
Rancho Bernardo Rd

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MANAGING EXPECTATIONS:

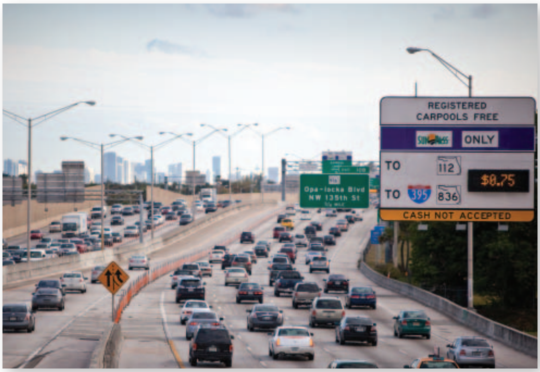
Using Dynamic Pricing Software to Improve Transportation Planning and Traffic Operations

Managed (or express) lanes provide an opportunity to develop a stronger link between transportation planning and operations. While planners seek to forecast traffic and revenue to determine design requirements and financial feasibility of transportation facilities, operations staff are starting to apply dynamic pricing to manage the traffic flow and revenue of express lanes. As the number of managed lanes projects grows and the data from these facilities becomes more robust, we will be able to more reliably predict traveler behavior in choosing express lanes over general use lanes.

AS MANAGED LANES PROGRAMS EVOLVE FROM CORRIDORS TO NETWORKS, A BETTER UNDERSTANDING OF TRAVELER BEHAVIOR WILL ENHANCE OUR ABILITY TO DETERMINE THE FEASIBILITY OF MANAGED LANES PROGRAMS AND THEIR BENEFITS.

As managed lanes programs evolve from corridors to networks, a better understanding of traveler behavior will enhance our ability to determine the financial feasibility of proposed managed lanes programs and their benefits. This will also allow us to develop decision support systems to assess the viability of proposed express lanes projects and provide real-time traffic management at a network level.

This article looks at best practices from the "95 Express" program in Miami that strengthened the linkage between planning and operations in managing our transportation systems more efficiently.



CONGESTION PRICING

Managed lanes are a set of highway lanes where operational strategies are proactively implemented and managed in response to changing conditions. They can appear in various configurations such as high occupancy vehicle (HOV) facilities (2+, 3+); reversible lanes; bus only lanes; truck only lanes; express lanes; and high occupancy toll (HOT) lanes. This article looks at HOT lanes in three different scenarios:

- **HOT Lane Conversions with Pricing.** HOT lane conversions are HOV lanes that allow vehicles not meeting normal occupancy requirements to "buy-in" to the lane by paying a toll that varies by time of day or level of congestion. HOT lanes allow drivers to use high-speed, uncongested HOV lanes either by meeting minimum occupancy requirements, or by paying a toll. Examples of HOT lane conversion projects include: I-15 in San Diego; I-10 / Katy Freeway in Houston; I-394 in Minneapolis; I-25/US 36 in Denver; SR 167 in Seattle; and I-95 in Miami.
- **Variable Pricing on New Express Lanes.** Some new expressways use variable pricing to reduce peak period congestion and generate new revenues. These facilities may give some preference to HOV travelers. The distinguishing feature of these projects is that instead of applying pricing to existing facilities, congestion pricing is introduced with new road capacity. SR 91 in Orange County, California is an example of this type of project.
- **Variable Pricing on Existing Toll Facilities.** This type of project introduces variable tolls on highway facilities that already have fixed tolls. The purpose is to reduce congestion by introducing prices that vary by day-of-the-week and time-of-day.

The variable prices are intended to encourage some travelers to use the roadway facility during less congested periods, to shift to another mode of transportation, or to select an alternate route. Toll agencies have also used the availability of off-peak toll discounts to encourage the use of electronic tolling.

The "95 Express" in Miami is the Florida DOT's congestion management program for I-95 in Southeast Florida, which combines HOT lanes with carpool and transit incentives, ramp metering, and rapid incident detection and management strategies. The program has considerably improved the overall operational performance of I-95. Customers choosing to use the express lanes (EL) have significantly increased their travel speed during the PM peak period (4pm–7pm) from an average speed of approximately 20 mph in the HOV lane to an average of 57 mph. Drivers travelling in the general purpose lanes have also experienced a significant increase in PM peak period travel speed from an average of approximately 20 mph to an average of 41 mph. This operational experience from "95 Express" and the software tools developed for this project are the basis for this article.

