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Reliable Travel: Clearer Roads, Cleaner Air

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RELIABLE TRAVEL: CLEARER ROADS, CLEANER AIR

A project explores the importance of travel-time reliability for evaluating the performance of a road network in terms of emissions, traffic and commuters' route choices.

The Issue

When planning a daily commute, drivers account for traffic they know can't be avoided: at peak times of day, like morning and afternoon rush hour, they allow extra time to get where they're going. The delays that are harder to accept are unexpected ones, when accidents, road work or a traffic bottleneck turn a thirty minute trip into an hour.

The unpredictable postponement leads to natural frustration for drivers, as it may cause them to be late to work or late picking up children from school. A reliable road network is one in which this is a rare occurrence. A project led by Portland State University's Miguel Figliozzi explored the value of this travel-time reliability using a study of commuters' route choices, taking a look at trade-offs between reliability, traffic congestion and air pollution.

The Research

In the first phase of the research, co-investigators David Levinson and Kathleen Harder of the University of Minnesota sought to measure the route choices drivers made in a real-world setting. Instead of having people fill out a survey about whether they would choose to take major roads or the freeway to work, this study placed GPS units in the cars of volunteers to record their actual behavior based on factors that arose each day. They wanted to determine the importance of reliability in commuters' route choices. If travelers could ensure reaching their destinations in a time-certain manner, the researchers thought, they might be willing to drive on paths with longer travel-times rather than risking the use of paths with shorter travel-times but higher variability.

Volunteers were provided with three customized routes, based on their origin and destination. They were given one choice that was mainly freeway, one that was mainly on arterial roads, and one that kept to the side roads. After a two-week period of familiarizing themselves with each route, they were given the freedom to choose which one they would take on a daily basis. Only 18 of 54 participants finished the study. The limited sample

THE ISSUE

A road network's reliability is measured by how much variation there is in travel times. Travel-time variability may increase harmful emissions and contribute to traffic congestion and delays.

THE RESEARCH

This project focuses on determining the importance of travel-time reliability to commuters on a road network, recording their route choices. The project also:

- Studied the effect of reliability on air pollution by measuring emissions and fuel usage;
- Explored trade-offs between reliability, congestion mitigation, and potentially harmful emissions;
- Developed a new methodology for recording commuters' route-choice behavior in a real-world setting.

THE IMPLICATIONS

The research offered conclusive evidence that reducing travel-time variability and increasing the reliability of a road network can reduce unnecessary delays, lower fuel usage, and cut down on harmful types of emissions.

Photo: Road work sign in southwest Portland, Ore.

size, and some unfortunate GPS equipment failure, made the results somewhat inconclusive. The added realism of the novel data collection method, however, may help to create more accurate models in the future, making it easier to predict traffic patterns. The development of the research methodology for this study stands to benefit future research in determining the importance of reliability to commuters' route choice behavior.

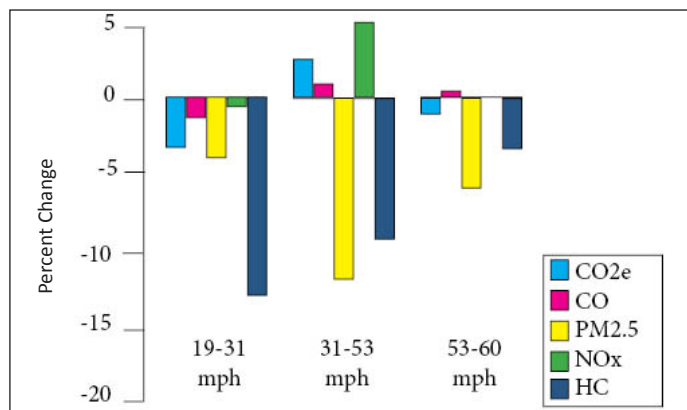
Figliozi built upon this research in the next phase of the project, with a study aimed at finding out the importance of reliability to decreasing air pollution. He, together with graduate student researcher Alex Bigazzi, also of Portland State, developed a model for understanding how road network reliability, congestion and emissions affect each other. After creating a mathematical function that let them enter values for travel rate, various types of emissions, and fuel consumption rates, Figliozi and Bigazzi applied their model to a congested freeway corridor in Portland, Ore., and to six distinct urban areas: Atlanta; Los Angeles; Raleigh-Durham, N.C.; Las Vegas; Nashville, Tenn; and Honolulu. They then calculated fuel costs and emissions based on two different scenarios: constant freeway capacity (reliable travel times), and a stochastic freeway-capacity model, where traffic flow breaks down at unpredictable moments (unreliable travel times).

Implications

Assuming a fixed value per trip in fuel costs, there is a clear relationship between reliability and optimal traffic flow. In all cases, as unreliability increases the traffic flows that are optimal from a societal point of view tend to decrease. Less intuitively, it was found that reducing congestion does not necessarily lead to a reduction in emissions because there is rebound in the travel demand. In fact, in many cases, even with low travel demand elasticity, reduced congestion can lead to an increase in emissions because the increase in the volume of vehicles

that are able to travel outweighs emissions reductions due to better vehicle operation.

Traffic congestion is increasing around the world, particularly on urban freeways. In developed nations, surface transportation networks have matured to the point where it is difficult to increase their functioning by adding new links or lanes. Adding extra capacity to a network can in some cases actually reduce overall performance. So it becomes a real challenge to find ways to cut down on congestion. The research in this project shows that increasing travel-time reliability is an important step toward decreasing congestion.



Change in emissions after freeway capacity is increased.

When congestion is lessened by increasing capacity, within certain speed brackets emissions of CO₂e, CO, and NO_x are actually increased, not decreased. The above graph shows this in a freeway setting.

PROJECT INFORMATION

TITLE: Value of Travel Time Reliability: Commuters' Route Choice Behavior and Study of Tradeoffs

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PROJECT NUMBER: 2009-248

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MORE INFORMATION <http://otrec.us/project/248>