784412442.117

Abstract Weather conditions may have significant impact on traffic flow. Under adverse weather, traffic speed reduces and congestion emerges. The joint effects of adverse weather and recurring traffic congestion throughout the day may lead to more unpredictable travel time. The objective of this study is to examine the impact of adverse weather on traffic speed and travel time reliability in various highways. Weather data collected from Road Weather Information System (RWIS) Environmental Sensor Stations (ESS) and speed data collected by INRIX are applied. Data for various highway classifications and different time periods are selected to conduct the
comparative analysis. **Travel time reliability** is measured by the buffer index. It was found that adverse weather reduces traffic speed and leads to less **travel time reliability**. The extent of influence varies with precipitation intensity. The results may assist transportation agencies for **traffic management** and travelers for trip planning under adverse weather.

**Publication Year** 2012

**Title** Incorporating **travel time reliability** in the estimation of assignment models.

**Source** 2011/12. (464) 99p


**Abstract** Route choice is determined by some function of mean **travel time** and distance on the routes available in most traffic assignment models. Increasing traffic volumes on a route increases delay, making a particular route less desirable. The NZTA (2010) Economic evaluation manual allows the benefits of improved network **reliability** to be monetised. However, our network models are unable to provide a convenient means of calculating the road user responses to **travel time variability**. Route choice is a more complex issue than a comparison of relative travel times and distance. It appears that road users are also considering travel time variability in their route choice. Variability may occur as a result of congestion in cities or on any network as a result of road geometry, a high volume of heavy vehicles on narrow steep roads, or other reasons. This research was carried out during 2008 to 2011 using Wellington data and sought to identify a methodology that best incorporated travel time variability into route choice models. The research determined the most useful formulation for use in models and the appropriate measure of travel time variability.

**Publication Year** 2011

**Title** Managing Highways for Better **Reliability**—Assessing **Reliability** Benefits of Ramp Metering.


**URL** [http://amonline.trb.org/](http://amonline.trb.org/)

**Abstract** **Reliability** of travel time is increasingly becoming an important part of transport policies around the world. However, a recent review of policies in Organisation for Economic Co-operation and Development (OECD) countries shows that, despite its importance, very few countries monitor reliability or explicitly incorporate reliability into transport policy making. The role of the government may be crucial in delivering optimal levels of reliability and a number of policy options are available to improve this aspect of transport management. Active management of the network through ramp metering is recognized as an efficient way to control motorway traffic, and field tests of
ramp control strategies show benefits to average travel time. However, far less is said about the reliability benefits of ramp metering. There have been few studies that specifically monitor improvements in travel time variability. This paper assesses reliability benefits of ramp metering on the basis of a before-and-after study on the A6W, a French motorway near Paris. The authors apply a number of indicators for travel time variability prior to and following the introduction of ramp metering. In order to take into account reliability in policy impact evaluation, cost-benefit assessment provides a consistent framework to assess the monetised benefits. The authors will therefore also calculate the monetary value of reliability benefits of ramp metering and, finally, discuss the policy implications of the results. The authors' results suggest that in addition to gains in average travel time, ramp metering significantly improves reliability of travel times. As different measures for reliability result in variations in the findings, it is important to communicate the results to decision makers and users of the network in the correct way. The authors therefore propose that indices such as buffer time or planning time are very useful, both for network operator and user. The authors suggest that failing to unbundle the time-saving benefits of a project between average travel time and the variability in travel time is likely to lead to sub-optimal policy solutions. The authors also argue that managing existing capacity better can be a cost-effective way to improve both average travel time and the variability in travel time.