"EXPRESS LANES MANAGER"

As part of the "95 Express" program, a software application was developed known as "Express Lanes Manager." The dynamic pricing algorithm embedded in the software relates toll rate boundaries to a facility's level of service and adjusts the toll rate based on how quickly traffic conditions deteriorate or improve. The software also has the ability to retrieve archived data to conduct operational analyses.

THE PRICING ALGORITHM RELATES TOLL RATE BOUNDARIES TO A FACILITY'S LEVEL OF SERVICE AND ADJUSTS THE TOLL RATE BASED ON HOW QUICKLY TRAFFIC CONDITIONS DETERIORATE OR IMPROVE.

The "Express Lanes Manager" software can also be used by transportation planners to calibrate and validate travel demand forecasting models based on actual traffic and revenue data. This includes volume, speed and occupancy data received by each

A BETTER UNDERSTANDING OF WHO USES THE MANAGED LANES AND HOW MUCH THEY ARE WILLING TO PAY IS NEEDED TO IMPROVE THE ACCURACY OF MODE-CHOICE MODELS.

of the vehicle detection stations along the corridor as well as the corresponding toll rates charged during the same time frame.

RESEARCH OPPORTUNITIES

While the "Express Lanes Manager" software is primarily used as an operations tool, we believe it has great potential applications for transportation planning. This is important because managed lanes have not been included in the long-range transportation planning process until recently. To realize the potential of these models as transportation planning tools, we recommend additional research in the following area:

- **Variables.** The traditional variables that influence the use of managed lanes are price and travel speed. However, planners should also consider other issues such as trip reliability, comfort, convenience and safety of using the managed lanes versus the general purpose lanes. These variables will need to be quantified as part of the mode choice model development.
- **Trip Building**. As managed lanes "segments" expand to "corridors" to "networks," the dynamic pricing software will need to account for combining multiple segments to provide a pricing structure that will be easily understood by the motorist. This is important because they will need to make travel choices in real-time. Similarly, the travel forecasting process will need to account for the total price of the trip (i.e., origin to destination), which may include several links and nodes of the managed lanes network.
- **Competition.** The travel demand forecasting models will need to consider the impacts of competing links of the managed lanes network as well as transit modes within or outside the network. This is no easy task because the pricing within the managed lanes network

may vary based on congestion levels of the various links and nodes within the networks.

- **Arterials.** Managed lanes applications for arterials may include grade separations at congested intersections with associated pricing built-in. Research should focus on determining the relative importance of delays on arterials, freeways, and toll roads and desired pricing to alleviate the delays.
- **Travel Behavior**. A better understanding of who uses the managed lanes and how much they are willing to pay for different trip types (e.g., home-to-work trips, social-recreational trips) is needed to improve the accuracy of mode-choice models. We also need a better understanding regarding payment by transponders (not out-of-pocket) and those not directly affected (e.g., children who are using the transponders and having parents that pay the tolls). For instance, if the driver does not pay a toll by cash, and the transponder being used to pay the toll is paid by others (parents), then the driver is probably less concerned about paying a toll in using the managed lanes
- **Dynamic Message Signs.** We need to consider the effect of placing specific "pricing" and "travel times" on dynamic message signs to provide the motorists an opportunity to make real-time decisions based on

real-time data. Other methods of sharing real-time information (e.g., 511, IVR, web sites, in-vehicle technologies) should also be explored as part of travel demand forecasting techniques.

- **Default Values.** The data collected by each of the managed lanes software systems can lead to the creation of default values to calibrate models in different regions of the country and in different area types (e.g., central business district, suburbs, intercity).
- **Business Travel.** As with traditional travel demand forecasting techniques, it is important to stratify origin / destination trip tables by trip type. In forecasting managed lane usage, "business" trips need to be carefully studied because the cost to use the managed lanes may be borne by the employer rather than by the employee. Furthermore, the value of time for business travel is likely to be worth more than that for non-business travel.
- **Travel Time Reliability.** While travel time reliability is typically included as a performance measure of managed lanes projects, there is little data to correlate the importance of this variable as part of the process to forecast the use of managed lanes.

