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Combating Gridlock:

How Pricing Road Use Can Ease Congestion

A Deloitte Research Public Sector Study

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EXECUTIVE SUMMARY

The cities of the world are being overwhelmed by traffic. From Paris to Jakarta, urban residents and commuters are confronting traffic conditions that are becoming increasingly unbearable. Few issues worldwide elicit such universal reactions of frustration and impotence from citizens and politicians alike as the seemingly futile effort to fight gridlock.

Without radical reforms, this situation will only get worse. The growth rate in motor vehicles is projected to exceed vastly the growth in new roads in nearly every country in the world over the next several decades, causing congestion to rise even further. In Western Europe, for instance, it is forecast that gridlock will rise 188 percent on urban roads by 2010.

Congestion is a huge drain on the economy. Its costs include unpredictable travel times, environmental damage, property damage, delays, and lost production. In OECD countries alone, the cost of congestion now amounts to nearly three percent of GDP, or about US$810 billion. In Asia, the situation is even worse. In Korea, for example, the cost of congestion is now about 4.4 percent of GDP.

What can be done? Many strategies have been tried: building more roads, trying to change land use patterns, encouraging people to make greater use of public transport, and so on. None of these has prevented traffic bottlenecks from getting worse. Only one strategy has demonstrated any serious ability to make a lasting impression: road user pricing. Unlike traditional toll roads that have been in place for years with the primary goal of raising revenue, one of the main purposes of most of today's schemes is to ease traffic congestion.

The Case for Charging for Road Use

A number of efforts under way around the world show that curbing gridlock comes down to the proper pricing of scarce road space. The challenge is to set prices that reasonably match up demand and supply among the millions of vehicles that use this finite space. Such a basic economic principle has long ordered the provision of the food we eat, the housing we live in, the clothes we wear, and indeed most of the myriad goods and services of our everyday lives. It has only been precluded in the area of road use by the difficulty and cost associated with charging people directly for road space.

Recent developments in technology, however, now make it not only acceptable but feasible to charge for roads on a usage basis. Expensive toll booths that stop traffic are no longer required, as road usage can be detected and recorded while allowing traffic to flow freely. The best-known recent example is the central London congestion charge. Vehicles driving within central London are charged a flat fee of GB£5 per day between 7:00 am and 6:30 pm, Monday to Friday. Since the road charge was instituted in February 2003, average traffic speeds in the centre of London have risen by 37 percent and traffic levels are down by 16 percent.

The Four Stages of Road User Pricing

Road user charging developments can be categorized in several distinct stages and according to different principles:

- **The corridor approach.** Traditional revenue-generating single road toll schemes were first used in Roman times and, until relatively recently, have remained the main form of road charging. Today's electronic tolling technologies allow conventional toll roads and new HOT (high-occupancy tolling) lanes to play a broader role in congestion management.
- **The area scheme.** Typically applied to urban congestion charging schemes, this refers to charging users to drive in an area that has a closely integrated road system. The Singaporeans were the pioneers here. The Singaporean scheme has reduced total peak period traffic by 45 percent and the number of cars by 70 percent.
- **National and transnational systems.** Here, the charged area extends to a wider road network, rather than just an individual zone. To date, nearly all of the road user pricing schemes that have reached this stage involve heavy goods vehicles (trucks) and vary from major highways to the inclusion of all roads. Austria, France, Germany, Switzerland, and the United Kingdom all have or plan to have road user pricing nationwide for trucks.
- **Integration.** This will be a future stage in which customers make informed choices at every step of the journey across transport modes. The road user charge is meant to provide an incentive for the customer to make the most efficient transport choice. Advanced transportation technologies play an important role in making this stage possible.

Strategies for Success

Experience around the world suggests ten strategies to successfully make the transition to road user charging. Neglecting any of these areas could derail the effort.

1) **Recruit an influential champion.** A skilled sponsor with political and public influence can create a sense of inevitability and be pivotal in keeping the project going.

2) **Keep the public and stakeholders informed and on your side.** All those impacted by the road user charging scheme need to be managed sympathetically, including citizens, local government bodies, consumer groups, and local businesses.

3) **Secure cooperation from third parties.** Highlight the benefits and emphasize transparency and teamwork.

4) **Make it part of an integrated strategy.** Set up appropriate complementary and alternative transport. If commuters cannot continue their daily lives by using public transport or other alternatives, they will return to their cars.

5) **Counter the "just another tax" charge.** Choose carefully where the revenues will go. It's crucial to the success of any pricing scheme to make the use of the funds acceptable or attractive to people so that it will not be perceived as "just another tax."

6) **Pick the right scale and pace.** Pilot project or "big bang?" The strategy has to be political. What makes the most sense to the most people?

7) **Use proven technology.** The key to the London scheme was that it used proven technology that was integrated on time and on budget.

8) **Focus on customer relationship management.** It should be relatively straightforward for anyone to make a payment using appropriate and cost-efficient channels. Enforcement processes must be effective and provide a sufficient deterrent to minimise persistent evaders.

9) **Ensure a successful debut—plan appropriate contingencies.** Before the project goes live, preparations should be made for all of the nightmares that can be envisaged.

10) **Don't lock yourself in.** No road pricing scheme is ever likely to look in its final form exactly the way it looked at the beginning. Having the flexibility to adapt to the changing environment is an imperative.

New technologies and changing public perceptions are transforming the debate about how to tackle the problem of ever-escalating traffic congestion. A number of cities have already seen great success by implementing road user charging schemes to cut down on traffic during peak periods. It is now becoming possible to apply market principles to road congestion to better match the increasing demand for road use to the finite supply of roads—through programmes that are convenient to use, increasingly transparent, and proven to ease the thorny problem of urban gridlock.

INTRODUCTION

Road congestion has become one of the most pressing local issues in cities around the world. Time is money, they say, and the adverse results of congestion are big money—tens of billions of dollars in lost productivity caused by delays and uncertain travel times. In OECD countries alone, the cost of gridlock equals nearly three percent of GDP, or about US$810 billion.[1] In Asia, the situation is even worse. In Korea, for example, the cost of congestion is now about 4.4 percent of GDP.[2]

Not only is congestion an economic drain, it's an environmental problem. It makes energy conservation and emissions control more difficult. A vehicle that is constantly accelerating, decelerating, and idling is burning unnecessary gas and emitting semi-burned fuel and other pollutants. Even road rage and the accidents that are sometimes a result can be blamed partially on congestion.

Many strategies have been tried in attempts to alleviate gridlock: massive road construction; the development of alternatives (new public transport, carpooling programmes, telecommuting, and staggered hours); and land-use planning to minimise the length of trips and maximise accessibility to public transportation. Without these programmes, congestion would undoubtedly be even worse than it is today—but none has come close to actually solving the problem.

As a result, policymakers are looking seriously at another approach to congestion management—charging a price for road use. While some road charging programmes such as toll roads have been in place for many years, they were implemented primarily to generate revenue; today's schemes are intended to reduce traffic bottlenecks. More than 72 percent of major European cities are either interested in or are already proceeding with a road pricing scheme to combat congestion (see Figure 1).

About the Survey

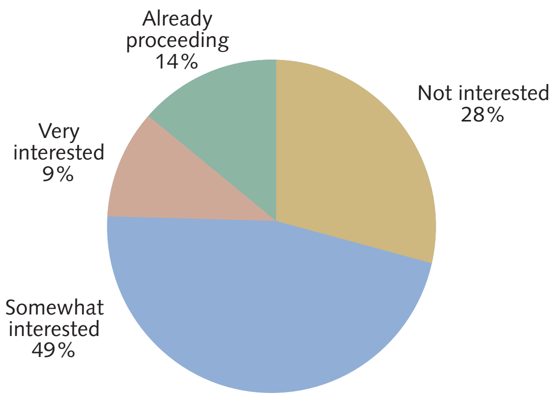
The survey data discussed throughout this report were obtained from a major survey conducted in 15 countries on congestion road user charging conducted by Deloitte in February and March 2003. The survey targeted prominent UK and continental European cities (mostly those with more than 400,000 inhabitants) that did not yet have road pricing schemes in place. A total of 73 municipalities were approached and 47 responses were received (64 percent response rate), representing more than 30 million citizens.

The reason for the interest in road pricing is simple: road space is often a scarce commodity, and it is so highly valued that more people want it than can be accommodated. The best way to ration such a scarce commodity is by charging for its use.

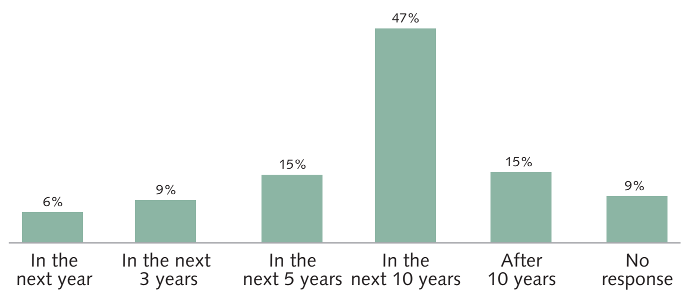
FIGURE 1. GROWING INTEREST IN ROAD PRICING

- 72 percent of European cities surveyed were either interested in or had already proceeded with congestion charging schemes
- 26 out of 34 cities that were interested are planning to start operating congestion charging within the next decade and out of these, five are planning to start operating within three years

Which of the following best describes your city or area's level of interest in adopting a congestion charging scheme?



If you are either thinking about it or already proceeding with it, when would you foresee your city or area starting to operate congestion charging?
(excluded respondents who answered "Not interested" in adopting a charging scheme)



The survey data were obtained from a major survey conducted in 15 countries on congestion road user charging by Deloitte in February and March 2003.
The survey targeted prominent UK and continental European cities (mostly those with 400,000-plus inhabitants) that did not yet have road pricing schemes in place.
SOURCE: DELOITTE RESEARCH

One recent project that has caught the attention of policymakers and interested citizens around the world is the central London congestion charge scheme launched in February 2003. This was a difficult project to get off the ground for a number of reasons. It had to be completed quickly, for political purposes, before the end of the mayor's short term. It was done in a city with a mercilessly critical media, skeptical commentators, and vigorous public argument. And pricing like this had never before been tried on such a scale in such a major city.

Early indications are that the London scheme is a great success —more successful, in fact, than its promoters had dared hope. Average traffic speeds in the charging zone are up by 37 percent. Congestion is down by 40 percent (compared to the predicted 20 to 30 percent reduction). Close to 100,000 individual motorists and some 12,000 fleet vehicles are paying GB£5.00 (US$7.50) a day to travel within the city centre, 20 percent fewer than traveled there when it was free.[3] To the great benefit and relief of most commuters, the charges have priced low-value car trips out of the central area in weekday daytime hours. Those taking such trips now manage to avoid central London altogether or take public transport.

There have been other smaller-scale but nonetheless important innovations in road user charging schemes—in Singapore, Norway, the United States, France, Italy, and Switzerland, for instance. The approaches vary widely, but all share the same intent: to reduce congestion. Some charge for travel within a particular area or zone, while others charge variable tolls in a corridor, single road, or individual lanes of a highway. Some are in the form of passes, granting the right to unlimited travel for a given period, while others levy charges per trip. Some exempt categories of users, others distinguish among different types of vehicles. Some cover just a few blocks, others larger areas, including entire countries.

Technological advances—namely, the availability of cheap and accurate transponders, on-board global positioning system units, and automatic license plate recognition—have made it possible to pay tolls or fees at highway speed, and to vary them in a sophisticated way to manage traffic and ensure free-flow conditions. This study examines the many different possibilities, bringing together some of the accumulated wisdom about this important development in transportation policy.

THE STATE OF CONGESTION: BAD…AND GETTING WORSE

> *"In the twentieth century, man conquered Mount Everest, walked on the moon, and plunged into the icy depths of the Atlantic Ocean. However, despite these huge advances in pedestrian, aviation, and maritime exploration, surface transport remains a vexing problem for metropolitan cities in OECD countries."* [4]
>
> – Organization for Economic Cooperation and Development (OECD)

The cities of the world are being overwhelmed by traffic. In wealthy countries or developing ones, in those with public transport in place or not, urban residents share the common problem of increasingly unbearable traffic conditions. In fact, the average speeds of road travel in many cities are not much greater today than they were in the days of horse-drawn vehicles of the nineteenth century. For hours each day, many motorways, freeways, and expressways resemble parking lots more than roadways.

Such congestion imposes huge costs on the economy and society. First, it obviously takes much longer than it should to go from one place to another. Just as costly, travel times become less predictable—heavy traffic on a motorway can one minute be flowing freely, but even small events or distractions can cause sudden major slowdowns. Flow breaks down and gridlock develops.[5]

This instability imposes further burdens, including higher contingency time (the extra time travelers allow because of uncertainty about the severity of traffic). In order to be relatively sure of getting somewhere on time, motorists need to plan on allowing an extra two minutes per mile to cover trip time variability in congestion, according to a study based on the incidence of different levels of congestion in Houston, Texas. [6]

COSTS OF CONGESTION

- Travel time unpredictability
- Environmental damage
- Increased property damage
- Increased delays
- Lost productivity

Stop-and-start traffic also has a deleterious effect on energy consumption. The incessant acceleration, deceleration, and idle time of a vehicle in heavy traffic is wasted energy. Tailpipe emissions, especially carbon monoxide and hydrocarbons (which results from less than fully burned fuel), are inversely related to speed.

