

**Value Pricing:
A Synthesis of Lessons Learned**

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ABSTRACT

As regional traffic congestion rises, traffic demand management strategies, such as value pricing, are being evaluated as a way to manage the transportation system more efficiently and effectively. This paper aims to evaluate the operating value pricing projects and feasibility studies to extract the lessons learned that can be applied to future studies and projects, specifically the ongoing efforts in Minnesota.

The four operating projects reviewed include the San Diego I-15 Express Lanes, the SR 91 Express Lanes, the LeeWay in Lee County, Florida, and the Katy Freeway in Houston, Texas. The feasibility studies examined are the Boulder Congestion Relief Study, the Portland Traffic Relief Options Study, and the Minnesota value pricing efforts. The eight criteria used to evaluate these projects and studies include: alternatives assessed, effectiveness of outreach efforts and public perception, effectiveness of enforcement, net revenues, equity, impacts on travel behavior and air quality, travel time savings, and impact on local business.

The lessons learned from this study highlight the benefits and barriers of these value pricing efforts. Operating projects have been effective at maximizing the capacity of a facility, inducing travel mode changes, increasing vehicle occupancy, and shifting the times of travel. Projects have been self-sustaining and generated revenues allocated to transit have mitigated some equity issues. However, equity remains a major in the public eye. Enforcement, gaining public and political support, and modeling constraints have been the largest barriers, but operating projects have effectively countered concerns with outreach and education efforts.

INTRODUCTION

As regional congestion problems continue to grow throughout the country, travel demand management policies have become increasingly more important in managing limited transportation resources. Value pricing adopts a concept often used in other parts of the economy, where price fluctuates based on the demand for a good. Goods and services, such as airlines, phone services, and gas and electric services, charge higher prices during high demand periods as a way to manage limited supply. In the transportation sector, value pricing adopts this theory, charging drivers a relatively higher fee to use limited road capacity during peak congested periods. When applied appropriately, value pricing can be a way to optimize scarce transportation resources while producing benefits for consumers, such as additional transportation choices, more reliable trips, and overall travel time savings.

The Federal Highway Administration began national efforts to evaluate the benefits of value pricing under the ISTEA legislation in 1991. In May 1998, continued funding was approved through Congress, and the Value Pricing Pilot Program was established, authorizing up to 15 projects. Under this program, several operating projects and studies have been funded, while even more project proposals are being submitted and reviewed. Throughout its tenure, the federal program has offered support to assist local governments in studying and implementing value pricing, while the local projects and studies have provided supporting evidence to the benefits of such policies, including the ability to reduce congestion, enhance mobility, decrease highway-related pollution, and increase the overall economic efficiency of highway transportation.

Implementing value pricing projects can be a complex process. Projects can encounter public acceptance barriers and political obstacles, as well as technical and legal enforcement issues. This paper aims to evaluate the benefits and barriers that operating projects and feasibility studies have encountered and extract the lessons learned that could be applied to future studies and projects, specifically the ongoing efforts in Minnesota. The four operating projects reviewed include the San Diego I-15 Express Lanes, the SR 91 Express Lane facility in southern California, the LeeWay in Lee County, Florida, and the Katy Freeway in Houston, Texas. The feasibility studies examined are the Boulder Congestion Relief Study, the Portland Traffic Relief Options Study, and the Minnesota value pricing efforts. The Value Pricing Pilot Program includes other operating projects and feasibility studies approved in 2000, but they have not been included in this assessment as project evaluations are not yet available.

Although each project and study is unique in structure, goals, political environment and need, parallels exist among the operating projects and studies, which can provide insight for future value pricing efforts. The eight primary criteria used to compare projects and extract lessons include:

- *Alternatives Assessed*
- *Effectiveness of Outreach Efforts and Public Perception*
- *Effectiveness of Enforcement*
- *Net Revenues*
- *Equity Implications*
- *Impacts on Travel Behavior and Air Quality Standards*
- *Travel Time Savings*
- *Impacts on Local Business*

METHODOLOGY

The data collection process involved gathering information and existing reports from each of the project managers and the associated research team. Reports from the operating projects included the initial project proposal, pricing feasibility studies, pre-project data collection reports, and project evaluation studies. The studies reported a combination of qualitative data, such as information from focus groups, traveler and telephone surveys, and quantitative data collected from vehicle and occupancy counts, speed demonstrations, and modeling work. The feasibility studies included similar qualitative and quantitative data, but to varying degrees based on the scope and progress of the study to date.

Interviews with project managers and associated research teams complemented the published studies. The interviews often provided more detailed evidence and refined project details. Where necessary, follow-up interviews or correspondence clarified conflicting points. Each of these projects is extremely complex. The information and data provided may not effectively reflect this complexity, but attempts have been made to highlight specific issues. This report aims to compare key points across projects, focusing on the successes and challenges faced when exploring value pricing.

THE OPERATING PROJECTS

The LeeWay in Lee County, Florida (1, 2, 3)

In August 1998, Lee County Florida began a value pricing pilot project on the Cape Coral and Midpoint bridges, two of the four bridges that connect Cape Coral and Fort Meyers. Both bridges carry a large number of commuters during peak periods, although neither suffers from severe congestion. This demonstration was intended to be a proactive measure to examine the affects of pricing on existing congestion, as well as install the technical infrastructure needed for future congestion management projects. Lee County had two primary goals in implementing the Variable Pricing Project: to extensively analyze the impacts of variable pricing in Lee County and to reduce congestion and prevent future congestion during peak periods.

In November 1997, electronic toll collection (ETC) equipment was installed on the bridges, allowing for a variable pricing tolling structure and extensive data collection. By varying the toll structure, the project uses pricing mechanisms to induce patrons who usually travel during peak periods to change their time of travel. The variable toll structure offers a 50% discount during the shoulder periods just before and after the peak traffic period (6:30 to 7:00 a.m., 9:00 to 11:00 a.m., 2:00 to 4:00 p.m., and 6:30 to 7:00 p.m.). This toll discount encourages patrons to change their time of travel without making the peak periods trips more expensive.

