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16. ABSTRACT
 The goal of this project was to identify appropriate technologies and conditions to implement open road electronic toll collection systems in the form of public-private partnerships on California's highway system. This research pursued two major objectives and provided practical guidelines and recommendations regarding Open Road Electronic Toll Collection technologies. The six deliverable document have been concatenated into one document.
 In the area of technology, four reports were generated, which are:
 1- Motivations behind electronic roadway tolling
 2- Implementation and management for electronic roadway tolling
 3- Electronic roadway tolling technologies
 4- Equity concerns in the electronic roadway tolling systems development
 In the area of issues surrounding public-private partnerships, two reports were generated which are:
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 2- Legislative settings for public private partnership in transportation projects.

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CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

**TASK A-1: Motivations Behind Electronic Road Pricing. What is the Driving Force Behind the Worldwide Rise in Tolling?
A Review of Innovative Road Pricing from Across the Globe**

Rebecca Kalaskas, Brian D. Taylor, Hiroyuki Iseki

**California PATH Research Report
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What is the Driving Force Behind the Worldwide Rise in Tolling?
A Review of Innovative Road Pricing from Across the Globe

California PATH Project—Task Order 6330

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Rebecca Kalauskas
Brian D. Taylor
UCLA Institute of Transportation Studies
3250 Public Affairs Building
Los Angeles, CA 90095-1656
www.its.ucla.edu

and

Hiroyuki Iseki
Department of Planning and Urban Studies
University of New Orleans
2000 Lakeshore Drive - 368 Milneburg Hall
New Orleans, LA 70148
<http://planning.uno.edu/>

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ABSTRACT

The report identifies the motivations behind and objectives of specific road pricing initiatives, and to explore why such policies are becoming an increasingly popular approach to transportation finance and management. Over the past 15 years, electronic road pricing projects have appeared in a variety of forms across the globe – from the Interstate 15 High-occupancy toll (HOT) Lanes in San Diego County, to the congestion cordon pricing scheme in central London, to the German weight-distance truck toll system, to the Oregon mileage-based user fees pilot program. While the stated objectives of these projects are typically straightforward, the underlying motivations behind the turn to electronic road pricing are nuanced and varied. Accordingly, this report explores the forces behind this gathering shift in transportation policy toward electronic pricing through a series of case studies from around the globe. The information was gathered primarily through a detailed review of primary, secondary, and, when available, tertiary source documents.

In each of the case studies examined for this report, we find that the status quo – that is the old system of transportation planning and finance – is in crisis. Whether the problem is insufficient revenue or choking congestion, transportation planners and policymakers around the world are struggling to keep pace with the rise in motor vehicle traffic, and the problems that such growth engenders. As with many other policy areas, technology is facilitating the development of innovative approaches to facilitating the transition from theory to reality. With respect to transportation planning and finance, we conclude that we are at a unique juncture, as the full range of possibilities for the potential of road pricing is only now being fully realized.

Keywords: road pricing, HOT Lanes, congestion pricing, electronic pricing

EXECUTIVE SUMMARY

INTRODUCTION

Over the past 15 years, electronic road pricing projects have appeared in a variety of forms across the globe – from the Interstate 15 High-occupancy toll (HOT) Lanes in San Diego County, to the congestion cordon pricing scheme in central London, to the German weight-distance truck toll system, to the Oregon mileage-based user fees pilot program. While the stated objectives of these projects are typically straightforward, the underlying motivations behind the turn to electronic road pricing are nuanced and complex. Accordingly, this report explores the forces behind this gathering shift in transportation policy toward electronic pricing through a series of case studies from around the globe. These case studies are then followed by a synthesis of common motivational themes behind the implementation of electronic road pricing in a wide variety of settings.

FACILITY CONGESTION TOLLS

- **Toronto’s 407 ETR Congestion Toll:** Faced with increasing traffic congestion, Ontario transportation officials partnered with private investors to construct a northern east-west route, the 407. In order to assure a return on investments, electronic tolling was introduced on the new roadway, making the 407 the first fully electronic toll road in the world.
- **Orange County’s SR-91 Express Lanes:** Grappling with growing congestion between Riverside and Orange Counties, the Orange County Transportation Authority partnered with the private investor California Private Transportation Company to fund the construction of toll lanes along the SR-91 median. Drivers in these lanes are charged a variable fee reflecting anticipated levels of congestion.
- **San Diego’s I-15 HOT Lanes:** In order to maximize the use of existing facilities and to fund new public transit services, the San Diego County Association of Governments converted High-occupancy vehicle (HOV) lanes to High-occupancy toll (HOT) lanes. These lanes utilized the world’s first fully dynamic variable congestion toll for single-occupant vehicles.
- **Houston’s I-10 QuickRide:** While Houston had an extensive network of HOV lanes, mounting traffic congestion necessitated a better use of these sometimes underutilized facilities. Although allowing two-occupant vehicles for free resulted in too much congestion in the lanes, permitting two-occupant vehicles to pay a fee optimized the utilization of the lanes.
- **Minnesota’s I-394 MnPASS Program:** Partially inspired by the success of San Diego’s HOT lanes, Minnesota transportation officials viewed HOT lanes as a critical component of the state’s long-range congestion relief plan. A broad coalition of political supporters played a critical role in the ultimate implementation of the growing HOT network.

- **Santiago, Chile:** Due to rapid economic growth, traffic began overwhelming Santiago's road network. In order to fund a quick expansion in road capacity, Santiago turned to private sector investors, who introduced variable tolls on privately financed road facilities.

CORDON TOLLS

- **Singapore's Road Pricing:** Due to Singapore's unique political structure, its transportation leaders were able to implement manual cordon tolls years prior to technological developments that made the concept operationally (and politically) feasible elsewhere. Singapore adopted the tolls to efficiently manage the business district roadways and establish its position as a prominent business center, upgrading to an electronic system in recent years.
- **Stockholm Congestion Fee:** Propelled mainly by a concern about degrading environmental conditions, Stockholm officials introduced a congestion fee for travel within the central city. The improvement of the city's public transit system served as an essential component in the acceptance of the plan.
- **London's Congestion Pricing:** In order to solidify its standing as a worldwide financial center and to generate funding a badly deteriorated underground subway system, London's regional mayor championed the implementation of congestion pricing to both reduce chronic traffic delays and to generate needed revenues. Without Mayor Livingstone's political tenacity, it is unlikely that the dramatic pricing program would have been implemented.
- **New York City Congestion Pricing Proposal:** Following the success of cordon congestion pricing in London, New York City's Mayor Michael Bloomberg developed a similar proposal for New York. Although the proposal was originally pitched as a component of the city's environmental sustainability plan, congestion pricing ended up being viewed as more important to the city's economic sustainability by many supporters. However, the proposal failed to attain the necessary state legislative approval and died ceremoniously in April 2008.

WEIGHT-DISTANCE TRUCK TOLLS

- **Austrian GO Truck Tolls:** The significant expense of road maintenance coupled with an increasing portion of foreign freight movement through their country motivated Austrian transportation officials to implement a system of truck tolls. This tolling scheme generated substantial revenues thereby allowing private investors to play a role in infrastructure development and maintenance in Austria.
- **Switzerland's Heavy Vehicle Fee (HVF):** The motivations behind Switzerland's HVF mirror many of Austria's concerns with through traffic. However, Swiss transportation

officials and residents have typically cited environmental concerns more often than fiscal concerns in supporting the implementation of the HVF.

- **German Toll Collect:** Like Austria and Switzerland, Germany experienced increasing levels of freight travel as the European Union opened up new trade routes. In order to off-set the costs these new users imposed on the road networks, Germany introduced the Toll Collect program, which is the first large-scale operation road pricing project to utilize satellite-based electronic fee collection technology.

MILEAGE BASED USER FEES

- **Oregon's Mileage Fee Concept:** The trial for Oregon's Mileage Fee was primarily motivated by the declining power and unsustainability of the current fuel-tax system. As nearly all other states are faced with similar funding crises, the trial has received substantial interest from transportation officials across the country.

ELECTRONIC ROADWAY TOLLING: LESSONS FROM AROUND THE WORLD

- **Technology:** Making Theory Reality: The rapid technological developments over the past twenty years have greatly eased the obstacles to implementing road pricing and, along with it, some of the popular and political wariness of pricing.
- **The Push of Revenue Crises:** Chronic revenue shortfalls are increasingly a strong motivating factor, particularly in places where there exists demand for new capacity and inadequate resources to finance them. This motivation has most often been cited as being behind the implementation of pricing projects in the United States, but increasingly jurisdictions around the world find themselves strapped for cash and in search of ways to accomplish more with less revenue from traditional sources.
- **Managing Congestion and the Need for New Capacity:** Even if the current transportation funding systems were sustainable, traffic congestion is rapidly increasing in cities around the world and road capacity is not keeping pace with rising travel in many places. Cost-effective alternatives to constructing new capacity are increasingly attractive; one way is through using road pricing to increase the "effective capacity" of metropolitan road networks with HOT lanes, cordon tolls, and the like.
- **Congestion Threatens Economic Development:** In our increasingly global economy, the leaders of metropolitan areas around the world are vying for economic advantage while coping with the travel demands of increasing trade. Reliable transportation systems are important to economic productivity, and the role of transportation systems in economic development planning remains central. Although opponents of congestion pricing often raise fears of economic losses to business districts as a major concern, such arguments typically ignore the cost congestion delays impose on businesses.

- **Climate Change: Reducing Emissions:** In addition to spurring economic development, many road pricing schemes were implemented with the explicit goal of mitigating environmental impacts by smoothing traffic flows thereby lowering emissions.
- **Charging Drivers for the Costs They Impose:** In that road pricing causes people to be more aware of the costs their travel choices impose on society, drivers make better informed and more societally optimal decisions about when, where, and even whether to drive.
- **Private Investments:** Private investments are playing an increasingly important role in transportation projects around the globe, and the ability to electronically toll roadways has played a critical role in attracting these investments with reliable revenue streams.
- **Federal Incentives & Legislative Changes:** Many of the electronic road pricing pilot projects are the result of incentives developed by a higher governing body. The European Commission supports member states in developing urban road pricing schemes that aim to internalize the external costs of private vehicle travel, and the federal government in the U.S. has in recent years provided both funding and other incentives for road pricing pilot projects. In addition, federal and state enabling legislation is often required before cities, counties, regions, or states can pursue road pricing projects.
- **Political Champions: Selling Projects to the Public:** While ideas about non-linear effects, internalizing externalities, and allocating scarce public resources with prices may be well-understood by many transportation planners and economists, persuasive rhetoric from a trusted leader is often required to sell economic theory to wary policy makers and a skeptical public.
- **Coalition of Supporters:** Just as a broad array of motives contribute to the implementation of road pricing, so does a wide range of supportive interest. While this wide array of supporters often aid in the implementation of road pricing, the varied motivations of sometimes strange bedfellows can result in conflicts over implementation.
- **Political Traction: Success Cases from Around the World:** Politicians hoping to introduce road pricing to their jurisdictions today have the luxury of being able to refer to a growing number of successful initiatives around the world. Momentum continues to build as more and more jurisdictions successfully implement road pricing initiatives, helping to dissipate public opposition.

CONCLUSION

In each of the case studies examined for this report, the status quo – that is the old system of transportation planning and finance – is in crisis. Whether the problem is insufficient revenue or choking congestion, transportation planners and policymakers around the world are struggling to keep pace with the rise in motor vehicle traffic, and the problems that such growth engenders. As with many other policy areas, technology is facilitating the development of innovative

approaches to facilitating the transition from theory to reality. With respect to transportation planning and finance, we are at a unique juncture as the full range of possibilities for the potential of road pricing are only now being fully realized.

INTRODUCTION

Although the concept of road pricing has existed in theory for decades, it is only in recent years that this theory has been transformed into reality. First conceived of by the economist A.C. Pigou in 1920 and later expanded upon by William Vickrey in the 1960s and 1970s, the road pricing model efficiently distributes the cost of utilizing the road network among users. However, practical accounting and technological limitations in the first half of the 20th century favored funding roads through the fuel tax rather than road pricing, thus resulting in the current fuel-tax based transportation funding model (Wachs, 2003). This model, however, is breaking down as a fundamental shift in road financing is occurring around the world. Over the past fifteen years, electronic road pricing projects have appeared in a variety of forms – from the San Diego HOT lane to central London congestion cordon pricing, and the German weight-distance truck tolls to the Oregon mileage-based user fees. The forces behind this dramatic shift in transportation policy are the focus of this report.

The stated primary objectives of these projects are typically straight forward: a majority are designed to either raise revenue and/or manage traffic congestion. However, our review of recent tolling projects from around the country and the globe revealed several trends about the underlying motivations behind electronic road pricing. In particular, several factors combined to create a political environment ripe for the exploration of new approaches to road finance and operation. Impending fiscal crises, increased strain on existing roadway capacity, technological advances, environmental concerns, interest in public-private partnerships, greater public support electronic tolling, and aggressive political champions have all played a significant role in the recent rise of new road pricing schemes. Although many transportation economists have been pushing the concepts of road pricing for decades, implementation lagged due to an absence of a conducive political environment and appropriate technologies. Today, however, Pigou's road pricing schemes are becoming a reality.

Methodology and Logistics

This report explores the underlying motivations behind the implementation of many of the world's most innovative road pricing projects. In doing so, we first identified a set of case studies that we felt represented both a broad range of models of road pricing as well as geographic diversity. The dates of implementation range from the 1970s in Singapore to the

present with New York's congestion pricing proposal, which is still in the planning stage. We then researched the history and background of each project to identify the reasons conceived and problems addressed by each initiative. A wide range of sources were utilized in this process, including academic journals, government publications, and media sources. For each case study, we identified a set of primary and secondary motivations that explain the introduction of the project.

We then synthesized the information gathered from the case studies to identify some common trends that cut across the projects. The major themes that resulted from the preliminary overview of the cases include technological advancements, political champions, revenue crises, and demand for new capacity. We followed the case studies with a discussion of implications and more broadly generalized conclusions for future road pricing initiatives. While there are limitations on general conclusions that can be drawn from any case studies, this report with a variety of road pricing cases certainly provides a better understanding of the motivations behind road pricing on a global scale.

Overview of Road Pricing Schemes

Electronic road pricing can take many forms. Most projects, however, fit into four distinct categories: (1) facility congestion tolls, (2) cordon tolls, (3) weight-distance truck tolls, and (4) mileage-based user fees (Sorensen, 2006). While the motivations to pursue electronic roadway pricing are in many ways unique to each of the cases examined for this research, we find that these motivations do tend to vary systematically by each of these four categories, as we will see below.

Perhaps the most familiar road pricing scheme within the United States is the facility congestion toll. This type of road pricing charges drivers tolls varying by the level of congestion for the use of a particular facility that ranges from a single lane to a bridge to an entire roadway. By varying tolls that affect the demand of travel, drivers are assured a constant flow of traffic on these facilities. A higher toll is charged during peak hours to lower the number of cars from an excess level to a moderate level, so that the throughput of the roadway increases; the total number of trips accommodated by this facility increases. In other words, the efficiency in the use of the facility improves. High-occupancy toll (HOT) lanes, which allows single-occupancy vehicles to pay a variable fee to utilize a former high-occupancy vehicle (HOV) lane while

HOVs are still able to use the designated lanes for free or a reduced fee, is one of the most prevalent form of facility congestion tolls. Cases of facility congestion tolls that will be discussed in this report include the San Diego's I-15 HOT lanes, Orange County's SR-91 express lanes, Houston's QuickRide, Toronto's 407 ETR congestion toll, Santiago's toll roads, and Minnesota's I-394 MnPASS program. Although facility congestion tolls could, in theory, provide an additional stream of revenue for transportation agencies, the congestion toll facilities that are already in place rarely produce revenue significant enough to serve as the sole justification for the project.

While facility congestion tolls might be the most common form of electronic road pricing, cordon tolls are perhaps the most controversial, sparking debates in some of the world's largest cities. Cordon tolls impose a fee on users for entering or traveling within a designated geographic area during specified hours. The cordoned area generally corresponds to a city's central business district. This tolling model aims to reduce traffic within the urban core, thereby reducing traffic congestion and associated pollution. Most cordon tolling models encourage travelers to shift trips to transit and utilize the toll revenue to enhance the city's transit system and increase its efficiency. Singapore, London, and Stockholm have all successfully implemented cordon tolls, while New York City is currently embroiled in a heated debate over a proposed cordon pricing plan.

Increasingly popular in Europe, weight-distance truck toll projects impose a fee on commercial freight haulers within a specific geographic area. The charge varies by vehicle weight and distance traveled. By assessing a fee on these commercial trucks, the jurisdictions are able to recover some of the costs imposed by the operation of these heavy vehicles and encourage different modes of freight transport, such as rail or shipping. The concept is particularly popular in Europe because European Union trade routes frequently result in freight being driven across multiple countries. Since many countries ended up serving as conduits for these heavy vehicles, the natural response was to develop a system of fees that would shift the costs onto the freight movers. Examples of weight-distance truck tolling include Austrian GO truck tolls, German Toll Collect, and Swiss HVF truck toll.

Finally, mileage-based user fees constitute perhaps the most comprehensive form of road pricing. Primarily driven by a desire to raise sufficient revenue and replace the fuel tax, this

model of road pricing charges users based on distance traveled. It might also be possible to vary the fees according to congestion levels or vehicle emissions. Although this plan is not fully implemented yet, several jurisdictions have explored the feasibility of introducing such a scheme, including the state of Oregon.

In the following sections, the history, politics, and implementation of each of these projects will be discussed in detail, and the underlying motivations behind each case will be teased out. We will then discuss the lessons drawn from these examples and any general patterns exhibited in regards to motivations behind the implementation. One lesson that is clear from the beginning is that every case has a unique set of circumstances and motivations.

FACILITY CONGESTION TOLLS

Toronto's 407 ETR Congestion Toll: Private Investments Lead to Much-Needed Capacity

Faced with increasing traffic congestion, Ontario transportation officials partnered with private investors to construct a northern east-west route, the 407. In order to assure a return on investments, electronic tolling was introduced on the new roadway, making the 407 the first fully electronic toll road in the world.

The construction of Toronto's H-407, among the world's first fully electronic toll roads, highlights the role that public-private partnerships can play in funding much needed additional capacity and the importance of utilizing new tolling technology to ease the toll collection process. For years, metropolitan

Toronto was serviced by a single east-west highway, H-401, which cuts through downtown Toronto. As population and travel demand grew, H-401 was expanded to 12 lanes, but any further capacity expansion along this route was unfeasible. The northern portion of the metropolitan area was developing rapidly, and resulted in a discussion of a construction of H-407, a northern east-west route first proposed in the 1960s. The province began establishing a right-of-way for this new road, and completed the process in 1992 (Commission for Integrated Transport, 2006).

Ontario lacked sufficient funds to construct the new roadway even though demand continued to grow rapidly. In 1993, provincial transportation leaders decided to fund construction through tolling and established a special-purpose "crown" corporation owned by the province, the Ontario Transportation Capital Corporation. Through this corporation, bonds were sold to design and construct the 407. The private company Raytheon constructed and operated the road from its opening in October 1997 through 1999. Instead of collecting the tolls through conventional toll booths, the 407-ETR became the first major toll road in the world to be entirely cash-free. In its system, most users use transponders to pay tolls, while those



Figure 1: Location of the 407 (Commission for Integrated Transport, 2006)

without transponders pay via video system, which records the license plate numbers and then sends a bill by mail (Poole R. , 2007) (Table 1).

With the toll revenue, the province quickly paid off its debt within two years and then leased the road to a private investor for 99-years for CA\$3.1 billion (US\$3.15 billion), far exceeding the original CA\$1.6 billion (US\$1.63 billion) investment (Commission for Integrated Transport, 2006). The investor agreed to add capacity and improve interchanges during the leased period. The 407-ETR is now 67 miles with 43 interchanges (Poole, Samuel, & Chase,



Figure 2: 407-ETR (Commission for Integrated Transport, 2006)

2005). The lease agreement also requires the company to maintain free-flowing traffic conditions through a combination of appropriate tolls and construction of sufficient capacity to meet demand. The tolls along the 407-ETR average 35 cents per mile, and the average trip is 12.7 miles (Poole, 2007).

Without tolling, the 407-ETR may never have been built. In order to attract private investors to fund the original construction and operation, the province needed to be able to guarantee a return for the private investment. By charging drivers a fee for utilizing the facility, private companies are able to both cover their investment as well as maintenance costs, and still make a profit. Furthermore, the new electronic collecting technology resulted in even larger returns on their investments since operating costs were significantly lower. The story of the 407-ETR highlights the critical role electronic tolling plays in creating valuable public-private partnerships to fund infrastructure projects.

Key motivations:

- Primary
 - Increasing congestion
 - Demand for new capacity & infrastructure construction
- Secondary
 - Public-private partnership
 - Revenue shortfall



Table 1: Toronto 407-ETR 2008 Toll Rate

	Light Vehicle		Heavy Single Unit Vehicle		Heavy Multiple Unit Vehicle	
	Transponder Recorded	Video Recorded	Transponder Recorded	Video Recorded	Transponder Recorded	Video Recorded
Regular Zone Peak Rate Weekdays 6am-10am, 3pm-7pm	19.25¢/km	19.25¢/km	38.50¢/km	38.50¢/km	57.75¢/km	57.75¢/km
Light Zone Peak Rate Weekdays 6am-10am, 3pm-7pm	19.00¢/km	19.00¢/km	38.00¢/km	38.00¢/km	57.00¢/km	57.00¢/km
Off-Peak Rate Weekdays 10am-3pm, 7pm-6am, Weekends & Holidays	18.00¢/km	18.00¢/km	36.00¢/km	36.00¢/km	54.00¢/km	54.00¢/km
Monthly Transponder Lease	\$2.55	\$0.00	\$2.55*	\$0.00	\$2.55*	\$0.00
Annual Transponder Lease	\$21.50	\$0.00	\$21.50**	\$0.00	\$21.50**	\$0.00
Monthly Account Fee	\$0.00	\$2.55	\$0.00	\$2.55	\$0.00	\$2.55
Video Toll Charge	0.00	\$3.60 per Trip	\$0.00	\$50.00 per Trip (temporarily discounted to \$15.00)	\$0.00	\$50.00 per Trip (temporarily discounted to \$15.00)

Source: 407 ETR (http://www.407etr.com/about/custserv_fees.asp)

Orange County’s SR-91 Express Lanes: Potential Pitfalls of Private Investment

Grappling with growing congestion between Riverside and Orange County, the Orange County Transportation Authority partnered with the private investor California Private Transportation Company to fund the construction of toll lanes along the SR-91 median. Drivers in these lanes are charged a variable fee reflecting current levels of congestion.

The SR-91 Express Lanes in California’s Orange County provide an example of a successful HOV-HOT conversion. Like Toronto’s 407-ETR, a new public private partnership played an essential role in the development of the project (Boarnet & Dimento, 2004). The possibility of a public-private partnership originated with 1989 California state legislation, Assembly Bill 680. Originally motivated by the then recent failure of a statewide bond issue

for highway improvement, AB680 permitted up to four private highway demonstration projects across California to explore the possible role that the private sector could play in infrastructure

development. Private developers were encouraged to experiment with creative approaches to the state's transportation dilemmas (Evans, Gougherty, Morris, & Smirti, 2006).

Simultaneously, Orange County Transportation Authority (OCTA) proposed the construction of HOV lanes in the median of SR-91, a heavily congested corridor between Riverside County and Orange County. SR-91 cuts through the Santa Ana Mountains, one of the few passes between housing-rich Riverside and job-rich Orange Counties, which results in waxing traffic levels as both counties rapidly grew (Boarnet & Dimento, 2004).

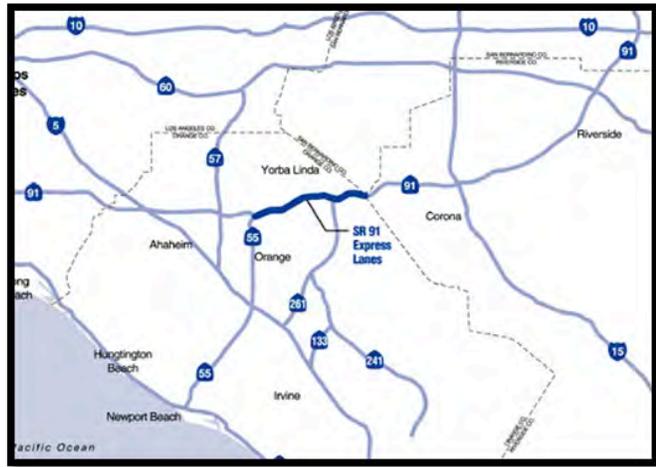


Figure 3: Location of SR-91 Express Lanes (Federal Highway Administration, 2003)

However, OCTA lacked sufficient funds, making the possibility of private-sector investments very appealing. Inspired partially by a policy study by Robert Poole, Director of Transportation for the Reason Foundation, Caltrans encouraged OCTA to seek out a private investor to fund HOT lanes rather than HOV lanes. Caltrans viewed the project as an opportunity to increase throughput along this route as well as to provide much needed funding. Additionally, by incorporating a private firm, some of the risks associated with the project were transferred from the taxpayer to the private investor. Following the advice of Caltrans, OCTA



Figure 4: SR-91 Express Lanes (DeCorla-Souza, Jacobs, Ballard, & Smith, 2003)

partnered with the California Private Transportation Company (CPTC) to develop ten miles of private toll lanes for the SR-91 median (Boarnet & Dimento, 2004; Poole R., 2005).

The four SR-91 Express Lanes opened in 1995 along the SR-91 median with variable tolls that reflect congestion levels and maintain steady traffic flow, making it the first congestion pricing

project in the United States. For those who choose to pay into the lanes, the tolls are collected entirely electronically (Boarnet & Dimento, 2004; Poole R., 2005).

While cash-strapped OCTA originally supported the project primarily as an experiment to add new capacity—tolling was seen as the only way to pay for the project—OCTA officials now appreciate and value the congestion management benefits of variable priced tolling (Evans, Gougherty, Morris, & Smirti, 2006).

CPTC ran the SR-91 Express Lanes for several years, until a clash with Caltrans over a capacity addition to the adjacent free lanes led to the sale of the facility back to OCTA. The original agreement between CPTC and Caltrans contained a “non-compete” clause that prevented public agencies from increasing highway capacity within a one-and-a-half mile corridor on either side of the toll lanes. However, in the late 1990s Caltrans developed a plan to construct additional merging lanes to a separate toll lane, the Eastern Transportation Corridor, with the goal of improving the safety of the roadway. CPTC contested the plans claiming it infringed on the non-compete clause. In order to facilitate Caltrans’ plan, OCTA purchased the express lanes from CPTC in 2003 and now operates the facility. Unfortunately, the controversy left a negative impression of the role of the private sector in infrastructure development and management for many in Southern California (Boarnet & Dimento, 2004).

Despite this controversy, SR-91 illustrates that space does exist for private involvement in the construction of new facilities, with some clear lessons on how best to improve the process. Like Toronto’s 407-ETR, it is unlikely the SR-91 Express Lanes would have been constructed without the involvement of the private sector and the incentive tolling provided the private sector to invest in infrastructure.

Key motivations:

- Primary
 - Rapidly increasing congestion
 - Demand for new capacity
 - Public-private partnership
- Secondary
 - Funding shortfall
 - Legislation



	Sun	M	Tu	W	Th	F	Sat
Midnight	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
1:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
2:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
3:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
4:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
5:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
6:00 am	\$1.25	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.25
7:00 am	\$1.25	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.25
8:00 am	\$1.60	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95
9:00 am	\$1.60	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95
10:00 am	\$2.60	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.40
11:00 am	\$2.40	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.40
Noon	\$2.90	\$1.95	\$1.95	\$1.95	\$1.95	\$3.00	\$2.90
1:00 pm	\$2.90	\$2.75	\$2.75	\$2.75	\$3.00	\$4.65	\$2.90
2:00 pm	\$2.90	\$3.90	\$3.90	\$3.90	\$4.00	\$4.60	\$2.90
3:00 pm	\$2.40	\$4.20	\$4.20	\$5.45	\$5.70	\$9.50	\$2.90
4:00 pm	\$2.40	\$6.55	\$8.25	\$8.75	\$9.55	\$9.30	\$2.90
5:00 pm	\$2.40	\$6.35	\$8.25	\$8.25	\$9.05	\$7.75	\$2.90
6:00 pm	\$2.40	\$4.20	\$5.10	\$4.60	\$5.40	\$5.05	\$2.40
7:00 pm	\$2.40	\$3.00	\$3.00	\$3.00	\$4.30	\$4.70	\$1.95
8:00 pm	\$2.40	\$1.95	\$1.95	\$1.95	\$2.75	\$4.30	\$1.95
9:00 pm	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.75	\$1.95
10:00 pm	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.95	\$1.25
11:00 pm	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25

	Sun	M	Tu	W	Th	F	Sat
Midnight	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
1:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
2:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
3:00 am	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
4:00 am	\$1.25	\$2.30	\$2.30	\$2.30	\$2.30	\$2.30	\$1.25
5:00 am	\$1.25	\$3.80	\$3.80	\$3.80	\$3.80	\$3.65	\$1.25
6:00 am	\$1.25	\$3.90	\$3.90	\$3.90	\$3.90	\$3.80	\$1.25
7:00 am	\$1.25	\$4.35	\$4.35	\$4.35	\$4.35	\$4.20	\$1.70
8:00 am	\$1.70	\$3.90	\$3.90	\$3.90	\$3.90	\$3.80	\$1.95
9:00 am	\$1.70	\$3.15	\$3.15	\$3.15	\$3.15	\$3.15	\$2.40
10:00 am	\$2.40	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.40
11:00 am	\$2.40	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.80
Noon	\$2.40	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.80
1:00 pm	\$2.80	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.80
2:00 pm	\$2.80	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.80
3:00 pm	\$2.80	\$1.95	\$1.95	\$1.95	\$1.95	\$2.40	\$2.80
4:00 pm	\$2.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.40	\$2.95
5:00 pm	\$2.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.40	\$2.95
6:00 pm	\$2.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.90	\$2.40
7:00 pm	\$2.40	\$1.25	\$1.25	\$1.25	\$1.25	\$1.95	\$1.95
8:00 pm	\$2.40	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
9:00 pm	\$2.40	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
10:00 pm	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
11:00 pm	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25	\$1.25

Figure 5: Tolling Schedule for SR-91 Express Lanes - Effective October 1, 2008 (<http://www.91expresslanes.com/tollschedules.asp>)

San Diego's I-15 HOT Lanes: Optimization of Existing Facilities

In order to maximize the use of existing facilities and to fund new public transit service, SANDAG converted I-15 HOV lanes to HOT lanes. These lanes utilized the world's first fully dynamic variable congestion toll for single-occupant vehicles.

In 1988, San Diego opened two reversible high-occupancy vehicle (HOV) lanes along the I-15 median. The HOV lanes originated at the SR-163 junction and continued for eight miles to the SR-56 junction. By the early 1990s, the general

consensus in San Diego was that these existing HOV lanes were being underutilized. Studies estimated that perhaps only a third of the lanes' capacity was utilized. Meanwhile, traffic congestion escalated along this route as Southern California development continued (Sorensen, 2006). Additionally, this route lacked sufficient public transit alternatives. The San Diego Association of Governments (SANDAG) developed a network of light-rail lines around the

region in the 1980s and early 1990s, but the I-15 corridor was excluded from rail plans due to a lack of funding (Evans, Gougherty, Morris, & Smirti, 2006).

In an attempt to address both the growing congestion and the dearth of public transit in the corridor, SANDAG recommended converting the I-15 HOV lanes to high-occupancy toll (HOT) lanes. The I-15 HOT lanes would allow high-occupancy vehicles to continue utilizing the lanes for free while charging single-occupancy vehicles a fee, which would vary depending on congestion levels. The revenues raised through the tolls would be dedicated to fund transit improvements along I-15 route.

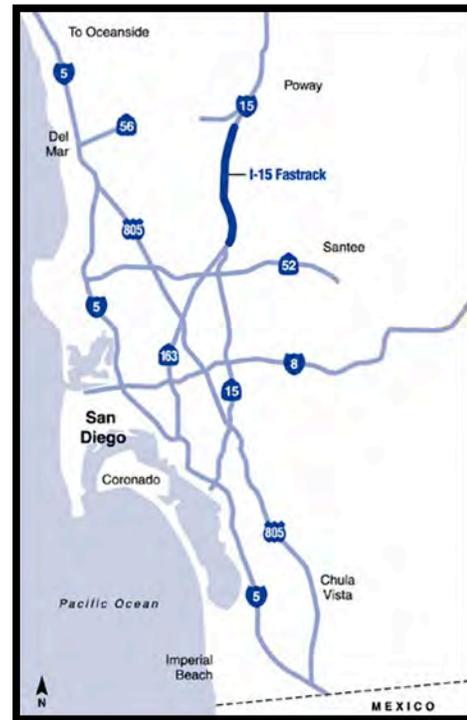


Figure 5: Location of I-15 HOT Lanes (Federal Highway Administration, 2003)

Jan Goldsmith, the former Mayor of the City of Poway and newly elected State Assembly member, adopted the issue as one of his pet causes, proposing the I-15 HOT plan to state and federal agencies. Goldsmith envisioned an area eventually serviced by a monorail or high-capacity transit system, which planners had determined to be unfeasible for the foreseeable future. As a way of funding his vision, Goldsmith became a vocal supporter of the conversion of HOV lanes to HOT lanes and played an instrumental role in the 1994 passage of Assembly Bill 713, which allows single-occupancy vehicles to buy into an HOV facility as long as adequate traffic flow is maintained. The legislation also limits the use of revenue to transit capital and operations (Evans, Gougherty, Morris, & Smirti, 2006; Schreffler, 2003). While Goldsmith was motivated by the revenue raising potential of the HOT lanes, Kim Kawada, a senior SANDAG planner, viewed HOT lanes as a capacity management toll and pushed the project forward as such. These differing interests illustrate that even leaders on the same project can have distinctive objectives and motivations (Evans, Gougherty, Morris, & Smirti, 2006).

In the course of pushing for the I-15 HOT lanes, Goldsmith wrote op-ed pieces and frequented local talk radio shows. He also made a considerable effort to meet individually with the various stakeholders to build support among elected officials. Perhaps most importantly, Goldsmith reached out to the public and sold the project as a mechanism to capture revenue on an existing underutilized facility. SANDAG was also instrumental in communicating with the general public and media through a well-planned marketing campaign including I-15 Express Lane newsletters and town hall style meetings (Evans, Gougherty, Morris, & Smirti, 2006).



Figure 5: I-15 HOT Lanes (DeCorla-Souza, Jacobs, Ballard, & Smith, 2003)

Additionally, officials were motivated to introduce the I-15 HOT lanes in part because HOT lanes were viewed as an innovative concept at the time. The novelty of the project helped garner support from the state and federal levels in the form of funding through the Federal Highway Administration’s Congestion Pricing Pilot Program, a part of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 (Sorensen, 2006).

In 1996, the I-15 HOT lanes opened with single-occupant vehicles paying into the lanes with a monthly flat fee. Phase II, FasTrak, was introduced in 1998, which incorporated the world’s first fully dynamic variable congestion toll that assures free-flowing traffic. Tolls vary from 50 cents to \$8 based on distance traveled, time of day, and level of congestion. The current amount is displayed on an electronic sign by the Express Lanes entrance, and single occupant vehicles now pay the variable fee via transponders. Revenues from the toll are dedicated to operations and funding the Inland Breeze Express Bus Service from Rancho Bernardo to downtown San Diego. While the I-15 HOT lanes are widely accepted and supported by the public, the success of the bus service has been questioned as it failed to attract the projected ridership (Schreffler, 2003). Despite the transit ridership shortfalls, the I-15 lanes are considered a success, and SANDAG is in the process of expanding the FasTrak program along I-15 with a

twenty mile, four-lane project from SR-163 to SR-78, scheduled for completion in 2012 and also serviced by bus-rapid transit (SANDAG).

Key Motivations:

- Primary
 - Existing underutilized facility
 - Political champion
 - Transit investment
- Secondary
 - Legislative changes

Houston’s I-10 QuickRide: Finding the HOV-HOT Balance

While Houston had an extensive network of HOV lanes, mounting traffic congestion necessitated a better use of these facilities. Although allowing two-occupant vehicles to use the lanes for free resulted in too much congestion in the lanes, permitting two-occupant vehicles to pay a fee optimized the utilization of the lanes.

Similar to I-15 case, the introduction of HOT lanes in metropolitan Houston resulted from a desire to increase utilization of existing HOV lanes. Traffic congestion has long been a hot topic of discussion in

Houston, a rapidly growing city with few transit alternatives. The Katy Freeway was originally designed to accommodate 80,000 vehicles per day, but over 200,000 vehicles per day were on the freeway by 2006 (United States Government Accountability Office, June 2006).

The Houston metropolitan area has a history of incorporating HOV lanes into their highway plans dating back to 1979. The Katy Freeway (I-10) HOV lanes first opened in 1984 and were originally intended to carry only transit buses and registered vanpools. However, political pressure quickly mounted to better utilize this roadway capacity by opening the lanes up to vehicles with two or more passengers. These new HOV lanes soon

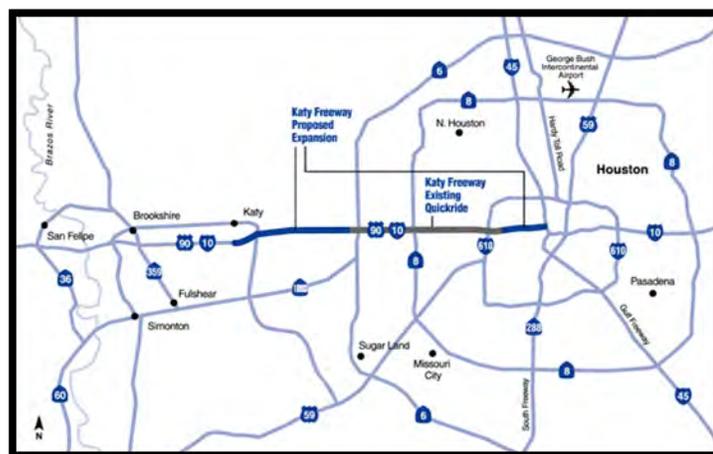


Figure 5: Location of QuickRide (Federal Highway Administration, 2003)

became congested and the Houston METRO and TxDOT restricted the usage of the lanes to vehicles with three or more passengers during the peak morning and evening rush hours. This restriction once again resulted in the underutilization of the lanes. Clearly some balance needed to be reached, leading to discussions of introducing HOT lanes (Burriss & Stockton, 2004).

The development of Houston's QuickRide program emerged from these discussions as well as a partnership with the Federal Highway Administration, as part of the Value Pricing Pilot Program, which provided funding for the study and implementation of the project. Introduced in 1998 on the Katy Freeway, QuickRide allows vehicles with fewer than three occupants to pay a fixed fee (currently \$2 in each direction) to utilize the lanes during the peak time periods when the lanes are normally restricted to vehicles with three or more passengers. Single occupant vehicles are not permitted to use the facility. Bus rapid transit also runs along these lanes with the toll-paying HOT lane users providing the revenue to fund the route (Regan, 2003).

Due to the success of the Katy Freeway HOT lane project, the QuickRide program was expanded to the Northwest Freeway in November 2000 (Burriss & Stockton, 2004). Additionally, I-10's expansion includes eight general purpose lanes and four value-priced managed lanes with higher rates for peak hours, which are being financed by the Harris County Toll Road Authority, which is a division of Harris County's Public Infrastructure Department. The QuickRide project highlights the ability of electronic congestion pricing to maximize efficiency of existing capacity by allowing drivers to buy into HOV lanes in situations where capacity expansions fail to keep pace with rapidly increasing travel demand. The project resulted from a desire to best utilize existing capacity and was further encouraged by federal government incentives to experiment with innovative road pricing approaches.

Key Motivations:

- Primary
 - Existing underutilized facility
 - Increasing congestion
- Secondary
 - Federal incentive
 - Replication of successful tolling model



Minnesota's I-394 MnPASS Program: The Importance of Tenacious Political Figures

Partially inspired by the success of San Diego's HOT lanes, Minnesota transportation officials viewed HOT lanes as a critical component of the state's long-range congestion relief plan. A broad coalition of political supporters played a critical role in the ultimate implementation of the plan.

Prior to the introduction of the MnPass program in 2005, the Minneapolis-St. Paul metropolitan area had no toll roads. Today, travelers along Minnesota's I-394 corridor have the option of buying into

value-priced HOT lanes. The MnPass implementation resulted from strong political champions and a broad coalition of forces who focused on educating the public as to the importance of variable road pricing as a long-term congestion mitigation strategy.

The Minnesota Department of Transportation (Mn/DOT) and the Twin Cities Metropolitan Council had been exploring the possibility of introducing value pricing in the Minneapolis/St. Paul metropolitan area since 1994.

These studies were primarily funded through the Federal Highway Administration's Congestion Pricing Pilot Program under ISTEA and TEA-21's Value Pricing Pilot Program. The Minnesota coalition was especially inspired by the success of the Orange County's SR-91 HOT lanes. In 1997, the state legislature approved an HOT lane demonstration project on I-394, a heavily congested route into Minneapolis's western suburbs.



Figure 5: Location of I-394 (Minnesota Department of Transportation, 2005)

Studies had concluded that the existing HOV lanes along I-394 were underutilized and the best use of the capacity would be open them up to general use. However, if the HOV lanes were opened up to all vehicles, the state would lose critical federal funding. Transportation officials therefore recommended to following San Diego's I-15 example and converting the existing HOV lanes to HOT lanes. However, the proposal was met with resistance from the public and was subsequently withdrawn. Although there was also some talk of introducing value pricing to the reconstruction of the I-35W and TH62 common areas, these proposals were also rejected as too controversial for the already complex projects. These failures highlighted the importance of fostering public support for future proposals (Buckeye & Munnich, 2004).

Not to be deterred, a 30-member Value Pricing Advisory Task Force, which consists of state legislator, mayors, and business, environmental and transportation leaders, pushed for another demonstration project starting in 2001. Led by researchers at the Hubert Humphrey Institute at the University of Minnesota and funded through FHWA value pricing grants, the coalition continued to champion for the implementation of value pricing through a communication campaign. As a result of this outreach work, public acceptance began to grow.



Figure 5: MnPass Lanes (MnDOT, 2006)

support, along with the backing of a newly elected Governor Tim Pawlenty and Lt. Governor and Transportation Commissioner Carol Molnau, led to the passage of 2003 legislation that allowed for the conversion of HOV lanes to HOT express lanes. The legislation also stipulated that revenue is to be used first to pay back the state trunk highway fund for the costs of implementation and administration of the project. Any excess revenue is to be split to enhance transit service in the corridor and to expand road capacity in the corridor. At the time, Minnesota Congressman Mark Kennedy was also promoting the introduction of FAST lanes at the national level, which would permit states to use toll revenue to add capacity to existing interstate highways. His efforts highlighted Minnesota's commitment to exploring innovative transportation policy approaches (Buckeye & Munnich, 2004).

With the legislation and public support in place, the Minnesota HOT lanes opened along I-394 in May 2005. The lanes feature dynamic pricing, with tolls for non-carpools varying from

Beyond the education campaign, several other factors may have helped bolster more support than the earlier attempt. At the time the state budget deficit exceeded \$4 billion, and the governor had pledged no new taxes. Furthermore, the Minneapolis-St. Paul metropolitan area's population was rapidly growing, exacerbating the already congested road network. Under these circumstances, state politicians reached an agreement that transportation issues needed to be placed at the forefront of policy debates. This bipartisan

25 cents to \$8.00 depending on congestion levels (United States Government Accountability Office, 2006). The project was implemented as a public-private partnership between the State of Minnesota and service vendor Wilbur Smith Associates, with the firm funding 20 percent of the project.

Receiving high levels of public support since its introduction in 2005, the MnPass program is largely considered a success by the Minnesota Department of Transportation, who claims that traffic in the HOT lanes maintain the speed limit for 95% of the time. The successful implementation of the MnPass illustrates the importance of building a broad coalition of support, the role that the federal government can play, and the importance of emulating successful models.

Key Motivations:

- Primary
 - Increasing congestion
 - Follow San Diego's I-15 model
 - Political champions/broad coalition
- Secondary
 - Public-private partnership
 - Budget deficit
 - Coalition supported both new road capacity and transit investment
 - Federal incentives



Santiago, Chile: Rapid Economic Development Leads to Demands on Infrastructure

Due to rapid economic gains, the strain on Santiago's road network became overwhelming. In order to fund the quick expansion of the road network, Santiago turned to private sector investors, who introduced variable tolls on the new facilities.

As a rapidly increasing portion of the population owns and drives cars, planners in Santiago saw the city increasingly choked by rising levels of traffic congestion and air pollution. Chilean transportation infrastructure was failing to keep pace with the rapid economic development during the 1980s

and 1990s. The vehicle fleet in Chile had increased from 900,000 in 1982 to 1.3 million in 1992 with traffic accidents nearly doubling over the same decade (Lorenzen, et al, 2000). The government tried to reduce the number of vehicles on the road by license-plate number schemes. However, the need for new roadway construction to reduce congestion became evident. At the time, the government was also under intense pressure to expand social services in addition to

improving transportation infrastructure. Given such competing demands, the government turned to the private sector to fund the necessary transportation infrastructure improvements (Constance, 2004). By developing concessionaires to finance the needed highways, the government was able to avoid raising taxes or increasing public debt. In addition to financing the projects, the private sector was involved in the management of the construction, maintenance, and operation of the projects (Constance, 2004).

The government commenced developing a legal and regulatory framework in 1994 and then opened the road concessions to proposals from international firms. During the bidding process, the criteria considered included the following: rate structure and level; the subsidy requested from the state; payments to be made by the concessionaire for the use of preexisting infrastructure; minimum revenue levels guaranteed by the state; and the distribution

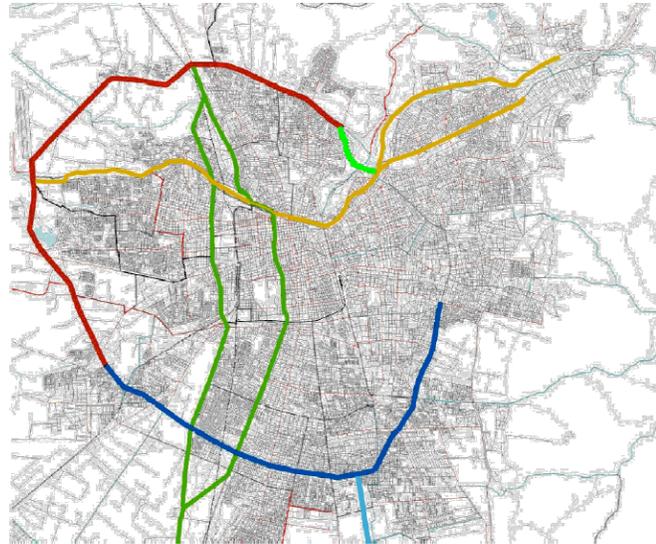


Figure 5: Santiago ETC System (Commission for Integrated Transport, 2006)

of risks between the state and the concessionaire (Lorenzen, et al., 2000). In total, 21 road concessions were awarded across Chile between 1993 and 2001, resulting in 27 consortia with more than 40 Chilean and foreign firms. In Santiago, four major urban toll roads were constructed around the metropolitan area under agreements with private consortia with the final road opening in 2006 (Commission for Integrated Transport, 2006).

In order to be guaranteed a return on their investment, the private investors would need to toll the facilities. Starting in 2004, drivers on these road networks were assessed a fee based on both distance traveled and time of day. The Santiago model is unique because of the level of integration achieved among the various toll roads, which are each managed by a separate concession agreement. Drivers need only one transponder and receive one bill at the end of the month detailing charges on all four toll roads. Additionally, the fee varies by congestion levels on the road network to assure free-flowing traffic. The charges are all collected electronically.

Due to the apparent success and public acceptance of the initiative, discussions have moved towards introducing congestion charges on the rest of Santiago's road network (Commission for Integrated Transport, 2006).

Key Motivations:

- Primary
 - Public-private partnerships
 - Fund new capacity
 - Growing congestion
 - Limited revenue
- Secondary
 - High levels of air pollution
 - Economic development



Figure 5: Santiago Tolling (Transit New Zealand, 2007)

CORDON TOLLS

Singapore's Road Pricing: No Political Barriers

Due to Singapore's unique political structure, its transportation leaders were able to implement manual cordon tolls prior to technological developments that made the scheme politically more feasible elsewhere. Singapore adopted the tolls to efficiently manage the business district roadways and establish its position as a prominent business center.

conditions and the economic prowess of the city-state. Its leaders wanted to establish Singapore as a major South-East Asian business center in the manufacturing, commercial, and trade industries, and an uncongested central business district was seen central to this objective. The dense development and geographic nature of the city made it virtually impossible for Singapore to significantly increase road capacity, so the government had to consider alternatives.

Accordingly, the government adopted a two-pronged approach to reducing congestion: limit vehicle ownership and reduce vehicles on the road. Vehicle ownership was suppressed by imposing a tax on new vehicle registration starting in 1972. Dissatisfied with the effectiveness of this tax, the government introduced a vehicle quota system in 1990, which limited the numbers of vehicles (May & Sumalee, 2003).

Singapore pioneered the implementation of road pricing years before the concept became politically feasible elsewhere. As rising incomes made vehicle ownership increasingly commonplace, congestion on the streets of Singapore increased significantly. The severe congestion threatened both the environmental

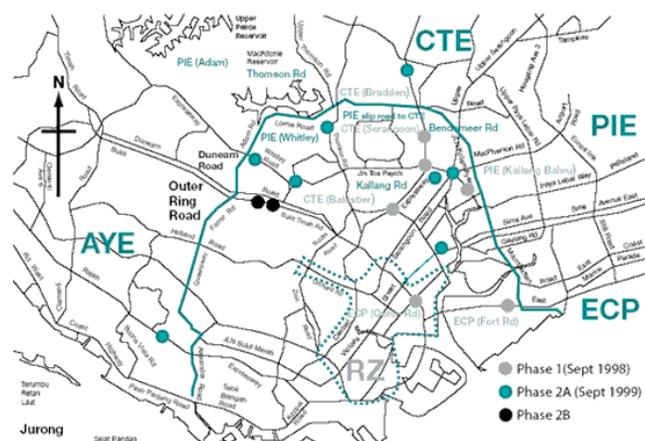


Figure 6: Map of Area License Scheme in Singapore (Commission for Integrated Transport, 2006)

In addition to limiting vehicle ownership, the Singapore Government's Land Transport Authority (LTA) attempted to keep vehicles off the road by implementing a road pricing scheme, making Singapore the first jurisdiction in the world to do so. In 1975, the area licensing scheme (ALS) limited vehicles in the central business district by requiring drivers to purchase a permit to drive into the central business district during peak hours along the major routes.

Since the technology was not developed at the time, the scheme was enforced manually with police officers at the designated check points. The scheme experienced marked success in shifting trips from private vehicles to public transit with public transit ridership increasing from 33% of commuting trips in 1974 to 67% in 1992 (May & Sumalee, 2003). Although a significant portion of trips into the central business district was diverted to feeder roads, the government addressed this traffic spillover problem by introducing a manually-operated road pricing scheme in 1995. In this scheme, the road pricing scheme extended the charge to enter the restricted downtown zone to include the three expressways and the congested feeder roadways.

Since the manual operation of these systems was cumbersome and expensive, the government introduced the electronic road pricing system (ERP) in 1998. Unlike the original scheme, where drivers purchased a pass that allowed them to cross into the cordon area for the entire day, the ERP charges vehicles on a per crossing basis. The technology of the ERP also allows for fee variation according to type of vehicle, time of day, location, and day of the week. The ERP resulted in a 17% traffic volume reduction.



Figure 7: Singapore ERP (Commission for Integrated Transport, 2006)

Unlike later cordon tolling projects, Singapore planners did not target revenue from the tolls solely towards transportation improvements, but instead placed the funds into the general government revenue (Jones, 2003). Even though revenue was not specifically dedicated to transit improvements, the government did undertake an extensive improvement of their mass transit system in 1988 with ALS funding (May & Sumalee, 2003). Of course, the unique political situation in Singapore allowed the government officials to implement the tolling project without the planning and political process that for years hindered so many other attempts of similar schemes. Additionally, Singapore was able to implement road pricing prior to the development of modern electronic tolling technology that enabled the rapid expansion of road pricing programs today. But even in the early case of Singapore, once the electronic road pricing

technology was introduced, the feasible possibility multiplied and the system was run much more efficiently.

Key Motivations:

- Primary
 - Increasing congestion
 - Economic competition
- Secondary
 - Environmental pollution
 - Limited space for new capacity
 - Political structure

Stockholm Congestion Fee: Evolving Program Reflects Evolving Goals

Propelled mainly by a concern about degrading environmental conditions, Stockholm officials introduced a congestion fee for travel within the central city. The improvement of the city's public transit system served as an essential component in the acceptance of the plan.

Originally introduced on a trial basis, Stockholm's congestion tax became a permanent element of Swedish transportation policy in September 2007 amid high levels of support among Stockholm residents. Like other cordon pricing schemes, the improvement of the city's public transportation network played a critical role in the development and

acceptance of the plan. Today, vehicles that pass within a 29.5 square-kilometer ring around central Stockholm are assessed a congestion tax varying by time of day. Stockholm's plan was motivated largely by desire to reduce levels of traffic congestion and improve accessibility to the city center. By reducing congestion, the government also hoped to enhance residents' perception of the street-level environment and reduce the levels of harmful greenhouse gas emissions (Miljöavgiftskansliet/Congestion Charge Secretariat, 2006).

Although Stockholm already possessed a well-developed public transportation system, increasing traffic congestion in the urban core was a growing cause of concern. Stockholm is located on a series of islands, connected together by a network of bridges. These limited access points result in heavily congested road networks. Despite recent and planned improvements to the road networks, including the New Arsta Bridge and the South Link tunnel, road capacity remained inadequate to handle the continued growth of vehicle travel. In autumn 2005, surveys

found that over half of Stockholm residents were concerned that worsening traffic congestion was contributing to poor air quality, and three-quarters felt that congestion was particularly acute on radial streets leading into the city center. That year, 73 percent of rush hour trips into and out of the inner city were on public transportation. Despite this very high transit mode split, during these peak travel periods traffic congestion on the major radials and arterials leading to Stockholm's inner city was still significant (Civitas, 2006).

The idea of implementating congestion pricing in Stockholm was first discussed in the 1970s, and a plan was proposed in the late 1980s but failed to garner adequate support. In 1992, the so-called "Dennis Agreement," a compact between three political parties in Stockholm City and Stockholm County, proposed to construct a ring toll road around the inner city and improve public transit with revenue from the congestion tolls. However, a final agreement on the project was never reached, and the proposal was finally abandoned in 1997 (Harsman, 2003; May & Sumalee, 2003).

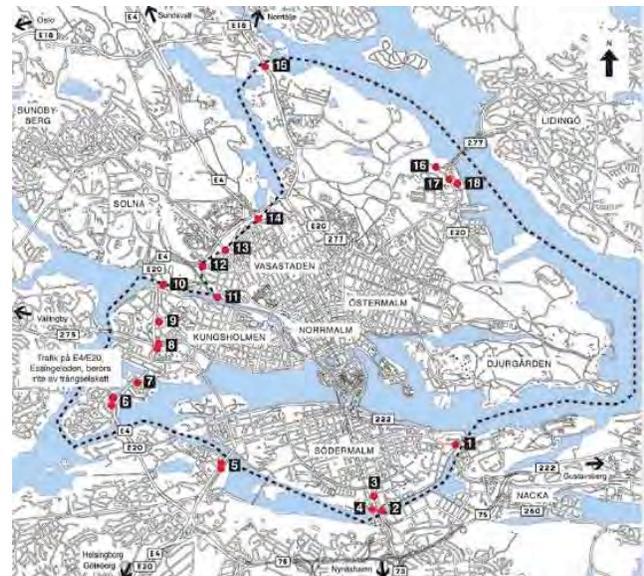


Figure 8: Map of Stockholm Congestion Fee Cordon (Commission for Integrated Transport, 2006)

By the end of the 1990s, mounting environmental concerns led to renewed political pressure to address traffic congestion. A new program was developed allowing local municipalities to take the lead on congestion charging. Among the diverse agencies pushing for congestion pricing were the Swedish Society for Nature Conservation, the Swedish Institute for Transport and Communications Analysis, and the Swedish Environmental Protection Agency (May & Sumalee, 2003). The 2002 Swedish general election led to an agreement between the Social Democrats, the Left Party, and the Green Party that included a provision allowing the conduct of a trial run of a congestion tax in Stockholm. In June 2003, Stockholm City Council passed a proposal to introduce congestion pricing trials, and the Swedish Parliament, the Riksdag, passed the Congestion Charges Act in June 2004, allowing Stockholm to proceed with the trial (Civitas, 2006).



Figure 9: Stockholm Congestion Fee (Commission for Integrated Transport, 2006)

While the primary goal of the Stockholm congestion fee was to reduce the number of vehicles on the busiest roads during peak periods, financial improvements to the city's public transit system played a key role in the trial. By reducing congestion and enhancing public transit, planners aimed to improve sustainable accessibility to Stockholm's downtown core. In order to maintain access to the city center throughout the trial, improvements to the public transportation system began prior to the implementation of the congestion tolls. The improvements constituted the largest coordinated expansion of the transit system since the initial Underground subway construction project in the 1950s (Civitas, 2006). Most of the public transportation improvements focused on enhancing bus service by introducing new routes and new buses. Rail lines and existing bus lines were improved as well. Finally, park-and-ride sites received funding for improvement (Civitas, 2006). The seven-month trial of the congestion tolls commenced in January 2006.

At the conclusion of the trial period in July 2006, the Congestion Charge Secretariat evaluated the trial run by examining a number of criteria that reflect the aims and motives behind the implementation of congestion pricing. During the congestion toll period, the Secretariat study determined that traffic in Stockholm decreased by 22 percent, exceeding expectations, and public transit ridership increased by six percent. The study also concluded that carbon dioxide emissions within inner-city Stockholm decreased by 40 percent. The effect of the reduced congestion levels on perceptions of the urban environment was more difficult to measure accurately (Miljöavgiftskansliet/Congestion Charge Secretariat, 2006). Prior to the referendum on whether to make the congested tolls permanent, the Swedish government distributed to all residents a pamphlet summarizing the results of the congestion fee trial.

In a general referendum in September 2006, residents of Stockholm voted in favor of maintaining the congestion fee, while residents of outlying suburbs voted to do away with it. In this same election, the Green Party, whose leaders had originally introduced the congestion scheme, was voted out of office. However, a new Alliance of center-right parties collectively decided to reinstate the congestion fee, honoring the Stockholm resident's vote. During political debates over whether to continue the fee, a compromise altered the use of revenue from the congestion tolls to be divided between new road construction in and around Stockholm and transit improvements, instead of the policy during the trial of using the funding solely for transit (Savage, 2006).

6:30 – 6:59 AM	SEK 10 (USD 1.26)
7:00 – 7:29 AM	SEK 15 (USD 1.89)
7:30 – 8:29 AM	SEK 20 (USD 2.52)
8:30 – 8:59 AM	SEK 15 (USD 1.89)
9:00 AM – 3:29 PM	SEK 10 (USD 1.26)
3:30 PM – 3:59 PM	SEK 15 (USD 1.89)
4:00 PM – 5:29 PM	SEK 20 (USD 2.52)
5:30 PM – 5:59 PM	SEK 15 (USD 1.89)
6:00 PM – 6:29 PM	SEK 10 (USD 1.26)

This shift in revenue use illustrates the importance of the political party's goals in determining the structure of the program as the motivations behind the continuation of the congestion fee differed from the original intent. The modified congestion fee was reintroduced in September 2007. While the congestion fee significantly reduced on congestion, time will tell whether the acceptance of this new congestion fee will increase now that funding goes towards new road capacity and public transit improvements.



Figure 10: Stockholm Roads (Naparstek, 2006)

Key Motivations

- Primary
 - Reduce congestion and improve accessibility
 - Reduce harmful emissions
 - Improve environmental conditions within city
- Secondary
 - Invest in public transit
 - Finance new road capacity
 - Political compromise

Source: Vägverket (<http://www.vv.se>)

London's Congestion Pricing: Paving the Way for the Implementation of Pricing

In order to solidify its place as a worldwide financial center, London's Mayor considered the implementation of congestion pricing essential to creating a reliable and efficient transportation network. Without Mayor Livingstone's political tenacity, it is doubtful the scheme would have been implemented.

In May, 2000, residents of greater London elected Ken Livingstone as their Mayor and in doing so took a step towards dramatically altering the future of transportation policy in London. Leading up to his election, traffic congestion was a

mounting concern on the streets of London with little possibility of adding new capacity to the road networks. Additionally, the underground subway system required significant repairs and upgrading. Livingstone's election platform included the proposal to enact congestion pricing to reduce traffic in central London, and using the toll revenue to improve the public transit system (Santos & Shaffer, 2004). In addition to reducing vehicle emissions levels, Livingstone was motivated to introduce congestion pricing to maintain London's economic vitality, which was threatened by the growing congestion levels. The business community provided Livingstone with a strong base of support in introducing the congestion pricing (May & Sumalee, 2003).

The Greater London Authority (GLA) Act passed in 1999 granted Livingstone the power to impose congestion charges for the first time. Although the origins of the London scheme can be traced back to 1964, Livingstone was the first London mayor armed with the power to finally put theory into action. The 1964 Smeed report originally outlined the principles of congestion pricing for London, but due largely to a lack of appropriate technology, the plan could not be implemented at that time. In 1967, the U.K. Ministry of Transport published *Better Use of Town Roads*, which proposed charging a flat fee within a cordon area. This proposal was expanded on in the Greater London Council's Supplementary Licensing plan of 1974, which aimed to reduce car traffic entering the cordon area by 45 percent. The Greater London Council leaders seriously

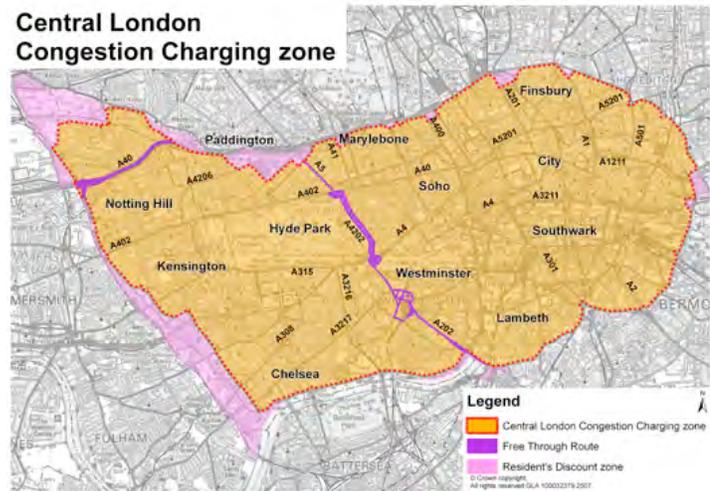


Figure 11: Map of London Congestion Charging (Transport for London, 2007)

considered implementing the proposal, but ultimately rejected it out of concerns regarding equity and economic implications. In the 1990s, road pricing entered a policy discussion again in the United Kingdom due to a loss in faith in transportation policy that focused on providing additional capacity (May & Sumalee, 2003). In 1992, the UK government studied the feasibility of London congestion charging, which ultimately resulted in the Labor government's passage of legislation in 1998 that provided local governments the authority to implement congestion pricing. Thus, when Livingstone took the office, the legislative framework had been laid for the implementation of long-planned congestion pricing.