Lastly, safety deteriorates as vehicles bunch together more closely and motorists have less time to react to movements of vehicles around them. Frustration and fatigue set in. Crash incidence, property damage, and accident-caused delays—not to mention injuries—all increase with the level of congestion (though crash severity may decline).[7]

Measuring the Costs of Gridlock

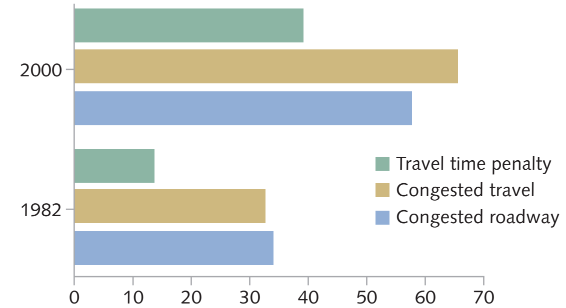
There is no one accepted "right way" to measure congestion and its costs. The simplest method is to compare actual speeds with speeds that would be attained in free-flow traffic conditions. From this simple equation, a congestion "penalty" can be computed, consisting of the extra time spent in journeys, extra fuel burned, and extra emissions released. Values can then be given to each and the total computed.

The cost of time lost due to congestion in the OECD countries as a whole is about two percent of GDP.[8] But adding fuel and other costs brings the total cost of congestion closer to three percent of GDP, or about US$810 billion a year, which translates to about US$678 per person.[9] The costs, of course, vary considerably from one country to another. The cost of congestion in the U.S., arrived at by a similar measure, was about US$150 billion or 1.5 percent of GDP in 2001,[10] while in Western Europe it was 1.9 percent of GDP. Congestion costs tend to be significantly higher in Asia. The cost of congestion in South Korea, for example, which rose steadily in the late 1990s, reached a full 4.4 percent of GDP in 1997.[11]

Of course, traffic congestion will never be totally eliminated. Traffic tie-ups that result from unexpected and random incidents, major sporting events, or holidays are inevitable. It would be far too costly to build an infrastructure for free flow in such conditions, and probably unfeasible to levy road user charges or tolls that would be high enough to ensure free-flowing traffic at all times. The solution lies in better management of those occasional surges in traffic while finding ways to tackle the real issue of day in and day out congestion, a phenomenon that is getting worse almost everywhere.

United States. The Texas Transportation Institute (TTI) has studied traffic patterns and issues in some 75 metropolitan areas in the U.S. for nearly two decades. According to the Institute, rush-hour travelers in 75 of America's metropolitan areas containing just under half the country's population now spend 3.5 billion hours in traffic jams each year and the number is increasing. From 1982 to 2001 the proportion of peak hour travel which experiences delays has doubled from 33 percent to 67 percent, and the average number of hours per day of congestion has grown from 4.5 to 7 hours.[12] The cost of congestion has climbed from an estimated $77 per person in 1982 to $517 per person in 2001 or from $8 billion to nearly $70 billion in aggregate.[13] All in all, the cost of congestion has grown more than four-fold in 20 years.[14]

FIGURE 2. CONGESTION GROWTH IN U.S.



SOURCE: TEXAS TRANSPORTATION INSTITUTE

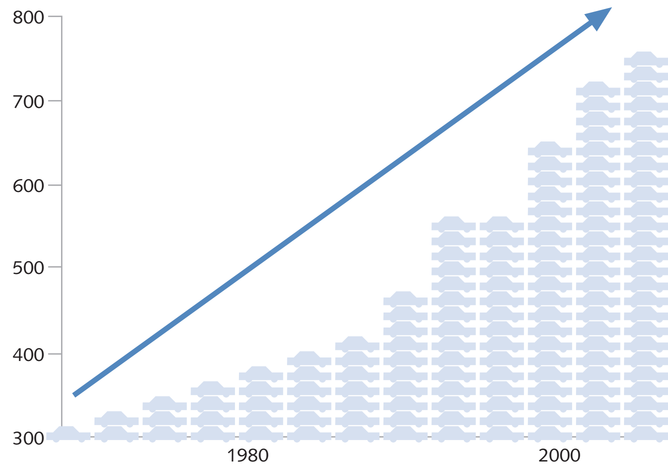
Europe. In Western Europe, it is forecast that congestion will rise 188 percent on urban thoroughfares and 124 percent on inter-urban roads by 2010.[15] In the United Kingdom, the RAC Foundation projects that average main or trunk road speeds will fall to 65 km/hr (40 mph) by 2030 and 50 km/hr by 2050. Notes the foundation: "If on average journey times increase by seven percent every ten years, then there will be many journeys currently undertaken at the shoulder of the peak or in moderately heavy traffic conditions, where the actual deterioration will be twice this." [16]

Asia. The rapid economic growth in Asia over the past three decades has resulted in an explosion in levels of traffic that the road infrastructure was never built to handle. The result is some of the world's worst congestion problems. Travel speeds in Bangkok, for instance, have slowed to less than 10 km/hr on average. Commuting times of more than two hours in both directions are common in the Bangkok, Jakarta, and Surabaya metropolitan areas, as well as in a number of other Asian cities.[17] The resent economic slowdown in Asia hasn't affected the growth in traffic. In Korea, the number of vehicles rose by 26 percent between 1996 and 2000, while in Japan vehicle growth far outstripped the average growth in GDP over the same period.[18]

Meanwhile, in Australia, about half of total urban vehicle-kilometers traveled are presently "performed under congested traffic conditions," according to the Australian Bureau of Transport Economics.[19] The bureau estimates the costs of urban congestion in Australia to be $A12.8 billion (US$7.7 billion), or 1.9 percent of GDP, a bit below the OECD average. Unless fundamental reforms are undertaken, the total cost of Australian urban congestion could rise to about $A29.7 billion (US$18 billion) a year by 2015.[20]

On a worldwide basis, the ratio of vehicles to people increased from 36 per thousand in 1960 to 123 per thousand in 2000. The number of vehicles almost doubled—from 380 million to 752 million—in just half that time (from 1980 to 2000), showing a cumulative annual growth rate of 3.5 percent compared to about 1.6 percent for population growth. Most of the richer countries now have vehicle-to-population ratios of about 500 per thousand (the U.S. is an outlier at nearly 800 vehicles per thousand).[21] Taking into account the expected growth in the developing world, the number of motor vehicles worldwide could grow a little more than threefold, from 0.75 billion to 2.4 billion within a generation, according to transportation economist Anthony Downs. [22]

FIGURE 3. GROWTH OF MOTOR VEHICLES WORLDWIDE



SOURCE: TRANSPORTATION ECONOMIST ANTHONY DOWNS

WHAT GOVERNMENTS HAVE DONE TO TRY TO COMBAT GRIDLOCK

"... in no other major area are pricing practices so irrational, so outdated, and so conducive to waste as in urban transportation."

–William S. Vickery, 1996 Nobel Prize laureate in economics

Congestion is caused by a lack of sufficient supply of road space compared to demand—a deficiency of road capacity relative to the number of trips people are making with their vehicles. This problem can be addressed by increasing supply, reducing demand, or some combination of the two. The main strategies that have been used to reach these goals so far have been to build more roads, to try to change land use patterns, and to encourage people to use public transport. None has prevented congestion from getting much worse.

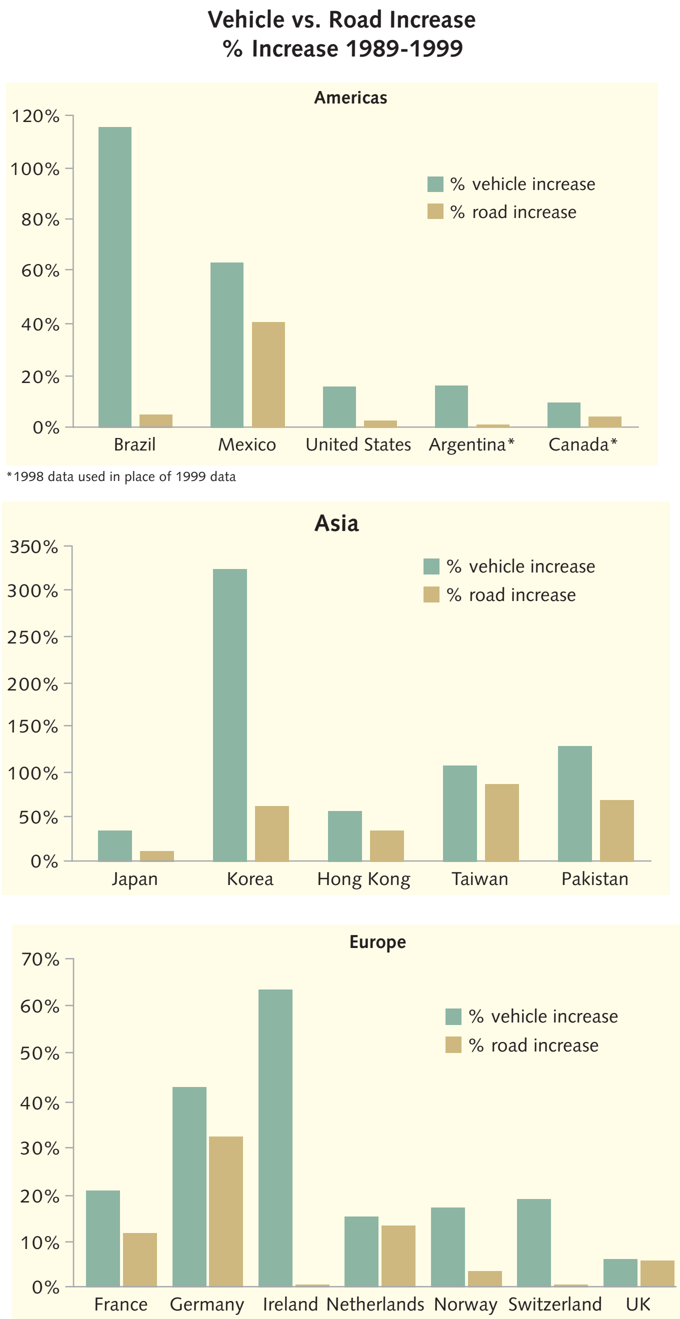
Building out of it

In the past, most transport planning was devoted to anticipating future demand and trying to build roads to meet that demand. It didn't work. No country or city has been able to sustain a road building programme sufficient to allow free-flow traffic. The U.S. came close during its period of major interstate highway construction from 1950 to 1970, and other countries, too, have had spurts of construction during which capacity was growing as fast as traffic. None, however, has been able to keep road supply ahead of ever-expanding demand.

In some cases, congestion should be addressed to some extent by new construction—to provide alternative capacity where none exists, for example, or where access is of low quality. But construction alone is insufficient. Free of any use charge, public funds simply cannot cover the massive costs of road construction needed to support the projected increases in traffic. And even if the money was available, the plans would face overwhelming resistance from property owners and environmentalists.

FIGURE 4. VEHICLE NUMBERS GROWING FASTER THAN ROAD CAPACITY WORLDWIDE

Throughout the world, countries are fighting a losing battle in building enough roads to meet the growing fleet of cars.



SOURCE: DELOITTE RESEARCH

Land use changes and planning—double-edged sword

Many large cities have tried to cope with the burgeoning pressures of traffic by reorganizing their land use patterns—either by trying to disperse activities and move them outward or by trying to concentrate businesses and housing in urban corridors in order to make public transport more viable. The rationale for the former is that more space exists on the fringes of cities to accommodate modern transport—more parking space, and more room to build loading docks and other specialised facilities for trucks. An unfortunate by-product of such an approach is "sprawl," which tends to push traffic out to the periphery. As for the latter approach, attempts to coerce businesses and individuals to concentrate in certain urban corridors through land use regulations can cause huge distortions in the market, tend to be very unpopular, and have not yet demonstrated that they can work.

The bottom line is that better land use planning can perhaps help to ease congestion, but probably not much. Indeed, reducing congestion through land use planning has been tried for more than half a century—but with very limited success.

Shifting people onto public transport

The notion of shifting people from automobiles to public transport plays a major role in discussions of congestion. This is especially true in large cities with long-established mass transit options such as London, New York, or Tokyo. Wherever there is a concentration of employment and other activities in a central or downtown area, it will make sense for most of the people working there to travel by train or bus. By improving service and extending hours, it may be possible to get more commuters to leave their cars, if not at home, at least at a local transfer point or intermodal centre, rather than cluttering the road corridor heading downtown.

However, the possibility of transit gaining a large share of commuters is limited in places where employment and other activities have dispersed away from a single major centre. In such places, the chances of being able to aggregate people going from one point to another at around the same time are very small. Transit starts to involve awkward trips to a station or a stop, long waits for service, and transfers. Sitting in a private car in traffic suddenly may not seem such a bad alternative after all, especially with a stereo and cellular phone to pass the time.

Improved transit will sometimes be *an* answer, especially for moving commuters to and from work at concentrated business centres. But transit clearly won't help much in areas where workplaces are dispersed, and it will rarely help for heavy shopping expeditions or short trips.

THE CASE FOR ROAD USER CHARGES

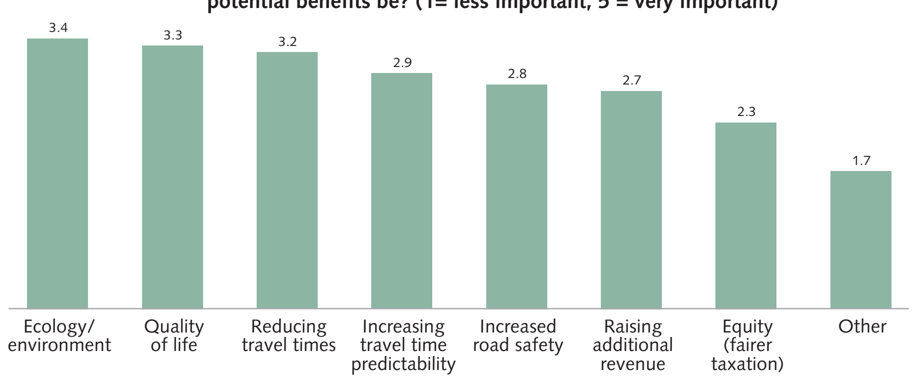
Congestion is as old as cities; even Roman emperors found traffic a vexing issue. In 45 BC Julius Caesar decreed the centre of Rome off limits to all but approved vehicles between the hours of 6:00 am and 4:00 pm.[23] After the attacks of 9/11/2001 in New York City, authorities imposed similar measures in order to free the streets for the rescue and recovery effort. Private single-occupant vehicles were barred from entering the southern half of Manhattan. The congestion problem was solved in an instant. Half the traffic disappeared, and what remained could usually drive at the speed limit.