Only ETC customers are eligible for variable discounts, requiring patrons to obtain a transponder and an account. Transponders either automatically debit a credit card or draw on prepaid toll accounts as patrons use the facilities. As of March 2000, 66,500 transponders had been issued, with 51.6 percent of them eligible for variable pricing discounts. On average, eligible participants make 25 percent of daily bridge payments. The success of this demonstration has led Lee County to explore other value pricing applications to improve overall traffic management.

Katy Freeway in Houston, Texas (4, 5, 6)

In January 1998, the Texas Department of Transportation (TxDOT), Houston Metro and FHWA funded a feasibility study of a high-occupancy toll (HOT) lane on the Katy Freeway, which resulted in a value pricing demonstration called QuickRide. The Katy HOV lane first opened in 1984 as a 13-mile, reversible lane on the west side of downtown Houston, flowing inbound in the morning and reversing in the afternoon. Initially, only transit and vanpools were permitted, but service was slowly expanded to include HOV-2+ vehicles. High demand from HOV-2+ resulted in degraded service on the lanes during the peak traffic periods. In order to maintain the quality and service of the lanes, the HOV status was upgraded to include only vehicles with three or more passengers during peak periods (6:45-8:00 a.m. and 5:00-6:00 p.m.). During the remainder of the day HOV-2+ vehicles could access the lanes. This strategy effectively countered the excess demand during peak periods, but left the lanes underutilized.

By allowing HOV-2 vehicles to buy-in to the HOV-3+ lane, QuickRide provided a way to utilize the excess capacity during peak periods without degrading the quality of the lanes. The program had several goals: to increase the overall person throughput on the Katy Freeway corridor during peak periods; to increase travel speeds on mixed flow lanes during peak periods by diverting traffic to the HOV lane; and to efficiently manage demand without adverse operating impacts on both the HOV lane and the general-purpose lanes. With a hangtag and a transponder, HOV-2's could enter the lanes during peak periods for a \$2.00 charge. The automated vehicle identification (AVI) technology and transponders had been established in previous demonstrations, so participants only needed to set up a \$40 debit account to

become eligible users. Initially, a total of 180 users signed up, with a 25% increase in participation after the first couple of months. By June 1998, a total of 468 users were enrolled in the program. The success of the QuickRide program has resulted in additional HOT lane projects on other regional facilities.

Interstate 15 Express Lanes in San Diego, California (7, 8, 9)

The I-15 Express Lanes are two reversible lanes, located in the freeway median, that flow southbound in the morning and reverse in the afternoon. Initially opened as an HOV facility in January 1988, the lanes span eight-miles along the Interstate 15 in San Diego, California. As strictly an HOV facility, the lanes did not fill to capacity. Transit also underserved the corridor in the early 1990's. In effort to overcome these constraints, the San Diego Association of Governments (SANDAG) Board passed a resolution and applied for a grant under the Value Pricing Pilot Program, which allowed pricing to be tested in a demonstration project along the corridor. The main purpose of the grant was to "design alternative congestion-pricing mechanisms to authorize and control the use of excess capacity on the I-15 HOV Expressway by single-occupant vehicle", an act that would allow the conversion of the HOV lane into a HOT lane, or HOV and toll lanes.

The Interstate 15 Value Pricing project began as a three-year demonstration project, implemented in two phases. The Phase 1 ExpressPass program, which allowed single occupancy drivers to buy-in to the HOV lane with a monthly pass, operated from December 2, 1996 to March 30, 1998. Initially, 500 color-coded monthly passes were available for \$50 per month, and was later increased to 1,000 at \$70 per month. By June 1997, an AVI transponder system was in place. In March 1998, Phase 2 began, instituting the FasTrak program.

The popularity of the project was immediately clear. Within the first week of operations, over 3,200 of the 5,000 available transponders were dispersed. By December 1998, 6,502 transponders were issued, with 4,850 corresponding FasTrak accounts. The facility instituted a dynamic tolling structure, which changed based on the congestion level, with tolls ranging from \$.50 to \$4, and possibly up to \$8 in very unusual circumstances. In August 1998, tolls during the peak shoulders decreased, in an effective effort to encourage drivers to travel in non-peak periods. The demonstration period ended in December 1999, but the project has continued to operate since it has been deemed to be self-sustaining and successful at achieving the prescribed goals.

SR 91 Express Lanes in Orange County, California (10, 11, 12)

The State Route 91 Express Lanes is a unique project in many respects. The four-lane toll facility, opened in December 1995, operates under a public-private partnership between Caltrans, the California Department of Transportation and a private company, California Private Transportation Company (CPTC), allowed under AB 680 legislation. The corridor, the main link between Orange and Riverside counties, represented the most congested section of the freeway at the time of the project's conception. Caltrans initially planned to develop HOV lanes along this corridor, but funding was not available. These constraints made SR 91 a prime candidate for a public-private partnership project. CPTC submitted the proposal to develop the Express Lanes in the median of SR 91, adjacent to the general-purpose lanes and separated only by a painted buffer and pylons. Two continuous lanes flowing in each direction were added, with no exits or entrances along the ten-mile corridor.

CPTC operates the lanes as an independent entity, managing the daily operations, as well as having been responsible for the design and construction of the Express Lanes. CPTC also has the power to set the tolls in order to keep the lanes congestion free and earn a reasonable return on its investment. Since the opening there have been a total of three toll increases. Toll is collected via Automated Vehicle Identification (AVI) transponders and are variable, based on the time of day of travel and the vehicle occupancy. All automobiles and motorcycles equipped with a transponder and a pre-paid account are eligible to use the lanes. Although the AVI transponder does not require a deposit, a minimum balance of \$40 is necessary to establish an account. Interoperability agreements are established between all California toll facilities offering electronic/AVI toll payment options under the single brand, "FasTrak".

Despite political tension surrounding the facility, CPTC has built a strong customer base and is looking to possibly expand eastward.