Publication Year 2011

Least Relevant Results

Speed Stochastic Processes and Freeway Reliability Estimation: Evidence from the A22 Freeway, Italy

Abstract

In this paper, a criterion for predicting the reliability of freeway traffic flow is presented. The idea is based on an analysis of spot speed time series divided into sequences of events of random and homogeneous traffic processes. For each process, the flow rate and density were calculated; then the relationships between parameters of spot speed processes and vehicular density were obtained. Using these relationships and a simulation procedure for the spot speed process, a formulation for predicting the reliability of traffic flow moving along the offside lane on the freeway roadway was derived. Through this formulation and the measurements of flow rate and speed, the probability of instability of the roadway under examination was calculated. Furthermore, with an inverse procedure, the capacity of a lane was estimated: setting the reliability value close to 1 and considering a 15 min interval, the resulting flow rate represented the capacity. Thus, the simulation procedure was used to provide, in real time, the incoming instability conditions on the roadway and to estimate roadway capacity for the A22 Brenner Freeway, Italy.


Developing a Systematic Method for Identifying and Ranking Freeway Bottlenecks Using Vehicle Probe Data

Abstract

Traffic congestion and freeway bottlenecks continue to challenge existing transportation networks. This study presents a systematic method to evaluate freeway performance and locate and rank freeway bottlenecks while accounting for both intensity and reliability dimensions of traffic congestion. A data-driven approach is used to determine a local range of the weighting factor. Based on the vehicle probe data collected on four interstate freeways in Mecklenburg County,
North Carolina, a case study is conducted to illustrate this new method. Numerical results clearly indicate that although two freeway segments have nearly identical reliability values, their intensity levels can be significantly different, and vice versa. Hence, quantifying both dimensions of traffic congestion in freeway bottleneck studies is necessary. The research results can provide insightful and objective information for decision makers and transportation professionals to systematically assess traffic conditions along freeway segments and objectively locate and rank freeway bottlenecks, competently develop congestion mitigation strategies, and thus allocate limited transportation funding in a more effective and efficient manner.
https://ascelibrary.org/doi/abs/10.1061/JTEPBS.0000119

Abstract
This paper presents a decision-making framework based on a travel time reliability methodology developed under the U.S. Strategic Highway Research Program. Existing methods consider a set of predefined prevailing conditions for the analysis of freeway facilities as the base case. However, a reliability analysis accounts for multiple recurring and nonrecurring congestion sources to estimate the travel time distribution over a long time horizon. This approach considers variations in traffic demand levels, inclement weather conditions, and incidents that occur stochastically on a freeway facility. Several performance measures are defined based on the travel time distribution, which comprehensively cover the full range of operational conditions on the system. Based on the proposed decision-making framework, mobility strategies can be identified, evaluated, and improved.
https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29TE.1943-5436.0000797

Standard Deviation of Travel Time in a Freeway Network--A Mathematical Quantifying Tool for Reliability Analysis
Abstract
Travel time reliability is a new way of looking at congestion and unpredictable variation of travel time. The standard deviation of travel time is a good indicator for investigating reliability of a network. This paper presents a mathematical model dealing with the standard deviation of the total travel time within a freeway network. In general, the distribution of the travel time of links and the distribution of delays at bottlenecks can be described by different probability distributions. The parameters of those distributions can be calibrated by measurements or simulation studies. However, it is hard to calculate the standard deviation or variance of travel time of a route consisting of several consecutive links or bottlenecks. The presented paper shows that, under some assumptions, the variance of the total route travel time can be calculated as the sum of the variances of the single links or bottlenecks in case that the travel times and the delays are independent of each other. In reality the independency between the consecutive links or bottlenecks may not be satisfied. In this case the variance of the total travel time can also be estimated given the correlation coefficient between the two consecutive links or bottlenecks. Again, this correlation coefficient can be calibrated by measurements or by simulation studies. Once the variance in the travel time is known, the standard deviation is also known. Using the proposed model, the standard deviation of travel time - and, thus, the reliability of a freeway network - can be quantitatively estimated given the geometric design of the freeway network and the traffic demand.
https://ascelibrary.org/doi/abs/10.1061/9780784413623.316
Title: Scale Forecast Method for Regional Highway Network Based on BPNN-MOP.