The trouble with this kind of command-and-control approach to traffic is that it allows no distinctions between trips of varying value. For example, a single commuter may find certain routes to work in a city centre off limits because he or she is alone, while a group of leisure travelers can access any route to get into the city. Under any command approach such inequities abound, the economy suffers, and people finally get fed up. The command regime eventually falls into disarray as enforcement gets lax, or it is quietly abandoned. In lower Manhattan the single occupancy ban was lifted in less than a year.[24]

Apart from the giving priority to emergency vehicles, a price-based system is the only proven way to allocate scarce road space among millions of vehicles. Under such a system, individuals faced with a road user charge can make their own judgment about the value of their trip.

FIGURE 5. REASONS FOR RISING INTEREST IN ROAD PRICING

If your city or area were to introduce congestion charging, how important would the following potential benefits be? (1= less important, 5 = very important)



Not all respondents allocated a score to each option.
The score is therefore based on total number of points divided by the total number of respondents.
Nine cities also commented that improvements for public transport would be an important benefit.

SOURCE: DELOITTE RESEARCH

The Economic Rationale for Charging for Road Use

A number of efforts under way around the world indicate that combating traffic congestion is possible by properly pricing scarce road space. The challenge is to set prices that reasonably match demand and supply. Such a basic economic principle has long ordered the provision of the food we eat, the housing we live in, the clothes we wear, and indeed most of the myriad goods and services of our everyday lives. It has only been precluded in the case of roads by the difficulty and cost associated with charging people for road space.

But imagine if food, for example, were priced the same way we now price road space. A general tax would be imposed, and that money would be used to buy food from farmers and wholesalers for supermarkets, which, in turn, would stock food at no price. Food would be available on a first-come, first-served basis, resulting in shortages and waste. There would be long queues after supplies came in, not to mention political pressure on the government to enlarge the programme because of the empty shelves and queuing.[25]

And while petrol/gasoline taxes may appear to be road user charges, they in fact are not charges for road use; they are charges on road users, a crucial distinction. In economic terms they are taxes, even though politicians may call them charges. Taxes differ from user charges in that what you pay is not tied directly to what you're using and how you're using it.

Road space is what economists call a perishable commodity. If available space is not used at a particular time, it can't be stored and used at some future time. On the other hand, providing an extra space during congested periods is extremely expensive—buying right of way, getting planning and environmental permits, plus immense construction costs. To use road space efficiently or to get the highest value from its use, it needs to be charged at this marginal cost.

Economists have looked at this as a case of maximising welfare through proper pricing—setting the price at marginal social cost.[26] Georgina Santos of the Department of Applied Economics of Cambridge University puts it this way: "The efficient charge [will] equal the external cost imposed on other drivers, or [the] difference between marginal social cost (MSC) and average private cost (APC). This is standard economic theory…"[27]

It also is the most logical approach to managing traffic. Nothing is as devastating to the performance of a roadway as its collapse into stop-and-go traffic. Therefore, one of the most effective forms of traffic management is to price road use to cover marginal cost, and by doing so prevent overload and the damaging breakdown in traffic flow.

The cost of road space varies enormously by place and time of day. A U.S. Department of Transportation estimate is that a typical trip at a peak hour in an average large U.S. metropolitan area costs 18 cents/km (30 cents/mile) traveled.

A trip on the same roadway costs as little as one cent/km (two cents/mile) for off-peak travel when only variable costs apply.[28] A realistic road use charge at, say, 18 cents/km in congested urban conditions would reflect the cost of the road space at those times, whereas the cost of traveling at other times and places when there is free flow would be much lower.[29]

ADDRESSING EQUITY CONCERNS

One of the major criticisms of road user pricing is that it's unfair to certain groups of people, ranging from low-income drivers who can't afford the toll charges to people living within the pricing zones who would be forced to bear a disproportionate share of the charges simply because of where they live.

Fortunately, there is a host of proven ways to address such concerns. One of the best ways to avoid adverse impacts on low- and medium-income individuals, for example, is to use some of the revenues from the pricing charges to improve public transport, as San Diego and London have done. People who are unable to afford the road user charge tend to be much less likely to drive to work and more likely to use public transport than those with higher incomes, and thus should benefit greatly from public transport improvements.

Another option is to provide discounts for certain categories of drivers. Some cities have exempted the disabled from pricing charges. Discounts could also be given to other categories of drivers, such as people under certain income levels or those living within the road pricing zone. In London, residents within the zonal area receive a 90 percent discount.

FIGURE 6. HISTORY OF ROAD USER CHARGES

320BC —	Kautilya's Arthasastra lays out the duties of a toll superintendent for an Indian king.
1176 —	Henry II charters Colechurch to build the first stone London Bridge in return for a toll concession.
1356 —	Edward III institutes toll on freight wagons on the Strand between Temple Bar and Westminster.
1706 —	British Parliament begins widespread chartering of turnpike trusts.
1963 —	Port Authority of New York/New Jersey demonstrates electronic toll collection at Lincoln Tunnel.
1974 —	Greater London Council proposes daily ticket of entry for cars and commercial vehicles. Withdrawn in face of opposition.
1975 —	Singapore institutes an Area Licensing Scheme.
1986 —	Bergen Norway implements a toll "ring" or cordon.
1987 —	Alesund Norway: First use by the public of electronic toll transponders.
1990 —	First use of electronic tolling to trips on A1 Milan-Florence-Naples-Rome. Oslo, Norway: first to deploy transponders for congestion pricing.
1991 —	First full highway speed, multi-lane electronic tolling on Denver's E-470. Trondheim, Norway: first to deploy transponders for congestion pricing.
1992 —	Differential toll rates are introduced on the A1 north of Paris.
1995 —	91 Express Lanes open in the Los Angeles area.
1997 —	Toronto opens 407-ETR, world's first multi-interchange tollroad providing highway speed electronic tolling.
1998 —	I-15 toll lanes in San Diego go live with dynamic pricing. Electronic Road Pricing replaces the sticker-based area license in Singapore. Rome requires payment for non-residents to enter historic centre of the city.
1999 —	UK local governments granted power to implement congestion pricing
2000 —	Ken Livingstone elected mayor of London—promises to introduce congestion charging in central London. Melbourne's City Link imposes road pricing charges for light and heavy commercial vehicles.
2001 —	Switzerland applies electronic fee collections to all domestic and foreign heavy vehicles exceeding 3.5 tons. The Port Authority of New York/New Jersey begins variable pricing on bridges into Manhattan.
2003 —	London launches the world's largest area road pricing system. Germany opens "Toll Collect," a road use charge system for Heavy Goods Vehicle travel—France to follow.

SOURCE: DELOITTE RESEARCH

DOES THE PRACTICE MATCH THE THEORY? VALUE PRICING IN CALIFORNIA

The economic theory and mathematics of road pricing have a long history.[30] The first real-world test using peak/off-peak differential pricing to moderate traffic was the French toll motorways ("*autoroutes a peage*") in the early 1990s. But it was in California in the second half of the decade that the notion of marginal pricing was fully implemented for the first time.

The state of California sought proposals for wholly investor-financed and -owned road projects that would help serve motorists while saving taxpayers money. California Private Transportation Company (CPTC) raised US$130 million to build a four-lane divided tollway in the central median of the eight-lane divided freeway known as the Riverside Freeway (or State Route 91) for 16 km (10 miles). This strategic east-west roadway links the communities of Riverside County (with 2.5 million residents) to Orange and Los Angeles counties and handles some 250,000 vehicles a day. Heavy flows westward in the mornings and eastward in the evenings cause major congestion.

Investors set their own tolls and schedules to maximise their return on investment. Their marketing people developed the phrase "value pricing" to describe a novel toll schedule. The value motorists would get from using the "91 Express Lanes" would vary with the amount of congestion in the free lanes alongside the toll road. An hour-by-hour toll schedule was devised with varying rates depending on the attractiveness of the express lanes relative to the free lanes.

There was an iron economic logic to this pricing. In order to be able to offer the value of free-flowing traffic conditions, the managers of the express lanes had to use their pricing to choke off any excess traffic that might threaten the speed in their lanes. Why? Because they were selling the assurance of an eight- or nine-minute trip versus the free trip that could take anywhere from 15 to 40 minutes. To build faith with motorists, they had to ensure free flow or "express" conditions at all times. As a result, they have to constantly readjust their toll rate schedules to discourage a disruptive margin from joining the lanes, particularly in time slots where traffic volume gets close to causing backups.

The 91 Express Lanes opened at the end of 1995 and continue to operate successfully.[31] They became profitable after about three years. Though they provide only a third of the highway's capacity in peak hours, they regularly carry 40 percent of the traffic—at 65 to 75 mph, versus an average 20 to 35 mph in the free lanes. About 30,000 tolls a day are collected from transponder-equipped vehicles traveling at full highway speeds, while automatic cameras detect violators.[32]

Another managed-lanes project in Southern California is known as I-15/FasTrak, or HOT (high-occupancy tolling) lanes. Located on the northern approaches to San Diego, I-15/FasTrak imposes a toll charge for what were previously exclusively high-occupancy vehicle (HOV) lanes.[33] (FasTrak is the brand name of California's standard electronic toll system.) To use the HOT lanes, drivers enroll in the programme and are given transponders to place in their vehicles.

Since local governments still wanted to provide incentives for people to carpool, they insisted on a system that controls the number of people using the toll lanes to make sure those lanes would never become too crowded.[34] The governments devised a dynamic pricing system of even greater sensitivity than the readjustable hourly schedules of 91 Express lanes—a system that readjusts the toll rate as frequently as *every six minutes* in order to meter entering traffic to the desired volume. Before the motorist's decision point where he chooses to pay the toll for the HOT lane or to take the free lanes sits a variable message sign displaying the toll rate. Vehicle sensing loops continuously compute traffic density in the lanes and a simple computer programme relates the different traffic densities to different toll rates and automatically readjusts tolls. A lag is built into the adjustment so that a motorist passing the system antennas that read the transponder won't be charged more than the rate on the display sign.

I-15's HOT lanes cater to 3,000 to 4,000 toll payers a day, each of whom pay a fee that ranges up to US$4.00, and to 10,000 or so carpoolers who still travel free. [35] The service is popular because it provides the option of an express ride while taking a few vehicles out of the crowded free lanes.

Managers of both variably priced projects report no significant problems with the equipment and systems, which suggests that using a flexible price to meter traffic is not particularly demanding. There are some upfront costs in designing the systems, modeling traffic flows, surveying potential customers, and marketing. However, the experience shows the theory works: Price signals can be effectively used to manage congestion.

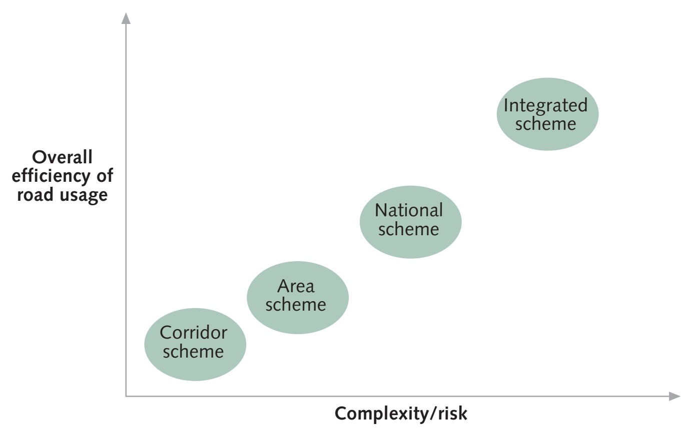
THE FOUR STAGES OF ROAD USER PRICING

Road user charging developments can be categorised in several distinct stages and according to a number of different principles.

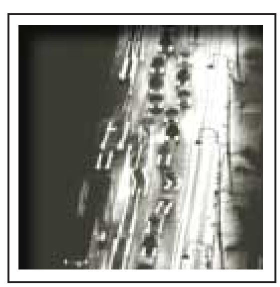
- **The corridor approach.** A charged stretch of road that provides a means of transport from one location to another, such as a traditional toll road. The main objective: revenue generation to pay for the road.
- **The area scheme.** Charging for driving in an area with a closely integrated road system. This is applied to urban congestion charging schemes. The objectives are to improve traffic conditions and to generate revenues.
- **National and transnational systems.** The charged area extends to a wider road network, rather than an individual zone. The objectives are to regulate the overall distance driven within the network and institute a more advanced charging structure than traditional vehicle and fuel taxes.
- **Integration.** A future vision in which customers make informed choices at every step of the journey across transport modes. The charges would provide incentives for a traveler to make the most efficient transport choices.

At a high level, the stages illustrate the trade-off between the overall efficiency of road usage and the complexity and associated risks of individual road pricing schemes.

FIGURE 7. THE FOUR STAGES OF ROAD PRICING



SOURCE: DELOITTE RESEARCH



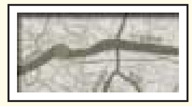
Stage I: Corridor Approach

The corridor charge was the first type of road user charge to be implemented. It imposes a toll for the use of a stretch of road and has traditionally been used for highways and bridges where access could easily be controlled.

The first step toward a modern-day viable toll road or corridor road user charge was taken in the United States in 1906 when William K. Vanderbilt persuaded his wealthy friends to finance the world's first motorway, the Long Island Motor Parkway. Opening in 1911, this 77 km (48 mile) stretch running down the centre of Long Island, New York, was the world's first roadway designed for motor vehicles alone. Privately owned, it was closed for car racing at slack toll times.[36] It was the first fully tolled road in modern history.