THE FEASIBILITY STUDIES

Traffic Relief Options Study in Portland, Oregon (13, 14, 15)

Beginning in 1996, Portland Metro, in conjunction with the Oregon Department of Transportation (ODOT), embarked on the three-year Traffic Relief Options Study. The goal of the study was to determine the feasibility of value pricing as a congestion relief option for the Portland metropolitan area. Portland Metro wanted to determine whether value pricing was appropriate for the region, if a pilot project should be done and the goals of such a project. They also aimed to increase the public and political understanding of value pricing. The study focused on the costs and benefits of peak period pricing. For the purposes of this study, peak period pricing was defined as a way to better manage traffic congestion by charging drivers a variable fee, which is higher during peak periods, encouraging some drivers to choose alternative routes, use other modes of transportation or travel at other times.

The evaluation of value pricing included the specification of the type of pricing, the location, the type of facility to be priced, a pricing schedule, and details of the application in the specified location. Several types of pricing were considered, including spot pricing applications of a single location, partial facility pricing, pricing of a whole facility, corridor pricing, and area pricing, such as a regional destination center. Technical studies and public outreach were the primary evaluation tools used to narrow the numerous value pricing options. In the end, the appointed Task Force recommended that value pricing be considered on new or significantly upgraded facilities. This was incorporated into the Regional Transportation Plan. However, they voted against advancing the study to the next level at this point in time.

Congestion Relief Program in Boulder, Colorado (16)

The Boulder Congestion Relief Program began with the principal goal of helping facilitate the City's overall transportation goal of a 15% reduction in SOV traffic by 2020. In accordance with the 1989 Transportation Master Plan (TMP-89), the City of Boulder endorsed efforts to minimize the impacts of automobile use in order to promote a high quality of life. The City preferred developing incentives to encourage a shift in mode, but as a contingent, the plan allowed disincentives to be developed to achieve the final goal. Despite an extensive program that yielded a shift in SOV traffic to alternative modes, an increasing concern about congestion and an effort to remain on track with TMP-89 goals led the City to explore the use of congestion pricing.

The Director of Public Works first conceived the concept of congestion pricing in Boulder in the early 1990's. As a joint effort between the Colorado Department of Transportation (CDOT) and the Divisional Office of FHWA, a grant was submitted, leading to the conception of the Congestion Relief Program. Support from within the Boulder City Council at the time of the proposal led to an overmatch of the required local funds to support a pilot project. According to the proposal, the objectives of the project were to develop alternative future scenarios for Boulder with and without the implementation of congestion pricing, to initiate a transferable public process methodology for building community acceptance of market-based demand management techniques, and to design a strategy for congestion pricing techniques that best served the needs of the community. Following the project initiation in May 1995, a series of studies and reports explored the costs and benefits of pricing in Boulder, culminating in the final report issued in December 1998.

Minnesota Demonstration (17, 18, 19)

Pricing initiatives have a long history in Minnesota. In 1994, legislation was passed directing the Minnesota Department of Transportation (Mn/DOT) and the Metropolitan Council, the regional planning organization, to jointly explore congestion pricing. This initiated the *Minnesota Road Pricing Study* in 1995. The study examined the feasibility of a congestion pricing pilot project and was conducted in three

phases. Phase 1 consisted of a study initiation, phase 2 defined and refined pricing options, performance measures, impact assessment and collateral actions, and phase 3 was the implementation plan and final report. This study intended to fully explore pricing with the intent of proposing a project and implementation plan.

At the same time, a TRANSMART program was being initiated in accordance with a legislative act passed in May 1993. TRANSMART is a public-private initiatives program designed to explore proposals for toll facilities. This program complemented congestion pricing efforts, as a proposed toll road would have the potential of becoming a congestion pricing demonstration. In 1995, after reviewing five public-private partnership proposals, Mn/DOT recommended the Trunk Highway 212 for development as a public-private toll facility. However, in accordance with the process, any of the affected communities could reject the tolling proposition, and one community exercised this veto power, ending this project proposal.

Despite this defeat, the early success of the SR 91 HOT lane in California encouraged Mn/DOT and the Metropolitan Council to examine the concept of a toll lane system in the Twin Cities. The *Toll Lane System: Preliminary Feasibility Study* examined the feasibility of adding high occupancy toll lanes (HOT lanes) to the system. In June 1997 under authorizing legislation, the Metro Division of Mn/DOT initiated the I-394 Congestion Pricing Demonstration Study. The study intended to test whether single-occupancy vehicles would be willing to pay to travel in the HOV lanes and if so, how much. The proposed demonstration consisted of three phases, beginning with a monthly pass system, followed by a ramp-meter bypass stage, and finally moving towards an automated transponder and billing system. However, the proposed demonstration and the concept of pricing did not gain much public support. Four days before the Metropolitan Council was scheduled to approve the demonstration project, the Commissioner of Transportation withdrew it with the intention of improving public education and support for pricing.

LESSONS LEARNED

Based on the experiences of each of these projects and studies, several key benefits and barriers have emerged as lessons to future studies. These lessons have been extracted by using a number of evaluation criteria. Although each project is unique, lessons can be drawn from their similarities as well as their differences.

Alternatives Assessed

An assessment of the alternatives allows projects to test a variety of market-based pricing options in order to determine the feasibility of a project before implementation. By establishing broader transportation goals for the specified project site, the impacts of value pricing were assessed based on the ability to best meet their established goals. In the case of the four operating projects, value pricing emerged as the alternative solution to a specific problem in a corridor, lane, or bridge.

As each of the operating projects had a clearly defined problem, the need to model the impacts of pricing on different regional facilities was minimal. The overarching goal for both the Katy HOV lane project and the I-15 Value Pricing demonstration were to maximize the capacity on the lanes (6,7). The HOT lane concept, allowing a lower occupancy vehicle to buy-in to the lanes, was deemed the most appropriate tool to achieve this purpose. In contrast, the SR 91 corridor experienced high demand with limited capacity. The topography, traffic patterns, and political constraints narrowed the alternatives available on the corridor (12).