Figure 12: London Congestion Pricing (Varone, 2007)

Prior to the implementation of the scheme, an extensive outreach campaign focused on improving public acceptability through meetings with key stakeholders, distribution of thousands of information leaflets on the proposed scheme to all London boroughs, and newspaper and radio advertisements

containing details of the scheme and information about participating in the consultation process (Santos & Shaffer, 2004). Additionally, the proposal was met with acceptance because it was presented as one component of a broad transportation strategy, including public transit investments, signal improvements, and infrastructure repairs (Turner, 2003).

Enacted on February 17, 2003, the London scheme charges motorists £5 (USD 9.90) to enter or drive within the cordon area in central London. The original cordon area incorporates 22 square kilometers and covers the city's major centers of government, law, business, finance, and entertainment (Sorensen, 2006). Upon entry into the cordoned area between the hours of 7:00 AM and 6:30 PM on weekdays, cameras in an automatic number plate recognition system record the vehicle license plates, which are then stored in a database. Drivers can pay the charge via a website, by text message, in shops equipped with a PayPoint, or by phone. If the payment is not received by the following day, the driver is charged a fine.

Following Livingstone's re-election, in 2005, the congestion charge was raised to £8 (US \$12) to enter or to drive within the cordoned area between the hours of 7:00 AM and 4:00 PM

Monday through Friday. The charge does not apply on weekends, English public holidays, designated non-charging days, and between 4:00 PM and 7:00 AM. If the charge is not paid on the same day it was incurred, the fee is raised to £10 (US \$15). In February 2007, the scheme was expanded from central London to incorporate portions of western London.

When originally developed, Livingstone's scheme aimed to reduce traffic by 10-15 percent year-round, increasing transportation reliability within London. According to the Transport for London's 2007 Annual Report, traffic levels entering the cordon zone in 2006 were 21 percent lower than levels in 2002 (Transport for London, 2007). In 2006/2007, the congestion pricing had generated a net revenue of £123 million (US \$248 million), which was spent on public transit improvements, specifically focused on enhancing bus services (Transport for London, 2007).

Beyond mitigating London's traffic congestion, the scheme plays a significant role on the global level, paving the way for congestion projects elsewhere. While Singapore had implemented congestion pricing decades earlier, London is the first major city in a democracy to enact congestion pricing, proving that the policy is politically viable (Hensher & Puckett, 2005).

Key Motivations:

- Primary
 - Political champion
 - Congestion inhibiting economic development
 - Legislative changes
- Secondary
 - Lack of space to build new capacity
 - Improve public transit

New York City Congestion Pricing Proposal: An Ultimately Unsuccessful Plan for Economic Sustainability

In December 2006, New York City Mayor Michael Bloomberg challenged New Yorkers to develop a comprehensive plan to address sustainability issues within the city. With a burgeoning population and waxing global climate change concerns, New York City, Bloomberg argued, needed a vision for the future. Between 2006 and 2010, the Department of City Planning projected that the population of New York will increase by 200,000 people, and the total population will exceed nine million by 2030, up from 8.2 million today. Additionally, New

Following the success of the London congestion pricing scheme, New York City's Mayor Michael Bloomberg developed a similar proposal for New York. Although the plan was originally pitched as a component of the city's environmental sustainability plan, congestion pricing is perhaps more important to the city's economic sustainability.

York City accounts for one percent of the total carbon emissions within the United States, a level equivalent to the emissions for the entirety of Ireland (The City of New York: Michael R. Bloomberg, 2007). After several months of development, Mayor Bloomberg introduced PlaNYC, a collection of 127 sustainability initiatives that incorporate improvements to land, air, water,

energy, and transportation policy.

One of the most controversial elements of PlaNYC was the Mayor's congestion pricing proposal, which aimed to relieve congestion for the dual purpose of reviving economic activity in New York City's central business district and reducing harmful emissions. The final proposal would have imposed a fee on drivers who travel below 60th Street in Manhattan between 6 am and 6 pm (Traffic Congestion Mitigation Commission, 2008). Vehicles traveling within the designated zone would have

been charged \$4 during designated peak hours. In particular, trucks would be charged a higher fee of \$21 to travel in this designated area while low-emission trucks would pay \$7. The stated goal was to reduce vehicle miles traveled in Manhattan south of 86th Street by 6.3 percent (Interim Report to the Traffic Congestion Mitigation Commission, 2008).

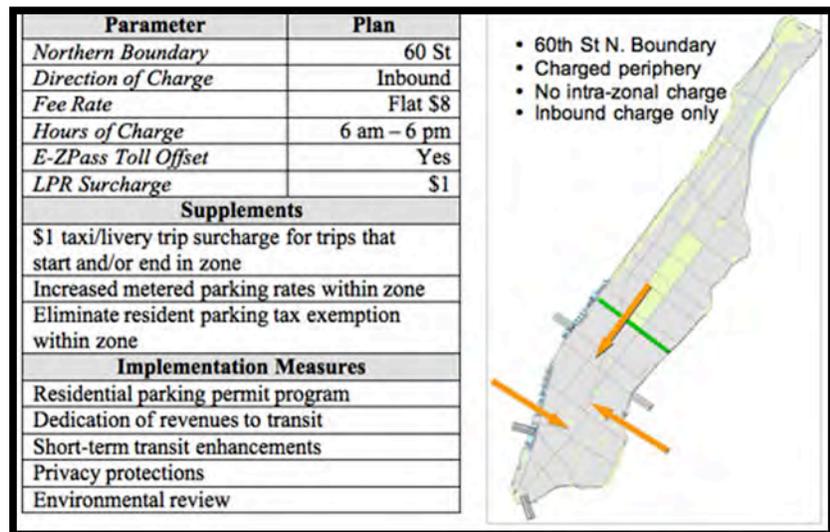


Figure 13: New York Traffic Congestion Mitigation Commission Recommendation (Traffic Congestion Mitigation Commission, 2008)

Like London, the congestion pricing proposal also aimed to raise revenue for the city's public transit system. Although ideas for congestion pricing in New York City have been around

since the 1950s, Bloomberg became the first high-level champion for implementation of the plan as congestion levels have soared. Eighty-seven percent of New York City voters viewed traffic congestion as very serious or somewhat serious problem in 2007, providing Bloomberg with public support in addressing transportation concerns (Quinnipiac University Polling Institute, 2007).

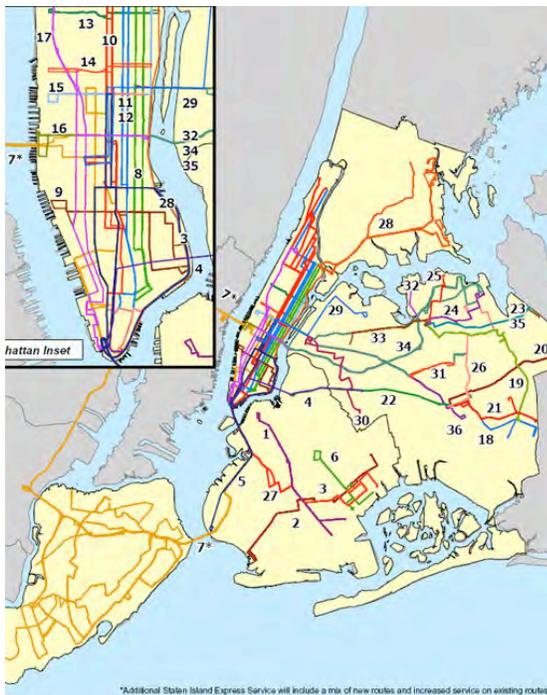


Figure 14: Proposed Bus Service Expansion (Traffic Congestion Mitigation Commission, 2008)

Also similar to London, New York’s dense development limits space available to construct new road capacity. In addition, like Stockholm, the island geography of the city makes the implementation of congestion pricing more feasible since drivers access the cordon area through a limited set of access points. As was the case with Stockholm and London, the New York proposal dedicated significant funding to improving public transit (Traffic Congestion Mitigation Commission, 2008). As the cases in the two European cities illustrated, the dedication of revenue to transit improvements is critical in maintaining access to the central business district. It is also critical to achieving high levels of public support as polls indicated that New York

residents were more accepting of congestion pricing if funds were dedicated to mass transit improvements. In a Quinnipiac University Poll, New York City voters would have supported congestion pricing by a margin of 53-41 percent if it provided funding to prevent a hike in mass transit fares (Quinnipiac University Polling Institute, 2007).

The success of London congestion pricing scheme played a significant role in the initial development of Mayor Bloomberg’s congestion pricing proposal – not only as inspiration but as motivation to improve transportation reliability in an economically competitive world. Not only did Bloomberg now have a successful London model to point towards, but a certain trans-Atlantic competitive spirit over which city is the most important in the global financial capital market drove Bloomberg’s proposal. Traffic congestion is thought to inhibit economic

development by leading to corporations establishing offices in cities with more reliable transportation networks. While critics of congestion pricing fear that the additional fees will hurt economic growth, London and New York's economic development is more threatened by choking congestion levels, which prevent businesses from operating efficiently. New York City's business community supports the congestion pricing proposal, including the Partnership for New York City, a nonprofit organization dedicated to maintaining and enhancing the city's economy. A study by the Partnership for New York City estimated that New York City regional traffic congestion is responsible for losses amounting to \$3.252-\$4.022 billion to the Gross Regional Product and 37,623-51,512 employment losses across the region, with the greatest job loss in the financial sector (Partnership for New York City, 2006).

New York and London also vied for the 2012 Olympic Games, magnifying the rivalry between the two cities. To prepare for the bid, Daniel Doctoroff, the Deputy Mayor for economic development, extensively researched the competition between London and New York and commissioned a report from McKinsey to determine how New York could be most competitive with London (Schuerman, 2007). As part of the final PlaNYC proposal in 2007, competition with London was cited as a reason to support the proposal: "Our competition today is no longer only cities like Chicago and Los Angeles—it's also London and Shanghai. Cities around the world are pushing themselves to become more convenient and enjoyable, without sacrificing excitement or energy. In order to compete in the 21st Century economy, we must not only keep up with the innovations of others, but surpass them (The City of New York: Michael R. Bloomberg, 2007, p. 10)."

In August 2007, the New York City congestion pricing proposal was selected by the U.S. Department of Transportation as one of the five Urban Partners programs. These five projects are eligible for federal funds to assist in the exploration of pricing-based congestion reduction strategies. If New York had been able to get a congestion pricing scheme approved, the City and State would have received \$354 million for transit and transportation system improvements. As tempting as federal funds might have been in times of budget shortfalls, federal funding alone was not enough to persuade skeptic state legislators.

Despite the many motivations for introducing congestion pricing to New York City, the proposal was unable to overcome intense political opposition within the New York State

Legislature. Although the congestion pricing measure was approved by the New York City Council on March 31, 2007 by a 30-20 vote, the proposal died soon thereafter in the state legislature. Assembly Speaker Sheldon Silver contended that there was inadequate support among assembly members to justify voting on the legislation, effectively killing the project in April 2008. Much of the opposition at the state level focused on equity concerns, demonstrating the importance of satisfactorily addressing fairness issues in developing road pricing proposals. Despite the ultimate fate of the proposal, without the leadership of Mayor Bloomberg, it is unlikely that the proposal would have survived as long in the political process, highlighting the importance of a champion to see through controversial projects.

Key Motivations:

- Primary
 - Congestion inhibiting economic development
 - Political champion
 - Economic competition
 - London model
- Secondary
 - Environmental concerns
 - Federal legislation & funds

WEIGHT-DISTANCE TRUCK TOLLS

Austrian GO Truck Tolls: Geographic Conditions Result in Innovative Funding

The significant expense of road maintenance coupled with an increasing portion of foreign freight movement motivated Austrian transportation officials to implement a system of tolls. This tolling scheme allowed for private investors to play a role in infrastructure development and maintenance.

While the Alps create stunning scenery, they also lead to substantial challenges in developing a transportation network. The mountainous Austrian landscape requires numerous tunnels and bridges, greatly increasing the construction

and maintenance costs for the road and rail networks. In addition to the high costs, the Austrian road system was heavily used by foreigners as the nation's central European location. As a result, some of the higher cost sections of the roadways have been tolled since the late 1960s in attempt to impose the burden of road system costs on users from other countries. Despite these tolls, the Austrian government still lacked sufficient funds for the road system. And with the inception of the European Union, trade-related traffic was rapidly increasing, placing additional strains on the network.

To join the European Union in 1995, Austria needed to reduce its debt to satisfy EU requirements. One strategy pursued was to generate new construction and maintenance revenues for Austria's high-cost roadway system. Austrian officials decided to seek private sector investors to take on road system debts by selling the rights to the entire motorway network to ASFINAG, a state-owned stock company. In 1996, the Austrian Parliament passed legislation permitting ASFINAG to impose tolls on its motorways. In 1997, ASFINAG introduced a time-based sticker system wherein vehicle owners purchased a sticker for a fixed rate for time periods ranging up to two years that allowed them to travel on any Austrian motorway (Schwarz-Herda, 2005).

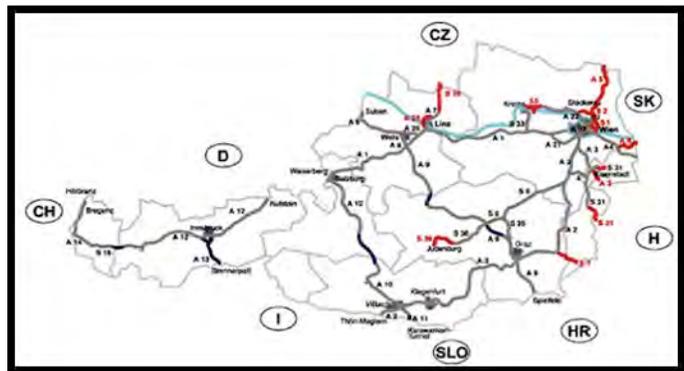


Figure 15: Map of Austrian Road Network (Commission for Integrated Transport, 2006)



Figure 16: Austrian Tolls (Commission for Integrated Transport, 2006)

In 2001, ASFINAG began seeking bids for the implementation of an electronic tolling system to partially replace the manually-administered sticker system. The bid eventually went to the Italian firm, Euroypass, which is a subsidiary of Autostrade, an Italian motorway concessionaire. The electronic tolling system was fully implemented in January 2004. Now all vehicles exceeding 3.5 tons must pay an electronic distance-based toll, while lighter vehicles still pay a time-related toll via the sticker system. The heavier vehicles are equipped with a so-called “GO-Box,” which tracks the progress of the vehicle over the Austrian road network. Higher toll rates apply to portions of the road network that cross the Alps and had previously been tolled. Larger trucks with higher emissions are also assessed higher toll rates. Toll revenues are dedicated to the maintenance, operation, and upgrades of the road network. To date the state-owned motorway company is entirely financed through these new tolls and receives no additional governmental funding.

In recent years, the toll rates have come under some scrutiny from the European Commissioners who have requested lower rates. However, Austrian officials contended that the tolls were justified because of recent increases in traffic diverted from the parallel routes through the Swiss Alps due to Switzerland’s new toll for heavy goods vehicles. Both the Austrian and Switzerland road networks cut through environmentally sensitive Alpine areas, and thus, argued Austrian officials, environmental concerns justified maintaining the road pricing scheme (Schwarz-Herda, 2005). While the environmental goals may have proven essential in defending the tolls, the original motivations lay elsewhere – in a desire to transfer debt to the private sector and raise revenue to finance the expensive-to-maintain Austrian road system.

Key Motivations:

- Primary
 - Revenue shortfalls
 - Public-private partnership
 - Desire to impose costs on users

- Secondary
 - Funding new expensive capacity
 - Increase in trade traffic
 - Environmentally sensitive area

Switzerland's Heavy Vehicle Fee (HVF): A Long Political Battle to Protect the Alps

The motivations behind Switzerland's HVF mirror many of Austria's concerns. However, Swiss transportation officials and residents cited environmental concerns rather than fiscal concerns for their implementation of the HVF.

Similar to Austria, Switzerland's central European location resulted in heavy use of the nation's roadways for foreign goods movement, which imports a disproportional amount of roadway damage and congestion from elsewhere. The dilemma of properly allocating

roadway costs among users has been the center of Swiss transportation policy debates for years. Back in 1972, the Swiss government commission concluded that the heavy vehicles traveling on Swiss roads were not covering the costs these vehicles imposed on the highway system. In response, the Swiss officials began developing a user fee system for freight transport. Although the commission recommended in 1972 a fee that varied to reflect costs imposed, the Swiss Parliament concluded that this type of fee was not technologically feasible (Balmer, 2004).

The 1980 opening of the St. Gotthard road tunnel facilitated a rapid increase in heavy truck movements across the Swiss Alps, particularly on the north-south routes. In order to shift some of these costs onto road users, Switzerland introduced in 1983 a flat fee on heavy trucks in addition to a motorway user permit, which was a flat fee for passenger cars (Balmer, 2004).



Figure 17: Swiss Border Crossings (Kallweit, 2003)

The flat fee was quickly contested by the Swiss Association for Transport & Environment (ATE), whose leaders pushed for performance-related fees that were considered necessary to promote a more environmentally-conscious freight transport. Additionally, Swiss officials considered road pricing in the mid-1980s, but as a short-term method to address

environmental concerns and concluded that the ultimate goal of Swiss goods movement policy should be to shift freight travel from road to rail. In order to achieve this objective, two new rail tunnels extending across the Alps would need to be constructed. The proposed new rail lines would be funded by a combination of loans and vehicle excise taxes.

The proposal was heavily criticized by both environmentalists and drivers groups. These debates dragged on until 1992, when a majority of Swiss voters gave the projects the green light. Voters' support stemmed largely from popular support for improving public transportation, addressing ecological concerns, decreasing traffic on roadways, and achieving international economic integration (Balmer, 2004). In 1994, the Swiss voters supported performance-related road user fees in a referendum entitled, "Initiative for the protection of the Alpine region against transit traffic," which sought the transfer of all freight through the Swiss Alps from road to rail. Although the Swiss government rejected the proposal as unduly discriminatory against trucking, it developed in response a compromise proposal to enact performance-related fees on trucks (Balmer, 2004).

Following the 1994 vote, the Swiss Transport Ministry drafted a law for the implementation of the fee, which was met with a great deal of criticism. Specifically, questions were raised over: (1) the proposal to calculate the fee based on consumption of diesel fuel and engine emissions, rather than performance, (2) a fear of shippers moving to more, lighter vehicles in order to avoid the paying the fee, (3) the lack of a reliable technology currently on the market, and (4) a desire to wait until the EU developed an official road pricing policy. After the rejection of this law, Switzerland entered a new round of negotiations with the EU that resulted in a compromise where higher weight limits were permitted for trucks and longer hours of freight operation were allowed in exchange for the right to impose substantial user charges on heavy trucks. Collectively, these compromises were thought to allow trucking firms to maintain efficient operation in a new regime of user fees.

This new compromise proposal was voted on in a national referendum in 1998. The proposal received majority support from the Swiss populace, and the Heavy Vehicle Fee (HVF) was implemented in January 2001. The introduction of the HVF was possible due to the Swiss decision not to join the European Economic Area (EEA) in 1992. If Switzerland had joined the EEA, EU regulations would have limited the ability of Switzerland to enact performance-related

fees (Balmer, 2004). Additionally, if Switzerland were a member of the EEA, the Swiss industry most likely would have rejected the HVF bill. Thus, most observers agree that the Swiss people supported the HVF bill in the interests of protecting the environment and in solidarity with the communities living along roadway routes.



Figure 18: Swiss Control Gantries (Commission for Integrated Transport, 2006)

The HVF applies to vehicles over 3.5 tons and is calculated based on: (1) the distance driven on Swiss roadways, (2) the weight in excess of 3.5 tons, and (3) the emissions class of the vehicle. All Swiss heavy vehicles are equipped with an on-board unit, which records mileage within Switzerland and all foreign vehicles are either equipped with the on-board unit or receive a chip card that stores the relevant information. As of 2002, approximately 22 percent of HVF charges were paid by foreign vehicles. The HVF revenue is dedicated entirely to improving transportation infrastructure, with two-thirds of the revenue set aside for financing national rail projects with the remaining revenue going towards road construction and maintenance (Commission for Integrated Transport, 2006).

The implementation of the Swiss HVF highlights the complex political process behind the introduction of any road pricing scheme. While the original policy goals to shift more freight transport from road to rail (and thereby aiding in protecting the sensitive alpine region environments) remain intact, compromises along the way may have shifted the structure of the model to address a broader array of concerns, such as improvements to public transportation and international economic integration. In the Swiss case, a long-standing interest in road pricing was realized with the availability of reliable technologies that made the HVF a reality.

Key Motivations:

- Primary
 - Environmental concerns
 - Desire to impose costs on users
- Secondary
 - Use of facilities by foreigners
 - Legislation/unique political situation

- New capacity
- Technological advances

German Toll Collect: Imposing Costs on Foreigners

Like Austria and Switzerland, Germany experienced increasing levels of freight travel as the European Union opened up new trade routes. In order to offset the costs these new users imposed on the road networks, Germany introduced the Toll Collect program, which is the first large-scale operation road pricing project to utilize satellite-based electronic fee collection technology.

Located in the heart of Europe, Germany has long served as a central hub for European transport. Estimates indicate that up to 35% of truck travel miles are by foreign vehicles or 470,000 of the 1.2 million heavy goods vehicles on the road each year (Hensher & Puckett, 2005). The Single European Market and the development of the European Union have

increased the amount of intra-European trade and levels of freight traffic traveling through Germany. Current projections are for truck traffic to increase by 64% between 2005 and 2015 (May & Sumalee, 2003). As freight travel has increased, so has the strain on the roadway systems, and the costs to maintain and upgrade these roadways.

Germany, of course, is not alone among European nations witnessing significant increases in foreign freight transport. In 2001, an alliance of countries, including Belgium, Denmark, Germany, Luxembourg, the Netherlands, and Sweden, imposed a license charge on all trucks exceeding 12 tons, with fees varying according to number of axles and engine emission levels (May & Sumalee, 2003). However, with the expansion of the EU to the east, freight traffic in and through Germany continued to grow. In response, the German government sought to incorporate distance fees for heavy trucks on German roadways. On April 12, 2002, the Motorway Toll Act for Heavy Commercial Trucks was approved, providing the legal basis for collecting the new, distance-based toll with the revenue going towards infrastructure projects (May & Sumalee, 2003).

In January 2005, Germany introduced the German Toll Collect System, which electronically charges all trucks over 12 tons fees that vary according to distance traveled, weight of the vehicle, and vehicle emissions. The program is administered by Toll Collect, a consortium formed by Daimler, Deutsche Telecom, and Cofiroute, on behalf of the German Federal

government (LKW-MAUT, 2008). Every truck is equipped with an on-board unit that utilizes GPS and digital road maps to track the vehicle's use of the highway network and assesses the appropriate fee automatically. Although some trucks still pay tolls manually, the German Toll Collect System is the first large-scale operation road pricing project that utilizes satellite-based electronic fee collection technology (Hensher & Puckett, 2005).

The motivations behind the German Toll Collect system are fourfold. First, the toll collect system aims to maximize the use of roadway capacity. Second, it seeks to raise revenue for maintenance and capacity expansion. Third, the program aims to allocate the costs imposed on the infrastructure fairly to the users with part of the goal to rectify the price ration between rail and road sectors. Finally, Toll Collect is designed to provide incentives to utilize the best of environmental technology to reduce the environmental costs of freight transport (Rothengatter & Doll, 2002).

While Austria and Switzerland experienced drawn out political debates in the implementation of their road pricing schemes, German officials were able to develop and introduce Toll Collect in a much shorter time frame, perhaps in part due to the Austrian and Swiss tolling precedence.

Key Motivations:

- Primary
 - Desire to impose costs on users
 - Raise revenue
- Secondary
 - Environmental concerns
 - Public-private partnerships

MILEAGE BASED USER FEES

Oregon's Mileage Fee Concept: Replacing an Unsustainable Revenue Source

The trial for Oregon's Mileage Fee was primarily motivated by the declining power and unsustainability of the current fuel-tax system. As nearly all other states are faced with similar funding crises, the trial has received substantial interest from transportation officials across the country.

Like all other U.S. states, Oregon's main source of revenue for repairing, maintaining, and constructing roadways is the motor fuel tax. In fact, Oregon led the way in establishing this tax in 1919. Today, the state is leading all states in efforts to replace the venerable levy. Although

several attempts had been made to raise the state gas tax in the 1990s, none was able to gather enough political support for passage. Because it is levied per gallon, the buying power of the fuel tax is eroded both by inflation and increasing vehicle fuel efficiency. The Oregon fuel tax now stands at 24 cents/gallon, with the last fuel tax hike taking place in 1993. In 2001, the Oregon House Transportation Committee began discussing the declining buying power of the fuel tax due to the increased popularity of alternative fuel vehicles and increased vehicle fuel efficiency. While the committee members viewed the new vehicles as a critical step in cutting carbon emissions, the inevitable consequence of moving to alternative fuel sources is a decrease in gasoline consumption and, in turn, highway revenues, creating a major revenue crisis for the state's roadways (Whitty, 2007; Pryne, 2004).

As a result, Republican state representative Bruce Starr introduced a bill that led to the creation of the Road User Fee Task Force assigned with the mission "to develop a design for revenue collection for Oregon's roads and highways that could replace the current system for revenue collection (Whitty, 2007, p. vi)." In a 2003 report, the task force concluded that, as gas prices rise, cars will continue to become more fuel efficient. The committee concluded that in 2014 Oregon's fuel tax revenues would begin to decline in absolute terms. After researching several different funding schemes, the committee decided to proceed with a 12-month pilot program to test the technological and administrative feasibility of the Oregon Mileage Fee Concept. The pilot initiative examined the feasibility of incorporating some form of congestion charging into the design of the scheme.

Essential in developing the technology for the pilot program was the new Office of Innovative Partnerships and Alternative Financing, which allowed the Oregon DOT to avoid the

normal bureaucratic steps that often prevent partnerships with outside agencies and the private sector. Instead, the appropriate technology was developed with the assistance from two researchers at Oregon State University (Hunter, 2007). Additionally, Oregon received significant support from the Federal Highway Administration, which contributed \$2.9 million over six years.

The pilot program concluded in March 2007 and the task force determined that existing technologies make it possible to implement the program on a wide scale. The review also found potential for integrating a diverse set of criteria into the distance-based fees, such as congestion charging or emissions fees. The greatest challenge the committee identified would be the cost of installing mileage trackers on all vehicles. Not surprisingly, the most efficient approach to equip the vehicles would be for the car manufacturers to include the features. However, such a commitment by auto manufacturers would not be likely until other states (or countries) adopt similar initiatives (Graf, 2007).

As with other pricing projects discussed, the Oregon proposal serves as a model for other states and countries facing similar revenue crises. James Whitty, Manager of the Office of Innovative Partnerships and Alternative Funding, has become a vocal supporter of the mileage-based fees and continues to travel around the country promoting the benefits of the initiative (Hunter, 2007). States across the country are taking note of Oregon's successful pilot program with Minnesota, Texas, and Colorado all contemplating feasibility studies of their own.

Key Motivations:

- Primary
 - Revenue - replacement of gas tax
 - Funding from federal agency
- Secondary
 - Strong leadership

ELECTRONIC ROADWAY TOLLING: LESSONS FROM AROUND THE WORLD

These case studies of electronic roadway tolling innovations make clear the wide variety of unique circumstances behind the rise of electronic road pricing in cities, states, and countries across the globe. Does such situational diversity offer any consistent lessons for policymakers in California? We think so.

The problems motivating electronic tolling are surprisingly similar and enduring – revenue shortfalls, rising needs, and increasing congestion are widespread. What’s changed in recent years is the technology that now makes it possible to put decades of pricing theory into practice. But these cases clearly suggest that while technology may be necessary for implementation, it’s not sufficient. In most, if not all, of the cases, a strong political champion helped to push the project through obstacles to completion.

The accompanying tables (Appendix A) summarize the primary and secondary motivations behind the cases discussed in the preceding pages. The desire to reduce congestion is a primary motivation behind a majority of the projects discussed, followed closely by a need to raise revenue. Among facility congestion-toll projects, a desire for public-private partnerships and a need for new capacity were most common. Among the cordon-toll initiatives, public transit funding needs were most common, followed by concerns over the effects of congestion on regional economic development. In contrast, all of the weight-distance tolling projects were motivated first and foremost by a desire to impose costs onto outside users, and secondarily by a need to fund new capacity. The distance-based fees were also frequently motivated by the goal of charging users for the road damage and environmental costs users, and in particular trucks, impose on society.

Turning from facility type to geographic location, the European projects tend to be motivated by a desire to fairly and efficiently allocate costs among users, and in particular motivating users to reduce vehicle emissions. In contrast, U.S. projects are more often motivated by revenue shortfalls. And only in the U.S. did projects aim to encourage use of existing underutilized facilities.

Over time, the growing number of successful electronic roadway tolling programs and projects reduces the risk of pursuing tolling by public officials elsewhere. In general, electronic

road pricing initiatives in the United States tend to be pitched to the public as a benefit to the individual traveler, such as through travel time savings due to reduced congestion. In contrast, European programs tend to emphasize overall societal benefits, such as environmental improvements (Jones, 2003). In France, for example, public acceptance of road pricing programs was higher when they aimed to impose social and environmental costs on users, while public acceptance in the United States and the United Kingdom was higher for road pricing projects that aimed to relieve congestion (CERTU, 2007). Further, road pricing initiatives in the United States were more likely to be accepted when they were structured as options – like with HOT lanes – that increase travelers’ choices, rather than with mandatory projects, such as cordon and road network tolls like those in London or Germany.

Technology: Making Theory Reality

As noted earlier, transportation economists have been touting the benefits of road pricing for decades. Officials in New York City first considered road pricing in the 1950s, London in the 1960s, and Switzerland in the 1970s. But despite a compelling logic and potentially enormous efficiency gains, implementing congestion in years past presented a host of challenges. Traditional toll booths require vehicles to stop to pay fees to an attendant, resulting in high operating costs, long queues, greater congestion, and more air pollution – the act of paying tolls would actually diminish the time-savings benefits being priced. While Singapore proceeded with introducing such a manual congestion toll system prior to the development of newer electronic toll-collection technologies, few other places possessed the political wherewithal to introduce such an invasive program. However, the rapid technological developments over the past twenty years have greatly eased the obstacles to implementing road pricing and, along with it, some of the popular and political wariness to pricing.

May and Sumalee divide these recent technological advances into two categories: (1) the Dedicated Short-Range Communications (DSRC) system, and (2) the Global Navigation Satellite System (GNSS) or the General Packet Radio System (GPRS). The DSRC systems consist of roadside equipment and an in-vehicle unit to charge users when they pass by a specified location utilizing two-way communication (May & Sumalee, 2003). The earliest and most prevalent form of the DSRC systems is the windshield-mounted transponders that were designed to speed up passage through toll-booths. Once engineers confirmed that these

transponders could work at highway speeds, open road tolling without the presence of toll booths became a real possibility. Automated license plate recognition via video cameras typically provides the necessary enforcement mechanism for those who attempt to use a priced roadway without a transponder. If the vehicle is lacking a transponder, the license plate recognition system can register the license plate number—as is done in Santiago, Chile—or send a bill in the mail to the address where the vehicle is registered—as is done in Toronto, Canada (Poole R., *Life in the Slow Lane*, 2007). These enforcement systems are best-suited for facility-congestion tolls or cordon tolls. The GNSS and GPRS systems can be used in either point or distance-based charging schemes, and are required for the implementation of any distance-based program (May & Sumalee, 2003). These technologies are still rapidly improving and the many potential applications of road pricing are only just beginning to be explored. For example, the Oregon pilot program focused on mileage based fees, but the possibility exists in such a pricing regime to integrate emissions fees or congestion pricing.

Not only do the necessary technologies now exist, but people around the world are becoming increasingly comfortable with and trusting of these tolling and tracking systems. The introduction of electronic toll collection on bridges and roads with flat tolls, such as FasTrack and E-Z pass here in the U.S., illustrates to many the user-friendliness of electronic tolling (Wachs, 2003). But while users appear increasingly comfortable with transponder technologies, wariness remains with the GNSS and GPRS technologies required for mileage-based schemes, particularly concerning privacy. In cases where the vehicles are tracked using satellite-based technologies, many citizens have expressed concerns about the government and potentially insurance companies being able to track their every move. As both the Oregon trial and the Austrian GO project illustrate, however, there are technological ways to address these privacy concerns. For example, some projects collect and retain data only on the distance traveled, not on the specific locations, time, or speed traveled. Additionally, in some cases, drivers can establish numbered accounts to ensure anonymity (Sorensen & Taylor, 2005).

Although technological advancements have clearly played a central role in enabling the implementation of congestion pricing, the cause and effect may work in reverse as well. Waxing interest in road pricing applications has likely encouraged and spurred the development of new technology applications (Worrall, 2003). The role of technology in enabling the implementation

of electronic roadway tolling is slated to be examined in more detail in a subsequent paper for this project.

The Push of Revenue Crises

In addition to enabling effects of technological advancements, a common motivation to test the waters of road pricing appears to be desperation. Specifically, chronic revenue shortfalls particularly in places where there exists demand for new capacity and inadequate resources to finance them; such cases have most often appeared in the United States, but jurisdictions around the world increasingly find themselves strapped for revenue and in search of ways to accomplish more with less revenue from traditional sources.

In the United States, most funding for highways has for decades come from federal and state fuel taxes, supplemented by other federal and state fees and taxes (such as vehicle registrations, drivers' license fees, etc.), bonds and other public borrowing, and, increasingly, locally generated revenues. Since the fuel tax is levied per gallon and not per dollar, it needs to be increased regularly to keep pace with inflation and/or increased vehicle fuel efficiency. But in an environment of increasingly partisan rancor over tax increases of all sorts, increases to the fuel tax has proven increasingly difficult at both the federal and state levels. As a result, the proportion of highway construction and maintenance needs financed by fuel taxes has declined over time. The last time the federal fuel tax was raised was on October 1, 1993. Between 1993 and 2007, the purchasing power of the fuel tax had declined by 29 percent (Samuel, 2007). The U.S. Department of Transportation Secretary Mary Peters recently predicted that, by 2009, the federal highway trust fund will have a negative balance (Replogle & Funderburg, 2006).

Beyond a political reluctance to increase the fuel tax per gallon levy to keep pace with inflation, increasing vehicle fuel efficiency means that less fuel is consumed per mile traveled, and therefore less tax revenue is collected per vehicle mile of travel on the road network. In the 1960s, fuel taxes averaged six cents in 2001 dollars per vehicle-mile traveled compared to three and a half cents in 2007, partially due to improved fuel efficiency of vehicles (Samuel, 2007). While the increasing share of light trucks and sport utility vehicles (SUVs) in the vehicle fleet during the 1980s and 1990s slowed the rise of vehicle fuel efficiency considerably, recent significant increases in fuel prices have renewed interest among consumers in vehicle fuel efficiency, and we are likely to see another ramp up in fleetwide fuel efficiency in the coming

years; while such a trend is good news for the environment, it's bad news for a highway finance system dependent on per gallon fuel taxes. Recent analyses suggest that hybrid vehicle sales grew twenty fold between 2000 and 2005 from 9,400 to over 200,000 and are expected to reach 1.5 million vehicles by 2025; the very high fuel efficiency of many hybrid vehicles promises to further diminish the buying power of the fuel tax (United States Government Accountability Office, 2006).

A common supplement to fuel taxes for transportation projects are sales or property taxes. However, this mechanism is regressive to both income and road network use, unfairly distributing costs to non-users of the transportation networks (Sorensen & Taylor, 2005). While many critics cite equity concerns in new road pricing systems, the current funding system can be viewed as inequitable as well – just with a different set of winners and losers (Sorensen & Taylor, 2005). In fact, road pricing mechanisms can minimize inequity more efficiently than the inequity in sales or property taxes. By using tolling revenue to subsidize public transit, road pricing benefits lower-income groups. Additionally, DeCourla-Souza developed the FAIR lane concept, which provides credits for occasional use of HOT lanes (Sorensen & Taylor, 2005).

Compounding the decreasing purchasing power of the fuel tax is the increasing expense of maintenance of existing infrastructure, which has for many years risen faster than the Consumer Price Index, meaning that higher proportions of state transportation budgets are spent on maintenance and rehabilitation instead of constructing new capacity (Wachs, 2003). Additionally, multi-modal transportation agencies are frequently tasked to mitigate the effects of highway construction by funding public transit projects, which further diverts highway funds from roadway construction and maintenance.

While revenue generation is clearly a strong motivation behind many recent electronic roadway tolling projects, among these only mileage-based fee schemes aim to replace the fuel tax. Most of the other programs and projects aim to supplement existing transportation revenues sources, often by financing particular road or transit projects. Several studies have concluded that, given their sometimes narrow scope, it is unlikely that most road pricing projects could completely replace the fuel tax. According to Weinstein, et al., “one cannot estimate with even rough precision the likely toll revenue generated statewide from new facilities (2006 p. 60)” in California. However, tolls are widely considered a promising supplement to fuel tax revenues

that are likely to generate the most significant revenues (1) in congested corridors where few alternatives exist or (2) in areas experiencing substantial population growth (Weinstein, et al., October 2006). Consistent with this observation, a majority of the case studies examined in this paper, such as the SR-91 Express Lanes and the MnPass program, have occurred in areas with rapidly growing populations amid congested road networks.

In the case studies we examined outside of the United States, the demand for additional revenue mostly stemmed from a need for specific capacity expansions or transit improvements, rather than as a more general strategy to fund maintenance of the roadway system. For example, in both Toronto and Santiago, tolls were put in place specifically to fund new road capacity projects. In Austria, the high-cost of maintaining a road network traversing the Alps and used widely by non-Austrians prompted a search for a new, targeted revenue stream. Austria was also faced with an EU mandate to reduce transportation-related debt. Finally, we find that electronic roadway tolling programs outside of the U.S. are more likely dedicated to fund public transit or inter-city rail in addition to road maintenance.

Managing Congestion and the Need for New Capacity

Even if the current funding systems were sustainable, traffic congestion is rapidly increasing in cities around the world. Mitigating this growth in traffic by adding capacity is very expensive, particularly in already built up areas. Such supply-side approaches to addressing traffic congestion have come under increasing criticism for being inefficient and environmentally unsustainable.

Clear demand for new capacity is highest in areas with rapid population growth, such as in Orange County, California and Houston, Texas, where available revenues have fallen far short of funding desired new road capacity. Within the United States, between 1993 and 2002, lane-miles increased by 0.2 percent annually while traffic demand increased by 2.5 percent annually. Within the U.S.'s urban highways, the lane miles increase by 51% while travel demand increased by 168 percent between 1980 and 2004 (Samuel, 2007). The Texas Transportation Institute's 2007 Urban Mobility Report examined differences between lane-mile growth and traffic growth. Metropolitan areas with significant traffic-capacity mismatches (defined by the TTI as traffic increases 45 percent greater than road capacity over a given time period) include Miami, Minneapolis-St Paul, San Diego, and Washington DC. Moderate mismatches (traffic growth was

between 30 and 45 percent greater than road growth) include Seattle, New York, San Antonio, Denver, and Boston (Schrank & Lomax, 2007). Many of the metropolitan areas experiencing significant mismatches between traffic growth and road capacity are cities experimenting with road pricing options – such as San Diego, New York, and Minneapolis-St. Paul. Additionally, a U.S. Government Accountability Office (GAO) survey found that a state’s rate of population growth is directly related to a state’s likelihood to implement tolling (United States Government Accountability Office, 2006). While tolling have proven more politically acceptable in these rapidly expanding metropolitan areas, the density of vehicle travel – which is a function of population density and the share of a jurisdiction’s population that resides in urban areas – is too low to support road pricing in more rural states like Montana, North Dakota, and Wyoming (United States Government Accountability Office, 2006).

In many congested places, road pricing not only provides the revenue to construct new capacity, but variable tolls can also signal where new capital investment is most needed. If a variable congestion toll is consistently high in order to maintain an uncongested flow of vehicles, this is an unambiguous signal of a location that should be targeted for capacity expansion (United States Government Accountability Office, 2006). Furthermore, road pricing encourages more efficient utilization of under-utilized facilities, such as HOV lanes, to aid increase throughput and reduce the need for new capacity. Often, converting existing un-priced or regulated lanes into managed HOT lanes can be more cost efficient than building new capacity because the free-flowing lanes move far more vehicles than congested ones. Experience shows, for example, that properly priced and managed HOT lanes move far more vehicles than parallel free, congested lanes (Replogle & Funderburg, 2006).

In many densely developed, congested areas like London or New York City, little or no space exists to widen traffic-clogged roads. In such places, cost-effective alternatives to constructing new capacity is needed – such as through using road pricing to increase the “effective capacity” of metropolitan road networks. While HOT lanes have proven to work well on congested highway links with previously under-utilized HOV lanes, cordon pricing has proven more effective in unclogging densely developed urban cores by both smoothing traffic flows in and out of central cities and shifting substantial numbers of travelers onto public transit. As such, cordon pricing in the U.S. is likely to work most effectively in the centers of cities like

Boston, New York, or San Francisco, as opposed to more sprawling places like Houston or Phoenix (Wachs, 2003).

Congestion Threatens Economic Development

Failing to successfully manage congestion can have direct consequence on a city's economic vitality, as reliable transportation networks are an essential component in any economic development strategy. Time loss due to congestion translates into economic loss. According to the Texas Transportation Institute's 2007 Urban Mobility Report, the time and fuel costs of congestion in 2005 amounted to \$67.7 billion across the 85 urban areas in the United States, up from \$59 billion in 2003. The 14 U.S. urban areas with populations exceeding 3 million were estimated to have wasted 1.7 billion gallons of fuel due to traffic delays alone (Schrank & Lomax, 2007).

As the case studies of Singapore, London, and New York noted, congested central business districts are widely viewed as bad for business. Mayors Bloomberg (New York) and Livingstone (London) received substantial, if not universal, support for congestion pricing from their respective city's business community. While loathe to pay tolls, the managers of most businesses value reliability of arrivals and departures of workers, customers, production inputs, and product outputs. In our increasingly global economy, the leaders of metropolitan areas around the world are vying for economic advantage, and a reliable transportation system is key to economic productivity. Although opponents of congestion pricing often cite economic losses to the central business district as a major concern, such arguments typically ignore the cost congestion delays impose on businesses.

Climate Change: Reducing Emissions

In addition to spurring economic development, many road pricing schemes were implemented with the goal of mitigating environmental impacts by smoothing traffic flows thereby lowering emissions. Santiago achieved this goal by constructing new road capacity to improve traffic flow, and Stockholm by reducing the number of vehicles on the road through a congestion fee. Although environmental concerns were a primary motivation in a few of the cases examined in this report, reducing emissions was generally a secondary consideration. As global climate change becomes central to more policy discussions, however, it is possible that emissions reduction may spur more road pricing initiatives in the years ahead.

As mentioned earlier, road pricing projects in Europe tend to tout to improvements in the general good, which include environmental enhancements and emissions reductions. The cases of London, Stockholm, Austria, and Switzerland all incorporated environmental concerns in their stated programmatic objectives. The Stockholm congestion fee was particularly focused on reducing emissions, and included an evaluation that measured changes in emissions levels during the trial.

Although environmental goals have been more commonly cited in projects implemented outside of the United States, such objectives have not been absent from U.S. projects. For example, the Oregon Mileage Fee concept grew out of concerns for lagging revenue due to an increase in alternative fuel vehicles in the fleet, and rising gas prices. While environmental concerns and global warming have been on the forefront of European policy-making for years, the urgency of the climate change situation is starting to be reflected in American politics as well as the public becomes increasingly aware of the issue. The New York City congestion pricing proposal stems from Mayor Bloomberg's PlaNYC, which emphasizes environmental responsibility and sustainability. According to a 2006 Washington Post-ABC opinion poll of environmental trends within the United States, only 16 percent of American adults considered global warming/climate change to be the single biggest environmental problem the world faces, whereas a year later, 33 percent of American adults considered climate change to be the most significant environmental problem (The Washington Post, 2007). As climate change may be slowly creeping into the forefront of the American consciousness, new environmental attitudes may bode well for road pricing in the years ahead.

Charging Drivers for the Costs They Impose

Another recurring motivation across the cases is the desire to make roadway users pay for the costs they impose on society, particularly with the weight-distance and mileage based fee projects. In places where outsiders are frequently using and damaging roadways, charging these users in proportion to the costs they impose is both efficient and equitable. The damage imposed on the roadway is particularly unequal in regards to trucking. The road wear from a 40 ton truck can be up to 60,000 times higher than that of a car (Commission for Integrated Transport, 2006). Therefore, routes with heavy truck traffic occasion significantly higher maintenance costs than those roads that host few trucks. This problem is exacerbated when many users are just passing

through and make little or no contribution to operation and maintenance revenues. In a fuel-tax system, foreign truckers can avoid paying for their share of utilization of the roadways by not purchasing fuel in that country, which is entirely possible in small European countries (Sorensen, 2006). Similarly, mileage-based fees charge users for the distance traveled, and thus indirectly for the damage occasioned on the road network. Variable road pricing measures provide a more accurate reflection of road wear and tear than the fuel-tax. With a fuel tax, an individual with a fuel-efficient vehicle will pay less to use the same road network as an individual with a lower gas-mileage. While this system might be efficient in reducing fuel consumption or gas emissions, it fails to reflect the costs imposed on the roads.

The goal of making people pay for the costs imposed by their driving was a common motivation for the cordon tolls, such as in Singapore and Stockholm. In contrast to efforts to price trucks, however, the emphasis tends to be on “internalizing” the costs congestion delays and vehicle emissions rather than roadway damage. In that, road pricing causes people to be aware of the costs their travel choices impose on society, drivers make better informed and more societally optimal decisions about when, where, and even whether to drive.

Private Investments

Private investments are playing an increasingly important role in transportation projects around the globe, and the ability to electronically toll roadways has played a critical role in attracting these investments. As global capital firms seek alternatives to traditional investments, electronic toll roads have proven attractive (Replogle & Funderburg, 2006). Prior to 1990, private investments in transportation infrastructure were rare. But during the 1990s, this began to change, and by 1998 nearly \$30 billion in private capital had been invested in transportation infrastructure around the globe (Replogle & Funderburg, 2006). And by 2006, Goldman Sachs estimated that \$250 billion in private capital was available for private infrastructure investments worldwide (Samuel, May 2007).

Private investment in transportation infrastructure can take many forms, ranging from private contract operation of public facilities, to complete finance, design, build, and operation of roads and the like. Private investments in public transportation facilities are supposed to allow governments to secure infrastructure improvements without a full public assumption of risk. Evidence suggests that roadways are often operated more efficiently by private firms, who tend

to be politically freer than public entities in setting tolls at optimal levels. Additionally, some research suggests that governments around the world are more likely to invest in areas widely viewed as direct, public responsibilities, such as emergency health care, education, and police, than in infrastructure that can be publicly or privately funded (Hensher & Puckett, 2005).

The case studies reviewed here suggest that a correlation exists between the local demand for new capacity and the popularity of public-private partnerships. This is because private investments can speed the development of new facilities and correspondingly reduce public-sector risk. Austria, Orange County, California, and Toronto have all witnessed significant private investment in transportation infrastructure in recent years, financed via toll revenues. While facility congestion tolls appear to be the most common form of road pricing involving the private sector, an increasing number of banks are expressing interest in financing area-wide congestion pricing schemes, which could serve as the next major venue for private investment in road pricing (Hensher & Puckett, 2005).

In the United States, many road pricing initiatives have been inspired, funded, or both, by federal legislation. The current Bush administration supports privatization in a wide variety of policy fields, including transportation. Secretary of Transportation, Mary Peters, has made clear her support of private investments in road pricing. This support for privatization has translated into legislation and funding that supports innovative public-private partnerships (though such efforts have been tempered by some wariness in Congress, particularly from Transportation and Infrastructure Committee Chair James Oberstar). The 2005 federal surface transportation legislation, dubbed “SAFETEA-LU,” expanded the role that the private sector could play in financing transportation infrastructure. While these policy initiatives indicate that public-private partnerships will most likely play a waxing role in the future of transportation investment, the experience of Orange County’s SR-91 serves as reminder of the importance of long range transportation planning and careful contract negotiation.

Federal Incentives & Legislative Changes

Many of the electronic road pricing pilot projects are the result of incentives developed by a higher governing body. The European Commission supports member states in developing urban road pricing schemes that aim to internalize the external costs of private vehicle travel (CERTU, 2007). The federal government in the U.S. has in recent years provided both funding

and other incentives for road pricing pilot projects. In addition, federal and state enabling legislation is often required before cities, counties, regions, or states can pursue road pricing projects (May & Sumalee, 2003).

In the U.S., the Value Pricing Pilot Program, authorized as part of Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, encouraged states, regions, and local governments to develop and evaluate congestion or “value” pricing approaches to managing congestion. In doing so, the ISTEA legislation loosened many pre-existing federal regulations regarding tolling in Interstate roadways (United States Government Accountability Office, 2006). The Value Pricing Pilot Program funded road pricing experiments in San Diego, Houston, and Minneapolis during the 1990s.

In 2005, SAFETEA-LU created incentives and room for jurisdictions to experiment with a broader array of road pricing initiatives. The bill requires state transportation plans to focus on four objectives: (1) improve mobility, (2) promote economic development, (3) minimize fuel use, and (4) minimize air pollution (Replogle & Funderburg, 2006). Additionally, SAFETEA-LU established 15 express lane demonstration projects with the goals of managing high congestion levels, reducing emissions to meet the Clean Air Act requirements, and/or financing new capacity. In addition, SAFETEA-LU authorized states to convert underutilized HOV lanes to HOT lanes. As noted above, SAFETEA-LU also created space for greater private sector involvement in transportation policy and planning. Most recently, the Urban Partners Agreement (UPA) incentivizes municipalities to consider road pricing as a method of reducing congestion. UPA is a component of the U.S. Department of Transportation’s *National Strategy to Reduce Congestion on America’s Transportation Network*, which focuses on reducing traffic congestion by promoting the “Four Ts” – tolling, transit, telecommuting and technology. As of March 2008, New York City, Miami, Minneapolis-St. Paul, Seattle, and San Francisco were all exploring the feasibility of road pricing with the promise of federal funds to help implement the proposals. However, by failing to attain appropriate legislative approval by the April 7, 2008 deadline, New York forfeited federal funds for both road pricing and traffic congestion relief initiatives. As the New York case study illustrated, even the promise of federal funding sometimes is not enough to overcome substantial political hurdles.

Political Champions: Selling Projects to the Public

With Jan Goldsmith in San Diego, Ken Livingstone in London or Michael Bloomberg in New York, many road pricing schemes have had passionate and influential political champions. The voice of an influential leader has frequently proven essential to communicating the sometimes opaque logic of road pricing to an often skeptical populace. While ideas about non-linear effects, internalizing externalities, and allocating scarce public resources with prices may be well-understood by many transportation planners and economists, persuasive rhetoric from a trusted leader is often required to sell economic theory to wary policy makers and a skeptical public.

While a clear political champion has often proven key to moving road pricing experiments along, well-organized coalitions in support of road pricing can serve a similar role in the absence of a widely visible political champion. For example, in Minnesota, a task force of local officials, citizens, and business leaders convened to explore and promote road pricing with the conversion of HOV lanes to HOT lanes (United States Government Accountability Office, 2006). The more controversial the proposal, however, the greater the need for a steadfast political champion, such as Ken Livingstone or Michael Bloomberg.

In addition, politicians today find themselves answering to accountability demands from a public in favor of improved transportation networks. The bridge collapse on I-35 in Minnesota in the summer of 2007 placed the spotlight on the nation's aging infrastructure. As a result, the public has grown more accepting of road financing alternatives, such as road pricing. A 2007 survey conducted shortly after the bridge collapse by the AAA Mid-Atlantic concluded that, while 54 percent of respondents opposed increasing gas taxes to pay for increased road and bridge maintenance and repair, 57 percent would support tolling for this purpose (Poole R. W., 2007).

Beyond concerns over failing infrastructure, constituents in many states have lost faith in the ability of federal government to make sound transportation policy decisions, given the significant rise in transportation earmarks in each of the last three pieces of federal transportation legislation – such as Alaska's notorious "bridge to nowhere." SAFETEA-LU contained 5,700 earmarks, totaling \$21.1 billion, compared to just eleven such projects in 1982 (Samuel, 2007). Thus, as the public becomes increasingly dissatisfied with transportation policy status quo,

politicians may be more likely to explore new innovative approaches to transportation funding and management.

Of course these political leaders do not ascend to power in a vacuum. All require the support of various coalitions and interest groups, which can have a profound effect on the political agenda. Examples of these influential organizations are discussed in the next section. Based on the information gathered on the cases reviewed within this paper, however, it is difficult to decipher just how significant a role these groups play in shaping a politician's actions versus the influence of the particular leader. The literature analyzed for this research suggested that strong political leadership was often essential in ensuring the success of a program, irrespective of interest group politics. Unfortunately, untangling the relative contributions of interest groups and political champions to the success, or failure, of road pricing programs is beyond the scope of this paper.

Coalition of Supporters

Just as a broad array of motives contribute to the implementation of road pricing, so does a wide range of supportive interest groups. As the case studies demonstrate, these interest groups have proven far ranging – from business and economic development groups to environmental interests. In the New York proposal and the London scheme, many business leaders rallied around the cause of creating a more economically viable central business district that would attract corporations with a more reliable transportation system. Similarly, many environmental groups, such as Environmental Defense and Friends of the Earth, support road pricing in hopes that it will reduce resource consumption and emissions by discouraging solo driving in favor of public transit, ride sharing, biking, and walking. Environmental supporters often want to see revenue dedicated to the development of public transit options rather than the construction of additional capacity (Replogle & Funderburg, 2006). Another frequent group of supporters includes libertarian organizations, such as the Reason Foundation, whose members view road pricing as market driven approach to funding the construction and maintenance of our roadways. For pro-market groups, electronic tolling is also viewed as a way to encourage private investment in transportation networks, thereby minimizing the government's involvement in such large-scale endeavors. While these wide arrays of supporters often aid in the

implementation of road pricing, the varied motivations of sometimes strange bedfellows can result in conflicts over implementation.

Political Traction: Success Cases from Around the World

Politicians hoping to introduce road pricing to their jurisdictions today have the luxury of being able to refer to a growing number of successful initiatives around the world. Not only are these projects successful in operation, but most of them have high levels of public support amidst smaller groups of sometimes vocal detractors. Stockholm, London, and the I-15 HOT lanes in San Diego County all have relatively widespread support among local voters. Such politically and operationally successful projects can assist political supporters in selling road pricing projects to skeptical elected officials and the voters who elect them. Furthermore, as more programs are implemented, the pioneers have worked out many of the kinks, and toolkits for successful projects are being developed as officials learn what aspects of road pricing do and do not work in which contexts. Many of the cases discussed in this report were heavily influenced by earlier projects – MnPass followed the lead of the I-15 HOT lanes, and New York attempted to follow the lead of London. Although congestion pricing had existed in politically closed Singapore for many years, the implementation of congestion charges in central London proved that the concept could work in a large, open, and diverse western city where politicians can easily be ousted from office (Hensher & Puckett, 2005). Not surprisingly, planners and elected officials interested in pricing frequently consult with those who have implemented road pricing elsewhere. For example, James Whitty of Oregon’s Office of Innovative Partnerships and Alternative Funding travels around the United States to tout the idea of mileage-based fees in order to encourage other states to consider implementation. Momentum continues to build as more and more jurisdictions successfully implement road pricing initiatives, helping to dissipate public opposition.

CONCLUSION

In every place where pricing has been implemented or is being seriously considered, the status quo – that is the old system of transportation planning and finance – is in crisis. Whether the problem is insufficient revenue or choking congestion, transportation planners and policymakers around the world are struggling to keep pace with the rise in motor vehicle traffic, and are addressing the problems that such growth engenders. As with many other policy areas, technology is facilitating the development of innovative approaches to facilitating the transition from theory to reality. With respect to transportation planning and finance, we are at a unique juncture as the full range of possibilities for the potential of road pricing are only now being fully realized.

Perhaps in part due to the enabling technologies, the political attitudes towards road pricing have also shifted significantly in recent years, with the mayors of some of the world's largest cities now embracing road pricing. It is no longer political suicide to propose road pricing schemes, as constituents gradually come to see that road networks cannot simply be free to all comers, and worsening traffic congestion brings with it a host of costs. This is not to say that road pricing programs are now widely embraced. While significant opposition to road pricing still exists, it is slowly being quelled as the political momentum continues to build. Thus, technological advancements have combined with a shifting political landscape to rapidly altering how we view both transportation funding and congestion management in the years ahead.

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Appendix A

Table A-1: Primary and Secondary Motivations – Type of Road Pricing

	Technology	Revenue Shortfall	Reduce Congestion	Construction of New Capacity	Underutilized Existing Facility	Public-Private Partnership	Political Champion/Coalition	Federal Incentives	Legislative Changes	Distribute Costs to Users	Public Transit Investment	Economic Development	Environment Concerns	Replicating Successful Tolling Models
I-15 San Diego			2		1		1		2		1			
SR-91 Orange County		2	1	1		1			2					
QuickRide Houston			1		1				2					2
407 ETR Toronto	2	2	1	1		2								
MnPass Minnesota		2	1			2	1	2						1
Santiago			1	1		1							2	
Singapore			1							2	2	1	2	
Stockholm			1	2					2	2	2		1	2
London			1				1		1		2	1	2	
New York			1				1	2			2	1	2	1
Swiss HVF Truck Toll		1		2						1			2	
German Toll Collect		1					2			1				
Austria		1	2	2		1				1			2	
Oregon Mileage Fee		1					2	1		1			2	

Table A-2: Primary and Secondary Motivations - Geographic

	Technology	Revenue Shortfall	Reduce Congestion	Construction of New Capacity	Underutilized Existing Facility	Public-Private Partnership	Political Champion/Coalition	Federal Incentives	Legislative Changes	Distribute Costs to Users	Public Transit Investment	Economic Development	Environment Concerns	Replicating Successful Tolling Models
I-15 San Diego			2		1		1		2		1			
SR-91 Orange County		2	1	1		1			2					
QuickRide Houston			1		1				2					2
Oregon Mileage Fee		1					2	1		1			2	
MnPass Minnesota		2	1			2	1	2						1
New York			1				1	2			2	1	2	1
407 ETR Toronto	2	2	1	1		2								
Santiago			1	1		1							2	
Singapore			1							2	2	1	2	
Stockholm			1	2					2	2	2		1	2
London			1				1		1		2	1	2	
Swiss HVF Truck Toll		1		2						1			2	
German Toll Collect		1					2			1				
Austrian GO		1	2	2		1				1			2	

Table A-3: Primary and Secondary Motivations - Chronological

	Technology	Revenue Shortfall	Reduce Congestion	Construction of New Capacity	Underutilized Existing Facility	Public-Private Partnership	Political Champion/Coalition	Federal Incentives	Legislative Changes	Distribute Costs to Users	Public Transit Investment	Economic Development	Environmental Concerns	Replicating Successful Tolling Models
Singapore - 1975			1							2	2	1	2	
SR-91 Orange County - 1995		2	1	1		1			2					
I-15 San Diego - 1996			2		1		1		2		1			
407 ETR Toronto- 1997	2	2	1	1		2								
Austria – 1997		1	2	2		1				1			2	
QuickRide Houston - 1998			1		1				2					2
Swiss HVF Truck Toll - 2001		1		2						1			2	
London – 2003			1				1		1		2	1	2	
Santiago - 2004			1	1		1							2	
German Toll Collect – 2005		1					2			1				
MnPass Minnesota - 2005		2	1			2	1	2						1
Stockholm - 2006			1	2					2	2	2		1	2
New York – Present			1				1	2			2	1	2	1
Oregon Mileage Fee – Present		1					2	1		1			2	

CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

Task A-2: Implementation and Management of Electronic Roadway Tolling: Lessons from Successful Cases

Rebecca Kalauskas, Brian D. Taylor, Hiroyuki Iseki

**California PATH Research Report
UCB-ITS-PRR-2009-11**

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Lessons from Successful Cases**

California PATH Project—Task Order 6330

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Rebecca Kalauskas
Brian D. Taylor
UCLA Institute of Transportation Studies
3250 Public Affairs Building
Los Angeles, CA 90095-1656
<http://www.its.ucla.edu>

and

Hiroyuki Iseki
Department of Planning and Urban Studies
University of New Orleans
2000 Lakeshore Drive - 368 Milneburg Hall
New Orleans, LA 70148
<http://planning.uno.edu/>

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Abstract

Over the past decade road pricing has moved from the drawing board to practice in projects large and small around the world. But while interest in and experience with electronic roadway tolling is on the rise, political acceptance is not yet widespread and standard models of implementation and management have yet to evolve. Accordingly, this report examines a variety of road pricing projects— some that were smoothly implemented, and others that encountered significant obstacles along the way. Based on these cases and a thorough review of the literature, we draw lessons to guide future implementation and management efforts. We find that the most common barriers to successful implementation concern political acceptability, incomplete or ambiguous public-private contracts, and the complex workings of highly bureaucratic government agencies. Collectively, these case studies show that there is no single best implementation and management structure; what works best depends significantly on the initiative's objectives, the availability of public and private resources, and political leadership.

Keywords

road pricing, congestion pricing, electronic toll and traffic management, electronic toll collection, dynamic congestion pricing, government policy, high occupancy toll lanes, policy, public private partnerships, toll roads, traffic congestion, management, implementation

Executive Summary

Introduction

While the preceding report in this series, Task A-1: *Motivations Behind Electronic Road Tolling*, considered *why* we are seeing a marked increase in the implementation of road pricing projects around the U.S. and around the world, this report focuses on *how* road pricing projects have been implemented. We concluded in that earlier report that the motivations behind road pricing were correlated with the type of tolling project, and we likewise find here that the most effective implementation paths and management structures are also related to the goals of the particular initiative. We conclude from this that the lead agency of any electronic roadway tolling project should carefully reflect on the goals and objectives of the initiative before developing a plan for implementation.

This report draws on road pricing and organization theory literatures, as well as on a number of examples of successful, and sometimes not so successful, implementation approaches to road pricing projects and concludes with a series of recommendations to help guide California and other states through the implementation and management design process. This executive summary briefly summarizes the principal findings of this work.

Overview of Organizational Structure for Electronic Roadway Tolling Projects

Once a road pricing project reaches implementation and planning stages, the three major organizational questions concern (1) who administers the program, (2) who manages and operates the program, and (3) who oversees the program. The administration of a road pricing program includes tasks such as determining toll rates, issuing bills, and collecting and distributing revenue. Management and operation responsibilities include managing the day-to-day operations of the initiative and the implementation of appropriate technologies. Finally, the overseeing organization makes many of the important policy decisions and manages relations between administrative and operating agencies or firms. Generally, the oversight of the program lies within the public sector while the management and operation responsibilities often rest within the public sector. On the other hand, the agency or firm that oversees administration tends to vary significantly from project to project. As mentioned earlier, the optimal organization structure depends heavily on the goals and objectives of the program.

