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"Efficiency - Equity - Clarity"

Guide to Calculating Mobility Management Benefits

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Abstract

Mobility Management (also called *Transportation Demand Management* or *TDM*) consists of various policies and programs that change travel behavior in order to increase transport system efficiency. It includes strategies that improved travel options, incentives to use the most efficient option for each trip, and more accessible land use patterns. Mobility management can provide various economic, social and environmental benefits. Conventional transportation evaluation practices tend to overlook and undervalue many of these benefits. More comprehensive analysis tends to support more mobility management implementation, and can help optimize mobility management policies and programs. This guide provides guidance for comprehensive mobility management evaluation. Examples illustrate how such analysis can be applied in particular situations.

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Introduction

Mobility Management (also called *Transportation Demand Management* or *TDM*) refers to policies and programs that change travel behavior to increase transport system efficiency (Schreffler, 2000; Cairns, et al, 2004; USEPA, 2004; VTPI, 2006). Table 1 lists various mobility management strategies. These strategies cause various types of travel changes including shifts in *mode* (from driving to walking, cycling, ridesharing, public transit, etc.), *destination* (closer rather than more distant services), *time* (from peak to off-peak), and *frequency* (consolidating trips and substituting telework for physical travel). Some increase land use accessibility (such as locating services closer to residential areas).

Table 1 **Mobility Management Strategies** (VTPI, 2006)

Improves Transport Options	Incentives	Land Use Management	Implementation Programs
Transit improvements Walking & cycling improvements Rideshare programs HOV priority Flextime Carsharing Telework Taxi service improvements Guaranteed ride home	Congestion pricing Distance-based fees Commuter financial incentives Parking pricing Parking regulations Fuel tax increases Transit encouragement	Smart growth Transit oriented development Location-efficient development Parking management Carfree planning Traffic calming	Commute trip reduction programs School and campus transport management Freight transport management Tourist transport management Mobility management marketing programs Transport planning reforms

This table lists various mobility management strategies. Many include subcategories.

There are many justifications for mobility management. It is a cost effective approach to reducing problem such as traffic congestion, pollution emissions or inadequate mobility for non-drivers. It can provide cost savings to developers and governments. It can support strategic planning objectives, such as urban redevelopment, openspace preservation, energy conservation and economic development. It includes strategies, such as telework and nonmotorized transportation improvements, that users value. Some travel changes improve physical fitness and public health. Many mobility management strategies are market reforms that correct existing market distortions and so increase economic efficiency.

However, conventional transportation planning tends to focus on just one or two of these benefits, such as congestion or pollution reductions, and so tends to undervalue mobility management. More comprehensive analysis, which considers a broader range of impacts, can justify greater implementation of mobility management solutions. This paper provides guidance for comprehensive economic evaluation of mobility management policies and programs, to help identify the optimal approach to improve transportation.

Comprehensive Evaluation

Current planning tends to be *reductionist*; assigning individual problems to a particular profession or agency with narrowly defined responsibilities (Litman, 1999). For example, reducing traffic congestion is the responsibility of transportation agencies while reducing pollution is the mandate of environmental agencies. This can result in organizations choosing solutions to problems within their mandate that exacerbate other problems facing society, and tends to undervalue strategies that provide multiple, modest benefits. For example, transport agencies may implement roadway capacity expansion to reduce congestion although this induces additional vehicle travel which increases other transport problems. Environmental agencies may increase fuel efficiency standards to reduce energy consumption, with similar negative effects (Table 2). Only by considering multiple objectives can the full value of mobility management be recognized.

Table 2 **Impacts of Various Policy Changes** (Litman, 2006)

Planning Objective	Expand Road Capacity	Increase Fuel Efficiency	Mobility Management
Congestion reduction	✓	✗	✓
Roadway cost savings	✗	✗	✓
Parking cost savings	✗	✗	✓
Consumer cost savings	✗	✓/✗	✓
Transport diversity	✗	✗	✓
Improved traffic safety	✗	✗	✓
Energy conservation	✗	✓	✓
Reduced pollution	✗	✓	✓
Efficient land use	✗	✗	✓
Improved fitness & health	✗	✗	✓

(✓ = helps achieve that objective. ✗ = Contradicts that objective.) Roadway expansion and increased vehicle fuel efficiency help achieve specific objectives but stimulate vehicle travel and so exacerbate other transport problems. Mobility management helps achieve many objectives.

To their credit, planners often recognize *cobenefits* of a particular strategy, such as the pollution reduction benefits of a congestion-reduction program, but this reflects a particular planner's knowledge and interests. There is no standard method that considers all significant impacts during evaluation.

Overvaluing roadway expansion and undervaluing mobility management can have large impacts due to *leverage* effects. For example, a million dollars spent to expand roadways may stimulate vehicle travel and sprawl that adds tens of millions of dollars in direct travel costs and hundreds of million of dollars in indirect costs. Spending the same amount on mobility management programs can provide millions of dollars in direct savings and much greater total economic, social and environmental benefits.

Existing Literature

Several categories of technical literature relate to mobility management evaluation. There are many publications concerning transport project evaluation produced by professional organizations such as AASHTO (2003). Computer models (such as *MicroBenCost* and *HDM-4*) are available for evaluating roadway investments, for example, to determine the optimal route for a new highway or when a dirt road should be paved.