Modeling, however, was a critical component to understanding the impacts of potential value pricing projects for the feasibility studies. Studies done in Portland, Boulder and the Twin Cities included extensive modeling work to assess the alternatives. Each study evaluated several pricing scenarios based on a list of criteria. The Boulder study evaluated five road pricing scenarios using a microsimulation model. The analysis found the optimal toll was a demand-based toll, priced at the cost of time delay imposed by a vehicle on the system. Optimal tolls were found to have the most significant impact on reducing auto VMT and drive-alone trips while increasing transit ridership and ride sharing. These

benefits decreased proportionately as tolls were adjusted downward. Accordingly, value pricing was deemed a beneficial tool to manage congestion given viable travel alternatives were in place (16).

The Portland study undertook two levels of evaluation. The first phase used six broad categories of qualitative and quantitative screening criteria to narrow 40 options down to eight based on their net benefits, while the second phase involved a more sophisticated model to conduct a more detailed evaluation (20). Based on the technical analysis, public and political feedback, the Task Force recommended pricing under certain conditions, such as new lane capacity, a new facility, or a major facility reconstruction (21).

A similar alternatives analysis was conducted in the Twin Cities, evaluating the potential impacts of pricing using preliminary criteria, followed by a more detailed modeling analysis, and finally determining an implementation plan to recommend. This analysis yielded similar results to other studies: pricing could influence travel behavior, manage and reduce congestion, raise revenues for transit and other alternatives, and reduce the overall vehicle miles traveled and vehicle emissions (17). Another preliminary study testing the potential of a toll lane system found that HOT lanes provide a way to preserve existing HOV lanes and can reduce congestion in the general-purpose lanes. HOT lanes were also found to be economically feasible, with the potential of guaranteeing toll revenue at levels above the cost of implementation and operation (18).

Effectiveness of Outreach Efforts and Public Perception

One of the primary barriers to value pricing projects can be gaining public acceptance and political support. Public outreach and education have proven effective in gaining support for value pricing projects and creating an understanding of the concept. To effectively gain public support, it is important that the public perceive the need for value pricing. This requires clear communication of the problem, the role value pricing plays in solving the problem, and the benefits of such policies.

Value pricing can prove difficult if the public does not believe the problem warrants the action. In Portland, the public voiced concern about the growing congestion problem, but did not view the problem as critical enough to use value pricing (13). Likewise, in Boulder, public concern over congestion did emerge, but the problem was isolated to a few specific intersections or roadways, and was not perceived as a regional problem. The public perceived value pricing as too extreme a solution for the problem (22). Through marketing research efforts, Minnesota found that value pricing should not be presented as the sole solution to congestion and that HOT lanes were seen as a temporary “band-aid” to the congestion problem. The public felt the need to explore other alternatives to pricing before recommending such a “drastic” solution (19).

Defining the problem was not a concern for most of the operating projects. In Lee County, people never challenged the idea that congestion would occur, even though congestion was not an issue at the time. They felt variable pricing served as a new congestion management tool, a proactive measure against future congestion (23). Value pricing on the Katy Freeway and on the I-15 were, in part, responses to public pressure to find a solution to the congestion problem and underutilized HOV lanes. Value pricing was marketed as an alternative to manage congestion and to utilize the excess capacity. Congestion was a real problem on SR 91, but the Express Lanes were a contentious solution, although more concern was generated over the private ownership issue than variable pricing (12).

In building support for the concept, it is important to engage key stakeholders. Bringing major stakeholders together as an advisory group may help create buy-in from opponents to the project. Advisory committees developed the concepts for some of the projects, including project planning, design, and implementation. The I-15 ExpressPass program engaged community groups, commuters and the media in an educational forum (24). The Lee County Commission appointed three citizen advisory committees to serve in this capacity, consisting of local bridge users and businesses (23). Portland Metro immediately formed a task force committee to oversee the entire process, bringing thirteen community leaders together to act as spokespersons and decision makers for the project. A Technical Advisory Committee and a Project Management Group acted in an advisory capacity for the Task Force (15). In

contrast, Boulder failed to form a key stakeholder group, making it difficult to achieve project buy-in on a grassroots level (16).

Regional stakeholders should also be incorporated into the process, especially when considering any type of regional pricing plan. In Portland, local municipalities were encouraged to participate in the process (13). A lack of regional support further strained the Boulder demonstration, as regional players and municipalities were not incorporated into the process (16). A Project Management Team (PMT) for the I-15 project convened monthly, bringing major governmental stakeholders from federal, state, regional and local agencies together as advisors. These stakeholders viewed it as a successful process, creating inter-agency support for the project (7).

Focus groups can provide insightful input on the formation of a project. They were often used to gauge the public's perception of value pricing as a solution and to inform the overall marketing plan. Although many of the focus groups expressed concerns over equity issues, several distinct public concerns were also voiced.

- Focus groups on the Katy Freeway feared value pricing would lead to additional tolling (4).
- CPTC holds ongoing focus groups. Initially they targeted potential customers to provide feedback on the project but now it allows them to improve their service (12).
- The I-15 ExpressPass program showed that commuters supported the project but HOV drivers and transit users were opposed (25).
- Focus groups held in Portland were firmly opposed to value pricing, although outreach built some support. The public viewed value pricing as only one option in solving the congestion problem, although many were unaware of other options or the inappropriateness of these options for the area (13).
- Residents living in the City of Boulder, often faced with the congestion problem, were supportive of the idea of pricing, while residents living outside the city in Boulder County were opposed (16).
- In Minnesota concerns about equity, the cost of administration, the reliability of technology, and the allocation of revenue from pricing efforts were found (17). A later study emphasized the need to present additional information on HOT lanes, enhance transit with revenues, allow tolled vehicles to bypass ramp meters, and encouraged free access for all HOV-2+ vehicles (18).

Feedback from focus groups, surveys, and advisory committees was instrumental in developing marketing messages. Although each project used similar marketing strategies, individual marketing campaigns were tailored to address local circumstances. The most common marketing tools included direct mailings of project brochures, local media, such as radio and television ads, or billboards, local newspaper ads, attending local speaking and community events, and developing project web sites. Lee County sponsored such events as a "Name-the Transponder" contest where the winner received a year of free tolls, and developed the "Transponder Man", who attended public events (23). The SR 91 Express Lanes conducted a very comprehensive marketing campaign, aimed at building a customer base. In addition to the basic marketing tools, CPTC began loyalty programs, providing discounts at gas stations and recreation centers for customers. However, the most effective marketing tools turned out to be word-of-mouth and road signage (12).