Public-Private Partnerships

While public-private partnership arrangements have in many cases brought significant benefits to road pricing projects, they can entail significant risks and usual present implementation challenges as well. In most public-private partnerships, except complete privatization, the public sector retains some ongoing oversight over the projects. Thus, while the private sector can play a significant role in the design, implementation, administration, and operation of road pricing facilities, the public sector rarely releases the entire oversight to the private firms, and public agencies must be structured to work effectively with the private sector.

The institutional knowledge that lies within public sector agencies can sometimes qualify their employees as the experts in this area, in contrast to the employees of private sector firms who may lack this institutional knowledge. On the other hand, a great deal of technical expertise frequently lies within private sector firms, which make them especially strong candidates to develop the necessary technology for road pricing projects. Therefore, the public sector often proves best suited for the oversight and administration responsibilities, while the private sector is frequently better suited for operational and management duties. Finally, the design of the contracts with private sector can play a significant role in determining the success or failure of a project.

Government Owned Corporations

In order to collaborate efficiently with private firms, governments (especially those in the former British Empire) often develop government-owned or state-owned corporations to oversee large infrastructure projects, road networks, or tolling projects. A government-owned corporation is a legal entity created to perform commercial or business activity on behalf of the state and often plays a critical role as a monitoring arm of the government.

Case Studies

Toronto's Highway 407: Financing and Constructing New Capacity

The Toronto metropolitan area desperately needed to expand roadway infrastructure in the early 1990s but lacked sufficient funds to do so. Due to a combination of economic stimulus goals and a lack of public funds, Ontario officials decided to pursue a private financing strategy to fund the project because they did not want to wait for the traditional funding mechanisms. However, ultimately, the overseeing agency, the Ontario Transportation Capital Corporation (OTCC), financed the project because the government determined this would be a more cost-effective approach, while the operation and development were contracted to private firms. Although the project was ultimately funded directly through the public, the private sector still played a significant role in the timely construction of the roadway. Once construction of the Highway 407 was complete, the roadway was leased to the ETR Concession Company, a private consortium of firms, which now administers, manages, and operates the highway. Flexible legislation and an incremental implementation approach both proved to be critical in the successful development of Highway 407.

German Toll Collect: Maintaining Infrastructure

While contracting with the private sector successfully aided in the development of Toronto's Highway 407, the role of private firms involved with the implementation of Germany's Toll Collect provides a more cautionary tale. In developing a weight-distance tolling system for trucks using German roadways, the German government contracted with Toll Collect to run the operations of the initiative. However, due to unclear goals at the outset of the project, lack of communication, and a series of technical problems, the implementation of the Toll Collect Project was substantially delayed. Because of these delays, the German government found itself missing a significant amount of potential revenue as well as experiencing a loss of the faith among German people regarding the effectiveness of road tolling. This case highlights

the importance of establishing clear contracts with private firms and clear program objectives. If the uses of revenue are unclear, the project is more likely to encounter substantial public or political opposition, delaying the implementation process.

London Congestion Charging Scheme: Managing Congestion

In contrast to the Toronto and German cases, the private sector had very limited involvement in the implementation and management of London's Congestion Pricing Scheme. Prominent national political figure Ken Livingstone was elected Mayor of the Greater London Council on, among other things, a platform advocating for the introduction of congestion charging in central London. The Mayor acts as the key decision-maker of the Greater London Authority (GLA), which allowed Livingstone to move forward with his congestion charging agenda with minimal political opposition. The GLA also established the Transport for London (TfL), which provided the local authorities with direct control over the transit network and, as a result, the power make the necessary improvement needed to obtain public support of road pricing. Therefore, the successful implementation of the London pricing scheme can be largely attributed to the fact that a single agency (TfL) oversaw the project, rather than a collaboration of various agencies.

San Diego's I-15 Express Lanes: Enhancing Regional Transit Service

Like many other road pricing initiatives, San Diego's I-15 Express Lanes were originally conceived of primarily to reduce congestion along the I-15 corridor by converting an underutilized HOV lane into an HOT lane and redirecting the revenue to enhance transit service in the region. The financing and management of the I-15 Express lanes lay almost entirely in the public realm. A significant portion of the implementation funding came from the federal level, which reflected interest among federal officials in experimenting with various road pricing approaches to relieve congestion. While the federal agencies played a larger role in the original inception and funding stages, as the project moved toward implementation, the local stakeholders took on a greater role. During implementation process, the project management team met monthly to oversee the progress of the project, allowing all stakeholders to keep in constant communication. Many of the keys to successful implementation that played a role in the London case also apply to the San Diego case. Like London, San Diego benefited from the presence of a strong political champion – Jan Goldsmith – and a strong community outreach campaign. Likewise, at the organizational level, the transit system and the Express Lanes were managed by the same authority, SANDAG, which facilitated the improvements.

Common Barriers to Implementation

A significant body of literature focuses on identifying barriers frequently encountered in attempting to implement road pricing proposals, and many of the findings from this literature were consistent with the findings of our case studies (discussed above).

Technological and Practical Barriers

Frequently encountered technological challenges include interoperability issues and reliability of technology on large-scales. Some common practical barriers jurisdictions face include the complex structure of urban road networks and a lack of space for added capacity in urban areas. While these technological and practical barriers can certainly hinder the

implementation of road pricing projects, it is unlikely that with currently available technologies, these would be the sole, or even principal, reason a project failed to move forward. Even if technological barriers prevent implementation of a large-scale project, the proposal could always be implemented piece-meal. On the other hand, any impending practical barriers may play a larger role in guiding the implementation process and determining the optimal structure. In the long-run, both technological and practical impediments can easily be overcome.

Legal and Institutional Barriers

Legal restrictions from higher governing bodies, such as federal or state governments, can often impede the progress of road pricing proposals, even if the support is present at the local level. In addition to legislative barriers from higher authorities, contradictory legislation can often hinder implementation. Past experience demonstrates that securing the necessary legal approval is easier if road pricing projects are implemented only temporarily to address a specific problem or if the legislation is subject to periodic review. Additionally, disconnected decision-making structures, multi-level structure of government decision-making process or the number of administrative levels, and the role of the private sector can determine the efficiency with which a proposal moves towards implementation. The distribution of responsibilities and powers across different governmental administrative levels is often not ideal to manage and move road pricing forward.

Like technological and practical barriers, legal and institutional barriers rarely serve as a long-term impediment to implementation. Though in the near-term, inadequate legislative authority can delay a program. However, new legislation is frequently developed and passed to support popular projects. Likewise, institutional and organizational structures can be altered to reflect changing demands of road pricing projects. These impediments highlight the importance of incremental rather than wholesale implantation of pricing, but legal and institutional barriers, except as they have been wielded by opponents to kill pricing proposals (as in the case of New York¹), are unlikely to sink a project when broad public and political support exists.

Acceptability Barriers

Strong public and political acceptance are perhaps the most important factors in determining whether a road pricing project moves forward. While technological, practical, legal, and institutional challenges can be overcome provided enough popular and political support exists, achieving such acceptance can be a daunting hurdle. The political and financial relationships among agencies at various levels of government – federal, state, and local – and between the various political parties can have a significant effect on the policy-decision making process. Rather than being grounded in economic principles, the decision often reflects parochial political interests. Certain justifications for introducing road pricing, such as expanded road capacity, environmental, and safety improvements, are more accepted than others. Another major hurdle in achieving public support is whether the road pricing program is perceived as

¹ In April 2008, New York State Assembly Speaker Sheldon Silver concluded that, due to a lack of support among New York State Assembly members, the New York City Congestion Pricing legislation would not be put to a vote, effectively killing the proposal, which required state legislative approval in addition to New York City Council approval. This case highlights that complex legislative hurdles can act as barriers to implementation when political support is mixed.

equitable and fair. The means in which toll revenues are used plays a large role in justifying the equity of road pricing initiatives. One of the most effective means for improving public support is to actively involve the community and key political leaders in the planning stages.

Lessons from Successful Implementation of Road Pricing

Six-Step Framework

Drawing on the research conducted for this report, we have identified six implementation steps common to many successful road pricing programs. While these steps are roughly ordered, they should not be construed to be a sequential step-by-step plan for implementation; rather these steps should be viewed as a checklist common to most successful road pricing. Implementation is, more often than not, an iterative process.

- 1. Articulate system objectives**
- 2. Affirm legal authority**
- 3. Determine implementation framework**
- 4. Design & evaluate road pricing plan**
- 5. Adopt system plan, financing scheme**
- 6. Procure management & technology services**

One Step at a Time...

A significant portion of the literature emphasizes the importance of adopting a gradual, incremental process to implementing road pricing. Because societies generally only accept drastic policy changes in emergencies, and not for chronic issues like heavy traffic, it is important to frame the introduction of road pricing as a gradual evolution and as the final element in comprehensive transportation planning process. Furthermore, toll rates do not necessarily need to be set at the optimal level upon initial implementation of the road pricing project. Rather than an optimal policy, the implementation path should follow a sequence of second-best alternatives moving towards the ultimate optimal policy. Finally, an incremental approach to implementation keeps the door open to alter or reverse actions at a reasonably low cost. This flexibility is particularly important in the later steps of the implementation path, so that plans can be altered if new information comes to light.

Conclusion

This report provides a review of the potential barriers to road pricing implementation, and the lessons from the successful implementation of pricing projects around the world. If a decision is made to move forward with road pricing, a special emphasis should be placed on addressing acceptability concerns as these are often the most challenging barriers to overcome. Additionally, while private firms often have a competitive and experiential edge over public agencies, the public sector still needs to be actively involved in the development, execution, and ongoing monitoring of such contracts. Finally, the organization of the public agencies tasked with implementation can also play a critical role in the success or failure of a project. Generally,

the more streamlined and less bureaucratic the government actors, the greater the likelihood of successful introduction of road pricing.

Such findings notwithstanding, there does not appear to be any one best practice for or approach to the introduction of road pricing. As jurisdictions in California move forward with road pricing projects, the best implementation and management scheme will depend greatly on the initiative's objectives, the availability of public and private resources, and most importantly, political leadership.

Introduction

The preceding report in this series, Task A-1: *Motivations Behind Electronic Road Pricing*, discusses the wide range of motivations that has driven the recent development of electronic road pricing projects across the globe. We conclude that the motivating factors behind the projects were as varied as the projects themselves. These motivations further played a key role in the ultimate project design – whether to toll a single facility, a cordoned area of the city, or to introduce a distance-based fee for an entire road network. While the preceding report considered *why* the world is seeing a marked increase in the implementation of road pricing schemes, this report focuses on *how* road pricing projects have been implemented. Just as the motivations behind road pricing were correlated with the type of tolling project, we find here that the most effective implementation paths and management structures are also related to the goals of the particular initiative. In other words, there is no universal “best practice.” Rather, we conclude that the lead agency in any electronic roadway tolling project should carefully reflect on the goals and objectives of the initiative before developing a plan for implementation. A project that aims to construct new road capacity will most likely have a very different optimal implementation and management structures than a program that aims to enhance transit service in the region.

To provide concrete examples of our recommendations, we review several cases of successful implementation and the methods used to overcome barriers and challenges. We selected cases with a wide variety of objectives and geographic locations to best discern some effective tools and methods. The model cases discussed include London’s Congestion Pricing Scheme, San Diego’s I-15 HOT lanes, Toronto’s 407 ETR, and Germany’s Toll Collect program.

From these case studies, we find that transportation agencies and elected officials must carefully consider the barriers that stand in the way of enacting a proposal. While the implementation path and management structure might vary, the barriers that officials must overcome are fairly consistent across project types and geographic regions. These barriers can be divided into three categories: (1) technological and practical, (2) legal and institutional barriers, and (3) acceptability barriers (Niskanene, et al., 2003). Successfully overcoming these barriers is what separates the road pricing systems in use today from those that will forever remain on the drawing boards. While this report focuses primarily on the legal and institutional barriers to implementation, the report for Task A-3 will delve into technology issues, and the report for Task A-5 will examine barriers associated with political and public acceptance. While these other issues are important, a significant body of literature suggests that levels of acceptability among both the public and elected officials is perhaps the single most important factor in determining whether a project moves forward or stalls (Banister, 2004; Niskanene, et al., 2003; Ison & Rye, 2005).

Finally, we conclude with recommendations to help guide California and other states through the implementation and management design process. While much of the available literature focuses on case examples in Europe and Asia, the question remains how best to

translate these lessons to the context of the United States. Undoubtedly, many of the same hurdles stand between conception and implementation, particularly acceptance barriers. Given this, what lessons can California learn from the challenges and pitfalls others have encountered along the way?

Methodology and Logistics

The information in this report was gathered through a comprehensive literature review. This review considered primary and secondary data for specific case studies, as well as tertiary data from the scholarly literature on the successful implementation of road pricing projects. Much of this literature for this report overlaps with topics and issues discussed in other reports in this research series, such as public acceptability. The cases reviewed here were selected to provide a representative cross-section of various road pricing projects – both geographically and structurally. While some of the cases were implemented smoothly, others encountered significant obstacles along the path to implementation, which provide equally important insight.

Overview of Organizational Structure for Electronic Roadway Tolling Projects

Once a road pricing project reaches implementation and planning stages, the three major organizational questions concern (1) who administers the program, (2) who manages and operates the program, and (3) who oversees the program. The administration of a road pricing program includes tasks such as determining toll levels, issuing bills, and collecting and distributing revenue. Management and operation responsibilities include the day-to-day management of operations. Additionally, issues such as development of appropriate technology fall under the category of management and operation. Finally, the overseeing organization makes many of the important policy decisions and manages relations between administrative and operating agencies or firms.

As mentioned in the introduction, the assignment of these various responsibilities depends heavily on the objectives of the proposal, with both the public and private sectors playing integral roles. The private sector is likely to play a more significant role in administration and management and operation stages, while the public sector more often tends to provide the oversight for projects. Generally, road pricing projects that aim to raise public revenues or manage congestion are overseen by the public sector. In these cases, the road pricing programs are most commonly overseen by a single jurisdiction, but multi-jurisdiction arrangements are likely to become increasingly common as road pricing becomes more widespread and interoperable technology improves (Sorensen & Taylor, 2005). Multi-jurisdiction projects can cross city lines, state boundaries, or even international divides. However, by incorporating multiple jurisdictions, implementation and management issues become increasingly complex. Examples of multi-jurisdictional projects include Australia's Austroads, Bristol, England's Truck/Cordon Demonstration, and ARMAS Pan-European Road Tolling Project. In the cases where the project spans multiple jurisdictions, an independent agency generally administers the program, collecting the fees from the users and then distributing the revenue to the jurisdictions based on a pre-determined formula (Sorensen & Taylor, 2005).

Table 1 summarizes some of the overall trends in the provision of administration, management and operation, and oversight of road pricing projects. This table also highlights the division of services in the case studies that are discussed later in this report. However, the division between the public and private sector can be ambiguous, as responsibilities often bounce between the two sectors as a project evolves. Additionally, in many cases, a quasi-governmental organization is established to oversee the private sector’s involvement in the administration, management, and operation of a project and to mediate between various public agencies and the private sector.

Table 1: Organizational Structure Trends

		Administration	Management and Operation	Oversight
Overall		Public/Private	Private	Public
Single jurisdiction application		Public/Private	Private	Public
Multi-jurisdiction application		Private	Private	Quasi-Public
Case Studies	Type of Tolling	Administration	Management and Operation	Oversight
(1) Toronto	Facility Congestion Toll – New Facility	Private <i>ETR Concession Company</i>	Private <i>Raytheon/ ETR Concession Company</i>	Quasi-Public <i>Ontario Transportation Capital Corporation (OTCC)</i>
(2) Germany	Weight-Distance Truck Toll	Quasi-Public <i>Infrastructure Funding Company</i>	Private <i>Toll Collect</i>	Quasi-Public <i>Infrastructure Funding Company</i>
(3) London	Cordon Toll	Public <i>TfL</i>	Private <i>Capita Group, IBM</i>	Public <i>TfL</i>
(4) San Diego	Facility Congestion Toll – Existing HOV Lanes	Public <i>SANDAG</i>	Public <i>SANDAG, Caltrans</i>	Public <i>SANDAG, FHWA</i>

While the public agency might also administer the program if it possesses adequate personnel and expertise, it is much more common for the actual administration and operation of the program to be contracted to the private sector. Private firms are in general better equipped with staff and resources to administer road pricing projects than the public sector (Sorensen & Taylor, 2005).

Likewise, public agencies often find it more efficient to turn to the private sector to develop and implement the needed technologies as part of the operations of the project. The two common approaches for securing technological assistance are: (1) contracting with a single or a consortium of firms or (2) put out a request for bids from multiple firms. In the first arrangement, the firm or firms are contractually obligated to deliver the technological services. However, as the German Toll Collect example illustrates, this contract can often lead to substantial delays in the implementation if the contracted firm encounters set-backs. In the alternative arrangement, firms are forced to compete with one another, and this competition in turn provides an incentive to lower the price and expedite the development (Sorensen & Taylor, 2005).

Public-Private Partnerships

The preceding section highlights the significant role the private sector can play in the implementation of road pricing projects. The accompanying deliverable (Task B-1) discusses public-private partnerships in great detail. Table 1 summarizes the various public-private structures as discussed in Task B-1: *Are Public-Private Partnerships a Good Choice for U.S. Highways?*. As that report notes, such arrangements demonstrate significant benefits to road pricing projects but also frequently demonstrate significant risks and added implementation challenges. While Task B-1 focused primarily on public-private partnerships as a financial mechanism, this paper concentrates more specifically the effectiveness of the private sector in a role of administrator and manager.

In most public-private partnerships, except full privatization, the public sector retains some ongoing oversight over the projects. Arrangements that involve the private sector in the administration, management, and operation and the public sector in the oversight of the project include the traditional procurement/service contracts, design-build/turnkey, and the build-operate-transfer/design-build operate/management contracts. The joint ventures, lease agreements, and design-build-finance-operate/concession arrangements also retain the public sector as the overseeing agency with the private sector playing a larger role in the administration and management and operation. Thus, while the private sector can play a significant role in the design, implementation, administration, and operation of road pricing facilities, the public sector rarely releases the entire oversight to the private firms, and public agencies must be structured to work effectively with the private sector.

Table 2: Structure of Public-Private Partnerships

<i>Traditional Procurement/Service Contracts</i>	Public agency issues separate contracts for the design, construction, and operation (if outsourced) to the lowest responsible bidders and remunerates them through direct payments
<i>Design-Build / Turnkey</i>	Similar to traditional procurement, except design and construction are combined into a single contract
<i>Build-Operate-Transfer / Design-Build-Operate / Management Contracts</i>	Entire project from design to operation is combined under a single contract, including project management, and the public agency pays through direct payments over the lifetime of the project
<i>Joint Venture</i>	The public agency forms a joint public/private company with local stakeholders to complete an improvement.
<i>Lease Agreements</i>	Existing or new facilities are leased to a private firm, which is allowed to charge tolls, for the purposes of operation
<i>Design-Build-Finance-Operate / Concession</i>	Similar to build-operate-transfer, except the private firm is allowed to collect tolls for a set period of time before transferring the facility to public control.
<i>Full Private Provision</i>	No reversion to public ownership takes place

Source: (Iseki, Uchida, & Taylor, 2008)

One of the frequently cited advantages of financing transportation projects through the private sector is the infusion of “up-front” capital to provide improvements or new services prior to the implementation of the project (Crawford & Catling, 2002). This benefit is particularly applicable in programs with the goal of improving infrastructure or transit options, but might not be as important for programs that aim just to manage congestion. Another commonly mentioned benefit of private involvement in the operation and maintenance of road pricing initiatives is that a private operator is not directly accountable to voters and therefore is free to raise prices to appropriate levels to efficiently manage congestion delays (Thornton, 2007).

The design of the contracts with the private sector can play a significant role in determining the success or failure of a project. Long-term contracts limit competition and thus the performance of the private firm might suffer without this incentive to improve efficiency within a competitive market (Sclar, 2000). Sclar also identifies several key factors that can play

a role in developing a model for a successful public-private contract. First, the expected service must be explicitly specified, so that a delivery of service is effectively overseen by the public agency without any dispute. Likewise, a careful delineation of service provision between the public and private sectors must be stated. As we will see later in this paper, the significant implementation delays experienced in the case of German Toll Collect highlights the critical need for full contracts to be developed at the time of the agreement. However, the ability of the government to enter into a complete contract is limited by unforeseen conditions. Another potential problem in the design of appropriate contracts is the “no-compete” clause, which can prevent the public sector from adding much-needed “competing” capacity in the case of corridor or facility pricing projects. In such a case, the private firm could conceivably continue to raise tolls to maintain a steady traffic flow for the corridor or facility in an environment of growing demand and static capacity. The case of Orange County’s SR-91 Express Lanes², and their eventual transition from private to public ownership is perhaps one of the best known examples of the political conflict resulting from the limitations of a non-compete clause.

Finally, the institutional knowledge that lies within public sector agencies can sometimes qualify their employees as the experts, in contrast to the employees of private sector firms who may lack this institutional knowledge (Sclar, 2000). On the other hand, a great deal of technical expertise frequently lies within private sector firms, which make them especially strong candidates to develop the necessary technology for road pricing projects. Therefore, the public sector might often be best suited for the oversight and administrative responsibilities, while the private sector is frequently better suited for operational and management duties. The cases discussed in this paper primarily break responsibilities along these lines.

Government-Owned Corporations

Since the private firms often assume responsibility for operations and administration and the public sector often retains oversight, the relationship between the two sectors needs to be managed effectively. In order to collaborate efficiently with private firms, governments often develop government-owned or state-owned corporations (called “crown corporations” in commonwealth nations) to oversee large infrastructure projects, road networks, or tolling projects. A government-owned corporation is a legal entity created to perform commercial or business activity on behalf of the state. The state-owned holding company often plays a critical role as a monitoring arm of the government (Sam, 2008). By managing road networks through government-owned corporations, the state no longer holds a monopoly over road operations and opens up the provision of road networks to a competitive market. Examples of tolling projects that are overseen by government-owned corporations include the Ontario’s Transportation

² In response to worsening congestion and lack of revenue for capacity expansion, the Orange County Transportation Authority (OCTA) partnered in the 1990s with the private investor California Private Transportation Company (CPTC) to fund the construction of four toll lanes in the median of State Route 91 in Santa Ana Canyon just west of the Riverside County border. Users of these lanes are charged a fee to save up to 30 minutes over traveling in the adjacent free, congested lanes. The fee varies by time and day from \$1.25 to \$9.50 to keep the toll lanes free-flowing. CPTC operated the SR-91 Express Lanes for several years, until a clash with Caltrans over capacity additions to the adjacent free lanes led to the sale of the facility back to OCTA in 2003. Today the lanes are publicly owned and regulated, but privately operated. The controversy left a negative impression of the role of the private sector in infrastructure development and management for many in Southern California

Capital Corporation, Italy's Autostrade, and Germany's Infrastructure Funding Company. Government-owned corporations are often eventually completely privatized, such as Autostrade in Italy.

Case Studies

Toronto's Highway 407: Financing and Constructing New Capacity

As discussed in the report for Task A-1, the Toronto metropolitan area desperately needed to expand roadway infrastructure in the early 1990s but lacked sufficient funds to do so. The Highway 407 was viewed as a critical step in reducing traffic congestion in northern area of the region. The province was still recovering from an economic recession, and a major infrastructure project would not only help alleviate congestion but also aid in stimulating the economy. Due to these economic stimulus goals and the lack of public funds, Ontario officials decided to pursue a private financing strategy because they did not want to wait for the traditional funding mechanisms coming through to fund the project.

With the hopes of attracting private investors, Ontario province created the Ontario Transportation Capital Corporation (OTCC) in 1993. OTCC is a crown corporation intended to manage investment in transportation infrastructure within the province of Ontario. Specifically, OTCC was mandated with the responsibility of securing private funding for the 407 Highway and managing the implementation of the proposed public-private partnership (Nix, 2001).

However, once OTCC officials had reviewed the design-build-finance-maintain-operate-transfer (DBFMOT) proposals from two companies, they determined that the public sector could borrow money at a lower rate than the private sector, thus resulting in significant cost savings. Instead of the original DBFMOT scheme, OTCC divided the responsibilities between multiple firms. The province entered a design-build-operate agreement with one firm and a contract for the development of the electronic tolling technology with a second firm (Nix, 2001). The private company Raytheon constructed and operated the road from its opening in October 1997 through 1999. However, OTCC retained responsibility for the financing and maintenance of the roadway.

Due to these changes in the distribution of responsibilities, the provincial government assumed a significant portion of the risk associated with financing, owning, and operating the facility. As a result, in the opinion of the Ontario's Office of the Provincial Auditor, a public-private partnership was never established. Although officials still debate whether or not the government saved money through this financing mechanism, most agree that the construction of the roadway was greatly expedited as a result of partnering with private firms (Nix, 2001).



Figure 1: Location of the 407 (Commission for Integrated Transport, 2006)

In April 1999, a consortium comprised of Spanish company Ferrovial, Cintra Concesiones de Infraestructuras de Transporte, SNC-Lavalin, and Capital d'Amérique CDPQ purchased the 407 ETR from Ontario for CA\$3.107 billion (USD 2.09 billion) by (Nix, 2001). At this point, the consortium renamed itself the 407 ETR Concession Company. While the province of Ontario retains ownership of the land Highway 407, the consortium leases the land from the province and owns the road, buildings and other structures on the land. The province will regain ownership of these facilities at the end of the 99-year lease.

Although the original legislation mandated that the tolls were removed once the debt was paid off, the sale of the ETR Concession Company to the consortium changed this condition. In 1999, the Ontario government ruled that

“The new owners will have the authority to set toll rates. However, they will be required to achieve pre-set traffic *congestion* relief targets established by MTO in order to increase rates above a specified toll level. The specified toll level is set at the current price of \$0.11 per kilometer. This level can be increased by 2% per year plus CPI for the first 15 years, and thereafter, by CPI only. This means that the specified toll level can only increase by about three cents per kilometer over the first 15 years. The specified toll levels are connected to congestion relief targets. Toll rates above the specified toll level will only be permitted if the traffic volumes are at or above target levels. If the required traffic volumes are not met, any income from tolls charged above the specified toll level will be clawed back by the province along with an additional penalty of the same amount. Toll rates for trucks will continue to be two times the automobile rate for single unit trucks and three times the rate for multiple unit trucks.” (Nix, 2001)

The implementation and management of Toronto’s Highway 407 highlights the importance of flexible legislation and incremental implementation. Furthermore, this project demonstrates that sometimes it is more cost-efficient to finance through the public sector rather than depending on private investments. Finally, the private sector clearly played an instrumental role in expediting the project’s implementation and construction even though it was not involved in the financing aspects.

Key Lessons:

- Financing through the public sector can save money
- Separate contracts for specific tasks
- Gradual implementation of tolling goals

German Toll Collect: Maintaining Infrastructure

While contracting with the private sector successfully aided in the development of Toronto’s Highway 407, the role of private firms involved with the implementation of Germany’s Toll Collect provides a more cautionary tale. The German government first developed the concept of Toll Collect in 1999 as a result of the desire of the German High Commission for Financing the Federal Infrastructure to switch from tax-based financing to

usage-based financing. In order to facilitate this transition, the Commission recommended the establishment of a Highway Funding Company (Fernstraßenfinanzierungsgesellschaft). This Company was conceived as a joint-stock company with the shares owned exclusively by the federal government. The company's infrastructure investments would be financed through a combination of distance-based toll revenue and debt on the capital markets. The Commission envisioned the revenue from the tolls to be used exclusively for the development of highway infrastructure while investments in other modes of transport were to be prohibited (Wieland, 2005).

However, once implemented in 2003, the company structure was very different from the original concept. Instead of the Highway Funding Company, the new firm was called the Infrastructure Funding Company (Verkehrsinfrastrukturfinanzierungsgesellschaft, VIFG). Rather than dedicating all investments to roadways, this firm was designed to cross-subsidize other forms of transport. According to the enabling national legislation, half of the toll revenues were to be dedicated to the development of rail and inland waterways. Additionally, the legislation stated that toll revenues were to go directly to the federal government, who would then disburse the funds to the Infrastructure Funding Company. This mandate contradicts the initial intention of the High Commission to separate the company's budget from the state's budget (Wieland, 2005).

While the finances would be managed through the Infrastructure Funding Company, the operation of the tolling system was to be managed by Toll Collect, a consortium of Deutsche Telekom, Daimler Chrysler, and Cofiroute. In 2002, Toll Collect was awarded the official license to run operations of the distance-based tolling system for 12 years with an agreement that the system would be operating by August 2003.

However, a series of technical problems significantly delayed the full implementation of the Toll Collect project until January 2005. Lack of communication between various Toll Collect teams led to the development of different software packages that did not have a common interface (Borgnolo, Stewart-Ladewig, & Neuenschwander, 2005). Additionally, the on-board units were not programmed with the European standard DRSC protocol, meaning Toll Collect on board units could not be interoperable with any other road pricing systems in Europe (Borgnolo, Stewart-Ladewig, & Neuenschwander, 2005).

Due to these delays, the German government became increasingly frustrated with Toll Collect's performance. Prior to developing the Toll Collect program, Germany had participated in the Eurovignette program, which provided some revenue from trucks. However, in anticipation of the implementation of Toll Collect, Germany pulled out of Eurovignette in August 2003. As a result, freight carriers were not paying any toll to Germany until January 2005, when Toll Collect was finally implemented. The revenue losses were estimated to be €163 million (USD 184 million) monthly in 2003 and €233 million (USD 290 million) monthly in 2004 (Borgnolo, Stewart-Ladewig, & Neuenschwander, 2005). Furthermore, Toll Collect was still unable to provide the government with a definitive start date.

As a result, Germany's Ministry of Transport cancelled its contract with Toll Collect February 2004. However, Toll Collect and the government were able to reach a compromise within 10 days of the initial cancellation, reinstating the contract on the terms that Toll Collect

would be restructured. During the negotiations to reinstate the contract, the German government stated that it felt that it should be compensated for the revenue loss due to the delay in implementation. As part of the compromise between the two parties, if the first stage of implementation of system did not occur by January 1, 2005, Toll Collect was subject to a fine of €40 million (USD 50 million) per month, which would increase in increments of €5 million (USD 6.2 million) for each additional month. The maximum allowed compensation was €80 million (USD 99.5 million) (Borgnolo, Stewart-Ladewig, & Neuenschwander, 2005). Additionally, the new contract stated that the second stage must be implemented by January 2006, and if it fails to be implemented, Toll Collect was to compensate the government equal to the expected revenues from road pricing. The German government retained the right to cancel the contract with Toll Collect if either stage of implementation fails (Borgnolo, Stewart-Ladewig, & Neuenschwander, 2005).

The Toll Collect system was finally implemented in two stages: a preliminary stage in January 2005 and a full version in January 2006, incorporating improvements to the onboard unit and software, which could make it feasible to incorporate secondary federal roads into the system (Wieland, 2005).

The delayed implementations of the Toll Collect system underscore the importance of developing stronger contracts with private firms so that the government does not lose on potential revenue. Wieland refers to the theory of incomplete contracts to explain the shortcomings of the German Toll Collect implementation (Wieland, 2005). The delays in the implementation led to nation-wide loss in faith of tolling systems (Borgnolo, Stewart-Ladewig, & Neuenschwander, 2005). Additionally, this case highlights the importance of balancing the best allocation of revenue with uses that are publicly acceptable. If the uses of revenue are unclear, the project is more likely to encounter substantial public or political opposition, delaying the implementation process. To avoid similar problems in the future, contracts should be written to include penalties for delays to compensate for potential revenue losses (Borgnolo, Stewart-Ladewig, & Neuenschwander, 2005).

Key Lessons:

- Financing structure can affect objectives and public acceptability
- Contracts should be designed to cover loss of revenue due to implementation delays

London Congestion Charging Scheme: Managing Congestion

In contrast to the Toronto and German cases, the private sector had very limited involvement in the implementation and management of London's Congestion Pricing Scheme. As discussed in the report for Task A-1, the congestion levels in central London in the 1990s had reached stifling levels, inhibiting economic growth and degrading environmental conditions. In addition, the extensive and aging London Underground subway was in desperate need of repair and upgrading, but with little available funding to do so. Prominent national political figure Ken Livingstone was elected Mayor of the Greater London Council on, among other things, a platform advocating for the introduction of congestion charging in central London. Immediately prior to Livingstone's election in 2000, a number of organizational and legislative changes paved

the way for the implementation of congestion pricing. In 1999, national legislation established the Greater London Authority (GLA), which proved to be critical in providing access to the necessary resources and revenue to implement the charging scheme. The GLA receives national funding, but the Mayor is also permitted to introduce local taxes, as well as fee programs like congestion pricing. More importantly, the Mayor acts as the key decision-maker of the GLA, which allowed Livingstone to move forward with his congestion charging agenda with minimal political opposition (Ison, 2004). The presence of such a strong political champion pushing for the implementation of the scheme played a critical role in the ultimate introduction of congestion charging, and the project likely would have stalled without Livingstone's advocacy.

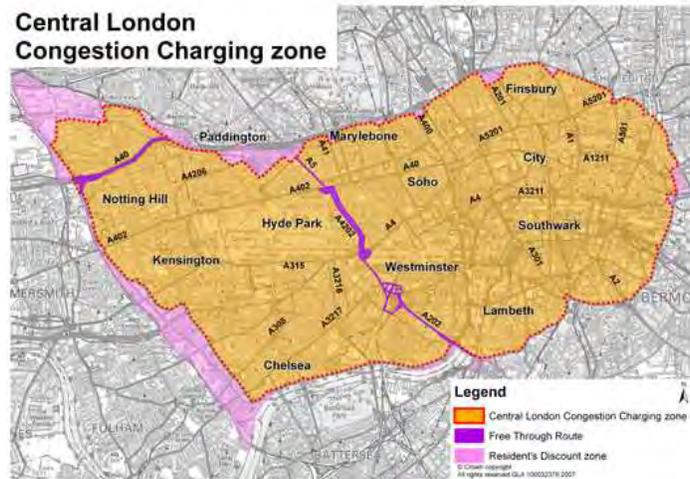


Figure 2: Map of London Congestion Charging (Transport for London, 2007)

Another essential component of the GLA was the establishment of the Transport for London (TfL). TfL is responsible for the major roads, buses, light rail, local transport capital funding for all local transport schemes, and the Underground (Ison & Rye, 2005). The members of the TfL board are appointed by the Mayor of London. The authority of TfL is unique in Britain, where local authorities often have no direct control over the transit network and, as a result, cannot make the necessary improvement needed to obtain public support of road pricing. Instead, the transportation agencies must depend on private operators to make the needed improvements (Ison, 2004).

The successful implementation of the London pricing scheme can be largely attributed to the fact that a single agency oversaw the project, rather than a collaboration of various agencies (Ison, 2004). TfL was charged with the responsibility of both the implementation of the road charging scheme and the accompanying improvements to both the Underground and surface bus systems. To manage the day-to-day operation of the pricing scheme, TfL contracted with the Capita Group, which in turn has employed sub-contractors, such as Mastek, which is responsible for developing and maintaining the information technology infrastructure. The current contract with Capita lasts through 2009, at which point IBM will take over the operations of the congestion charging scheme with a five-year contract (Capita to lose congestion charge, 2007).

Leape (2006) has categorized the costs associated with the implementation of the pricing scheme into five categories: (1) the initial set-up costs associated with the installation of infrastructure and services, (2) the operation costs, (3) the supervisory costs, (4) the traffic management costs, and (5) enforcement costs (Leape, 2006). The cost of initial implementation is estimated at approximately £200 million (USD\$394 million). The continuous operating costs are considered to be the single largest cost associated with the pricing scheme and are estimated at £80 million (USD\$158 million) per year. The operating costs are incurred in the form of payments from TfL to Capita, which manages operations. Furthermore, since TfL was

responsible for both the development of the congestion charging scheme and the alternative transportation options, the agency dedicated £100 million (USD\$197 million) for traffic-management programs.

Since implementation, London officials have discussed various means of changing the program – both ways to increase its scope and, most recently, contracting it. Following initial implementation, the cordoned area was expanded to include a greater portion of central London. Additionally, recent proposals evaluated incorporating levels of vehicle emissions into the charge. Both of these proposed expansions illustrate the importance of utilizing an incremental approach to introducing road pricing projects.

While the position of Mayor involves considerably more than overseeing the central London congestion pricing program, and while Livingstone had generally proved to be a popular Mayor, Livingstone was recently ousted as Mayor in an election surprise by Boris Johnson. Johnson, an iconoclastic conservative has signaled his intent to halt the proposed western expansions of the congestion pricing program, though the existing central area pricing cordon will remain (Milmo, 2008).

Many agree that congestion pricing in London most likely would not have been implemented without Mayor Livingstone's work championing for the project. The infusion of revenues for transit and the gradual, albeit in some cases grudging, support from businesses and other key interests also played a substantial role in the successful development of the project (Banister, 2004). Finally, the unique organizational structure of the GLA and TfL facilitated streamlined the implementation process (Ison & Rye, 2005).

Key Lessons:

- Strong project management and political commitment critical in successful implementation
- Integrated team and partnership essential
- Importance of a clear procurement strategy
- Importance of public information campaign and presenting congestion charging as a component of an comprehensive transportation strategy

San Diego I-15 Express Lanes: Enhancing Regional Transit Service

Like many other road pricing initiatives, San Diego's I-15 Express Lanes were originally conceived of primarily to reduce congestion along the I-15 corridor by converting an underutilized HOV lane into an HOT lane and redirecting the revenue to enhance transit service in the region. In contrast to some of the other cases reviewed here, the financing and management of the I-15 Express lanes lay almost entirely in the public realm. A significant portion of the implementation funding came from the federal level, which reflected interest among federal officials in experimenting with various road pricing approaches to relieve congestion. The project was initially funded through the Federal Highway Administration's (FHWA) Congestion Pricing Pilot Program (Value Pricing Program). The FHWA grant provided \$7.96 million in funding. In addition, the project received \$1.99 million in local

matching funds and \$230,000 from the Federal Transit Administration (FTA) (Schreffler, Golob, & Supernak, 1998).

The federal agencies played a larger role in the original inception and funding stages, but as the project moved toward implementation, the local stakeholders took on a greater role (Schreffler, Golob, & Supernak, 1998). In order to move forward with the implementation, the various stakeholders established several agreements distributing authorities and responsibilities. Caltrans and the FHWA entered into a contract to manage the distribution of the federal funds to the state. Additionally, the California Department of Transportation (Caltrans) and the San Diego Association of Governments (SANDAG) developed a Program Supplement Agreement for the purpose of transferring funds and project responsibilities to SANDAG. The FHWA environmental justice requirements attached to the funding caused some confusion and concern about adequately meeting the requirements. But the stakeholders felt that the funding was adequate for implementation. The implementation of the project was delayed less than a year and that was due mainly delays in finalizing essential agreements between FHWA, Caltrans, and SANDAG (Schreffler, Golob, & Supernak, 1998).



Figure 3: Location of I-15 HOT Lanes to (Federal Highway Administration, 2003)

SANDAG and Caltrans served as the primary partners in managing and implementing the I-15 Express Lanes project. The lanes are enforced by the California Highway Patrol (CHP), and transit improvements are provided by the Metropolitan Transit Development Board (MTDB). The original project management team consisted of SANDAG, FHWA, FTA, CHP, MTDB, the Cities of San Diego and Poway, the Automobile Club of Southern California, and Assemblyman Jan Goldsmith's office (Schreffler, Golob, & Supernak, 1998). Assemblyman Goldsmith acted as the primary political champion for the implementation of the Express Lanes. Like the London case, it is likely that the project would have stalled without Goldsmith's advocacy work. During implementation, the project management team met monthly to oversee the progress of the project, allowing all stakeholders to keep in constant communication.

In addition to funding duties, Caltrans was responsible for the operations and safety/liability issues related to the I-15 Express Lanes. At the local level, SANDAG established a Policy Advisory Committee and a Citizen's Advisory Committee, which were very active in the planning phase. Various consultants played an important role in the planning phases with the provision of analytical reports to support decision-making in regards to setting prices, public relations, and operational issues (Schreffler, Golob, & Supernak, 1998).

Many of the keys to successful implementation that played a role in the London case also apply to the San Diego case. Like London, San Diego benefited from the presence of a strong political champion – Jan Goldsmith – and a strong community outreach campaign. At the organizational level, the transit system and the Express Lanes were managed by the same authority, SANDAG, which facilitated the improvements.

Key Lessons:

- Integrating revenue and improvements in public transit to present comprehensive strategy
- A single agency oversaw both the HOT lanes and the transit improvements
- Public relations campaign essential in building supportive coalition
- Gradual implementation

Common Barriers to Implementation

A significant body of literature focuses on identifying barriers frequently encountered in attempting to implement road pricing proposals and many of the case studies discussed had to overcome these impediments. As mentioned in the introduction, the common barriers can be categorized into three groups: (1) technological and practical barriers, (2) legal and institutional barriers, and (3) acceptability barriers. Table 3 on the next page provides a summary of the three categories of barriers and frequent issues associated with each group. While much of the academic literature is drawn from experiences in European road pricing, many of the lessons can be carried over to the context of the United States as any successful initiative needs to address this full-range of challenges. Additionally, it is important to keep in mind that many of the impediments to road pricing are interdependent on one another. For example, achieving adequate public support is dependent on the existence of adequate technology (Niskanene, et al., 2003). Additionally, the relevant significance of specific barriers can vary greatly depending on a number of factors, such as the political context. This paper focuses primarily on the identified legal and institutional barriers to implementation.

Technological and Practical Barriers

As technology rapidly advances, technological impediments to the implementation of road pricing are fading. One common technological challenge that remains, however, is that some existing technology may be too expensive to justify implementation on a broad scale. Additionally, some of the technology that permits fully differentiated pricing based on congestion levels has not been widely tested in the field in a full variety of situations. Furthermore, interoperability problems continue to be a concern in the development of pricing initiatives that cross jurisdictional boundaries. While interoperability issues may not be a major problem at the outset of a project, as initiatives expand to incorporate a broader geographical area, interoperability of charging mechanisms could prove to be a major issue (Niskanene, et al., 2003). Furthermore, interoperability allows for economies of scale with respect to fixed costs of electronic tolling systems. Interoperable smartcards make it cheaper and more convenient for users if they can use one system for all transactions. As the case of the German Toll Collect

project illustrates, technology problems can play a role in significantly stalling a project, but these technological issues can usually be overcome.

Table 3: Common Barriers to Implementation based on Implementation of Marginal Cost Pricing in Transport - Integrated Conceptual and Applied Model Analysis (MC-ICAM)

Type of barrier	
Technological and practical barriers	<ul style="list-style-type: none"> • While technology for road pricing exists, it is not widely tested and is often considered too risky to justify full-scale implementation in the short term • Interoperability problems among systems • Complex structure of urban road networks and lack of space for added capacity in urban areas • Availability of reliable cost estimates and other data
Legal and institutional barriers	<ul style="list-style-type: none"> • Predominance of policy goals that are contradictory with economic efficiency and the principle of marginal cost pricing • Lack of federal laws to permit or facilitate road pricing as a general policy approach • Lack of coordination between adjacent cities and states • Disconnected nature of the decision-making structures and processes • Bureaucratic nature of implementation process – dealing with multiple administrative levels • Public-Private-Partnership (PPP) for funding, producing, and operating infrastructure • Legislation to prevent direct charges for road use on the basis of freedom of access and movement and certain civil liberties and privacy needs • Opposition by non-governmental stakeholder groups and opposition parties
Acceptability barriers	<ul style="list-style-type: none"> • Low public acceptability • Low business acceptability • Low political acceptability

Source: (Niskanene, et al., 2003)

More relevant to the focus of this paper are the practical barriers to implementation. A common practical impediment is access to quality and sufficient data on costs as well as of the welfare benefits and other potential effects of road pricing. Without accurate estimates of the implications and costs, it is much more challenging to garner the necessary support. This form of uncertainty is gradually declining as pricing programs become more commonplace. Additionally, the complexity of transportation networks and the geography of the jurisdiction play a major role in the feasibility of road pricing initiatives. For example, mono-centric and poly-centric cities might have very different optimal pricing strategies. Many feel that the urban form in Europe might be better suited for area-based congestion charging than the urban form of many American cities, which tend to be more sprawling without a strong central business district (Lindsey, 2003). Therefore, these differences in urban form imply that the road pricing programs should be designed differently. For example, facility-based tolling is perhaps more applicable in the U.S. context while cordon tolling may be more relevant to the European context.

Additionally, studies have shown that road pricing is both more urgent and more accepted in larger cities (Lindsey, 2003). This is likely due to higher levels of congestion in larger cities, which is critical in demonstrating the need for road pricing. For example, in response to attempts to introduce congestion pricing to Hong Kong, the Automobile Association there suggested the congestion problem had been exaggerated. Additionally, feasibility studies in both Hong Kong and Cambridge, England suggested that road pricing was not justified based on current congestion levels. On the other hand, London congestion levels had reached unacceptable levels – many Londoners felt drastic measures were justified. Therefore, proposals can fail if traffic congestion has not yet reached what are locally perceived to be unbearable levels (Ison & Rye, 2005).

The timing of the introduction of road pricing proposals can also play a critical role in its success or failure. The timing of the implementation can affect the public's perception of existing congestion and thus the need for road pricing programs. For example, the Hong Kong proposal failed in part because the proposal coincided with the merger of the Mass Transit Railway and Kowloon Canton Railway. This merger resulted in the creation of an urban rail transit network in excess of 200 kilometers and 150 stops/stations, which, in combination with an economic downturn in Hong Kong, significantly decreased congestion and thus the perceived need for road pricing. Political stability is another factor that varies based on the timing of the proposal. For example, the London congestion charging scheme was introduced early in Mayor Livingstone's term, which provided a certain level of political stability, allowing the measure to move forward (Banister, 2004; Ison & Rye, 2005).

While technological and practical barriers can certainly hinder the implementation of road pricing projects, it is unlikely that with current technology, this would be the sole reason a project failed to move forward. Even if technological barriers prevent implementation of a large-scale project, the proposal could always be implemented piece-meal. On the other hand, the practical barriers can play a larger role in guiding the implementation process and ultimately determining the optimal structure. For example, in dense urban environments, it might simply not be feasible to construct a new facility and instead cordon charging might be a better structure. In the long-run, both technological and practical impediments can easily be overcome (Niskanene, et al., 2003).

Legal and Institutional Barriers

Legal restrictions from higher governing bodies, such as federal or state governments, can often impede the progress of road pricing proposals, even if the support is present at the local level. In Europe, many countries limit the legal ability of local governments to introduce road pricing projects by creating stipulations that projects must meet. For example, France limits road pricing to new infrastructure, and in Sweden road tolls are considered taxes and therefore must be approved by the Parliament (Niskanene, et al., 2003). In other countries, civil liberty protections prohibit the tracking of the location of vehicles. Additionally, European Union legislation restricts the level of permissible tolling prices. Within the United States, tolling was prohibited on Interstate highways until the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) loosened the restrictions (Lindsey, 2003).

In addition to legislative barriers from higher authorities, contradictory legislation can often hinder implementation. For example, civil liberty, taxation, and environmental legislation can often pose a challenge to the legal standing of road pricing projects (Niskanene, et al., 2003). Laws pertaining to civil liberties can limit the ability of agencies to track the locations of individual vehicles, which is necessary in distance-based fee programs. Taxation legislation often prohibits jurisdictions from implementing new charges on road networks. Furthermore, some countries have legislation that prohibits tolls from varying over time, which greatly limits the ability to manage traffic flows. Past experience demonstrates that securing the necessary legal approval is easier if road pricing projects are implemented only temporarily to address a specific problem or if the legislation is subject to periodic review (Lindsey, 2003). For example, U.S. federal legislation is subject to re-examination automatically through the Reauthorization process. In Norway, the tolling schemes must be renewed every fifteen years. These legislative challenges closely coincide with building a strong political coalition across all levels of administration to prevent politicians from wielding legislation to block road pricing projects.

Organizational structure issues can also inhibit the implementation of road pricing plans. Disconnected decision-making structures, multi-level structure of government decision-making process or the number of administrative levels, and the role of the private sector can all determine the efficiency with which a proposal moves towards implementation. For example, in Europe, the management of urban roads is typically the responsibility of local cities, whereas interurban roads fall under the national jurisdiction (Niskanene, et al., 2003). Similarly, in the United States, urban surface streets are the responsibility of cities, and counties in unincorporated areas, while the Interstate and other state and federal highways fall under combined federal/state jurisdiction. These mixed, and sometimes competing, jurisdictions can make it challenging to coordinate a comprehensive road pricing approach as they may often have conflicting interests and goals.

Furthermore, the multi-level structure of bureaucratic decision-making can inhibit implementation. The distribution of responsibilities and powers across different governmental administrative levels is often not ideal to manage and move road pricing forward. In particular, the democratic political system with opposing parties and reelection concerns limits the ability of government to take political risks for the sake of operating efficiency (Niskanene, et al., 2003). While many jurisdictions face these barriers of distributed authority under democracy, a growing number of jurisdictions, like London, have overcome them. It's perhaps not surprising the first successful experiment in congestion pricing was in Singapore, a city-state that has a sole administrative level for implementing and deciding on transportation policies. The failure of the New York City Congestion Pricing proposal, due to an unwillingness of the state legislature to grant the necessary legislative authority, is a recent example of the challenges in multi-level approval processes to move projects forward.

Ison and Rye (2005) identify the existence of a single implementing body as a key characteristic of the success of the London Congestion Pricing Scheme. In London, the Mayor possessed the ability to make key decisions pertaining to congestion charging, as the head of the Greater London Authority. Furthermore, Transport for London was responsible for the implementation of the project, which expedited the process as the agency controls the major roads, buses, light rail, and local transport capital funding for all local transport schemes and the Underground. Transport for London is both well-funded and well-staffed, making it easier for

the agency to retain control of the implementation process. Since Transport for London is also responsible for managing the alternative transportation modes, it was possible to make the public transit improvements that proved to be so critical in building acceptance for the congestion pricing. In contrast, implementation attempts in Cambridge, England and Hong Kong were mired in conflicting political interests at various levels of government. Additionally, political stability is also critical in successful implementation. For example, London was politically stable throughout the implementation since it was introduced early in Mayor Ken Livingstone's term (Ison & Rye, 2005).

When the private sector is involved in the administration or oversight of a road pricing project, the government often loses the ability to set the optimal prices to manage congestion. Rather, the goal of the private sector is to maximize profits, and prices are set with this objective in mind (Niskanene, et al., 2003). While in practice the two are related, they are not identical. As private investors continue to play a large role in the development of road pricing projects, two regulatory models to curb monopoly power of private road developers have emerged: rate-of-return regulation and toll regulation. Rate-of-return regulation allows operators to implement time-of-day pricing freely in response to congestion levels in order to maintain steady vehicle flow – as on SR-91 and I-15 HOT lanes. With a toll regulation, the maximum toll is pre-determined by the government based on traffic levels and inflation index – as with Highway 407 in Toronto (Lindsey, 2003). On the other hand, since private operators have greater incentive to control costs, these tolls charged on private roads serve as benchmark for evaluating efficiency of competing public roads.

Like technological and practical barriers, legal and institutional barriers rarely serve as a long-term impediment to implementation. Perhaps in the near-term, inadequate legislative authority can delay a program. However, new legislation is frequently developed and passed – as is the case with the authorization that enabled London's Congestion Charging Scheme or California state legislation that permitted the conversion of HOV lanes to HOT lanes – with sufficient political support. Likewise, institutional and organizational structures can be altered to reflect changing demands of road pricing projects. Furthermore, an advantage of having numerous jurisdictions experimenting simultaneously with road pricing is that new projects can take lessons from various programs – both the successes and failures – to determine the ideal project design for the particular project (Lindsey, 2003). These impediments highlight the importance of incremental rather than wholesale implantation of pricing, but legal and institutional barriers, except as they have been wielded by opponents to kill pricing proposals (as in the case of New York), are unlikely to sink a project when broad public and political support exists.

Acceptability Barriers

Strong public and political acceptance are perhaps the most important factors in determining whether a road pricing project moves forward. While technological, practical, legal and institutional challenges can be overcome provided enough popular and political support exists, achieving such acceptance can be a daunting hurdle. Although we will elaborate on this topic in the report for Task A-5, this section will discuss some of the key political barriers and some of the steps that can be taken in the implementation phase to minimize acceptability problems.

One important aspect of the development of political will is the interaction between political support and the existing legal and institutional structures. The political and financial relationships among agencies at various levels of government – federal, state, and local – and between the various political parties can have a significant effect on the policy-decision making process. Rather than being grounded in economic principles, the decision often reflect parochial political interests. For example, often one level of government is fearful that it might lose out on a new source of revenue. Also, the institutional nature of government is often biased against change, and government employees are often fearful of new policies or organization arrangements that could potentially threaten their job security (Niskanene, et al., 2003).

Certain justifications for introducing road pricing are more accepted than others. Among the more acceptable justifications are (1) expanded road capacity, (2) environmental improvements, and (3) safety improvements. Tolling that is introduced for the purpose of travel demand management tends to meet stronger opposition (Niskanene, et al., 2003). It might be difficult for the public to grasp the benefits of road pricing in terms of demand management, but funding road expansion is an easier concept to explain.

Another major hurdle in achieving public support is portraying the road pricing program as equitable and fair. Equity issues are often defined in two ways: vertical equity and horizontal equity. Vertical equity pertains to how people or firms of different types fair relative to one another, while horizontal equity pertains to how similar people or firms fair relative to one another. With respect to road pricing, these similarities or differences are most often expressed in terms of income, but can also refer to race/ethnicity, geographic location, mode, or (in the case of firms) industry type (May & Sumalee, 2003). Equity concerns also vary greatly based on the type of tolling project, with cordon tolls and HOT lanes generally receiving far more criticism than weight-distance fees, which are not based on locations traveled. Logically, those residents who are likely to absorb a significant portion of the costs but enjoy few of the benefits are more likely to consider a road pricing program inequitable, compared with those who experience many of the benefits, even if they also pay a substantial portion of the costs.

Equity issues are treated in detail in Task A-5 in this research series. In a nutshell, a variety of approaches have proven effective in easing equity concerns among both the public and elected officials. For example, the means by which toll revenues are used plays a large role in justifying the equity of road pricing initiatives. Experience suggests that projects that are seen as enhancing the mobility of all or most of a region's residents raise fewer equity concerns and can help to overcome the equity concerns that do arise. One effective method of improving mobility across the region has been to dedicate funds to transit improvements. Many other proposals to address equity issues in road pricing have been proposed (Kind, Manville, and Shoup, 2007), including rather complex and elegant proposals such as "FAIR" lanes, but many have yet to be put into practice. One of the most effective means for improving public support has proven to be to actively involve the community in the planning stages (Banister, 2004; Niskanene, et al., 2003). The importance of community engagement has been highlighted in a number of case studies, including London and San Diego. Finally, gradual, incremental implementation has been shown to be effective in easing concerns over fairness among both public officials and the voting public.

Lessons from Successful Implementation of Road Pricing

Six-Step Framework

Replogle (2006) has developed a six-step framework to guide the successful implementation of road pricing. This framework incorporates many of the lessons learned from the case studies and the identified barriers that must be overcome to introduce road pricing. While these steps are roughly ordered, they should not be construed to be a sequential step-by-step plan for implementation; rather these steps should be viewed as a checklist common to most successful road pricing. Implementation is, more often than not, an iterative process.

1. Articulate system objectives

As the literature review and case studies have demonstrated, the ability to clearly identify and communicate the goals of the road pricing project is not only critical in designing the project, but also in securing public and political acceptance. First, a consensus must agree that transportation problems, such as congestion, warrant the introduction of a new policy approach. A road pricing project must be seen as a solution to an accepted problem for the scheme to be successful from the user's perspective (Ieromonachou, Warren, & Potter, 2006). For example, the London proposal clearly stated the program's objectives as to reduce total traffic in zone, increase traffic speeds and reduce levels of congestion in terms of vehicle delays (Ison & Rye, 2005).

2. Affirm legal authority

Likewise, considering potential legal barriers is critically important in determining who has the legal authority to implement a road pricing project. Furthermore, it is critical to determine whether any restrictions exist as to conditions of facilities where tolling is limited. It is also important to keep in mind that legal approval is often easier to obtain either if road pricing projects are implemented only temporarily to address a specific problem or if the legislation is subject to periodic review (Lindsey, 2003). For example, the cases of Oslo and Stockholm illustrate that by continuously re-evaluating the progress of the road pricing projects, initial acceptance is higher.

3. Determine implementation framework

The optimal implementation framework is closely related to the system objectives, as discussed in the report for Task A-1. For example, a cordon charging scheme would be more appropriate for a project that aims to manage congestion levels, while a facility toll might be more appropriate for a project that aims to fund new infrastructure. The potential for diversion of traffic from tolled facilities should be considered as this may have an impact on the type of scheme implemented (Bowerman, 2007). Furthermore, at this point, any applicable barriers to implementation should be identified so that the project can be developed efficiently. The timing of the implementation path should also be a major consideration – at what point is the project likely to be met with the least amount of resistance?

4. Design & evaluate road pricing plan

The five major factors that should be considered here are: (1) the coverage or scope of the pricing system, (2) the composition of pricing measures and their levels, (3) degree of differentiation, (4) use of revenues, and (5) need of supplementary measures, such as transit development (Niskanene, et al., 2003). As officials evaluate various road pricing designs, they should keep in mind that project viability heavily affected by the level of the fee, the potential for evasion or diversion, and the security of information about people's travel (Small & Gomez-Ibanez, 1998). Simple, tested, and easy to understand technologies increase the likelihood of successful implementation. Furthermore, flexibility in the scheme's design and technology are critical in dealing with unanticipated changes in the future of the project and can help ensure the long-range success of the program.

5. Adopt system plan, financing scheme

The implementing agency must determine the most effective method of funding the project and the level of financial risk that public sector is willing to assume. The various funding mechanisms and lessons learned from the report from Task B-1 should be considered at this step of the implementation process. While private investment in road infrastructure has the potential to deliver transportation improvements at a lower cost and a shorter timeline than traditional procurement methods, partnering with the private sector can also, when poorly structured, prove to be costly in the long-run (Iseki, Uchida, & Taylor, 2008). Public-private partnerships are not just "free money," but rather a redistribution of costs and risks between the public and private sectors (Iseki, Uchida, & Taylor, 2008).

6. Procure management & technology services

More often than not, public agencies turn to the private sector to develop technology and manage the day-to-day operations of road pricing projects because the applicable technical expertise often resides in the private sector. However, as the German Toll Collect case illustrates, the importance of developing so-called "complete contracts" with these firms cannot be understated. In the German case, the failure to develop adequate technology in a timely fashion nearly sunk the entire project.

One Step at a Time...

A gradual, incremental process has proven to be one of the most effective approaches to implementing road pricing. The identification of relevant barriers to the specific situation are critical in determining the constraints a government faces in implementing a road pricing initiative, and in determining what is possible and feasible in the short, medium, and long-term runs (Niskanene, et al., 2003). In addition to the barriers that prohibit immediate implementation, costs associated with introduction, such as transition, transaction, and adjustment costs, justify a gradual implementation process (Niskanen, et al., 2003).

Generally, societies only accept drastic policy changes in emergencies. Although increasing traffic congestion certainly imposes extensive negative externalities, its gradual evolution makes it less likely to be perceived as a crisis or emergency, at least not overnight (Ison, 2004). The most fundamental reason gaining public acceptance is so challenging that members of the public perceive that they stand to lose by raising the cost of travel, but the benefits of the toll revenue are ambiguous and not direct. In other words, the added costs are certain, while the promised benefits are not. People are generally suspicious of plans to change arrangements with which they have grown comfortable (Small & Gomez-Ibanez, 1998). Gradual, incremental approaches, on the other hand, permit learning and enhance understanding and acceptance among the public (Ieromonachou, Warren, & Potter, 2006). The gradual growth in popularity among those who live and work around the SR-91 Express Lanes in Orange County is an example of this idea that familiarity breeds acceptance.

In order to maximize acceptability, road pricing proposals are often best presented as the final element in comprehensive transportation planning process, only introduced once all other alternatives have been exhausted (Ison, 2004; Harsman, 2003). Furthermore, people are more likely to be accepting when the relationship between tolling and revenue is clear, such as financing a new facility, which is funded directly by the revenue (Small & Gomez-Ibanez, 1998; King, Manville, and Shoup, 2007). In fact, introducing tolling to a region by applying it to a new facility might be an effective means of gaining public support (Niskanene, et al., 2003; King, Manville, and Shoup, 2007). Examples of cases that have utilized this approach include the Toronto 407 ETR and the SR-91 in Orange County. Road pricing cases that incorporate transit improvements, such as London, Stockholm, and San Diego, also emphasize the fact that road pricing is just one policy in a comprehensive approach to relieving traffic congestion.

Extensive literature has focused on the fact that toll rates do not necessarily need to be set at the optimal level upon initial implementation of the road pricing project. Rather than an optimal policy, the implementation path should follow a sequence of what economists would term “second-best” alternatives in moving towards the ultimate optimal policy. Although these second-best prices are not ideal in all respects, they can still be effective in achieving most of a program’s goals, such as congestion relief or time savings. These second-best policies are inferred from the specific barriers to implementation. As a project moves towards optimal implementation, the relevant impediments will decrease over time. These barriers fall away due to a combination of society’s growing acceptance and/or government’s deliberate actions (Niskanene, et al., 2003). In Europe, policy-makers have found that lower toll levels help build public support and that the tolls can then be raised later to the optimal levels to control congestion (Harsman, 2003). The European PRIMA³ case studies support findings that this stepwise implementation process is most effective (Harsman, 2003). In the United States, experiences with the SR-91 in Orange County suggest that the reasonable level of pricing, although not optimal, still generate sufficient revenues to cover all the operating cost while increasing the public’s awareness of the efficacy of road pricing.

³ The goal of the PRIMA project is to produce policy recommendations and guidance for implementation of urban road pricing systems in Europe through a series of case studies. The eight cities studied were Oslo, Barcelona, Marseille, Lyon, Stockholm, Rotterdam, Bern, and Zurich.

In order to optimize efficiency of implementation, both top-down and bottom-up approaches are helpful. For example, the federal and state legislation often needs to be changed, which requires the top-down authority (Harsman, 2003). However, in order to build adequate public support, it is also important to harness bottom-up support. The political challenges play a critical role in the successful implementation of road pricing proposals. In a democratically accountable governmental organization, the often conflicting presidential, national, federal, state, and local electoral cycles result in very few neutral periods where road pricing can be planned and implemented. Therefore, it is much more effective when the proposal is promoted by a single layer of government, if possible on the basis of an electoral mandate, as with Ken Livingstone or Jan Goldsmith. However, this concept failed in the attempted implementation of the New York City Plan. When a decision needs to be ratified by multiple authorities or multiple levels of government, and where government officials are subject to varying electoral timelines, it would be difficult to discuss sensitive issues such as revenue-raising measures (Baker, 2002).

Yet another advantage of taking an incremental approach to implementation is that this method keeps the door open to alter or reverse actions at a reasonably low cost (Niskanen, et al., 2003). This flexibility is particularly important in the later steps of the implementation path, so that plans can be altered if new information comes to light. On the other hand, in terms of reliability, sometimes it is best to design the implementation path in such a way that the government or implementing agency cannot deviate from the plan once it has been put into motion (Niskanen, et al., 2003).