Several studies and guides describe evaluation of public transit improvements (ECONorthwest and PBQD, 2002; Litman, 2005; "Transit Evaluation," VTPI, 2006) pricing reforms (Pricing Evaluation, VTPI, 2006), commute trip reduction programs (Concas and Winters, 2007; Modarres, 1993; "Commute Trip Reduction," VTPI, 2006), and land use policy reforms, such as smart growth and transit oriented development (Seggerman, et al, 2005; "Land Use Evaluation," VTPI, 2006). Another set of literature examines the degree to which various mobility management programs can help address specific planning objectives, such as reducing traffic congestion (ITE, 1997) or air pollution (USEPA, 2004).

There is extensive literature on some transportation costs, such as congestion, accidents and pollution ("Transportation Costs and Benefits," VTPI, 2006). A few studies provide a framework for evaluating the cost savings and benefits of vehicle travel reductions (Delucchi, 1998; Litman, 2006; *ExternE* [http://externe.jrc.es]; *UNITE* [www.its.leeds.ac.uk/projects/unite]). The *Transportation Cost Analysis Spreadsheet* (www.vtpi.org/tca/tca.xls) provides cost estimates for various modes in a format that can be used to calculate the cost savings from automobile travel reductions and mode shifts.

A growing body of literature concerns how various factors affect travel behavior (Pratt, 2007). Transportation elasticity information which predict how prices affect travel behavior ("Transportation Elasticities," VTPI, 2006). Integrated transportation/land use models which predict the effects of land use changes on travel behavior and how this can change land use patterns ("Land Use Impacts on Travel," VTPI, 2006). Because many mobility management programs involve innovative and multiple strategies, conventional models do not predict their travel impacts accurately, although this is improving with newer models ("Transport Model Improvements," VTPI, 2006). Specialized programs, such as the *Commuter Model* (USEPA, 2005), and the *TRIMMS Model* (Concas and Winters, 2007) can help predict the impacts of certain mobility management strategies. The *Mobility Management Evaluation Spreadsheet* (www.vtpi.org/mm_eval.xls) calculates the vehicle travel reductions, energy savings and emission reductions caused by various combinations of mobility management strategies, taking into account the portion of travel they affect.

Economic Evaluation

This guide describes *economic evaluation* (also called *economic analysis* or *appraisal*), which involves determining the value of a policy or program (Litman, 2001). This can help answer planning questions such as whether a particular option is cost effective (benefits exceed costs), which of several options provides the greatest value (optimization), and how impacts are distributed (equity analysis).

Economic *impacts* refers to benefits and costs. These include both *market* impacts (involving goods commonly traded in markets, such as land, fuel and labor) and *non-market* impacts (involving goods not normally traded in markets, such as personal travel time, pain and suffering, and ecological damages). These can be defined in terms of *objectives* or their opposite, *problems* (for example, if congestion is a problem, congestion reduction is considered an objective), or in terms of *benefits* and *costs* (if congestion is a cost, congestion reduction is a benefit). Planners tend to use the terms *objectives* and *problems* (which are more qualitative), while economists tend to use the terms *benefits* and *costs* (which are more quantitative), all of which are different approaches for evaluating the same impacts, as illustrated in the table below.

Table 3 **Ways to Describe An Impact**

	Positive	**Negative**
Qualitative	Objective	Problem
Quantitative	Benefit	Cost

Objective, Problem, Benefit and Cost are different ways to describe an impact.

Economic evaluation is based on *net benefits*; incremental benefits minus any incremental costs, including program costs (costs of program implementation), and any external costs (costs to other people). For example, a telecommuting program's net benefits are the benefits of reduced automobile commuting minus program costs (costs for any additional telecommunications equipment or services), and any external costs from additional vehicle trips for errands that participants would otherwise make while commuting. Economic analysis requires an *evaluation framework* that identifies:

- *Evaluation method*, such as cost-effectiveness, benefit-cost, lifecycle cost analysis, etc.
- *Evaluation criteria*, the impacts considered in a particular analysis.
- *Modeling techniques*, which predict how a policy or program will affect travel and land use.
- *The Base Case*, the conditions assumed to occur without the proposed policy or program.
- *Comparison units,* such as costs per lane-mile, vehicle-mile, passenger-mile, etc.
- *Base year and discount rate,* which indicate how analysis reflects the time value of money.
- *Perspective and scope*, such as the geographic range of impacts to consider.
- *Dealing with uncertainty*, such as which statistical tests will be used.
- *How results will be presented*, such as reporting standards and format.

There are often several steps between a mobility management policy or program and its ultimate benefits, as illustrated in Figure 1. For example, a particular strategy may improve transit service, causing some travelers to shift mode, which reduces traffic congestion, thereby increasing economic productivity. Mobility management evaluation requires understanding these various relationships, some of which are complex and difficult to measure. For example, although we are confident that improving transit service can increase transit ridership, it can be difficult to predict the magnitude of mode shifting, congestion reductions and economic productivity gains.

Figure 1 **Steps Between Policy or Program and Ultimate Benefits**

Policy or Program
(fuel tax reform, commute trip reduction program, increased transit funding, pedestrian planning, etc.)
↓
Incentives
(higher fuel prices, parking cash out, better transit services, improved walking conditions, etc.)
↓ ↓

Travel Changes (shifts in travel time, mode, destination, frequency, etc.) ↓	→ ←	**Land Use Changes** (reduced parking supply, more compact development, more land use mix, etc.) ↓

Direct Physical Effects
(reduced congestion, reduced accidents, reduced pollution emissions, improved mobility for non-drivers, etc.)
↓
Ultimate Economic, Social and Environmental Benefits
(increased economic productivity, improved health, ecological integrity, increased opportunity for disadvantaged people, etc.)
↓
Monetization of Impacts
(measuring impacts in monetary units for economic evaluation)

This figure illustrates the various steps between a particular mobility management strategy and its ultimate effects and benefits.