Marketing efforts on the Katy Freeway and I-15 were more contained because of the limited capacity available for sale. In retrospect, a more visible campaign on the Katy Freeway would have been more successful (26). The I-15 Express Lanes expanded marketing efforts in Phase II of the project to include sign-up incentives and educational tapes for prospective and existing customers about the new program (8). Portland Metro leveraged targeted focus groups to create small pockets of support throughout the region (13). Boulder constructed a Congestion Relief kiosk for use at public events as well as engaging local students in discussions on congestion. They planned to sponsor a Household Budget Exercise, intended to personalize the costs of travel, but canceled it due to negative media coverage (22).

The ability for outreach efforts to leverage public support varied by project. Most of the operating projects have experienced overall support. Lee County found that 87 percent of those surveyed had some knowledge of the variable pricing program. People generally liked the program and saw it as a preemptive way to address an impending congestion problem (3). Likewise, the Katy Freeway experienced overwhelming support, with a survey showing a high support among users and non-users. The general public never raised potentially controversial issues, such as double taxation or equity (27). ExpressPass users on I-15 were supportive, but marketing efforts were not as successful with non-users (28). Low awareness and support existed for allocating revenues to transit (7). In Phase II, marketing efforts were deemed effective at raising awareness, but current users felt program changes should be better communicated (8). CPTC was effective at communicating with customers. The initial approval ratings for variable pricing were not high, but support grew as users participated in the program, although non-user support remained low (10). Overall, public support has declined somewhat from 1997 to 1999, perhaps based on political issues (29).

Public support and acceptance was not as high among the feasibility studies. Two attempts to implement value pricing ended in Minnesota because of a lack of public support. The outreach efforts failed to counter the concerns raised during market research and convey the overall concept of pricing to the public. With the exception of the privacy issue, concerns raised in Boulder were not addressed nor incorporated into the project (22). Outreach efforts in Portland had mixed results, with the general public being only passively aware of the concept. Targeted focus groups were more supportive, viewing value pricing as a potential management tool for new or upgraded facilities, but not existing facilities (13).

Politically, the operating projects were more successful at gaining support than the feasibility studies. Having a political champion to promote value pricing, specifically an elected official, can prove invaluable to a project. An effective political champion counters criticism and is vocally supportive of efforts to move the project forward. The former Mayor of the City of Poway, who later became an Assemblyman, acted as the political champion for the I-15 project (9). The Mayor of Houston was considered a passive political champion for the Katy Freeway (26). A County Commissioner in Lee County spearheaded the LeeWay project, and Orange County officials played significant supportive roles in pushing forward the SR 91 Express Lanes (23,11). However, political resistance from Riverside County has raised the awareness of the project with negative publicity, causing public support to falter.

In contrast, the Boulder and Twin Cities studies lacked a main political champion, making it difficult to move forward and implement a final project. The lack of consistent internal political support in the City of Boulder was a weakness in the project. Although a city employee was the champion of the idea, support faltered later in the process, and the project failed to move forward thereafter (16). Pricing remains unpopular on a regional and local level in the Twin Cities. Pricing efforts have been perceived as a governmental solution, but no political champion exists to move the efforts forward. Despite legislative mandates, the political strategy made any kind of tolling effort vulnerable and placed pressure on local governments to support initiatives that were not locally popular. The Portland study lacked a true political champion, but the Task Force consisted of several visible elected politicians, who may emerge as future political champions (13).

Media coverage of value pricing can also become a key component in gaining public acceptance. However, positive media coverage helps outreach efforts and increases public support less than negative media coverage harms them (30). Negative media coverage is often difficult to counter. This stresses the need to develop a relationship and educate the media on value pricing, in order to ensure accurate reporting on value pricing efforts. In Lee County, one person acted as the main contact, ensuring a single, consistent message was communicated to the public (23). On SR 91, public support has fallen due to continued coverage of the political battles between the CPTC and Riverside County (29). Negative media surrounding Boulder's technology demonstration, despite neutral coverage earlier in the project, was the most effective outreach tool, spurring constant debate, but condemning the project (16).

Effectiveness of Enforcement

Enforcement is a strategic component in the design of a value pricing project. An enforcement plan establishes the effectiveness of traffic demand management in the system. The toll structure and overall control over revenues are determined by the ability to effectively enforce priced facilities, especially on dynamically priced facilities. The enforcement system also underscores the safety and reliability of the facility. Violation rates are one measurement of the effectiveness of an enforcement system.

Several legal issues must be considered in establishing an enforcement plan on a priced facility. Enforcement agents must be legally empowered to enforce the law. On the Katy Freeway, Houston Metro had the capacity to charge tolls on the facility, but to implement the project, they were required to establish a toll structure, administrative regulations, rules of participation, participant responsibilities, and a civil enforcement program, which included criminalizing the non-payment of tolls (4). Conversely, SR 91 was required to have legislation passed that decriminalized toll evasion and established toll violation penalties for California toll facilities (12). There is a concern on SR 91 that someone could fight a ticket, as vehicle codes, used to identify violations, can be ambiguous and difficult to enforce. However, to date, there have not been any problems (31). On the I-15, ticketing occupancy violators was legal, but new legislation was required to allow single occupancy vehicles to travel the lane legally with a transponder (7). Although the legal constraints vary by locality, understanding the barriers is essential in designing a feasible project. Projects requiring major changes in legislation can raise public awareness and political barriers.