Until the late 1980s toll payment required motorists to stop just as they did back in 1911. Charges were levied either toll point to toll point, or by trip.[37] But tolling has changed dramatically since then. In 1987 the Swedish company Combitech (now Kapsch AB) introduced the world's first electronic toll system at a bridge near the small Norwegian town of Alesund.[38] The next year Q-Free (as it is now known) put electronic tolling in place on the E14 motorway at the Ranheim toll station in Trondheim, while in the U.S., Amtech (now TransCore) began electronic tolling on the Dallas North Tollway in Texas in 1989. Electronic tolling is now an option at most toll facilities around the world, and in some countries about half of all collections are now done this way. Indeed, a number of toll roads are now in operation, and new ones under construction, with no cash collection facilities at all—they rely entirely on electronic tolling.[39]

Technically, electronic tolling can collect tolls at speeds of 70 mph and higher, which means shorter queues and fewer disruptions around toll plazas.[40] However, other forms of enforcement are needed to replace the traditional gate arm to make the road exclusive to the paying drivers. These have met resistance in countries in Europe, Asia, and Latin America where no legal support exists to collect unpaid tolls and penalties based on camera evidence. Nevertheless, systems in Toronto, Canada, Melbourne, Australia, and several U.S. toll facilities with open road electronic tolling have found a way to use camera evidence to solve the problem. At this time, the technology for all stages of road pricing depends to some degree on camera enforcement, meaning that road pricing will be handicapped until a solid legal basis for enforcement is established.

Stage I at a Glance	
Characteristics 	The charged stretch of road provides a means of transport from one location to a destination. Under normal circumstances the user can choose an alternative route to get to the destination.
Purpose	**Financing more roads and recovering internal costs:** The charge is a way to generate revenue that will cover the costs of constructing the road.
Necessary market conditions	**The road must be made exclusive to those who pay.** The cost of imposing this exclusivity will affect the profitability of the charging scheme and so the market solution must therefore be done at the lowest possible costs.
Examples	SR 91 (Southern California) City Link (Melbourne)

ELECTRONIC TOLLING AND CONGESTION MANAGEMENT

Electronic tolling offers a range of benefits that allow conventional toll roads to play their part in broader congestion management. Differential peak/off-peak toll rates are possible, of course, with a cash collection system, but toll plaza superintendents have rejected the idea. They argued that motorists waiting in queues who saw the toll rate go up while they waited would become enraged. But partly because it eliminates most queuing, varying toll rates by time of day seem to be acceptable with electronic tolling. In France, peak/off-peak toll rate differentials are in place on the A14 coming into central Paris from the west, and on the Tunnel Prado Carenage, a main commuter route into central Marseilles from the north. In the U.S., they are in use in special toll express lanes in San Diego, on the 91 Express Lanes in the Los Angeles area, in Houston, and on some of the most heavily used toll facilities in the country—the New Jersey Turnpike and the Hudson River crossings. Since April 2001, the world's busiest bridge, the 14-lane, 320,000 vehicles-per-day George Washington Bridge and the important Lincoln and Holland Tunnels have operated with varied peak to off-peak toll rates (and special nighttime discounts for trucks) for the half of their customers equipped with E-ZPass toll transponders. Though they cannot precisely quantify the effects due to disruptions caused by 9/11, Port Authority staff members believe that the differential tolls have succeeded in reducing congestion without lowering revenues—and in fact may have even increased them.[41]

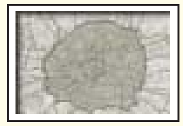
Stage II: Area Scheme

The corridor approach can be applied to roads until they become part of an integrated local road network. At that point it becomes impossible to levy tolls for exclusive access to individual roads, and an area congestion charging scheme becomes a more viable alternative. From the road users' perspective, the condition of the whole network, not just individual roads, affects their driving experience. This means that users will only benefit from paying a charge that improves the conditions of the overall network. What is more, a community implementing such a scheme should evaluate not just the benefits to the road user, but the overall impact on the area.

The central London congestion charging scheme (discussed in more detail on page 21) is clearly the leader among the area schemes. It has been such a success since its introduction in February 2003 that it will likely be extended, and its technology improved, to allow more discriminating pricing in the years ahead. Moreover, the London scheme is likely to be emulated. Stockholm has decided to go ahead with a full-scale 18-month pilot scheme. Edinburgh and Bristol, in the UK, have detailed plans for road pricing, and half a dozen other British cities are doing serious preparatory work.

Singapore. Singaporeans were the pioneers of the area scheme, also referred to as a zone, ring, or toll cordon. In 1975, Singapore introduced a scheme that levied a charge for the right to enter a six sq km (2.3 sq mile) restricted zone covering the city's busiest central area during morning peak hours—unless the vehicle had four or more occupants. The system was based on a paper license displayed on the windshield (or windscreen) that drivers could buy for S$3 (about US$1) a day or S$60 (about US$20) per month. Observers at 22 roads leading into the central area enforced the scheme by noting the plate numbers of violators.

The Singapore scheme reduced total peak period traffic by 45 percent and the number of cars by 70 percent. Average speeds in the charging zone increased from 18 km/hr to 35 km/hr (11 mph to 21 mph). The scheme well exceeded its initial goal of a 25 to 30 percent reduction in traffic.[42]

Stage II at a Glance	
Characteristics 	**The charged area consists of a road system where individual roads can't be unbundled and charged for individually.** This can be done by charging the access points to the area (area scheme) or charging all the roads within the area (zone scheme).
Purpose	**Reduce congestion, improve mobility,** and address external costs, such as the perceived cost of congestion, polluting, and noise the road user impose on others.
Necessary market conditions	**Establish trust.** The value of the benefits will only be realised in the longer term. The scheme therefore needs to create the trust that the overall benefits in the future outweigh the costs that have to be paid now. In addition to this, area charging schemes must create trust in the enforcement of the charge, or the drivers will avoid paying.
Examples	Norwegian toll rings, Central London congestion charge, Singapore licensing scheme

In April 1998 Singapore converted its pricing to a per-trip system with a gantry-based electronic setup. It also began tolling major expressways. All of the city's tolls are highest in peak hours and lower or not in force off-peak.

The electronic system's managers have become quite innovative in adjusting toll rates and relativities—as frequently as three times per month. They now have a punitively high toll for only about 30 minutes each day. What started as a somewhat crude idea to simply reduce traffic has been turned into a sophisticated system that manages traffic for optimum results.

TABLE 1. SINGAPORE AREA SCHEME

DESIGN	
Type	Stage 2
Pricing scheme	Vehicles entering the zone pay a variable charge depending on the time of day.
Payment technology	Vehicles and motorcycles have a smart card in an on-board unit. The system is based on drivers charging up the card in advance.
Detection technology	The smart card is checked when the vehicles enter the zone. Video cameras capture the back plates of violators.
RESULTS	
Effect on local business	Quantitative information is not available. The Land Transport Authority (LTA) reports of no signs of adverse effects on local businesses.
Effect on public transport	65% of commuters now use public transport, up from 46%.
Effect on average speed	The variable charging structure is adjusted to a target speed of 35-65 kph for expressways and 20-30 kph for arterial roads.
Effect on traffic demand	A year after Singapore switched from a manual to an electronic system, there was a daily reduction in traffic of 15%. The LTA reports of only a slight increase since then.

Norway. The Norwegians have a long tradition of tolling bridges and tunnels that cross fjords and other waterways. A ring of toll points or city "cordon" are seen as a way of gaining more revenue and improving the environment in cities. Norwegians also have tried to overcome the diversion effect of applying a toll on one route while alternative routes remain untolled by putting in place a ring of electronic toll stations around several of the country's major cities.

Norway has four toll rings in place: in Oslo (19 toll stations), Bergen (seven toll stations), Trondheim (17 toll stations), and in the Nord Jaeren region (21 toll stations). Bergen implemented tolls mostly with quarterly or annual passes. Oslo has flat rate tolls which apply 24 hours a day, seven days a week and rely heavily on transponders. In Oslo the reduction in traffic is estimated to be between 6 and 10 percent. In Trondheim, traffic across the ring has dropped by about 10 percent during toll hours.[43] Businesses inside the ring have made up for this by doing more business in the evenings and on weekends. Traffic at those times has risen 8 percent.[44]

The toll ring around the Nord Jaeren region, which opened in 2001, operates only during weekday peak hours. It is innovative in applying a half-toll on the hour before and the hour after each toll period, smoothing the transition to and from tolling.

HOT Networks. Gaining momentum in the U.S. is the concept of HOT networks. Developed by transportation researchers Robert Poole of the Reason Foundation and Kenneth Orski, HOT networks are interconnected systems of limited access lanes on urban freeways.[45] The central idea is to transform the patchy and unconnected HOV lanes that exist in most metropolitan areas into high-occupancy vehicle (HOT) lanes and then extend and link them to each other to form regional HOT networks of free-flowing priced roads. Such a system would provide motorists with "congestion insurance," contend Poole and Orski, because they would be able to completely bypass congestion—as long as they were willing to pay for the privilege. Given the prevalence of HOV lanes and the dispersed spatial patterns in U.S. metropolitan areas, implementing a HOT network, or some variation of the concept, is the most likely approach U.S. cities will take in transitioning to areawide approaches.

TABLE 2. OSLO, NORWAY CORDON SCHEME

DESIGN	
Type	Stage 2, cordon scheme
Pricing scheme	Vehicles pay a set charge when passing through the toll ring. Charges for heavy vehicles are higher than cars.
Payment technology	Electronic seasonal passes, automatic debiting on prepaid accounts, coin machines and cash in manned toll booths
Detection technology	Drivers cannot enter the city centre without passing through one of the nineteen toll plazas situated three to eight Km from Oslo city centre
RESULTS	
Effect on local business	Information not available
Effect on public transport	20% of the revenue is earmarked to public transport. This has been used to finance a metro and expanded the bus network.
Effect on average speed	Information not available
Effect on traffic demand	Immediate reduction in traffic: 5%. Reduction in the centre of Oslo: 20%

THE CENTRAL LONDON CONGESTION CHARGE

London has long suffered from some of the worst traffic in Europe. Every weekday morning the equivalent of 25 busy motorway lanes of traffic tried to enter central London. Drivers entering the city would spend half their time in queues. This cost the local economy GB£2–4 million every week in lost time.

For decades, there had been discussions about instituting a congestion charge to alleviate this gridlock, but all such proposals were shelved due to intense opposition. But in 2000, several circumstances conspired to create a more favorable climate for road pricing. First, public clamor for politicians to "do something" about traffic reached a crescendo. In a survey conducted for the 1999 Road Charging Options for London report, more than 90 percent of greater London residents said, "There is too much traffic in London." Meanwhile, in a survey conducted by Market Opinion and Research International, 70 percent of London businesses said "improving public transport" should be a priority for the next mayor; 55 percent said "reducing traffic levels" was a high priority.

Second, leading mayoral candidate Ken Livingstone announced he would consider a congestion charge for London if he was elected. After being elected, he indeed quickly committed to implementing such a charge. Three years later on 17 February 2003, London's congestion charge went live.

Design. The London scheme, the largest of its kind in the world, charges vehicles driving into central London a flat fee of GB£5 per day between 7:00 am and 6:30 pm, Monday to Friday. The charged area is 21 km^2 in size and involves daily monitoring and charging of around 200,000 vehicles.[46]

Enforcement of the charge is based on automatic number recognition (APNR) technology using cameras situated on the boundary and throughout the charging zone. The charge can be paid through several channels including online, the telephone, SMS text messaging, post, and retail outlets. Paying vehicles are registered in a database which the system accesses to check captured images of license plates of vehicles entering the zone. Unregistered vehicles are issued a penalty charge notice of GB£80, a figure that is reduced to GB£40 if paid within 44 days.

Enforcement has been one of the biggest challenges of the scheme. There have been problems with stolen license plates, with drivers incorrectly entering registration details, and with criminals replicating the license plates of other motorists. Several measures have been taken to address these problems, ranging from asking drivers to confirm certain details when they set up their accounts to using vans to track persistent evaders.

Some of these problems may have been avoided by using a transponder-based system, but such an approach would have delayed the project by several years. London's scheme thus had to make use of less advanced technology. This meant that the more sophisticated pricing approaches used in California and Singapore (i.e., those that vary prices according to the costs imposed on other traffic) weren't possible, at least during the initial stages of the project. The project's design, however, will enable eventual migration to a system with more advanced technology and pricing, potentially using credit card accounts.[47]

Results

- Traffic speeds have increased by 37 percent;
- Congestion has plummeted 40 percent during charging hours;
- The number of vehicles driving within the zone has fallen 16 percent;
- Journey time on a round trip to and from the zone has dropped 13 percent; and
- Buses now run more reliably and with shorter journey times, providing commuters with better public transport alternatives.[48]

Ironically, the biggest problem to date may be that the charge has worked too well. The reduction in the number of vehicles has exceeded expectations, raising concerns that the scheme may fall short of the GB£120 million revenue target in the first year. The steep drop in traffic has also led to complaints that the charge is hurting local businesses. According to a survey by the London Chamber of Commerce, 74 percent of firms said their sales were down between 10 and 15 percent. Nearly 60 percent of respondents said they thought that the drop was either "all" or "mostly" due to the congestion charge. On the other hand, the business association London First reported that the scheme's impact on business overall had been positive. Only a small minority of association members (five percent) reported a negative impact. The majority, 65 percent, said that the charge had had no impact and 30 percent said the impact of the scheme had been positive. The conflicting results from these surveys make it hard to reach any real conclusions at this time.

Lessons

Though it is still in its early days, several lessons have already emerged from the London experience. First is the importance of strong political commitment. Unwavering support from Mayor Ken Livingstone meant that the scheme went ahead despite several attempts to delay and undermine it.