Small and Gomez-Ibanez (1998) point to the important role incremental implementation played in the development of road pricing in Scandinavia. Road pricing in this region started in Norway with toll rings implemented to help finance transportation infrastructure, but gradually incorporated traffic management goals as a secondary objective. The experiences in Norway allowed Stockholm to adopt a much more extensive traffic management strategy through an area congestion fee. By the time the congestion fee was proposed in Stockholm, residents were familiar with the existence of tolls in Norway and their success. The Stockholm program was also implemented as a fixed-term experiment that, at its conclusion, was put before the voters, the majority of whom elected to make the program ongoing. Such gradual spillover effects are currently taking place within the United States as more HOT lanes are successfully implemented across the country from Houston to San Diego and Denver to Minneapolis.

Conclusion

This report provides a review of the potential barriers to road pricing implementation, and the lessons from the successful implementation of pricing projects around the world. While much of the information presented is drawn from case studies of congestion pricing from around the world, we believe that many of the lessons are applicable to California. While the technological and acceptance issues will be expanded on in later deliverables, special emphasis should be placed on addressing acceptability concerns as these are often the most challenging barriers to overcome. The six-step framework presented here provides guidance for important issues to consider at each step of the implementation process. Lessons from success cases also

highlight the importance of adopting an incremental implementation approach, particularly to build adequate political and public support.

While the role the private sector can play in road pricing projects was discussed at length in the report for Task B-1, this report paper focused more narrowly on the potential for private sector involvement in technical and management aspects. Private firms often have a competitive and experiential edge over public agencies in providing these services as their staff are often more experienced and have access to a greater array of resources. However, the public sector still needs to be cautious in developing such contracts to avoid situations such as those described in the case of the German Toll Collect.

The organization of the public agencies tasked with implementation can also play a critical role in the success or failure of a project. Generally, the more streamlined and less bureaucratic the government actors, the greater the likelihood of successful introduction of road pricing. The London Charging program highlights the advantages of a single agency managing both transit improvements and the road pricing initiative.

As was noted at the outset, there does not appear to be any one best practice for the introduction of road pricing. The U.S. is certainly different from the Europe, so many of the lessons from European examples should be carefully contextualized. As jurisdictions in California move forward with road pricing projects, the best implementation and management scheme will depend greatly on the initiative's objectives and the availability of public and private resources.

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CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

TASK A-3: Examining the Linkages between Electronic Roadway Tolling Technologies and Road Pricing Policy Goals

**Alexander Demisch
Hiroyuki Iseki
Brian D. Taylor**

**California PATH Research Report
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**TASK A-3: Examining the Linkages between Electronic Roadway
Tolling Technologies and Road Pricing Policy Objectives**

California PATH Project—Task Order 6330

Alexander Demisch *
Hiroyuki Iseki, Ph.D. **
Brian D. Taylor, AICP, Ph.D. *

* UCLA Institute of Transportation Studies
3250 Public Affairs Building
Los Angeles, CA 90095-1656
www.its.ucla.edu

** Department of Planning and Urban Studies
University of New Orleans
2000 Lakeshore Drive - 368 Milneburg Hall
New Orleans, LA 70148
<http://planning.uno.edu/>

Abstract

The surge of road pricing projects in the U.S. and around the globe over the past fifteen years has been enabled by a set of new communication and transportation technologies. There is currently a wide array of technical configurations ranging from systems based on “tried and true” short-range radio communications to experimental systems relying on global positioning satellites. These technologies provide for a more efficient collection of simple tolls, and also facilitate a movement toward more dynamic, variable user fees.

In this study, we provide a comprehensive literature review of eight road pricing cases to identify types of tolling technologies employed, given various policy objectives. In particular, we examine two examples from each of four types of road pricing programs: 1) facility congestion tolls, 2) cordon tolls, 3) weight-distance truck tolls, and 4) distance-based user fees. In the selected cases, we specifically examine various suites of technologies and evaluate approaches to their implementation in road pricing programs with regards to system design and policy.

In our literature review, we first describe three major technical tasks to be performed—metering road use, calculating charges, and communicating data—that are implemented by a set of nine technologies varying from on-board units to global navigation system satellites. Secondly, we identify six primary policy goals of these road pricing systems: a) maximize underutilized capacity, b) offer a congestion-free alternative, c) generate revenue, d) reduce congestion, e) allocate costs to users, and f) develop a user-fee alternative to the fuel tax.

In our careful synthesis of the literature, we find that two main policy decisions most often determine the selection of roadway tolling technologies: (1) the geographical scale of the road network tolled, and (2) the complexity of calculating the fee to be charged. The combination of these two factors can vary greatly – from tolling individual facilities with flat fees, to nationwide road networks priced with dynamic tolls that vary by vehicle class, time of day, and congestion level. Taking into account the severe funding shortfall for transportation infrastructure, serious concerns about traffic congestion, and related adverse environmental impacts, we expect electronic road pricing systems to continue to grow in scale as well as in number. While systems with newer technologies are continuously in development, the most difficult hurdle for road pricing programs is now less of technical feasibility, but rather political and public support for implementation.

Key Words: road pricing technologies, electronic toll collection, technology policy.

Executive Summary

The surge of road pricing projects in the U.S. and around the globe over the past fifteen years has been enabled by a set of new communications and transportation technologies. These technologies provide for a more efficient collection of simple tolls, and also facilitate a movement toward more dynamic, variable user fees. The relationship between the evolution of tolling technologies and road pricing policies is symbiotic; while technologies *enable* implementation of road pricing policies, transportation pricing policies, in turn, *encourage* the development and use of technologies.

This report is part of a larger study examining the various economic, institutional, operational, and political factors influencing the implementation of electronic roadway tolling around the world to help decision-makers in California weigh the pros and cons of expanded implementation in the Golden State. In this report, to identify the linkages between technological design and relevant policy/pricing issues, we examine various suites of technologies and approaches to implementation in eight road pricing programs found around the world.

We organize our analysis around four distinct classes of road pricing programs, and draw on two examples for each type:

1. Facility Congestion Tolls (*San Diego I-15 HOT Lanes & SR-91 Express Lanes*)
2. Cordon Tolls (*London & Singapore Congestion Toll*)
3. Weight-Distance Truck Tolls (*German “Toll Collect” & Austria GO Truck Toll*)
4. Distance-Based User Fees (*Oregon Mileage Fee & University of Iowa Road User Study*)

Facility congestion tolls are designed around an individual segment of the road network, and charge tolls that vary by the level of congestion. Cordon tolls are charged within an enclosed area, such as a central business district, to limit the number of automobiles entering the area and reduce congestion. Weight-distance truck tolls levy fees on trucks to internalize the costs that they impose on the road network. Finally, distance-based user fees charge all vehicles on the road network a fee that is proportional to distance traveled.

From the review of these case studies we find two main policy decisions that most often determine the selection of roadway tolling technologies: (1) the geographical scale of the road network tolled, and (2) the complexity of calculating the fee to be charged. The combination of these two factors can vary greatly – from tolling on individual facilities with flat fees, to nationwide road networks priced with dynamic tolls that vary by vehicle class, time of day, and congestion level. Within all of these road pricing programs, there are three distinct technical tasks to be performed: metering road use, calculating charges, and communicating data. To perform these tasks, systems rely on a set of nine technologies:

- **On-Board Units (OBU)** that are in-vehicle devices of varying complexity, ranging from radio transponders to small computers
- **Global Navigation System Satellites (GNSS)** that can determine latitude and longitude on the Earth’s surface

- **Geographic Information Systems (GIS)** that are used to translate latitude and longitude into a location on the road network
- **Electronic Odometer Feeds** measure vehicle miles traveled and transfer the data between a vehicle's odometer and an on-board unit
- **Automated Number Plate Recognition (ANPR)** that can take a photo of a license plate and convert it into digital text
- **Dedicated Short Range Communications (DSRC)** that involve short-range microwave or radio communications between vehicles and roadside antennas
- **Global System for Mobile Communications (GSM)** that is essentially satellite based cellular communication technology
- **Smart Cards** that are credit card-sized devices embedded with a computer chip providing data storage capability
- **Supporting Information Technology** that include the Internet, database management systems, and on-line banking protocols that provide the backbone of many electronic toll collection programs

Despite the wide variety of possible combinations of these technologies, most systems tend to fall under two broad categories that can be characterized by the primary technology applied to meter road use: Dedicated Short Range Communications (DSRC) and Global Navigation Satellite Systems (GNSS).

Systems based on DSRC typically employ roadside and in-vehicle transponders that determine when a vehicle enters a particular road segment or area. The simplest form of these DSRC-based systems employs windshield-mounted transponders allowing vehicles to pass through open road tolling at higher speeds, essentially eliminating the need for manually operated tollbooths. While the DSRC-based system is easier to implement, it places most of the required technical infrastructure roadside, making it costly to install over large geographical scales.

The second type of system relies on GNSS communicating with on-board units to determine vehicle location. GNSS-based systems rely more on in-vehicle equipment (as well as orbiting satellites) than roadside infrastructure, making system expansion relatively easy. GNSS-based systems are relatively new but are making rapid progress, and have significant potential in various applications of road pricing in the future.

From our review of the eight case studies, we observe some patterns between road pricing systems, policy goals, and technologies employed. In particular, we identified six primary policy goals: a) maximize underutilized capacity, b) offer a congestion-free alternative, c) generate revenue, d) reduce congestion, e) allocate costs to users, and f) replace the fuel tax. Another key consideration for all factors is the geographic scale at which the pricing policy is directed. The following table describes the key characteristics of each case study as well as the patterns between pricing programs, policy goals, and technologies employed in the eight reviewed cases

Table ES-1: Road Pricing Programs, Policy Goals, and Technologies Employed

<i>Road Pricing Program</i>	Geog. Scale	Level of Complexity in Pricing	Goals of Pricing Policies:	On-Board Units	GNSS Receivers	GIS	Electronic Odometer Feeds	ANPR	DSRC	GSM	Smart Cards	Supporting IT	Note	
Facility Congestion Toll	Geographically focused	Dynamic fee to keep congestion free traffic flow											Simple; off-the-shelf technology (OST)	
San Diego I-15 HOT Lanes			a, b, c	●					●			●		
Orange County SR-91 Express Lanes			b, c	●					●	●				●
Cordon Congestion Toll	Limited scale	Flat fee												
London Congestion Toll			c, d					●					●	Simple (OST), no privacy protection
Singapore Congestion Toll			D	●					●	●		●	●	Costly infrastructure
Weight-Distance Truck Toll	Large; National scale	Variable tolls; interoperability (German)												
German Toll Collect			c, e	●	●	●			●	●			●	Easy to expand; new technology
Austrian GO Truck Toll			c, e	●					●	●				●
Distance-Based User Fee	Large, across facilities and jurisdictions	Variable tolls; a true user fee; high privacy												
Oregon Mileage Fee			c, f	●	●	●	●		●				●	Need to install sophisticated equipment on all vehicles
University of Iowa Road User Study			c, f	●	●	●	●			●			●	

Goals of Pricing Policies: a) maximize underutilized capacity, b) offer a congestion-free alternative, c) generate revenue, d) reduce congestion, e) allocate costs to users, and f) develop a user-fee alternative to the fuel tax.

Facility congestion toll programs have the primary goals of raising revenue and offering a congestion-free alternative while cordon congestion tolls aim to reduce overall congestion. To accomplish this, a road pricing system needs to charge users as they enter an individual facility or a defined area. DSRC-based systems generally work best at these small geographical scales, and can be quickly deployed at a low cost; building overhead gantries and antennas is relatively easy to do in a small area, and on-board transponders are inexpensive and easily installed. These systems provide for significant flexibility in charging programs as well.

However, as systems begin to incorporate larger geographic scales, DSRC-based systems become less practical due to the need to build roadside gantries throughout the road network. These road pricing programs, weight-distance truck tolls and distance-based user fees, also have the common policy goal of raising revenue. In addition, weight-distance truck tolls seek to allocate the full cost of road use to the driver. This may involve measuring a variety of factors such as distance traveled, time of day, vehicle class, and congestion levels. Furthermore, distance-based user fee trials in the United States have the primary goal of developing user fee alternatives to the fuel tax. Because of the large geographic scale and complexity of the fee to be charged, GNSS-based systems are better suited to these applications.

An underlying concern in many cases examined here is the issue of privacy.¹ However, in all examples where privacy was of particular consideration, system designers have been able to take appropriate steps to protect personal information. This is typically accomplished through the use of smart card technology or by dispersing personal information, vehicle attributes, and distance data across various system platforms. While it is uncertain if it is possible to lose the “Big Brother” association altogether, the public should nevertheless be assured that electronic road pricing systems are designed in such a way that travel behavior data cannot be linked to personal information without prior consent.

We have noted that GNSS technology is rather new, and that GNSS-based systems currently take longer to implement. However, as interest in large-scale GNSS-based road pricing programs grows among policymakers, they will become a more proven and more easily implemented technology. One current limitation is that GNSS that may be off by as much as 15 meters in its positioning, and needs backup technologies for more accurate measurements. However, new developments in this technology may fix this problem, making GNSS-based systems the logical choice for most road pricing projects in the future. Another question that still remains regarding GNSS-based systems is how to phase in the necessary equipment throughout the vehicle fleet, but this is primarily due to the fact that all domestic systems are still in the pilot stages. As more jurisdictions begin to see larger scale road pricing as a potent revenue generator as well as a congestion management tool that can incorporate smaller scale policies, we expect to see more region or even statewide GNSS-based systems in the future.

All of the fully operational electronic toll collection systems examined in this report have been successful in fulfilling their primary objectives. In addition, experiments of domestic GNSS-based systems that seek to replace the fuel tax are promising. In general, the sentiment is that technical feasibility is no longer a problem in facilitating the policy goals for road pricing

¹ In this paper, we focus primarily on privacy as it relates to system design issues. The greater issue of privacy with regards to public acceptance will be covered in greater detail in a later phase of this research.

programs. That is, road pricing's limiting factor is no longer technology, but rather political and public support for implementation.

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1. Introduction

The surge of road pricing projects in the past fifteen years has put us on the brink of what some call a “renaissance” in electronic road tolling applications (Sorensen & Taylor 2006). This report is part of a larger study examining the various economic, institutional, operational, and political factors influencing the implementation of electronic roadway tolling around the world to help decision-makers in California weigh the pros and cons of expanded implementation in the Golden State. In the first phase of this research (Kalauskas, Taylor & Iseki 2008), we identified a multitude of factors contributing to the rise in electronic toll collection, one of which is a new set of communication and transportation technologies.

This paper provides a comprehensive literature review to examine the linkages between technological design and relevant policy/pricing issues. To do so, we synthesized information from reports by tolling authorities, transportation agencies, and academic research articles to describe the status of road pricing technologies as well as examine the policy factors related to technology selection. More specifically, we review the set of new technologies and investigate eight cases to illustrate what programs have in common as well as the diversity of policy goals and system design.² In particular, we examine the pros and cons of various technologies and approaches, the possibility of changes in these pros and cons stimulated by the arrival of new technologies, and technological configurations that work best in given situations and environments, specifically with regard to policy objectives.

All of the road pricing programs examined here have been successful in achieving their primary policy goals, and we do not intend to minimize these achievements. Most issues that arise concern secondary matters and long-term issues such as privacy and system expansion. That said, each system certainly has its pros and cons and we evaluate each approach with regards to system design and policy.

Without a doubt, these technologies are transforming the concepts of road pricing into reality. Transportation economists A.C. Pigout and William Knight wrote about road pricing as early as the 1920s, and touted the benefits of employing direct user fees to encourage the efficient use of road systems (Wachs 2003). For most of the 20th century, however, a lack of enabling technologies prevented the implementation of these user fees. For example, the most state of the art means of toll collection was the manned tollbooth, which was so cumbersome that in many cases, its high labor and time costs outweighed the benefits of road pricing. As a result, jurisdictions established a proxy for the user fee – the motor fuel excise tax. However, the gas tax was acknowledged as a second best solution, as it did not fulfill all of the criteria for a direct user fee (Wachs 2003). After many decades of the gas tax serving as an approximation of a user fee, we have recently observed the rise of new technologies, such as short-range radio transponders and global positioning systems, which provide for a return to toll collection programs that incorporate the user fee. Electronic toll collection also represents a potential new revenue source that has coincided with increasing fiscal shortfalls within the transportation sector.

² We selected seven cases that were already referenced in Tasks A-1 and A-2 (so as to build upon them) and one new case that is not included in the previous tasks – we found it necessary to include the University of Iowa’s Road User Study in order to provide a diversity of system design for similar policy objectives.

Inflation and the improving fuel economy of the vehicle fleet, combined with a political failure to raise fuel taxes to keep up with the needs of transportation systems, have led to what Wachs (2006) terms a “quiet crisis in transportation finance.”

These technologies provide a more efficient collection of current tolls as well as the ability to collect new ones. Worrall (2003) describes the relationship between road pricing technology and policy as an iterative process; while these technologies certainly enable policies, specific policy goals equally determine the development of new technology applications and the design of electronic toll collection systems. That is to say, transportation policy also drives the use and development of these technologies in road pricing applications. The two primary policy decisions that determine system design are (1) the geographical scale of road network tolled, and (2) the complexity of the fee collected. Regarding the geographical scale, pricing policies range from tolling a specific segment or facility (i.e. tunnels and bridges) to an entire corridor. The charges levied can also be quite simple, such as a flat fee, or quite complex, such as a dynamic toll that varies by vehicle type, time of day and level of congestion. Generally speaking, as the geographical scale and fee complexity increase, system designs become more elaborate and require incorporation of newer technologies.

Although there are various possible combinations of geographical scale and fee complexity, four distinct categories of distinct road user electronic charging programs emerge from available cases. We have classified our findings according to the following programs introduced by Sorensen (2006):³

- (1) Congestion tolls on individual facilities
- (2) Congestion charges for cordoned areas, such as a central business district
- (3) Weight-distance truck tolls
- (4) Distance-based user fees applied to an entire road network

These road pricing programs have distinct policy goals and different system designs, but present varying levels of success. Facility and cordon congestion tolls have been implemented in many cities and, by and large, have accomplished their goals admirably. Electronic weight-distance truck tolls have had mixed technical results, although they have met their immediate objectives. It is too early to gauge the success of large-scale distance-based user fees as most are not yet ready for full implementation. However, pilot programs have yielded promising results (Sorensen & Taylor 2006). Although examples within each program generally share a common system design, each instance has a different story relevant to the specific suite of technologies employed. In most cases, the type of management – a public, public-private partnership, or private project – has little effect on system design.

In this report, we examine the enabling technologies and their application to road pricing programs. Following the introduction, we provide an overview of electronic roadway tolling (road pricing) technologies. In the third section, we examine eight cases around the world in which the tolling technologies have been adopted or under experiment, with particular attention to goals set for pricing policies. In the fourth section, we discuss our findings, synthesizing

³ Throughout this report, we draw a significant amount of information from an earlier UCLA Institute of Transportation Studies report by Sorensen (2006).

information from the eight cases. The last section summarizes our findings in the study and provides a few remarks regarding technology implementation.

In summary, from our examination of the eight cases, we identify six primary policy goals that exhibit some patterns in road pricing systems and technologies employed. While road pricing can yield significant benefits and could perhaps be implemented for all of these reasons, we only focus on the immediate objectives of each system as explicitly specified in the documents we reviewed.⁴ Thus, these goals are not present in every project, and most examples tend to have only two or three of these primary objectives:

- a) Maximize underutilized capacity
- b) Offer a congestion-free alternative
- c) Generate revenue
- d) Reduce congestion
- e) Allocate costs to users
- f) Develop a user-fee alternative to the fuel tax

In selecting particular road pricing technologies, we find the geographic scale at which the pricing policy is directed and the level of complexity of pricing programs to be particularly important. We also find that newer technologies, Global Navigation Satellite Systems in particular, (more commonly known as GPS in the U.S.) enable road pricing policies to be implemented at larger geographic scales and a return to charging programs that incorporate the user fee. While GNSS-based systems have not yet been implemented in the U.S., it is conceivable that such a road pricing program (at either the state or national level) would be able to incorporate many of the smaller scale tolling systems that exist today. One question that remains regarding GNSS-based systems is how to phase in the necessary equipment throughout the vehicle fleet, but this is primarily due to the fact that all domestic systems are still in the pilot stages. As Global Navigation Satellite Systems technology is still rapidly developing, it is likely that its applications within electronic road pricing will grow in the future.

2. Overview of Technologies

Because different technological approaches to road pricing have led to varying levels of success, it is necessary to review the array of technologies employed by these programs. Despite the wide variety of electronic tolling policies and applications, there are certain technical tasks that are required within an electronic toll collection program. These new technologies facilitate more efficient operations of these tasks, which, in turn, enable new pricing policies. Sorensen (2006) defines these tasks:

⁴ We interpret the immediate objectives to be related to the key motivating factors behind actual implementation (as described in Task A-1). For instance, regional planners in San Diego had long considered facility congestion tolls as a means to offer a congestion-free alternative as well as optimize HOV lane capacity, but it was only when politicians representing communities along the I-15 corridor saw road pricing as a means to fund transit improvements that the idea had enough support to be implemented (Duve 1994). Thus, we regard revenue generation, maximizing capacity, and offering a congestion-free alternative to be the primary objectives in this case.

- **Meter road use.** This task involves determining a vehicle’s entry or exit from a tolled facility or general presence in a tolled area. In some cases, it may also involve measuring distance traveled and/or time of travel as well as vehicle identification, emissions class, weight, and/or axles.
- **Calculate charges.** Road usage is compared to a rate schedule to determine charges owed.
- **Communicate data.** Billing data are transmitted to a collections agency for issuance of bills, and payment is collected from the users. Some measures are taken to prevent evasion and fraud.

From Sorensen (2006), we identified nine technologies that have played a significant role in enabling electronic toll collection. Each technology has a function within an electronic road pricing system, and there are no systems based solely on one technology. Some technologies are mature, while others have emerged only recently. Table 1 shows the three broad technical tasks in electronic toll collections systems, and the technologies used to implement each task. A description of each item follows the table.

Table 1: Tolling Technologies Classified by Application

<i>Technology</i>	Metering Road Use	Calculating Charges	Communicating Data
On-Board Units	●	●	●
GNSS	●		
GIS	●		
Electronic Odometer Feeds	●		
ANPR	●		
DSRC	●		●
GSM			●
Smart Cards			●
Supporting IT		●	●

Source: Sorensen (2006)

- ***On-Board Unit (OBU).*** This term applies to a device that is installed on board users’ vehicles. It typically provides data storage, computational power, and a framework for integrating other on-board technologies, such as global navigation satellite system receivers and wireless communications. For simpler systems such as the I-15 HOT lanes, the OBU may simply serve as a radio transponder, while for more complex systems like German Toll Collect it typically records usage data and calculates charges owed. OBU’s may also store vehicle identification information, emissions classification, or axle configuration (Sorensen 2006).
- ***Global Navigation Satellite Systems (GNSS).*** GNSS is a satellite-based system that can determine the position of an object in terms of latitude and longitude on the Earth’s surface. The United States and Russia currently operate the two satellite networks, named GPS and GLONASS, respectively (May & Sumalee 2003). In addition, the European Space Agency expects to have their Galileo system operational by early 2009 (ESA

2007). In road pricing programs, OBU's typically have GNSS receivers to determine the vehicle's location, speed, time of travel, and total distance traveled. While some systems rely heavily on roadside equipment to monitor facility usage, GNSS employs satellite and OBU's to perform this task. GNSS has thus facilitated road pricing programs of wide geographic scales, namely truck tolling programs and distance-based user fees. However, the accuracy of existing GNSS networks is limited to 10-15 meters (May & Sumalee 2003). This restricts their ability to toll road links in dense networks, unless another technology such as an electronic odometer feed is used as well. In addition, some slight misrepresentations of such system designs have sparked concerns that GNSS continuously track the vehicles. But as Wachs (2006) points out, vehicles are not tracked at all. Rather, the OBU only *receives* GNSS information and uses this to locate itself, not the other way around.

- **Geographic Information Systems (GIS).** In order to translate latitude and longitude information from GNSS receivers into a vehicle's location on the road network, OBUs need digital road maps stored in GIS format. Any road pricing program that relies on GNSS must also incorporate GIS technology as well (Sorensen 2006).
- **Electronic Odometer Feeds.** Electronic links between OBU's and the odometer serve as a means to measure distance traveled and are primarily employed in mileage-based user fee programs like the Oregon Mileage Fee. Since the vehicle industry has developed odometers to be relatively tamperproof for warranty reasons, odometers can be relied upon to deliver accurate measurements. In some cases, odometer feeds are used as a backup when GNSS signals are lost or they may be the primary means for recording distance (Sorensen 2006).

- **Automated Number Plate Recognition (ANPR).** ANPR technology can read digital images of vehicle license plates and translate them into a useable format by computer databases. They are typically used for enforcement purposes in facility and cordon tolling programs, but in London's case it is the primary means of monitoring road use. The technology was developed in the 1970s, and has been continuously improved since, although photography angles and very reflective license plates are still of particular concern (Redcorn 2008).

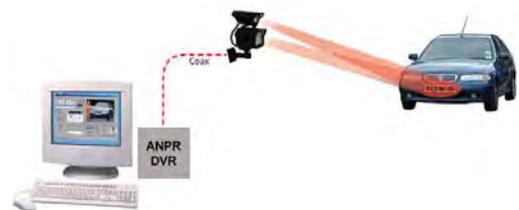


Figure 1: ANPR Technology (Rednaus Industrial Design & Control)

- ***Dedicated Short Range Communications (DSRC).*** DSRC involves short range microwave or radio communications between vehicles and roadside antennas. It is most commonly used to measure entry and exit of facility or cordon tolling programs, although some systems use DSRC for enforcement and billing purposes as well. DSRC has proven to be a reliable off-the-shelf technology, and is a key element of most electronic roadway pricing systems in the United States (such as the I-15 HOT Lanes, SR-91 Express Lanes, I-394 MnPass Program, and the I-10 Quickride). Since the majority of existing electronic road pricing programs have been designed around small areas and individual facilities, DSRC has been a well-suited technology due to relatively easy installation. However, as pricing policies begin to cover larger geographic areas, DSRC begins to lose its practicality due to the high cost of installing roadside transponders across the road network (Sorensen 2006).



Figure 2: Roadside antenna communicates with vehicle-mounted transponder via DSRC (TransNet 2008)

- ***Global System for Mobile Communications (GSM).*** GSM is essentially satellite based cellular communication technology. While it has existed in the communications industry for some time, it is beginning to appear as an alternative to DSRC in road pricing applications because it does not require the installation of roadside transponders. Thus, it is of particular use to complex pricing programs on a wide geographic scale like the German Toll Collect system, and is primarily used to communicate travel or billing data.
- ***Smart Cards.*** Smart cards are credit card-sized devices embedded with a computer chip providing data storage and transmission capability. While they have a multitude of uses both within and outside of the transportation sector, they are primarily used to store and transfer billing data in electronic toll collection programs (Sorensen 2006). They are typically inserted into an OBU and are removed to add money to the user's account or update information, as seen in the Singapore ERP program.
- ***Supporting Information Technology.*** A wide variety of information technologies, such as the Internet, database management systems, and on-line banking protocols, provide the backbone of many electronic toll collection programs. Without these supportive technologies, most road pricing programs would not be as seamless as they are today (Sorensen 2006).

The primary challenge in selecting technologies and designing a road pricing system is the need to balance ease of implementation with flexibility in charging options. Older technologies are generally more established and reliable, and they can be taken “off-the-shelf” for implementation in road pricing rather easily. At the same time, these older technologies tend to have more limitations in terms of the range of policies that can be implemented, and are better suited to applications at smaller geographical scales. In contrast, while newer technologies are relatively

less proven for their capability and reliability, they hold greater potential in the range of pricing options. Systems that are more complex and employ newer technologies also tend to cover larger geographic scales and provide more flexibility in charging programs. In their decision to choose which technologies to employ, policymakers and system designers must often make a tradeoff between ease of implementation and complexity of the system.

Despite the wide variety of possible systems designs, most tend to fall under two broad categories that can be characterized by the primary technology applied to meter road use: DSRC and GNSS.

DSRC-based systems typically employ roadside and in-vehicle transponders that determine when a vehicle enters a particular road segment or area. The simplest form of these DSRC-based systems employs windshield-mounted transponders allowing vehicles to pass through open road tolling at higher speeds, essentially eliminating the need for manually operated tollbooths (Kalauskas, Taylor & Iseki 2008). These systems usually use roadside cameras and ANPR as a means of enforcement. When a vehicle without a transponder passes through the payment point, its license plate is recognized by the system to register the license plate number or send a billing statement by mail to the vehicle owner (Poole 2007). While the DSRC-based system is easier to implement, it places most of the required technical infrastructure roadside, making it costly to install over large geographical scales.

The second type of system relies on GNSS communicating with OBUs to determine vehicle location. GNSS-based systems usually involve an additional technology such as an electronic odometer feed to ensure accuracy in determining vehicle location and travel distance. GNSS-based systems rely more on in-vehicle equipment (as well as orbiting satellites) than roadside infrastructure, making system expansion relatively easy. GNSS-based systems are relatively new but are making rapid progress, and have significant potential in various applications of road pricing in the future (Kalauskas, Taylor & Iseki 2008).

In general, facility and cordon area congestion tolls employ DSRC-based systems while weight-distance truck tolls and mileage-based user fees are designed around GNSS-based systems. This is, however, a loosely fitting characterization, as there are prominent exceptions. For instance, the Austrian GO Truck Toll is a weight-distance truck toll that employs a DSRC-based system while the London Congestion Toll, a cordon area program, does not use a DSRC or a GNSS system at all.

While DSRC and GNSS are primary technologies found in most road pricing programs, the combination of other technologies varies. In the next section, we describe the applications of road tolling technologies and the suitability of various systems to policy goals.

3. Applications of Road Tolling Technologies

In order to illustrate the diversity of technologies employed, we examine the relationship between system design and policy goals in eight road pricing programs found around the world. For each of the four types of road pricing, we draw on two case. The I-15 HOT Lanes and SR-91 Express Lanes are both facility congestion tolls in Southern California and use DSRC-based

systems to offer a congestion-free alternative and generate revenue. Cordon congestion tolls in London and Singapore both have the primary goal of reducing congestion in a CBD, although they do so through different technical approaches. Similarly, weight-distance truck tolls in Germany and Austria similarly use GNSS-based systems and DSRC-based systems, respectively, to accomplish the same goals of generating revenue and equitably distributing the costs of road use to drivers. Lastly, we draw on two demonstration projects of distance-based user fees in Oregon and the University of Iowa that have both developed GNSS-based systems with the primary goals of generating revenue and equitably distributing the costs of road use to drivers. Table 2 classifies the cases by system type.

Table 2: Cases by System Type

DSRC-Based	GNSS-Based	ANPR-based
<ul style="list-style-type: none"> ▪ San Diego I-15 HOT Lanes ▪ Orange County SR-91 Express Lanes ▪ Singapore Electronic Road Pricing Program ▪ Austria GO Truck Toll 	<ul style="list-style-type: none"> ▪ German Toll Collect ▪ Oregon Mileage Fee ▪ University of Iowa Road User Study 	<ul style="list-style-type: none"> ▪ London Congestion Charge Zone

Facility Congestion Tolls

While tolling individual facilities is not new, varying the toll level to guarantee free flowing traffic conditions has only been implemented within the last two decades in the United States. This idea has been particularly successful when applied as a means to provide the option of uncongested travel in the midst of severe congestion. These high occupancy toll (HOT) lanes typically allow high occupancy vehicles (HOV) to enter for free, while single occupancy vehicles (SOV) are allowed to use the excess HOV lane capacity for a price. Two prominent examples of HOT lanes are found in San Diego and Orange County, California. In both cases, the facilities operate independently, with no overarching road pricing network. Thus they employ relatively simple systems focused on electronic toll collection within the HOT lanes only.

San Diego’s I-15 HOT Lanes

In 1988, two reversible HOV lanes were opened in the median for 8 miles of I-15 in northern San Diego County. The goal of these HOV lanes was to offer a time savings incentive to carpoolers. However, it became quickly apparent that these lanes were underused, and the San Diego Association of Governments selected this facility for a HOT lanes demonstration project between 1996 and 1999 (SANDAG 2007). Also key to the conversion from HOV to HOT was the support of an elected official representing a community along the I-15 corridor, who saw the tolls as a means to generate revenue for transit improvements for his constituency (Duve 1994). The implementation of the HOT lanes has been quite successful and they have continued to operate since the end of the demonstration project (SANDAG 2007).

As the lanes were already in place when the HOT lanes policy was implemented, the electronic toll collection program was designed around these 8-mile lanes. Because the lanes are barrier-separated throughout their entire length (and thus only have one point of entry and one point of

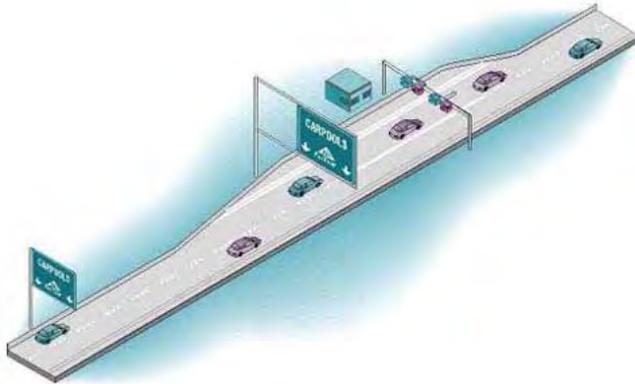


Figure 3: I-15 FasTrak System (SANDAG 2007)

exit), monitoring facility usage is a relatively simple task to accomplish using DSRC technology at one location. A set of overhead gantries equipped with short-range antennas is placed at the middle of the lanes.⁵ Solo drivers who wish to buy into the lanes must purchase a FasTrak windshield-mounted transponder before use (SANDAG 2007). A few miles before the HOT lanes begin, drivers are alerted to the price via electronic displays placed on the side of the road, and if they choose to use the lanes, they can take the appropriate on-

ramp. Vehicles pass underneath the gantries at high speeds while the gantry antennas briefly communicate with the transponder. From this transmission, centralized computers deduct the toll from the user's prepaid account as well as use the information to monitor the quantity of vehicles using the facility (Commission for Integrated Transport 2006). Carpoolers with a transponder simply need to place the device into an anti-static bag that inhibits communication with the gantry antenna so that the toll will not be charged (VTA 2005).

If too many vehicles start entering the lanes such that the overall traffic speed is expected to decrease, the centralized computers automatically raise the toll to reduce the number of entering vehicles. The price can be modified every six minutes, and requires no manual input or authorization. In general, the toll is kept high enough to maintain a level of service C (or fewer than 27 vehicles per lane per mile) (Brownstone et al. 2003). The price typically varies between 50 cents to \$4, and increases to as high as \$8 on occasions of extreme congestion (SANDAG 2007).

The I-15 HOT lanes have been very successful in achieving their primary goals of maximizing underutilized capacity and offering a congestion-free alternative. Between 1998 and 2006, the total number of vehicles using the HOT lanes increased by 66 percent (SANDAG 2007), and the system has been able to maintain a reliable option for travelers. In addition, a portion of the toll revenue generated by the I-15 HOT lanes has been used to completely fund transit improvements along the same corridor (SANDAG 2007). Technically speaking, the system was relatively easy to implement and maintain. One downside to the current design is a lack of means to automatically cite toll violators. The system can alert highway patrol officers when there has been a violation in the current system, but plans are underway to implement a more automated method using ANPR. The success of the I-15 HOT lanes has led to an expansion of the I-15 facility as well as bringing similar programs to other corridors in San Diego (SANDAG 2007).

Key Characteristics:

- Geographically focused system design
- Dynamic tolling system to keep congestion free traffic flow

⁵ While repairing the overhead gantries requires the lanes to be closed, mounting the antennas above is preferable to the sides due to better communication with the transponder (FHWA 2003).

Goals of Pricing Policies:

- Maximize underutilized capacity
- Offer a congestion-free alternative
- Generate revenue (for transit)

Pros:

- Using simple off-the-shelf technology (DSRC) led to easy implementation

Cons:

- Lack of means to automatically cite toll violators

SR-91 Express Lanes

The SR-91 Express Lanes were opened in 1995 and consist of four lanes (two in each direction) in the median of a ten-mile stretch of the SR-91 freeway in Orange County. The Orange County Transportation Authority (OCTA) had planned to construct HOV lanes on the SR-91 but continuously lacked the funds to do so. In order to offer congestion relief without spending taxpayer money, the OCTA allowed a private firm to build and operate the lanes in the early 1990s (OCTA 2007). The concept of the lanes evolved into HOT lanes in order to generate revenue for private investors (Boarnet & Dimento 2004).

The SR-91 Express Lanes operate very similarly to the I-15 HOT lanes. They are a limited access facility with no exit or entry for the entire ten miles, and there is no overarching road pricing system in place. The use of lanes is also variably priced so that a congestion-free flow is maintained. The SR-91 Express Lanes use the same DSRC technology to collect the toll; users must purchase a windshield-mounted FasTrak radio transponder that communicates with an overhead gantry-mounted antenna.⁶ Users are alerted to the toll price a few miles before the lanes begin. Should they choose to use the lanes, drivers simply pass underneath the gantry and the toll is deducted from their account (Boarnet & Dimento 2004).

There are a few differences between the SR-91 Express Lanes and I-15 HOT lanes worth noting. First and foremost, although the use of lanes is variably priced, this pricing is not dynamic like the I-15 toll that is updated every six minutes. Instead, the toll authority establishes a toll schedule that determines the price for any given hour on any day of the week. The prices are established using historical data, and can be modified every three months. Currently, the price ranges from \$1.20 during off peak periods to \$10.00 between 3 pm and 4 pm on Fridays (OCTA 2007). Secondly, the SR-91 Express Lanes have established different pricing structures for frequent users and discounts for carpoolers and disabled drivers. For instance, vehicles with three or more passengers can usually travel free on the lanes but must pay 50% of the fare during the Friday peak period, and people who plan to use the lanes more than 20 times a month can travel for \$1 less during each trip by buying a “91 Express Club” account (OCTA 2007). DSRC technology can identify unique users, and these flexible pricing structures are relatively easy to implement by storing additional information to each account in the system. Thirdly, the SR-91 Express Lanes employ ANPR technology as a means of enforcement. If a SOV without a transponder passes underneath the gantry, a picture is taken of its license plate. With this

⁶ The same FasTrak transponder can be used on the I-15 HOT lanes, or any other FasTrak facility in California (OCTA 2007).

information, the SR-91 Express Lanes can access the address associated with the plate number to mail a bill (VTA 2005).

The SR-91 Express Lanes have also been quite successful in improving overall throughput, offering a congestion-free alternative, and generating revenue (Sorensen 2006). Because of the private sector's desire to protect their revenue flow, the system is designed to be slightly more successful in enforcing payment than the I-15 HOT lanes. Like the I-15 HOT lanes, expansion plans for the SR-91 Express Lanes are currently underway.

Key Characteristics:

- Geographically focused system design
- Static, but flexible tolling system to keep congestion free traffic flow
- Use of ANPR technology provides for efficient enforcement

Goals of Pricing Policies:

- Offer a congestion-free alternative
- Generate revenue (to construct new capacity)

Pros:

- Using simple off-the-shelf technology (DSRC & ANPR) led to easy implementation

Cons:

- Perhaps a dynamic toll would manage lane capacity more efficiently

Cordon Tolls

Cordon tolls charge users for entering or driving within a geographically enclosed area. While facility congestion tolls only apply to those who elect to use them, cordon tolls apply to anyone who drives inside the zone primarily to reduce congestion within the enclosed area, typically a central business district. However, technical approaches taken to accomplish this goal vary. An examination of two prominent examples, in London and in Singapore, reveals that cordon tolling is generally successful in achieving its goals although more complex system designs can provide for more flexible pricing policies and user privacy.

The London Congestion Toll

The London Congestion Toll program began in 2003 with the aim of reducing congestion within central London to protect its economic vitality and to provide revenues to improve transit services. The cordoned area includes major centers of government, law, business, finance, and entertainment, and was expanded westward in 2007. Transport for London (TfL) manages the toll, which is currently set at £8 (US \$16) to enter the zone, enforced between 7 a.m. and 6 p.m., Monday to Friday. Drivers can pay using the internet, at kiosks within the zone, at certain retail establishments, and with their cell phone. A network of 340 stationary and mobile cameras continuously takes pictures of license plates of vehicles entering, exiting, and traveling within the zone. The pictures are fed to a central data center where ANPR software reads the plate numbers, and these records are compared to a database of people who have paid the toll. Because the plate number links the vehicle to the owner, the collection agency can pursue the driver until all charges have been paid. To address privacy concerns, TfL deletes the images the

day after the person pays the toll. However, if the charge is not paid within two days, TfL keeps a copy of the image for 13 months. TfL also has an agreement providing law enforcement agencies access to available images as long as the request is for a legitimate purpose (TfL 2007a).⁷ Although ANPR technology is rather simple itself, the centralized management of user information provides Transport for London with flexibility in pricing structures through individual accounts. Policies include a 90% discount for residents of the zone and exemptions for the disabled (TfL 2008).

The simplicity of the system design has its advantages and disadvantages. ANPR was a safe bet as there was little uncertainty to implementing the system itself. Relying primarily on cameras and ANPR also does not require drivers to purchase any equipment prior to use – a boon to infrequent users and visitors. In addition, while the program allows flexible pricing structures, it does not easily provide for a variable charging schedule based on congestion levels and/or time of day as seen on the I-15 and SR-91 HOT lanes. While current policy may be trying to keep the plan simple enough for the public to understand, the system’s ability to encourage or discourage driving within the cordoned area during certain times of day is indeed limited (Sorensen 2006).

Nonetheless, the congestion pricing program has been wildly successful in achieving its goals, and the use of an established technology (ANPR) was instrumental in implementing a reliable system. Within the zone, the initial 2003 policy cut automobile traffic by 33 percent, increased speeds by 14 to 20 percent (Small 2005), and reduced excess waiting times for buses by 33 percent (Turner 2003). Toll revenue, amounting to a net £123 million (\$US \$248 million) has been reinvested into transit improvements. As Small (2005) notes, decreasing automobile traffic through pricing also creates a perpetual “virtuous cycle” of cost savings and ridership increases to transit. However, there are considerable privacy concerns associated with the installation of a network of cameras and centralized management of user information. Despite the limitations TfL has placed on access to vehicle location data, the “big brother” perception still prevails and many claim their privacy has been invaded. As Litman (2006) notes, privacy may be particularly problematic concern in London’s case due to the existence of surveillance systems in many British cities.

Key Characteristics:

- Flexibility in pricing structures through individual accounts
- Simple system design with high reliability
- No up-front cost to drivers
- No capability for flexible pricing

Goals of Pricing Policies:

- Reduce congestion (to protect economic vitality)
- Generate revenue (for transit)

⁷ “Legitimate purposes” are defined under the Data Protection Act of 1998. It is worth noting that the Metropolitan Police Service is subject to certain exemptions of this act for the purposes of national security (and not general crime) (TfL 2007a).

Pros:

- Using simple off-the-shelf technology (ANPR) led to easy implementation
- Easy for drivers to use

Cons:

- Cannot vary price by particular route, time of day, or level of congestion
- Camera system and centralization of user information raises privacy concerns

Singapore's Electronic Road Pricing Program

The evolution of Singapore's congestion toll over the last three decades exemplifies how technology facilitates more efficient operations and direct user fees. While many jurisdictions have adopted road pricing to take advantage of enabling technologies, Singapore started experimenting with such programs before the process was as seamless as it is today. Facing a dramatically rising automobile ownership rate since the 1970s, Singapore pursued a number of policies to reduce vehicular traffic within the CBD in order to protect its economic vitality. Such policies required the public to obtain permits for vehicle purchase and drivers to buy passes in order to enter into a cordoned area of downtown. Although it reduced traffic within the area, congestion spilled over onto the roads leading up to the zone. In 1995, the Singaporean government implemented the Road Pricing Scheme that charged users a flat fee to enter downtown as well as use the expressways and feeder streets leading into the zone. While successful, the policy relied on manual enforcement and proved to be burdensome and expensive to administer (Goh 2002).

In 1998, Singapore introduced the Electronic Road Pricing (ERP) Program, replacing all previous road tolling programs. In order to alleviate concerns about centralized management of personal information, ERP spreads the electronic toll collection tasks over various technologies, collecting detailed personal information only when required. ERP employs a wide network of DSRC overhead gantries on all entry points to the tolled area. Each vehicle that travels into the zone must have a DSRC transponder that communicates with antennas on the gantries, and violators are caught using ANPR cameras.

Payment information is stored on neither the transponder nor a centralized processing center, but on prepaid smart cards that are inserted into the transponder. These smart cards store the individual account information, and agencies only access personal information in the case of insufficient funds or the lack of a transponder. Individuals can add money to their account balance at retail outlets, banks, kiosks (Goh 2002) as well as online, and can also use the cards to pay for a variety of other goods and services including parking, retail purchases, and vending machines (Networks for Electronic Transfers 2007). Storing personal data and billing information on the smart cards rather than a centralized processing center has been key in alleviating privacy concerns (May & Sumalee 2003)



Figure 4: Transponder and Smart Card (EPVIS 2002)

While the smart cards manage the billing and personal information, the transponders contain information about the vehicle, such as class and weight, which ERP uses to charge a variable price. In addition, ERP can change the toll prices based on point of entry and time of day. This provides ERP with the ability to manage routes via prices. If one route is in particularly high demand during the morning peak, for instance, they can set the toll to be high on the main route while lowering prices on alternative routes. This encourages more efficient use of the road network, maintaining high speeds, reliable travel times, and lower vehicle emissions (Goh 2002).

ERP has been the most successful of Singapore's road pricing programs. The vehicle purchase permits and paper passes only indirectly approached user fees, but ERP sends direct price signals to inform drivers of the costs they impose on other drivers and society by driving a certain vehicle on a particular route at a certain time of day (which the London Congestion Toll cannot do). And while installing the DSRC, ANPR, and smart card infrastructure is a costly endeavor, the ERP system has achieved improved efficiency and lower operational costs than the old imprecise manual enforcement method. Singapore's previous tolling policies achieved certain reductions in auto usage and congestion, which ERP was able to further. Within its first year of operations, ERP resulted in increased travel speeds on the CBD and on the expressways, a 16 percent increase in average bus speeds, and a successful spreading out of traffic over the course of the day (Goh 2002).

Key Characteristics:

- Dynamic toll varies by route, time of day, and level of congestion
- Smart cards store personal information and protect privacy
- DSRC transponders store vehicle information used to charge variable tolls

Goals of Pricing Policies:

- Reduce congestion (to protect economic vitality)

Pros:

- Ability to vary the toll based on point of entry and time of day makes it possible to manage the level of traffic on routes in the road network via prices
- Privacy is protected by diffusing different tasks to different technologies

Cons:

- Relies on costly infrastructure

Weight-Distance Truck Tolls

Although many jurisdictions currently levy fees to reflect the damage caused by trucks on roadways, most programs used do not directly communicate the true costs trucks impose. Electronic tolls are better able to charge fees based on weight, location, and emissions class. Electronic weight-distance truck tolls are particularly popular in European nations because they can ensure that foreign truckers passing through will pay their fair share in fees. The systems vary greatly in sophistication – from complex programs providing for considerable flexibility in pricing policies to those employing simple and reliable technologies, if at the cost of flexibility.

Germany's and Austria's programs represent both ends of the spectrum, respectively, and these two cases illustrate the advantages and disadvantages of both approaches.

Germany's "Toll Collect" Truck Tolling Program

As the development of the European Union has furthered economic integration among the member nations, Germany has experienced significant growth in truck traffic, a great deal of which is comprised of foreign vehicles traveling through (May & Sumalee 2003). As the volume of goods movement traffic increased, so did concern regarding the use of public funds to maintain the quality of the road network. During the early 2000s, the German government sought the development of a system that could shift the burden of finance from taxpayers to the freight industry itself (Toll Collect 2007). In 2005, Germany launched the "Toll Collect" system, an ambitious and technologically sophisticated road pricing program for goods movement within the country. Toll Collect was primarily designed to implement direct user fees, but also to raise revenue and institute an emissions-related toll. The tolls apply to heavy goods vehicles, defined as trucks over 12 tons. The system employs on-board units equipped with GNSS receivers and digital road network maps that determine the location of the truck. As the truck drives along the highway network, the OBU keeps track of distance traveled, calculates the appropriate charges (averaging 15 cents/kilometer), and communicates this billing data to the collection agency via GSM. Various enforcement methods are employed, including DSRC communications between the OBU and roadside units. Most trucks participate in the electronic Toll Collect program although a manual payment system remains for vehicles without OBUs (Toll Collect 2007).

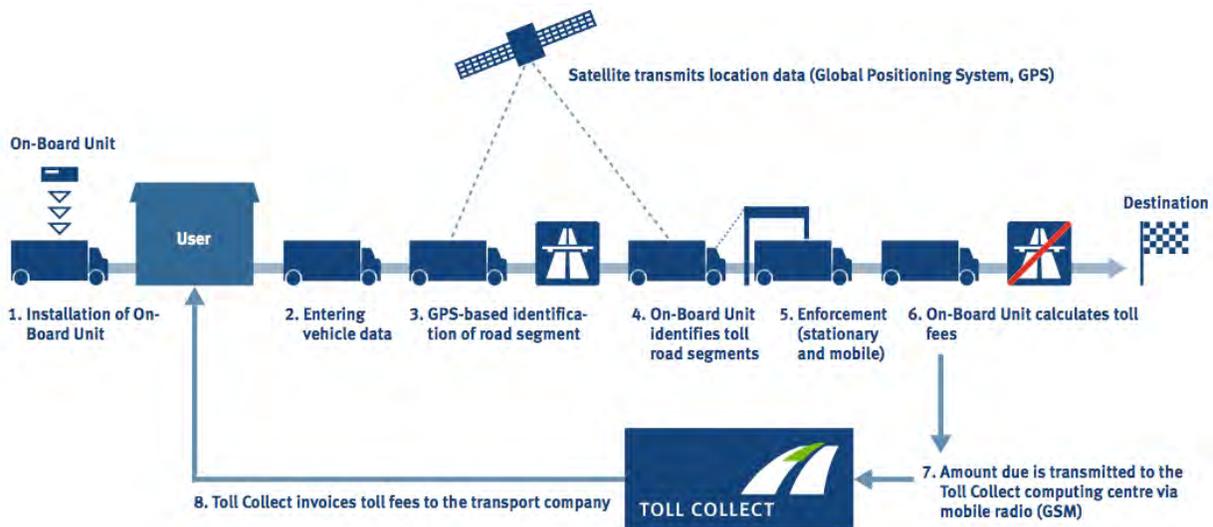


Figure 5: German Toll Collect Technological Configuration (Toll Collect 2007)

This system design provides considerable flexibility in charging policies. The OBU stores vehicle-specific information allowing fees to be levied on weight (via number of axles) and emissions class. Heavier and more polluting vehicles are charged higher tolls than cleaner ones (the heaviest and most polluting vehicles are charged approximately 50% higher tolls than the lightest and cleanest), thus encouraging lighter and cleaner vehicles via price signals (Toll Collect 2007). GNSS technology allows distance charges on a kilometer basis as well as the

ability to expand the network of priced roads rather easily. The latter is particularly important since some trucks are expected to deviate from the tolled highways to other roads not desired for goods movement. Since very little roadside infrastructure is needed, the tolling program could easily begin pricing these secondary roads to discourage diversion from the highways (Bolte 2003).

Although Toll Collect is currently a successful operation, the considerable risk of implementing new technologies was exemplified by delays and budget overruns in designing a system that had never been tried before. Although the project was scheduled to start in 2003, significant problems in developing the Toll Collect system pushed the implementation date to 2005. The German government initially cancelled the contract with Toll Collect, but reinstated it under the agreement that Toll Collect would pay the German government for the revenues it would have collected, had the system kept on schedule (Samuel 2004). Toll income is earmarked for transportation infrastructure, most notably rail improvements in order to encourage a mode shift of goods movements. As noted earlier, the OBUs are also equipped with DSRC capability. As the rest of Europe decides between DSRC and GNSS-based systems as a common format for road tolling programs, Toll Collect's inclusion of both types ensures interoperability in the future (Ruidisch 2004).

Key Characteristics:

- OBUs store vehicle information, enabling Toll Collect to vary fees by vehicle weight and emission class
- GNSS provides ability to charge distance-based fees and to easily expand the network of priced roads
- Inclusion of the two standard types of technologies provides for interoperability with other countries' systems in the future

Goals of Pricing Policies:

- Generate revenue
- Allocate costs to users

Pros:

- System can be easily expanded over wider geographic areas

Cons:

- Using newer and less tested technologies incurred greater risk in implementation

Austria's GO Truck Tolls

Austria's electronic tolling program was launched in 2004, and is a relatively simple system relying primarily on DSRC technology. Like the Toll Collect System, the primary goal of the program is to raise revenue and charge freight vehicles for the costs they impose by traveling on Austrian highways (of particular concern is the high cost of maintaining tunnels and bridges that line the Austrian Alps) (Schwarz-Herda 2005). Participating trucks must be equipped with an in-vehicle transponder, while those vehicles without a transponder can pay tolls manually. Austria has installed a network of over 800 overhead gantries equipped with antennas throughout the highway network and as trucks pass underneath the gantries, the toll is deducted through a simple transmission between the gantry and the transponder. One hundred of these gantries have

enforcement cameras that take pictures of trucks that pass underneath the gantry without a valid transponder reading. From these pictures, enforcement officials use ANPR to read the license plate and identify the truck owner (Schwarz-Herda 2005).

In comparison with Germany's Toll Collect program, Austria's GO program is very simple, relying on tried and true technologies rather than experimenting with new systems altogether. Depending on a reliable technology saved Austria the delays and cost overruns that Germany experienced while implementing the Toll Collect system. However, Austria's system is rather inflexible, and while it allows for variable tolling based on vehicle size and road link, it is not easily expanded. As Sorensen (2006) explains, both Germany and Austria have experienced significant problems with trucks diverting to local streets (which are not designed to withstand heavy truck traffic) to avoid tolls. While Germany can easily expand their tolled road network, it is impractical and expensive for Austria to install gantries on additional segments of the road network. In this sense, DSRC technology may be pushed to its limits in terms of geographical dispersion and a GNSS-based system would have been a more appropriate choice. While Germany's Toll Collect system came only after a great deal of delay and additional expense, it is likely that the benefits of a geographically flexible system will eventually outweigh these costs. Regardless, the program has been successful in raising revenue that is invested back into the road network, and Austria has been able to price their roads in a way to encourage travel on routes parallel to the Alps (Schwarz-Herda 2005).

Key Characteristics:

- Fees vary by vehicle size and road link
- DSRC gantries installed throughout the national highway system

Goals of Pricing Policies:

- Generate revenue
- Allocate costs to users

Pros:

- Using simple off-the-shelf technology ensured lower costs and faster implementation

Cons:

- System cannot be easily expanded

Distance-Based User Fees

Distance-based user fee programs that include automobiles are currently under development and have not yet seen full-scale implementation. However, there are a handful of user fee proof-of-concept experiments within the United States and results are indeed promising (Sorensen 2006). The two most thoroughly researched examples are in Oregon and at the University of Iowa. In both cases, the primary motivation is the replace dwindling gas tax revenue, although dynamic fees are also possible.

Oregon Mileage Fee Concept

Facing declining revenue from the current state gas tax, the Oregon Department of Transportation (ODOT) put together a Road User Fee Taskforce to research and develop a

mileage based user fee system to eventually replace the gas tax. The task force established several criteria for the new system:

- Accurately measure distance traveled
- Be technically feasible and reliable with minimal evasion potential
- Differentiate travel between zones as well as time of day
- Place a minimal burden on motorists and the private sector
- Provide for a seamless transition
- Respect privacy concerns of the public
- Have low administrative costs

The task force partnered with universities to develop the Oregon Mileage Fee Concept. Each vehicle is equipped with an on-board unit that includes a dashboard display, a GNSS receiver, a DSRC communicator, and an electronic feed to the odometer used to measure miles traveled. The odometer feed is the primary distance measurement tool while the GNSS receiver is used to differentiate which miles are driven in certain tolling zones, so that the appropriate fees can be levied (Whitty 2007).

The OBU also continuously keeps track of charges owed, and payments are made during the refueling process. Fueling stations are equipped with DSRC radios and communicate with the OBU automatically. DSRC was chosen over GSM for this task for its lower costs, greater reliability, and provisions for greater privacy. In the current pilot program, the distance charges are added to the cost of fuel while the state gas tax is subtracted. The driver does not need to perform any other extra tasks or pay additional bills since the mileage fee is paid during the fuel transaction. The receipt shows the separate amounts for fuel and user fees. If there is no DSRC transmission between the fueling station and the vehicle, either due to the absence of the appropriate equipment or attempts to tamper with it, then the usual state gas tax is charged (Whitty 2007).

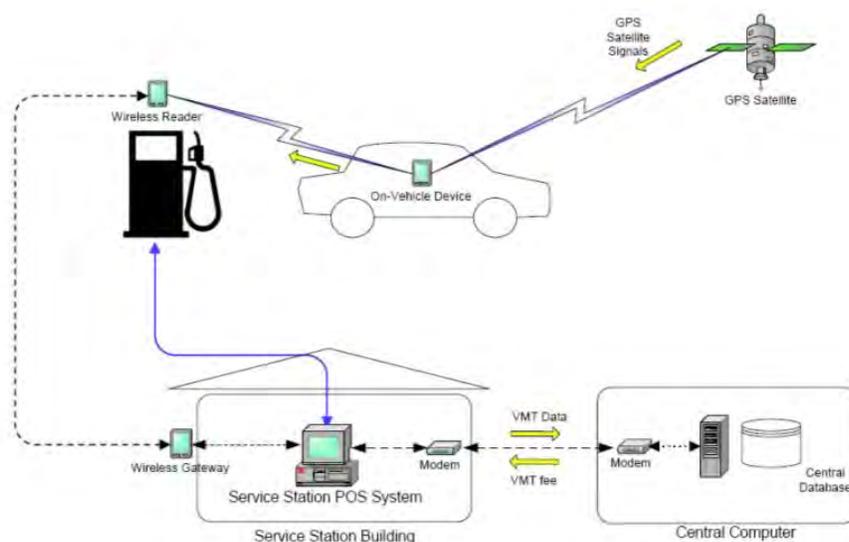


Figure 6: Oregon Mileage Fee Technical Configuration (Zhang & McCullen 2007)

From April 2006 to April 2007, the task force conducted a pilot program of the Oregon Mileage Fee Concept using nearly 300 volunteers and two service stations in Portland. In general, the program was successful and demonstrated its ability to meet the aforementioned goals of the user fee program. The OBU and fuel station devices were not available off-the-shelf and had to be developed from scratch, and a few minor problems arose in the pilot program. First, some field test participants noted that their OBU simply did not work or significantly drained the car battery, however, the researchers note that these issues were primarily due to the pilot nature of the program. Secondly, the service station operators noted some difficulty in incorporating the experimental billing equipment with their own, which would have to be streamlined in the instance of full implementation. Lastly, station owners stated that they would require greater reliability with the fuel pump devices as well as a means to offset the additional costs associated with accounting. Thus, although the system operated successfully for the most part, these components need slight modifications for smoother operations in a wider implementation setting (Whitty 2007).

From a policy perspective, the pilot project demonstrated that technologies are capable of electronically determining and collecting user fees. System design can also be modified according to policy goals. Results from the pilot project indicated that a more complex network of spatial zones with more flexible time schedules is feasible, and that environmental concerns can also be met by charging variable rates based on the emissions class of each vehicle. The user fee can also be pegged to an index in order to protect the revenue stream from inflation (although this could arguably be done to the gas tax). And lastly, Oregon's system protects privacy by delegating different tasks over multiple technologies and devices in a way that personal information, vehicle attributes, and distance data are dispersed. No agency – billing, administrative or otherwise – can link an individual to his or her travel behavior (Whitty 2007).

As Oregon's transportation revenue continues to decline, the Road User Fee Taskforce urges a statewide implementation of the user fee concept as soon as possible. Although system designers have taken many attempts to reduce the amount of equipment necessary, phasing in the required devices throughout the vehicle fleet and Oregon's fueling stations is still a significant undertaking. However, the task force estimates that with vigorous assistance from the state and federal departments of transportation, the Oregon Mileage Fee Concept could be fully operational within three to five years (Whitty 2007).

Key Characteristics:

- System can toll a statewide road network based on distance traveled
- Varying the toll based on vehicle type and emissions class is possible
- OBU calculates charges, and payment is automatically included into fuel charges
- User fee could replace the fuel tax, and attempts to tamper with the equipment results in a default fuel tax payment
- Protects privacy by delegating tasks over multiple technologies and devices

Goals of Pricing Policies:

- Generate revenue
- Develop a user-fee alternative to the fuel tax

Pros:

- Allows for charges on a wide geographic scale
- Tolls can vary by vehicle type or emissions class
- Provides for a true user fee

Cons:

- Installing equipment on the entire vehicle fleet is a challenging task

University of Iowa Road User Study

Under a joint funding partnership between the Federal Highway Administration and 15 state departments of transportation, transportation researchers at the University of Iowa have been working on a mileage based user fee system for automobiles and trucks. Like the Oregon Mileage Fee, the motivation behind a user fee charging system is primarily to replace funds from the dwindling motor fuel tax revenue. However the University of Iowa's system is being designed to operate across many states and quite possibly at the national level, so there is a greater focus on flexible charging programs allowing different rates for different jurisdictions. (Forkenbrock 2005).

An OBU in the vehicle contains a GNSS receiver, a GIS map file, a rate schedule, and an electronic odometer feed. These technologies in concert can determine a vehicle's location within a jurisdictional billing zone, and measure miles traveled to calculate total charges (Forkenbrock 2005). In addition, vehicles are equipped with a GSM transmitter that will automatically communicate the appropriate charges to a billing center on a monthly basis. This center will issue charges and collect payment through a variety of options such as billing statements or prepaid accounts (Kuhl 2007).

Like the Oregon Mileage Fee, respecting user privacy is a paramount concern. This is accomplished through an embedded security key for user authentication and data encryption. Furthermore, the system uploads the total charges per user separate from the distribution of those charges by jurisdiction. Under this program, it will be impossible to connect which jurisdictions users have been to (Forkenbrock 2005).

Because this program was developed under an agreement between multiple states and a federal agency, the design team developed a dynamic system that can be updated with new boundaries and charging policies. This includes the ability to incorporate additional transportation policies, such as congestion tolls, variable charges based on emissions class, and fee adjustments for trucks based on weight. Fees and taxes can be simultaneously collected at the local, state, and federal level as well (Kuhl 2007).

The University of Iowa team is currently testing the technology to ensure smooth operations and examine the potential to implement the program nationwide (University of Iowa Public Policy Center 2008). According to Paul Hanley of the University of Iowa (personal communication, January 27, 2009), a field test with 1,200 participants in six regions (San Diego, Boise, Austin,

Eastern Iowa, Baltimore, and the research triangle in North Carolina) began in January of 2009 and is scheduled to finish in August of the same year. The researchers will evaluate the system design and collect attitudinal data, and then proceed with a second testing phase with another 1,200 volunteers. Due to its flexibility and scale, the University of Iowa program holds enormous potential to change the nature of transportation finance.