URL: http://dx.doi.org/10.1016/j.trpro.2017.05.284

Abstract: The forecast of the scale of highway network is of great importance in the planning of regional highway network. This paper is to seek a hybrid method to improve the accuracy and reliability of scale-forecast and obtain the optimal hierarchical structure of highway network in Hangzhou in the Year 2015, 2020 and 2025. Firstly, drawbacks of traditional scale-forecast methods of highway network and advantages of the combinative forecast method which embraces BP neural network (BPNN) and Markov chain are illustrated. Then, a novel prediction method which is based on BPNN and Markov chain with the consideration of five elements, including gross domestic product (GDP), total population, the number of civil motor vehicle ownership, passenger capacity and volume of freight traffic is proposed. After that, a multi-objective programming (MOP) model is established to obtain the optimum technical grade structure of highway network. Thirdly, with the Program for the 13th Five-Year Development Plan of Highway Transportation in Hangzhou, the scale of highway and its optimal hierarchical structure in the year of 2015, 2020 and 2025 is obtained. Finally, the results show that the accuracy and reliability of the forecast method are improved, and the model proves to be of both theoretical and practical significance.

Publication Year: 2017

Title: Freeway Network Connective Reliability Analysis Based Complex Network Approach.
URL: http://dx.doi.org/10.1016/j.proeng.2016.01.271

Abstract: The freeway plays an essential role in intercity transportation, due to its safety, convenience and efficiency. To ensure the gradually networked freeway system to operate smoothly and efficiently, the connective reliability evaluation becomes extremely important. Applying the complex network approach, the improved evaluation indicators of complex network, such as structural degree, betweenness and shortest path length are defined respectively to reflect the freeway network's structural properties firstly. Secondly, a measurement considering the effective paths number is proposed to evaluate freeway network's connective reliability. Finally, based on the freeway network in Shandong Province (SFN), which is the largest scale freeway network in eastern China, those evaluation indicators are calculated, and the freeway network's connective reliability is evaluated under different scenarios. The nodes with high structural betweenness must be given more protection so as to improve the reliability of the SFN under random attack. The structural properties and reliability analysis of freeway networks are helpful for road planning and unexpected major events control.

Publication Year: 2016

Title: Highway Level of Service Evaluation Using the Reliability Model.
Source: Conference Title: 16th COTA International Conference of Transportation ProfessionalsTransportation Research BoardInstitute of Transportation Engineers (ITE)American Society of Civil Engineers. Location: Shanghai. Sponsored by: Transportation Research Board. Held: 20160606-20160609. 2016. pp 128-140 (Refs.)
URL: http://dx.doi.org/10.1061/9780784479896.013

Abstract: The highway network toll data are used for extracting the travel time distribution. Three indexes are put forward to compare the fitting results, including error sum squares (SSE), the determination coefficient (R2), and cumulative distribution of the error sum squares (SSE of CDF). The results show that it is the most appropriate to model the travel time with the extreme value distribution, compared with log-normal, normal, and Weibull distribution models. On the basis of annual average daily traffic data, the level of service (LOS) is quantified by the evaluation index of the service reliability. The evaluation method of highway LOS is established. Finally, an example of verification is carried out on the highway sections in the Shaan'xi province. Evaluation results show that reliability can reflect the quality of highway sections and the fluctuation objectively. It is more suitable than the traditional LOS on describing the actual conditions in highway networks. The proposed method is effective as the calculated result is consistent with the actual observation.
Optimization of Transportation-Infrastructure-System Protection Considering Weighted Connectivity Reliability.

This study proposes a model and a solution method to optimize protection planning for transportation-infrastructure systems such as highway networks, which are subject to disasters given a limited budget. When links of a highway network fail because of disasters, the connectivity of the highway network can be damaged and travel demand cannot be served. In this study, a situation is considered when links of a highway network can be protected against disasters to maintain its connectivity. Given that damage to a highway network caused by a disaster is probabilistic, a two-stage stochastic programming (SP) model is developed to identify the optimal protection plan that maximizes connectivity reliability for highway networks. The measure of connectivity reliability is defined as the expected number of origin-destination pair groups that can be served under all scenarios of link failure caused by a disaster. The main contribution of the model formulation is that the travel cost of alternative paths and (normal or postdisaster) travel demand can be simultaneously considered in the optimization. As the probability of failures caused by a disaster can be extremely low, the required number of scenario samplings to obtain accurate estimates for connectivity reliability could be large, which causes computational difficulty for solving the SP problem. Therefore, a solution method is developed to practically solve the SP model. The proposed methodology is demonstrated with a highway bridge system that is subject to earthquakes. Results show that the proposed model has potential for improving the connectivity reliability of highway networks that are subject to disasters.