Second, the charge was introduced as an integrated part of the mayor's transport strategy,[49] which was critical to the success of the scheme. Reinvesting all revenues in transport improvements increased public acceptance, while offering enhanced bus services—with more than 300 new buses provided a public transport alternative.

Third, a thorough consultation process was developed to ensure that the scheme recognised the concerns of various stakeholder groups. Other transport authorities in the city were also brought on board so that effective working relationships could be established. The various user groups were widely consulted as part of an extensive public information campaign. The general public was also consulted on key aspects of the scheme, such as discounts, exemptions, and the charging hours. This helped to resolve misunderstandings and, as a result, the widely predicted mass opposition to the scheme never materialised.

The consultation process was put to the test when the Westminster Council began legal proceedings to challenge the lawfulness of the scheme. Westminster is divided by the scheme's boundaries and, amongst other charges, the council claimed that the project team failed to consult residents who "are separated from their places of worship, their doctors, their shops, and their schools." The claims were ultimately dismissed in the High Court.

Lastly, studies such as Road Charging Options for London[50] ensured that the final solution was the result of a careful evaluation of a range of options. The solution then underwent rigorous consultation and legal scrutiny. This created a solid case for congestion charging and enabled a short development cycle as design and testing could be carried out in parallel with procurement activities.

Stage III: National and Transnational Systems

Stage III at a Glance	
Characteristics 	**Complete road user charge:** The charged area extends to the wider road network, rather than an individual area. Therefore, the emphasis is on charging for the distance travelled rather than for the targeted bottlenecks.
Purpose	**Fairer charging structure:** The objectives are to regulate the overall distance driven within the network and institute a fairer charging structure than traditional vehicle and fuel taxes.
Necessary market conditions	**Interoperability:** As the schemes meet at border points, the user costs will increase if each scheme has to be dealt with separately. There is therefore the need for the schemes to develop interoperability.
Examples	The distance-based heavy vehicles fee LSVA (Switzerland), Toll Collect (Germany)

The third stage, the national or transnational system, takes the area stage one step further by instituting electronic road user pricing nationwide. One thing that differentiates this from the area schemes is that it often will require governments to address interoperability issues—i.e., getting different existing technologies to operate together. “Different national policies and fees policies are the real barrier to international charging schemes,” says Switzerland’s Bernhard Oehry. “The technology can easily be standardised, but at the same time the development of new scheme structures is policy driven rather than technology driven.”

These schemes are moving not just toward geographical interoperability, but also toward interoperability between different modes of transport. This gives users a consolidated view of their travel plans, allowing them to make automatic payments from one convenient account. Interoperability also allows road pricing schemes to share their development costs and even system and customer services costs. This is particularly important for less elaborate schemes that don’t have the critical mass of road users to pay off large initial investments.

To date, nearly all of the road pricing schemes that have reached the third stage involve goods vehicles, although the principle could be extended to cover all vehicles. Austria, France, Germany, Switzerland, and the United Kingdom all plan to launch or already have instituted road user pricing nationwide for goods vehicles (see Table 3 and the Appendix for more expanded discussions of the Swiss and German schemes). Particularly significant are the German scheme—for its technology and innovative public-private partnership—and the UK scheme—for its scope.

On November 1, 2003, Germany will launch “Toll Collect” (TC), a system for collecting lorry or truck road use charges for travel on the autobahn system.[51] Upward of a million trucks (vehicles over 12t or 26,450 pounds) now use the autobahns and travel some 23 billion vehicle-km per year. Most of the charges, which average 15 cents/km (25 cents/mile), will be calculated via an on-board unit (OBU) which contains a vehicle positioning system that uses satellite GPS signals, the vehicle’s tachometer (or odometer), and the short-range wireless signals that are used for normal transponder-based electronic tolling. The units will also provide a constantly operating datalink via GSM mobile telephone. (See Appendix for more information.)

TABLE 3. LORRY/TRUCK ROAD USE CHARGING SCHEMES

	Start	Truck size	Roads	Type	System
Austria	2004-01-01	>3.5t	Untolled motorways	Per km	Transponder
Switzerland	2001-01-01	>3.5t	All roads	Per km	Odometer
Germany	2003-08-31	>12.0t	Motorways	Flat rate	GPS
UK	2006	>3.5t	All roads	Varied	GPS
France	Not decided	No decision	All main roads	No decision	GPS

TABLE 4. SWITZERLAND NATIONAL SCHEME

DESIGN	
Type	Stage 3
Pricing scheme	Heavy vehicles are charged based on the distance driven, the weight and the type of emission
Payment technology	Vehicles are given on-board units, using the tachograph and GPS. Foreign vehicles can also use an ID card issued on arrival at the border.
Detection technology	Beacon checkpoints with video cameras capturing number plates
RESULTS	
Effect on local business	Trade has not been affected. The transportation of goods has become more effective
Effect on public transport	Two thirds of the income, an expected US$1.1 (1.5 CHF) by 2005, will go towards public transport projects.
Effect on average speed	Information not available
Effect on traffic demand	Distance driven by heavy vehicles fell by 5% in 2001. This broke the trend of 7% increases in previous years.

Germany has an extensive motorway network but few arterial intercity routes—unlike the U.S., with its state and U.S.-designated routes, or Britain with its "A" or trunk roads. Therefore, the Germans have less reason to be concerned that motorway tolling will divert trucks to "lesser" roads, though German law allows tolls to be extended to any routes being used to bypass the motorway tolls.

Technically, the German system could be used on any road in the country, and the basic infrastructure could be extended to include all types of vehicles. The German on-board units are modular, but a typical configuration costs about US$700. A simplified, much less costly OBU would be needed for personal vehicles, which could use the infrastructure developed for the truck system.[52] The system is expected to cost US$600 million to set up and will yield US$3.4 billion per year in revenue. The proceeds will be dedicated to highway improvements such as widening, extensions, and rebuilding interchanges.

Expanding the Scope in the UK

The UK government will introduce lorry road user charges in 2006, covering all lorries on all roads.[53] Thanks to a commitment to reduce other user charges (probably diesel fuel duty or tax) by an amount equal to the lorry road user charge, the project has, for the most part, the support of the trucking industry and business. The British scheme will likely use similar technology as the German Toll Collect—heavy reliance on GPS to support the OBU, plus a call-up payment system for occasional users. The details are expected to emerge from vendors' bids. But in at least two respects the UK system will be more far-reaching than Toll Collect. First, it will encompass a much larger proportion of the commercial traffic —most two-axle delivery vans, for example. Second, it will cover not just motorways but also all other roads. And though it is not firmly committed to details, the latest government proposal raises the possibility of varying charges by time of day or level of congestion, and of setting higher non-motorway rates to encourage motorway use, particularly at night.

Key to all national schemes is the intent to charge all users regardless of nationality. Currently, overseas haulers pay taxes (by purchasing fuel) outside the country whose roads they are using. Charging all haulers, independent of country of origin, will more equitably share the costs of the local roads with the consumer of that resource.

Stage IV: Integration

A fully integrated system would provide a balanced competitive market across all existing modes of transportation. A number of transport alternatives exist, and an intelligent system would give travelers the ability to make informed choices, first as to which mode of transport to use and second as to which route to take. Single payment mechanisms for road and public transport, such as smart cards, could be used to pay for both the congestion charge and all other public transport modes.

Balanced competition enables the desirable allocation of resources across the different transport modes by combining internal and external costs with the intelligence that enables informed choices by users. By monitoring these developments, customers can avoid congestion and road construction and choose the most efficient alternatives both in terms of time and mode of transport.

In addition to road pricing, the other major prerequisite of this stage is the widespread adoption of sophisticated transportation technologies. Such technologies, referred to as telematics (vehicle-based) and intelligent transport systems (ITS) (infrastructure-based), can play an important role in wringing more capacity out of a given amount of road space. As much as half of congestion volume is attributed to accidents, breakdowns, or other disruptions such as road maintenance and repairs. ITS can help to manage all of this through efficient surveillance and prompt responses.[54]

On major surface arterials, traffic signals can be managed more effectively. Intelligent ramp meters can smooth merges onto motorways, enhancing safety a great deal and capacity by a small margin. In-vehicle telematic systems offer the opportunity for major improvements in safety and more efficient navigation. Such systems can also reduce incident-generated congestion.

Stage IV at a Glance

Characteristics 	**The transportation system connects the user** with the destination across transport modes. It allows the user to make the optimal choice of transport at each stage of the journey. This, together with a flexible charging structure for the different transport options, allows for transparent competition between transport modes.
Purpose	**Informed transport decisions and a balanced market:** Road user charging forms part of an overall transport charging structure that adjusts to conditions and reflects the full internal and external costs for each mode of transport. Instant access to information means that users can react to changes at short notice. This liquid market makes it possible for supply and demand to adjust to each other.
Necessary market conditions	**Market flexibility and access to information:** The user must be able to access the relevant information in time to change transport choice and be presented with alternatives.
Examples	This level is a future vision which several schemes are trying to move toward.

Further in the future is the possibility of automated highways, made possible by smart vehicles and smart roads. These automated driving systems make use of automatic steering by way of magnetic markers embedded in the centre of lanes or by cameras that "read" lane markings. These systems also operate accelerator and braking functions using radar or lasers that maintain a continuous watch on the vehicle ahead. These sensing systems feed data to an in-vehicle computer that takes on much of the driving role.[55]

It is likely that the first automated-drive vehicle systems will involve specialised vehicles on limited routes—such as snow plows in rural areas, drayage operations in large intermodal yards or ports, or bus operations on dedicated roads. More comprehensive systems that could play a role in reducing congestion are some years away.

TEN STRATEGIES FOR
TRANSITIONING TO ROAD USER PRICING

Success in congestion pricing will depend on politics, good assessment, public consultation, planning, advocacy, and implementation. It will also depend on the prudent boldness of good leadership.

Politics is by far the greatest challenge: most everyone who has been through a project of this kind will say that in retrospect the political and policy problems loomed largest. The processes are obviously important. The technology has to work. The design has to fit local circumstances and public attitudes. Due attention needs to be paid to choosing the right systems and integrating them effectively. But it is usually policy issues, or politics, that will make or break a project.

In particular, there are ten strategies for successfully making the transition to road user charging. Neglecting any of these areas could result in a failed project.

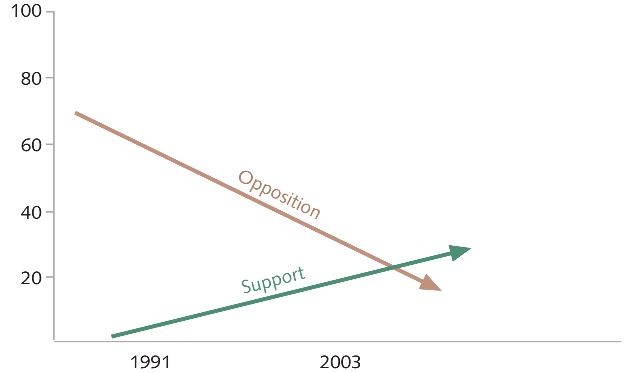
Strategy #1. Prepare for Battle: Recruit an Influential Champion

Successful projects need a public champion, a person or persons who will take up the cause and speak up for it effectively and persistently. These individuals must be prepared to state what the project will not achieve, as well as what it may reasonably be expected to do. The chief advocate must appeal to fair-mindedness and common sense.

Most pricing projects that have made it all the way to implementation have had strong champions. London had the maverick Laborite, mayoral candidate, and then elected mayor Ken Livingstone. San Diego's I-15/FasTrak project had a local mayor, then assemblyman, Jan Goldsmith as champion. In Trondheim the champion of the ring tolls was Tore Hoven, a dynamic young engineer. In New York City the differential pricing of the Hudson River Crossings was relentlessly pressed by Ken Philmus, director of the Bridges, Tunnels, and Terminals division of the Port Authority of New York New Jersey, who put his job on the line in a dramatic argument on the telephone with the governor of New Jersey to salvage the project at the last minute. These people staked their reputations and careers on these projects.

A skilled political leader can create the same sense of inevitability as occurs with broad popular support. A number of pricing projects have proceeded successfully without majority public opinion support at the time they were being implemented. The 91 Express Lanes in California and the Oslo and Trondheim ring tolls both faced considerable public scepticism

FIGURE 8. PUBLIC OPINION REGARDING TRONDHEIM SCHEME



SOURCE: DELOITTE RESEARCH

and hostility before they were rolled out. Each gained support only after being in operation for some time. Public opposition to the Trondheim toll ring was about 70 percent before it was launched in 1991 and is now in the range of 35 to 45 percent. Supporters went from less than 20 percent to the range of 30 to 40 percent.

There are three main tests for a politician considering moving forward on road pricing: (1) Has congestion become intolerable? (2) Have all other remedies been tried? (3) Is road pricing politically viable—at least in the long term—in this jurisdiction? The first has to be a gut political decision. For the second it is possible to compile a checklist of remedies (see box).

Waiting for the elusive "perfect time" to launch is not advisable. There comes a time to just take the plunge and move forward with the plan. Explains Norwegian Road Authorities Chief Engineer Kristian Waersted:

> *"In the late 1980s I attended a meeting with a European road user charging project team to discuss a common European standard for road user charging. At this point Norway had chosen to go ahead with its own standard, and the project leader commented that Norway was unwise not to wait for the common standard which supposedly would be ready in 1988-89. Subsequently both the Dutch and German authorities got cold feet and the standard never materialised.[55] "*

Norwegian officials made the right decision. They would have gained nothing by waiting, and the national support would have been jeopardised. The key was that they believed in what they were doing and weren't deterred by those waiting for the scheme to fail.

