Commission Briefing Paper 4H-04

Potential Impacts on Transit Systems of Increased Demand Resulting from TDM Strategies

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on the effects of increased demand for passenger travel on public transportation resulting from the use of Transportation Demand Management (TDM) strategies. Public transportation is used for a wide variety of personal daily trips, and it is increasingly used for the beginning and the end of intercity trips. TDM strategies can raise the effectiveness of public transportation service (and other modes as well) by fostering reduced peak-period trip-making and increasing off-peak trips.

Background and Key Findings

The information and findings presented in this paper are extracted from a wide variety of sources, both professional and academic. Key findings include:

- Predicting the impacts on transit demand of specific TDM strategies is relatively straightforward in specific, limited geographic areas such as specific, congested travel corridors. However, generalizing these demand impacts across regions requires sophisticated modeling.
- The TDM strategies of greatest significance to public transportation demand appear to be: increases in transit service; improved parking management; employer-provided transit vouchers and parking cash-out; joint development and related land use activity; and congestion pricing on the roadway system.
- A $2 per day employer-provided transit voucher can reduce automotive commute trips in a dense activity center by 5.8 percent to 23.5 percent, while each 1 percent increase in transit service may raise transit use by an average .5 percent.
- TDM strategies are generally implemented in the short-term, but if they result in land use changes (reduced parking levels, traffic calming, zoning changes) their effects may be felt for many years. These strategies are essential to maximizing the cost-effectiveness of public transportation investments, due to their effects on transit use by discretionary travelers.

Travel Demand Management (TDM)

Transportation Demand Management (TDM) (also known as *Mobility Management*) is a general term for various strategies that increase transportation system efficiency.[1] TDM treats mobility as a means to an end, rather than an end in itself, and so helps individuals and communities meet their transport needs in a more efficient way, which often reduces total vehicle traffic. TDM seeks to prioritize travel based on the value and costs of each trip (where known), giving higher value trips and lower cost modes priority over lower value, higher cost travel, when doing so increases overall system efficiency. It emphasizes the movement of people and goods, rather than motor vehicles, and so gives priority to public transit, ridesharing and non-motorized travel, particularly under congested urban conditions.

Motorists can travel to most destinations with reasonable speed, comfort and safety, except under urban-peak travel conditions. These are the conditions in which TDM tends to be effective, due to concentrated travel demand. The major transportation problems facing most communities (traffic and parking congestion, inadequate mobility for non-drivers, and external costs from traffic), are the types of problems that TDM can effectively address. The measures employed may be applied at various levels, by a wide variety of stakeholders. Thus, Alternative Work Schedules will be applied by employers in the congested area, while non-motorized facility planning and management is usually undertaken by the public works department. Table 1 lists some of the TDM measures with the stakeholders who might apply them. Many TDM measures are justified on an economic basis because their effects in mitigating congestion yield a wide variety of benefits, including energy conservation, clean air benefits, mobility benefits for non-drivers, and increased opportunities for living near work (thus lowering household transportation costs).

The primary use of TDM is to manage congestion. The measures rely upon pricing and other effects of scarcity (in parking, travel lanes, and so on) to modify individual travel behavior. The result is usually to shift some travelers at the margin from traveling during peak periods to the off-peak, although it may also discourage some less valuable trips entirely. TDMs are usually undertaken as a program of several complementary measures, in response to a particular situation, such as congestion around a major employment area. Thus, employers may be encouraged to implement staggered work schedules, and provide transit passes to their employees who currently drive to work. The department of public works may adjust the number or cost of public parking spaces in the congested area, to discourage all-day parking. New buildings may be authorized fewer parking spaces than usual in the congested area. And the transit agency may be requested to shorten headways (add buses to reduce waiting times) along specific routes.

[1] The discussion on this page is drawn in its entirety from: “TDM Encyclopedia” Todd Litman, Victoria Transport Policy Institute, 2006.

Table 1: Example Transportation Demand Management Measures

Stakeholder/Implementer	TDM
City or County Public Works	Bicycle and pedestrian facilities Sidewalk improvements TDM marketing Street calming
Public Transit Provider	Change transit schedules and service Provide new transit service, lines, routes Expand or build new park-and-ride Joint development (land use) activity
City or County Dept. of Transportation	Street calming Downtown parking charges HOV priority
City or County Zoning Office	Density bonuses around transit stations Parking maximums Mixed-use development zones
Employers and Private Sector	Flextime, Alternative Work Schedules Transit Benefit and Parking Cash-Out Car-sharing

All of these measures have the effect of mitigating the worst part of the congestion while the local transportation department tries to determine what capacity improvements may be necessary to accommodate the continuing growth in the area.[2] This implies a short-term (two to five-year) focus for the TDM. However, the changes in parking authorization, street design, building heights and density, all affect land use to varying degrees. At that point, the TDM measures become long-term strategies – they lead to combined land use and transportation planning. That is, even though the mechanism seems easily reversible, such as a short-term permitting authority to reduce parking requirements, the infrastructure that accompanies the mechanism has a useful life of many years, and thus an effect over a longer period of time than the original legal authority.