These impacts often change over time. Highway capacity expansion tends to reduce traffic congestion in the short-term, but this benefit declines over time due to generated traffic (additional vehicle travel resulting from roadway improvements). On the other hand, mobility management benefits are often slow to develop but increase over several years as people take these changes into account when making decisions such as where to locate and whether to purchase another vehicle. Shorter-term analysis therefore tends to favor highway capacity expansion, while longer-term analysis tends to support more mobility management.

Mobility Management Benefits

This section defines various categories of benefits, describes how they can be quantified and monetized, discusses the degree they are considered in current transport planning, and identifies the most effective mobility management strategies for achieving specific planning objectives. For more information see Cairns, et al (2004), Concas and Winters (2007), Litman (2006) and VTPI (2006).

Congestion Reduction

Traffic congestion is the incremental delay resulting from interference among vehicles in the traffic stream as a roadway reaches its capacity. Congestion increases travel time, driver stress, vehicle operating costs, crash rates (although it tends to reduce injuries and deaths) and pollution. Although most traffic congestion indicators (such as roadway *level of service ratings* and various *congestion indices*) only consider impacts on other motor vehicle traffic, vehicle use can also cause delays to non-motorized travel (called the *barrier effect* or *severance*, as discussed in Litman, 2006). Reduced congestion can provide various specific types of benefits, such as those listed below.

Congestion Reduction Benefits Subcategories

- Reduced delay/improved mobility for personal travel, commercial services and freight transport.
- Reduced vehicle operating costs (fuel and brake wear).
- Reduced energy consumption and pollution emissions.
- Reduced traffic crashes (but increased crash severity).
- Reduced delay to walking and cycling.
- Improved emergency response.

Mobility management tends to reduce congestion to the degree that it reduces urban-peak vehicle travel. Some strategies, such as flextime, also reduce transit crowding. Congestion reduction benefit analysis is complicated by the tendency of congestion to maintain equilibrium due to *latent demand* (additional peak-period trips that people would make if congestion declines). For example, if a mobility management program causes some commuters to shift from driving to an alternative mode, some additional vehicle trips may be made that would otherwise have been deterred by congestion. As a result, congestion reduction benefits decline over time and an increased portion of benefits consist of user benefits from those additional peak-period trips. Since these are the trips consumers most willingly forego in response to higher travel costs (time and fuel), their net value tends to be small.

Some mobility management strategies reduce the point of congestion equilibrium (the degree of congestion at which people forego peak-period vehicle trips), by improving alternative modes (such as increased speed relative to driving, convenience, comfort, and affordability), by applying targeted road and parking fees, by reducing total vehicle travel demand, or by changing land use patterns to reduce distances.

Strategies that improve alternative modes, particularly grade-separated transit or HOV routes, are also particularly effective at reducing congestion (Litman, 2005). Commute, school and tourist transport management programs also tend to be particularly effective for reducing congestion. Freight transport management can reduce congestion on corridors with heavy truck traffic. Smart growth that concentrates activities tends to increase the intensity of congestion but reduce its overall costs by reducing the distance between destinations and improving alternative modes.

Table 4 **Mobility Management Congestion Reduction Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Transit & rideshare improvements HOV priority Flextime Congestion pricing Telework Parking management & pricing Commute trip reduction programs & incentives School and campus transport management Tourist transport management	Walking & cycling improvements Marketing programs Distance-based fees Carsharing Fuel tax increases Taxi service improvements Freight transport management Nonmotorized promotion Transit oriented development	Smart growth Location-efficient development Carfree planning Traffic calming	Land use management strategies that concentrate activities tend to increase congestion intensity (as measured by roadway level-of-service) but reduce per capita congestion costs by reducing travel distances and improving travel options such as walking and high quality public transit.

This table identifies how various mobility management strategies affect congestion.

Conventional transport planning gives congestion costs considerable consideration, although it often overlooks the downstream congestion induced by generous, cheap parking, highway expansions and sprawled land use. Standard methods exist for monetizing congestion costs and therefore the congestion reduction benefits of reducing vehicle travel (TTI, 2005; Litman, 2006). Typical estimates range between 5¢ and 20¢ per urban-peak vehicle-mile, with higher values under certain conditions. However, commonly-used congestion cost indicators have the following problems:

- They measure motorist delay relative to freeflow road conditions, which represents the higher end of reasonable monetized values. Many economists consider it more accurate to measure delay relative to a moderate level of congestion or based on consumers' willingness to pay for increased mobility, which results in lower values.
- They only measure *motorists'* delay, and therefore do not recognize the congestion reduction benefit to people who shift to alternative modes such as walking, cycling, grade-separated transit or telework, or from smart growth land use policies that reduce travel distances. They therefore undervalue many mobility management strategies.
- They ignore congestion impacts motor vehicle traffic imposes on non-motorized travel, and so undervalue strategies that reduce conflicts between motorized and nonmotorized modes.

Roadway Cost Savings

Roadway costs are the costs to build and operate road facilities, including land, construction, maintenance, and traffic services such as policing and emergency response (this section refers primarily to direct financial costs; indirect, environmental and social costs of sprawl are discussed later in the *land use impacts* section).

Roadway Cost Savings Subcategories

- Roadway construction cost savings (to the degree that roadway projects are avoided).
- Roadway maintenance cost savings.
- Roadway operating costs savings, including traffic services such as policing and emergency response.

Nearly any reduction in vehicle travel reduces roadway operating costs. Strategies that target urban peak travel tend to provide particularly large savings by reducing the need to expand urban highways (a congestion cost). Conventional transport planning gives considerable consideration to roadway construction costs, but ongoing operation costs are often overlooked, for example when transport pricing reforms are evaluated.