Key Characteristics:

- System can toll the road network based on distance traveled and recognize different pricing policies for separate jurisdictions
- Varying the toll based on vehicle type, emissions class, time of day, particular link of the road network, and level of congestion is possible
- Protects privacy using an embedded security key
- Dynamic system with high flexibility for future needs

Goals of Pricing Policies:

- Generate revenue
- Develop a user-fee alternative to the fuel tax

Pros:

- Allows for charges on a wide geographic scale
- Tolls can vary by vehicle type, emissions class, time of day, particular link of the road network, and level of congestion
- Provides for a true user fee

Cons:

- Installing equipment on the entire vehicle fleet is a challenging task

4. Analysis

From our review of the eight cases, we observe some patterns between road pricing systems, policy goals, and technologies employed. In particular, we identified six primary policy goals:

- a) maximize underutilized capacity
- b) offer a congestion-free alternative
- c) generate revenue
- d) reduce congestion
- e) allocate costs to users
- f) develop a user-fee alternative to the fuel tax

As we have previously noted, these goals are not present in every project, and most examples tend to have two or three of these primary objectives. Another key consideration for all factors is the geographic scale at which the pricing policy is directed. Table 3 shows the relationship between pricing programs, policy goals, and technologies employed in the eight reviewed cases.

Table 3: Road Pricing Programs, Policy Goals, and Technologies Employed

<i>Road Pricing Program</i>	Geog. Scale	Level of Complexity in Pricing	Goals of Pricing Policies:	On-Board Units	GNSS Receivers	GIS	Electronic Odometer Feeds	ANPR	DSRC	GSM	Smart Cards	Supporting IT	Note	
Facility Congestion Toll	Geographically focused	Dynamic fee to keep congestion free traffic flow											Simple; off-the-shelf technology (OST)	
San Diego I-15 HOT Lanes			a, b, c	●					●			●		
Orange County SR-91 Express Lanes			b, c	●					●	●				●
Cordon Congestion Toll	Limited scale	Flat fee												
London Congestion Toll			c, d					●					●	Simple (OST), no privacy protection
Singapore Congestion Toll			d	●				●	●			●	●	Costly infrastructure
Weight-Distance Truck Toll	Large; National scale	Variable tolls; interoperability (German)												
German Toll Collect			c, e	●	●	●			●	●			●	Easy to expand; new technology
Austrian GO Truck Toll			c, e	●					●	●				●
Distance-Based User Fee	Large, across facilities and jurisdictions	Variable tolls; a true user fee; high privacy												
Oregon Mileage Fee			c, f	●	●	●	●		●				●	Need to install sophisticated equipment on all vehicles
University of Iowa Road User Study			c, f	●	●	●	●			●			●	

Goals of Pricing Policies: a) maximize underutilized capacity, b) offer a congestion-free alternative, c) generate revenue, d) reduce congestion, e) distribute costs to users, and f) develop a user-fee alternative to the fuel tax.

Primary Policy Goals and Technologies Employed

As Table 3 shows, the primary policy goals for facility congestion tolls are to offer a congestion-free alternative and generate revenue. For cordon area programs, the main objective is to reduce congestion. Weight-distance truck tolls seek to generate revenue and allocate costs to users while distance-based user fee experiments have been pursued to develop a user-fee alternative to the fuel tax.

Two key factors of concern for all of these goals are the geographical scale of the pricing policy and the complexity of calculating fees to be charged. For the most part, facility and cordon area congestion tolls operate at a small geographical scale and employ simple DSRC-based systems, while weight-distance truck tolls and distance-based user fees work at a larger scale and are designed around GNSS-based systems. There are, however, a few variations of systems that cross this classification boundary.

Although the policy goals and technologies employed vary among road pricing programs, there are some aspects most systems have in common. All systems except the Singapore Congestion Toll have an explicit goal of raising revenue. Supporting information technologies such as the internet and online banking protocols play a secondary yet important role in all of the cases reviewed here, and it is difficult to imagine any electronic road pricing program that could operate without them. In addition, OBU's are found in all of the cases that employ DSRC-based or GNSS-based systems (London being the sole exception).

With regards to facility congestion tolls, the I-15 HOT Lanes and SR-91 Express Lanes show cases where the main policy goals are to offer congestion free alternatives on geographically limited facilities and to raise revenue. In these cases, simple off-the shelf DSRC-based systems proved to be effective in achieving these goals at a relatively low cost.

The two cordon pricing cases we examined, London and Singapore, have a clear policy goal in common – reducing congestion in a confined area. To accomplish this task, these road pricing programs apply a simple economic principle: the higher the price of a good, the lower the demand for the good. As long as the pricing system can charge all vehicles entering the cordoned area, congestion is reduced. The two cases in London and Singapore examined in this report show how using different technologies can determine pricing policy: Singapore's DSRC-based system has variable pricing based on congestion levels while the London system deploys only a network of cameras and ANPR technology to meter road use for a flat toll per day,

The two large-scale road pricing programs, weight-distance truck tolls and distance-based fees, share the primary policy objective of generating revenue. Weight-distance truck tolls also explicitly seek to allocate costs to users while the distance-based fee programs in the Oregon and University of Iowa examples leave a varying fee as an option. This involves accurately measuring distance traveled, location on the road network, and in some cases, varying the fee based on time of day and level of congestion. Because they operate at such large geographic scales and must have complex pricing structures to incorporate dynamic user fees, these systems employ advanced technologies. Most are GNSS-based, and also employ GIS and electronic odometer feeds. In these cases, policy goals direct technological specifications.

Secondary Policy Goals and Technologies Employed

In addition to geographic scale and the complexity of the pricing program, a few other policies influence system specifications and selection of technologies. The first concern is planning for future expansions of the system. While the German Toll Collect system can easily enlarge its tolled road network by simply reprogramming their GNSS-based system, Austria's DSRC-based system with on-board transponders is more difficult to expand to a large area due to the needs to install roadside gantries.

Secondly, some systems better address privacy concerns through careful system design.⁸ In particular, smart cards were employed in the Singapore Congestion Toll specifically to separate billing data from personal information. In the cases of GNSS-based systems (where the possibility of tracking individuals through orbiting satellites is of high concern), privacy can be protected by dispersing personal information, vehicle attributes, and distance data across various system platforms (such as in the Oregon Mileage Fee) or by encrypting personal data (as in the University of Iowa example).

Lastly, the need for speedy implementation determines the level of complexity and advancement of technologies to employ. That is, there is clearly a tradeoff between ease of implementation and complexity of the system; the more complex the pricing policy, the more complex the system, often leading to longer development and implementation phases. Older technologies, while proven to be successfully applied in many road pricing programs, are more limited in terms of the range of policies that can be implemented. In contrast, newer and more advanced technologies have more capability of implementing various pricing options in a larger geographic area. For example, large-scale GNSS-based systems show that it will be technically feasible to incorporate facility or area-specific policies into an overarching road pricing program.

Advancements in Technology and the Changing Nature of Road Pricing Systems

As we have previously discussed, newer GNSS-based road pricing systems are enabling the implementation of large-scale dynamic user fees. We also found in the first report of this research series, "Motivations Behind Electronic Road Pricing" (Kalauskas, Taylor & Iseki 2008), that one of the most prevalent motivations behind many recent road pricing programs is the need to raise revenue. In the United States, this is driven, in part, by declining revenue from the fuel tax and jurisdictions looking to road pricing as a means to replace a primary source of transportation funds. As the geographic scale of road pricing systems with user fees increases, so does the amount of revenue generated. This has led to the design and development of large-scale GNSS-based road pricing systems such as the Oregon Mileage Fee and University of Iowa study. In this sense, policy is strongly determining the direction of technology.

Should programs like those in Oregon and the University of Iowa continue to develop as expected, it is conceivable that a well-designed GNSS-based system can essentially achieve the objectives of many road pricing programs in effect today. These programs hold great potential to flexibly implement user fees on a large scale, and represent a potential new revenue source that

⁸ In this paper, we focus primarily on privacy as it relates to system design issues. The greater issue of privacy with regards to public acceptance is to be covered in greater detail in a later phase of this research.

could alleviate the crisis in transportation finance. However, since these programs rely more on in-vehicle equipment than roadside infrastructure, the primary technical challenge with these systems is to install the appropriate technology on all vehicles. A secondary technical problem is that current GNSS networks may position vehicles by as much as 15 meters away from their actual location. Thus, it would be difficult for current GNSS-based systems to differentiate between very small links in a dense urban street network. However, GNSS is still a rapidly developing technology, and it is likely that the problem of accuracy will eventually be overcome (Grush 2008).

If these two hurdles can indeed be overcome, then the necessary infrastructure will be in place for charging programs that can vary by a multitude of factors, such as road segments, time of day, vehicle class, and congestion levels. That is to say, future developments in GNSS could essentially render DSRC-based systems obsolete and most systems would be GNSS-based, employing a similar set of technologies. Indeed, both London and Singapore are considering upgrading to GNSS-based systems due to advantages in geographic scale and pricing flexibility over their current systems (TfL 2006; Schindler 2007). We expect that transportation agencies wishing to implement electronic toll collection only at the facility and/or cordon level will most likely continue to employ DSRC-based systems in the short term. However, as more jurisdictions begin to see larger scale road pricing as a potent revenue generator as well as a congestion management tool that can incorporate smaller scale policies, we expect to see more regional or even statewide GNSS-based systems in the long run.

Phasing in GNSS Technology

As we have just noted, interest in GNSS-based systems is growing, but installing the necessary equipment throughout the vehicle fleet would be no easy task. How could the appropriate in-vehicle technology for a GNSS-based system be phased in? In this section we describe some of the strategies and issues that researchers and transportation agency officials have discussed on this subject.

A simple way to ensure that all vehicles will be compatible with a GNSS-based tolling system in the future would be to require auto manufacturers to include GNSS receivers and other associated equipment on every new car and truck rolling off the production line. As the vehicle fleet turns over, the technology would slowly become ubiquitous. Based on sales and scrappage rates for automobiles and trucks, Forckenbrock (2005) roughly approximates that it would take about 20 years for 95 percent of all vehicles to have the required technology. While the cost to develop prototype equipment is high (about \$400 per vehicle in the Oregon example), mass production of the units could realize significant cost reductions through economies of scale (Whitty 2007), and Sorensen (2006) estimates the additional cost for auto manufacturers to install the equipment to be on the order of \$100.

While current vehicles may not have the complete set of equipment needed for a GNSS-based toll system, these technologies are nevertheless becoming more and more widespread in the transportation and communication sectors. As a result, the necessary elements of a GNSS-based toll system might already be in place, albeit not for calculating and collecting a toll. For instance, Forckenbrock and Hanley (2006) point to the proliferation of GNSS receivers (as well as the

accompanying GIS map files) in vehicles for navigation purposes, and suggest that a tolling system could simply utilize these devices instead of installing a duplicate device. In addition, GSM technology is nearly universal in cellular phones, and the use of smart phones equipped with GNSS receivers is growing as well. Thus, it might be possible to utilize the capability of these devices for the purpose of tolling (Kitchen 2008). This approach might be a more cost-effective than installing similar equipment for the sole purpose of road pricing.

Indeed, this use of after-market devices instead of dedicated equipment has a precedent in California. Caltrans' Vehicle-Infrastructure Integration (VII) concept envisions a statewide system where vehicles equipped with in-vehicle displays, GNSS receivers, and DSRC could communicate with a similar set of roadside equipment. Caltrans engineers conceived of over 100 uses for such a system, one of which is electronic toll collection. However, the very high cost of installing this infrastructure led Caltrans to pursue a demonstration project (called SafeTrip-21) that utilizes GNSS-enabled smart phones instead. Project leaders hope that the pilot project will demonstrate the benefits of VII and result in additional resources in the future (Larson 2008).⁹

However, others warn against the use of after-market devices for electronic toll collection. As Kitchen (2008) explains, such an approach might be appropriate for the purposes of navigation or providing real-time traveler information, but road pricing requires more trusted equipment. In other words, the nature of electronic toll collection demands that the primary functions (metering road use, calculating charges, and communicating data) be performed in a secure system. This is necessary to protect both the user and tolling authority from intended or unintended fraud.

Even though strategies for how to phase in the appropriate technology may differ somewhat, there is a greater consensus that whatever the strategy, it will take some time. As a result, there must be a system in place to allow those with the equipment to pay the distance-based user fee and for those without to continue paying the fuel tax (Whitty 2007; Forkenbrock & Hanley 2006; Forkenbrock 2005). For purposes of equity, many argue that the user fee should not differ greatly from the gas tax (Forkenbrock 2005). The Oregon Mileage Fee concept was designed to accommodate this transition, and Forkenbrock (2005) describes a similar system of differentiating vehicles at the pump and charging accordingly charging them user fees or gas taxes. Transportation authorities might also encourage drivers to retrofit their vehicles with the necessary equipment via incentive programs that significantly discount the user fee in a way that is financially beneficial.

Clearly, an explicit implementation plan does not yet exist, but this is due to the infant state of GNSS-based systems. If policy makers were to adopt such a large-scale pricing program, they would need to specify specific objectives and goals for system designers to follow.

⁹ Given the toll collection applications, the development of a VII system holds potential for the future of electronic road pricing in California as well.

5. Conclusion

In this report, we provide an overview of nine specific technologies that have been applied to electronic road pricing in recent years. These technologies have provided the necessary capability for more efficient operations for simultaneously collecting current tolls and enabling new pricing policies. In the cases examined in this report, we observed that policy decisions regarding the size of the network to be tolled and the complexity of the charging program drove the system design of each electronic toll collection system. While each system is different, most systems can generally be categorized by the primary technology employed to implement meter road use, that is, DSRC, GNSS, or ANPR. We also identified six primary policy goals of road pricing systems:

- a) Maximize underutilized capacity
- b) Offer a congestion-free alternative
- c) Generate revenue
- d) Reduce congestion
- e) Allocate costs to users
- f) Develop a user-fee alternative to the fuel tax

All of the cases we examined had a primary policy goal of generating revenue, except for the Singapore Congestion Toll.

Facility congestion toll programs have the primary goals of raising revenue and offering a congestion-free alternative while cordon congestion tolls aim to reduce overall congestion. To accomplish this, a road pricing system needs to charge users as they enter an individual facility or a defined area. DSRC-based systems generally work best at these small geographical scales, and can be quickly deployed at a low cost; building overhead gantries and antennas is easy to do in a small area, and on-board transponders are inexpensive and easily installed. As demonstrated by the I-15 HOT lanes and Singapore's congestion charge, these systems provide for significant flexibility in charging programs as well.

However, as the geographic scale of the tolled road network increase, DSRC-based systems become less practical due to the need to build roadside gantries on a large scale. These road pricing programs, weight-distance truck tolls and distance-based user fees, also have the common policy goals of raising revenue and distributing the full cost of road use to the driver. The latter may involve measuring a variety of factors such as distance traveled, time of day, vehicle class, and congestion levels. Because of the large geographic scale and complexity of the fee to be charged, GNSS-based systems are better suited to these applications.

We have noted that GNSS technology is a new technology, and that GNSS-based systems currently take longer to implement. However, as interest in large-scale GNSS-based road pricing programs grows among policymakers, they will become a more proven and more easily implemented technology. One current limitation is that GNSS that may be off by as much as 15 meters in its positioning, and needs backup technologies for more accurate measurements. However, new developments in this technology may fix this problem, making GNSS-based systems the logical choice for most road pricing projects in the future.

An underlying concern in many cases examined here is the issue of privacy. In particular, London's congestion toll may be especially unpopular among users because it relies on a network of cameras spread throughout the city and the centralization of user data. But in all examples where privacy was of particular consideration, system designers have been able to take appropriate steps to protect personal information. In London's case, the vehicle images are promptly deleted and in Singapore, user data and billing information are kept on a smart card belonging to the driver. In GNSS-based systems, satellites send one-way communications to OBU's, so that vehicles are never tracked. In the Oregon example, usage and billing data are diffused over different components and the University of Iowa's system uses an encryption key. In all cases, privacy is protected through careful system design. While it is uncertain if it is possible to lose the "Big Brother" association altogether, the public should nevertheless be assured that electronic road pricing systems are designed in such a way that travel behavior data cannot be linked to personal information without prior consent.

All of the fully operational electronic toll collection programs examined in this report have been successful in fulfilling their primary objectives, although some systems address secondary concerns more efficiently. In addition, experiments of domestic GNSS-based systems that seek to replace the gas tax are promising, and there are a handful of feasible strategies for phasing in the necessary equipment. In general, the sentiment is that technical feasibility is no longer a problem in facilitating the policy goals for road pricing programs. That is, road pricing's limiting factor is no longer technology, but rather political and public support for implementation.

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Addressing Equity Challenges to Implementing Road Pricing

Brian Taylor, Rebecca Kalauskas, Hiroyuki Iseki

**California PATH Research Report
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ADDRESSING EQUITY CHALLENGES TO IMPLEMENTING ROAD PRICING

California PATH Project

Evaluation of Open Road Electronic Toll Collection for California Applications (XB-604)

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By

Brian D. Taylor, PhD, AICP *
Professor and Chair of Urban Planning
Director, UCLA Institute of Transportation Studies
3250 Public Affairs Building
Los Angeles, CA 90095-1656
(310) 903-3228
E-mail: btaylor@ucla.edu

Rebecca Kalauskas, MA*
Research Assistant
UCLA Institute of Transportation Studies

And

Hiroyuki Iseki
Assistant Professor of Planning and Urban Studies
School of Urban Planning and Regional Studies
University of New Orleans
368 Milneburg Hall, 2000 Lakeshore Dr.
New Orleans, LA 70148
e-mail: hiseki@uno.edu
Phone: 504-280-6029; Fax: 504-280-6272

Abstract

Many public officials looking for ways to increase the efficiency, equity, and financial stability of transportation systems are turning to metering road use with electronic tolls. While tolling today is easier and cheaper than ever, officials face many obstacles to implementing tolling – especially concerning equity. Accordingly, this paper examines road pricing equity from a variety of perspectives. We begin by developing an evaluation framework that defines three distinct bases for evaluating equity – free markets, equal opportunities, and equal outcomes. We then use this framework to guide a review of five case studies of road pricing – in San Diego, Minneapolis-St. Paul, Germany, Stockholm, and New York – that explore how equity concerns have been raised and addressed in practice. We find that equity was a central question in each case, alternatively motivating (1) the implementation of pricing (Germany), (2) the funding of alternative modes (San Diego, Minnesota, and Stockholm), (3) mid-course restructuring of the pricing program (Stockholm), and (4) successful opposition to a pricing proposal (New York). Successful mitigation of equity concerns have entailed: (1) careful planning of the project or program, paying attention to the dedication of toll revenues to both transit and highway improvements in and around the tolled areas to create constituents for the pricing program, (2) a limited geographic scope to central, congested zones, particular travel corridors, or particular market segments, (3) incremental implementation to allow for mid-course adjustments in project development, and (4) ongoing, substantive, and sincere public outreach and education efforts that have meaningfully influenced program design.

Executive Summary

Concern with the sustainability of auto-dependence, chronic metropolitan traffic congestion, and a decades-long erosion in the buying power of motor fuel taxes has left many public officials looking for ways to increase the efficiency, equity, and financial stability of transportation systems. One approach to both increase transportation efficiency and secure new revenues is to meter road use with electronic tolls. While technological advances make such tolling easier, cheaper, and more reliable than ever, many worry that charging people for driving on public roads is unfair, even un-American. Such concerns reflect the complex, and sometimes confusing, nature of road pricing and its outcomes.

This paper examines road pricing equity from a variety of perspectives to facilitate understanding of various road pricing. Given the often competing views of equity, this paper develops an evaluation framework that defines three distinct bases for evaluating equity – free markets, equal opportunities, and equal outcomes (Table A).

Table A. Confounding Notions of Equity in Transportation Finance			
Unit of Analysis	Type of Equity		
	<i>Market Equity</i>	<i>Opportunity Equity</i>	<i>Outcome Equity</i>
<i>Geographic States, counties, legislative districts, etc.</i>	Transportation spending in each jurisdiction matches revenue collections in that jurisdiction	Transportation spending is proportionally equal across jurisdictions	Spending in each jurisdiction produces equal levels of transportation capacity/service
<i>Group Modal Interests, racial/ethnic groups, etc.</i>	Each group receives transportation spending/benefits in proportion to taxes paid	Each group receives a proportionally equal share of transportation resources	Transportation spending produces equal levels of access or mobility across groups
<i>Individual Residents, voters, travelers, etc.</i>	The prices/taxes paid by individuals for transportation should be proportional to the costs imposed	Transportation spending per person is equal	Transportation spending equalizes individual levels of access or mobility

This framework transcends the sometimes ideological characterizations of equity to allow for a more practical consideration of the fairness of transportation finance and pricing (Table B).

Table B: Using the equity evaluation framework to compare congestion tolls and transportation sales taxes

Unit of Analysis	Type of Equity and Level of Equity (underlined)		
	Market Equity	Opportunity Equity	Outcome Equity
Geographic States, counties, legislative districts, etc.	<p><i>Congestion</i> Toll: <u>High</u> because expenditures are likely targeted to where they are collected</p> <p><i>Sales</i> Taxes: <u>High</u> because expenditures are likely targeted to where they are collected</p>	<p><i>Congestion</i> Toll: <u>High</u> because revenues are usually used to improve transportation service in jurisdiction where they are collected</p> <p><i>Sales Taxes: Moderate</i> because revenues collected from all consumers are likely to improve service for travelers living in the area where the taxes are collected</p>	<p><i>Congestion</i> Toll: <u>Low</u> because expenditures are not usually targeted to areas with low levels of mobility</p> <p><i>Sales</i> Taxes: <u>Low</u> because expenditures are not targeted to areas with low levels of mobility</p>
Group Modal Interests, racial/ethnic groups, etc.	<p><i>Congestion</i> Toll: <u>High</u> because revenues are used to improve mobility of each group is in rough proportion to the collection of toll from each group</p> <p><i>Sales Taxes: Low</i> because light-users of transportation systems are almost certain to cross-subsidize heavy transportation system users</p>	<p><i>Congestion Toll: High to Moderate</i> because the revenues are generally spent to improve transportation services for groups from whom the tolls are collected.</p> <p><i>Sales</i> Taxes: <u>Moderate</u> because the revenues collected from all consumers are likely used to improve transportation services for the groups from whom the taxes are collected</p>	<p><i>Congestion</i> Toll: <u>Low</u> because expenditures are usually not targeted to groups with low levels of mobility</p> <p><i>Sales</i> Taxes: <u>Low</u> because expenditures are usually not targeted to groups with low levels of mobility</p>
Individual Residents, voters, travelers, etc.	<p><i>Congestion</i> Tolls: <u>High</u> because revenues are generally used to improve mobility of toll payers</p> <p><i>Sales Taxes: Low</i> because tax payments are unrelated to transportation system cost imposed or benefits received</p>	<p><i>Congestion</i> Tolls: <u>Moderate</u> because transportation toll revenues are likely used to improve transportation services for individual travelers</p> <p><i>Sales Taxes: Low</i> because transportation expenditures are unlikely to be returned to taxpayers in proportion to payments</p>	<p><i>Congestion</i> Toll: <u>Low</u> because expenditures are usually not targeted to individuals with low levels of mobility</p> <p><i>Sales</i> Taxes: <u>Low</u> because expenditures are usually not targeted to individuals with low levels of mobility</p>

Given these frameworks, the paper then reviews five case studies of road pricing – in San Diego, Minneapolis-St. Paul, Germany, Stockholm, and New York – to explore how equity concerns have been raised and addressed. This review finds that equity was a central question in each case, alternatively motivating (1) the implementation of pricing (Germany), (2) the funding of alternative modes (San Diego, Minnesota, and Stockholm), (3) mid-course restructuring of the pricing program (Stockholm), and (4) successful opposition to a pricing proposal (New York).

We find from this review that, in practice, successful mitigation of equity concerns have entailed:

1. Careful planning of the project or program, paying attention to the dedication of toll revenues to both transit and highway improvements in and around the tolled areas to create constituents for the pricing program;
2. A limited geographic scope to central, congested zones, particular travel corridors, or particular market segments;
3. Incremental implementation to allow for mid-course adjustments in project development, and
4. Ongoing, substantive, and sincere public outreach and education efforts that have meaningfully influenced program design.

Such efforts have increasingly turned equity objections to pricing on their head by presenting pricing as, not only a way to substantially increase transportation system efficiency, but also to address and correct substantial inequities in our current systems of transportation finance. The equity analysis framework outlined in this paper is intended to foster such comprehensive evaluations of road pricing equity vis-à-vis other forms of transportation finance in the years ahead.

Overview

Allowing drivers to crowd onto roadways without regard to the costs their travel imposes on others increases traffic delays, fuel consumption, vehicle emissions, crashes, and encourages sprawling development. While economists and transportation analysts have long touted the potential efficiency benefits of directly charging users for the costs their travel imposes on society, technological limitations for years prevented road pricing. Recent technological advances, however, have made it far easier and cheaper to charge vehicles for road use, and indeed we are witnessing a gradual rise in electronic roadway tolling applications around the globe. While road pricing holds the promise of reducing congestion, emissions, and fuel use while raising needed revenues, the growth in toll programs and projects is halting, and well short of a groundswell. This is because the idea of road pricing—charging travelers fees to drive on roads that rise and fall with the level of congestion, vehicle weight, and so on—generally remains unpopular with businesses, voters, and the people whom they elect. In particular, many fair-minded people raise concerns that lower-income people might be unfairly priced off roads.

This paper examines the fairness of road pricing from a variety of perspectives, with a focus on successful efforts to address equity concerns in practice. This report begins by examining the circumstances that have led public officials to consider experimenting with tolls, and then places transportation finance into a broader context of social equity. It then discusses why various views of equity often conflict in the context of transportation finance and, based on this discussion, proposes a practical framework for evaluating transportation finance/pricing equity. The paper further explores how the tensions between equitable transportation finance programs and equitable transportation finance systems have led most elected officials to inappropriately separate transportation pricing from finance in policy debates. Next, the paper

uses the transportation pricing/finance equity framework to compare the equity of road pricing with the increasingly popular technique of dedicating local sales taxes to transportation. Finally, the paper summarizes the findings of five case studies of how equity concerns have emerged and been addressed in prominent road pricing projects, offering lessons learned from this review.

The details of these case studies are summarized in the appendix.

Putting Transportation Pricing and Finance Equity in Context

Nearly all transportation policy and planning debates concern money, and nearly all transportation finance debates concern equity. To some, this second assertion may seem puzzling, even counter-intuitive. But the way that public officials think of equity in transportation pricing and finance is far different from the way that most social scientists or transportation analysts would define the term. Thus, “equity” gets defined quite differently by different interests at different times. To paraphrase former Supreme Court Justice Potter Stewart on the question of pornography, most of us cannot precisely define equity or inequity in transportation finance, but we think that we know it when we see it.

There are two principal ways one can think about transportation equity: We can conceive of transportation as an end in itself and a means to an end. With respect to the latter, transportation analysts typically describe the demand for transportation as a “derived demand.” That is, with the exception of walks in the park or cruising the boulevard on Saturday night, the demand for transportation is derived from a desire to consume non-transportation-related products and services and engage in non-transportation-related activities. One stands on a crowded subway each morning not for the thrill of the ride, but to get to work on time; one searches for a parking space at the grocery store not for the pleasure of finding an open space,

but to stock one's house with food. As transportation is an important, often critical, link to education, paid work, recreation, health care, culture, and many other aspects of quality living, planners, policymakers and public officials are rightly concerned that most members of society have sufficient levels of mobility. Mobility, combined with the number of opportunities, services, and goods available in a given area, creates accessibility to quality living. So in addition to public goods and market failure rationales, many public officials justify public investments in transportation in order to provide for basic mobility needs (e.g. being able to move about in order to reach essential goods, services, employment, and housing) disadvantaged members of society regardless of ability to pay.

In addition to ability to pay, access is affected by peoples' age, sex, physical ability, cognitive ability, and cultural background. Indeed, a large body of research examines how the young and the old, the disabled, and the poor suffer from lower levels of mobility and accessibility (see, for example, Blumenberg & Waller, 2003; Bullard & Johnson, 1997; Deka 2004; Clifton & Lucas, 2004; Garrett & Taylor, 1999; Hodge 1995). The focus here, however, is four questions about the public sector role in transportation: 1) Who pays for transportation?, 2) How do they pay?, 3) Who benefits from transportation?, and 4) Where do they benefit?

Theorizing About Equity

Many transportation economists and policy analysts characterize along two dimensions. The first dimension is horizontal equity, which considers how similarly situated people (the elderly, bus riders, and so on) fare relative to one another. Horizontal equity is achieved, for example, when all members of the same income class pay equal taxes. The second dimension is vertical equity, which considers how differently situated people (poor vs. wealthy, drivers vs.

non-drivers, etc.) fare relative to one another. Vertical equity is achieved, for example, when taxes are levied on households proportional to the ability to pay. Increasingly, the concepts of longitudinal or intergenerational equity have been incorporated into the equity analyses of transportation policies, particularly in regards to road pricing (Levinson 2001; Szeto and Lo 2005; Viegas 2001). While horizontal and vertical equity are central concepts in taxation and finance, questions of transportation equity run much deeper and are summarized in Table 1.

How can we make sense of such a disparate set of competing theories, and how can they be applied, separately or in concert, to practical questions of road pricing? Arguments over transportation pricing and finance frequently directly or indirectly incorporate parts of the theories described in Table 1, but often in an internally contradictory, even illogical fashion. Voters, and the people they elect, frequently judge policies that distribute scarce resources based on instinct or feeling formed by limited or incomplete introductions to the many ideas of distributive justice. Indeed, public opinion research has consistently found that most people's conception of justice is highly variable and complex; studies of both stated preferences and actual behavior show that people switch among characterizations of justice according to the situation (Frey, 2003; Tetlock, 2002; Rozin et al., 1999; Gladwell, 2002). Members of the public, and the officials whom they elect, will frequently argue that roadway tolls would be unfair because they disproportionately affect the poor, and yet those same officials campaign for and voters approve highly income-regressive sales and other non-transportation-use-based tax increases earmarked for transportation without raising similar equity concerns. This may be because tolls represent a significant change from the status quo, are highly visible, and at times can be quite high. In contrast, sales taxes, in contrast, are not so visible, as they are levied in small amounts over very large numbers of transactions. Or it may be simply that sales taxes are

common, familiar, and therefore escape scrutiny, while things like congestion charges are less familiar, inviting skepticism (Derrick & Scott, 1998). But in either case such distinctions are not based on consistently applied principals of equity.

Table 1. Relating Theories of Justice to Public Finance		
Theory of Justice	Conception of Justice in Relation to Public Finance	Relation to Notions of Transport Finance Equity in Table 3 Below
Strict Egalitarianism	Each member of society receives the same magnitude of goods and services irrespective of contribution.	Outcome Equity
Difference Principles	Individuals have equality in basic rights and liberties, but society is better off when individual success is cultivated and allowed to benefit individuals directly.	Opportunity Equity
Resource-based Principles	Goods and services are equally distributed at the outset, but there is little or no cross-subsidization from that point forward.	Opportunity Equity
Desert-based Theories	Those who increase wealth in society are entitled to benefit directly from that wealth.	Market Equity
Libertarianism	Consensual transfers of goods and services within a society are just by definition.	Market Equity

From Theory to Practice: A Framework for Transportation Pricing and Finance Equity

A common dilemma in public policy involves evaluating the tradeoffs between efficiency and equity. Policy analysts sometimes complicate matters further by analyzing the tradeoffs between efficiency, efficacy,¹ and equity (Table 2).

¹ We use the term “efficacy” here as synonymous with the term “effectiveness.”

<i>Efficiency</i>	The ratio of outputs (<i>lane miles of new roadway</i>) to inputs (<i>expenditures on land, labor, and capital</i>)
<i>Efficacy</i>	The ratio of consumption (<i>passengers</i>) to outputs (<i>vehicle hours of transit service</i>)
<i>Equity</i>	The relative distribution of transportation inputs (<i>transportation revenue collections</i>), outputs (<i>transportation expenditures</i>), or consumption (<i>driving on roads</i>).

But whether considering efficiency alone or in concert with efficacy, these two measures are often considered to be in tension with equity. Indeed, proposals to improve the efficiency and efficacy of transportation systems – such as through congestion pricing – are often objected to on equity grounds. Such protests notwithstanding, it is not evident that efficiency and equity in transportation finance are incongruent.

Programs of transportation finance have three broad effects: they generate revenues, they meter travel, and they redistribute income (among people, groups, and places). For example, congestion pricing, which aims to reduce traffic delay, emissions, and fuel consumption by variably pricing scarce road space, has long been favored by economists as a way to substantially increase efficiency in managing traffic congestion (Walters, 1961; Mohring, 1970; Small, Winston, & Evans 1989). Revenues collected for transportation from non-transportation-based sources, like the increasingly popular local option transportation sales taxes, used to provide transportation capacity and affect travel as well. By disconnecting the consumption of transportation capacity from the prices paid for travel, non-transportation-based finance instruments – like sales taxes and general obligation bonds – discourage travelers from considering how their travel choices impose costs on society (through congestion delays, noise, emissions, and so on).

A relatively large body of research suggests that travelers with lower incomes are more sensitive to variations of fares, tolls, and fees than higher income travelers (Cohen, 1987; Giuliano, 1994; Harvey, 1994; Richardson & Bae, 1998; Santos & Roley, 2004). However, a similarly well-established body of research shows that higher income travelers are more likely than lower income travelers to travel longer distances in peak hours and in peak directions – precisely the locations where congestion tolls are likely highest (Dittmar et al., 1994; CARB, 1995; Frick et al., 1996; Lari & Iacono 2006; Sullivan, 2000; Taylor, Garrett and Iseki, 2000; Jakobsson, Fujii and Gärling, 2000). So while a given lower income traveler is more likely to be discouraged by a toll from making a peak-hour, peak-direction trip, shifting from sales and other non-transportation-based taxes for transportation to peak-based tolls in many cases would shift the burden of transportation finance away from lower income travelers as a group and toward higher income travelers as a group (Schweitzer and Taylor, 2008). Thus, improving equity in transportation finance is not a simple task, and the most discernable effects are not necessarily the most important.

Disagreements over equity in transportation pricing and finance arise from the competing and contradictory ways that equity is both framed and evaluated. Further complicating matters is the wide variety of *reference units* by which one can measure the equity of a given policy's effects. For example, financing and pricing modes on the basis of trips, passenger-miles-traveled, or on a per capita basis all yield different measures of equity. These factors combine to intensify confusion and misunderstanding among public officials and the public over the fairness of transportation finance.

Borrowing from the theories of distributive justice described above, we can say that egalitarian philosophies emphasize outcomes, difference or resource-based philosophies

emphasize opportunities (or vertical equity), and libertarian philosophies emphasize markets (or horizontal equity). Each of these philosophies can, in turn, be applied to different actors, or units of analysis, in transportation pricing and finance debates – individuals, groups, or jurisdictions. While “units of analysis” may seem itself an abstract concept, it allows us to understand how and why people so often talk past one another in debates over transportation finance. The concept likewise allows for specificity in describing divergent conceptions of equity that the more common concepts of *horizontal and vertical equity* simply cannot (Table 3).

In Table 3, three units of analysis and three types of equity make up nine distinct bases on which road pricing equity can be debated. Market equity seeks to align who pays for travel with who benefits from travel in the fashion of private markets; opportunity equity seeks to equalize resource allocations on some consistent basis; and outcome equity seeks to equalize mobility outcomes. So while the effects of road pricing on travelers of different incomes is obviously a question of vertical equity, so too is the geographic distribution of road pricing revenues across jurisdictions and travel modes.

Unit of Analysis	Type of Equity		
	<i>Market Equity</i>	<i>Opportunity Equity</i>	<i>Outcome Equity</i>
<i>Geographic States, counties, legislative districts, etc.</i>	Transportation spending in each jurisdiction matches revenue collections in that jurisdiction	Transportation spending is proportionally equal across jurisdictions	Spending in each jurisdiction produces equal levels of transportation capacity/service
<i>Group Modal Interests, racial/ethnic groups, etc.</i>	Each group receives transportation spending/benefits in proportion to taxes paid	Each group receives a proportionally equal share of transportation resources	Transportation spending produces equal levels of access or mobility across groups
<i>Individual Residents, voters, travelers, etc.</i>	The prices/taxes paid by individuals for transportation should be proportional to the costs imposed	Transportation spending per person is equal	Transportation spending equalizes individual levels of access or mobility

Source: Adapted by Taylor 2004 from Lem 1997.

In general, social science scholars of transportation tend to focus on *individual equity* (Fullerton & Rogers, 1993; Due & Mikesell, 1994; Besley & Rosen, 1998; Derrick & Scott, 1998; Bento et al., 2005; Santos & Catchesides, 2005; Shoup, 2005; Jia & Wachs, 1998; Sanchez et al., 2003; Blumenberg, 2003), advocates and activists are more likely to focus on *group equity* (Blumenberg & Ong, 2001; Raphael & Rice, 2000; Raphael & Stoll, 2000; Hodge, 1995; Garrett & Taylor, 1999; Deka, 2004; Forkenbrock, 2001; Martens 2009), while elected officials are most concerned with *geographic equity*. This focus on geography is because representation in the U.S. is organized spatially into a hierarchy of jurisdictions. And because it is elected officials who oversee the collection and distribution of transportation funds, most debates in transportation pricing and finance center first and foremost on questions of *geographic equity*.

The Geo-Political Equity Imperative

Geographic equity arises frequently in the context of federal transport policy. For example, the more populous, urbanized states tend to generate more in federal motor fuel tax revenues than they receive in fuel-tax-funded federal expenditures, whereas less populous, rural states tend to receive more in federal transportation funding than their motorists generate in federal fuel taxes. This redistribution of federal fuel tax revenues from “donor” states to “donee” states has been hotly debated in Washington for decades and actually delayed the passage of both the TEA-21 legislation in 1998 and the SAFETEA-LU legislation in 2005.

Supporters of redistribution argue that it enables wealthier states to cross-subsidize poorer states, and it allows us to have an inter-connected national highway system, and a basic level of public transit in most urban areas. Such redistribution is often used to justify federal

involvement in transportation finance. However, critics have countered that the redistribution reflects a rural bias in the federal transportation program (especially highways), and research has shown that it actually redistributes funds from poorer states (those with less fiscal capacity) to richer states (with more fiscal capacity) (Lem, 1997), and from states with high levels of transit use to states where driving dominates (De Cerreno et al., 2003).

Critics of the redistribution of federal transportation revenues contend further that the national highway system is largely in place, and the most significant transportation investment needs are in congested urban areas. If all federal fuel tax funds were simply returned to states exactly proportional to their collection, there would be no rationale for a federal fuel tax; it could be eliminated and states would then be free to collect as much as they needed from higher state fuel taxes. Some have even argued that federal transportation tax collections should be dropped and that each state should be left to make do on its own (Roth, 1998).

Along these lines, some have argued that systems of transportation pricing and finance favor suburbs over central cities. Chen (1994) argues that the intra-metropolitan distribution of federal transportation dollars and local non-transportation-based taxes for transportation tend to favor developing over developed areas and suburbs over central cities (as well as highways over public transit and rail transit over buses). Chen in effect criticizes market equity return-to-source rationales in favor of funding distributions based instead on opportunity or outcome equity. Likewise, Bullard, et al. (2004) complain that higher rates of street and highway expenditures in growing suburban areas is biased against disproportionately minority areas and, therefore, racist.

Similarly, Ong (2004) finds that automobile insurance premiums for drivers with identical driving records can vary dramatically by metropolitan area residential location. In general, insurance premiums are higher in central city areas and lower in suburban locations.

While insurance companies may base such rates on variable claims rates among neighborhoods, Ong argues that it is non-resident drivers (many of whom commute into job-rich central city areas from outlying suburbs) who are responsible for the higher crash rates, and claims rates, in central city neighborhoods.

Given overriding political concerns with geographic equity in the distribution of transportation revenues, distortions emerge when transportation use or demand does not vary comparably across jurisdictions. Public transit is perhaps the most striking example of this. Transit ridership is concentrated spatially in the largest, most densely developed cities. About one-third of all transit passengers in the U.S. are in the New York metropolitan area. The ten largest U.S. transit systems carry over 60 percent of all riders; the hundreds of other, smaller systems carry less than 40 percent of all passengers (Taylor & McCullough, 1998; Taylor, Miller, Iseki, & Fink, 2009). In the *realpolitik* of public transit finance, however, debates center on how resources are doled out to jurisdictions and the *suppliers* of transit service, with little regard for the enormous spatial variation in the *consumers* of transit service.

The New York Metropolitan Transit Authority (NY MTA) alone carries over 27 percent of the nation's transit riders each year (American Public Transportation Association (APTA), 2003a). During the six years between 1995 and 2000, federal capital and operating subsidies combined averaged \$0.20 per unlinked passenger trip on NY MTA. In contrast, riders on Chapel Hill Transit in North Carolina, which carries three ten-thousandths (0.03 percent) of the nation's transit riders, enjoyed federal transit subsidies which average \$0.97 per trip during the 1990s (APTA 2003a, 2003b). Such geographic disparities are not confined to federal transportation finance. In California, the San Francisco Municipal Railway carries nearly half (45 percent) of all Bay Area transit riders, but receives just 10 percent of the subsidies allocated through the

state Transportation Development Act (TDA). On the other hand, Santa Clara Valley Transit Authority in the San Jose area carries 11 percent of all Bay Area transit riders yet receives over one-third of the region's TDA transit subsidies (Metropolitan Transportation Commission, 2003; Taylor, 1991).

The reason for these disparities is quite straightforward: representation in Congress and most state legislatures (with the exception of the U.S. Senate) matches the geographic distribution of voters, not urban transit patrons. Geographic equity, therefore, allocates public transit funding "equally" among jurisdictions, often regardless of how they are used. The centrality of the imperative of geopolitical equity in transportation policy and planning can hardly be over-emphasized. It explains why Texas has received \$2.7 billion *less* in federal fuel tax revenues between 1956 and 1994 than motorists in Texas paid in federal fuel taxes. In contrast, Hawaii has received \$2.2 billion *more* than motorists in Hawaii paid in federal fuel taxes; for every \$1.00 in federal fuel tax generated in Hawaii, the state has received \$4.11 in fuel-tax funded appropriations (Poole, 2001). It also explains why new rail transit systems were built in Atlanta, Miami, and many other sprawling Sunbelt cities over the last quarter century, while the long-planned Second Avenue subway in transit-oriented Manhattan has yet to carry a passenger (Lawlor, 1995).

Evidence of the geo-political equity imperative can be seen in the equity arguments over transportation pricing and finance. Arguments *in favor* of some transportation finance schema are often made on jurisdictional equity grounds, while equity arguments *against* some given proposal are most often made on group or individual equity grounds (Table 3). For example, calls to raise the guaranteed minimum return of federal motor fuel tax dollars to "donor" states prior to the passage of the recent federal SAFETEA-LU surface transportation legislation were

nearly always cast in terms of geo-political equity. On the other hand, arguments against congestion tolls, peak-hour transit pricing, or weight-distance truck tolls are often cast as unfair to the poor or individual owner-operator truck drivers. But as Wachs (1994) has noted, concern over the plight of the poor under various pricing proposals is frequently made by self-interested parties (trucking, auto clubs, etc.) who, “seem to have little concern over the well-being of the poor or of working women when considering other policy initiatives, such as sales tax increases to support the expansion of rail lines.”

Equitable Transportation Programs versus Equitable Transportation Systems

This overriding concern with the geographic equity of transportation funding among states, districts, and jurisdictions ensures a political focus on the expenditure effects of transportation *finance programs*, which makes it all but impossible to consider how transportation funding decisions affect the efficiency, efficacy, or the equity of *transportation systems*. So to understand the pricing and finance equity of transportation systems, we must evaluate both the geo-politics of the transportation *finance program* and the effects of this finance program on the deployment and use of the transportation *system*. Table 4 offers an overview of how we might simultaneously evaluate the performance of transportation finance program in each of these realms.

	Program Performance	System Performance
<i>Efficiency</i>	> Has low administrative, overhead, and transactions costs relative to the revenue collected.	> Optimizes provision of transportation service for a given level of expenditure
<i>Efficacy</i>	> Is politically feasible: has stable political support, is popular with voters, and has little opposition from powerful stakeholders. > Revenues generated meet needs and are stable and predictable.	> Optimizes utilization of existing capacity. > Lowers travel costs and promotes economic development.
<i>Equity</i>	> Is perceived as treating places and jurisdictions fairly. > Major stakeholders and interest groups perceive they are treated fairly.	> Provides all users with transportation access, regardless of circumstances (age, income, disability, etc). > Is progressive based on the ability to pay. > Charges users in proportion to the costs they impose on the system and society.

Source: Brown et al. 1999.

Program performance criteria evaluate how well a finance mechanism meets tests of political acceptability and administrative ease. These questions tend to be prominent in policy debates. *System performance* criteria, on the other hand, address how finance mechanisms influence the use and performance of the transportation system itself. System performance criteria acknowledge that finance policies are not just about collecting and distributing money. Pricing and finance instruments also profoundly affect the way transportation services are provided and the way citizens use them, though elected officials often act as though this were not the case.

The Divorce of Pricing and Finance in Transportation Policy

With all of the attention paid to the politics of geographic equity, public officials frequently fail to consider how transportation finance programs affect the use and performance of transportation systems. Yet the use and finance of transportation systems are tightly intertwined and cannot be considered separately, though many elected officials do try. Fees imposed on users in proportion to the costs users impose on society are typically the finance mechanisms that will help optimize resource allocation, efficiency, and transportation system efficacy. User fees make people more aware of the social costs of travel (in the form of wear and tear on the system, delay imposed on others, environmental damage, increased likelihood of accidents, and so on). Such information encourages drivers to shift low priority trips to less socially costly times of day, routes, modes, or destinations.

But despite the obvious and well-documented relationship between the pricing of transportation systems and their use, public officials are frequently loathe to even *consider* pricing transportation systems. What to build and where to build it, for example, are often treated as entirely separate from who should pay and how they should pay for it (Taylor 2004). But how both the supply of and demand for transportation are influenced by the price—production costs on the supply side and user costs on the demand side—is neither abstract nor trivial. On the demand side, the fares, fees, tolls, and taxes paid by travelers affect their decisions on where to travel, when to travel, how to travel, and even whether to travel. Use of the transportation system in turn greatly influences the maintenance and new capacity “needs” of the system, which, along with other factors, determines the costs to supply and maintain transportation infrastructure and services, and therefore affects the finance system. Thus, the

transportation finance system and the performance (in terms of efficiency, efficacy, and equity) of the transportation system are mutually reinforcing.

The issue of truck-weight fees provides an example of how the transportation finance system affects user decisions. Damage to pavements caused by heavy trucks increases significantly with weight per axle. Many people are surprised to learn that a relatively small share of trucks with heavy axle loads does most of the damage to roads (Small, Winston, & Evans, 1989; USDOT FHWA, 1997; Forkenbrock, 2001). Yet for decades many states levied truck weight fees based on the weight of *empty* trucks; and toll ways frequently set rates based on the number of axles per vehicle. Both policies encourage truckers to load heavy weights onto as few axles as possible, and thereby *maximize* damage to roadways. Such truck fee systems increase maintenance and rehabilitation costs in comparison to jurisdictions where fees are assessed in ways to encourage truckers to reduce axle weights. Thus, changing the way that fees are levied on trucks would change truckers' behavior, and, in turn, substantially lower maintenance costs without necessarily increasing either taxes or revenues.

Why the Push to Reunite Pricing and Finance?

Most transportation economists agree that transportation finance programs should, as much as possible, charge users the *marginal social cost* of travel (Walters, 1961; Mohring, 1970; Small, Winston, & Evans, 1989; Murphy & Delucchi, 1998). The term *marginal* refers to the cost of providing for one additional trip, given that others are already using the system at the same time. For example, when a car gets on a crowded freeway, it takes up space that other automobiles can no longer occupy, it imposes some delay on vehicles upstream, and it also causes some amount of pavement damage. If there are very few vehicles already on the freeway,

then the cost of providing for that one additional car is very small. On the other hand, if there are many cars already on the freeway, one additional vehicle can slow other cars upstream and increase congestion to a surprising degree. In such cases, the marginal cost of accommodating an additional car is large. The term *social* refers to the costs that society pays for providing for that one additional vehicle. These social costs result mostly from congestion, pollution, noise, vehicle crashes, and road wear and tear from a trip.

The same holds true for the provision of public transit. The marginal cost of providing additional peak period or peak direction public transit is much greater than the marginal cost of providing transit service in the off-peak or non-peak direction. This is because transit agencies must size their labor force and vehicle fleets to meet peak levels of demand, regardless of whether these workers and vehicles sit idle at other times (Taylor, Garrett, & Iseki, 2000).

A large body of research shows that the current transportation finance programs do not make users pay the marginal social cost (delays imposed on others, pavement damage, emissions, noise, non-renewable resource consumption, etc.) of vehicle use (USDOT, 1997; Littman, 2002; Delucci, 1996; California Department of Transportation (Caltrans), 1997; Forkenbrock & Schweitzer, 1997; CARB, 1995; National Cooperative Highway Research Program (NCHRP), 1994; Pozdena, 1995; Puget Sound Regional Council (PSRC), 1997). Yet as the role of the motor fuel tax has declined relative to non-transportation-related instruments like sales and other non-transportation-based taxes and bonds, we are actually moving further away from marginal social cost pricing of transportation (Goldman & Wachs, 2003; Sciara & Wachs, 2007; Sorensen 2006).

So in crafting our current system of surface transportation finance, we have often paid careful attention to geo-political equity questions regarding from where revenues for

transportation are collected and to where they are expended. But in doing so we have come to increasingly depend on highly income-regressive sales and other local taxes unconnected with transportation use. As a result, jurisdictional equity is trumping, not only transportation efficiency and efficacy, but group and individual equity as well.

Transportation Pricing Equity: Compared to What?

As revenues for transportation have lagged far behind the growth in travel and congestion in recent years on many transportation systems, elected officials are looking for new ways to raise revenue for transportation. But a waxing anti-tax climate amid concerns with rising fuel prices has made it all but impossible to increase traditional sources of transportation revenues, such as the motor fuel user tax, which have been the foundation of transportation finance for nearly a century.

Amid such a challenging fiscal climate, many public officials are for the first time open to considering various forms of road pricing. But these officials for the most part remain wary of transportation pricing: wary of something so new, of a possible political backlash, of something that might be, or seem to be, unfair.

It is in this climate that many equity arguments against road pricing transportation are posed. Many fear – some sincerely and others tactically – that poor people will simply be priced off roads and transit vehicles, leaving free-flowing systems for the wealthy. Such social equity concerns are indeed important, but they ignore the social inequities of our *current* transportation finance system based largely on income-regressive motor fuels, property, and sales taxes (Chernick and Reschovsky 1997; Schweitzer and Taylor 2008). These current inequities are often ignored in debates of transportation pricing equity.

Under the logic of market equity, equitable taxes are those levied on each individual in proportion to the costs imposed or benefits received by that individual. In practice, the benefits of pricing are more complex, ephemeral, and normative than the costs imposed by pricing (FHWA, 1997). When road pricing has been attempted, it has usually sought to internalize the normally external costs of travel. Within this rubric, charging users according to the incremental social costs they impose on society when using the transportation system is equitable. On the other hand, opportunity equity suggests that a method of finance based solely on costs each individual imposes on society may burden the poor. From this (vertical equity) perspective, an equitable finance program will treat fairly people who have different abilities to pay, with ability measured primarily by income.

Current transportation user fees, like the motor fuels tax and driver's license fees, fare well under market equity principles, but less well under opportunity equity (Chernick & Reschovsky, 1997; Lari & Iacono 2006; Poterba, 1991; Wiese, Rose, & Schluter, 1995). In contrast, transportation sales taxes – because they are income-regressive and unconnected with transportation system use – tend to fare poorly under *both* market equity and opportunity equity. Given that local option sales taxes for transportation and electronic roadway tolling are the two of the most frequently debated new forms of transportation finance (Abrams, 2007; Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance, 2006; Hymon, 2008; Hymon & Weikel, 2008; Sorensen & Taylor, 2006), they are compared below with respect to the multiple dimensions of equity outlined above in Table 3.

While many scholars have examined equity in sales taxes (Derrick & Scott, 1998; Due & Mikesell, 1994; Poterba, 1996; Santi, 1994) and many more have examined the equity of congestion pricing (Arnott, de Palma, & Lindsey, 1994; Bonsall & Kelly 2005; Bureau &

Glachant 2008; Cohen, 1987; Giuliano, 1994; Glazer & Niskanen, 2000; Maruyama & Sumalee 2007; Richardson & Bae, 1998; Zhang et al., 2009), only one study has directly compared equity effects of sales taxes for transportation versus congestion pricing (Schweitzer & Taylor, 2008). They examine the household incomes of the toll payers on the State Route 91 High-Occupancy/Toll Lanes in Orange County, California and compare them to the household incomes of who would have paid had the four lanes of expressway capacity been financed with revenues from Orange County's local option sales tax. They find that two kinds of transfers would occur with such a change. First would be a transfer of burden from middle- and upper-middle income households to the highest and lowest income households. Second would be a transfer from people who travel in the corridor frequently to people who drive very little. With regard to the first burden transfer, the switch from congestion tolls to sales tax payments would cause the very highest income households to pay more in absolute terms (because high income people buy so many goods and services subject to the sales tax), while the lowest income households would pay substantially more in relative terms (because a large share of purchases by low income households are subject to the sales tax). And with regard to the second effect, the users of the toll lanes (who voluntarily pay a toll ranging from \$1.25 to \$10.00 depending on direction and time-of-day to bypass nine miles of frequently congested "free" lanes) carry the entire burden of retiring the debt on the \$200 million (2008 \$) capacity expansion, while sales tax finance would spread the burden over hundreds of thousands of consumers, most of whom never travel in the lanes. Weinstein et al. (2006) also undertook an assessment of the equity of various financing mechanisms for the State of California, including various tolling options and sales taxes. This report supports Schweitzer and Taylor's conclusions that the sales tax is the

least equitable method of funding transportation while tolls are more equitable from both user benefit and ability to pay perspectives (Weinstein et al, 2006).

Drawing on both Schweitzer & Taylor (2008) and the broader literatures on sales tax and congestion pricing equity, Table 5 presents the transportation finance equity evaluation framework developed above with regard to the multiple dimensions across which the equity of congestion pricing vis-à-vis sales taxes for transportation might be compared. First, this comparison suggests that outcome equity is currently a radical notion in public policy. Equal outcomes, given only limited public policy influence over inputs, is much harder to achieve, so it requires extreme precision in targeting the particular units of analysis. For example, targeting expenditures to equalize outcomes among geographic areas seizes funds and consumes resources that might otherwise be available to increase outcome equity among groups with low levels of mobility, or among individuals with low levels of mobility. While market and opportunity equity do not have to be incongruous, specific outcome equity objectives require more trade-offs with other types of equity and units of analysis.

Table 4: Comparing the Equity of Congestion Tolls and Transportation Sales Taxes

Unit of Analysis	Type of Equity and Level of Equity (<u>underlined</u>)		
	<i>Market Equity</i>	<i>Opportunity Equity</i>	<i>Outcome Equity</i>
Geographic States, counties, legislative districts, etc.	<p><i>Congestion</i> Toll: <u>High</u> because expenditures are likely targeted to where they are collected</p> <p><i>Sales</i> Taxes: <u>High</u> because expenditures are likely targeted to where they are collected</p>	<p><i>Congestion</i> Toll: <u>High</u> because revenues are usually used to improve transportation service in jurisdiction where they are collected</p> <p><i>Sales Taxes: Moderate</i> because revenues collected from all consumers are likely to improve service for travelers living in the area where the taxes are collected</p>	<p><i>Congestion</i> Toll: <u>Low</u> because expenditures are not usually targeted to areas with low levels of mobility</p> <p><i>Sales</i> Taxes: <u>Low</u> because expenditures are not targeted to areas with low levels of mobility</p>
Group Modal Interests, racial/ethnic groups, etc.	<p><i>Congestion</i> Toll: <u>High</u> because revenues are used to improve mobility of each group is in rough proportion to the collection of toll from each group</p> <p><i>Sales Taxes: Low</i> because light-users of transportation systems are almost certain to cross-subsidize heavy transportation system users</p>	<p><i>Congestion Toll: High to Moderate</i> because the revenues are generally spent to improve transportation services for groups from whom the tolls are collected.</p> <p><i>Sales</i> Taxes: <u>Moderate</u> because the revenues collected from all consumers are likely used to improve transportation services for the groups from whom the taxes are collected</p>	<p><i>Congestion</i> Toll: <u>Low</u> because expenditures are usually not targeted to groups with low levels of mobility</p> <p><i>Sales</i> Taxes: <u>Low</u> because expenditures are usually not targeted to groups with low levels of mobility</p>
Individual Residents, voters, travelers, etc.	<p><i>Congestion</i> Tolls: <u>High</u> because revenues are generally used to improve mobility of toll payers</p> <p><i>Sales Taxes: Low</i> because tax payments are unrelated to transportation system cost imposed or benefits received</p>	<p><i>Congestion</i> Tolls: <u>Moderate</u> because transportation toll revenues are likely used to improve transportation services for individual travelers</p> <p><i>Sales Taxes: Low</i> because transportation expenditures are unlikely to be returned to taxpayers in proportion to payments</p>	<p><i>Congestion</i> Toll: <u>Low</u> because expenditures are usually not targeted to individuals with low levels of mobility</p> <p><i>Sales</i> Taxes: <u>Low</u> because expenditures are usually not targeted to individuals with low levels of mobility</p>

Given that transportation sales taxes represent the most significant change in transportation finance over the past two decades (Goldman & Wachs, 2003), Table 5 suggests that, in comparison with our current system of transportation finance, a user fee system based on the principles of marginal cost pricing (or its proxy in the form of road pricing) would clearly increase market equity and may increase overall opportunity equity as well. As noted earlier, travel behavior research has shown that use of the highway system in congested conditions is positively correlated with income. That is, higher-income travelers tend to spend a larger share of their travel time in traffic congestion than do lower-income travelers (Dittmar et al., 1994; Deakin & Harvey, 1995; Frick et al., 1996; Sullivan, 2000). Thus, a shift to a transportation finance system that charges drivers more on congested routes and less elsewhere would fare well under the market equity when compared to our current finance system (Schweitzer & Taylor, 2008).

While this framework allows us to consider the many possible dimensions of the equity of congestion pricing vis-à-vis sales taxes for transportation, such systematic evaluations have rarely been performed in practice. How have equity issues in road pricing been raised, and how have they been dealt with in actual pricing programs and projects? The following section examines five notable case studies of road pricing where equity issues have played a central role to examine how they arose and how they have been mitigated (or not in one case) in practice.

Case Studies: Addressing Equity Concerns in Practice

Since road pricing is an umbrella term for many different types of tolling policies – such as cordon tolls, high occupancy toll (HOT) lanes, and weight-distance based fees – the fairness issues raised often depend on the particulars of the road pricing initiative. Cordon tolls and HOT

lanes generally receive far more criticism on equity grounds than weight-distance fees, which charge (mostly commercial to date) users for distance traveled, not locations traveled. Programs that utilize a pay-as-you-go model of project finance tend to raise fewer questions of fairness criticism, and in fact are often hailed as improving equity (Sorensen & Taylor, 2005). In contrast, HOT lanes have often been dubbed “Lexus Lanes” and criticized as an unfair way for wealthy residents to buy their way out of congestion, leaving the less well-to-do stuck in the congested free lanes (Buckeye & Munnich, 2004; Sorensen & Taylor, 2005; Weinstein & Sciara, 2006). (Though of course, if true, the incidence of the fees with respect to income would be entirely progressive.) Like HOT lanes, cordon tolls, such as the schemes that are in place in central London and Stockholm and have also been proposed for New York, are often subject to extensive scrutiny on equity grounds since such tolls impose a new fee on what was previously uncharged. Given their geographic focus, cordon tolls are also more likely than other road pricing models to be criticized on geographic equity grounds; that is, they are criticized for treating residents, employees, or travelers in some areas differently than others.

Equity debates in five prominent congestion pricing programs were examined: San Diego, Minneapolis-Saint Paul, Germany, Stockholm, and New York City. These cases were selected because equity questions figured prominently in the planning and implementation of each program (the findings from these case studies are separately summarized in the appendix). These five cases collectively show that the three scales of transportation finance equity – individual, group, and geographic equity – motivate both support for and opposition to road pricing proposals. While most people think of equity in terms of opposition to pricing, road pricing proponents are frequently motivated at least in part by a desire to correct inequities in current systems of transportation finance– both in terms of unpriced externalities (emissions,

congestion, etc.) and in strengthening the link between who pays for and who benefits from transportation investments. The result is sometimes an equity paradox whereby efforts to use pricing to bring the distribution of transportation costs and benefits in line are opposed as unfair by those who disproportionately benefit from current, demonstrably inequitable, finance regimes. In response, road pricing proponents have sought to turn typical equity objections to pricing (double-taxation, would hurt the poor, etc.) on their heads by presenting pricing as a way to address and correct substantial inequities in our current systems of transportation finance, as well as to substantially increase transportation system efficiency. However, concerns with inequities in existing, long-standing systems of transportation finance have not gained much traction in a political system focused more on scrutinizing changes than the *status quo*.

Just as people's equity perceptions vary based on the type of road pricing proposal, the most effective approaches to mitigating equity concerns are situationally dependent. But some lessons can be generalized. First, the dedication of revenues is critical; successful programs have commonly dedicated toll revenues to transit and road improvements across the transportation system thereby creating constituents for the toll revenues. Second, limited scales keep the scope of the pricing program focused on the problems at hand, and phased, incremental implementation – such as the trial approach followed by a plebiscite employed in Stockholm – allows officials the opportunity to adjust the program to address equity issues that arise during implementation. Third, open and ongoing public dialogue on equity questions during project planning and development is common to every successful case of pricing implementation. An important part of this dialogue has been to use the planning process as an opportunity to consider and debate inequities in current systems of transportation finance, and how these might be addressed with a move to road pricing. Each of these three lessons is briefly reviewed in turn below.

Dedicating revenues to transit service and to road improvements in the tolled corridor

In developing San Diego's I-15 HOT lanes, toll revenues were dedicated to transit improvements to increase corridor travel options in an explicit effort to address equity concerns. While transit improvements are often funded with toll revenues, an exclusive focus on transit has often proven problematic. In Stockholm and New York City, transit funding proposals were downscaled and funds were shifted to roadway improvements in response to complaints that funding transit only with revenues was unfair to drivers and their passengers.

In Stockholm, outer suburban residents complained about geographic equity – that toll revenues collected from suburban commuters went to transit improvements that primarily benefitted central city and inner-ring suburban residents. In response, some of the toll revenues were shifted to road projects favored by suburbanites. This adjustment contributed significantly to increasing public acceptance of the congestion pricing program in Stockholm and its eventual endorsement by voters.