One example of an apparently short-term strategy was the Central London Congestion Zone. Implemented to reduce congestion in the most crowded part of central London, England, the initial implementation reduced downtown traffic in the peak by just 17 percent overall, but it lowered congestion (increased vehicle speeds) by nearly 30 percent.[3] To achieve this effect required Transport for London to increase public transit service by the addition of 200 buses, in an area with over 1,000 buses already providing service.[4] The Central London zone has since been expanded to nearly twice its original area. The city is also planning an "emissions influenced charge" which will be separate from the congestion charge, aimed at reducing the use of high pollutant emission vehicles. The lowest-polluting vehicles would enter the congestion zone at no charge.

[2] However, due to the efficiencies produced in their implementation, TDM also produces significant economic benefits, by lowering commuter and freight delays, transportation emissions, energy use, and infrastructure costs.
[3] The reason for this apparently disproportionate impact is that congestion occurs at the margin. It is the increment of vehicles that causes the highly congested condition. Thus, removal of a relatively few vehicles, as little as 17 percent, is sufficient to greatly increase traffic mobility.
[4] "First year assessment report: Central London Congestion Zone", Transport for London, 2005

The risk in implementing the emission influenced charge, of course, is that it could easily foster a significant changeover to ultra-low emission vehicles being used in the emission zone to such a degree that the beneficial effects of the congestion zone would be overwhelmed by the influx of single-occupant vehicles. This has become the case in a similar context on the I-66 HOV lane in northern Virginia. The State has allowed single-occupant ultra-low emission vehicles (such as hybrid-electric cars) to use the HOV. Many residents have purchased these vehicles specifically to gain access to the HOV lane. This has lowered the service level of the HOV lane nearly to that of the unrestricted lanes during peak periods.

Transit Effects

As indicated in the London Congestion Zone example, implementing TDMs is likely to involve increasing transit service as well. Analysis over the last decade or so indicates that addressing congestion by increasing lane-miles yields diminishing returns, while shifting travelers to alternative modes has longer-lasting benefits. This is primarily because increased capacity leads to greater use, while increasing mode choice provides greater opportunity for differentiating between trip purposes. This allows trips more appropriately made on foot or by transit to be made so, while automotive trips are generally reduced.

The primary driver for personal travel behavior is cost. Whether the cost is direct (gasoline prices, fares, tolls) or whether it is indirect (delay time, taxes, insurance) has some effect on how travelers behave in the near term and long term. Changes in direct cost tend to have relatively immediate effects, while changes in indirect costs may not have the same immediacy or amount of effect. For example, if gasoline prices increase by 50 percent, some travelers may choose to drive less. However, if insurance rates on the automobile increase by 50 percent, this is unlikely to have a near-term impact on driving behavior (although it may influence the decision to acquire a future vehicle). The pricing signals that influence traveler behavior are described by "price elasticities"–that is, the change in behavior that results from a fixed change in the cost of travel.

The factors that are most commonly used to estimate changes in travel behavior are:

- Fuel Price Elasticity
- Road Pricing and Tolls
- Mileage and Emission Charges[5]
- Travel Time
- Transit Benefits and Parking Cash-out
- Transit Fare Elasticities

The basic conclusions reported in the VTPI TDM Encyclopedia indicate that, for example, a 10 percent price increase in fuel will generally lead to a 1.5 percent decrease in vehicle travel in the short run and as much as a 3 percent decrease in the long run. A reduction of travel time on a roadway of 20 percent leads to a 10 percent increase in vehicle travel in the near term, and a 20

[5] Harvey and Deakin (1998) modeled the effects of a 2¢ per mile fee on travel in four California urban areas. Their model indicated a modest reduction in automotive trips (7 percent) but a more significant reduction in congestion delay (14 percent).

percent increase in the longer term. However, these specific elasticities do not indicate, by themselves, the likely mode shift that might occur as a result of the decreased automotive travel. Driving less may lead to less travel overall, or it may lead to increased walking, avoiding casual (low-value) trips, or increased public transit use.

For example: some drivers may shift to a more fuel-efficient car to address fuel price; some drivers may shift away from tolled facilities (maybe even driving further for each trip); and some drivers may shift their travel time to avoid peak period delays. However, European research reported by VTPI indicates that a 10 percent rise in fuel prices increases transit use by 1.6 percent in the short term and 1.2 percent in the longer term. The decline in effect over time is the result of some drivers purchasing more fuel-efficient cars.

One factor—parking cash-out—has been identified by Donald Shoup as significantly affecting automotive travel in commuting. In 1997 he found that solo driving declined from 76 percent of commute trips to 63 percent after employers implemented a parking cash-out program. This is where the employer offers the employee cash in lieu of free parking. The employee is free to use the cash for any travel, including parking off-site or using public transit. A transit voucher program was found to shift 20 percent of employees' commute travel from personal automobile to transit.[6] These programs are implemented because the national (and often local) government provides tax benefits to employers for their implementation. Thus, while parking at work remains tax deductible as a fringe benefit, the employer can also offer parking cash-out on a tax-deductible basis, or a transit voucher that is a tax-exempt employee fringe.