EXHAUSTING ALL OTHER REMEDIES: A POLITICIAN'S CHECKLIST

- **Will improved signals help?** Most major cities have smart signal systems by now. They can be improved with the addition of extra staff time and money, but this yields diminishing returns after several generations. There comes a time when most intersections are being fully used and signal "smarts" have no more to give.
- **Can parking policies do more?** These have to strike a balance between leaving road space for moving vehicles and giving access. There is no point in just moving vehicles or providing parking. Is the mix right?
- **Traffic calming.** This can help make traffic less intolerable to pedestrians (though it may enrage motorists). It is unclear that it has much of a role in reducing congestion.
- **Can traffic be relocated through land use?** Some land uses generate heavy motor traffic and are impractical to serve with transit or public transport. They can be encouraged to move to areas where they will be better served by roads. But there are limits. Almost all activities generate traffic, and too vigorous a relocation programme might "kill the city in order to save it."
- **Are public transport alternatives adequate?** Can improved public transport be delivered efficiently prior to road user charging being introduced and can the funding be freed up to do it?
- **Delivery hours.** Few truck deliveries are scheduled during commuter peaks anyway. But with the peak periods extending, sometimes becoming continuous throughout the daylight hours, the suggestion has been made that truck deliveries be restricted to nighttime. For some businesses this is reasonable, but for many others it adds too much to their costs, and they'll leave. Another balancing act.
- **New road.** This traditional solution sometimes still makes sense, especially if there is some unused or underused facility that can be converted. Otherwise it is usually costly. Underground construction avoids much of the need to acquire and demolish buildings, but even tunnels require ventilation towers and ramps, and must contend with underground obstacles. They may also require pricing to help finance construction.

Strategy #2. Obtain Buy-In: Keep Stakeholders and the Public Informed and on Your Side

In every city and country considering road user pricing exists scores of interest groups and powerful politicians with the ability to derail the initiative before it ever gets off the ground. Identifying potential opponents and crafting strategies to gain their support—or at least reduce their opposition—is critical for success.

A road user pricing project that fails to sufficiently take into account stakeholder concerns and local traditions and circumstances is doomed. Consider Hong Kong's Electronic Road Pricing System (ERP) experiment. Launched in 1983, it was a technical success (the system showed 99.7 percent reliability) but the scheme was scrapped because it was rejected by the public. This can be attributed to three major reasons. First, the public perceived it as an additional tax. Second, with the 1984 Sino-British agreement of the handover of Hong Kong to China in 1997, the public was extremely concerned about privacy issues. Third, the scheme was only going to charge private cars—a policy extremely unpopular with the general public.[57]

The organisers of London's congestion charging scheme employed a five-step process for gaining stakeholder support. First they focused on key stakeholders and legislative bodies, holding dozens of meetings and hearings to educate interested parties on the main features of the scheme and incorporating feedback before moving forward. This helped to ensure a basic understanding and agreement about the scheme among the most powerful stakeholder groups.

The second step was public consultation. The mayor published a draft version of his transport strategy with a detailed outline of the proposed scheme. The public was then given the opportunity to comment on specific issues such as exemptions and discounts.

Third was the publication of the final transport strategy. Based in part on the outcome of dialogues with stakeholders, the report sent a powerful signal to the public that the scheme was inevitable. It also gave the public time to get used to the idea of congestion charging.

Fourth, the transport agency published legally binding documentation of the scheme. Subsequent consultation focused on the details through extensive communications with the public, legislators, and other stakeholders. The final modifications were then made and the legal documents were confirmed.

The last step was extensive communications with stakeholders that continued after the implementation.

All in all, London's approach to stakeholders allowed for a host of modifications to the scheme, many of which are now considered critical to the general acceptance of the congestion charge, such as the 90 percent discount given to residents who live within the road charging zone.

Strategy #3. Work Together: Secure Cooperation from Third-Party Authorities

It is crucial at the outset that the project has support from the government agencies whose permits or cooperation are needed. They need to be shown the project fits with their programmes and policies, and that it has a fair chance of success.

Most important in this respect is to identify and work with all authorities who control transport in the city or region. They might be bus operating companies, port authorities, train companies, or tram networks. Transparency and teamwork should be emphasised and benefits to all should be highlighted. The political champion may be needed to bring all parties together behind a common goal.

Strategy #4. Cover all the Bases: Make It Part of an Integrated Transport Strategy

The first part of getting the design right is ensuring that it is part of an integrated transport strategy. Explains AP Gopinath Menon, the senior manager of traffic and road management at the Singapore Land Transport Authority:

> *"[The scheme in] Singapore is able to maintain overall public acceptance because the transport strategy in Singapore has always been an integrated package of different measures. The people of Singapore see the improvement brought about by the different components of the strategy…The public has therefore come to believe in the value of the strategy as they see improvement in the road conditions and the other transport choices. It all works together."*[58]

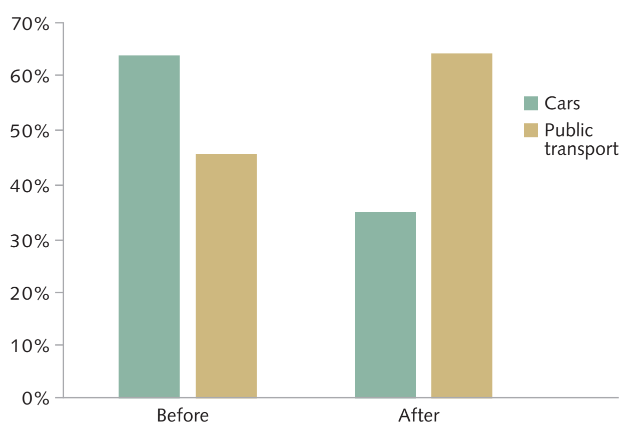
Part of this process involves producing a systematic assessment of the likely results of different road user charges on the overall transport network. This assessment should also show how the benefits of the project exceed the costs in aggregate.

Also important is investing adequately in complementary (or alternative) forms of public transport. If congestion has been cut by 25 percent, there will be quite a few extra people still trying to make their way to work—not using their cars. There will be a massive public outcry if they can't get there. The Singapore road pricing scheme, for example, resulted in a significant shift towards public transport and away from cars. About 65 percent of commuters now use public transport, up from 46 percent before the charge was introduced.

If commuters can't continue their daily lives by using public transport, they will seriously consider returning to their cars.

Planning is the key to success. It will ensure that complementary measures exist, that they are capable of taking up the strain, and that any modifications necessary for them to run, such as extra bus lanes, have been made.

FIGURE 9. SHIFT TO PUBLIC TRANSPORT IN SINGAPORE AFTER ROAD PRICING



SOURCE: DELOITTE RESEARCH

Strategy #5. Counter the "Just another Tax" Charge: Make the Use of Funds Acceptable to the Public

One sure killer of any pricing project is the notion that it is "just another tax." Most people are fatalistic about what "the government" is already taking from them, but except perhaps in times of national emergency, they are viscerally antagonistic to new or higher taxes.[59]

In the early 1990s, a variable pricing scheme for the San Francisco-Oakland Bay Bridge—America's second busiest bridge—collapsed due to lack of political support in the state legislature. Several million dollars had been spent on studies and public consultation. Some political observers said that the scheme was doomed when a prolonged public fight broke out between several local agencies over who was entitled to what proportion of the proceeds. Voters told their legislators that they saw peak-period pricing as a "new tax"—an impression made vivid by the squabbling. By the time the project was ready to launch, not a single legislator could be found to sponsor the necessary amendments in the state house.

People are also extremely sceptical about the possibility of using pricing to reduce congestion. They think everyone travels when they have to, and nothing will change their travel time. (In fact, only a small proportion of travelers need to change their travel times and habits to gain useful reductions in congestion.) It is therefore crucial to the success of any pricing scheme to find an acceptable use of funds.

In the case of Olso and Melbourne, the revenue was used to pay for new capacity, the traditional rationale for toll projects. Many pricing projects, however, won't involve new capacity but instead will make better use of existing limited capacity. These projects are more difficult to gain support for, but as San Diego's I-15/FasTrak and London have shown, it is certainly not impossible. Still, in each of these cases it has been crucial to highlight where the money was going. In the case of the I-15 project a new express bus service was the major beneficiary of the money. In London the toll revenues are going heavily into new bus services, too, but are also being used for road improvements.

A third option is to make a commitment to revenue neutrality. This is the approach the UK government has adopted in promoting the 2006 lorry road user charge. The government has committed to reducing other fees—most likely duty or tax on diesel fuel—to fully offset the lorry road user charging revenues.

Strategy #6. One Size Doesn't Fit All: Pick the Right Scale and Pace

Pilot project or "big bang?" What should be the scale and pace of a pricing project? A cautious and sometimes prudent approach is to start small and then "grow" the scheme as circumstances dictate. Such a "pilot project" can help to minimise opposition and the money and political capital at stake. A commitment can be explicitly made ahead of time that the scheme will be abandoned if it isn't performing as advertised.

The New Jersey Turnpike Authority adopted such a low-key approach in May 2000 when it introduced peak/off-peak differentials in toll rates for transponder patrons. The differentials were small and applied only to cars. Trucks were not included because the state trucking association objected. The executive director of the Turnpike, Ed Gross, said at the time, "Let's prove its value with cars. Then, when we can show it helps, we'll talk to the trucking association again."[60] A strong believer in congestion pricing, Gross' approach was to go where there was least resistance.

Of course, a low-key, incremental approach is only possible if some kind of pricing is already in place. Choices then must be made about the size of the area to be priced, the types of charges to assess, and the types of vehicles to include. It may make sense to start small and simple, assess the results, and then add territory and more discriminating charges.

In marked contrast to such incrementalism was an ambitious proposal for a pricing scheme covering the four major cities of Holland: Rotterdam, Amsterdam, Utrech, and the Hague. A bruising political fight surrounded this proposal, called the Randstat scheme, with almost all the motoring and motor sales interests involved in a fierce campaign to block it. To make matters worse, the government coalition collapsed at a vital stage. In retrospect, the plan was overly ambitious, and its supporters might have been better advised to mount the scheme first in a single, smaller city where there was local support. If that pilot project worked well, it could have been extended.

That said, sometimes a "big bang" approach makes more sense. There have been a number of cases where pricing projects have failed specifically because they were applied to one corridor and not to others nearby. Resentment ensues when some people must pay tolls while others get a free ride. In such cases, the pricing project should be launched covering a larger area from the start.[61]

Strategy #7. Don't Be Blinded by Science: Utilise Proven Technologies

> *"Any sufficiently advanced technology is indistinguishable from magic."*
>
> –Arthur C. Clarke (1917 -), Writer

Often when people are faced with complexity they think that the abundance of shiny buttons will provide all the answers. When NASA first started sending astronauts into space, they quickly discovered that ballpoint pens would not work in zero gravity. To combat this problem, NASA scientists spent a decade and US$12 million developing a pen that writes in zero gravity, upside down, under water, on almost any surface, and at temperatures ranging from below freezing to over 300C. The Russians used a pencil. Or so the myth goes.

The moral is to keep it simple and use proven technology. A surefire way to significantly increase the risk of failure in a large-scale technical project is to use technologies that haven't been commercially proven. You don't want to be the guinea pig for a technology that has been proved only under laboratory conditions.

A better approach is to use individual components that have been tried and tested in their own right—even if they may not have been previously deployed in such a manner. For example, despite the fact that global positioning technology (GPS) has only recently been considered for mass deployment on road user pricing projects, it nevertheless is a proven technology that has been around for more than 30 years.

Strategy #8. Don't Neglect the Boring Stuff: Focus on Customer Relationship Management

Many of the problems of road pricing systems tend to arise from customer relations issues such as properly billing customers and dealing with their initial confusion. For this reason, customer service is one of the major expenses of road pricing systems. A sound customer relationship management strategy makes it convenient for road users to pay the charge and is flexible enough to handle many types of customers, from daily commuters to occasional road users. Staff members must be available to talk to customers on the telephone without too long a wait. High standards of data entry and record checking are important to keep clerical errors by staff or customers to a minimum and to maintain accurate, up-to-date information throughout the system.

In general, the easier you make it for people to pay the charge, the fewer problems you will have with enforcement. This is just one reason why it's important to offer an array of payment mechanisms—cash payments, mailed checks, call centres, Paypal, the Internet, mobile phone text messaging, automatic bank transfers—so every customer will find a convenient way of paying. Similarly, road users should be able to buy a single trip, multiple trips, or one-day, weekly, or monthly passes.

Offering this kind of convenience, of course, comes with a price. It forces the operator to build and manage a more complex and agile system that also balances sophisticated and multiple payment channels with revenue. Melbourne's CityLink, for example, came close to failing because it offered advanced payment solutions without fully understanding the need for technological agility in its back-office systems. The problem was that the system's technical design was based on a traditional toll road approach and wasn't capable of handling all the special modifications necessary to support new solutions such as automated payment accounts.

Most pricing projects use several payment technologies. Technologies such as on-board units require an investment to purchase and install, but from the viewpoint of the operator, they "read" with extremely high accuracy—in excess of 99 percent—and they increase the capacity of the payment channels. In the case of the Oslo cordon system, the lanes for registered vehicles with electronic payments can take four times as many vehicles per hour as the nonregistered vehicles.

The system must also cater to occasional users for whom it is impractical to enroll in an account and supply equipment for their cars. A workable payment solution here is a digital camera system from which a reasonable proportion of license plate numbers can be obtained (at around 85 percent accuracy). The lower accuracy rate and higher operational cost of cameras can be offset with multiple read points, as in London.

Road pricing schemes cannot afford to ignore occasional users. For example, Trondheim lowered the capacity of its cash payment lanes because of the 90 percent subscription rate it achieved with on-board units. But the whole system came to a complete standstill in the tourist season when the demand for cash payment from cars without units suddenly skyrocketed.

Strategy #9. Ensure a Successful Debut: Plan Appropriate Contingencies

Road user pricing projects are often judged based on their initial success. This makes effective management of the go-live phase critical to the ultimate success of the scheme. While a launch that goes off without major hitches won't guarantee public acceptance, it can help to build confidence in the system.