In the case of the ill-fated New York proposal, however, a politically acceptable modal and geographic balance of revenue dedication was never reached. Despite the vetting of a variety of proposals for the distribution of toll revenues, some critics of the pricing proposal complained that a modal split of toll revenues between transit and roadways would not leave sufficient funding for the increased transit service needed to accommodate the increase in demand due to the pricing of driving in Manhattan. Whether toll revenues are dedicated to transit, highways, or both, geographic equity concerns are most frequently assuaged by

dedicating the revenues to improvements in the tolled corridor(Small & Gomez-Ibanez, 1998; Minken and Ramjerdi, 2008).²

Limited scale and phased, incremental implementation

Successful implementation has typically entailed careful attention to reducing political risk and uncertainty of what can be new, unfamiliar, and, to many elected officials, potentially threatening pricing programs. Road pricing projects have commonly been limited in geographic scope to central, congested zones (Stockholm), particular travel corridors (San Diego and Minnesota), or particular market segments (such as commercial trucking in Germany). Further, the phased, incremental implementation plan has proved effective. The case of Stockholm's central area congestion fee is particularly instructive. Despite strong support from planners and key public officials, most greater Stockholm residents were – by a 2 to 1 margin – initially opposed to the proposal. To garner sufficient support to move forward, the project was structured at the outset as a short-term, fixed-end-date pilot test, which was followed by a thorough evaluation. The evaluation helped make a series of modifications to the program to address equity concerns; the modified pricing program was then put to a vote of the people, who voted to permanently adopt the modified central area pricing program. Had the program been put to a vote prior to the pilot test, it would have been resoundingly defeated. But a fixed-term

² King, Manville, and Shoup (2007) argue persuasively that revenues from road pricing projects should be dedicated primarily to the communities through which priced highways run, rather than to corridor highway or transit improvements, as these communities bear the brunt of the traffic, noise, and pollution generated by congested roads. Doing so, argue the authors, is both fair and would create a natural and powerful constituency for road pricing.

pilot test proved far less threatening, allowing Stockholmers to see first-hand the dramatic congestion reductions of the pricing program and allowing planners to adjust the program to address equity concerns that arose during the test.

Public outreach and education

As the San Diego and Minnesota cases demonstrate, public outreach is critical to addressing equity concerns in order to achieve popular and political acceptance of pricing. These public outreach efforts have been most effective when public feedback is sincerely and substantively incorporated into the project design (Kuehn, 2008; Niskanene, et al., 2003; Weinstein & Sciara, 2006).

Such outreach efforts are critical because traffic congestion is both widely despised and poorly understood. Traffic delays are non-linear; small changes in the system can dramatically increase or decrease congestion. This non-linearity is non-intuitive, making most people unfamiliar with road pricing doubtful that it could meaningfully reduce congestion absent draconian tolls. This prevailing skepticism toward pricing makes outreach and education especially important.

Successful implementation of pricing has therefore required effective and ongoing communication with public officials, drivers, voters, and the media. Successful examples of public outreach have emphasized how road pricing improves travel conditions for all residents – not just those wealthy enough to pay the fees. Further, the idea that pricing programs increase traveler options – such as HOT lanes that allow drivers to decide on a trip-by-trip basis whether to pay for time savings or travel in congestion without paying a toll, or corridor transit

improvements that offer meaningful alternatives to driving – is often a central element of public education.

Outreach and education efforts have also presented opportunities to shift the terrain of pricing debates from general public distaste for tolling to using pricing to correct inequities in *current* systems of transportation finance (Schweitzer & Taylor, 2008). This was a primary focus on outreach efforts in Germany where rapid increases in commercial trucking were viewed by German officials as both problematic, and not sufficiently financed by the trucking industry, especially non-German truckers of maintaining and expanding the increasingly congested German highway network.

Conclusion: What's a Fair Price for Transportation?

While equity may indeed be in the eye of the beholder, this paper has shown that it is possible to systematically consider and evaluate any transportation finance instrument – including roadway pricing – in terms of the many possible dimensions of equity. But careful, systematic evaluations of transportation pricing and finance equity remain quite rare. Instead claims of inequity or bias are often tossed about in debates over transportation pricing and finance with little or incomplete supporting evidence, and sometimes quite cynically. While no scheme can satisfy all possible dimensions of equity, it is possible to offer comparative equity assessments of various approaches to transportation pricing and finance, and that efficiency and equity are not always at odds. Further, this paper has shown that the current trend in transportation finance toward dedicated non-transportation-based taxes (like local sales taxes) is, by most measures of equity, less fair than most forms of marginal cost transportation pricing (like congestion tolls) about which equity concerns are most often raised.

Finally, the review of five case studies of road pricing programs conducted for this paper shows that equity was a central issue in each, alternatively motivating (1) the implementation of pricing (Germany), (2) the funding of alternative modes (San Diego, Minnesota, and Stockholm), (3) mid-course restructuring of the pricing program (Stockholm), and (4) successful opposition to a pricing proposal (New York). In practice, successful mitigation of equity concerns has entailed:

- Careful attention to the dedication of toll revenues to both transit and highway improvements in and around the tolled areas to create program constituents,
- Limited geographic scope to central, congested zones, particular travel corridors, or particular market segments,
- Incremental, phased implementation that allows for corrections and adjustments during implementation and pilot testing, and
- Ongoing, substantive, and sincere public outreach and education efforts that have meaningfully influenced program design.

Such efforts have increasingly turned equity objections to pricing on their head by presenting pricing as both a way to substantially increase transportation system efficiency and to address and correct substantial inequities in our current systems of transportation finance as well. The equity analysis framework outlined in this paper is intended to foster such comprehensive evaluations of road pricing equity vis-à-vis other forms of transportation finance in the years ahead.

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APPENDIX: Five Case Studies of Equity in Electronic Road Tolling Projects

The case studies below explore how equity concerns have been raised and addressed in five very different tolling contexts. These five cases were selected because equity issues were central at some point in the planning and implementation process, and because the circumstances and outcomes differ substantially from one another. Information on each of these cases was drawn from primary, secondary, and tertiary sources. The mitigation efforts examined ranges from improving public outreach to dispel equity misconceptions, to dedicating revenues to offset both real and perceived inequities. While elaborate compensation programs, such as FAIR lanes that would provide toll credits for low-income drivers, have been proposed, none have yet been put into practice (Weinstein & Sciara, 2006). Although equity concerns have delayed, and in one case helped to kill, road pricing projects, equity concerns have not been consistently proven a deal breaker. In most cases, sincere and comprehensive planning and community outreach efforts have shown that equity criticisms can be fully addressed.

San Diego's I-15 HOT Lanes: Revenue Dedicated to Transit & Public Outreach Campaign

In converting the existing, underutilized HOV lanes to HOT lanes along the I-15 corridor in the suburbs north of downtown, San Diego transportation officials were able to avoid extensive equity objections by spearheading a comprehensive outreach campaign and dedicating revenue to transit improvements along the corridor. The HOT lane development was designed to address both the worsening congestion in the San Diego region and the dearth of public transit in the I-15 corridor. In 1996, the I-15 HOT lanes opened with single-occupant vehicles initially paying into the lanes with a flat monthly fee. Phase II, FasTrak, was introduced in 1998, which incorporated the world's first fully dynamic variable congestion toll to assure free-flowing

traffic. Single occupant vehicles now pay a variable fee via transponders. To fund corridor transit improvements, revenues from the toll lanes are dedicated to funding the Inland Breeze Express Bus Service from Rancho Bernardo to downtown San Diego.

Throughout the planning and implementation of the HOT lanes, an ongoing public dialogue was encouraged by transportation officials. One of the project's most outspoken champions was Jan Goldsmith, the former Mayor of the north San Diego County City of Poway and newly elected State Assembly member, who adopted the issue as one of his primary causes. In the course of pushing for the I-15 HOT lanes, Goldsmith penned several op-ed pieces in local papers and appeared on numerous local talk radio shows. He also went to considerable effort to meet individually and repeatedly with the various stakeholders to build support among elected officials and the public. Goldsmith aggressively and enthusiastically touted the project as a means to generate revenues for needed services from an existing underutilized facility without raising taxes.

The San Diego Association of Governments (SANDAG) was also instrumental in communicating with the general public and media through a well-planned marketing campaign that included I-15 Express Lane newsletters and a series of town hall-style meetings (Evans, Gougherty, Morris, & Smirti, 2006). In addition to these education efforts, SANDAG employed focus groups and opinion surveys to frequently assess the public perception of the HOT lanes, particularly regarding the perceived fairness of the facility (Weinstein & Sciara, 2006). As part of these efforts, SANDAG established a Policy Advisory Committee and a Citizen's Advisory Committee, which were very active in the planning phase. Various consultants also played important roles in the planning phases by producing a series of analytical reports to support decision-making regarding the setting prices, public relations, and operational issues (Schreffler,

Golob, &Supernak, 1998). By incorporating public opinion surveys into the planning process, SANDAG was able to adjust the project design to assuage equity concerns as the project evolved. .

Once the I-15 HOT lanes opened, several evaluation studies tracked user demographics to address concerns that the lanes might become Lexus Lanes for the rich. Although the users of the I-15 HOT lanes were found to have higher average incomes than drivers in the parallel, free lanes, the lanes were used by middle, lower-middle, and some lower income drivers as well. Furthermore, opinion surveys conducted after the opening of the lanes found widespread support for the HOT lanes across all income groups and among both users and non-users. The San Diego officials were successful in selling the HOT lanes as a new transportation choice for all drivers, which aided in increasing approval levels of the project (USDOT, 2008). In addition to the new option of congestion-free toll travel, the increased utilization of the former HOV lanes reduced free-lane congestion, contributing importantly to their popularity.

The San Diego case demonstrates the importance of incorporating community input and outreach into the program design process from the outset. The I-15 project also illustrates the potentially important role that revenue dedication can play in assuaging equity critics. By funding transit service, the HOT lanes improved transportation options for drivers and non-drivers alike.

Minnesota's I-394 MnPass: Bipartisan Support Quells Equity Objections

HOT lanes proposals in the Minneapolis region weathered over a decade of criticism before finally being implemented in 2005. Although Minnesota transportation officials attempted to follow the San Diego's HOT lanes implementation model, Minnesota's residents

and political leaders proved much more critical of the HOT lane concept than those in San Diego. Much of this criticism focused around equity concerns, with opponents repeatedly dubbing the facility “Lexus Lanes.” However, a broad bipartisan political coalition, which focused on public education and outreach, was eventually able to overcome and quell many of the equity concerns.

The Minnesota Department of Transportation (Mn/DOT) and the Twin Cities Metropolitan Council had been exploring the possibility of introducing value pricing in the Minneapolis/St. Paul metropolitan area since 1994. In 1997, the state legislature approved a HOT lane demonstration project on I-394, a congested freeway route into Minneapolis’s western suburbs. However, the proposal met with strong initial resistance from the public and was subsequently withdrawn; much of the public outcry centered on questions of fairness. The Minnesota Governor at the time, Arne Carlson, responded to the public objections by rejecting Mn/DOT proposals to incorporate HOT lanes as part of Minnesota’s transportation plan (Sorensen & Taylor, 2005). For a time, the proposal appeared dead.

Not to be deterred, a 30-member Value Pricing Advisory Task Force, consisting of state legislators, area mayors, and business, environmental, and transportation leaders, pushed a new demonstration project proposal beginning in 2001. Led by researchers at the Hubert Humphrey Institute at the University of Minnesota and funded through Federal Highway Administration (FHWA) value pricing grants, the coalition repeatedly and publicly championed value pricing through an aggressive communications campaign. As part of the campaign, a series of local and regional workshops were conducted to address citizen concerns. This public dialogue and gradual acceptance eventually led to bi-partisan support for the project. MnPass(as the project came to be known) planners also used focus groups and opinion surveys to assess the public

perception of HOT lanes (Weinstein & Sciara, 2006). As a result of this outreach work, public acceptance began to grow.

Beyond the education campaign, several other factors likely contributed to waxing support for the project. In the early 2000s, the Minnesota state budget deficit exceeded \$4 billion, and the governor had pledged no new taxes. Furthermore, the Minneapolis-St. Paul metropolitan area's population was growing rapidly, exacerbating the already congested road network. In concert, congestion had become one of the top issues on the public agenda. This bipartisan support, along with the backing of a newly elected Governor Tim Pawlenty and Lt. Governor and Transportation Commissioner Carol Molnau, led to the passage of 2003 legislation that allowed for the conversion of HOV lanes to HOT express lanes. The legislation also stipulated that revenue were to be used first to pay back the state trunk highway fund for the costs of implementation and administration of the project. Any excess revenue was to both enhance transit service in the corridor and to expand corridor road capacity (Buckeye & Munnich, 2004).

With the legislation and public support in place, the Minnesota HOT lanes opened along I-394 in May 2005. The lanes featured dynamic pricing, with tolls varying from 25 cents to \$8.00 depending on congestion levels (United States Government Accountability Office, 2006). As with the San Diego case, the MnPass program reduced congestion levels across the entire corridor, not just in the MnPass lanes. And similar to the San Diego case, although higher income drivers are somewhat more likely to purchase MnPass transponders and use the lanes, drivers of all income levels participate in the MnPass program, contributing to public acceptance of the project (Munnich & Kenneth, 2007).

German Toll Collect: Moving Towards a Fair Distribution of Costs

In contrast to the two previous case studies, the German Toll Collect program was motivated explicitly by a desire to develop a more equitable distribution of transportation costs among road users. With rise of international trucking in the European Union, the Toll Collect Program was structured to charge commercial users fairly for the costs they impose on the German highway system and to encourage the movement of goods by rail (Rothengatter & Doll, 2002).

Located in the heart of Europe, Germany has long served as a central hub for European transport. Estimates indicate that up to 35% of truck vehicle miles are driven by about 470,000 foreign trucks each year (Hensher & Puckett, 2005). The Single European Market and the development of the European Union have dramatically increased the amount of intra-European trade and, in turn, levels of truck traffic traveling through Germany. This growth is expected to continue, with projections of a 64% increase in truck traffic between 2005 and 2015 (May & Sumalee, 2003). As truck travel has increased, so have the costs of maintaining and upgrading German highways. Prior to Toll Collect, Germany was not able to collect much revenue from the foreign vehicles, as fuel taxes paid in other countries remained in those countries.

In an attempt to fairly distribute the increasing road maintenance costs, the German government sought to incorporate distance fees for all heavy trucks on German roadways. In January 2005, Germany introduced the Toll Collect System, which electronically charges all truck over 12 tons fees that vary according to distance traveled, vehicle weight, and vehicle emissions. Every truck is equipped with an on-board unit that utilizes GPS and digital road maps to track the vehicle's use of the highway network and assesses the appropriate fee automatically. Although some trucks still pay tolls manually, the German Toll Collect System is the first large-

scale operation road pricing project that utilizes satellite-based electronic fee collection technology (Hensher& Puckett, 2005).

Research has long found that roadway damage increases exponentially with axle weights, depending on the “design capacity” of a given roadway. That is, road damage is greatest when a vehicle’s weight exceeds a road’s design capacity (which is determined largely by roadbed composition and thickness). Accordingly, the Germans devised a fee system that varied with vehicle weight in rough proportion to the damage costs imposed by vehicles of various weights(Rothengatter & Doll, 2002).

As with the San Diego road pricing programs, the allocation of the revenue collected from road users also plays a significant role in the public’s perception of the equity of the tolls. Twenty percent of German Toll Collect revenue is returned to the toll operator to cover basic operation costs. The remaining 80 percent is dedicated to the federal transport network (50 percent to roads, 38 percent to rail and 12 percent to inland waterways). Dedicating the net revenues to freight infrastructure, and mostly to highways, proved critical in achieving the acceptance of the trucking organizations (Doll & Schade, 2005).

Although the Toll Collect program was initially conceived of as a mechanism to more equitably distribute infrastructure costs, many within the trucking industry view the charge as unfair to the commercial freight industry. In a 2005 survey, road users reported the belief that the charges would be more equitable if vehicle related taxes were reduced or a fuel tax rebate for those paying road charges was introduced (Stewart-Ladewig, 2005). Some users have also criticized the lack of transparency in determining the Toll Collect fees, which to the uninitiated may appear arbitrary. Furthermore, some users reported the opinion that the program would be more equitable if the truck tolls were consistent across all European countries, rather than current

system whereby each country implements different road finance systems (Stewart-Ladewig, 2005). Given that studies have repeatedly suggested that heavy trucks inflict more damage on roadways than they pay in road taxes, it is perhaps unsurprising that truckers would express dissatisfaction with a new pricing regime that explicitly and intentionally shifts more of the finance burden in Germany onto heavy vehicles.

As the Toll Collect case illustrates, perceptions of equity and fairness vary among those who now pay less or more in highway tolls and taxes. Although German residents and government officials widely viewed Toll Collect to be a logical step towards a fairer distribution of costs, many truckers view the system as a new and unwarranted burden. Such complaints notwithstanding, the explicit focus on fairness and the dedication of the revenues to roadway and goods movement improvements have combined to quell opposition and keep the system in place.

Stockholm Congestion Tax: Pilot Program Allows Policy Adjustments

Although the various congestion charging proposals for the Stockholm area had been discussed since the 1970s, the proposals did not gain any traction until the late 1990s when mounting environmental concerns led to renewed political pressure to reduce traffic congestion. The 2002 Swedish general election led to an agreement between the Social Democrats, the Left Party, and the Green Party that included a provision allowing for a congestion pricing trial in Stockholm. In June 2003, Stockholm City Council passed a proposal to introduce a congestion pricing trial, and the Swedish Parliament, the Riksdag, passed the Congestion Charges Act in June 2004, allowing Stockholm to proceed with the trial (Civitas, 2006).

Prior to the introduction of a congestion pricing trial, Stockholm area residents had little direct experience with congestion pricing and overwhelmingly opposed the central area cordon fee by a margin of two to one. Much of this opposition pertained to fairness issues, particularly concerns over geographic inequity, whereby central area residents and employees would be unfairly burdened by fees not levied elsewhere.

The trial began in 2006 when a fee was levied on all vehicles traveling within a 29.5 square-kilometer central Stockholm ring that varied by time of day. The revenue raised during the trial period was dedicated to public transit improvements in the Stockholm region. By both reducing congestion and enhancing public transit, planners of the congestion fees sought to improve sustainable accessibility to Stockholm's downtown core. In order to maintain access to the city center throughout the trial, improvements to the public transportation system began prior to the implementation of the congestion tolls. The improvements constituted the largest coordinated expansion of the transit system since the initial Underground subway construction project in the 1950s (Civitas, 2006). Most of the public transportation improvements focused on enhancing bus service by introducing new routes and new buses. Rail lines and existing bus lines were improved as well. Finally, park and ride sites received funding for improvement (Civitas, 2006).

At the conclusion of the trial period in July 2006, the Congestion Charge Secretariat evaluated the trial run by examining a number of criteria reflecting the aims of and motives behind the congestion pricing program. The Secretariat study determined that, during the congestion toll period, traffic in Stockholm decreased by 22 percent, exceeding expectations, and public transit ridership increased by six percent. The study also concluded that carbon dioxide emissions within inner-city Stockholm decreased by 40 percent. However, the effect of the

reduced congestion levels on perceptions of the urban environment proved difficult to measure (Miljöavgiftskansliet/Congestion Charge Secretariat, 2006).

Although some complaints focused on unfair distribution of taxes, a study conducted during the trial period found that during one two-week period, almost half of all privately owned cars in Stockholm paid the congestion tax at least once. However, the study also concluded that 75 percent of the revenue was collected from fewer than 100,000 vehicles, which is approximately one-fifth of all cars in Stockholm County (Transek, 2006). Furthermore, because Stockholm's congestion fee covers the entire downtown area, larger, for example, than the zone in London, the congestion tax charges most auto commuters from outlying suburbs, which has contributed to perceptions of equity (Poole, 2007).

Although significant opposition arose among outer suburbs residents, the study found that the average payments by northern outer suburbs residents was only SEK 78 (\$11 USD) per person/year, compared to SEK 500 (\$70 USD) per person/year for residents of the inner city (Transek, 2006). The trial study concluded that residents of the inner city and Lidingö overall paid approximately twice as much as residents of other areas, with men (who are more likely to drive in Sweden) paying almost twice as much as women. Households with higher discretionary incomes paid nearly three times as much as households with lower discretionary incomes, and employed residents paid about three times as much as unemployed residents. Because higher income residents proved more likely to pay the congestion tolls, the burden of the tolls during the trial was highest, on average, among affluent men living in a two-adult household with children located in the inner city or in Lidingö (Transek, 2006). In total, the Stockholm congestion fee increased car travel costs by 31 percent for residents of the inner city, 11 percent for residents of

the inner suburbs, and only 5 percent for residents of the outer suburbs – where opposition to the fee was highest.

At the conclusion of the trial, the continuance of the program was put before the voters in a general referendum in September 2006. Residents of Stockholm voted in favor of maintaining the congestion fee, while residents of outlying suburbs voted to do away with it. The combined vote was a slim majority (52%) in favor of continuing the program. Even though the residents of the inner city paid a greater share of the tax, they also experienced the greatest benefit with significantly reduced traffic levels through their neighborhoods, faster auto and transit travel times, and enhanced transit options financed by the fee (Transek, 2006).

In this September 2006 election, the Green Party, whose leaders had originally introduced the congestion fee, lost. However, a new Alliance of center-right parties collectively decided to reinstate the congestion tax, honoring the Stockholm resident's vote. During political debates over whether to continue the fee, a compromise altered the use of revenue from the congestion tolls to be divided between new road construction in and around Stockholm and transit improvements, instead of dedicating revenue solely to transit as was done during the trial (Savage, 2006). One of the new projects to be funded by the tax is a \$3 billion north-south expressway, underground through the western suburbs. With this new use of congestion tax revenue, overall support for the policy increased from 52 percent to 67 percent – a complete reversal of the two-thirds who had initially opposed the program prior to the trial (USDOT, 2008). With these new levels of support, the modified congestion tax was reintroduced in September 2007 on a permanent basis.

The trial period implementation in Stockholm allowed transportation officials to test a controversial pricing proposal for which equity concerns had been raised. This gave public

officials considerable political cover had the trial proven ineffective or unpopular. By introducing the congestion fee on a trial basis, residents were able to experience the congestion reduction effects first-hand, provide feedback to policymakers, and ultimately make a more informed decision when it came time to cast a ballot. To quell opposition from suburban voters who felt unfairly taxed during the trial, the revenue was split between central city transit and suburban highway projects resulting in supermajority support for the now permanent program.

New York City Congestion Pricing: Perceived Inequities Help to Kill the Proposal

The congestion pricing proposal in New York City is an illuminating story of equity concerns helping to kill a project. Proposed by New York City Mayor Michael Bloomberg in April 2007, the initiative was met with both fanfare and fierce political and public opposition. Many of the arguments against the proposal focused on equity issues – both geographic and economic fairness. As designed, the congestion pricing initiative would have charged vehicles entering Manhattan south of 60th Street \$8 and vehicles traveling within the zone \$4 during designated peak hours. The revenue collected would have been dedicated to mass transit improvements to help accommodate the many former drivers expected to switch to transit. Furthermore, had the proposal been approved, New York City would have received an additional \$354 million of federal funding for mass transit improvements.

While the new revenue streams proved attractive to many elected officials, opposition to the project was never sufficiently quelled. In response to persistent vocal opposition to the proposal, the New York State Legislature failed to grant the necessary legislative authority for the program to proceed by the deadline for receipt of the federal funding in April 2008.

Equity concerns with the proposal were raised by poverty advocates and elected officials representing low-income districts, as well as a number of politicians representing wealthy suburban districts. While the expression of these equity concerns was sincere among many critics, it's likely that such objections were largely tactical by others. Regardless, those campaigning against congestion pricing were successful in wielding inequity fears to help sink the proposal.

As with the other cases reviewed here, equity issues motivated pricing proponents as well. Although New Jersey vehicles account for only 24 percent of those entering the New York City CBD, their drivers pay 45 percent of all Manhattan bridge toll revenues. In comparison, Manhattan drivers contribute only 7 percent of the total toll revenues, while residents of the other four boroughs pay 29 percent. Under the proposed congestion pricing program, residents of Manhattan would have paid a larger share of the much larger pot of revenues – between 28 and 31 percent, residents of the other four boroughs would have paid between 38 and 49 percent of the tolls, and New Jersey residents between 7 and 17 percent of toll revenues. Proponents argued that this was a more equitable distribution of burden than the current system, since the revenue collected would be used primarily to fund transit improvements that would benefit the residents of New York City (USDOT, 2008).

As the proposal moved through the legislative process, equity issues were frequently cited as a key reason to oppose the legislation. Among the most vocal opponents were members of NYC Congestion Free, who frequently cited equity concerns (Keep NYC Congestion Tax Free, 2007). New York State Assemblyman Richard Brodsky, a Democrat from Westchester County, helped to spearhead opposition to the proposal (Berger, 2008). Brodsky claimed congestion pricing would be regressive, disproportionately burdening working and middle class

residents. In July 2007, Brodsky produced a report purporting to support his assertion (Hakim, 2007; Brodsky, 2007).

In addition to opposition from suburban representatives, many politicians from Manhattan, Brooklyn, and Queens strongly opposed the measure as well. Assembly Speaker Sheldon Silver, a representative of Manhattan's Lower East Side, backed Brodsky in opposition to congestion pricing. Silver voiced concerns that the neighborhoods surrounding the congestion pricing zone would be transformed into virtual parking lots, serving those who would drive in from the outlying areas and then park at the border of the zone to avoid the charges. Therefore, Silver argued, traffic levels would not be reduced in neighborhoods such as Harlem, the South Bronx, and Bedford-Stuyvesant. Since many supporters of congestion pricing cited improved air quality as one of the benefits of the program, Silver argued that the city's poorest neighborhoods would in fact experience no improvement in their local air quality and perhaps would even experience decreased air quality, doing little to battle the high asthma rates in these neighborhoods (Hakim, 2007). In the New York City Council vote, councilmembers from Brooklyn and Queens opposed the congestion pricing bill by a margin of nearly two to one.

Overall, however, representatives from the Bronx and Manhattan voted overwhelmingly in favor of the congestion pricing plan, moving it forward to the state legislature. But once in Albany, 16 of the 18 state assembly members from Queens signed a letter opposing the plan (Neuman, 2008). Assemblyman Hakeem Jeffries, a representative of Brooklyn neighborhoods Prospect Heights, Bedford-Stuyvesant, and Clinton Hills, joined with Brodsky in opposing to the proposal on the grounds that it imposed an unfair burden on working families. Some representatives from Brooklyn also claimed that the plan would geographically isolate residents of the borough by forcing drivers to pay a toll to cross Manhattan on the way to New Jersey.

But while concerns with the impacts on low-income households were raised by many, not all elected officials believed that the congestion pricing initiative would negatively affect their lower-income residents. Assemblyman Keith L.T. Wright, a Democrat representative from Harlem, supported the congestion pricing, as did the City Councilwoman for the East Harlem and the South Bronx, Melissa Mark-Viverito, who cited equity as a major reason behind his support of the proposal. Mark-Viverito in particular questioned the sincerity of elected officials from suburban communities who claimed to be concerned about the impact of the congestion tolls on lower-income residents. Mark-Viverito argued that her lower-income constituents would benefit from reduced traffic from outlying suburbs en route to the CBD, resulting in improved air quality and public health. Noting that only five percent of commuters from Brooklyn, Queens, Staten Island, and the Bronx travel to Manhattan by private car, Mark-Viverito argued that congestion pricing revenues would benefit the public transit systems that transport the majority of commuters in the five boroughs (USDOT, 2008).

As the federal deadline neared in April 2008, equity arguments persisted among pricing proponents and opponents with no movement toward consensus. Speaker Sheldon Silver determined that there was not enough support in the Assembly to justify bringing the enabling legislation to a vote, which effectively killed the proposal.

The New York City experience suggests that equity concerns – both sincere and tactical – can indeed kill congestion pricing projects. The case in New York shows that geographic equity concerns – in particular, who pays and which areas might be negatively affected – can be multifaceted and murky. Because questions over the geographic equity effects of the program were not adequately addressed by program proponents, *uncertainty* over who, and where, would win and lose led to the demise of congestion pricing in Manhattan.

CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

Are Public-Private Partnerships a Good Choice for U.S. Highways? A Review of the Literature

Hiroyuki Iseki

Brian D. Taylor

Kansai Uchida

California PATH Working Paper

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Are Public Private Partnerships a Good Choice for U.S. Highways? A Review of the Literature

California PATH Project

Evaluation of Open Road Electronic Toll Collection for California Applications (XB-604)

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Hiroyuki Iseki, Ph.D.

Assistant Professor of Planning and Urban Studies
School of Urban Planning and Regional Studies
University of New Orleans
368 Milneburg Hall, 2000 Lakeshore Dr.
New Orleans, LA 70148
e-mail: hiseki@uno.edu
504-280-6029

Brian D. Taylor, PhD, AICP *

Professor and Chair of Urban Planning
Director, UCLA Institute of Transportation Studies
3250 Public Affairs Building
Los Angeles, CA 90095-1656
(310) 903-3228
E-mail: btaylor@ucla.edu

And

Kansai Uchida, MA*

Research Assistant
UCLA Institute of Transportation Studies

ABSTRACT

In light of chronic funding shortfalls and waxing highway construction and maintenance demands, public private partnerships (PPPs) (often though not always in conjunction with road pricing) have been garnering increasing attention from government officials in the U.S. and abroad. Despite many strongly-held opinions on PPPs – both pro and con – systematic evaluations of their efficiency, effectiveness, equity, and feasibility are all too rare.

This paper is the first part of a research project that aims to rectify this shortage of careful, evenhanded, and rigorous analyses of PPPs by drawing on the research literature to develop a comprehensive PPP evaluation framework. Drawing on a careful and extensive review of the research literature, we (1) present the often misunderstood economic properties of highway and road infrastructure, (2) outline the rationales governments cite for engaging in PPPs, (3) review the various types of applicable PPP arrangements, and (4) describe the conditions and factors that influence the success of PPPs. In the final section, we emphasize the differences between financial and socio-economic evaluations of PPP in describing our proposed PPP evaluation framework for highway projects. These differences in focus – between shorter-term financial considerations and longer-term economic considerations – lead to an important point that PPPs are not revenue sources *per se*. Rather they are means by which projects can be financed, delivered, and operated, but may or may not do so more cheaply than through more traditional finance, delivery, and operation. To the extent that tolling may be implemented to generate a revenue stream for a private contractor, PPPs may allow governments to tap into new sources of funding. But in such cases it is the tolls that generate funding, not the PPPs.

Despite this, and despite the potential efficiencies of private sector development and operation, PPPs appear to public officials as a way to generate “free money” for highway projects. But, of course, neither lunches nor highway projects are free. In attracting private capital, PPPs often redistribute costs and risks between the public and private sectors in ways that are not always clear to all involved. When project responsibility and authority is explicitly allocated to either the public sector or the private actor with the most relevant expertise and experience, significant efficiencies can be realized.

Despite the desperate need for upgrades to California’s highway network, officials must approach the PPPs carefully to ensure that projects will generate public benefits that exceed public costs. Whether or not a PPP is a good deal for the public very much depends on the project specifics. When properly structured and managed, PPPs can bring significant public benefit, but poorly conceived projects may entail far more risk than enthusiastic public officials may realize. When it comes to PPPs for highway projects, the devil is indeed in the details.

EXECUTIVE SUMMARY

In light of chronic funding shortfalls and waxing highway construction and maintenance demands, public private partnerships (PPPs), often in conjunction with road pricing, have been garnering increasing attention from government officials in U.S. and abroad. Despite many strongly-held opinions about PPPs – both pro and con – systematic evaluations of their efficiency, effectiveness, equity, and feasibility are all too rare. This is due partly to the lack of evenhanded research on the topic, and partly because the recent wave of projects is so new that few evaluations have been conducted on them. Furthermore, PPPs vary significantly in terms of political, economic, legislative, contractual, and environmental conditions, making comparisons difficult.

This paper draws on the existing research literature to organize and discuss information about (1) the economic properties of highway and road infrastructure, (2) the rationales for PPPs, (3) the types of PPP arrangements, and (4) the important conditions and factors to consider for the success of PPPs.

The important economic properties of highway and road infrastructure are related to those of *public goods*—which entail both non-rivalry and non-excludability in consumption. While roads as an economic good have typically been difficult to classify, they have historically exhibited traits more characteristic of public goods rather than private (for which public access can be controlled, as in the case of food or clothing). However, due to increasing traffic congestion (which entails “rivalry” for limited road space) and the emerging array of road pricing technologies (which can limit, or “exclude,” access) roads can now be better characterized as “quasi-public” or “club” goods, which opens the door for more private sector involvement. Thus, private involvement in the production and provision of highway infrastructure and service has become increasingly feasible.

However, when making a choice between public and private production and operation of roads, there are many important factors to consider: externalities, accessibility equality, the merit of free parallel highways (demand options), and availability in times of emergency. In addition, some tasks appear in most cases to be best left to the public sector, while others are usually best handled in the private sector. Thus, the most efficient division of responsibility and authority would leave certain responsibilities to the sector best equipped to handle them. Furthermore, accountability – related to public values that justify or prohibit a particular means of production, provision, or distribution of goods and services – is of paramount concern. Finally, transportation infrastructure exhibits both economies of scale and network effects, which usually need coordination through some level of public intervention.

When gauging the success of transportation projects, it is also important to consider a variety of factors, such as the magnitude of the financial investment, the planning and construction time horizons, the stimulation of economic activity via reductions in travel time and costs, and the inevitable uncertainty in evaluating costs and benefits. Using PPPs to provide transportation infrastructure has the potential to affect all of these factors.

The literature on PPPs generally defines a spectrum of PPP arrangements for highway infrastructure based on the degree of private-sector involvement, ranging from traditional public procurement to full privatization, depending on how the responsibilities are divided between the public and private sectors (Table EE-1). This categorization of PPPs is driven mainly by three factors: 1) governmental decisions about whether to (i) outsource or (ii) share the responsibility for designing, constructing, financing, and operating highways, 2) methods by which the public

sector compensates the private sector and provides opportunities for profit, and 3) highway facility ownership arrangements.

Table EE-1: Key Types of PPPs

<i>Traditional Procurement / Service Contracts</i>	Public agency issues separate contracts for the design, construction, and operation (if outsourced) to the lowest responsible bidders and remunerates them through direct payments
<i>Design-Build / Turnkey</i>	Similar to traditional procurement, except design and construction are combined into a single contract
<i>Build-Operate-Transfer / Design-Build-Operate / Management Contracts</i>	Entire project from design to operations is combined under a single contract, including project management, and the public agency pays through direct payments over the lifetime of the project
<i>Joint Venture</i>	The public agency forms a joint public/private company with local stakeholders to complete an improvement. Not frequently used for transportation projects.
<i>Lease Agreements</i>	Existing or new facilities are leased to a private firm, which is allowed to charge tolls, for the purposes of operation
<i>Design-Build-Finance-Operate / Concession</i>	Similar to build-operate-transfer, except the private firm is allowed to collect tolls for a set period of time before transferring the facility to public control
<i>Full Private Provision</i>	No reversion to public ownership takes place.

Each of these PPP types has been implemented with varying degrees of success. It is therefore not possible to conclude that any one PPP model is, in general, better than the others. Instead, the outcome of a particular PPP project depends on how well the agreement is tailored to its social, political, economic, and operational settings. Thus the first step a public agency should take in determining whether to pursue a PPP strategy is to fully understand the many factors and variables that influence the strategy's outcome. The influential factors include not only those related to engineering, such as design standards and the environmental conditions of the construction site, but also economic, fiscal, social, institutional, and contractual conditions. Table EE-2 outlines these conditions.

Table EE-2: Risks and Background Conditions Affecting PPP Agreements

<u>Legislative:</u>	PPP-enabling legislation allowing a speedy approval process or hefty incentives can lower the transaction and time costs associated with initiating the agreement and make the PPP more attractive to private investors. A good balance between offering private incentives and protecting the public interest is needed. Public agencies usually shield private investors from the risk of legislation turning against a project once it is underway.
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<u>Contractual:</u>	The type of PPP contract used affects the opportunities for the private firm to streamline costs. Ideally, the chosen program would incentivize the private entity to consider the long-term effects of choices made during the project, seek to minimize its lifetime costs, provide flexibility, include opportunities for profit and efficiency gains sufficient to offset the set-up costs of the PPP, and align the motivations of the private entity with the public interest. A key part of the agreement hinges upon the initial value assessment of the project. Undervaluation of the asset is a particular risk of the public sector, while overvaluation, or “winner’s curse,” is a risk facing the winning bidder.
<u>Political / Public Perception:</u>	Public hostility toward PPPs and privatization can jeopardize projects. The political support for PPPs can be worsened if the public has already experienced a failed PPP for a similar type of project.
<u>Public-Private Relations:</u>	Conditions, such as rate-of-return caps, ensure that the private sector does not exploit the project in the interest of maximizing profits. However, experience to date suggests that a cooperative relationship between the public and private entities is more beneficial to a PPPs success than a meticulously worded contract. Because long-term concessions may span multiple political administrations, PPPs viewed unfavorably by the public may become political campaign issues and worsening public-private relations could result in early termination or violations of the original contract.
<u>Public vs. Private Sector Goals</u>	The PPP agreement must successfully balance the public sector’s goal of protecting the public interest with the private sector’s profit-driven motives.
<u>Competition:</u>	If a new toll PPP facility is built too close to an existing parallel toll route, the split traffic demand may be insufficient to financially support both projects. Additionally, there will be high transaction costs involved with orchestrating cooperation between private entities where competing PPP routes intersect affect one another. Where untolled alternatives to a PPP facility exist, anticipating the level of demand for a tolled PPP facility may be very challenging. Also, the public partner should be careful not to limit its ability to carry out its long-range transportation plans by agreeing to excessive non-compete clauses.
<u>Market Conditions:</u>	PPP proposals must remain competitive with other investment opportunities available to private firms. When the private market presents many attractive investment opportunities, the public sector may have to add incentives and lessen the degree of investor risk transfer in order to keep PPP projects competitive, but this may diminish the overall cost savings and increase payments from both the highway agency and the road users.
<u>Environmental Approval Issues:</u>	Many countries require environmental approvals before projects can begin construction. Because the length of time needed to obtain these approvals can be uncertain, the public sector usually retains this responsibility either for obtaining approval before soliciting private sector bids, or by offering to compensate investors for time lost due to environmental delays.
<u>Construction:</u>	Changes in construction material and labor costs can hinder the cost effectiveness of a highway construction project.

<u>Usage:</u>	Traffic demand is generally projected to increase over time, but there is a chance that demand for travel along a new roadway may not meet projections, posing financial risks to private entities involved in both real toll or shadow toll PPP programs. The public sector sometimes offers to subsidize this risk because the private sector has little control over traffic demand.
<u>Currency:</u>	Developing countries sometimes use foreign finance institutions to fund highway PPPs. Devaluation of the home currency against the finance one can be fatal to a project under this funding program.

Assessing a PPP strategy depends partly on one's definition of success. Our review of the research literature reveals that most analyses to date focus on the net *financial* benefit for government. This involves considering such factors as land values, interest rates, construction costs, transaction costs, and the distribution of risk. Since the most common motivation for governments to pursue PPPs is to advance project development when traditional funding is tight, the evaluation of projects based on financial criteria makes intuitive sense. However, considering only government financial benefits does not provide a complete picture of the total costs and benefits of PPP strategies vis-à-vis other means of project delivery and finance. Public agencies might mistakenly view PPPs simply as a means of getting projects built *cheaply*, since the absolute level of up-front public funding required is typically reduced, especially under toll concession models where the payments to the private concessionaire are made directly by the road users over the concession period. Such arrangements are often, and quite inappropriately, viewed by public officials as “free” money generated by PPPs. Rather such revenues are actually a transfer from road users to taxpayers. This may in fact be a desired outcome, but it is a transfer nonetheless. In other words, toll concession models shift a burden of payment from taxpayers to road users, and in doing so they may or may not increase overall economic efficiency. Such transfers may shift the financial burden for roads on the beneficiaries of roads, internalizing the many externalities of road use and increase overall economic efficiency in the process. But such transfers may also cause the public to pay more in tolls (and transaction costs in collecting the tolls) for the roadway under a PPP than it would have via fuel taxes under traditional finance methods.

Because both PPPs and traditional highway procurement methods entail costs (of one form or another) to the public, public agencies should focus more broadly on the *socio-economic* benefits that new facilities will confer on society when determining whether or not the construction is worth pursuing. While this might sound abstract and academic, the point is not a trivial one. In addition to considering financial criteria, evaluating a project from a socio-economic perspective involves examining factors such as operating efficiency, transportation system innovation, the distribution of public benefits, and environmental costs. It makes little difference whether an ineffective new facility was built at a low cost; expenditures on poorly-conceived projects are wasted. And whether to build a facility using a PPP thus emerges as a secondary consideration in the evaluation process of costs and benefits; an important consideration to be sure, but secondary. But in some cases, the cart has been put before the horse and the decision to pursue PPPs has driven project selection. In doing so, public officials have failed to distinguish the *financial* motives to pursue PPPs apart from the *economic* benefits conveyed by a given highway project.

Given our conceptual review of the literature and past PPP projects, we have developed a conceptual framework to evaluate the financial and economic merits of various PPP (and non-PPP) strategies. In this framework we emphasize the difference between the two criteria discussed above—(1) *financial* costs and benefits, and (2) *socio-economic* costs and benefits. We have, in addition, identify the factors and conditions that influence each criterion and briefly describe the *financial* internal rate of return (FIRR) and *economic* internal rate of return (EIRR), which are commonly used in the project evaluation in the international development field, including transportation infrastructure projects.

To conclude, PPP agreements have the *potential* to help deliver much-needed highway improvements at a lower cost and on a shorter timeline than via traditional procurement methods. On the other hand, there also exists the very real possibility that a PPP agreement could prove more risky and costly in the long run. Even PPPs that help a public agencies “bottom line” may not result economic benefits overall – measured in terms of lower user fees, lower tax payments, or increased economic benefits for the public. Whether or not a PPP is a good deal for the public very much depends on the project specifics. When properly structured and managed, PPPs can bring significant public benefit, but poorly conceived projects may entail far more risk than enthusiastic public officials may realize. When it comes to PPPs for highway projects, the devil is indeed in the details.

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1. INTRODUCTION

*Sadly, there is no reason to expect the political process to lead to the right pattern of privatization. Unless we are luckier or more careful than we are likely to be, political pressures will tend to retain for the public sector functions where privatization would make sense, and to privatize tasks that would be better left to government. (John D. Donahue, *The Privatization Decision*, 1989, page 13)*

Facing both chronic funding shortfalls and growing highway construction and maintenance demands, federal, state, and local governments in the U.S. are increasingly turning to alternative highway financing strategies. In particular, public-private partnerships (PPPs), often in combination with tolls or congestion pricing, have emerged as a popular financing strategy since the 1980s in Europe (Medda et al. 2007), and more recently in the US. The recent concession deals for the Chicago Skyway (99 years, \$1.83 billion) and the Indiana Toll Road (75 years, \$3.8 billion) have escalated public debate over the appropriateness, efficacy, efficiency, effectiveness, feasibility, fairness, and equity of public-private highway partnerships.

Supporters range from those who see PPPs as an opportunity to increase the economic efficiency of highway projects in certain, limited situations, to those who view PPPs as a way to avoid unpopular tax and fee increases by the widespread leveraging of private capital at little or no cost to the public. Likewise, opponents range from those concerned that the potential of PPPs may be oversold, to those philosophically opposed to private sector involvement in the provision of traditionally public services. In such an environment, evenhanded analyses of the pros and cons of PPPs have often been in short supply.

While the leaders of several states, such as Indiana, Texas, and Virginia, have been aggressively promoting PPPs by passing state legislation to support them, Congressman James L. Oberstar (D-MN), Chairman of the U.S. House of Representatives Committee on Highway and Infrastructure, and Peter DeFazio (D-OR), Chairman of the Subcommittee of Highways and Transit have called for a slowing of the trend toward PPPs in transportation. In their joint letter to state governors on May 10, 2007, they wrote, “[w]e write to strongly discourage you from entering into public-private partnerships (“PPP”) agreements that are not in the long-term public interest in a safe, integrated national transportation system that can meet the needs of the 21st Century.” To some extent, the debate and discussion in Congressional hearings to date are characterized by dichotomous views of PPPs – either strongly for or against them.

Despite the often strongly professed opinions on PPPs, research on highway PPPs is so diffused and limited that it does not adequately inform policy makers. This is due partly to the lack of evenhanded research on the topic, and partly because the recent wave of projects is so new that few evaluations have been conducted on them. Furthermore, PPPs vary significantly in terms of political, economic, legislative, contractual, and environmental conditions, making comparisons difficult.

This paper draws on the existing literature to organize and discuss information about (1) the economic properties of highway and road infrastructure, (2) the rationales for PPPs, (3) the types of PPP arrangements, and (4) the important conditions and factors to consider for the success of PPPs. In the next section, we discuss the properties of highway infrastructure that justify public provision, but do not necessarily require it. In the third section, we define and describe the types of PPPs for transportation infrastructure financing. In the fourth section, we introduce rationales

for shifts from public provision to PPPs, identify the central questions in debates over PPPs, and explore the conditions and factors that affect outcomes of PPPs. In the fifth section, we discuss three PPP cases from three parts of the world—Malaysia, the United Kingdom, and California—as examples to underscore the importance of carefully examining conditions and factors. We then provide our preliminary concept for a comprehensive PPP evaluation framework for highway projects, paying particular attention to the difference between financial analysis and socio-economic analyses.¹ Along the way, we show why comprehensive evaluations PPPs are difficult because it requires consideration of such a wide array of economic, political, and social conditions/context that vary across both space and time (Bult-Spiering and Dewulf 2006). Finally, we conclude the paper by outlining the key questions to be addressed in future research.

2. PROPERTIES OF HIGHWAY INFRASTRUCTURE

When considering the appropriate balance of public and private sector involvement, it is useful to review the theoretical rationales for the provision and production of goods and services. We start with a discussion of public goods, which provides the grounds for public sector provision.

Pure public goods are characterized by nonrivalry and nonexcludability in consumption. Nonrivalry means that once the good is provided, it does not occasion additional resource costs to provide the good for another person's consumption (Donahue 1989; Rosen 1999). While the highway and road infrastructure, as a lump-sum good, may seem like a nonrival good at first, the quality of service on highways and roads decreases as congestion increases. Therefore, with rising congestion, road service does not remain nonrival (Rosen 1999). Nonexcludability means that it is impossible or very costly to prevent the consumption of the good by anyone who does not pay for it (Rosen 1999). In this regard, the consumption of "freeways" is nonexcludable due to legal arrangements; by law, for example, interstate highways cannot be tolled. However, with a variety of technology available for road pricing, the consumption of highways and roads is not strictly nonexcludable. For this reason, private involvement in the production and provision of highway infrastructure and service is generally feasible.²

Highways with high levels of traffic certainly generate externalities, in addition to their direct benefits of travel time savings. Positive externalities include economic benefits that can be realized by the increased level of accessibility of surrounding areas. Negative externalities include noise, air and water pollution, disruption of communities, and aesthetic impacts. Some level of collective action through public intervention is justified in order to induce these positive socio-economic benefits, while minimizing negative externalities due to market failure. In addition, since accessibility can be considered indispensable to everyone's life, equity to accessibility (or distribution of the highway service (Rosen 1999)) needs to be carefully examined (Donahue 1989). If the private provision of highway infrastructure leads to the geographic monopoly of accessibility, it will incur significant costs to the public. This issue is more relevant when there is no alternative route available to a corridor provided by the private sector. In addition, others point out the merit of free parallel highways (option demand), which do not

¹ This framework requires further refinement once the project gets to the stage of in-depth case studies.

² Rosen states that the production and provision of public goods are not necessarily in the realm of the public sector (Rosen, 1999).

produce profits in a market economy but bring benefits to society, particularly in the time of emergency, such as accidents in the primary corridors and evacuation due to natural disasters.

Donahue (1989) discusses two basic dimensions of the choice between public and private: 1) financing and 2) performance or delivery. In regard to financing, we need to judge whether we should pay for the goods and services individually (*i.e.* user fees) or pay collectively with funds raised through taxation. Regarding performance (or delivery), we need to answer the question of whether the good or service should be delivered by the government or by the private sector (or any other non-governmental organization). For service contracts, choosing the provider that can perform tasks at the lowest cost is more important than whether that provider is public or private, but the same may not be true for the provision of infrastructure; the public and private sectors each have comparative advantages and disadvantages in performing different tasks, and should share responsibilities in ways that ensure tasks are assigned to the party that can accomplish them most efficiently. In other words, it is ideal to strategically divide tasks in a way that takes advantage of efficiencies both in the market environment and in the public sector.

In addition to efficiency, accountability is an important consideration when selecting the types of production and provision (Donahue 1989). Within this framework of accountability, the means of production and provision, and the quality and distribution of goods and services need to meet the values of the general public -- this includes citizens, voters, taxpayers, and beneficiaries of goods and services. These values also justify public intervention, such as quality control standards for road surface conditions, safety, and environmental impacts. Regarding quality of service, the government cannot write a so-called “complete contract” when unforeseen contingencies are important and may also be taken advantage of by the private firm to maximize profit (Hart, Shleifer, and Vishny 1996). This concern is particularly relevant when traffic demand significantly exceeds forecasts, and the private sector can charge high tolls while the public sector cannot provide alternate routes due to a non-competition clause in the contract. Finally, transportation infrastructure exhibits economies of scale and network effects; coordination between segments of PPP highways and other road infrastructure should remain intact for efficient operations. This need for coordination usually requires public intervention.

Doi (2002) lists important considerations for transportation project evaluation:

- (1) the size of the investment, particularly sunk costs (Gomez-Ibanez 1999)
- (2) the long planning and construction periods due to the longevity and immobility of transportation infrastructure (Gomez-Ibanez 1999)
- (3) the need to take into account intangible elements, such as time savings and added convenience, in estimating costs and benefits
- (4) the difficulty of computing economic costs based on the market value due to various economic distortions, such as the public intervention in the market
- (5) the difficulty in accurately forecasting future travel demand and other relevant factors related to the valuation of risk
- (6) the significant and complex impacts of the project on economic activities
- (7) the complexity of comparing various plans, including the “no-build” alternative, where travel demand continues to grow over time, but no capacity is added.

3. PUBLIC-PRIVATE PARTNERSHIPS (PPPS) FOR TRANSPORTATION INFRASTRUCTURE

Governments worldwide use a variety of public private partnerships (PPPs) when financing highways. A low-involvement type, for example, might include the combination of the construction and maintenance contracts, or the outsourcing of project management. The more-involved types contain provisions for sharing financing responsibilities between the public and private sectors, such as by transferring effective ownership of the facilities to the private sector for decades.

The literature on PPPs generally defines a spectrum of types based on the degree of private-sector involvement, ranging from traditional public procurement to full privatization (1995; Fayard 2005). In this general categorization of PPPs, we can identify three main factors. First, for the most part, the differences between PPP models stem mostly from governmental decisions about whether to outsource or to share the responsibilities of designing, constructing, financing, and operating highways. Second, the methods by which the public sector compensates the private sector and provides opportunities for profit also distinguish different types of PPPs from one another. Third, PPP models can have different arrangements for the ownership of highway facilities. That is, the public agency might retain ownership of the highway and merely lease it to a private agency for the duration of the partnership, or the private agency might be the rightful owners of the facility, similar to private toll roads. In many cases, the agreements include provisions for control of the facilities to be transferred back to the public sector after a set number of years, usually a few decades or the design life of the roadway.

Each PPP agreement is unique and may fall between two of the following models depending on how the responsibilities are shared between the public and private sectors. For example, a design-build-finance-operate contract with a very long concession period (some are as long as 99 years (Lockwood, Verma, and Schneider 2000)) or one that is renewed upon expiration, begins to imitate full private ownership. Consequently, sorting existing projects into rigid categories of PPP types is difficult.

Difficulty notwithstanding, in the following sections we describe several popular PPP arrangements that can be and have been adopted to highway infrastructure (Table 1).

Traditional Procurement

Under the traditional public procurement method in the U.S., which is typically not considered as a PPP due to the limited degree of private involvement and risk assumption, the public agency overseeing the project first contracts with a design firm, then holds a competitive bidding process to select the builder once the design is finished (*Public Private Partnerships* 2007). Upon completion of the project, the agency either provides operational services for the facility, or holds another competitive bidding process for operations.

One argument against this model is that because all of the contracts are serviced by different private firms, there is little opportunity for efficiency gains beyond the initial design of the facility. For example, if the public agency combines the design and maintenance contracts, the contractor would have an incentive to look for ways to make small adjustments to the design that would reap long term maintenance cost savings. Under the traditional procurement method with separate contracts, the design firm does not have any financial interest in doing this, and would not likely expend the extra effort. Similarly, under combined contracts, the temptation for any

one contractor to cut corners and transfer costs to the others is removed, thus improving the quality of the roadway and potentially lowering the cost to the public (Ward and Sussman 2006).

Table 1: Key Types of PPPs

<i>Traditional Procurement / Service Contracts</i>	Public agency issues separate contracts for the design, construction, and operation (if outsourced) to the lowest responsible bidders and remunerates them through direct payments
<i>Design-Build / Turnkey</i>	Similar to traditional procurement, except design and construction are combined into a single contract
<i>Build-Operate-Transfer / Design-Build-Operate / Management Contracts</i>	Entire project from design to operations is combined under a single contract, including project management, and the public agency pays through direct payments over the lifetime of the project
<i>Joint Venture</i>	The public agency forms a joint public/private company with local stakeholders to complete an improvement. Not frequently used for transportation projects.
<i>Lease Agreements</i>	Existing or new facilities are leased to a private firm, which is allowed to charge tolls, for the purposes of operation
<i>Design-Build-Finance-Operate / Concession</i>	Similar to build-operate-transfer, except the private firm is allowed to collect tolls for a set period of time before transferring the facility to public control
<i>Full Private Provision</i>	No reversion to public ownership takes place.

Source: (*Public Private Partnerships* 2007; Bult-Spiering and Dewulf 2006; Kumar and Prasad 2004; Reeves 2005)

Design-Build

The design-build model combines the design and construction of the project into a single contract. In the U.S., this is also known as the “turnkey model,” since the contractor is basically selling a finished highway facility to the transportation agency in a ready-to-use condition. It essentially transfers the responsibility for project management to the private sector, simplifying the administrative process for the public agency, and improving efficiency by having one private entity responsible for multiple project tasks (*Public Private Partnerships* 2007).

Although this model reduces the number of public contracts and subsequent administrative costs needed to complete a project, the remaining contracts with the design-build company or consortium are typically more complex and time-consuming to implement because the scope of work is larger and the relationship between the public and private entities is more intricate (Ragazzi 2005). This type of PPP involves a low degree of private sector involvement compared to the others, as the responsibilities for maintenance, financing, and operation fully remain with the public sector. Many government entities in the U.S. are experimenting with design-build, since it offers the potential for cost and time savings, but does not usually require new enabling legislation or carry the political risks associated with strong private involvement in what have been traditionally public sector functions. That is to say, highway design and construction have

traditionally been contracted to the private sector, so combining the two tasks into one contract does not incite as much controversy as the types of privatization below.

Build-Operate-Transfer

Build-Operate-Transfer involves greater private sector involvement than design-build. The public agency issues a contract to a private entity, usually a consortium of firms specializing in the various tasks needed to carry out the project, to construct and operate the facility for a set period of time. The government remains responsible for financing, and remunerates the private entity through any combination of fixed payments, direct user fees (such as actual tolls), or payments based on the amount of road use (so-called *shadow tolls*).

Under a fixed payment agreement, the government is essentially buying the *availability* of the roadway from the private contractor, meaning that the contractor receives payments simply for having the facility open to motorists (Bult-Spiering and Dewulf 2006). When user fees or *shadow tolls* are involved, the private contractor assumes some risk of low traffic levels, but receives payments that are proportionate to the amount of road wear. *Shadow tolling* is especially useful where the public is reluctant to pay tolls to travel on facilities that have historically been free. But there is debate over whether the private sector assumes much financial risk in a *shadow toll* agreement since the traffic levels will almost surely rise over time (Mackie and Smith 2005; Medda et al. 2007). The Portuguese government has begun to favor real tolls as traffic volume increases (Bult-Spiering and Dewulf 2006).

Like design-build, there is the potential for cost savings by having one entity overseeing the entire design and construction process. More significantly, build-operate-transfer allows for potential long-term operation cost savings because the private firms might find it economical to spend additional money on the construction to save on later maintenance, and they typically have access to non-unionized labor. However, it remains to be seen whether private firms will allow the roads to deteriorate when their PPP agreements near expiration.

Joint Venture

Joint venture PPPs are most commonly used in local redevelopment projects, and do not usually enter the realm of transportation improvements. Unlike concession PPPs, the private sector usually consists of local landowners who have a direct interest in the quality of the project and its ability to raise land values. Stakeholders typically partner with the public agency to form a joint public-private company. The government must balance its role as both regulator of public interest and shareholder in the company so as not to become too heavily focused on profit (Bult-Spiering and Dewulf 2006). Public agencies have undertaken programs similar to joint ventures on a few occasions where a new transit or highway facility will bring significant economic benefits to the surrounding area. For example, Texas highway authorities have previously requested the donation of highway rights-of-way from adjacent landowners who stood to profit from the new facility (Brereton and Ashcroft 1986).

Lease Agreements

In some instances, highway agencies will transfer existing or new facilities to a private contractor for the purpose of outsourcing operations and maintenance. The contractor either receives payments from the public agency, or is allowed to charge user fees along the facility.

The public agency typically continues to shoulder some of the operational risk for the highway by guaranteeing a portion of the payments based on *availability* of the roadway for traffic rather than actual usage, so as not to penalize the contractor should travel demand fail to meet projections (Taylor 2005). However, agencies still find it useful to base some of the payment on usage, either through a toll concession or direct payments that vary with usage (*shadow tolls*) to ensure that the contractor maintains the road well enough that it handles traffic efficiently and provides maximum benefit to users (Jamieson et al. 2005). Lease agreements for existing roadways can be politically risky because the public and politicians often object whenever previously-free facilities become toll roads unless significant visible upgrades are added (Bult-Spiering and Dewulf 2006; Gougherty 2005a; Little 2005).

Design-Build-Finance-Operate

Design-build-finance-operate transfers almost all functions pertaining to the facility to the private sector, though the public agency usually retains rightful ownership and regains control over the highway after a set number of years. The government may shoulder the responsibility for gaining environmental approvals, but nearly every remaining aspect of the project's development and operation is transferred to the private sector in the PPP contract (*Public Private Partnerships* 2007).

This model differs from build-operate-transfer in that the responsibility for financing the project does not rest with the public sector. Instead, the consortium, which often includes a bank, uses private capital markets and typically recovers its investment through tolls (Bult-Spiering and Dewulf 2006). Although the direct costs to the overseeing public agency are drastically reduced from traditional procurement under this model, the facility may in fact be more expensive to the public if the tolls rise too high. Additionally, there is a significant political risk since this model exhibits similarities to full privatization.

There is currently a particularly active debate over the potential effectiveness of the design-build-finance-operate model. Proponents argue that this model maximizes the ability to share risks while still allowing for significant government oversight in the form of regulations, thus enabling significant cost savings due to private sector efficiency (Sawyer 2005). However, there is disagreement over whether this model truly generates savings over public procurement (Boeuf 2003). If PPPs do not generate any real savings, the same goals could be realized if governments simply streamlined administrative and political processes and adopted toll financing. Moreover, whether any cost

Congestion pricing:

Adopting a toll finance structure provides the added opportunity to implement congestion pricing along the tolled routes. By charging the minimum facility toll needed to keep traffic flowing smoothly, toll authorities can increase total vehicle throughput along the facility during peak hours, and increase passenger throughput even further by incentivizing motorists to carpool and split the toll. Electronic toll collection technologies provide a relatively inexpensive method of implementation compared to manually-staffed toll booths, and do not impose the time costs associated with queuing to pay cash. The time savings generated by the free-flowing lanes and delay-free tolling can increase the public's perception of value for money, and help build political consensus for future toll-financed projects.

savings is returned to the public or simply absorbed as profit by the private entity depends on the PPP contract.

Build-Operate-Own

Build-operate-own is essentially full private provision of traditionally public services and facilities. The public sector may provide some guidance, regulation, or assistance in the design of the project and securing of the environmental and political clearances, for which the private firm might pay. But the construction, operation, and full ownership responsibilities reside with the private sector.

Each of the above-mentioned strategies has been implemented with varying degrees of success. It is therefore not possible to conclude that any one PPP model is, in general, better than the others. The outcome of a particular PPP project depends on how well the agreement is tailored to the social, political, and economic setting. It is possible, however, to offer some recommendations on the ingredients of successful PPP projects.

4. CONDITIONS AFFECTING THE SUCCESS AND FAILURE OF PPPS

The first step in identifying successful PPP strategies is to understand the factors and variables that influence the strategy's outcome. The influential factors include not only those related to engineering, such as design standards and the environmental conditions of the construction site, but also economic, fiscal, social, institutional, and contractual conditions. In this section, we will discuss these influential factors.

Government Rationales for Adopting PPPs for Transportation Infrastructure Financing

Governments typically see public private partnerships as a means of completing much-needed public works projects when traditional funding methods are insufficient. In the U.S., the lack of political will to raise fuel taxes to support the highway finance structures of the past several decades has forced highway authorities to consider the use of other taxation methods as well as user fees and public-private partnerships (Sorensen 2006).

Table 2 summarizes arguments for and against transportation infrastructure financing programs involving PPPs. Proponents of PPPs cite private sector efficiency and innovation as the reason for cost savings under these programs, where the private sector substitutes user fees for traditional taxes in order to retire the debt (Ragazzi 2005; Sawyer 2005).³ Additionally, keeping the number of contractors working on a project low and allowing each more free reign over the design, construction, and operation removes some of the project management responsibilities from the public sector (1995). Some other commonly cited motives for adopting PPPs include the minimization of risks for the public sector, faster construction, stimulation of private sector business, introducing competition to improve the quality of the finished highway, and assumption of a *lifecycle* approach to the project (Bult-Spiering and Dewulf 2006).

³ Furthermore, many proponents suggest that such tolls be set to manage demand on the facility (i.e. variable pricing) so that motorists can enjoy a quicker and more reliable trip than might otherwise be provided (Samuel and Poole 2007). However, variable pricing is not exclusive to roadways financed by PPPs.

Table 2: Free Money?

Financial Motivations for Highway Agencies to Choose PPPs	Corresponding Potential Disadvantages
<p>PPPs can overcome the state’s budget crisis by circumventing the highway fund and collecting money directly from road users in the form of tolls. The highway agency spends far less money on a PPP road than a traditional road.</p>	<p>Though the highway agency perceives a cost savings, road users can end up paying more in tolls under a PPP than they would have in taxes under traditional procurement. The highway agency’s budget savings may not be a true savings for the public.</p>
<p>PPP agreements often include provisions for an initial cash payment (rent) from the private sector to the highway agency. This payment allows the highway agency to fund other road projects.</p>	<p>The highway agency typically loses the ability to make capacity upgrades to facilities near the PPP project unless they are identified in a long-range transportation plan at the time the agreement begins.⁴ This can be difficult to plan when agreements last for several decades.</p>
<p>PPPs allow the highway agency to transfer substantial risks and responsibilities for the roadway to the private sector. This alleviates demands on the public highway fund.</p>	<p>Should any of these risks become costly, the highway agency might, in the interest of keeping the PPP agreement alive, feel compelled to bail out the private contractor with an extended concession period or other subsidy that negates any actual risk transfer. Also, the private contractor might pay for any additional costs incurred from risks simply by charging road users more in tolls. In both scenarios, the public ultimately bears the brunt of the risk, despite the contractual risk transfer from the highway agency to the private contractor.</p>

Critics of PPPs often point out that governments may be tempted to enter into PPPs because the costs of project construction will be spread out over their entire lifespan but kept off of public debt rolls, thus freeing up real and debt capital to begin multiple projects at once. That is to say that paying user fees or shadow tolls to a PPP contractor imitates debt service on highway construction without the need to actually take out a loan. However, the state transfers effective ownership and much of its control over the road to the private contractor in order to obtain this cash advance, which is not the case with public bond finance.