Table 5 **Roadway Cost Savings Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Commute trip reduction Congestion pricing Freight transport management Marketing programs Parking management & pricing Rideshare programs Transit improvements and encouragement Walking & cycling improvements	Carsharing Distance-based fees Taxi service improvements Nonmotorized promotion Telework HOV priority Tourist transport management	Flextime Fuel tax increases Smart growth Location-efficient development Carfree planning Traffic calming Transit oriented development	Increased land use density may increase unit costs (cost per lane-mile), although per capita costs do not necessarily increase if total roadway-miles are reduced.

This table identifies how various mobility management strategies affect road and parking facility costs.

Various *cost allocation* (also called *cost responsibility*) studies have examined the costs of building and maintaining roadways, estimated the share of these costs imposed by different vehicle classes, and calculated optimal user fees (FHWA, 1997; “Roadway Costs,” Litman, 2006). These studies indicate that U.S. vehicle user fees only pay about 65% of roadway costs. Local and property taxes fund the rest. Most roadway cost allocation studies only account for costs included in roadway agency budgets, and tend to overlook costs for traffic policing, street lighting, and emergency response, and the opportunity costs of roadway land. Urban roadway costs tend to be relatively high, so reducing urban-peak trips tends to provide relatively large savings. Including these factors tends to increase mobility management benefits.

Parking Cost Savings

Parking costs are the costs to build and maintain parking facilities, including land, construction, maintenance and operations.

Parking Cost Savings Subcategories

- Residential parking cost savings.
- Business parking cost savings.
- Government parking cost savings.

Reductions in vehicle ownership tend to reduce residential parking costs, while reductions in vehicle trips , particularly reductions in peak period and longer duration trips, tend to reduce parking costs at other destinations. Land use strategies that increase development density tend to allow more shared parking, which reduces parking costs. Conventional transport planning gives little consideration to parking facility costs.

Table 6 **Parking Cost Savings Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Commute trip reduction Parking management & pricing Rideshare programs Smart growth Transit improvements and encouragement Walking & cycling improvements	Carsharing Freight transport management Nonmotorized promotion Telework HOV priority Tourist transport management	Flextime Carfree planning Traffic calming Transit oriented development	Increased density may increase unit costs (cost per parking space or lane-mile), although per capita costs do not necessarily increase if a community reduces the total number of parking spaces and lane-miles.

This table identifies how various mobility management strategies affect road and parking facility costs

Parking costs typically ranges from $400 to $2,500 annual per space. Actual savings vary depending on specific conditions, including the severity of parking problems in the area, and the marginal savings that would result if parking demand declines ("Parking Costs," Litman, 2006). In some cases there may be minimal short-term parking cost savings if unused parking spaces will simply sit unoccupied, but over the medium and long run most urban parking facilities have an opportunity cost, by avoiding the need to build more parking, or allowing parking facilities to be rented, sold or developed for other uses.

Consumer Savings

Mobility management programs that improve affordable travel options and land use accessibility tend to provide consumer savings, increase transportation affordability, and support equity objectives (VTPI, 2006).

Consumer Cost Savings Subcategories

- Vehicle operating cost savings (fuel, oil, tire wear).
- Reduced mileage-based depreciation (vehicle wear-and-tear, increasing maintenance, repair and replacement).
- Vehicle ownership cost savings.
- Housing cost savings (such as reduced residential parking costs).

Mobility management strategies that improve lower cost transport options, such as walking, cycling, ridesharing and public transit, tend to provide the greatest consumer savings. Some strategies, such as *parking cash out* (allowing commuters the option of choosing cash instead of parking subsidies), *Pay-As-You-Drive insurance*, and *location-efficient development* provide direct financial benefits to consumers that drive less than average. Some pricing reforms directly increase consumer costs but their overall impacts depend on how revenues are used and the quality of travel options available.

Table 7 **Consumer Cost Savings Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Walking & cycling improvements Transit improvements Rideshare programs Carsharing Telework Commute trip reduction PAYD vehicle insurance Location-efficient development	Transit oriented development School and campus transport management Tourist transport management Taxi service improvements Nonmotorized promotion Flextime HOV priority	Smart growth Marketing programs Carfree planning Traffic calming Freight transport management	Parking pricing Fuel tax increases Congestion pricing *Overall impacts depend on how revenues are used and the quality of transport options available.*

This table identifies how various mobility management strategies reduce consumer costs.

Conventional transport economic evaluation considers vehicle operating costs, but often overlooks mileage-based depreciation and vehicle ownership costs. Reduced vehicle mileage provides fuel cost savings averaging 10¢ to 20¢ per mile, and reduces mileage-based depreciation that also averages 5¢ to 20¢ per mile. Improved travel options allow some households to reduce vehicle ownership, providing savings that typically average $2,000 to $4,000 annually per vehicle eliminated. Parking cash out and PAYD insurance provide hundreds of dollars in annual financial benefits to people who drive less than average. Specific analysis would help evaluate overall impacts of user charges that reduce other fees and taxes.

Transportation Diversity

Transportation diversity refers to the quantity and quality of accessibility options available, particularly for non-drivers. Improved diversity increases transport system efficiency by allowing users to choose the best travel option for each situation, reduces chauffeuring responsibilities, improves disadvantaged people's economic opportunities, and increases community resilience. It is the opposite of *automobile dependency*.