Reliability Analysis of Highway Evacuation Network Post-Earthquake Disaster.

In countries with a high population density, evacuating large amounts of people in a short time post-disaster is a critical challenge for emergency response agencies. This paper analyzes the reliability of a highway evacuation network post earthquake disaster. The capacity of a road segment after disasters is modeled as a discrete probability function. A modified stochastic flow algorithm based on k-shortest path algorithm is proposed to calculate the possibility of transporting a given the number of people in a pre-defined time window on a potentially damaged highway network. Northeast Sichuan is used as case study site and real world data are collected to
develop multiple scenarios in order to test the proposed methodology. The results show that the reliability of an evacuation network is highly sensitive to the tightness of an evacuation time window and the damage probability of a critical road segment. The proposed methodology illustrates prominent potential of application in regional emergency planning and risk assessment.

**Title** Comparative Study on Travel Time Reliability Indexes for Highway Users and Operators.

**Source** Journal of Advanced Transportation. 2012/10. 46(4) pp 318-339 (Figs., Maps., Refs., Tabs.)

**URL** [http://dx.doi.org/10.1002/atr.1194](http://dx.doi.org/10.1002/atr.1194)

**Abstract** This article reports the findings of a comparative study on travel time reliability indices designed for highway users and operators. The authors focus on travel time reliability indexes for a highway network and propose new travel time indexes for users. They also discuss and compare several previously and newly proposed indexes. They present two models for estimating travel time variation. One is the multi-hierarchical stochastic model for estimating travel time variation under uncertainty in demand and service. The other is the temporal and spatial transition model using actual traffic detector data. Operators of highway network are interested in the degree of congestion and delay, thus the previously proposed indexes are regarded as operator-side indexes. Highway users are interested in the accuracy of their travel time and in earlier arrival at their destination. For this population, the authors propose the user-side indexes. The authors compare 11 indices, each with different characteristics. One of the results is that these indexes behave differently for the same route. The authors suggest that understanding an index's formulation and characteristics is important for selecting the appropriate index according to both the purpose of use and the characteristics of the study route. They conclude that this comparative study suggests that the combination of average travel time and an appropriate travel time reliability index is very important for both users and operators.

**Title** Measuring, Describing and Modeling Travel Time Reliability.


**URL** [http://pubsindex.trb.org/orderform.html](http://pubsindex.trb.org/orderform.html)

**Abstract** Assessing the performance of a highway network is a challenging task. Many authorities are hardly dealing with the responsibility of gathering data and estimating relevant performance indicators. With the important evolution of congestion in many
In urban areas, it has become critical to better assess the evolution of travel times. In fact, with the increase in the frequency and duration of congestion states, it is becoming less possible to focus on sole detection of decreases in travel times. Hence, the challenge is now to ensure reliable travel times. Monitoring highway network performances requires the definition of new indicators involving both travel times and their variability. In Montreal, researches are being conducted to assess the reliability of travel times on the main highway corridors. This paper presents the outputs of a methodology that was developed to estimate travel times using almost 30,000 observations from floating cars. It builds upon previous results based on the systematic division of routes in one kilometer segments. Clustering techniques are used to associate segments to particular clusters based on the similarity of travel time distributions. The process outputs sixteen clusters of segments, eight for each period (AM, PM). The travel time distributions of each cluster are modeled using three additive log normal distributions. New performance indicators are also proposed: a network malfunction indicator and a mean-variability indicator. In the future, the proposed method will enable planners to simulate the expected travel time on various routes, evaluate its reliability as well as the probability to face atypical travel conditions.