Even the best designed scheme will usually experience a surge of customer questions and complaints in its early stages. At the same time, processes and technologies may show unexpected weaknesses. It is in this period that the project will get a reputation for good or bad customer relations, which will often carry forward as the lasting impression of the whole project. It is therefore critical to ensure a high level of flexibility that allows for an initial period of large capacity and a continuing ability to react swiftly to any unexpected customer behaviour.

Melbourne's CityLink toll ring received more than 30,000 calls a day during its opening phase, partly as a result of freight industry traffic being 100 percent greater than initially anticipated. Without its well-developed launch strategy and public education programme, CityLink would not likely have survived the initial strong public scepticism toward the project.

Two things can be done to spread out the inevitable early surge in customer service demand. The first is to set the launch date at the time of lowest traffic so that troubleshooting can be done with minimum traffic disruption. Midnight or the early hours of a Sunday morning work well here, as do school holidays. Second is to get as many as possible transponders or on-board units distributed and installed before the start-up. Otherwise, the provisions for cash payers could be swamped.

The greatest single problem encountered in converting to electronic tolling has been in the timing of the opening of dedicated or transponder toll lanes. Put them in too early and you get massive backups because too many vehicles are trying to get into too few cash lanes. Hold off too long and transponder users can't make use of their new devices and their uptake stagnates.

The London scheme didn't use transponders but experienced similar difficulties getting companies with large numbers of vehicles to sign up for the dedicated fleet scheme. In Melbourne, freight companies waited until the very last moment to register. The result: freight traffic was 100 percent higher than expected and the call centre was flooded with an unexpected high volume of 32,000 phone calls on day one. Needless to say, such volumes did not make for the best initial user experiences for the new initiative.

Strategy #10. Don't Lock Yourself In: Maintain Flexibility

No road pricing scheme is ever likely to look in its final form exactly the way it looked at the beginning. It will change over time regardless of initial plans. Forecasts are likely to be off. Prices will need to be tweaked or even fundamentally revised. Boundaries will need to be adjusted, zones rearranged, technology upgraded, and new rules introduced. Maintaining the flexibility to adapt to the changing environment is an important part of retaining public acceptance. It's also key to maintaining political sponsorship because it helps to minimise the political risk taken by the project champion. It's important, therefore, not to create the expectation that the scheme will remain fixed.

The same holds true for technology changes. The overall system should be designed in a modular fashion so that parts can be upgraded and new functions introduced without having to redesign the whole. It is also worth starting out with a set of proven technologies. In Europe there are now standards for transponder systems and designs for interoperability. There are no standards, however, for on-board units making use of tachograph/odometer and global positioning system locational data, but it seems likely the German-designed systems will soon become the de facto standards. These OBUs are modular—designed to work with different component technologies and thus help maintain the necessary flexibility.

FUTURE DEVELOPMENTS

The tools are now available to better manage road traffic in a number of ways. Until the early twentieth century we were only able to charge for road use at a discrete point, which traffic could bypass. The invention of the access-controlled motorway marked a further advance that allowed a corridor to be tolled and managed. During the 1980s, transponders marked a third advance, driving down the cost of toll collection to the operator, reducing the hassle of payment for the motorist, and facilitating free-flow highway-speed toll collection. That made more interchanges possible, variable toll rates more acceptable, and separately tolled lanes feasible on a road that is otherwise free. The 1990s saw the extensive deployment of cameras and license plate recognition systems. In the first decade of the twenty-first century we are likely to see the following six trends:

Miniaturisation

Miniaturisation will characterise future technology. When a transponder was first deployed for radio frequency identification (RFID) at the Lincoln Tunnel in New York in the 1960s, it was a shoebox-sized contraption. By now most transponders are about the mass of a mobile/cell phone and will only decrease further in size. (Already there is a transponder on a printed sticker.) The smaller the transponder, the easier it will be to deploy and use with minimal hassle.

Lower Costs

Costs are dropping too. The 1960s transponder was a US$500 device. Today, most cost about US$25 to manufacture, but single-digit dollar costs appear likely. The same trends are likely to be seen in mass produced satellite positioning system equipment like on-board units.

Ubiquitous On-Board Units

Within just a few years it seems certain that vehicle manufacturers will be building transponders into vehicles. The truck OBUs are already an option from manufacturers. As the market broadens and deepens, it is possible that they will be standard items of equipment in all new vehicles in less than ten years. Since the automobile vehicle fleet has an average age of about nine or ten years (and increasing) it will be perhaps twice as long before the overwhelming majority of vehicles are equipped.

At first glance this would suggest that eventually fully camera-based systems won't be needed. This, however, won't be the case. Cameras will remain important for enforcement as a fill-in technology and to check up on the operation of radio frequency communications equipment. Given that a certain proportion of vehicles will either be unequipped, or have disabled or malfunctioning RF equipment, cameras will be needed. They are capable of being improved, too, to give higher rates of sensitivity and accuracy.

Improved forecasting

Analytical techniques and technologies are expected to improve as well. For example, if some travelers are willing to have their vehicles tracked and the drivers interviewed, perhaps over the Internet, it should be possible to get a much clearer picture of what generates trips, and to improve forecasting and design of transport systems.

Better traveler information

A related area of improvement will be in tracking and communications. In ITS jargon this is called Advanced Traveler Information Services. It means informing travelers of their travel options, warning them immediately of major incidents affecting their travel, and suggesting the best response.

Greater interoperability

Greater interoperability among systems is the way of the future. People who range across different charging systems should not have to bother getting different equipment or establishing new accounts. The E-ZPass system in the northeast U.S. is the world's largest operating system using joint equipment, which allows for the recognition of mutual customers and the intersystem account clearances. In Europe the equivalent is PROGR€SS and there are similar efforts in Australia, California, and Virginia. In Italy and Japan the solution has been to have one single transponder issued from the beginning.

Interoperability sometimes comes at considerable expense, however, which is usually why it is resisted. What's more, standardization sometimes inflicts unsuitable technology on some for the benefit of many. Standardization also can lead to lowest-common-denominator decisions and to technological stagnation by making any upgrade a difficult political exercise. Good management will recognise these tradeoffs and look for ways to serve customers and mutual interests without closing off options for the future.

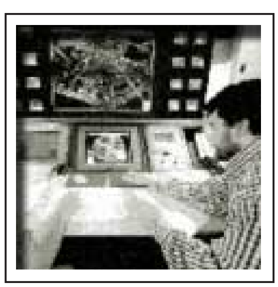
All these technologies can be developed further, and integrated better, but we clearly are at a point where lack of technology is no longer an excuse for inaction or a legitimate constraint on policy. The systems can be developed to do whatever we want to do with road user charging. We are set to implement road user charging over wide national networks of roads. Indeed, the technical and political stars seem to be in alignment for a fundamental change in how road space is funded and provided.

APPENDIX:
SUMMARIES OF VARIOUS CONGESTION CHARGING SCHEMES

Rome's Zonal Charge

Rome's ancient centre of tiny streets is quite unsuited to general motor traffic, and in many places has no separation of footway from vehicular roadway. In 1994, the city administration instituted a Limited Traffic Zone (ZTL in Italian abbreviation) which allowed residents of the area to have continued free admission. At first the scheme was enforced by police officers but it now uses transponders and cameras. Since 1998, most non-residents have had to buy a pass (¤320/year) to enter the area. Fears that shopping would be adversely affected have proven unfounded, apparently because the reduction of 20 percent in motor traffic has made the area more attractive to pedestrians, who have added to sales. There are now moves to extend the zone.

Major problems have included public confusion over the hours during which restrictions apply and unintentional violations. There has also been some abuse of exemptions for drivers looking after handicapped persons.



Switzerland's Nationwide Road User Charge for Trucks

The Swiss were the first to institute a nationwide road user charge for goods vehicles. It applies to all vehicles over 3.5t (7,715 pounds) and is levied according to distance traveled with rates per-kilometer depending on axle weight and tailpipe emission class. It started January 1, 2001, at the same time the country allowed a major increase in truck weights to get it closer to conformity with the European 44t (97k pound) standard. The truck tachometer (odometer) is the primary means of measurement for the toll due but the on-board system is triggered by RFID antennas at border points. It uses a GPS unit as backup and a check on the tachograph/odometer. A portable smart card is used to transfer the travel data from the on-board unit to the toll collection system. All Swiss trucks are required to be equipped with OBUs and they are available for lease for foreign trucks. Occasional users from abroad without the on-board system book their journey and pay charges at border stations, and must stop to pay any balance of extra in-country travel when they depart. The Swiss Customs service operates the scheme.

Germany's Toll Collect: Introduction of New Technologies

Germany's Toll Collect system, to be launched in November 2003, was developed in its core technology by DaimlerChrysler for commercial vehicle fleet management and was adapted for tolling when the German legislature called for road user charge proposals. Costing about US$700, the unit is intended to serve multiple purposes. DaimlerChrysler has been planning to give away the OBUs to truckers as part of service contracts with the goal of rapidly developing them as all-purpose wireless services units. The automobile giant is in partnership with Deutsche Telekom and Cofiroute to provide the Toll Collect service for the German government. Using the same OBUs as are used for calculating the road charges, they plan to offer systems for optimizing truck routing, navigation, messaging, stolen-truck tracing, and other "value-added telematics" services under the brand name Truckmatix.

The EU Competition Commissioner is requiring that other vendors of telematic services be given access to the network and that it be operated by a company at arm's length from DaimlerChrysler and its partners in Toll Collect. Extremely difficult issues of policy are raised by the effort to achieve economies of scale and gain multiple benefits from the same sophisticated technology while providing choice and competition. The issues are similar in character to those surrounding Microsoft's development of the Windows operating system. The general principle of this compromise in the Microsoft anti-trust cases has been that of "unbundling" by which the operating system is designed as minimal core with open standard interfaces. These allow separate applications to compete with those proprietary to Microsoft rather than being bundled in as part of a whole. Similarly, in road user charging there could be a core on-board unit which is universal but which accommodates competing data measurement modules, computing, storage, and communications devices, and allows for different software as well.

The Toll Collect system is not entirely dependent on the sophisticated OBUs. For truckers only making occasional trips on the German autobahns, Toll Collect will allow payment by telephone, the Internet, or from entries at 3,000 terminals located at fueling/rest areas, particularly at the borders. It also is making provision for EU-standard short range (DSRC) transponder systems. The Toll Collect system will have some 300 gantries for overhead equipment—one gantry every 40 km (24 miles). These will carry the readers or beacons needed for the data exchanges with the windshield-mounted transponders in use in countries where toll roads represent a high percentage of their total highways, such as France, Spain, Italy, and Portugal (once the toll systems of those countries implement the new transponder standard). Thus it will be technically possible for a British truck with, say, a current DART Tag to be able to pay the German road user charge through that tag.

The gantries will also carry vital equipment looking for toll evaders or truckers without functioning OBUs. They will carry specialised video equipment that "profiles" vehicles as they pass in the traffic stream, analyzing their image and estimating their size and shape to distinguish trucks from cars and other vehicles. Any truck without the required OBU or transponder will have its image recorded by the camera and its license plate number extracted by automatic character recognition algorithms. A central tolling system will then scan its database of trucks that have paid for trips via the call-in centre, the Internet, or the point-of-sale terminals to ascertain whether the payment was made or not.

End Notes

[1] OECD statistics: http://www1.oecd.org/publications/figures/2001/anglais/012_013_GDP.pdf.

[2] Economic and Social Commission for Asia and the Pacific, "Statistical Abstract of Transport in Asia and the Pacific 2002."

[3] Press release on first annual monitoring report, Transport for London, June 6, 2003.

[4] Foreword to "Road Travel Demand: Meeting the challenge" Organisation for Economic Co-operation and Development (OECD), Paris, France, 2002.

[5] Tim Lomax et al. "How bad is the situation and what is being done about it?" Texas Transportation Institute, September 2001, p. 3.

[6] David Schrank and Tim Lomax, "The 2002 Urban Mobility Report, Texas Transportation Institute, The Texas A&M University System, p.25.

[7] Ibid, p.20.

[8] "The total cost of the time spent traveling in OECD countries is equivalent to roughly 7 percent of GDP. Using the definition of 'additional time spent traveling compared with free-flowing travel,' congestion is estimated to cost the equivalent of about 2 percent of GDP." "Synthesis of OECD Work on Environment and Transport and Survey of related OECD, IEA, and ECMT Activities: Congestion" Working Group on Transport and Environment, ENV/EPOC/PPC/T(99)11/FINAL, p14. Also see European Committee of Ministers of Transport, "Urban travel and sustainable development," OECD, Paris, 1995.

[9] "OECD statistics," http://www1.oecd.org/publications/figures/2001/anglais/012_013_GDP.pdf.

[10] Texas Transportation Institute's modeling showed congestion time losses and fuel waste at US $69.6 billion for 75 metro areas of the U.S. containing 134.7 million people in 2001. (See: David Shrank and Tim Lomax ,"The 2003 Annual Urban Mobility Report," Texas Transportation Institute, the Texas A&M University, September 2003). Total population in metropolitan areas over 250,000 people was counted in the 2000 Census at 206.7 million. That would have been about 209 million by mid-2001 so the TTI sample covered approximately two-thirds of the urban population. (See: US Census Bureau "Population Change and Distribution: Census 2000 Brief" April 2001, page 7). On that basis an estimate of national congestion costs should scale up the TTI figure by about 50 percent which amounts to a total of $103 billion for the time and fuel costs. Congestion also produces substantial extra costs in tailpipe emissions and consequent air pollution. It also increases the number of accidents and injury and property costs. Such extra costs have been estimated at 50 percent of delay and fuel costs which would bring the national cost of congestion in the U.S. to about $150 billion. In short, US congestion costs are running at a bit over $530 per capita per year. That is not greatly different from the $700 per person costs in other OECD countries. Assigning higher cost numbers to the health costs from congested traffic and air emissions in the U.S. could easily close the gap. In general, the problem is of similar magnitude on both sides of the Atlantic.