Transportation Diversity Benefits Subcategories

- Allow people to choose the travel option (reducing stress and increasing enjoyment).
- Reduced need to chauffeur non-drivers.
- Financial savings, particularly for lower-income people.
- Increased economic opportunity for non-drivers (supports equity objectives).
- Increases transportation system resilience (ability to accommodate unexpected and sudden change).

Mobility management generally increases transportation diversity by improving alternative modes and creating more accessible communities. Improvements that accommodate people with disabilities (called *universal design*) are particularly helpful. Programs that encourage discretionary travelers (people who could drive) to use alternative modes can provide indirect benefits to non-drivers' by increasing public support for alternative modes and increasing their social acceptability.

Table 8 **Transportation Diversity Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Walking & cycling improvements Universal design Transit improvements Rideshare programs Carsharing Telework Location-efficient development Smart growth Transit oriented development Taxi service improvements	Marketing programs Commute trip reduction programs & incentives School and campus transport management Tourist transport management Flextime HOV priority Carfree planning Traffic calming	Freight transport management Parking pricing Fuel tax increases Congestion pricing	*May reduce the convenience and affordability of automobile travel.*

This table identifies how various mobility management strategies help increase transport diversity.

Conventional transport planning gives some consideration to the value of maintaining multiple roadway route options and public transit services, but lacks a comprehensive methodology for evaluating transport system diversity. Some transportation diversity benefits can be monetized, including economic benefits from improving mobility for non-drivers, reduced chauffeuring costs, and *option value* (Forkenbrock and Weisbrod, 2001; VTPI, 2006). Total benefits are the sum of these individual benefits.

Transportation Safety

Traffic crashes cause huge economic costs, including deaths, disabilities, and injuries, and resulting productivity losses and medical expenses, plus costs for property damages, emergency services and traffic delay.

Transportation Safety Benefits Subcategories

- Reduced traffic fatalities, disabilities and injuries (including suffering and loss of companionship).
- Reduced productivity losses (from deaths and disabilities).
- Reduced medical and rehabilitation expenses.
- Reduced property damages.
- Reduced emergency services.
- Reduced traffic delay.

Mobility management strategies tend to reduce total crashes (Litman and Fitzroy, 2005). Shifts from driving to public transit tend to reduce crashes. Shifts to nonmotorized modes may increase per-mile risk to people who shift, but reduce risk to other road users, and tends to reduce per capita crash rates. Smart growth strategies that increase land use density can increase crash frequency but reduce severity, reducing total injuries and deaths. Pay-As-You-Drive vehicle insurance and strategies that reduce traffic speeds are particularly effective at reducing crash costs.

Table 9 **Safety Benefit Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Transit improvements Rideshare programs Traffic calming Traffic speed management PAYD vehicle insurance Carfree planning Transit oriented development Taxi service improvements	Marketing programs Commute trip reduction programs & incentives School and campus transport management HOV priority Carsharing Telework Location-efficient development Congestion pricing	Freight transport management Parking management & pricing Fuel tax increases Walking & cycling improvements Flextime	*Smart growth land use development, which increases traffic density, may increase crash rates per vehicle-mile, although per capita crash rates and severity tend to decline due to reduced automobile travel distances and speeds.*

This table identifies how various mobility management strategies reduce traffic accident costs.

Conventional transport planning gives consideration to crash risk measured per unit of travel (per 100 million vehicle-miles or billion vehicle-kilometers), but tends to ignore increased mileage as a crash risk factor and mobility management as a safety strategy. Economists have developed monetized estimates of traffic accident costs and the value of reducing crashes. Many transportation agencies use these values for evaluating traffic safety improvements (Delucchi, 1998; Litman, 2006). They typically estimate crash costs at 5¢ to 15¢ per automobile mile.

Pollution Reduction

Motor vehicle use emits various types of air, noise and water pollution. Air pollution causes human illness, disability and death, and various types of ecological damages. Noise pollution causes distraction and stress, and so reduces property values along roads with heavy traffic. Water pollution causes ecological damages.

Pollution Reduction Subcategories

- Reduced air pollution reduces human illnesses.
- Aesthetic benefits of cleaner and clearer air.
- Reduced greenhouse and acid rain impacts.
- Reduce noise pollution.
- Reduced water pollution.

Mobility management strategies that reduce vehicle travel tend to reduce pollution emissions. Reductions in short trips and congested vehicle travel provide relatively large emission reductions, freight travel reductions provide large benefits per vehicle-mile, and reductions in urban travel tend to provide relatively large benefits due to high exposure (many people live or work close to roadways). Reductions in vehicle ownership tend to provide extra water pollution reductions, since some vehicles drip fluids when parked. Some strategies, such as smart growth and traffic calming, may increase emissions per vehicle-mile, but by reduce total emissions by reducing total vehicle travel.

Table 10 **Pollution Reduction Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Congestion pricing Emission fees Fuel tax increases Walking & cycling improvements Carsharing Transit & HOV improvements Rideshare programs Traffic speed management Freight transport management	Marketing programs Commute trip reduction programs & incentives School and campus transport management Telework Distance-based fees Carfree planning Parking management & pricing	Smart growth Traffic calming Flextime	*Smart growth and traffic calming may increase emission rates per vehicle-mile, but tend to reduce per capita emissions.*

This table identifies how various mobility management strategies reduce pollution costs.

Conventional transport planning often considers certain pollution costs when evaluating major projects, but not when evaluating smaller projects. Monetized pollution cost estimates typically range from 1¢ to 10¢ per vehicle-mile (Delucchi, 1998; Litman, 2006). Many of these estimates only account for a portion of total vehicle pollutants (many estimates overlook urban noise, road dust and climate change emissions) and so tend to undervalue the full emission reduction benefits of reduced vehicle mileage.