Technologically, all of the projects have installed AVI technology and transponders. Lee County has not encountered problems with enforcement, as vehicles are required to pass through gates to enter the facility (23). However, SR 91, I-15, and the Katy Freeway all use visual enforcement as the primary means of patrolling the lanes. On the Katy Freeway, Houston Metro officers visually check the windshield of QuickRide participants during peak periods for a transponder and a color-coded hangtag, as well as monitoring for single occupancy vehicles (SOV) violators (27). Likewise, SR 91 and I-15 both contracted with the California Highway Patrol (CHP) to check for transponders as well as checking for occupancy (7,11). SR 91 has supplemented visual enforcement by officers with a video-base monitor that hangs over the lanes, photographing vehicle license plates as they enter. CPTC matches the license plates against a customer database to distinguish customers from violators (12).

Although difficult, enforcement has proven effective for each of these projects. Violation rates are low, estimated between 2-5% on the Katy HOV lane (26). The violation rate on the I-15 decreased significantly after the start of the program, falling from 15 percent in October 1996 to 2 percent in February 2000 (32). The ticket for a violation varies among the projects, \$87 on the Katy Freeway, \$271 on the I-15 Express Lanes, and \$300 on the SR 91 Express Lanes (27,9). Violations on SR 91 are treated like any other offense by CHP, with funds from fines being directed to local jurisdictions. Violations detected via photo enforcement are treated as a marketing opportunity. CPTC assumes a first offense was a mistake and sends a letter, describing the violation, requesting the toll money but no fine, and including information on how to become a customer (31).

Based on the violation rates, the fines in conjunction with the visibility of the patrolling officers have been effective deterrents. However, visual enforcement is considered primitive and has proven difficult in certain respects. It is very difficult for officers to check the occupancy of a vehicle and look for a transponder on a vehicle that is traveling at high speeds. In addition, shoulder space is limited on each facility, requiring officers to monitor vehicles where space is available and making it difficult and dangerous to pull violators over. Some QuickRide participants have taken advantage of this situation by placing the transponder in a non-readable pouch as they pass the AVI reader and then replacing it in the windshield before they pass the patrolling officer (27).

As a result, projects have considered more effective enforcement alternatives. Houston Metro has explored installing electronic monitoring equipment at the exit of the Katy Freeway and having officers monitor at the same location. Houston Metro and SANDAG have also considered changing the

enforcement technology to a more advanced system. However, SANDAG found video cameras and automated enforcement to be ineffective in monitoring vehicle occupancy at this time (9).

Finally, incidences of speeding and safety have been considered a potential enforcement problem. Specifically, policymakers feared changes in speed would occur around discount periods. Despite the perception that drivers travel at higher speeds on toll lanes, researchers have no data showing significant changes in speed on priced facilities. Safety has become an issue on SR 91. It is perceived that Caltrans has compromised the safety of the main lanes by the agreement with CPTC, which prevents Caltrans from improving the SR 91 main lanes. The latest efforts are to condemn the Express Lanes, which would nullify the agreement, opening the Express Lanes to the public. This has generated much legal activity as well as negative press. However, studies monitoring accident rates and the overall safety on priced lanes, including SR 91, have not found any conclusive evidence showing differences from the general-purpose lanes (29).

Net Revenues

Revenue generation provides financial incentives to implementing value pricing. To the extent that value pricing can cover the capital and operating costs, it becomes a viable alternative financing option. Potential revenues can be invested in additional transit options and expansion of the system, or used to mitigate some of the equity concerns. In the Portland study, the Task Force recommended that any revenues earned via pricing efforts be allocated to road improvements and alternative mode uses along any demonstration project corridor (21). Likewise, alternative transportation would have benefited from any revenues generated from a value pricing project in Boulder (16).

HOT lanes can be designed to be self-sustaining, depending on the tolling structure. On the SR 91 and the I-15 Express Lanes, dynamic tolling maximizes revenue while effectively managing traffic at the maximum capacity. On the I-15, there is more revenue potential by pricing on a per trip basis (32). The I-15 Express Lanes project, initiated in part as a means to fund transit, is self-sustaining, with revenues between \$1-1.2M and total costs around \$500,000, including electronic tolling equipment, administration and maintenance, and enforcement costs (9). Thus, the project produces a small amount of revenue, which has been used to operate the *Inland Breeze*, a new bus service established on the lanes. Houston Metro wanted to ensure that any solution implemented on the Katy Freeway was sustainable, although it was not necessary to generate large amounts of revenue. The initial start-up costs were not very high, as the technology investments were already in place. For the year 2000, the QuickRide program is projected to break even. Any additional revenues are required to be allocated to transit-related activities, although no specific use has been agreed upon between TxDOT and Houston Metro (27).

Operated by a private company, the SR 91 Express Lanes are run with the intent of making a profit. According to the franchise agreement, CPTC has the authority to collect tolls over a 35 year period, after which ownership reverts to Caltrans (10). The variable toll rates are used as a management tool. Accordingly, toll rates increased annually during the first years of operation, but vehicle trips also continued to grow, indicating the cost did not exceed the benefits of traveling on the lanes (11). In August 1998, CPTC achieved a cash flow break-even point, where the company could cover operating, capital and debt expenses from the earned revenue (33). Although the early opening of the Eastern Toll Road threatened the profitability of the SR 91 Express Lanes, a 20 percent decrease in traffic only amounted to 3 percent decrease in revenues (12).

In Lee County, shoulder period tolls were lowered while peak period tolls remained constant, resulting in a loss of toll revenue on the facilities. However, the overall revenue loss was negligible at 1 percent despite an almost 50 percent decrease in toll charges during selected periods (23). Federal funds from the value pricing grant were allocated to offset lost income. The loss was not a concern in light of the benefits accrued from the project. However, after federal funds are exhausted, the project must find another way to supplement these funds (1).

Equity

Equity is a common question associated with value pricing. It is difficult to determine how disproportionate the impacts from a value pricing project will be. However, it is important to assess potential equity issues, so the design of the project can mitigate them to the extent possible. Portland Metro worked with the Urban League to evaluate the equity impacts within their modeling process. The results showed that although net benefits accrued to all vehicle classes, low income groups disproportionately realized costs from certain pricing options (34). The City of Boulder also conducted an extensive equity analysis, yielding two main conclusions. First, work-based trips provide a net benefit for all under the pricing scenarios, with overall increases in transit use and decreases in auto use. Secondly, pricing non-work trips disproportionately impacts minorities and low-income populations, as individuals must either combine or chain trips, or not take the intended trip at all, which adversely affects their mobility (16).