Publication Year 2010
Title Development and Application of a Travel Time Reliability Estimation Method for Freeways.
URL http://pubsindex.trb.org/orderform.html
Abstract The research reported in this paper developed a methodology and tools for estimating travel time reliability measures, and implemented these on a freeway section and the freeway network of a large metropolitan area. The paper first provides a brief overview of travel time reliability approaches, followed by an overview of the methodology. Next, example applications for implementing the tools developed on a freeway section in South Florida are presented. It was concluded that the tools developed can be applied to provide travel time estimates which can be used to make systems planning and project development decisions. It is noted that the methods and results presented here are the first effort to estimate travel time reliability on freeways and it is expected that many refinements will be added for accuracy, but also to facilitate the use of the tool for additional applications.

Publication Year 2010
Title Travel Time Reliability on a Highway Network: Estimations Using Floating Car Data.
Source Transportation Letters. International Journal of Transportation Research. 2010/1. 2(1)
Abstract

With the substantial increase in traffic in many urban areas, travel time reliability is becoming a more critical and more relevant factor than travel time. Currently, new indicators involving travel times and their variability are being used to better assess the efficiency of road networks. The authors' research here is an attempt to assess the reliability of travel times on the main highway corridors of the Montreal Area (Canada), using floating car data gathered from 1998 to 2004 by MTQ (Quebec's Ministry of Transport). This paper presents the outputs of the data analysis and modeling process that was developed to estimate travel times using such data, as well as to assess the level of variability of those times. Almost 30,000 travel time observations were gathered on fifty different routes over a 6-year period. These routes were divided into 1-kilometer road segments, which were analyzed and modeled using various techniques. The process involves finding the best statistical model to describe travel time distribution, while controlling for a number of factors (period, month, year, or weather) and identifying segments presenting high variability. Secondly, the mean time and time variability are simulated all along the routes and areas that suffer recurrent congestion. Finally, the analysis introduces two new indicators: the probability of non-recurrent incidents, and an index summarizing both the mean travel time and the variability of travel times. In the future, the authors expect to be able to simulate the expected travel time per portion of a route, its reliability, and the probability of encountering incidents of any kind.

Publication Year
2010

Title
Travel Time Reliability Models.

Source
2008/8/31. 34p (10 Figs., 4 Refs., 4 Tabs.)

Abstract
Two previous Florida Department of transportation (FDOT) research projects (FDOT Contracts BD-545-48 and BD-545-70) on travel time reliability developed models for predicting travel time reliability for freeways, using data from Philadelphia, Pennsylvania. The objectives of this research are to implement the results of these projects to estimate travel time reliability on the Florida Strategic Intermodal System (SIS), to enhance the previously developed models based on Florida data, and to develop a framework for estimating travel time on arterial streets. The first part of the report describes a methodology and respective tools for estimating travel time reliability for a freeway section as well as for a freeway network, and it applies those tools to estimate various travel time reliability measures for a freeway section in South Florida. The second part of the report summarizes the data analysis conducted using data from Jacksonville, Florida to evaluate the travel time estimation models previously developed. It was concluded that the difference between model estimates and field observations are relatively low for non-congested conditions (less than 5%), while they are relatively larger for congested conditions (as high as 23.7%). The discrepancies may be due to model limitations as well as sensor calibration issues. The third part of the report developed a framework for estimating arterial travel time and obtaining the related travel time reliability performance measures. It is recommended that a total of 16 scenarios be used to obtain travel time estimates for arterials. Future work should focus on obtaining field data to calibrate the conceptual models provided in this report. Generally, it is recommended that the methodology developed and
illustrated in this report be implemented to estimate travel time reliability for the SIS and evaluate the model predictions for existing conditions. Such an evaluation will identify any atypical conditions for which adjustments to the existing models need to be made and will identify any inconsistencies between predicted and observed travel time. Subsequently, the application can be used to test various project implementations and estimate travel time reliability in the entire SOS, or is specific SIS sections as a function of various operation and design changes.