Energy Conservation

Transportation activity consumes considerable amounts of energy, particularly various fossil fuels. Producing, transporting and consuming this energy imposes a variety of costs on society. Consuming nonrenewable resources reduces their availability to future generations. Importing resources imposes economic costs (reduced employment, business activity and investment), and dependency on foreign fuel creates national security risks. Fossil fuel consumption releases climate change emissions (as described in the previous section).

Energy Conservation Benefits Subcategories

- Environmental impacts from petroleum production, transport and processing.
- Depletion of non-renewable resources.
- Economic costs of importing resources.
- National security costs of being dependent on imported resources.

Mobility management strategies that reduce vehicle travel tend to conserve energy. As with pollution emissions, reductions in short trips and congested vehicle travel tend to provide particularly large energy conservation benefits. Fuel tax increases are particularly effective at encouraging energy conservation, since they encourage both reductions in vehicle travel and selection of more fuel efficient vehicles. Other incentives to choose fuel efficient and alternative fuel vehicles are not mobility management strategies, but are sometimes incorporated into mobility management programs.

Table 11 **Energy Conservation Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Fuel tax increases Walking & cycling improvements Carsharing Transit improvements HOV priority Congestion pricing Traffic speed management Freight transport management	Marketing programs Commute trip reduction programs & incentives School and campus transport management Rideshare programs Telework Distance-based fees Parking management & pricing	Smart growth Traffic calming Flextime Carfree planning	*Smart growth and traffic calming may increase energy consumption per vehicle-mile, but tend to reduce per capita energy use.*

This table identifies how various mobility management strategies reduce energy consumption.

Conventional transport planning generally considers energy conservation a desirable objective but gives it little consideration when evaluating individual projects. There are several monetized estimates of fossil fuel external costs and the benefits to society of energy conservation. These estimates vary depending on assumptions and perspective (Delucchi, 1998; Litman, 2006). Estimates of U.S. petroleum external costs range from $25 to $150 billion annually, which averages 0.5¢ to 3¢ per vehicle-mile.

Physical Fitness and Public Health

Health experts are increasingly concerned about the health problems caused by a sedentary living, and so value transport and land use policies that increase physical activity, such as daily walking and cycling. Increased physical activity can reduce many significant health risks, including cardiovascular disease and diabetes, providing potentially large direct and indirect benefits.

Fitness and Health Benefits Subcategories

- Reduced fatalities, disabilities and illnesses.
- Reduced productivity losses (from deaths and disabilities).
- Reduced medical and rehabilitation expenses.
- Productivity gains from increased worker fitness.
- Support for recreation, sport and tourist activities.
- Increased property values in walkable and bikeable communities.
- Personal enjoyment.

Strategies that improve walking and cycling conditions or encourage nonmotorized travel are particularly effective at increasing physical activity. Reduced motor vehicle travel tends to increase walking and cycling activity, since nonmotorized trips often substitute for automobile trips, either completely or in conjunction with transit trips, since most transit trips include walking or cycling links. Smart growth land use reforms that result in more walkable and bikeable communities tend to increase public fitness and health.

Table 12 **Fitness and Health Benefits Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Walking & cycling improvements Walking & cycling encouragement Universal design Commute trip reduction programs School & campus transport management Carfree planning Traffic calming Tourist transport management Smart growth	Marketing programs Transit improvements Rideshare programs Parking pricing Parking management Fuel tax increases Congestion pricing	Carsharing Taxi service improvements Telework Flextime HOV priority Freight transport management	*Increased walking and cycling activity, and increased development density, may sometimes increase crash risk and air pollution exposure.*

This table identifies how various mobility management strategies help increase transport diversity.

Conventional transportation planning generally considers increased physical activity a desirable objective but outside transport agencies' primary responsibility, as indicated by the tiny portion of transport budgets typically devoted to nonmotorized improvements, and so gives it little consideration when evaluating individual projects. There is no standard method for monetizing the health benefits of increased physical activity, but they are probably comparable to crash reduction benefits ("Health and Fitness," VTPI, 2006).

Efficient Land Use

Motor vehicle traffic, transportation facilities (roads, parking lots, terminals and airports), and automobile-oriented land use development patterns (commonly called *sprawl*) tend to impose various undesirable land use impacts, as summarized in Table 13.

Table 13 **Transportation Land Use Impacts** (Litman, 2004)

Cost Category	Motor Vehicle Traffic	Transportation Facilities	Automobile-Oriented Development (sprawl)
Environmental Degradation	Harms wildlife, distributes invader species.	Pavement displaces greenspace. Heat island effects.	Reduces greenspace.
Aesthetic and Cultural Degradation	Motor vehicle traffic tends to be noisy and unattractive.	Pavement displaces natural and human-made landscape resources.	Development displaces natural and human-made landscape resources.
Social Impacts.	High traffic roads reduce community cohesion.	Wide roads and large parking lots reduce community cohesion.	Mixed.
Public Service Costs	Vehicle travel requires publicly-funded roads and parking facilities.	Increases stormwater management and facility maintenance costs.	Increases costs of providing public services, such as utilities and deliveries.
Increased Transportation Costs	High traffic roads discourage walking and therefore transit.	Wide roads and large parking lots discourage walking, and therefore transit.	Dispersed destinations and reduced transport options reduces accessibility.

This table summarizes categories of transportation land use costs.

Mobility management tends to reduce undesirable land use impacts by reducing motor vehicle ownership and use, reducing the need to expand roads and parking facilities, and supporting smart growth land use policies. Many mobility management programs involve smart growth implementation. In addition to helping to achieve transportation planning objectives, such as reducing accidents and improving mobility for non-drivers, these changes help achieve many land use planning objectives, such as greenspace preservation, urban redevelopment and reduced stormwater management costs.