Agencies operating managed lanes systems, in partnership with universities, should conduct research in all of these areas. Furthermore, a "Managed Lanes Pool" working group should be formed to share relevant data and research throughout the nation.

APPLICATIONS

As managed lanes data becomes more robust, transportation agencies will be able to develop more effective tools to enhance transportation planning and operations. We suggest further research on the following tools:

- **Predictive Models**. In addition to improving the reliability of travel demand forecasting models, predictive models should be developed to support real-time operations. These predictive models can be used to forecast congestion and simulate the impacts of alternative mitigation plans that can be evaluated either on-line or off-line through knowledge-based expert systems. We can use video analytics to examine historic data and convert it to predictive information.

- **Visualization Tools**. The data being collected and archived by the managed lanes software may support the development of visualization tools for real-time operations. These tools can be used by traffic engineers and transportation management center (TMC) operations staff to proactively manage traffic using visual displays at their workstations and on the video walls. These tools could provide visual displays of queuing (by roadway, direction, lane(s), interchanges(s)) based on different operating scenarios for recurring congestion or for various incident types and levels of severity (e.g., lane closures).
- **Fleet Management**. Customized web sites using specific traffic profiles may be developed to help commercial users optimize traffic management for their fleet of vehicles.
- **Transportation Systems Management & Operations (TSM&O).** TSM&O strategies provide improved integration in operating freeways, toll roads, arterials and transit systems. More accurate models will enable TSM&O staff to better predict the effects of dynamic pricing strategies so that "TMC operators" may evolve into "mobility managers."

- **Network Congestion Nodes / Links**. As managed lanes corridors grow into managed lanes networks, the travel demand models need to be able to predict the impacts of dynamic pricing on interconnected managed lanes facilities (e.g., freeway to arterial, toll road to toll bridge). This will enable the managed lanes network to avoid or mitigate congestion impacts where one facility feeds a high flow rate into another facility that may not have adequate capacity at that time.
- **Driver Information Systems**. More accurate predictive models can support the evaluation of various driver information systems which post the real time toll rate. These analyses may include the type (e.g., dynamic message sign, website, IVR) as well as the location of devices to influence driver decisions.

- **Vehicle Composition**. The data collected by the software can be used to develop more accurate mode choice models that predict the distribution of vehicles within the managed lanes. The same data can be used to estimate vehicle distribution by time of day. These models would be very useful in analyzing the effectiveness of various managed lanes scenarios and eligibility to use the managed lanes.
- **Design Issues**. The enhanced travel forecasting models can be used to evaluate various managed lanes "access/egress" strategies and their impacts.
- **System/Operational Issues**. The data collected by the software can support the development of dynamic pricing algorithms that consider historic trends; develop predictive models for recurring and non-recurring congestion; and support the analysis of alternative toll collection and enforcement strategies.
- **Performance Measures**. The data collected by the software can support performance measure prediction and reporting including trip reliability for vehicle classes (e.g., buses, cars); person throughput; transit usage; and revenue generation.
- **Origin/Destination Data**. The transponders, which are used to automatically collect tolls, can also generate origi /destination data to refine the trip tables used in the traffic forecasting and micro-simulation process.

These are only a few of the applications that may be developed as more managed lanes projects come on-line and operational data is collected. Other applications may include the optimization of the managed lanes systems by different variables (e.g., revenue generation, trip reliability, travel time, and delay).

SUMMARY

Many of the managed lanes projects recently implemented as HOT lane facilities were not included in the long-range transportation plans, nor did they undergo detailed alternatives analyses as part of environmental assessments. We need more comprehensive tools to address the impacts of managed lanes design, access, and operational strategies on demand management, revenue generation, and air quality conformance.

In certain cases, managed lanes have been studied within a system network. For example, the "Managed Lanes Vision for Southeast Florida" presents a proposed network consisting of three subsystems: an expressway network, an arterial network, and a truck lanes network. High-level revenue and cost estimates developed for the proposed system indicate that the system can pay for itself while also creating a 200 mile Bus Rapid Transit system and reducing overall congestion by 35 percent.

The suggestions in this article provide a starting point for applying dynamic pricing software to improve the efficiency of our transportation systems by strengthening the linkages between planning and operations.

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