This has been the UK’s experience with the *Private Finance Initiative (PFI)* program (Boeuf 2003).⁵ Even though the British program did not yield sizeable savings over the traditional

⁴ The initial SR-91 contract included perhaps the most restrictive and egregious example of non-compete clauses, and transportation agencies have learned from this mistake. However, weaker non-compete clauses still remain an option in some PPPs such as the Indiana Toll Road and a number of toll roads in Texas, including the existing Toll 130 and Toll 45 SE routes near Austin and the future Highway 290 east expansion. As a result, concerns over non-compete clauses that can limit improvements or capacity enhancements still remain strong.

⁵ The PFI is a form of PPP introduced by the Conservative Government of the UK to increase the involvement of the private sector in the provision of public services, combining a procurement of private capital items by the public with an extension of public services contracting out (Allen 2001). In the PFI, the public sector retains responsibility

procurement methods, it was able to commence many highway projects simultaneously. In the case of the Indiana Toll Road, the State of Indiana received about \$3.8 billion for the 75 year lease, which enables the state to fully fund the 10-year highway modernization program (Poole 2007a). The prospect of such a sizeable cash advance in the face of funding shortfalls could lead highway authorities to adopt a myopic determination to engage in PPPs even when a PPP arrangement is not suitable for a particular *single* project.

By 2001, the British *PFI program* was becoming less popular with the growing realization by the public that so many projects had been undertaken that little public money remained to start new ones (Mackie and Smith 2005). Although using the PFI model reduced the *startup* costs of new highway projects, the government initiated so many projects that its foreseeable funds to pay shadow tolls to the contractors over the lifetimes of the roads had all been committed. In the interest of protecting the government's credibility and keeping PPP programs viable, public agencies are often tempted to bail out the private entities even at high taxpayer expense if the PPP begins to fail (Boeuf 2003). However, this can ultimately lead to more money being spent on the project than would have been under traditional procurement methods. Further, critics argue that no real risk transfer takes place if the public offers a safety net in the event of a failure.

Another critique of PPPs pertains to transactions costs and transfers. Allowing the private sector to enter markets traditionally within the public realm requires increased government regulation of private business, which can raise administrative costs and undermine savings for both the public and private parties involved (Gomez-Ibanez, Meyer, and Luberoff 1991). Additionally, governments sometimes argue that implementing a PPP program will stimulate private sector spending and tax revenues in turn, but the program does not actually increase the amount of investment capital available from the private sector. It is more likely, however, that the program may simply be drawing investments away from other private investment opportunities (Gomez-Ibanez, Meyer, and Luberoff 1991). In their efforts to mitigate the high costs of highway infrastructure provision and stimulate private investment, public agencies might merely be converting costs to administrative overhead and, in the process, adding more investment options to the private market.

Factors and Conditions that Influence the Outcome of PPPs

No simple set of conditions will ensure the success or failure of a PPP, largely because each of many PPP models is represented by only a few projects, and many of these projects are fairly new and their agreement lifetimes have not yet ended. Public agencies are just now establishing the best practices for undertaking PPPs, and their early efforts might not be representative of the full potential of PPP programs. Additionally, the conditions needed for success may vary from country to country based on the economic climate, legislative barriers, policy-makers' willingness to undertake PPPs, and the prevailing cultural attitudes toward private involvement in public sector affairs (1995; Mackie and Smith 2005; Sawyer 2005; Ward and Sussman 2006). Nevertheless, public agencies' experiences with PPPs thus far have yielded some useful lessons

to purchase services or implement the project, while the private sector is responsible for arranging finance to provide both the services and capital asset for the project. The most common form of PFI is a DBFO with output specifications decided by public sector managers and their departments.

with regard to the conditions needed for a successful agreement, especially in the early stages of the process. Table 3 lists some important conditions affecting PPP agreements.

Table 3: Risks and Background Conditions Affecting PPP Agreements

<u>Legislative:</u>	PPP-enabling legislation allowing a speedy approval process or hefty incentives can lower the transaction and time costs associated with initiating the agreement and make the PPP more attractive to private investors. A good balance between offering private incentives and protecting the public interest is needed. Public agencies usually shield private investors from the risk of legislation turning against a project once it is underway.
<u>Contractual:</u>	The type of PPP contract used affects the opportunities for the private firm to streamline costs. Ideally, the chosen program would incentivize the private entity to consider the long-term effects of choices made during the project, seek to minimize its lifetime costs, provide flexibility, include opportunities for profit and efficiency gains sufficient to offset the set-up costs of the PPP, and align the motivations of the private entity with the public interest. A key part of the agreement hinges upon the initial value assessment of the project. Undervaluation of the asset is a particular risk of the public sector, while overvaluation, or “winner’s curse,” is a risk facing the winning bidder.
<u>Political / Public Perception:</u>	Public hostility toward PPPs and privatization can jeopardize projects. The political support for PPPs can be worsened if the public has already experienced a failed PPP for a similar type of project.
<u>Public-Private Relations:</u>	Conditions, such as rate-of-return caps, ensure that the private sector does not exploit the project in the interest of maximizing profits. However, experience to date suggests that a cooperative relationship between the public and private entities is more beneficial to a PPPs success than a meticulously worded contract. Because long-term concessions may span multiple political administrations, PPPs viewed unfavorably by the public may become political campaign issues and worsening public-private relations could result in early termination or violations of the original contract.
<u>Public vs. Private Sector Goals</u>	The PPP agreement must successfully balance the public sector’s goal of protecting the public interest with the private sector’s profit-driven motives.
<u>Competition:</u>	If a new toll PPP facility is built too close to an existing parallel toll route, the split traffic demand may be insufficient to financially support both projects. Additionally, there will be high transaction costs involved with orchestrating cooperation between private entities where competing PPP routes intersect affect one another. Where untolled alternatives to a PPP facility exist, anticipating the level of demand for a tolled PPP facility may be very challenging. Also, the public partner should be careful not to limit its ability to carry out its long-range transportation plans by agreeing to excessive non-compete clauses.
<u>Market Conditions:</u>	PPP proposals must remain competitive with other investment opportunities available to private firms. When the private market presents many attractive investment opportunities, the public sector may have to add incentives and lessen the degree of investor risk transfer in order to keep PPP projects competitive, but this may diminish the overall cost savings and increase payments from both the highway agency and the road users.

<u>Environmental Approval Issues:</u>	Many countries require environmental approvals before projects can begin construction. Because the length of time needed to obtain these approvals can be uncertain, the public sector usually retains this responsibility either for obtaining approval before soliciting private sector bids, or by offering to compensate investors for time lost due to environmental delays.
<u>Construction:</u>	Changes in construction material and labor costs can hinder the cost effectiveness of a highway construction project.
<u>Usage:</u>	Traffic demand is generally projected to increase over time, but there is a chance that demand for travel along a new roadway may not meet projections, posing financial risks to private entities involved in both real toll or shadow toll PPP programs. The public sector sometimes offers to subsidize this risk because the private sector has little control over traffic demand.
<u>Currency:</u>	Developing countries sometimes use foreign finance institutions to fund highway PPPs. Devaluation of the home currency against the finance one can be fatal to a project under this funding program.

Source: (Bult-Spiering and Dewulf 2006; Doi 2002; Lockwood, Verma, and Schneider 2000)

As the many factors suggest, it is important to understand the types of risks and carefully examine whether it is beneficial to transfer risks from the public sector to the private sector, taking into account a potential tradeoff between the amount of transferred risks and the attractiveness of a project. Among the financial risks associated with highway projects are:

- (1) the environmental clearance risks arising from delays in obtaining the needed approvals,
- (2) the risk of political and public opinion delaying or requiring costly modifications to the project
- (3) construction cost overrun risks,
- (4) risks associated with operations, and
- (5) the risk of natural disasters.

Most of these risks, with the exception of those pertaining to construction and operations, are usually best managed by the public sector because of their political nature and uncertain timeframes. Additionally, public agencies may not be well-versed in the many financial management strategies commonly employed by the private sector. This may place the public sector at a competitive disadvantage when negotiating PPP contracts with private entities.

When public agencies get into a PPP arrangement with a private contractor, they must be careful to only transfer those costs that the private sector is capable of minimizing (*e.g.* construction cost overruns, but not politicians' changes of opinion regarding support for the project), otherwise there may be no cost advantage to having the private sector involved, and the uncontrollable risks will make the project unattractive to investors. In some cases, the project could be worse off if the transferred risks are better managed by the public sector, such as building political consensus. Ultimately there is a trade-off between public and private sector interests: the public sector wants to transfer enough risks to realize financial savings, but not so many that the private sector becomes uninterested in the deal or charges exorbitant user fees to protect itself in an overly-risky transaction. The key is to assign risks to the party best able to control them.

Legislation

PPP-enabling legislation ultimately governs what types of programs highway agencies can undertake. Policymakers can provide incentives to private firms willing to participate in PPPs as a means of making the agreements more attractive than competing investment opportunities. In addition, streamlined approvals processes increase the attractiveness of a project by reducing anticipated delays. However, governments must tread carefully when promulgating supporting legislation since the voters are often wary of governments enacting measures that, on the surface, can be construed to broadly endorse privatization, or that trade public interest for private profit. On the other hand, the laws cannot be so restrictive that they provide insufficient incentives for private sector involvement in PPPs.

In France, for example, the passage of a 2004 law made possible PPP contracts beyond long-term lease agreements (Lestrange et al. 2005). Though France's existing concession model for long-term lease agreements affords the private entities some protection from uncontrollable events that substantially raise the risk of the project, such as changes in law or low demand for the new facility, the system of incentives for the newly-allowed design-build-finance-operate programs may not be attractive enough to offset the risks shouldered by private investors and generate significant interest in the program (Lestrange et al. 2005).

In contrast, Spain has gradually passed a series of laws since the 1950's to increase the attractiveness of PPP agreements by lengthening concession periods, protecting the concessionaires against interest rate fluctuations, and fending off motorist unrest by using shadow tolls (Bult-Spiering and Dewulf 2006). While this increased shouldering of risks by the public sector makes PPPs more viable to private entities, it reduces the potential for savings over the traditional public procurement methods.

Contractual (Initial Setup) Issues

In order to protect the public interest, Gilroy et al. (2007) and Poole (2007b) suggest that concession agreements between public and private entities incorporate detailed provisions to cover a variety of issues, such as limits on tolls or rates of return, who pays for rehabilitation or future expansions, how the contract can be amended, and how to value the project in the case of early termination. A good value assessment of the project is essential to forming a sound agreement, but risk valuation in and of itself can be unreliable because PPP projects usually include complex agreements dependent on location and contextual details (Bult-Spiering and Dewulf 2006). Governments are often at risk of undervaluing existing infrastructure assets due to inexperience (Checherita and Gifford 2007). Conversely, winning private bidders are at risk of "winner's curse:" the possibility that their bid is best because they miscalculated the risks and returns (Checherita and Gifford 2007).

Risk sharing works best when contracts are flexible enough to allow for modifications in the event of unforeseen circumstances. In the case of the Virginia Dulles Toll Road, for example, the State Corporation Commission of Virginia retained the power to set toll schedules along the new facility so as to provide a reasonable return on investment for the private firm while protecting the public against exorbitant tolls (1992). This legislative provision demands a degree of trust between the public and private entities because the profitability of the project for the private entity lies in the hands of the public commission. In addition, provisions for the possibility of a breach of the contract and possible termination (*e.g.* if the public partner were to

limit the private partner's ability to set tolls, or if a competitive clause were to be violated) are both advisable and common to such contracts (Checherita and Gifford 2007). However, very easy early contract termination terms can make it easy for one party to abuse the agreement (Boeuf 2003). For example, given that the public sector often retains the residual risk of asset ownership, public contract partners may experience heightened risk if the private contractor uses the threat of easy early termination clauses repeatedly seek to renegotiate the terms of the contract (Checherita and Gifford 2007).

Streamlining the contracting process is usually desirable because it reduces the amount of time and resources that both the public and private sectors must spend on bidding. Officials in Ireland noticed a drop of PPP proposals because the government demanded that private entities create overly-elaborate submissions with no guarantee of winning the contract (Reeves 2005). In crafting terms more attractive to potential bidders, governments must ensure that the bidding process remains fair and open to public participation, but a completely transparent bidding process poses some risk to the bidders, making their proposals available to their competitors (AECOM Consult 2007).

In addition, the payments to the private sector, whether direct government subventions or in the form of tolls, must cover the costs of providing a reasonable profit to the private investors, something the public sector does not require. Thus, a wide range of PPP projects may appear attractive to public agencies because they present the potential for savings, but in order for PPPs to be a cost-effective choice for the motoring public, the project must realize sufficient efficiency gains and cost savings to offset the increased *transaction costs* over the traditional procurement method and the profit for the private investors. In other words, there is a potential for a PPP to deliver a project at a lower cost than traditional procurement, but the high costs of establishing a complex PPP agreement might negate this savings.

Political / Public Perception

Public perception of PPP projects is a key element in the formation of political consensus, so governments must establish an open and transparent contracting process. PPPs are often misconstrued by the media and general public as privatization and can encounter the ensuing heated debates as seen in the recent debates over the Chicago Skyway and the Indiana Toll Road. Mistrust of the PPP model can be heightened if the jurisdiction has experienced a failed PPP in the past. Motorists are also likely to disapprove of instituting tolls on facilities that were previously toll-free. Hong Kong's government, in the face of the public perception that taxes were high enough to finance new roads if better managed, adopted a policy, whereby new roadways were entirely financed with tolls and existing roadways were entirely financed with tax revenues, to ensure that the tolls were not perceived as a tax increase (Stafford and Chen 1993). The European Union took similar measures in 1999 by banning the levying of tolls and taxes on the same roadway segment, though tolls may be spent on segments where only taxes are collected (Borgnolo and Rothengatter 2005)

Malaysia's government has opted to minimize the amount of time needed to establish PPPs by shortening the bidding process, conducting negotiations in secret, and removing nearly all public participation. However, this savings in setup costs comes at the price of increased political risk, since the public has grown suspicious that the contracts are being awarded based on political connections rather than potential public benefit (Ward and Sussman 2006). Brazil

has taken a different path to streamlining the contracting process by increasing the transparency of the proceedings and setting rigid guidelines for bidding (Dijck and Haak 2006)

In the case of the Virginia Dulles Toll Road, state lawmakers exercised caution by allowing each affected local jurisdiction veto power over the roadway project (1992). While this increases the political acceptability of the project and allays any mistrust of the state government at the local level, it gives one small jurisdiction the power to cancel a project that would have far-reaching regional benefits.

Although PPPs are undoubtedly a step in the direction of privatization, they represent a sharing with, rather than a full transfer of risks and responsibilities to, the private sector (Bult-Spiering and Dewulf 2006). Additionally, the public sector almost always retains ownership of the facility. The public is more likely to be accepting of tolling if they can see the direct benefits of their payments (Stafford and Chen 1993). In any event, the political acceptability of highway PPPs is still not well understood and must be tested further (Little 2005).

Public-Private Sector Relations

Numerous writers have suggested that a positive working relationship between the public and private entities is ultimately more vital to the success of a project than a specifically worded contract, and much of the groundwork for this relationship is laid during the formation and selection phase of the PPP (Sclar 2000). Experience suggests, therefore, that the selection process invariably includes consideration of factors above and beyond the lowest responsible bid; relationships of trust are often the key.

Additionally, most PPP agreements include rate of return caps to ensure that the private sector does not net too much profit at the expense of roadway maintenance, construction quality, or reasonable user fees. Agreements typically require any profits beyond the cap to be returned to the state highway fund (1992). Ideally, the private sector will contribute the positive attributes of speed, efficiency, market familiarity, and risk-taking ability to the project, and the public sector will use its influence over the law, access to low-interest debt, reliability, and eminent domain powers to facilitate the project (Bult-Spiering and Dewulf 2006). In order to increase the political palatability of PPPs, states often reserve the use of eminent domain on behalf of the private entity to circumstances where private negotiations are failing (1992). However, the use of low-interest public debt in a PPP may trigger additional regulatory conditions normally imposed upon fully public projects, or be prohibited altogether (1995). Latin American countries, such as Chile, have also made a point of seeking experienced toll road builders and operators to participate in PPPs as a way of assuring the public of the finished facility's quality (Carniado 2005).

Differences in Public and Private Sector Goals

Officials in public agencies must also realize that their public interest goals often differ from the private sector's profit-driven ones, and they must take care to craft PPP agreements in a way that avoids the *principal-agent problem*. That is, the private entity might carry out projects in a way that serves its own self interests, and this might be incompatible with the public interest (Sclar 2000). To guard against this phenomenon, the Netherlands employs a system of strict performance standards, and can terminate a PPP contract if the concessionaire fails to meet them (Bult-Spiering and Dewulf 2006).

The public sector is oriented toward maintenance of political favor, risk minimization, and democratic pursuit of social goals, while the private sector focuses primarily on profit maximization, risk-taking, and corporate competition (Bult-Spiering and Dewulf 2006). Some degree of reconciliation is needed in PPP contracts, and some conflict of interest may still persist. Private entities are likely to only take an interest in the most profitable projects, where there is potential for streamlining the construction or procurement process (Bult-Spiering and Dewulf 2006). These concerns come to the forefront in countries experiencing heated debates over privatization. PPPs are especially vulnerable to criticism because they bring to light all of the financial and social risks involved in highway projects as they are divvied up between the public and private sectors. These risks, such as cost overruns, construction defects, and delays, have historically been present in all highway construction projects, but they are not readily apparent when absorbed by the public sector (Boeuf 2003).

Competition

Competition among private entities for PPP contracts is the key to realizing efficiency gains. Otherwise, firms will face little incentive to streamline their plans and place the best possible bid. However, this requires a competitive process and precautions against private monopolies, forcing the public sector to spend a lot of time considering proposals and selecting the winner, especially since the lifetime of the agreement usually spans several decades. This adds to the increased set-up or transaction costs over traditional procurement methods.

If multiple PPP projects are constructed by different private entities in close proximity to each other, the government will also have to step in and regulate the tolls to ensure an optimal distribution of traffic, further increasing transaction costs (Gomez-Ibanez, Meyer, and Luberoff 1991). Where alternatives to the PPP already exist, failure to anticipate the level of demand for the PPP facility, or to provide for some form of compensation for competition, may lead to lower than expected returns for the private partner's investors (Page et al. 2008). Highway agencies must also take care to balance their own future development plans with the private entities' needs for profit. On one highway widening project in Southern California, adjacent to the SR 91 Express Lanes PPP, many aspects of the agreement worked well, but a "non-compete clause" in the contract prevented the State of California Department of Transportation (Caltrans) from making improvements to the parallel unpriced lanes, prompting the premature end of the agreement and the Orange County Transportation Authority to buy out the private entity's concession (Gougherty 2005a). This negative experience helped lead California to withdraw plans for additional PPP highway projects, and nearly a decade passed before the state revisited PPP legislation (Tolls, User Fees, and Public-Private Partnerships: The Future of Transportation Finance in California? 2007).

Market Conditions

PPP projects represent an investment opportunity for the prospective private sector contractors. As such, public agencies must package the agreements in a way that makes them attractive vis-a-vis other private investment opportunities. This can be done by adding bonus incentives, allowing for longer concession periods, or diminishing the amount of risk transfer. Each of these strategies can potentially increase the cost of the project to the public, and diminish the attractiveness of PPPs. Consequently, when the market is flooded with investment projects,

public agencies may have to add heavy incentives to PPP projects, thereby increasing public sector assumption of risk and reducing their cost effectiveness.

Environmental Approval Issues

The design of PPPs presents a dilemma for public agencies. Determining the stage at which to bring the private entity into the project can be vexing. Most believe that responsibility for obtaining the necessary environmental clearances is best left with the public sector, since the process involves delay risks that are mostly out of the control of the private entity, and public agencies have more experience with the process. However, a detailed design plan is needed in order for the environmental clearances to proceed.

In PPPs, public agencies generally want to involve the private sector in the design phase of the project so as to allow as much input as possible, but do not want to complicate things by transferring the responsibility for obtaining environmental clearances to the private contractor or impose an uncertain delay period in the PPP contract while the environmental clearances are being obtained. Transferring this responsibility can significantly increase financial risk for design-build-finance-operate concessionaires because environmental study challenges can take years to resolve, particularly in the U.S. This can also greatly increase risk and costs for private contractors to start servicing debt accrued during the project's design phase. The Portuguese government, for example, shields the private concessionaires from delay risks stemming from environmental review court challenges by compensating them for lost time (Bult-Spiering and Dewulf 2006). Likewise, private firms wanted the State of California to include as part of Assembly Bill 680⁶ that Caltrans would guarantee repayment for government-caused project delays (1992). Thus, environmental review requirements can reduce the amount of cost effectiveness in the design phase of a PPP by disallowing private entity involvement until after the contract has been signed (Bult-Spiering and Dewulf 2006).

Construction, Usage, and Currency

The wide array of project risks ultimately affects the profitability of a PPP project. Changes in labor and material costs can raise the price of construction and erode the profitability. Construction cost inflation is especially risky for large infrastructure projects, like highways, where construction will likely span several years. Cost overruns and project delivery delays brought about by changing costs or availability of labor and materials, design changes, poor management or construction practices, or defaults by suppliers are typically borne by the private partner, although they may be mitigated in some cases by using fixed-price construction contractors (AECOM Consult 2007; Checherita and Gifford 2007; Fishbein and Babbar). Unexpected construction costs and delays brought about by challenging geography, however, is sometimes shared (AECOM Consult 2007; Checherita and Gifford 2007; Fishbein and Babbar).

When real or shadow tolls make up a significant portion of the private sector's revenues, shortfalls in traffic demand can spell financial trouble. The public sector will usually step in and offer protection against diminished returns due to low travel demand, since it is a factor over

⁶ Assembly Bill 680 (AB 680) was enacted by the California legislature in 1989. It authorized four toll PPP demonstration projects, two in Northern California and two in Southern California. The bill mandated that Caltrans retain official ownership of each highway facility at all times, but permitted leases to private entities for periods of up to 35 years.

which the private sector has little control. The use of shadow tolls, which separates facility usage and toll collections from payments to contractors for collecting the revenue can also expose the public sector to additional risk if demand and toll revenues are higher than projected; the higher revenues and higher associated contract payments may mean that revenue for other transportation needs is lost (Ortiz and Buxbaum 2008; Shaoul, Stafford, and Stapleton 2006). Portugal initially used shadow tolls instead of real tolls so as not to risk reducing traffic levels, but the government eventually shifted toward real tolls when it became apparent that traffic levels nearly always increased over time (Bult-Spiering and Dewulf 2006). In Ireland, the government requires that a free alternative route to every toll road be available (Reeves 2005), but this exacerbates the usage risk because it is uncertain how many motorists would choose the toll road over the free one, and if the toll revenues would be sufficient to cover the private entity's expenses.

Developing countries sometimes use foreign banks to finance infrastructure PPPs, but a devaluation of the project's currency against the finance one can render a project bankrupt. As a result, several Latin American governments have instituted a policy of only using local debt (Carniado 2005).

The numerous factors influencing the outcomes of PPP strategies underscore the need for careful consideration of the appropriateness of PPPs for a given project. It quickly becomes apparent that PPPs exist in the context of a market economy and carry with them all of the associated risks. Private investors will not participate unless it makes financial sense for them to do so, and the compromises required to attract them are sufficient to make public agencies realize that PPPs are not synonymous with free funding. As a result, agencies might find the decision of whether to use PPPs difficult. The following section accordingly draws on PPP use studies to suggest criteria for determining the potential efficacy of PPPs.

5. EXAMPLES OF PPP PROJECTS

All of the above-mentioned risks and issues can be addressed, but not simultaneously. For example, a PPP project cannot have a short, inexpensive setup period and still allow for all public and environmental concerns to be thoroughly incorporated. Policymakers must choose a balance between all of the relevant factors based on the economic, political, social, institutional, and environmental settings in which the PPP projects are to be implemented.

In this section, we discuss three PPP case studies from three parts of the world: 1) Malaysia, 2) the United Kingdom, and 3) California. These examples underscore the importance of carefully selecting a balance between competing factors and risks, as well as comprehensively forecasting future traffic demand and infrastructure needs. Malaysia and the United Kingdom represent two ends of the spectrum when it comes to public input and ensuring an equitable contract awarding process, both with mixed results. California, on the other hand, managed to build a stable PPP that was undone by a disagreement over contractual terms.

Malaysia – Political Risks Realized

Malaysia began using toll road PPPs in the early 1980's to finance nearly 1,000 miles of new highways (Ward and Sussman 2006). At the inception of the program, state-owned enterprises were performing poorly, and political leaders sought to stimulate private Malaysian-owned businesses through a series of PPP programs (Ward and Sussman 2006). Though most of the

PPP projects have proceeded as envisioned, the Malaysian government has, until recently, largely ignored the political risks associated with private sector collaboration, and the resulting public unrest has negatively affected the country's PPP program.

Though the country has managed to construct an expansive highway system using PPPs, this method of finance is becoming increasingly unstable due to growing public opposition towards the contracting and setup process. In order to minimize the setup costs of PPP agreements, the government has opted to largely ignore environmental concerns regarding new roads (such as sprawl, noise, and air pollution) and keep negotiations with private contractors secretive (Ward 2005). Politically well-connected applicants usually win whenever competition arises (Ward and Sussman 2006). Private entities are permitted to propose new PPP projects, a condition that favors the private sector but can lead to under-the-table dealing. Additionally, the government frequently shields investors from financial risks by extending concession periods or granting additional cash payments from public funds whenever toll income begins to lag (Ward and Sussman 2006). Thus, a portion of the financial risk is shifted from the private concessionaire to taxpayers at large. This has resulted in widespread public mistrust, and public protests have proven sufficient to force policymakers to reduce tolls and delay expansion of the highway system (Ward and Sussman 2006). These events underscore the importance of the political risks surrounding PPPs, as insufficient public input and unwelcoming attitudes toward privatization can spawn accusations of government corruption and misuse of toll revenues. In the United States, where public input already plays a prominent, legally-mandated role in planning, the effects of such political unrest would be even more pronounced. Ultimately, the Malaysian government has responded by allowing limited public participation in the PPP planning process, with the first project to allow public comments occurring in 2003 (Ward and Sussman 2006). Though the government is now taking steps toward allaying public concerns about the PPP process, these actions are unlikely to erase the political damage wrought by decades of closed-door negotiations.

United Kingdom – Maximum Political Acceptability but Unclear Financial Benefits

Facing a dire need for highway system expansion and a lack of public funds, the United Kingdom government undertook the Private Finance Initiative (PFI) program in 1992 to help the cash-strapped highway agency use a design-build-finance-operate program (Debande 358). Agency officials tout the successes of the program, citing high-quality project management on the part of the private investors and attractive opportunities to shift moderate-risk projects off of the public budget (Standard & Poor's 2005). However, in efforts to create a politically palatable program, the government has sacrificed some of the potential benefits associated with PPPs.

Unlike Malaysia, the UK's bid review process is lengthy and comprehensive, involving several stages of negotiations taking up to two-and-a-half years to complete (Bult-Spiering and Dewulf 99-101). This markedly increases the PFI setup costs, shouldered by both the public and private sectors, underscoring the need for financial savings over the lifetime of the PFI agreement to sufficiently offset the additional money spent on establishing the contract. Though the enabling legislation standardizes this process, it still proves time-consuming. Furthermore, the UK does not allow the private sector to propose new projects, thus ensuring that bidders cannot propose contracts that they are best-suited to win, but reducing the potential for innovative proposals (Bult-Spiering and Dewulf 99-101). However, these laws allot adequate time for public input and provide for very transparent negotiations.

The PFI program favors protecting taxpayers' investment in the highway system more than it shields private firms from risks that could result in financial losses. Highway officials admit that some contractors have lost money on PFI projects, up to £100 million in some cases, but maintain that these were due to faulty cost estimates at the time when fixed payment amounts were negotiated (Standard & Poor's 2005). The UK government has typically not offered contract renegotiations to bail out concessionaires who begin to experience financial trouble, thus protecting taxpayers from paying for potential mismanagement on the private sector's part (Standard & Poor's 2005). As a result, banks and lawyers representing the private concessionaire now spend even more time examining PFI contracts prior to approval, further increasing the setup costs. Officials also note that private firms have also become more averse to accepting clauses allowing changes in specifications (Standard & Poor's 2005).

The UK has elected to use shadow tolls to maintain political acceptability in areas where people are accustomed to using highways free of charge, while still remunerating the concessionaire in proportion to road wear and encouraging roadway design that maximizes traffic throughput. In most cases of the PFI projects, traffic is almost certain to increase, and shadow tolls have generated revenue close to fixed payments which are indexed to inflation (Mackie and Smith 2005). By substituting largely-predictable government payments for direct user fees, shadow tolls essentially convert PFI finance to a long-term mortgage more akin to a build-operate-transfer program than design-build-finance-operate. In these cases, the public sector pays about the same amount as it would under traditional procurement methods, but the up-front costs are converted to payments stretched out over a the lifespan of the PFI agreement, thus initially freeing up capital to begin multiple projects at once (Mackie and Smith 2005). Though the public can potentially benefit from having much-needed roads built sooner for the similar price, it is unclear whether the UK's PPP financing program brought any additional economic benefits compared to traditional procurement. By 2001, the committed shadow toll payments added up to a level where no public funds remained to issue new contracts, effectively ending the PFI program. Additionally, increases in interest rates in 2003 made private debt unattractive compared to public debt, though the substitution of private finance for public funds nevertheless remains attractive whenever public money is scarce (Mackie and Smith 2005).

Though the UK government has taken steps to maximize the political acceptability of toll roads, these precautions have placed limitations on the potential for savings over traditional procurement methods. The combination of shadow tolls, exhaustive setup procedures, and substantial deference to public opinion is indicative of a PPP program that is unwilling to accept new risks on the public side, and subsequently provides few opportunities for public benefit.

California – Contractual Issues

California initiated its experimentation with PPP toll roads in 1989 with the passage of Assembly Bill 680 (AB 680). The bill authorized four demonstration PPP projects, with at least one in Northern California and at least one in Southern California so as to promote geographic equity. The bill allowed the State of California Department of Transportation (Caltrans) to enter into PPP agreements with private entities for the purposes of facility construction, with lease periods of up to 35 years. The private entities would be able to charge tolls to recover their investments, and Caltrans had the option of continuing the tolling after the facilities reverted to full public control. In order to prevent private profits from absorbing a large amount of the toll revenues, contract limited the rate of return on each project to 18 percent (Gougherty 2005).

One of the AB 680 projects, the SR 91 Express Lanes, added four new lanes to an existing eight-lane freeway in Orange County between Anaheim and the Riverside County line, a distance of about ten miles. In order to preserve the benefits of congestion relief provided by the new lanes, they were designed as congestion-priced high-occupancy toll (HOT) lanes, where variable tolls would keep traffic moving freely at all times of day. The private consortium, California Private Transportation Company (CPTC) undertook the construction and then transferred the new lanes to the Orange County Transportation Authority (OCTA), which then allowed CPTC to operate the roadway and charge tolls for 35 years (Gougherty 2005).

OCTA sought to construct the SR 91 expansion under the provisions of AB 680 largely because voters had defeated a sales tax initiative to fund the project. Problems began to surface when neighboring Riverside County became frustrated that it had spent public funds to build its portion of the expansion, but Riverside County residents would still have to pay tolls on the facility when passing through Orange County. Though the two counties eventually reached a compromise, a later problem led to the premature termination of the PPP contract. After the facility had opened, Caltrans announced its intent to add capacity to the free lanes along SR 91 in the vicinity of a congested interchange. However, the contract with CPTC stipulated that Caltrans could not add any additional free capacity near the PPP facility because it would diminish the advantage of driving in the toll lanes, and hence eat away at toll revenues. Eventually, OCTA bought CPTC out of the contract so that the interchange upgrades could be built, but still contracts with CPTC for the purposes of operating the roadway (Gougherty 2005).

The PPP troubles with SR 91 spurred the state legislature to pass Assembly Bill 1010, which effectively ended the program set forth by AB 680 by scaling it from four projects down to just two: SR 91 and another project already underway in San Diego County (Gougherty 2005). California's experience with SR 91 demonstrates the need for both parties (public and private) to carefully consider long-term traffic projections and anticipate the potential need for new traditionally-financed projects when considering PPP contract provisions. This case proves especially true when inserting a new PPP road into a network of deteriorating public roads that will likely require upgrades in the near future. Though the initial disagreement between Orange County and Riverside County officials proved minor compared to the later contractual problems over the "non-compete" clause, the conflict highlights the potential "double payment" equity problems of having a PPP road whose users reside in multiple jurisdictions, especially where one jurisdiction will be using fuel tax revenues for construction, and another will be using tolls. Even if the road is fully contained in one jurisdiction, motorists frequent cross political boundaries in their daily commutes, and disparities between payment mechanisms should be taken into account. Motorists traveling exclusively on toll highway networks would still be paying fuel taxes into a general highway fund.

In light of the arguments by PPP supporters that the fundamental aspects of the SR 91 partnerships were successful and the toll structure provided sufficient payment to CPTC while in place, California legislature enacted Assembly Bill 1467 in 2006. This bill, like AB 680, allows for four PPP HOT lane demonstration projects, as well as four PPP goods movement projects to be supported by tolling commercial vehicles (Caltrans 2007). Additionally, the Caltrans Director recently called for further legislation identifying high-priority corridors for PPPs and allowing regional transportation authorities the ability to enter into PPPs for these projects, as well as to build toll roads using traditional procurement methods (Caltrans 2007). Thus it appears that, in light of overwhelming port and highway traffic and the lack of public funds to improve the

existing transportation system, California officials are ready to learn from their experiences with AB 680 and revisit PPPs for the state's highways.

These three examples present different situations in which tradeoffs among different risk factors resulted in less success than expected. These examples also suggest that it is simply not possible to treat all PPP transportation programs/projects in the same way due to a wide variety of economic, political, social, institutional, and environmental factors. Therefore, each proposed project requires a careful evaluation. At the same time, legislative settings provide, if appropriate laws are enacted, the basic legal framework that can protect public interests and foster conditions for successful PPPs. Given appropriate legislation, a prudent public agency can design an effective contract to best utilize particular PPPs for a project. Contractual conditions, combined with legislative conditions, determine potential costs, benefits, and risks for both the public and private sectors. With several different models to choose from, public agencies must develop a framework for selecting the most appropriate type of PPP, if any, for a given project.

6. PRELIMINARY FRAMEWORK FOR EVALUATING PPPS

Assessing a PPP strategy depends partly on the definition of success. Our review of the research literature reveals that most analyses to date focus on the net *financial* benefit for governments. This makes intuitive sense, since the most common motivation for governments to adopt a PPP strategy is to advance project development when traditional funding is tight. However, conventional evaluation of transportation projects is based on the net *socio-economic* benefits to the public, a more comprehensive approach. When spending public money, public agencies must primarily consider the *socio-economic* benefits that new facilities will produce to the society when determining whether or not the construction is worth pursuing. It makes little difference whether an ineffective new facility was built at a low cost; any amount of expenditure constitutes wasted funds if it does not meaningfully benefit the public. Whether to build a facility using a PPP thus emerges as a secondary consideration, and any evaluation should focus first and foremost on how such a program would affect the *socio-economic* effects of the facility, rather than the much narrower question of whether the public agency could save money relative to other means of project finance. In essence, it is important to distinguish in any discussion of PPPs between an evaluation from the *financial* perspective and an evaluation from the *economic* perspective. Making no explicit distinction between the financial and economic evaluation perspectives ultimately a principal source of disagreement between public officials who promote PPPs to reduce the government financial spending, and those who are concerned about the broader economic effects of a given project.

Considering only government financial benefits does not provide a complete picture of the total costs and benefits of PPP strategies vis-à-vis other means of project delivery and finance. Public agencies might mistakenly view PPPs simply as a means of getting projects built *cheaply*, since the absolute amount of up front funding required in the public agencies' budget is typically reduced, especially under toll concession models where the payments to the private concessionaire are made directly by the road users over the concession period. However, PPPs should under no circumstances be construed by public officials as "free" money; rather toll concession models shift a burden of payment from taxpayers to road users, which may or may not be desirable depending on public policy objectives. It is possible that a PPP will increase economic efficiency, and it is likewise possible that the public may end up paying more in tolls

for the roadway under a PPP than it would have in fuel taxes or issuing bonds under traditional finance methods.

Focusing exclusively on the financial costs and benefits for a moment, while PPPs often appear beneficial from the public agency's relatively narrow financial perspective, they may not necessarily generate *net financial* benefits for the public. More broadly, the question of net financial benefits (most often framed as cost savings) to the public does not ensure a project with a PPP method result in net positive economic benefits for the society.

In addition, should the private entities involved in a PPP encounter financial troubles, motorists may experience toll changes due to factors unrelated to the instant project. In other words, the public agency is not always the loser when risks arise in a PPP deal. This can cause highway agencies to overlook important potential drawbacks when entering into PPP agreements or use PPPs to implement projects that may not be financially sound, creating "principal-agent" problems between highway users and the transportation agency.

It is thus important for public officials to keep in mind that PPPs *may or may not* reduce the costs of highway building. If not, PPPs may only shift the responsibility for paying for roads from one group to another. Both PPPs and traditional procurement, in other words, ultimately draw funds from the pockets of the public, both road users and taxpayers more broadly (Federal Highway Administration 1992). Any real value addition will come only from financial, managerial, and technological efficiency gains large enough to offset the increased transaction costs,⁷ and it is debatable whether PPPs are the only or best means of creating these efficiency gains.

Table 4 describes criteria frequently used to evaluate PPP projects. It also specifies whether each criterion is typically included in the *financial* evaluation and the *economic* evaluation.

⁷ Cost-savings that the highway agency intends to realize through new PPP methods may be offset by additional transactions or other costs of such new methods. Whittington and Dowall (2006) compared two projects of similar scope, one delivered by a design-build contract and the other by more traditional means, and found that design-build contracts produced virtually no cost savings. While the design-build project had relatively small costs associated with change orders and administration, these savings were offset by much higher construction cost estimates.

Table 4 Criteria Frequently Used to Evaluate PPP Projects

Criteria Typically Considered in Financial Evaluations	
<u>Type</u>	Description
<u>Valuation of asset:</u>	Procurement of land, opportunity cost of use of land
<u>Construction costs</u>	Material and labor costs
<u>Maintenance & management costs:</u>	On-going costs associated with operation, management, administration, and maintenance of the facility
<u>Interest for bond issuances/borrowing</u>	Interest that public agencies need to pay creditors when they borrow money, such as loans and bonds
<u>Revenue:</u>	Income from toll collection, and the private entity's ability to carry out the highway project at a lower cost to the highway agency and motorists than the traditional public procurement and finance methods
<u>Transaction Costs:</u>	The length and complexity of the bidding and contract management process, and whether the process is costly enough to erode the potential benefits of the project and/or scare away potential bidders.
<u>Risk Distribution:</u>	Whether the risks transferred to the private entity were the ones that it had the most control over, and was therefore best-suited to minimize.
Additional Criteria Typically Considered in Economic, but not Financial Evaluations	
<u>Type</u>	Description
<u>Efficiency:</u>	Whether the private entity delivered the project on schedule and within budget.
<u>Innovation:</u>	Whether the private sector involvement resulted in technological innovation despite the government and financing institutions' aversion to untested practices that could add risk.
<u>Public Benefit:</u>	The degree to which the project and the use of a PPP program served the public interest. This is often difficult to describe with certainty, because there is usually no consensus over what factors comprise the public interest.
<u>Others:</u>	Environmental costs, equity impacts in users' accessibility

Source: (Bult-Spiering and Dewulf 2006)

In order to promote better informed evaluations of transportation infrastructure projects, our preliminary evaluation framework integrates both financial and economic criteria into the project evaluation process. The most effective and efficient transportation investments are those that significantly reduce travel times and costs for users. However, as we have noted, transportation agencies in the U.S. tend to focus only on financial criteria, and not economic criteria, in their consideration for various PPP financing methods, although various PPP financing methods often have different economic cost and benefit outcomes that include financial costs to and benefits for society. While often ignored in PPP research here in the U.S., the difference between financial and economic evaluation is nothing new in the international development field, and such project evaluations are commonly used by international investment organizations for projects, including

transportation infrastructure development. The difference between the financial and economic evaluations can be seen in the discounted cash flow (DCF) method, which is commonly used for a project evaluation (Doi 2002; McFarquhar 2001). The DCF converts a stream of costs and benefits over time to a net present value (NPV), an internal rate of return (IRR), and a benefit/cost ratio (B/C ratio), all of which can be used to evaluate the effects of a project.

Among these, the IRR has an advantage in its ability to be calculated in analyses even with substantial uncertainty regarding interest rates or social discount factors (SDR), compared to the NPV and B/C ratio methods (Doi 2002). The IRR is, by definition, is a value, which is equivalent to an interest rate (or social discount factor) to make a NPV equal to zero in equation (1).

$$NPV = \sum_{t=1}^T \frac{B_t}{(1+r)^t} - \sum_{t=1}^T \frac{K_t + O_t - S_t}{(1+r)^t} \quad \text{Eq. (1)}$$

where

B_t : annual revenue in the financial analysis, and annual benefit in the economic analysis

K_t : capital investment/cost

Q_t : annual operating cost

S_t : salvage value

r : interest rate or social discount factor (SDR)

t : year, T : the total number of years of a project

The IRR has two types. First, the *financial* internal rate of return (FIRR) focuses the financial flow of money and vitality of the project, ignoring externalities (costs and benefits) to the financing entity. In this case, B_t in equation (1) represents annual financial revenue from the project. In contrast, the *economic* internal rate of return (EIRR) takes into account externalities in the computation of costs and benefits for a specified time period, and is used in a public project proposal.⁸ In this case, B_t in equation (1) represents benefits accrued from the project by the society—typically travel time savings, reduction of accidents, and reduced negative environmental impacts.

In the economic benefit analysis, the EIRR from the proposed project can be compared to that for an alternative plan (including the “no-build” option). In this way, this method can evaluate the net benefits of a project for different types of provision strategies, including PPPs. However, in reality, the factors discussed in the previous sections influence benefits, costs, different risks

Net Present Value (NPV): The discounted present value of future benefits

Internal Rate of Return (IRR): The expected percentage yield on capital invested in a certain project

Benefit/Cost Ratio (B/C): A measure of investment worthiness, comparing the value of expected benefits to the costs needed to obtain them.

⁸ Particularly in the case of international agricultural development projects, the intervention effects of a project cause price distortions for both consumers and producers, resulting in changes in societal benefits and costs. In principle, “[s]ocial or economic benefit must account for externalities by incorporating social or shadow prices, i.e. prices that would occur in the market, were it free from intervention” (McFarquhar 2001).

associated with different strategies, and what should be reflected in discount rates (McFarquhar 2001).

One of substantial advantages of using the private capital is that a transportation project can be implemented earlier than it would be if queued up waiting for scarce public funds. When traffic tends to increase over time and benefits include only reduction in user costs, *the first year return method* shows the net benefit to implement a project by one year can be shown by the following equation (Doi 2002).

$$(\text{Net-Benefit})_{t^*} = (b - a)Q_{t=t^*} - \bar{r}K \quad \text{Eq. (2)}$$

where

a: maintenance cost per unit of traffic

b: reduction in the user cost per unit of traffic

Q_t : annual maintenance cost

K: the construction cost of facility (assumed to complete in one year for simplicity)

\bar{r} : known interest rate

t: year, τ : time period

This equation also needs to be modified for a more general case of a PPP strategy, taking into account the evaluation criteria: 1) cost savings (or increase) to the public agency, 2) cost savings (or increase) to taxpayers and highway users, 3) avoidance of cost overruns, 4) transaction costs, 5) timeliness of construction completion, 6) transfer of risks which the private sector has the ability to minimize, 7) technological innovation (Bult-Spiering and Dewulf 2006), 8) other socio-economic benefits for the society, 9) interest rates for the initial investment, and 10) the stream line of revenue from user fees for the private firm.⁹ It should be noted that these evaluation criteria are greatly influenced by subjective values that vary based on political and social context. These contexts, combined with the presence of many stakeholders disagreeing over what exactly comprises the public interest, make it difficult to assess the degree to which the public interest is served and compare projects across borders (Bult-Spiering and Dewulf 2006).

One of the critiques to this type of analysis can be seen for a public sector comparator used in the United Kingdom to determine if a project will yield good value for money if carried out using a PPP. A public sector comparator is a measurement of how much it costs and how long it takes to execute and complete a project with a PPP agreement, compared to the estimated costs and time of traditional procurement. That is, public sector comparators estimate the value added to a project by using a PPP agreement. However, these comparators are often criticized for relying too heavily on quantitative measures at the expense of important factors like public satisfaction (Bult-Spiering and Dewulf 2006). If the project provides little public benefit in the first place, the use of a PPP will do little to improve the usefulness of the facility.

7. CONCLUDING REMARKS

Public private partnerships (PPPs), often in combination with some form of road pricing, have garnered increasing attention from public officials in the U.S. and abroad who find

⁹ This idea of modification requires more careful consideration.

themselves short of funds to construct and maintain transport infrastructure. In this extensive review of the PPP literature, we discussed the properties of highway and road infrastructure relevant to PPPs, described various types of PPP arrangements applicable to highway infrastructure projects, reviewed the factors and conditions that influence the outcome of PPPs, and discussed examples from recent PPP projects in both the United States and abroad. Based on both contracting theory and our reviews of past PPP projects, we developed a preliminary conceptual framework to evaluate both the financial and economic merits of various PPP (and non-PPP) strategies. In this framework, we emphasize the differences between two criteria—(1) *financial* costs/benefits, and (2) *socio-economic* costs/benefits, and identified factors and conditions that influence each. We then briefly compare and contrast *financial* internal rate of return (FIRR) and *economic* internal rate of return (EIRR), which are commonly used in the project evaluation in the international development field.

In later phases of this research we will review and examine both federal and state legislative and institutional frameworks that significantly affect the adoption, feasibility, risk, and outcomes of PPP strategies for highway projects. This research in combination with our ongoing review of PPP highway projects will allow us to develop useful guidelines on both the legislative and contractual settings that lead to the best PPP outcomes from the perspective of the public sector. We also intend to develop an evaluation framework that public agencies can use when considering various highway finance strategies, including PPPs.¹⁰

To close, PPP agreements have the *potential* to deliver much-needed highway improvements to the public at lower costs and on shorter timelines than traditional procurement methods. Such potential can lead some to advocate PPPs with uncritical enthusiasm. But the potential rewards of PPPs are balanced by risks: PPP agreements can go sour and cost the public more than it benefits society. PPPs may save a given public agency money, but such savings do not necessarily translate to lower user fees, lower tax payments, or increased economic benefits for the public. Although public officials anxious to find new revenue sources for highways, PPPs may at first appear to generate “free money” for highway projects. But money, like lunches, is never free. PPPs generate revenue by redistributing costs and risks between the public and private sectors in a way that often benefits the party with the most relevant expertise and experience. Public officials would thus be wise to consider PPPs, but in a careful way that ensures that the public financial and economic benefits of PPP projects outweigh their risks and costs.

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¹⁰ Most of this research is slated for Phase II of this project, which was on hold at the time of this report.

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Task B-2: Status of Legislative Settings to Facilitate Public Private Partnerships in the U.S.

**Hiroyuki Iseki, Jeanette Eckert,
Kansai Uchida, Ryan Dunn, Brian D. Taylor**

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Task B-2: Status of Legislative Settings to Facilitate Public Private Partnerships in the U.S.

California PATH Project

Evaluation of Open Road Electronic Toll Collection for California Applications

(Task Order 6330)

Hiroyuki Iseki, Ph.D.
Department of Planning and Urban Studies
University of New Orleans
2000 Lakeshore Drive - 368 Milneburg Hall
New Orleans, LA 70148
<http://planning.uno.edu/>

Jeanette Eckert
Department of Geography and Planning
University of Toledo
2801 W. Bancroft,
Toledo, OH 43606-3390

Kansai Uchida
Ryan Dunn
Brian D. Taylor, Ph.D.
UCLA Institute of Transportation Studies
3250 Public Affairs Building
Los Angeles, CA 90095-1656
www.its.ucla.edu

ABSTRACT

In the search for new sources of funding, federal, state, and local government officials in the U.S. have recently been exploring public private partnerships (PPPs). While promising, PPPs are neither a panacea nor an unwarranted gamble: both shining successes and troubling failures abound. Given the large variation in the efficiency, effectiveness, equity, and feasibility of public-private highway finance partnerships in past projects, federal and state officials have been enacting legislation and statutes to both promote PPPs and to protect public interests from the potential pitfalls of PPPs.

In this paper, we review past U.S. legislation to promote and/or limit PPPs on transportation projects in order to evaluate their relationship with the recent planning and implementation of highway projects through PPPs. We also carefully examine existing state legislation that address issues on economics, public finance, and governance as well as technical details of PPPs in order to provide an overview of the status of legislative settings pertinent to PPPs in the US.

Legislation sets the ground rules by which a public agency and private firms can settle on an appropriate PPP scheme among the many different forms of PPP available for designing, constructing, operating/managing, and/or financing transportation infrastructure. Specifically, legislation sets conditions that: 1) either promote or prevent PPPs for highway projects, 2) provide foundations for contracts between a public agency and a private firm, and 3) affect risks involved in PPPs for both parties. Legislation is the higher hierarchical instructional setting that determines the level of flexibility in contract negotiation between transportation agencies and private firms and, ultimately, the success of PPPs. While states with PPP-related legislation appear to have reached consensus on several issues (such as allowing for design-build projects, long-term leases, and use of the Transportation Infrastructure Finance and Innovation Act—TIFIA—funds), there is a huge variation among the same states in how best to deal with other issues (such as restricting what types of transportation projects are eligible for PPPs). This variation in legislation reflects each state's general philosophical orientation toward PPPs: 1) aggressive (Indiana, Texas, and Virginia), 2) positive, but cautious (Arkansas and Minnesota), and 3) wary (Alabama, Missouri, and Tennessee). In addition, there are some issues and a certain level of details, such as toll rates and non-compete clauses that are more often worked out in contracts by the parties involved in projects that vary significantly in scope, scale, and setting.

Key Words: Public-private partnerships (PPPs), highway financing, legislation

Executive Summary

This report is the second in a series that examines private-public partnerships (PPP) as an alternative way to manage and finance highways in the US. This report provides an overview of Federal legislation that has paved the way in the last three decades to allow PPP projects, and also reviews individual state legislation that addresses issues on economics, public finance, and governance as well as technical aspects of PPPs. Examples of such legislation includes (1) designating specific types of funding sources, limiting type, location, or number of projects, (2) outlining the project selection and review process, and (3) assigning rights to non-compete clauses, toll rate controls, and alternate non-toll routes—essentially providing a framework for PPP projects from inception through operation. State legislation is likely the more important factor in determining the level of flexibility in contract negotiation between parties involved and whether PPP projects will come to fruition and be successful in each highway project in a given state. This report was compiled by examining and analyzing both academic and professional PPP literature as well as previous and existing Federal and state transportation and PPP legislation. The focus of this report is on description, synthesis, and interpretation; we do not reach specific conclusions regarding the wisdom of PPPs, nor do we make recommendations to Caltrans regarding the pursuit of PPPs.

With few exceptions, since the passage of the Federal Aid Highway Act of 1956, user costs for the state and interstate highway systems have been paid by the public sector, mostly from motor fuel taxes collected from drivers. As increases to fuel tax levies have proven increasingly difficult politically, inflation-adjusted highway funding has failed to pace the growth in vehicle travel. In response to a worsening financial squeeze, many state and local transportation agencies are looking to PPPs as an innovative way to address chronic funding shortfalls. However, recent, controversial concession deals in the US, such as the Chicago Skyway and the Indiana Toll Road, have sparked significant debate among the public and policymakers. While there was some opposition to these projects by taxpayers, the deals brought in significant cash flow for these two states to utilize for social services, other infrastructure improvements, debt repayment, and rainy day funds. But the long-term financial benefits of these deals for Chicago and Indiana remain very much in question, and may reveal spectacular failures that may set very unsuccessful precedents to swipe off consideration of carefully designed PPP schemes.

Twenty-three states currently have PPP-enabling legislation. Legislation sets the ground rules by which a public agency and private firms can negotiate an appropriate PPP scheme among the many different forms of PPP available for designing, constructing, operating/managing, and/or financing transportation infrastructure, in addition to no PPP. Specifically, legislation sets conditions that: 1) either promote or prevent PPPs for highway projects, 2) provide foundations for contracts between a public agency and a private firm, and 3) affect risks involved in PPPs for both parties. Legislative conditions also influence the attractiveness of PPP deals for private firms. However, when the laws are set to reduce the risks for the private sector, they often reduce the benefits for the public sector in the PPP deal.

Most evaluators of PPPs agree that appropriate legislation should be set in place prior to private sector involvement to enable the best outcome from PPPs and to protect the public interest. Legislation establishes in advance which phases of highway projects should be privatized and what types of PPP schemes highway agencies can undertake. While some details should be left to contracts between agencies and private firms for individual projects, lawmakers can institute legislation to either aggressively promote PPP projects in order to reap the financial

benefits with recognized risk, or to limit applications of PPPs in order to protect the public interest from the risks (and benefits) of PPPs. Given that voters are often wary of enacting measures that may be construed to broadly endorse privatization and risk the public interest, successful PPP legislation has been promulgated in a careful, deliberative fashion.

There are numerous risks to be carefully considered in PPP planning. Most obvious are the financial risks, which can be placed upon private entities investing in the project, or public agencies, which in turn can expose taxpayers to considerable risk. Thus, a related risk of PPPs is losing the trust of the public, or a backlash against PPPs by the public because of the risk, real or perceived, placed upon taxpayers. Such concerns have only been heightened amid the recent economic downturn and associated government efforts to bail out the banking and automobile industries. Other risks include accurate projection of future traffic flows, competition from other projects, and the environmental limitations or impacts of infrastructure construction. Uncontrollable risks include natural disasters and other unforeseen events. These risk factors are considerable, and are carefully distributed between the public and private sectors in successful PPPs.

There are important federal policies that since the late 1980s allow individual states to promulgate enabling legislation. Beginning in 1987, federal legislation has allowed toll roads and road pricing on federal highways. The 1991 *Intermodal Surface Transportation Efficiency Act* (ISTEA) included the federal pilot program for toll-based public-private partnerships, and moved forward with the *Congestion Pricing Pilot* program that allowed states to begin congestion pricing projects on a few of their Interstate highways. This limited trial program covered initial projects in California, Texas, and Florida. The *Transportation Equity Act for the 21st Century* (TEA-21) passed in 1998 included provisions that granted states the authority to levy tolls on new and reconstructed state highways, as well as new Interstate highways, through creation of the *Interstate Reconstruction and Rehabilitation Pilot Program*. TEA-21 also widely enabled the use of high-occupancy toll (HOT) lanes. The 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) federal transportation bill allowed greater use of toll finance and private sector involvement in highway procurement, while limiting the use of revenues.

Federal legislation generally provides guidelines for PPP implementation, but leaves it to officials in each state to decide whether it wants to allow PPP projects. Consequently, PPP legislation varies widely from state to state. Although officials in many state governments are expressing interest in experimenting with new PPP legislation, first-hand experience with PPP projects in the United States, particularly privately financed projects, is still limited. Of the 23 states that have PPP legislation, only 15 have made significant use of PPP schemes. Our review of existing state legislation suggests that statutes governing PPPs fall into five general categories: 1) Project Selection and Approval; 2) Procurement and Project Management; 3) Proposal Review Process; 4) Funding Requirements and Restrictions; and 5) Toll Management. Within these categories, there are more specific provisions that are often included in legislation, either to allow or disallow certain activities in the PPP process (See Table ES-1).

Table ES-1 State Legislation in Five Categories

<p>1. <u>Project Selection and Approval</u></p> <ul style="list-style-type: none"> • Allows for Unsolicited Proposals • Limits Number of Projects • Restricts Geographic Location • Restricts Mode of Transportation • Allows for Conversions of Existing Roads • Prior Legislative Approval Required • Subject to Local Veto • Restricts PPP Authority to State Agencies • Design-Build Readily Allowed? • HOT Lane Projects? • Number of Major PPP Highway Projects Since 1991 	<p>2. <u>Procurement and Project Management</u></p> <ul style="list-style-type: none"> • Allows Public Agency to Hire Own Consultants • Allows Payments to Unsuccessful Bidders • Requires Application Fees • Requires Time for Public Review • Specifies Evaluation Criteria • Structures Proposal Review Process • Protects Confidentiality of Proposals
<p>3. <u>Proposal Review Process</u></p> <ul style="list-style-type: none"> • Allows State and Federal Funds • Allows TIFIA Funds • Restricts Toll Revenues from General Fund • Allows Public Sector to Issue Revenue Bonds • Allows Public Sector to Form Nonprofits and Issue Debt 	<p>4. <u>Funding Requirements and Restrictions</u></p> <ul style="list-style-type: none"> • Allows for Multiple Types of Project Delivery • Exempts PPP Projects from State Procurement Laws • Allows for Outsourcing of Operations and Management • Requires Public to Maintain Comparable Non-Toll Routes • Requires Non-Compete Clauses • Allows for Long-Term Leases to Private Sector
<p>5. <u>Toll Management</u></p> <ul style="list-style-type: none"> • Rate-Setting Control Set in Agreement • Requires Removal of Tolls After Payment of Debt 	

While states with PPP related legislation appear to have a consensus on several issues (such as allowing for design-build projects, long-term leases, and use of funds from the Transportation Infrastructure Finance and Innovation Act—TIFIA—of 1998, which provides Federal credit assistance to major transportation projects of national importance to fill market gaps and leverage private investment), there is a huge variation among the same states on other issues (such as restricting what types of transportation are eligible for PPP projects). Further, there are some provisions that have not been widely addressed in legislation. For example, only five states—California, Colorado, Delaware, Florida, and Minnesota—address HOT Lane projects (all of which permit them). Additionally, there are policies on which only a handful of states differ from the majority. For example, all states with legislation addressing unsolicited proposals allow them, except for Indiana and North Carolina. In fact, Nevada allows *only* unsolicited proposals. Of the 21 states with legislation regarding local vetoes, only Arizona, Delaware, and Minnesota require that proposals be subject to possible vetoes. Of the twelve states with legislation addressing proposal confidentiality, only Arkansas and California protect confidentiality. Georgia is the only state to prohibit the public sector from issuing revenue bonds.

Only Mississippi disallows outsourcing of operations and management, and only Arizona and North Carolina require the public to maintain comparable non-toll routes. Only North Carolina

and Tennessee require that tolls be removed once the financing debt has been paid. Such variation in legislative specifics reflects each state's general philosophy toward PPPs: 1) aggressive (Indiana, Texas and Virginia), 2) positive, but cautious (Arkansas and Minnesota), and 3) wary (Alabama, Missouri, and Tennessee). In addition, there are some issues and a certain level of details, such as toll rates and non-compete clauses, that appear to be better decided in contracts by the parties involved in each project, reflecting the significant variation in the scope, scale, and settings of projects.

In the future, federal legislation may become more or less favorable toward highway PPPs as the current projects progress and long-term results become apparent and public agencies accumulate their experience and knowledge on PPPs. In any case, with so much flexibility at the federal level, states clearly must exercise care when crafting their own enabling legislation to ensure that they meet their needs and receive the results they desire, while protecting the public interests, in their highway PPP programs.

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1. INTRODUCTION: CONTEXT AND BACKGROUND FOR PPPS

Facing the funding shortfall and the continuous demand in construction and maintenance of highways in the nation, federal, state, and local governments in the U.S. began to look for alternative highway financing strategies outside the traditional framework of public financing. Public-private partnerships (PPPs) in combination of tolls or congestion pricing have emerged as a popular financing strategy since the 1980s in Europe (Medda et al. 2007), and more recently in the US. The recent concession deals of the Chicago Skyway (99 years, \$1.83 billion) and the Indiana Toll Road (75 years, \$3.8 billion) escalated the public debate on the appropriateness, efficacy, efficiency, effectiveness, feasibility, fairness, and equity of public-private partnerships in financing highways, which have historically been provided by the public sector without tolls except for the limited number of turnpikes and state highways after the passage of the Federal Aid Highway Act of 1956 to build the interstate highway system.

The conditions of PPP legislation at the Federal or state level determine the feasibility and likelihood of a PPP project. Lawmakers can design legislation to limit the role of the private sector, or place much of the risk of the project upon them. The key to successful legislation is to balance the rewards and risks equally. The extent of privatization of a highway is determined via legislation in regards to how comfortable state lawmakers and taxpayers are with the concept. This report will discuss the wide range of levels of enthusiasm for PPP projects, as some legislation allows only for a fixed number of trial projects, while other legislation, particularly in Europe, allows for more complex design-build-finance-operate projects. The legislation must establish from the beginning which party will be responsible for what, how each party will be protected against risk, competition issues and environmental concern. Legislation may also provide guidelines for the type of contract to be used in the project.

Our first report on public-private partnerships—*Are Public-Private Partnerships a Good Choice for U.S. Highways?*—identified several important conditions that affect PPP agreements in other studies (Bult-Spiering and Dewulf 2006; Doi 2002; Lockwood, Verma, and Schneider 2000) (Table 2-1). It is still too early to evaluate many PPP projects in the US and other countries for the two main reasons. First, many of the projects have been recently initiated and have not yet reached their agreement ending dates. Second, it is likely that the conditions that lead to a successful project vary depending on a number of factors, including the economic climate, legislative barriers, policy-makers' willingness to undertake PPPs, and the prevailing cultural attitudes toward private involvement in public sector affairs (Apogee Research 1995; Mackie and Smith 2005; Sawyer 2005; Ward and Sussman 2006).

In this paper, we review past U.S. legislation to promote and/or limit PPPs on transportation projects in order to evaluate their relationship with the recent planning and implementation of highway projects through PPPs. We also carefully examine existing state legislation that address issues on economics, public finance, and governance as well as technical details of PPPs in order to provide an overview of the status of legislative settings pertinent to PPPs in the US. In the next section, we review the significance of legislative settings in facilitating PPPs. In section three, we discuss current federal legislation for PPPs in the United States, and how this legislation shapes PPP projects. In the fourth section, we define different types of PPP legislation and examine what types, allowances and limitations are in place by state. We will look at legislation governing all stages of a PPP project, from project selection through tolling management.

2. SIGNIFICANCE OF LEGISLATIVE SETTINGS TO ENABLE PPPS

In this report, we focus our discussion on legislative conditions. In most cases, appropriate legislations should be set in place prior to the private sector involvement in designing, building, operating, maintaining, and financing transportation infrastructure on public land. Such legislations govern which part of functions to be privatized and what types of schemes highway agencies can undertake. While highway agencies are in charge of specifying details in contractual terms, policymakers pass legislations to either: (1) promote PPP schemes to aggressively pursue resulting financial benefits with recognized associated risks, or (2) limit applications of PPP to be prudent about protecting the public interest against any associated risks. In addition, governments must carefully proceed when promulgating PPP supporting legislation since the voters are often wary of governments enacting measures that may be construed to broadly endorse privatization and risk the public interest.