In the operating projects, equity concerns were tempered. The tolling structure in Lee County mitigated some of the potential equity problems as tolls were not increased in peak periods, but decreased in the surrounding shoulders. The average worker who is unable to change their time of travel is not required to pay any additional toll, but may receive the benefit of other drivers shifting out of peak period travel (1). As a controversial project, the press has concentrated on the equity concerns on SR 91, specifically the dispute between Riverside County and CPTC. Although participants in the project seem satisfied, Riverside County residents feel it is inequitable to pay taxes to support a road on which they must pay a toll to drive (31).

Possible negative equity impacts can be mitigated to a certain extent by making concurrent investments in mass transit along the priced corridors. On the I-15 Express Lanes, equity concerns have been partly mitigated by allocating project revenue to new transit, primarily used by low-income lane users, and HOV lane improvements. However, there is a lack of public support for funding transit (7). Boulder suggested four programs, including a new capital investments program, a lifeline tolling program, offering subsidized travel, or targeting transportation programs at those adversely affected by pricing (16).

Examining the demographics of users and non-users and the frequency of use indicates potential equity issues. On the Lee County LeeWay, differences in age, gender, education, and employment type are apparent, as program users can be assumed to have schedules that are more flexible (35). The average Katy Freeway user is a 38-45 year old professional who works downtown, with an income over \$100,000, living in a 3-4 person household, and has used the Katy HOV before (5). Likewise, the profile of the I-15 Express Lane user was similar: male, 35-54 years old with a high level of education, annual income over \$100,000, two car household, and a solo driver commuting for work-related purposes (8).

In contrast, a study of the demographics on the SR 91 Express Lanes found no apparent differences between users of the Express Lanes and general-purpose lanes. Although the lanes are located in a fairly affluent corridor, low-income users do participate in the program. The study found that low-income groups have a high value of time during specific situations and rely on the lanes during these times. However, the more affluent users demonstrated different usage patterns, using the lanes more frequently. High-income users were more than twice as likely to be frequent user of the toll lanes as low-income users and about half as likely to be non-users. Women and intermediate age groups were also more likely to use the lanes (10). Similar findings were noted on the I-15 Express Lanes, although a larger percentage of women and a broader income distribution emerged as the program progressed (8).

Impacts on Travel Behavior and Air Quality

One of the major potential impacts of a value pricing project is its ability to influence travel behavior. Depending on the design of the project, value pricing can potentially maximize the road capacity while maintaining a high level of service, induce travel mode changes, increase vehicle occupancy rates, and shift the times of travel. According to travel modeling done in Portland, the implementation of pricing could accrue travel time savings to individual commuters, increase the capacity

of a corridor, and result in an exponential decrease in congestion (14). The modeling process in Boulder predicted that overall auto trips would not change significantly. However, total trips for the elderly and poor would decrease, transit and ridesharing would increase, and non-work transit trips would rise dramatically (16).

The operating projects studied the actual effects of value pricing on travel behavior. Where tested, value pricing was able to shift the time of travel on the priced corridor. As one of the main goals in the Lee County demonstration, variable pricing proved effective at influencing the traffic patterns of eligible users. Data showed an estimated 300 trips per day were diverted from peak period travel to discounted shoulder periods (35). On the Katy Freeway, about 8-10 percent of the 2-person trip carpools switched from traveling in the shoulder time period into the peak period (5). SR 91 experienced sharper peak travel around 5 p.m., attributed to commuters readjusting their travel behavior based on the additional capacity on the Express Lanes and the free lanes.

Value pricing projects also experienced induced traffic demand trends and a change in trip frequency. Data from Lee County show that eligible users were making an additional 151 trips per day and that 25.9 percent increased their trip frequency in the first few months of variable pricing (36). Value pricing increased the usage of the Katy Freeway lanes, but only by a small fraction of the available capacity (27). On the SR 91 Express Lanes, it was estimated that 21 percent of the traffic returned from parallel arterials, 20 percent was underlying traffic growth, and the remaining 59 percent of the first year growth was being induced by improved traffic conditions for non-work purposes (10). However, the frequency of use for most participants has been noted to be low, as most do not use the lanes on a regular basis. Many participants consider the lanes an insurance policy, using them only when necessary (12).

The impact of value pricing on travel mode changes and vehicle occupancy rates has been notable. Although no significant change in travel mode or occupancy has occurred on the LeeWay (37), the Katy Freeway found more than half of users are former single-occupancy vehicles formed carpools and moved into the HOV lane, about one quarter of the 2-person carpools moved from the main lanes to the HOV lane during peak hours, and the number of 3+ carpool trips increased by 6.1 percent in the evening. About 18 percent of the morning QuickRide trips diverted from higher occupancy modes, but only 1 percent in the evening. Transit ridership did show a slight decrease after QuickRide was implemented, but the absolute number of riders was miniscule (5). On SR 91, a 40 percent increase in HOV-3+ traffic was evident within the first three months of opening. Although SOV traffic increased significantly, a net movement from SOV to HOV occurred and the HOV count has been stable or growing slowly ever since. A larger jump in SOV caused an initial drop in the average vehicle occupancy, but it has been stable from 1997 to 1999 (29).

Finally, the I-15 experienced a significant movement of carpools from the main lanes to the Express Lanes. In fact, carpool traffic increased by 69 percent from the 1996 pre-project level to June 2000. SOV traffic increased by 28 percent between 1997-1998, but SOV violations decreased from 14.7 percent to 5.3 percent. Overall, transit ridership increased on the corridor, attributed mostly to the start up of the *Inland Breeze*, which began operation in November 1997 (8). Examination of the type of riders indicated that increasing transit options on the corridor benefited those with no other travel alternative the most.