Land Use Benefits Subcategories

- Greenspace, farmland, and wildlife habitat preservation.
- Preservation of cultural resources (historic sites, traditional communities, etc).
- Redevelopment of existing communities.
- Increased community cohesion (positive interactions among neighbors).
- Reduced costs of providing public services.
- Improved accessibility, reduced transportation costs, improved travel options for non-drivers.
- Reduced stormwater management costs and heat island effects.
- More attractive communities, higher property values.

Mobility management strategies that reduce vehicle travel tend to reduce transport land use impacts and support strategic land use planning objectives. Land use and parking management strategies, which reduce per capita impervious surface area, are particularly effective at supporting these objectives. Improved walking conditions and reduced traffic speeds also tend to be particularly important for achieving land use planning objectives.

Table 14 **Land Use Benefits Effectiveness**

Most Effective	Moderate Effects	Least Effective	Negative Impacts
Smart growth Walking & cycling improvements Transit improvements Congestion pricing Carsharing Traffic speed management Traffic calming Carfree planning Parking management & pricing	Marketing programs Commute trip reduction programs & incentives School and campus transport management Rideshare programs Telework Distance-based fees HOV priority Freight transport management	Flextime Fuel tax increases	*Increases in land use density may increase some costs, particularly unit costs of infrastructure, such as per-mile roadway costs.*

This table identifies how various mobility management strategies support land use planning objectives.

Conventional transport planning considers certain land use planning objectives, such as preserving high value ecological and cultural resources (mitigation is often required during transportation facility construction to minimize negative impacts), and some communities have integrated transport and land use plans which give priority to transportation projects that support strategic land use development objectives, but land use planning objectives are often overlooked when evaluating individual transportation policies and projects. For example, many communities have generous road width and parking requirements, and make it difficult for developers to reduce these requirements in exchange for mobility management and parking management programs, although this supports their land use planning objectives.

Although they are difficult to quantify, these land use impacts are often significant in value (Litman, 2004). Various studies of the costs of sprawl and benefits of smart growth can provide guidance on measuring these impacts (Burchell, et al, 1998). Some impacts can be measured based on economic saving and benefits, such as reduced stormwater management costs, increased public service efficiency, reduced per capita transportation costs, increased agricultural productivity, and increased nearby property values. Some require public surveys to determine the value that residents place on preservation of cultural resources or improved community cohesion. Some impacts require application of other ecological economics methodologies to determine the value of ecological services and resources.

Benefits Summary

Table 15 summarizes various categories of benefits that should be considered when evaluating mobility management. Current transportation planning practices tend to overlook and undervalue many of these benefits.

Table 15 Mobility Management Benefit Summary

Category	Subcategories	Current Planning
Congestion reduction	Reduced road and parking congestion delays, and additional fuel consumption and pollution emissions. Improved walking and cycling conditions. Deferring, reducing or avoiding the need to expand facility capacity to solve congestion.	Receives consideration, but not always considered when comparing road and parking facility expansion with mobility management options.
Roadway cost savings	Roadway construction and maintenance cost savings. Reduced traffic service costs (traffic policing and emergency services).	Roadway construction costs receive consideration. Future maintenance costs receive less consideration.
Parking cost savings	Parking facility construction and maintenance cost savings.	Parking costs receive little consideration in most transport planning analysis.
Consumer savings	Reduced consumer costs, such as vehicle operation and ownership expenses.	Short-term vehicle operating costs considered but mileage-based depreciation and ownership costs are often overlooked.
Transport diversity (mobility options for non-drivers)	Improved mobility and accessibility options, particularly for non-drivers. Reduced chauffeuring requirements by drivers. Support for equity objectives, such as the fair share of resources to non-drivers and affordability.	Some consideration, particularly the provision of walking facilities and basic transit services. Often overlooked when evaluating other types of planning decisions.
Road safety	Reduced per capita traffic crashes.	Although safety receives consideration attention, increased vehicle mileage is not generally considered a risk factor and mileage reductions are not generally considered safety strategies.
Energy conservation	Consumer cost savings. Reduced economic costs of importing petroleum. Reduced environmental costs of producing fuel.	Considered desirable, but not generally considered when evaluating individual projects.
Pollution reduction	Reduced air, water and noise pollution emissions. Improved public health.	Some pollution impacts are considered in major transport planning.
Public health	Increased walking and cycling increases fitness and health.	Considered desirable, but not generally considered when evaluating individual projects.
Efficient land use (smart growth)	Increased accessibility and improved travel options. Reduced public service costs. Reduced stormwater management costs and heat island effects. Openspace and cultural resource preservation. Improved community cohesion.	Certain land use planning objectives are often considered during strategic transport planning, but not generally considered when evaluating individual projects.

Mobility management can provide a variety of economic, social and environmental benefits. Many of these tend to be overlooked in current transport planning.

Special Considerations
Various factors to consider when evaluating mobility management are discussed below.

Overlap
There may be some degree of overlap among mobility management benefits. For example, congestion reduction can help reduce air pollution and increase economic productivity. Double-counting should be avoided to prevent exaggerating total benefits. Impacts should only be counted once if they are quantified and summed.

When calculating net benefits it is important to recognize the difference between true benefits and costs (changes in total resources) and economic transfers (shifts in resources). For example, although road and parking fees are costs from users' perspective, they are revenue (benefits) to businesses or government. The true costs are any incremental costs for collecting and enforcing payments.