Legislative conditions also influence the attractiveness of PPP deals for private firms, the types and levels of risks for both public and private sectors, and actual financial benefits for the public. In France, for example, the passage of a 2004 law made possible PPP contracts beyond long-term lease agreements (Lestrange et al. 2005). With long-term lease agreements of France’s pre-2004 concession model, the private entities have some degree of protection from uncontrollable events that substantially raise the risk of the project, including changes in law insufficient traffic demand to recoup the cost. However, the newly-allowed design-build-finance-operate schemes may not provide incentives attractive enough to offset the risks that private investors have to take, or to generate sufficient interest in the program (Lestrange et al. 2005).

In another example, when it decided to contract out the management of the Virginia Dulles Toll Road, the State Corporation Commission of Virginia was required by a legislation to retain a right to set toll schedules (1992). This demands a degree of trust between the public and private entities because the profit for the private firm in this deal can be limited by the decisions of the public commission. This type of legislation may reduce the attractiveness of a project to the private sector. It should be emphasized that legislations provide a general framework or a set of ground rules within which highway agencies can use PPP strategies (or not) for the provision of highway infrastructure.

Table 2-1: Risks and Background Conditions Affecting PPP Agreements

<u>Legislative:</u>	PPP-enabling legislation allowing a speedy approval process or hefty incentives can lower the transaction and time costs associated with initiating the agreement and make the PPP more attractive to private investors. A good balance between offering private incentives and protecting the public interest is needed. Public agencies usually shield private investors from the risk of legislation turning against a project once it is underway.
<u>Contractual:</u>	The type of PPP contract used affects the opportunities for the private firm to streamline costs. Ideally, the chosen scheme would incentivize the private entity to consider the long-term effects of choices made during the project, seek to minimize its lifetime costs, provide flexibility, include opportunities for profit and efficiency gains sufficient to offset the set-up costs of the PPP, and align the motivations of the private entity with the public interest. A key part of the

	agreement hinges upon the initial value assessment of the project.
<u>Political / Public Perception:</u>	Public hostility toward PPPs and privatization can jeopardize projects. The political support for PPPs can be worsened if the public has already experienced a failed PPP for a similar type of project.
<u>Competition:</u>	If a new toll PPP facility is built too close to an existing parallel toll route, the split traffic demand may be insufficient to financially support both projects. Additionally, there will be high transaction costs involved with orchestrating cooperation between private entities where competing PPP routes intersect affect one another.
<u>Market Conditions:</u>	PPP proposals must remain competitive with other investment opportunities available to private firms. When the private market presents many attractive investment opportunities, the public sector may have to add incentives and lessen the degree of investor risk transfer in order to keep PPP projects competitive, but this may diminish the overall cost savings and increase payments from both the highway agency and the road users.
<u>Environmental Approval Issues:</u>	Many countries require environmental approvals before projects can begin construction. Because the length of time needed to obtain these approvals can be uncertain, the public sector usually retains this responsibility either for obtaining approval before soliciting private sector bids, or by offering to compensate investors for time lost due to environmental delays.
<u>Public-Private Relations:</u>	Conditions, such as rate-of-return caps, ensure that the private sector does not exploit the project in the interest of maximizing profits. However, experience to date suggests that a cooperative relationship between the public and private entities is more beneficial to a PPPs success than a meticulously worded contract.
<u>Usage:</u>	Traffic demand is generally projected to increase over time, but there is a chance that demand for travel along a new roadway may not meet projections, posing financial risks to private entities involved in both actual and shadow toll PPP schemes. The public sector sometimes offers to subsidize this risk because the private sector has little control over traffic demand.
<u>Construction:</u>	Changes in construction material and labor costs can hinder the cost effectiveness of a highway construction project.
<u>Currency:</u>	Developing countries sometimes use foreign finance institutions to fund highway PPPs. Devaluation of the home currency against the finance one can be fatal to a project under this funding scheme.
<u>Public vs. Private Sector Goals</u>	The PPP agreement must successfully balance the public sector's goal of protecting the public interest with the private sector's profit-driven motives.

Source: (Iseki, Uchida, and Taylor, 2007).

When the laws are set to reduce the risks for the private sector, it may reduce the benefits for the public sector in the PPP deal. For example, Spain gradually passed a series of laws since the 1950's to promote PPPs by increasing concession periods, protecting the concessionaires against interest rate fluctuations, and using shadow tolls to fend off motorist unrest (Bult-Spiering and Dewulf 2006). While this increased shouldering of risks by the public sector makes

PPPs more viable to private entities, it reduces the potential for savings over the traditional public procurement methods.

Our first report on public-private partnerships identified the following financial risks associated with PPP strategies for highway projects:

- (1) the environmental clearance risks arising from delays in obtaining the needed approvals,
- (2) the risk of political and public opinion delaying or requiring costly modifications to the project,
- (3) construction cost overrun risks,
- (4) risks associated with operations, and
- (5) the risk of natural disasters.

These factors should be carefully distributed between the public sector and the private sector—whichever best able to control each of these risks—taking into account a potential tradeoff between the amount of transferred risks and the attractiveness of a project. To some degree, risk sharing works best when legislation and contracts are flexible enough to allow for modifications in the event of unforeseen circumstances. At the same time, when policymakers are seriously concerned and do not desire to leave the allocation decision to highway agencies in regard to any of these risks, they can enact laws to specify a responsible party for such risks. For example, since the first and second risks are political in nature, laws can require the public agency to be responsible for these risks.

There is a fundamental trade-off between public and private sector interests that legislation need to take into account and balance out. While legislation should enable public agencies to transfer as much risk as possible to realize financial savings, it should not require a transfer of so much risk that it will lead to a significant reduction of the private sector's interest in the deal, or cause the private entity to charge exorbitant user fees to protect itself in an overly-risky transaction.

3. GENERAL DESCRIPTION OF THE HISTORY AND PRESENT STATUS OF FEDERAL LEGISLATION PERTINENT TO PPP IN THE US

For the past half-century, the federal government has funded much of the construction and maintenance of the United States' Interstate highways using fuel tax revenues. As the paying entity, it holds much of the decision-making power over policy changes affecting the nation's interstate highways. In light of the declining ability of the federal fuel tax to finance the nation's road travel needs and recognizing the dire financial state of much of the country's highway agencies, the federal government has begun to consider partial private-finance as a solution to the funding shortfall. The federal government introduced increasingly aggressive bills allowing states to develop and implement highway PPP proposals, gradually evolving from pilot programs in the late 1980's to broader enabling legislation by the mid-2000's (AECOM Consult 2007)

Since 1987, the federal legislation began to allow toll roads and road pricing on federal highways. The 1991 *Intermodal Surface Transportation Efficiency Act (ISTEA)* included the federal pilot program for toll-based public-private partnerships, and moved forward with the *Congestion Pricing Pilot* program that allowed states to begin congestion pricing projects on a few of their Interstate highways. This limited trial program covered initial projects in California, Texas, and Florida (Gougherty 2005a).

The *Transportation Equity Act for the 21st Century* (TEA-21) passed in 1998 marked a step further toward the widespread use of toll finance. Although converting existing toll-free interstate highways to toll roads is generally prohibited, the provisions in TEA-21 granted states the authority to levy tolls on new and reconstructed state highways, as well as new Interstate highways, through creation of the *Interstate Reconstruction and Rehabilitation Pilot Program* (Federal Highway Administration 2002). This pilot program authorized states to use road pricing for up to three facilities that were previously non-tolled interstate highways, but limited the use of toll revenues to directly cover upgrade costs. TEA-21 also widely enabled the use of high-occupancy toll (HOT) lanes by allowing states to designate certain HOV lanes where single-occupant cars would be permitted. Together, these policies formed the basis for concession-based PPPs, and allowed individual states to form their own enabling legislation (Gougherty 2005b).

The 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETY-LU) federal transportation bill allowed greater use of toll finance and private sector involvement in highway procurement, while limiting the use of revenues. For example, while the HOT lanes program was expanded to include all HOV lanes in the country, the bill mandates that any single-occupant cars must be charged a variable toll, and that revenues cannot be spent outside the corridor where they were generated. Also, the SAFETY-LU limits the number of congestion pricing projects where revenues may be spent on other corridors. In short, a significant limitation for PPPs is the requirement that *any new interstate highways financed by toll revenues* must give preference to public toll authorities, though this restriction does not apply to state highways (Gougherty 2005b). As a rule of thumb, states may levy any type of toll on new and reconstructed state highways, new interstate routes, and *reconstructed* toll interstate facilities, but tolls may not be charged on existing free interstate highways. Limitations on revenue generally direct states to spend the money within the tolled corridor with priority given to actual construction costs (Gougherty 2005b). In addition, the *Federal Acquisition Regulation* enforces limitations on procurement methods, as it does for most government-funded projects. Contracts must be awarded based on a competitive selection process, with the intent to provide equal opportunities to bidders and maximize cost-efficiency (Bult-Spiering and Dewulf 2006).¹

Federal legislation provides some guidelines for PPP implementation, but leaves it to officials in each state to decide whether it wants to allow PPP projects. Consequently, PPP legislation varies widely from state to state, and some states do not yet have any PPP-specific laws at all. Officials in many states that have expressed interest in experimenting with PPPs primarily seek to push much-needed highway projects forward without spending large amounts of scarce public funds. Enacting enabling legislation is the first step that state governments take toward building a highway PPP program, but the legislation must conform to federal guidelines. In addition, officials of state governments need to be aware that the legislation formation process involves significant risks associated with the choices made, such as taxation constraints, control issues, right-of-way procurement, and rejection by the public.

¹ However, this often forces states to award contracts to the lowest responsible bidder, and not necessarily the most reputable one. It is also costly in terms of time, as the bid procurement and review process can be lengthy. Arizona notably circumvented the competitive bidding requirement by prohibiting the spending of state funds on PPP projects unless the money is reimbursed later (Federal Highway Administration 1992).

While several states, such as Indiana, Texas, and Virginia, have been aggressively promoting PPPs and passing state legislation toward this new financing strategy, some people raise a serious concern regarding the protection of public interests. James L. Oberstar (D-MN), Chairman of the U.S. House of Representatives Committee on Highway and Infrastructure, and Peter DeFazio (D-OR), Chairman of the Subcommittee of Highways and Transit, in their letter to state governors on May 10, 2007, wrote, “[w]e write to strongly discourage you from entering into public-private partnerships (“PPP”) agreements that are not in the long-term public interest in a safe, integrated national transportation system that can meet the needs of the 21st Century.” To some extent, the debate and discussion that have been held in the Federal committees are characterized by different perspectives on the two extremes, strongly for or strongly against PPPs, similar to the political/ideological differences over any privatization of the production and provision of public infrastructure and services.

Some states, including California, begin cautiously, allowing only a limited number of pre-approved demonstration projects. In these instances, highway agencies are implementing PPPs on a trial basis with the intent of creating future legislation to allow more projects if the initial ones produce favorable results (AECOM Consult 2007). Lawmakers see this as a prudent strategy for initiating a PPP program, since it allows the state transportation agency to gain firsthand experience with the new finance models before making a long-term commitment to their use. Such a strategy is also more politically palatable, seeing as the public will recognize the initial use of PPPs as a temporary experiment, rather than a drastic and permanent shift in the way highway improvements are funded.

If state policymakers are pleased with the outcome of the trial program, they may then initiate a second-phase trial, or introduce more permanent legislature allowing unlimited PPP projects and clarifying the conditions of their use. This gives officials a chance to incorporate lessons learned during the trial program when making long-lasting changes to their states’ highway programs. A state government wishing to make a bolder first step might skip the trial program and use permanent legislation to initiate PPP use.

With the many types of PPP schemes available for highway finance, states have adopted a variety of enabling legislation. Some have limited themselves to models like Design-Build, which varies from traditional procurement methods by combining several contracts into one, compared to having different contracts with potentially different private parties for different stages of the project. Others have pursued a more radical departure from conventional finance methods, and adopted long-term leases and concessions that allow highway operators, regardless of whether it is public or private, to charge tolls.

In summary, the federal legislative acts—original pilot programs, ISTEA, TEA-21, and SAFETY-LU—form the legal basis for highway PPPs in the United States. States are given considerable authority to decide whether to implement tolls, adopt congestion pricing schemes, or solicit greater private sector involvement. Should current economic trends continue, state governments will face continuous funding shortfalls in future, and federal legislation may become more flexible toward highway PPPs. Federal transportation administrators under the Bush administration have issued declarative, unequivocal statements that they believe PPPs will lower the costs of highway projects and speed their completion in most cases, citing the severe lack of public transportation funds as the key motive for pursuing PPPs so aggressively (AECOM Consult 2007). The federal government has accordingly given state governments the authority to pursue highway PPPs as they see fit, and they have a lot of leeway with regard to

which models and projects they select. However, as we observe in the deals for Chicago and Indiana, the long-term financial benefits of on-going PPP projects remain very much in question. Furthermore, several early long-term concession deals, including ones in Chicago and Indiana, which were made without much PPP experience in the U.S. transportation industry, may be shaping up to be such spectacular failures that it will wipe off future possibility of effective PPP schemes with careful analysis and decision making transparency (Ortiz and Buxbaum 2008). Therefore, even with so much flexibility given at the federal level, states must exercise care when crafting their own enabling legislation to ensure that they receive the results they desire, while protecting the public interests, in their highway PPP programs. State officials must also keep in mind that full public projects are always an available option.

4. TYPES OF LEGISLATION AND THEIR EFFECTS

State laws regarding PPP highway projects vary considerably. Twenty-seven states currently do not have legislation enabling PPPs (AECOM Consult 2007). Of those that do, only fifteen have made significant use of PPP schemes (AECOM Consult 2007). Fewer still have pursued aggressive toll-financed projects, such as high-occupancy toll (HOT) lanes, which are characteristic of the more-privatized PPP models. Texas leads the way with 24 transportation (both transit and highway) concession projects as of 2006; no other state has more than 10, and most have only one or two, if any (AECOM Consult 2007). As such, first-hand experience with PPP projects in the United States, particularly private finance-driven ones, is low, though many state governments are now expressing interest in experimenting with new legislation.

Of the states that do allow some form of highway PPPs, many have done so only on a trial basis with a limited number of projects, and in some cases only one project. Table 4-1 compares the status of PPP laws in states with enabling legislation, and we examined several factors that demonstrate the extent to which each state has embraced aggressive PPP finance schemes.²

State legislatures have taken many different paths in creating PPP programs, as detailed in Section 3. Some states, such as Virginia, have laid out explicit regulations and standards for PPP facilities. Other states, like Minnesota, have only minimal statutes or provide for only a few types of projects, leaving a lot of discretion to the parties crafting the agreement between the public and private entities.

Statutes governing PPPs fall into five main categories:

1. Project Selection and Approval
2. Procurement and Project Management
3. Proposal Review Process
4. Funding Requirements and Restrictions
5. Toll Management

The following sections describe provisions include in each of these categories include the following provisions.³

² For a summary of California's current PPP legislation and past legislative actions, please see Appendix I.

³ These elements were originally developed by the law firm of Nossaman, Guthner, Knox, & Elliott, LLP. Sample statutes addressing these points are available at http://www.fhwa.dot.gov/ppp/pdf/legis_key_elements.pdf (last accessed on June 19, 2009), in the Nossaman document entitled "Overview of Key Elements and Sample Provisions." Additional information for state-

4-1. Project Selection and Approval

Unsolicited projects. Two states, Indiana and North Carolina, restrict PPP projects solely to solicited projects, while Nevada allows only unsolicited projects. The remaining states have either no express provision on allowing for unsolicited projects or explicitly provide for both solicited and unsolicited projects. Allowing for unsolicited projects can create a more effective transportation network, as the private sector is often more innovative than the public sector in

coming up with ideas for PPP projects. At the same time, however, states must ensure that they are reviewing only feasible unsolicited projects. States can require application fees or deposits in order to ensure this. Allowing for both solicited and unsolicited projects still provides a way for the public sector to ask the private sector to present proposals for needed infrastructure improvements.

1. Project Selection and Approval

- Are unsolicited proposals allowed?
- Do the statutes authorize only a limited number of projects?
- Are there restrictions on the geographic location of projects?
- Are PPP facilities limited to only certain types of transportation?
- Can existing roads be converted to tollways?
- Is prior legislative approval required for PPP projects?
- Do the statutes provide for a local veto of approved PPP projects?
- Are local entities authorized to enter into PPP agreements without the approval of the state department of transportation?

Limited number of projects. As a first step in developing a PPP program, some states, including Arizona, Missouri, and North Carolina, have provided for only a limited number of PPP projects in their statutes. This criterion is useful for determining how robust and permanent a state's PPP-enabling legislation is. These statutes do provide an affirmative first step towards promoting PPP projects, and also provide the time for an agency to gain experience in contracting for PPPs without taking significant risks for the public interest.

At the same time, they also signal that lawmakers have reservations about dedicating a

state to the PPP process for the long term, discouraging private interests from developing a PPP network in a state. This approach is not recommended for the long term, as states have ways of managing the number and location of PPP projects other than strictly limiting the number of projects through legislation. The project selection must be based on a solid assessment of economic gain in each PPP project, and should not be limited by an arbitrary number of projects. If states receive more PPP proposals, which will likely increase economic efficiency, than what the statute provides, it can be difficult to encourage the legislature to timely amend the statutes to provide for additional projects.

by-state information can be found at <http://www.ppptoolkit.fhwa.dot.gov/statestory.aspx> (last accessed on June 19, 2009), unless otherwise noted.

Table 4-1: Project Selection and Approval

Code	Provisions	AL	AK	AZ	CA	CO	DE	FL	GA	IN	LA	MD	MN	MO	MS	NV	NC	OR	SC	TN	TX	UT	VA	WA
1-a	Allows for Unsolicited Proposals			Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y			Y	Y	Y	Y
1-b	Limits Number of Projects		Y	Y	N	N	N	N	N	Y	N	N	N	Y	N	N	Y	N	N	Y	N	N	N	N
1-c	Restricts Geographic Location		Y	N	Y	N	N	Y	N	Y	N	N	N	Y	Y	N	Y	N	N	Y	Y	N	N	N
1-d	Restricts Mode of Transportation	Y	N	Y	N	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	N
1-e	Allows for Conversions of Existing Roads		N		Y	N			Y	Y	Y	Y	Y	N	N	N	Y			N	Y	Y	Y	Y
1-f	Prior Legislative Approval		N		Y	N	Y	Y	N	Y	Y	N	N	N	N	N	N	N	N	Y	N	N	N	Y
1-g	Subject to Local Veto		N	Y	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N		N	N	N	N
1-h	Restricts PPP Authority to State Agencies	Y	Y		N	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	Y	Y	N	Y	N	Y
1-i	Design-Build Readily Allowed?	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
1-j	HOT Lane Projects?				Y	Y	Y	Y					Y											
1-k	Number of Major PPP Highway Projects Since 1991	0	1	2	7	4	0	5	0	1	0	0	1	0	0	2	1	1	5	0	3	2	4	1

*A cell left blank indicates state legislation does not make an explicit provision regarding that category.

*Nevada allows unsolicited proposals only.

*1-k is from page 63 of FHWA Guidebook (AECOM Consult 2007).

*Information for California in table 4-1 is from January 2009 legislation.

Geographic restrictions. Just as some states have limited the number of projects a state can approve, so too have some states placed geographic restrictions on where PPP projects can be located. California's PPP program mandates that two of the four PPP projects allowed by statute be located in Northern California, with the remaining two in Southern California. North Carolina requires that at least one of the three approved projects be located in a rural county, and at least one of the three in an urban county. These provisions, while they may represent a political compromise, are not recommended, as they force public agencies to pursue projects in areas where they may not be needed. There is no direct connection between geographic locations and potential economic gain in the application of PPPs in projects. Therefore, the project selection should not be limited by geographic locations.

Limitations on types of transportation. In order for states to promote innovative ways of funding projects and to avoid needing to amend legislation each time a new type of transportation project is proposed for a PPP, states should provide language allowing for a broad range of transportation-related PPP projects, from ferries to HOT lanes, unless clear costs and/or negative impacts are identified for particular types of projects. Unfortunately, many states allow only a few types of projects in their transportation-related PPP statutes at this point. Ten states provide various limitations on the types of transportation projects allowed. For example, Alabama allows PPPs for toll roads, toll bridges, ferries, and causeways only, leaving out many types of non-tolled facilities such as truck lanes or rail improvements. It is better for states to provide for a wide range of projects in their PPP statutes, through either a long list of transportation projects allowed by the statute or a broad definition of "transportation facility."

Converting existing roads to tollways. Although federal law prohibits the conversion of existing free interstate highway facilities to toll roads, state highways are exempt from this law. The presence of legislation enabling such conversions of state highways indicates that the government is interested in using PPPs not only to finance construction contracts (green fields projects), but standalone maintenance and operation contracts (brown fields projects) as well. While we often find discussion to mix adoption of tolls and PPPs, these two issues are fundamentally separate, as there is no strong link between financing and the organization of infrastructure provision (OECD 2008). Thus, it is not necessary to relate an application of tolls to PPP legislation.

Apart from PPPs, an application of tolls should be considered for any facility where it increases the efficiency to the use, finance, maintenance, and management of existing facilities while it does not cause significant adverse effects on equity. Five states have restrictions on converting existing roads to tollways, with six others silent on the matter. Colorado, for example, allows only for existing HOV lanes to be converted into HOT lanes. Although allowing for existing fee-free roads to be converted into toll roads can be very unpopular with users, it can increase the efficiency of the use and also provides more flexibility to public agencies when crafting PPP agreements. In June 2007, Texas restricted the ability of public agencies to convert free roads to tolled roads as part of an anti-privatization bill (Barlas 2007). In the long run, however, it is a better idea to allow for these conversions and provide the public with a way to comment on such proposals, in addition to a careful analysis of economic efficiency in these projects.

Prior legislative approval. Six states require various forms of legislative approval before PPP projects can move forward. Delaware requires that the co-chairs of the state General Assembly's bond committee meet to approve or disapprove PPP proposals. Washington provides for the state finance committee to approve a project in the absence of a public benefit corporation (for example, a port authority or other infrastructure authority). Georgia does not require that the legislature approve the project, but does require that the project's sponsors present the legislature and the governor with a copy of the letter of intent to negotiate a PPP deal. Such requirements can chill private participation in PPPs, as allowing for a legislative veto *late in the process* dramatically increases the risk that a project will not be approved. States must be careful to weigh the public interest in managing public agency participation in PPP projects with the discouragement that such legislative approval provides. Removal of the need for legislative approval of each individual project both streamlines the PPP application process and demonstrates the state government's trust in its PPP agreement guidelines. It also provides reassurance to private contractors that the projects will be approved as long as they conform to the established PPP laws, thus lessening the political and approvals risks commonly associated with highway PPPs. As an exception, some states wish to retain legislative approval requirements during their trial programs as a way to gain experience and refine their PPP guidelines early on.

Local veto. Just as in the legislative approval setting, allowing for local residents to veto plans for a PPP project introduces substantial risk for final project approval. Three states, Arizona, Delaware, and Minnesota, allow for some form of local veto of a project. In Arizona, the approval of the local governing body is needed if a PPP project will connect with a local road, while in Minnesota the governing body of any municipality or county where a PPP proposal is located can veto the project within 30 days. Just as with legislative approval, these requirements are not recommended, unless there is any clear identification of adverse impacts on local communities. If a state is concerned about including local input on a PPP proposal, it can mandate that local or regional transportation agencies be involved with the PPP planning process for projects within its jurisdiction.

Restricts PPP Authority to State Agencies. Promotion of PPPs assumes that a responsible agency already possesses or will obtain sufficient capacity and knowledge that is necessary to properly implement PPPs. While a network issue associated with fragmented adoption of PPPs and potential application of toll financing has to be carefully examined, there is no fundamental difference between local government and state government as long as both have the same level of capacity and knowledge for PPPs. On the other hand, statutes like this could operate as a safety mechanism in which a state department can make it sure that local adoption of PPP will not cause serious network problems. In reality, it often takes some time for any government which does not have any prior experience in PPPs to gain capacity and knowledge, it is recommended to have a central unit of employees that are equipped with a set of skills in PPPs and serve not just for a transportation service but for other public services (OECD 2008).

Five states, Minnesota, Nevada, Texas, Virginia, and just recently, California, allow for public agencies other than a state agency to enter into PPP agreements, while the other states either allow only the state agency to participate in PPPs or have no expressed provision. Minnesota allows "road authorities" to enter into PPP projects, which is any public agency with the authority to construct roads, from the state department to town boards. If public agencies

other than the state Department of Transportation have the expertise to enter into these types of agreements, a state should provide them with the expressed ability to do so. For example, if a city owns and maintains a facility, it should be granted the ability to enter into a PPP agreement to maintain the facility or for construction of improvements. If, however, the state DOT is the main road-building agency in a state or the only agency equipped to manage the PPP process, it would be wise to grant it the sole ability to enter into PPP agreements.

Design-Build Readily Allowed. Design-Build is one of the most limited forms of PPP, as it varies only slightly from the traditional Design-Bid-Build model. Because this model only combines contracts for design and construction that would normally be issued separately, the public likely views it as more of a streamlining of the contracting process rather than a step toward privatization. As such, the political risks of Design-Build agreements are low, and many states readily allow their highway agencies to pursue this PPP model.

With less than half of the states in the country presently allowing highway PPP projects, and even fewer pursuing the riskier concession models, it is uncertain whether most states are willing to attempt the Build-Operate-Transfer or Design-Build-Finance-Operate schemes. Thirty-one of the forty-four major highway PPP projects undertaken in the United States since 1991 have been Design-Build (AECOM Consult 2007). PPP legislation must carefully balance the desire to protect government agencies from risks while still keeping proposals attractive to the private sector when compared to the other investment opportunities available on the private market. Trying to offload too many risks to the private sector or not providing enough government-backed incentives will diminish private interest in a state's PPP proposals.

HOT Lane Projects. The presence of HOT lane projects is an indication that a state is amenable to charging tolls on their highways, which is a common method of revenue collection under the more private PPP models. Many states have HOT lane projects in place or under consideration, and these variable toll facilities are the only allowable way to toll existing free HOV lanes (Gougherty 2005b). It should be noted that many states have traditional, non-HOT toll lanes, and these are not accounted for in the "HOT Lane Projects" column.

Number of Major PPP Highway Projects Since 1991. The number of high-value projects in a state is another good measure of the amount of faith the government has in PPP finance for its highways. Instead of measuring a state's embracement of PPPs in terms of number of projects adopted, counting only the high-value projects identifies the states that have demonstrated willingness to shoulder a large amount of risk in each PPP agreement. Interestingly, when projects costing less than \$53 million are removed, states with numerous low-value PPPs, such as Texas, begin to appear more leery of private finance (AECOM Consult 2007). Accordingly, states whose legislation is more cautious toward the widespread adoption of PPPs begin to look bolder because the few projects undertaken have had high price tags.

4-2. Proposal Review Process

Streamlined approvals processes increase the attractiveness of a project by reducing anticipated delays. Streamlining the contracting process is usually desirable because it reduces the amount of time and resources that both the public and private sectors must spend on bidding. Officials in

Ireland noticed a drop of PPP proposals because the government demanded that private entities create overly-elaborate submissions with no guarantee of winning the contract (Reeves 2005). But in crafting terms more attractive to potential bidders, governments must ensure that the bidding process remains fair and open to public participation (Iseki, Uchida, and Taylor Under review).

2. Proposal Review Process

- Can the public entity hire its own consultants?
- Is the public entity required to reimburse unsuccessful bidders?
- Can the public entity require application fees?
- Do the statutes require time for public review?
- Do the statutes specify evaluation criteria for the public entity to use?
- Do the statutes specify the structure of the review process?
- Is the public entity required to protect the confidentiality of PPP proposals?

Public agencies hiring their own

consultants. When a public agency can hire its own consultants to assist in preparing guidelines and reviewing proposals, all parties to a PPP benefit. No states currently limit the ability of public agencies to hire such outside consultants, but eight states do not have a specific provision authorizing the use of these consultants. In order to encourage public agencies to develop relationships with key advisors who can help bring PPP projects to reality, States should pass affirmative legislation allowing engineers, attorneys, or others to help.

Allowing payments for unsuccessful

bidders. To encourage private firms to submit both solicited and unsolicited proposals, three

states, Delaware, Indiana, and Texas, have statutes requiring payments to unsuccessful bidders, to reimburse them for the costs of compiling a proposal and other work provided. Georgia, Louisiana, and Maryland, on the other hand, take the opposite approach and explicitly prevent public agencies from reimbursing bidders, even if these agencies do use some of the work that the private agency put forth. Allowing public agencies to pay unsuccessful bidders for their work may encourage better projects by stimulating more bids as long as public agencies carefully monitor the contents and quality of submitted proposals, so that private firms do not get paid multiple times for the same or similar proposals. In general, statutes that allow for these payments are recommended.

Requirement of application fees. Allowing public agencies to collect application fees can help offset the costs of soliciting PPP proposals, reviewing unsolicited proposals, and managing the proposal process. Further, these fees likely increase the likelihood that the proposals offered to public agencies will be made in good faith. Eleven states grant public agencies the ability to charge application fees. Delaware is the only state to put a cap on its fee, a cap of \$50,000. Nevada calls for a “reasonable” fee, a nebulous definition that leaves a lot of discretion to the public entity. Using such language is recommended, as it gives the public agency flexibility to charge more in fees for more involved projects, and also allows the amount charged for a fee to be indexed for inflation without needing to amend it through the legislative process.

Requiring time for public agency review. Since the length of time it takes to review a project depends upon how complex it is, it is difficult to set a standard amount of time public

agencies must take in order to review a proposal. States have implemented a broad range of statutes in this area. Georgia provides the longest period of time, 135 days, for public agencies to review the proposal and solicit competing proposals. Colorado requires 14 days, but then allows public agencies to provide more time, depending upon the complexity of the project. Just as in the requirement of application fees context, states should provide for at least a minimum length of time for public agencies to review proposals but then allow for agencies to grant more time for review of complex projects.

Table 4-2: Proposal Review Process

Code	Provisions	AL	AK	AZ	CA	CO	DE	FL	GA	IN	LA	MD	MN	MO	MS	NV	NC	OR	SC	TN	TX	UT	VA	WA	
2-a	Allows Public Agency to Hire Own Consultants		Y			Y		Y	Y	Y		Y			Y	Y	Y	Y			Y	Y	Y	Y	
2-b	Allows Payments to Unsuccessful Bidders						Y		N	Y	N	N									Y				
2-c	Requires Application Fees						Y	Y	Y		Y	Y		Y		Y		Y			Y		Y	Y	
2-d	Requires Time for Public Review			Y	Y	Y	N	N	Y	Y	Y	Y		Y	Y			Y			Y		Y	Y	
2-e	Specifies Evaluation Criteria		N		N	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N	N	N	N	N	N	Y	Y
2-f	Structures Proposal Review Process		N		Y	N	Y	N	Y	Y	Y	Y	N	N	Y	N	N	Y	N	Y	Y	Y	N	Y	
2-g	Protects Confidentiality of Proposals		N		N		Y		Y	Y	Y	Y		Y				Y			Y		Y	Y	

***A cell left blank indicates state legislation does not make an explicit provision regarding that category.

Specification of evaluation criteria. Ten states provide at least minimal guidance for public agencies for setting standards related to evaluation of proposals. The guidance that most of these statutes give is very broad in nature, like the statutes in Louisiana, Maryland, and Nevada, which ask public agencies to determine the “public need” for the project, the interconnections between the new facility and existing facilities, the estimated cost of the project, and the ability of the group proposing the project to meet its proposed timeline. Texas, in contrast, directs the state Department of Transportation to develop evaluation criteria. Such broad standards are generally useless for public agencies, as nearly any project could be justified on these grounds.

On the other hand, providing detailed evaluation criteria may dissuade private firms from proposing projects that are innovative or outside the normal course of PPP projects a state has constructed. These criteria may include the capability of the sponsoring agency to effectively manage the project, the transparency of the procurement process, capabilities of the project delivery team, and proposed use of new technology to improve the cost-effectiveness of the project (AECOM Consult 2007). In general, all cases are so unique that they may require different considerations. In this sense, a statute can provide general guidelines and a minimum set of factors that must be carefully evaluated, such as a project’s innovative methods or broader socioeconomic merits.

Specification of review process. Nine states specify the structure of the PPP proposal review process. In Washington, in order to move forward with projects with costs over \$300 million, public agencies must, by statute, form an advisory committee made up of members of participating public agencies “offering a diversity of viewpoints.” Georgia requires an evaluation committee made up of members from the governor’s office, a designee with a finance background, and the head of the state Department of Transportation. Providing for the structure of these committees or any other method for reviewing proposals before proposals are received is a good way to legitimize the approval process and remove any questions about the process before the first proposal is received. States can structure these review committees in whatever way they see fit, but should include people with backgrounds in finance, project management, engineering, and other related fields.

Protecting the confidentiality of PPP proposals. In order to protect the intellectual property of firms making proposals, ten states have confidentiality statutes allowing for firms to protect sensitive information, such as financial information about a firm or its proprietary work product, from the public record on a project. In Missouri, all proposals made to the state are considered a “closed record.” Maryland requires that proposers identify the portions of their proposals that the proposers deem confidential and asks them to justify why such information should be kept secret. Maryland’s approach may be best, as it provides for flexibility in the process for determining what parts of a proposal should be kept from the public and from the private firm’s competitors. On the other hand, states must also remember that providing adequate information to the public is important in any PPP process gaining public legitimacy. States need to keep this balance in mind when protecting sensitive information.

4-3. Funding Requirements and Restrictions

State and federal funding for PPP projects. Giving public agencies flexibility in funding projects is essential to creating an efficient PPP program, especially when the costs of these projects are enormous. At the same time, however, restricting public agencies from using public monies to help fund private operations is a way of insulating legislators from the riskiness of these projects (Gougherty 2005b).

Fourteen states have provisions in their PPP statutes allowing for public agencies to use both state and federal funding for PPP projects. The Delaware statute is among the best, authorizing the state Department of Transportation to “use any federal, state, or local funds” to finance projects, explicitly allowing public agencies to use any of these sources without limits. Further, the Delaware statute allows the state DOT to apply for federal funding which the DOT can then give as grants or loans to PPP projects. States should provide for this type of flexibility in their PPP statutes to avoid judicial challenges to financing plans. At the same time, states also need to be aware of the requirements that certain federal funding programs require, such as adherence to Davis-Bacon labor rules, “Buy America” requirements, and others (AECOM Consult 2007). Adopting PPPs for federal interstate projects may also trigger other federal regulations limiting the use of private debt or equity (Gougherty 2005b).

3. Funding Requirements and Restrictions

- Can both state and federal funds be used for PPP projects?
- Can federal TIFIA funds be used for PPP projects?
- Do the statutes prevent revenues from PPPs from being transferred to the state’s general fund?
- Can public entities issue revenue bonds to fund PPP projects?
- Are public agencies authorized to form nonprofit entities and issue debt?

Use of federal TIFIA funds. Funds granted through the federal Transportation Infrastructure Financing and Innovation Act, or TIFIA funds, are another source of funding for public agencies to utilize. The TIFIA program provides subordinated credit assistance for projects that are national or regional in origin, thus making them valuable for very large, complicated projects that require funding outside of the normal PPP financing process.⁴ Needless to say, just as states should provide for the ability of public agencies to pursue federal, state, and local funding sources, so too should they promote the use of this unique federal program. Ten states provide public agencies with the expressed ability to pursue TIFIA funds, many of them incorporating language authorizing TIFIA into the statutes allowing for federal and state funds for PPP projects.

⁴ http://www.innovativefinance.org/topics/finance_mechanisms/federal_loans/tifiasp (last accessed on June 19, 2009.)

Table 4-3: Funding Requirements and Restrictions

Code	Provisions	AL	AK	AZ	CA	CO	DE	FL	GA	IN	LA	MD	MN	MO	MS	NV	NC	OR	SC	TN	TX	UT	VA	WA	
3-a	Allows State and Federal Funds		Y			Y	Y	Y	Y	Y	Y				Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
3-b	Allows TIFIA Funds		Y				Y		Y	Y	Y						Y	Y			Y			Y	Y
3-c	Restricts Toll Revenues from General Fund		N	Y	Y	Y	Y	Y		Y	N	N	N	N	Y		Y	Y			Y	Y	N	Y	Y
3-d	Allows Public Sector to Issue Revenue Bonds		Y			Y		Y	N	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y			Y
3-e	Allows Public Sector to Form Nonprofits and Issue Debt					Y			Y					N					Y	Y		N		Y	N

***A cell left blank indicates state legislation does not make an explicit provision regarding that category.

Restricting PPP-related revenues from a state’s general fund. Not all PPP projects provide toll revenue for states to use, but allowing states to redirect toll facility revenues into their general fund is controversial. States allowing the state treasury to divert funding from any tolled facilities (not just PPP facilities) to pay for other non-transportation services can undermine support for tolled facilities in general, but diversion of this kind is a more politically popular way for cash-strapped states to raise funds for other services. In the case of the Indiana Toll Road, part of the \$3.85 billion concession fee is transferred to fund a 10-year highway modernization project (Poole 2007). Some consider this Indiana case an innovative transportation financing. But others express a serious concern due to the expedited spending of the concession fee in the short term in exchange of a private management of the toll road for the next 75 years, which poses a significant level of uncertainty to the public. In the case of the Chicago Skyway, the \$1.9 billion concession fee was used for providing other city public services, such as social services, and reducing debt (Seliga 2007; Brown 2007). Controversy arose because some of this money was used for non-transportation purposes, but only after the outstanding Skyway debt had been repaid (Ortiz and Buxbaum 2008). This diversion of the fund was made available for other services because the bridge was a city asset (Johnson, Luby, and Kurbanov 2007).

Eleven states restrict tolled PPP facility revenues from the state’s general fund. Arizona restricts toll revenues in a PPP agreement to a highway user fund and regional road fund. Virginia does not limit these excess funds from going to public transportation funds but only instructs that the funds “may” go to the general transportation fund or the private entity to help pay off the debt. Ideally, states should keep transportation revenues separate from other funding sources unless alternative arrangements were made clear to the legislature and public.

Issuing toll revenue bonds for PPP projects. Only one state, Georgia, does not allow public entities to issue toll-backed revenue bonds to support PPP projects, and seven other states have no statutes explicitly allowing for them included with their PPP statutes, but may include this authority elsewhere. Utah, one of the thirteen states allowing for revenue bonds, in its PPP statutes allows for a tollway development agreement to have requirements for performance security including performance-based bonds. In the spirit of allowing PPPs to have flexibility when arranging financial structures, the authority to sell such revenue bonds should be explicitly granted to public agencies by statute.

Public agencies forming nonprofits to issue debt. An additional way for public agencies to issue debt to help fund PPPs is for public agencies to form “63-20 corporations.” These projects refer to IRS Rule 63-20, allowing not-for-profit corporations to issue tax-exempt debt on behalf of public agencies and private firms that are engaged in PPP deals, by leveraging future toll revenues, farebox revenues, or future lease payments.⁵ The Pocahontas Parkway project in Virginia utilized this type of financing; where over \$350 million in revenue-backed tax-exempt bonds were sold by a not-for-profit corporation set up for the sole purpose of funding the project. The use of these 63-20 funds was approved by the state of Virginia and had no impact on the state’s bond credit ratings.⁶ While states will be limited by their bonding capacity to the number

⁵ http://www.fhwa.dot.gov/PPP/defined_dbfo_6320.htm (last accessed on June 19, 2009.)

⁶ <http://www.fhwa.dot.gov/innovativefinance/ifa62.htm#tech> (last accessed on June 19, 2009.)

of PPP projects they can finance with 63-20 corporations, this setup still provides a way to fund transportation projects without advancing scarce public funds.

New Jersey, a state with no current PPP program, is exploring the possibility of creating public nonprofit corporations to issue debt instead of full privatization of the state's toll roads, which was politically unpopular (Barlas 2007). Currently, Missouri, Texas, and Washington prevent the use of 63-20 corporations. Texas explicitly excludes nonprofits from issuing debt in this way, and Washington requires that any PPP-related debt be issued by the State Treasurer. Only Colorado, Georgia, South Carolina, and Virginia explicitly allow for non-profits to issue debt.

Considering the IRS support of this way of issuing debt, it is somewhat surprising that a state would prohibit the use of 63-20 corporations. It is a process by which states can generate funding to update infrastructure without impacting their bond credit ratings or detracting from the budget. Fifteen states have not put an express provision in their legislature regarding whether the public sector can form non-profits and issue debt, leaving the option open. States should enable their public agencies to take advantage of this IRS ruling as a way to limit direct public funding of a project, especially given the success of Virginia in its Pocahontas Parkway. For successful use of 63-20 financing, it must be understood that the nonprofit corporation will not just be a passive financing conduit, but will have long-term construction and operating responsibilities. Contracts should grant the 63-20 corporation an appropriate measure of supervision and control throughout the life of the project.⁷

4-4. Procurement and Project Management

4. Procurement and Project Management

- Do the statutes provide for all types of project delivery (design-build, etc.)?
- Are PPP projects exempt from state procurement laws?
- Can public entities outsource project operations and management?
- Are public entities required to maintain comparable non-toll routes?
- Are non-compete clauses required for PPP projects?
- Can public agencies enter into long-term leases of PPP facilities to the private sector?

Providing for multiple types of project delivery. Allowing states to enter into a wide assortment of PPP arrangements better matches the flexibility needed to create an efficient PPP process. States that allow for only a few types of agreements necessarily limit the types of proposals they will receive. Only Alaska and Arizona have limits on the types of arrangements PPP proposals can take, and both of these states have thus far only authorized three PPP facilities by statute.

States should instead provide for all types of procurement processes, develop appropriate guidelines to shape these processes, and allow transportation agencies

flexibility to adopt the best financing scheme for a project. Virginia's PPP legislation has allowed many different kinds of projects to move forward, from design/build agreements for tolled expressways between interstates to expansion of existing roads for truck lanes (Gougherty 2005a).

⁷ For further discussion of 63-20 corporations, see Hedlund (2007).

Exemption from state procurement laws. States that choose to exempt PPP projects from procurement laws benefit the project by relieving private agencies from meeting labor, bidding, and other procurement-related requirements that public agencies must meet when building transportation facilities. Allowing exemption from procurement requirements may mean that innovative procurement methods will withstand legal challenges. Nine states exempt PPP projects from procurement laws while nine do not. Florida explicitly requires these projects to use state general procurement laws. These exemptions come at the cost of circumventing a public bidding process that ensures legitimacy of the process and obtain the best available deal from the private sector for the public benefits. States need to strike a balance between ensuring the validity of the procurement process and allowing for innovative ways of sponsoring PPP projects through lifting some state procurement requirements.

Table 4-4: Procurement and Project Management

Code	Provisions	AL	AK	AZ	CA	CO	DE	FL	GA	IN	LA	MD	MN	MO	MS	NV	NC	OR	SC	TN	TX	UT	VA	WA
4-a	Allows for Multiple Types of Project Delivery		N	N	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	Y		Y	Y	Y	Y	Y
4-b	Exempts PPP Projects from State Procurement Laws		N		N	Y	Y	Y	Y	Y	N	N	N	Y	Y		Y	Y	N	Y	Y	N	Y	Y
4-c	Allows for Outsourcing of Operations and Management	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
4-d	Requires Public to Maintain Comparable Non-Toll Routes			Y	N	N	N	N	N	N	N	N	N	N			Y	N	N		N	N	N	
4-e	Requires Non-Compete Clauses	Y	N	N	Y	N	N	Y	N	N	N	N	N	N	Y		Y	N	N	N	Y	N	N	N
4-f	Allows for Long-Term Leases to Private Sector	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y

***A cell left blank indicates state legislation does not make an explicit provision regarding that category.

Outsourcing of project management and operations. The Chicago Skyway PPP project and the Trans-Texas Corridor both provide for long-term leases of the project to private agencies, effectively outsourcing both the management of the project and its operations. The Chicago Skyway project was the first long-term lease of an existing toll road in the U.S, which was built and operated by the City of Chicago. In this project, an international group entered into a 99-year lease with the city to operate the structure. Such agreements represent another form of PPP project, one that requires no new construction—brownfield projects—but can take advantage of private sector efficiencies in managing and operating an existing facility in exchange of compensation for private sector either by payment from public agency or revenue from direct user tolls.

All states that authorize the use of PPPs for transportation facilities except South Carolina provide for this type of arrangement. Delaware puts a 50-year cap on the length of these leases and Indiana provides for leases of up to 75 years in length. Such blanket legislative restrictions are not advised, and a decision of a lease term should be made by transportation agencies and private firms based on financial and economic assessments. At the same time, it is true that the level of uncertainty and risk significantly increases for longer term contracts to make financial and economic assessments of a project very difficult (Iseki, Uchida, and Taylor Under review). Therefore, legislators can cap the term if they are seriously concerned—especially when a state wishes to make a lease concession agreement its first foray into PPP usage.

Maintaining comparable non-toll routes. When PPPs provide for tolled facilities, Arizona and North Carolina require that public agencies maintain existing non-toll routes. Arizona and North Carolina, not coincidentally, are two of the states with the least experience in developing transportation facilities using PPP projects. While keeping non-toll routes and regular lanes parallel to toll routes and lanes is often used to gain the political and public acceptance for new road pricing schemes in their early stage, there is no economic reason to require non-toll routes and lanes. None of the states with more extensive PPP experience require comparable non-toll routes; as such routes divert some traffic away from toll routes and reduce toll revenues, which discourage private investment on such facilities. These requirements also lessen the ability of public agencies to pursue projects in areas where it is infeasible to keep both toll roads and competing non-toll facilities open. Although these requirements may placate the public afraid of having no choice but to drive on tolled facilities, the fundamental concept of tolls or any road pricing is that drivers are paying for the costs that they incur to the society. To protect the public from outrageous tolls, toll caps can be introduced within a contract but not in legislation. In addition, experience has shown that even U.S. drivers will pay to use superior transportation facilities (Kalauskas, Taylor, and Iseki 2009).⁸

Non-compete clauses prohibited. Non-compete clauses may be necessary for some projects and not for others. These clauses may include other requirements that a minimum number of users travel on the facility, in effect limiting the ability of public agencies to develop alternative routes. Non-compete clauses can have a significant effect on traffic demand on a PPP facility, toll revenues, and profits for private management firms. With non-compete clauses, an increase in traffic demand directly leads to an increase in cash flows for private management firms. In a situation where there is no alternative road, non-complete clauses create a geographic monopoly

⁸ For example, Orange County’s SR-91 Express Lanes, San Diego’s I-15 HOT Lanes, and Minnesota’s I-394.

situation, which allows faster and/or larger toll increases. Because of restrictive non-compete clauses in the contract, California had to buy back its lease of the express lanes of SR-91 when the state DOT wanted to expand the highway capacity between Riverside and Orange Counties (Sullivan 2003; Swan and Belzer 2008). Indiana accepted non-compete clause which, combined with a loose toll cap, may allow the concessioner to raise the toll higher faster than inflation (Swan and Belzer 2008).

Just as with the requirements that states maintain non-toll routes, the ability to insert non-compete clauses into a PPP agreement seems to come with PPP experience. Three states with minimal PPP development, Alabama, California, and North Carolina, do not allow for a PPP project to infringe upon the ability of public agencies to develop nearby roads. States with more extensive PPP experience, Delaware, for example, allow non-compete clauses to be included in PPP agreements where appropriate. Whether or not to allow non-compete clauses depends on various factors, such as present and future traffic demand, geographic conditions of facility sites, and potential facilities that compete PPP projects, which vary by project. Therefore, it is recommended not to have non-compete clauses in the legislative level.

Allowing long-term leases of PPP projects. Just as with outsourcing project management and operations, states should also allow for public agencies to enter into long-term leases of asset management functions for projects constructed through PPP agreements such long-term leases are assessed as the best option, taking into account financial and economic uncertainty, risks, costs and benefits. All states except California (which has no statute explicitly allowing for this) permit these types of arrangements. Alabama limits these contracts to a term of 20 years, while Louisiana explicitly allows private entities to contract with third parties to maintain PPP facilities. Virginia requires private agencies to submit asset management contracts to a competitive bidding process unless these contracts are part of a comprehensive agreement.

4-5. Tolling Management

<p>5. Tolling Management</p> <ul style="list-style-type: none"> • Which party has the rate-setting control? • Is the public entity required to remove tolls after the debt has been paid?

Specifying party with rate-setting control.

In principle, taking into account that operating environment and future demand significantly vary for different facilities, the toll rate should be negotiated and determined in a contract for each case. Most of the existing PPP agreements actually include rate of return caps to ensure that the private firms do not gain too much profit at

the expense of roadway maintenance, construction quality, or reasonable user fees (Iseki, Uchida, and Taylor Under review). Agreements typically require any profits beyond the cap to be returned to the state highway fund (Federal Highway Administration 1992). Only when the state government has a concern regarding the capability of a public entity in charge of this negotiation and procurement of services should it specify the maximum rate. Alternatively, the state government can also set the maximum rate for profit for contractors in order to avoid the public's resistance toward PPP projects. At the same time, these maximum rates should not be so low that they discourage private firms from bidding for projects.

These agreements should also authorize the PPP project to utilize many different types of toll collection, from traditional tollbooths to video-based collection processes. In six states, the public entity directly controls the toll rate that can be collected. Fifteen other states provide for

the rate to be set by contract, and some of these also provide for a maximum rate of toll increase. In Minnesota, one of the fifteen allowing the agreement to determine toll increases, by statute a toll facility development agreement must establish a reasonable rate of return on investment, which essentially requires that toll increases be built into an agreement. In Florida, toll rates must be indexed to the Consumer Price Index or another inflation-based index and private entities can request to increase the rates by more (Florida Department of Transportation 2008).⁹

The public and private partners should have the ability to agree to a sensible rate of return in a PPP agreement, weighing the public interest in having a stable toll rate against the financial interests of the private entities. At the same time, these agreements must be carefully crafted, as embedded toll increases in Illinois and Indiana projects have led to windfall profits for leaseholders (AECOM Consult 2007). Another provision in these laws might provide for actions to take in the event of windfall profits caused by high facility demand.

Requirement of toll removal after debt satisfaction. North Carolina and Tennessee require that tolls be removed from PPP facilities upon the satisfaction of the debt that they financed. This was likely a politically popular maneuver, but one that does not serve to create a more efficient transportation network. Revenues collected from tolled transportation facilities after debt satisfaction can go towards funding other improvements and maintenance to the transportation network. Public funding shortfalls for transportation is an issue that is not likely to go away, and these tolls can be used to fund additional projects. Instead of requiring that tolls should be dropped after debt satisfaction, states should explicitly allow for continued tolling, to allow private entities to ensure their rate of return is met and to provide funding for subsequent transportation facilities.

⁹ <http://www.dot.state.fl.us/publicinformationoffice/pdf/2008%20Final%20Summary%20vetoes.pdf> (Last accessed on June 19, 2009.)

Table 4-5: Toll Management

Code	Provisions	AL	AK	AZ	CA	CO	DE	FL	GA	IN	LA	MD	MN	MO	MS	NV	NC	OR	SC	TN	TX	UT	VA	WA
5-a	Rate-Setting Control Set in Agreement	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y		Y	N	Y	N	N	Y	N	Y	Y
5-b	Requires Removal of Tolls After Payment of Debt		N	N	N	N	N		N	N	N	N	N	N	N		Y	N	N	Y	N	N	N	N

***A cell left blank indicates state legislation does not make an explicit provision regarding that category.

5. CONCLUDING REMARKS

PPP legislation aims to both protect public agencies and taxpayers while promoting environments that attract private investment in public roadways. While federal legislation has set the stage to make PPPs possible, their desirability is very much dependent upon the legislative setting in individual states. As such, effective state legislation strikes a balance that allows private agents to profit, protects taxpayers, and allows public agencies a reasonable amount of control over public-private projects over time. Legislation thus sets the basis for PPPs and has to be in place before they can go forward. Having carefully crafted legislation in place has been shown to limit problematic projects that require renegotiations or abandonment that can cost taxpayers dearly.

The research finds that the legislative landscape for PPPs varies widely from state to state. In many cases, states are divided in whether they allow or prohibit certain aspects in the PPP process. For example, 13 states have legislation limiting the mode of transportation eligible for PPPs, while 10 states have no restrictions. In many cases, most states take a similar position on legislative specifics. For example, no state prohibits Design-Build projects, nor does any state prevent a public agency from hiring its own consultants or from entering into a long-term lease. Similarly, all states that have statutes requiring application fees, and all existing legislation allows state and federal funding, as well as TIFIA funds, to be used on projects.

In contrast, some provisions have not been widely addressed in legislation at all. For example, only five states—California, Colorado, Delaware, Florida, and Minnesota—address HOT Lane projects (all of which permit them). In addition, there are policies on which most state legislation is congruent, but on which a few states differ. For example, all states with legislation addressing unsolicited proposals allow them, except for Indiana and North Carolina. Nevada, in fact, *requires* unsolicited proposals. Of the 21 states with legislation regarding local vetoes, only Arizona, Delaware, and Minnesota require that proposals be subject to a local plebiscite. Of twelve states with legislation addressing proposal confidentiality, only Arkansas and California protect confidentiality. Georgia is the only state to disallow the public sector from issuing revenue bonds. Only Mississippi disallows outsourcing of operations and management, and only Arizona and North Carolina require the public to maintain comparable non-toll routes. Only North Carolina and Tennessee require that tolls be removed once the financing debt has been paid. These exceptions to the rule likely reflect each state’s general philosophy toward PPPs, which we would characterize as follows:

1. **Aggressive** (Indiana, Texas, and Virginia),
2. **Positive, but cautious** (Arkansas and Minnesota), and
3. **Wary** (Alabama, Missouri, and Tennessee).

That we observe so many examples of individual states going against the grain in promulgating PPP legislation perhaps reflects the current period of experimentation with PPPs. As the experience with PPPs grows over time, it’s possible that we will see some convergence in PPP enabling legislation as a consensus on best practices emerges. In the meantime, variety is the rule. For example, requiring non-toll alternatives or the removal of tolls are ways to appease taxpayers. In this report, we have discussed many ways in which states have attempted to use legislation to finance projects through PPPs; some have proven successful, others less so. For example, Virginia’s use of the IRS 63-20 ruling allowing states to form non-profits and issue tax-exempt bonds is one method to skirt traditional public financing; it’s likely that other states will consider using this ruling to their advantage. By stipulating toll-removal requirements in PPP

projects, North Carolina and Tennessee are foreclosing the possibility of generating transportation revenues from tolls in the years ahead. Likewise, the extraordinarily long-term deals, such as a 99-year lease on the Chicago Skyway and a 75-year lease on the Indiana Toll Road, limit the ability of future public officials to negotiate with private firms over the operation of a critical piece of transportation infrastructure. These examples suggest that PPPs offer significant potential benefits to government agencies, but present significant risk and uncertainty as well. As to whether PPPs for highway projects are a good idea, the devil, as they say, is in the details.

6. ACKNOWLEDGMENT

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Appendix I: California Legislation for Public Private Partnerships for Transportation Projects

California has issued four legislations related to public private partnerships for transportation projects that have become law with the Governor's approval, including Senate Bill (SB) 4 that was signed by Governor Schwarzenegger on February 20, 2009.¹⁰

This appendix lists the current and past legislations passed in California to facilitate partnerships with the private sector for the private capital investment and expertise for future transportation infrastructure projects in the state in reverse chronological order.

1. Senate Bill (SB) 4, Second Extraordinary Session (Cogdill) Chapter 2, Statutes of 2009

This legislation has been approved by Governor Schwarzenegger on February 20, 2009. It provides the legislative authority to regional transportation agencies and Caltrans to enter into an unlimited number of Public-Private Partnerships (PPP) until January 1, 2017. This legislation removed the constraints under the prior legislation on the number and type of projects that public agencies in California may undertake, and require the projects to address mobility, operations, safety, and quantifiable air quality benefits.

This bill eliminated prohibition of amendment of lease agreements by the Legislature and the provision in AB 1467 that requires approval or rejection of the Legislature in 60 legislative days. Instead, this bill requires all lease agreements to be approved by the California Transportation Commission as well as reviewed by the Legislature and the Public Infrastructure Advisory Commission. Under this legislation, regional transportation agencies can accept unsolicited proposals, while awarding contracts to such an unsolicited bidder requires at least another responsible bid to be reviewed. An award of contract is based on either the lowest bid or best value criterion.

SB 4, Second Extraordinary Session also provides the legislative authority until January 1, 2014, for the state to have a total of up to 15 design-build demonstration projects, combining:

- the maximum of five projects (local street or road, bridge, tunnel, or public transit projects) for the local transportation agencies, and
- the maximum of ten projects (state highway, bridge, or tunnel projects) for Caltrans.

This bill provides in demonstration projects an opportunity to examine the benefits and challenges of design-build contracting in evaluation criteria, such as reduction in project costs, expedition of project time, or design features that the traditional design-bid-build method does not achieve.

This bill requires transportation entities to report to the California Transportation Commission, which is required to provide a mid-term and a final report to the Legislature, regarding the design-build process. The bill also specified a procedure for bidding submission, including a requirement for design-build entities to provide a statement of qualifications to the transportation entity.

¹⁰ Source: http://www.dot.ca.gov/hq/innovfinance/Public-Private%20Partnerships/PPP_main.html. (last accessed on June 19, 2009.) There are more proposals for PPP legislation or other innovative finance legislation. However, because of various reasons, such as premature proposals, political opposition, and funding issues, such proposals do not make it through the passage, or even do not reach a discussion and voting in the state congress.

2. Assembly Bill (AB) 521 (Runner) Chapter 542, Statutes of 2006

This assembly bill was approved by Governor Schwarzenegger on September 28, 2006. This legislation modified provisions in AB 1467 to allow the California State Legislature to act within 60 legislative days after submittal of a Public-Private Partnerships (PPP) negotiated lease agreement. The rejection of agreement requires the passage of a resolution by both houses of the Legislature within this specified time period.

3. Assembly Bill (AB) 1467 (Nunez) Chapter 32, Statutes of 2006

This assembly bill was approved by Governor Schwarzenegger on May 19, 2006, and became in effect on January 1, 2007. This legislation authorized the Department of Transportation (Caltrans) and “regional transportation agencies to enter into comprehensive development lease agreements with public and private entities, or consortia of those entities for certain transportation projects that may charge certain users of those projects tolls and user fees, subject to various terms and requirements” until January 1, 2012.

The number of projects under these provisions is limited to 4, with 2 in each of northern California and southern California, and would be selected by the California Transportation Commission with a primary focus on improvement of goods movement. This legislation also provides authority to regional transportation agencies, in cooperation with Caltrans, to apply to the commissions to develop and operate high-occupancy toll (HOT) lanes. Such projects include the “administration and operation of a value pricing program and exclusive or preferential lane facilities for public transit.”

This legislation requires all negotiated lease agreements to be submitted to the Legislature for approval, which will be given by the enactment of a statute. It also requires a responsible agency to have at least one public hearing at a location at or near the proposed facility and receive public comments on the proposed lease agreement. A lease agreement for the legislature’s review should be submitted with public comments from public hearings.

4. Assembly Bill (AB) 680 (Baker) Chapter 107, Statutes of 1989

This assembly bill was approved by Governor Wilson on July 10, 1989. This legislation authorized the Department of Transportation (Caltrans) to have four transportation demonstration projects, including at least one in northern California and one in southern California, involving agreements with private entities for the construction and lease of transportation infrastructure for up to 35 years. This bill authorized the agreements to allow the private entity to charge tolls for the use of the privately constructed facilities.

This legislation sought the following through approved public private partnership projects:

- 1) private sector efficiencies in designing and building transportation projects,
- 2) identification of capital funds needed for transportation projects in the state,
- 3) reduction in the level of congestion in existing transportation corridors,
- 4) continued compliance with environmental requirements and state and federal laws applicable to all publicly financed projects, and
- 5) provision of alternative traveling routes to the public.

Table A-I-1: Current CA Legislative PPP Guidelines Summary

Code	Provisions	CA	Note
1-a	Allows for Unsolicited Proposals	Y	
1-b	Limits Number of Projects	N	
1-c	Restricts Geographic Location	Y	
1-d	Restricts Mode of Transportation	N	
1-e	Allows for Conversions of Existing Roads	Y	
1-f	Prior Legislative Approval Required	Y	
1-g	Allows for Local Veto	N	
1-h	Restricts PPP Authority to State Agencies	N	
1-i	Design-Build Readily Allowed?	Y	
1-j	HOT Lane Projects?	Y	
1-k	Number of Major PPP Highway Projects Since 1991	7	
2-a	Allows Public Agency to Hire Own Consultants	Unspecified	
2-b	Allows Payments to Unsuccessful Bidders	Unspecified	
2-c	Requires Application Fees	Unspecified	
2-d	Requires Time for Public Review	Y	
2-e	Specifies Evaluation Criteria	N	
2-f	Structures Proposal Review Process	Y	
2-g	Protects Confidentiality of Proposals	N	

Table A-I-1: Current CA Legislative PPP Guidelines Summary and Recommendations (Continued)

Code	Provisions	CA	Note
1-a	Allows for Unsolicited Proposals	Y	
1-b	Limits Number of Projects	N	
1-c	Restricts Geographic Location	Y	
1-d	Restricts Mode of Transportation	N	
1-e	Allows for Conversions of Existing Roads	Y	
1-f	Prior Legislative Approval Required	Y	
1-g	Allows for Local Veto	N	
1-h	Restricts PPP Authority to State Agencies	N	
1-i	Design-Build Readily Allowed?	Y	
1-j	HOT Lane Projects?	Y	
1-k	Number of Major PPP Highway Projects Since 1991	7	
2-a	Allows Public Agency to Hire Own Consultants	Unspecified	
2-b	Allows Payments to Unsuccessful Bidders	Unspecified	
2-c	Requires Application Fees	Unspecified	
2-d	Requires Time for Public Review	Y	
2-e	Specifies Evaluation Criteria	N	
2-f	Structures Proposal Review Process	Y	
2-g	Protects Confidentiality of Proposals	N	
3-a	Allows State and Federal Funds	Unspecified	
3-b	Allows TIFIA Funds	Unspecified	
3-c	Restricts Toll Revenues from General Fund	Y	

3-d	Allows Public Sector to Issue Revenue Bonds	Unspecified	
3-e	Allows Public Sector to Form Nonprofits and Issue Debt	Unspecified	Allowing states to form non-profits and issue tax-exempt bonds is one method to skirt traditional public financing.
4-a	Allows for Multiple Types of Project Delivery	Y	
4-b	Exempts PPP Projects from State Procurement Laws	N	
4-c	Allows for Outsourcing of Operations and Management	Y	
4-d	Requires Public to Maintain Comparable Non-Toll Routes	N	
4-e	Requires Non-Compete Clauses	Y	
4-f	Allows for Long-Term Leases to Private Sector	Y	Extremely long-term leases limit the ability of future public officials to negotiate with private firms over the operation of a critical piece of transportation infrastructure.
5-a	Rate-Setting Control Set in Agreement	Y	
5-b	Requires Removal of Tolls After Payment of Debt	N	