The impacts of individual TDMs, or even combinations of them, may be enhanced or minimized by land use policies. If the land uses in the congested area lead to greater diversity and concentration of activities, the result may be continuing congestion for automobiles but increasing trips by other modes including public transit. However, if the land uses are not managed in concert with the TDMs, trip-making may decline without any concurrent benefit in travel time or system efficiency. This might happen as peak period travelers avoided the congested time, shifted their commutes to alternate routes, or found substitute parking arrangements.

Potential Impacts in Transit

The foregoing indicates that making specific projections of transit impacts of TDM measures is a major modeling effort, requiring highly localized statistics and travel behavior data. TDM strategies have the potential to help manage congestion in localized, congested corridors and probably entire downtowns, but each case will depend upon local circumstances.

One way of demonstrating this analysis would be to apply it to a case example. This paper considers Los Angeles in this context. The city grew during the early part of the 20th Century on a public transit framework. It exemplifies the sprawl behavior that makes public transit service difficult to provide, yet it also has distributed nodes of significant density that are served effectively by public transit. The Los Angeles system is comprised of contracted bus service, providing the overwhelming majority of annual trips (82 percent), but includes Metro, Light Rail, and Commuter rail service which provides the balance of annual trips. Altogether, public

[6] "Transportation Elasticities", TDM Encyclopedia, Victoria Transport Policy Institute, 2006.

transit in Los Angeles carried 481.9 million trips in fiscal 2006, for an average of 125 trips per person per year.[7]

What would be the effect of instituting broad-based TDM measures, such as initiating a transit voucher and parking cash-out program, or increasing transit service? Each of these has different (and highly variable) elasticities, depending on local circumstances. The presence and growth of high-quality public transit service, and the concentrations of employment and population density in Los Angeles may provide a good basis for answering the question. Table 2 projects the current population and transit service use, based on current figures, for 2025 and 2050. The projection is derived from Census data[8] and the current level of transit use per capita – that is, it represents a baseline. Against these baseline figures will be applied elasticities of mode share for a transit subsidy program, and for an increase in transit service.

Table 2: Los Angeles Population and Transit Use Baseline		
	Population	**Transit Trips**
2005	3,844,829	481,962,491
2025	4,761,821	597,132,318
2050	5,720,851	717,394,767

Transit Vouchers
The effect of employer-provided transit vouchers on trip-making can be substantial. Table 3 summarizes one estimate of the effects of providing differing levels of daily subsidy for commute trips by carpool and transit, based on the degree of mode-centeredness of the worksite. For this example, the worksite is defined as being an Activity Center. The three orientations are all found in major urban areas.

Table 3: Percent Vehicle Trips Reduced by Daily Transit Benefit [9]				
Worksite Setting	**\$0.50**	**\$1.0**	**\$2.0**	**\$4.0**
Activity Center – Rideshare	1.1	2.4	5.8	16.5
Activity Center – Mode neutral	3.4	7.3	16.4	38.7
Activity Center – Transit Oriented	5.2	10.9	23.5	49.7

What this table indicates is that a $2 per day employer-provided transit voucher will reduce single-occupant automotive commute trips by 16.4 percent in a mode-neutral activity center (recalling that some of the trip reductions will take place in car-pools and vanpools because these are also eligible for transit vouchers), and by 23.5 percent in a transit-oriented activity center.

Transit Service Improvement
As mentioned above, there is also elasticity around transit service itself. Increases or decreases in transit use are directly linked to how much transit is provided, whether it is new or existing transit service, and how the service increase is implemented. For example, increasing the number of vehicles on a route, so that waiting times are reduced from 15 minutes to 10 minutes,

[7] One of the highest rates of transit use per capita in the U.S. Los Angeles MTA Fact Sheet, 2006.
[8] The same as is used in the Transit Mode Share paper (4B-7).
[9] Source: Comsis Corporation, 1993.

has a large effect on transit use. On the other hand, it may take up to three years for a brand new service to reach its operating potential. And, as with other factors, the supporting conditions of density, connectivity, or activity center will influence the variability in the service elasticity. Some elasticities include service expansion (0.6 to 1.0 percent for every 1 percent change), or headway (0.5 percent average for every 1 percent change).

Service expansion of existing routes into new service areas is usually done in response to expressed demand, which explains why the service elasticity is so strong. The headway elasticity (how many minutes between buses or trains) depends on the degree of change. If the headway is changed from 30 minutes to 20 minutes, there will be some increase in use as a result. But if the change is from 20 minutes to something less than 15 minutes, the increase will be more substantial. Applying the headway service elasticity to the figures in Table 2 results in an increase in 2005 transit trips of 2.4 million per year for every 1 percent increase in transit service provided in Los Angeles. A 1 percent increase in transit service in 2050 would result in 3.6 million additional trips. This does not indicate how many additional automotive trips would be avoided by walking or bicycle use, and it does not include any effects from expansion of existing routes into new service areas.