Most of the projects did not analyze the impacts of value pricing on air quality. The I-15 project is the exception, using the California Air Resource Board's EMFAC7G air quality model. Based on data produced from the model, air quality was estimated to worsen as a result of the value pricing project, with increases in emissions of volatile organic compounds, carbon monoxide, nitrogen oxides, and particulate matter. Most of this can be attributed to the increases in speeds and volumes of vehicles traveling along the corridor. An air quality study done in Boulder found the opposite, that pricing decreases the total vehicle miles traveled, proving beneficial to overall air quality. This was specifically true under the optimal fee scenario. However, the study concluded that revenues from any form of pricing allocated to alternative transportation could improve air quality (16). An air quality study is underway for the SR 91 corridor, as the Express Lanes are being considered for an expansion, but data are not available at this point.

Travel Time Savings

Quantifying the actual travel time savings can become a tangible asset for a value pricing project. Travel time savings is estimated to accrue not only to drivers using the lanes, but also to drivers in the general-purpose lanes, which achieve higher speeds as traffic is diverted to the toll lanes. Although some studies have been done, much of the travel time savings data are based on estimates.

The actual impact of the projects on travel time savings was mixed. The San Diego I-15 experienced a small but significant savings accruing in the morning peak, but not in the evening. Lee County hypothesized that variable pricing would decrease the travel time during peak hours, but found no significant changes (38). However, the project was intended to shift peak traffic or the time of travel, not necessarily the length of time it took to travel. In contrast, travelers on both the SR 91 Express Lanes and Katy Freeway experienced significant time savings. Actual time savings on SR 91 showed a maximum of 12-13 minutes saved per trip on normal traffic days. It has been estimated that travel time savings are maximized during peak periods, where commuters realize a value of \$13-14 an hour (10). A study done on the Katy Freeway by Hickman, Brown and Miranda calculated a travel time savings by dividing the length of the lane by the average travel speeds recorded by day. The estimate found the average daily time savings to be 20 minutes, valued at \$6.00/hr (\$2/20 minutes) (5).

Despite the actual time savings, the perception of time saved induces travelers to purchase the benefit on the lanes. A survey in Lee County showed that 43 percent of eligible drivers obtained the account to save time (35). On the Katy Freeway, it is estimated that people generally perceive a 15-minute time savings, lower than the actual estimated savings (27). Commuters on the SR 91 Express Lanes perceived to save in excess of 20 minutes per trip during peak periods (10). Finally, a survey of project participants on the I-15 Express Lanes found that 52 percent reported saving between 13 and 22 minutes while another 18 percent estimated to save between 23 and 32 minutes (8). Although these estimates may factor in time saved on ramp meter bypasses, it reflects the perception that the lanes provide a faster and more reliable trip.

Impact on Local Business

The local business community has not been a major stakeholder in most of the operating projects or feasibility studies. However, studies assessing the impact of value pricing projects on local businesses have been conducted. Integrating the business community into the process could prove beneficial. Efforts to gain business support, as well as coordinate pricing efforts with flextime programs could improve the overall efficiency and effectiveness of any pricing solution.

As alternative work arrangements contribute to the goals associated with value pricing, it is important to incorporate the business community in the planning process. Lee County has actively pursued outreach education to the business community, mostly promoting flextime working options, as well as implementing such policies within the County government (2). Houston Metro has also tried to encourage demand side remedies by working with local employers (26).

Several studies were conducted to gauge the awareness and support of the business community. A survey done of local business along the SR 91 Express Lanes found the majority felt the project would have a positive long-term effect on business, as it improved the reliability of a trip, especially for delivery-based employers (10). A study of business along the I-15 corridor found that although more site-based employers were aware of the program, delivery-based employers found it slightly more important to their business. However, the overall impact of the program on business was perceived as minimal (8).

A study done in Boulder found that many businesses expected to accrue net benefits from pricing, as pricing improves overall travel time. However, pricing may also adversely affect businesses employing low-income workers. In addition, downtown retail firms competing in a regional context may also be adversely affected by pricing, as it would become less expensive for customers to travel outside Boulder (16). This underscores the need to coordinate with business and incorporate alternative transportation plans into pricing efforts.

CONCLUSION

Through the Federal Highway Administration's Value Pricing Pilot Program, operating projects and feasibility studies have been able to evaluate the potential and actual impacts of value pricing on travel behavior, revenue generation, local businesses, and equity implications. Value pricing projects have been able to increase the use of a facility, induce travel mode changes, increase vehicle occupancy rates, and shift the times of travel. Projects have been self-sustaining and generated revenues have been allocated to maintain and improve the facility and increase transit on the priced corridor. Users generally perceive a travel time savings on a priced facility, although only some projects have achieved a significant time savings. This reinforces the value of priced facilities as a reliable commuting option.

Gaining public and political support can be the largest barrier to a project. A clear understanding of the problem and the role of value pricing as a solution are critical in developing a project. Projects engaging key stakeholders and using focus group feedback to inform the general outreach were more successful in generating support. Having a political champion, specifically an elected official, also proved invaluable in moving a project forward. The media can also play a role in gaining support for a project, although negative coverage has been more harmful than positive coverage has been helpful. Equity has also emerged as a key concern in the public eye. Although many of the operating projects did not contend with many complaints about the equity of a project, modeling work showed that low-income households could disproportionately bear the costs in certain pricing scenarios. Although lower income households do participate in programs, as everyone has a high value of time in certain situations, it is important to determine the equity effects of value pricing and mitigate them to the extent possible. Constraints in technology inhibit policymakers from understanding the true costs and benefits of value pricing. Despite technological advances in electronic toll collection, visual enforcement, though difficult, is the most effective means of monitoring for violators. This can compromise the effectiveness of pricing efforts.

Although value pricing has been effective in several situations, key constraints exist that need to be addressed before implementing any project. The lessons from these projects and studies can be used to educate policymakers of the benefits associated with value pricing policies and to inform future value pricing efforts. They should be expanded to broaden the scope of pricing strategies. They should be enhanced as a way to increase the effectiveness of this tool. And above all, they should be built upon as a way to improve traffic demand management and offer choices to policymakers, drivers and the general public when addressing the limits of our transportation system.

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