[11] Economic and Social Commission for Asia and the Pacific, "Statistical Abstract."

[12] David Shrank and Tim Lomax, "The 2003 Annual Urban Mobility Report", Texas Transportation Institute, the Texas A&M University, September 2003, p.14.

[13] A major element in the cost estimates is a value of time that is related to wages. These have risen from $7.20 to $13.25 per hour or 84 percent.

[14] "The Mobility Data for all 75 Urban Areas," an annex to the 2003 Texas Transportation Institute report. See: www.mobility.tamu.edu.

[15] IFRAS, "External Costs of Transit," March 2000.

[16] "Motoring towards 2050," RAC Foundation, London, May 2002, p.127.

[17] Walter Hook "The transport crisis in Asia," United Nations Human Settlements Programme, UNCHS (Habitat) *Habitat Debate,*1998.

[18] International Road Federation, "World Road Statistics 2002." See: http://www.irfnet.org. GDP figures from the Delegation of European Commission in Japan, http://jpn.cec.eu.int/english/eu-relations/e3-10-0.htm.

[19] It defines heavy congestion as average speeds of a third or less of that possible in free flow. Interrupted flow is where traffic speeds are half to one third of free-flow speed.

[20] David Cosgrove, "Urban Congestion" Information Sheet 16, Bureau of Transport Economics, Canberra, Australia, May 2000, p.2.

[21] Anthony Downs, "Traffic Congestion in Global Cities" Speech at the Harvard Conference on Global Cities, September 6, 2002.

[22] Downs, "Global Cities" speech.

[23] Only a list of high-ranking citizens, government officials, priests, and honored visitors were permitted. In AD50 Claudius I extended the central area daytime controls to other Italian cities, and Marcus Aurelius broadened it to major towns throughout the Roman empire in AD180. M. G. Lay, "Ways of the World: A History of the World's Roads and of the Vehicles That Used Them," New Brunswick, NJ: Rutgers University Press, 1992, p.176-177.

[24] There isn't any account of what happened in Roman cities, but we suspect that immediately after the announcement of the draconian rule all kinds of favor-seeking started, and some time later various liberalisations and exemptions began to creep in, and traffic grew again. Within a few years, no doubt, it was all forgotten.

[25] A colloquial illustration was provided by Nobel Laureate William Vickrey. Quoted by Timothy D. Hau, "Congestion pricing and road investment," Chapter 3 of *Road pricing, traffic congestion and the environment: issues of efficiency and social feasibility* edited by Kenneth J. Button and Erik T. Verhoef, Edwin Elgar Publishing, Cheltenham Gloucestershire, UK, 1998, p39. If a group of, say, 20 friends go out to dinner and agree to split the bill among them, then everyone is likely to end up overeating and overdrinking, because no single member of the group will make any significant savings by economizing. Forgoing a prime steak costing, say, US$25 for a US$5 hamburger will save a woman in the group only US$1, and forgoing that extra US$2 drink will only save another member, say a man, only ten cents. Now there's nothing wrong with an occasional "To hang the expense, let's party" arrangement like this on special occasions, but it is a poor way to finance a basic social service like roads day in and day out.

[26] See Timothy Hau, p.45-47.

[27] Georgina Santos, "On the economic, technological and political aspects of road pricing as a tool of traffic demand management," Transportation Research Board, Washington, DC, 2002, p.2.

[28] Patrick DeCorla-Souza "The long-term value of value pricing in metropolitan areas," Transportation Quarterly, Eno Transportation Institute, Washington, DC, Vol. 56 Number 3, Summer 2002, p19.

[29] Another important economic characteristic of road space derives from its distinctive dynamic performance. The speed of travel that a roadway lane supports declines only gradually at first as extra vehicles join the flow, but as it approaches the maximum —somewhere between 2,000 and 2,400 car-equivalents per lane per hour—the traffic bunches up as drivers adjust to maintain a comfortable speed for the distance to the car ahead. At that point average speed drops noticeably and for a short while throughput keeps increasing slightly. This is the point of extreme sensitivity in traffic flow. A slight perturbation and flow breaks down, speeds collapse, and throughput declines too, sending a backup (or tailback) down the road. This is the "backward-sloping speed flow curve" of many engineering manuals and textbooks. See for example Fig 4.1 "Basic speed-flow-density relationships for uninterrupted flow" in Wolfgang S. Homburger and others, "Fundamentals of Traffic Engineering," 14th edition, Institute of Transportation Studies, University of California Berkeley, 1996, p.4.

[30] "Brief history of road congestion pricing," an annex to chapter 4 in Gabriel Roth, *Roads in a Market Economy*, Brookfield, VT: Ashgate Publishing, 1996.

[31] The 91 Express Lanes project has had political problems. These arose from the investors' desire to move their funds elsewhere and a nonarm's length deal with a not-for-profit entity needing support from a state bank. The deal was initially approved by the state secretary of transportation and treasurer. But after a public scandal the decision was reversed, the deal cancelled, and two senior officials fired. A longer running controversy concerned a clause in the investors' contract which protected their traffic against competition from construction of extra free lanes. As congestion grew, politicians in the area began calling for a government buyout of the investors in order to negate the no-new-lanes clause. In 2002 the operation was taken over by the county government, which so far has not altered the way they are managed, or advanced plans to actually build any lanes beyond the existing 12. There has been some political rhetoric about reducing high toll rates but so far no move to implement that, perhaps because they see it would detract from the "value" of the value-priced lanes.

[32] See www.91expresslanes.com.

[33] The I-15/FastTrak is a project of the San Diego Association of Governments (SANDAG), a regional grouping of the many separate cities and counties that make up local government in America's most southwesterly metropolitan area. SANDAG started out in 1995 with a 13 km long (8 mile) two-lane reversible high occupancy vehicle (HOV) facility in the middle of I-15, a six-lane freeway. This is a commuter route with directional flows—south in the morning and north in the afternoon. Its problem was that congestion was horrible in the general purpose lanes while the HOV lanes were underutilised —embarrassingly empty. Not enough people would carpool to make good enough use of the facility. Motorists stuck in the general purpose lanes produced an undercurrent of criticism of the government for operating "empty" lanes alongside the stop-and-go traffic. At the same time politicians representing the bedroom communities at the northern end of the HOV lanes were keen to beef up long distance express bus service but were reluctant to suggest higher taxes. I-15/FasTrak was intended to solve both problems.

[34] Level of Service is ranked from level A, representing lightly trafficked free-flow conditions, down to Level of Service F, which represents stopped or slow-speed traffic in dense conditions. LOS-C is still close to free flow.

[35] See http://argo.sandag.org/FasTrak/.

[36] "History: Willie Vanderbilt's Tollway," *Toll Roads Newsletter*, Number 57, December 2001, p. 30.

[37] Point-by-point tolling levies tolls at discrete points along the road or with a toll road network, whereas a trip toll system issues a ticket on entry with a record of that entry point and the toll is paid just once on exit by computation of the trip.

[38] Electronic tolling is a loosely used term but it most commonly describes the use of an in-vehicle radio frequency communications device called a transponder which sends an identifying code to antennas or beacons fixed on a roadway structure under which the vehicle passes. The very short range of the process allows the communication to operate at very low power, allowing the battery to have long life. Low power and short range also allow reuse of frequency and minimise interference. The communication allows the toll operator's system to debit the account of the passing motorist. Such transponder systems are backed up by equipment which senses the approach of the vehicle, obtains a volumetric profile, or counts axles to classify the vehicle to apply the correct toll rate by vehicle class. Also needed for enforcement in a free-flow environment is automatic license plate reading camera equipment to record details of vehicles without a functioning transponder. Such equipment may be used as a primary vehicle identification system as in central London's congestion charging scheme or on Toronto's 407-ETR. The term "electronic tolling" is often used also to encompass systems based on an electronic tachograph (odometer) and geographic positioning by satellite (GPS or the future Galileo) such as is being installed in Germany for truck tolling on the autobahn network and proposed for use for Lorry Road Use Charges in the UK from 2006.

[39] The 91 Express Lanes in California, and several other facilities in the U.S., are transponder-only road facilities. More ambitious electronic toll facilities are highway 407-ETR in Toronto, Melbourne CityLink in Australia, and the Trans-Israel Highway which not only allow transponders but operate a system for billing or granting passes to occasional users by using cameras designed for gaining pictures of vehicle license plates and using automatic character recognition algorithms to generate lists that can be referenced against those who have an account, or, failing that, against motor vehicle registry lists to gain names and addresses of vehicle owners to bill.

[40] Retrofitted into existing compact and low-speed toll plazas, as in New York City, it would be unsafe to introduce high-speed traffic into an environment with toll collectors having to talk across lanes, and where the safe diverges and merges of cash-payers and transponder-users cannot be accommodated. That can be overcome in the design of new toll roads by building any cash collection toll lanes off to the side of the motorway like service areas.

[41] Traffic patterns were heavily disrupted during the aftermath of the attack, and afterwards the economy of the city changed.

[42] Christopher Willoughby, "Singapore's experience in managing modernization and its relevance to other countries," TWU Series 43, Transport Division, The World Bank, April 2000, p. 10.

[43] See http://data.vatt.fi/afford/casecities/oslo.html. In 1998 Trondheim added extra toll points and instituted more differentiation of toll rates by time of day. The 1998 transition to the multi-zone charging system was advocated on several grounds: (1) it would enhance revenue and enable the city to accelerate road and public transport improvements (2) it was fairer since the 40 percent of people living within the ring would now contribute, and (3) it would reduce congestion further by spreading traffic better over the day, deterring some trips altogether, and shifting some to public transport.

[44] See http://www.progress-project.org/Progress/tron.html.

[45] Robert W. Poole, Jr., and C. Kenneth Orski, "HOT Networks: A New Plan for Congestion Relief and Better Transit," Policy Summary No. 305, Reason Public Policy Institute, February 2003. p.2.

[46] It was unfeasible to include all of Greater London in the mayor's first term because of the scale of the scheme and the consultations required with external authorities. The charged area in Central London was chosen because of its high traffic densities and good public transport accessibility.

[47] In fact, in the summer of 2003 Transport for London announced that there may be future expansions to the London scheme. See: Transport for London Official Journal Notice Ref 2003/S 84-75175.

[48] Statistics based on data published by Transport for London on 6 June 2003. Transport for London (TfL) is the integrated body responsible for London's transport.

[49] http://www.london.gov.uk/mayor/strategies/transport/.

[50] The Road Charging Options for London (ROCOL) report was written by independent transport experts. In addition, Transport for London also made its own investigations.

[51] See www.toll-collect.de.

[52] The gantries will use vehicle classification profilers to distinguish heavy trucks from the general flow of traffic to trigger

interrogation of a transponder and, if unsatisfactory, a camera read of the truck. Additional mobile enforcement will be conducted by 300 vans with similar equipment.

[53] "Modernising the taxation of the haulage industry—lorry road-user charges," Progress report two, May 2003, published under the imprimatur of HM Treasury, HM Customs and Excise, and Department for Transport. www.hm-treasury.gov.uk.

[54] There is considerable potential for reducing incident-generated congestion. It is the nature of congestion that any disruption to traffic flow becomes cumulative. A lane closed for ten minutes may be three or four times as disruptive as one closed for five minutes, for example. ITS can help, too, by redirecting traffic and warning some motorists of the backups (tailbacks) and dangerous weather conditions by means of variable message signs, radio announcements, beepers, wireless PDAs, and emails. Good alternate route plans can help siphon traffic away from the crippled lane.

[55] In a test environment with test drivers within the automated drive lane, the systems work well. But there are major problems designing transitions between manual and automatic driving, checking vehicles to see whether the vehicles are capable of operating safely in automated drive, and handling the handbacks from automated to manual drive. These would require special interchanges and multiple ramps. It seems out of the question that automatic and manually driven vehicles could be operated together in the same roadway, so separate lanes, probably segregated by concrete barriers would be needed. Legal liability for accidents is likely to be complicated and would need to be addressed by legislation and probably some case law.

[56] Kristian Waersted, Interview with one of the authors, April 2003.

[57] Timothy D. Hau, "Transport for Urban Development in Hong Kong," University of Hong Kong, Hong Kong, China.

[58] A P Gopinath, Menon, interview with one of the authors, April 2003.

[59] Neil Kinnock, a former politician seems to have been giving voice to this general sentiment in these remarks when speaking as EU Transport Commissioner in 1997: "the current system of 'flat rate' taxes...patently gives no incentives to reducing congestion, pollution or accidents. The present levies just collect money—money, indeed, which mainly disappears into the great black hole of general taxation."

[60] Ed Gross, Interview with one of the authors, May 2000.

[61] Similarly with launching a scheme to cover trucks only. The cut-off size (12t or 3.5t) may create major political problems and distort competition. Sometimes saying "Everyone is in this" will strike people as fairer.

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Acknowledgments

Deloitte colleagues Ian Simpson (UK-London) and Jon Weg (UK-London), who lead Deloitte's transport practice, played a major role developing many of the concepts and key insights in the study. Other helpful comments and insights from Deloitte colleagues came from Greg Pellegrino (Boston, MA), Chris Loughran (UK-London), Neil McLauchlan (UK - London), Greg Vukasovic (UK-London), Bob Campbell (Austin, TX), and James Hawkins (UK-London). We also would like to thank the dozens of transportation officials who took time out of their busy schedules to be interviewed or to respond to our survey of road pricing, particularly Bernhard Oehry of Rapp Trans AG, Ken Daley of Transurban, Kristian Wærsted of Norsk Vegvesen, Menon A P Gopinath of Singapore Land Transport Authority, and Daniela Fiorelli of Comune di Roma.

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ISBN 1-892384-76-4

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