Mobility Versus Efficiency Benefits
Mobility management tends to provide both *mobility* and *efficiency* benefits (Litman, 2005). Mobility benefits result when improved transport options allow disadvantaged people to travel more, for example, if improved walking and transit service allow non-drivers better access to education and employment. Efficiency benefits result when incentives cause travelers to shift to a more efficient mode, for example, if HOV priority causes commuters to shift from driving alone to ridesharing or using public transit. Both types of benefits should be considered when evaluating mobility management. This can be confusing, however, because they are measured in different ways: mobility benefits are indicated by *increased personal travel by disadvantaged people*, while efficiency benefits are indicated by *reductions in total motor vehicle travel*.

User Impacts
User impacts are the direct benefits and costs to people who change travel behavior in response to mobility management. For example, a particular mobility management strategy may cause users to shift from driving to a slower mode that takes more time but provides various user benefits, such as reduced stress, financial savings or physical exercise. Under favorable conditions (a comfortable transit ride or bicycle trip), consumers may consider time spent on alternative modes to have lower unit costs than driving, while under unfavorable conditions (an uncomfortable walk or transit ride), travel time unit costs may be higher. If travel shifts are optional, travelers will sort based on their needs and preferences, so those who can or prefer will shift mode, and those who need to or prefer automobile travel will drive. This tends to maximize user benefits.

When people change travel behavior in response to *positive* incentives (such as improved walking conditions or transit services) or financial rewards (such as parking cash out), they must be better off overall, or they would not change. Conversely, when people change behavior in response to *negative* incentives (such as higher motorist fees or vehicle restrictions), they are worse off. *Consumer surplus analysis* can be used to determine net user impacts from price changes and financial incentives (Litman, 2001).

Analysis Scope

The temporal (time) and geographic scope of analysis can significantly affect economic evaluation results. Transportation planning decisions can have durable and indirect impacts, so a broad scope, sometimes called *sustainability planning*, is usually justified. For example, a particular transportation planning decision can affect the quality of travel options (walking, cycling, driving, public transit, etc.), regional land use development patterns, energy consumption and pollution emissions, causing dispersed economic and ecological impacts.

Expanding the analysis scope often affects results. In particular, urban highway capacity expansion tends to provide larger short term benefits which decline over time due to *induced travel* ("Rebound Effects," VTPI, 2006), while transit and HOV priority projects tend to have smaller short-term benefits that increase over time. Similarly, land use reforms usually require decades to achieve their full benefits. As a result, a narrower scope tends to favor automobile-oriented improvements while a broader scope tends to favor mobility management solutions.

Economic Development Impacts

Economic development refers to progress toward a community's economic goals, including productivity, employment, incomes, community redevelopment, property values, and tax revenues. Mobility management supports economic development in various ways, reducing transportation costs, improving education and employment access, reducing community expenditures on imported resources (particularly vehicle fuel), and supporting specific industries such as tourism. Many of these are indirect effects of other mobility management benefits, such as congestion reduction, energy conservation and smart growth land use.

Economic Development Benefits Subcategories

- Increased economic productivity (employment, incomes, business activity and tax revenue).
- Community redevelopment.
- Increased property values.

Conventional transport planning tends to consider some economic development benefits, such as industrial expansion, but overlooks others, such as the regional employment impacts of consumer transportation expenditures. Some of these benefits can be monetized using standard economic evaluation tools such as input/output tables and property value studies. Many communities have economic development objectives which can be referenced when evaluating these benefits.

Quantifying Travel Impacts

Mobility management benefits depend on the travel impacts that result, as summarized in Table 16. For example, strategies that reduce peak-period trips reduce traffic congestion, and strategies that reduce vehicle trips reduce parking costs. Benefits may vary depending on circumstances. For example, shifts from *automobile* to *walk-transit* provide parking cost savings, but shifts from *automobile* to *auto-transit* only reduce parking costs if park-and-ride parking is cheaper to provide than parking at the trip destination.

Table 16 **Benefits Provided By Various Types of Travel Changes**

Planning Objective	Reduced Veh. Ownership	Reduced Veh. Trips	Shift Mode	Shorter Trips	Shift Trip Time	Reduced Traffic Speeds
Congestion reduction	✓	✓	✓	✓	✓	
Roadway cost savings	✓	✓	✓	✓	✓	
Parking cost savings	✓	✓	✓			
Consumer cost savings	✓	✓	✓	✓		
Transport diversity	✓	✓	✓		✓	
Improved traffic safety	✓	✓	✓	✓		✓
Energy conservation	✓	✓	✓	✓	✓	✓
Reduced pollution	✓	✓	✓	✓	✓	✓
Efficient land use	✓	✓	✓	✓		✓
Improved fitness & health	✓	✓	✓	✓		✓

✓ = helps achieve that objective.

Table 19 summarized the typical travel impacts of various types of mobility management strategies. This can help identify the categories of benefits they provide.

Table 19 **Travel Impacts of Common TDM Strategies**

Strategy	Travel Impact
Increased automobile user charges (fuel, VMT and parking charges).	Reduced automobile use, including reduced total travel and shifts to other modes.
Congestion pricing.	Reduces vehicle travel on congested roads, including changes in travel times, routes, and modes, and reductions in total travel.
Transit service improvements and promotion.	Increased bus use, mode shifts from automobile, improved service for existing transit users, increased travel by non-drivers.
Rideshare matching and promotion.	Increase vehicle occupancy, reduced automobile use.
Pedestrian and bicycle facility improvements and promotion.	Increased walking and bicycling, mode shifts from automobile.
Flextime promotion.	Automobile trips shifted from peak to off-peak.
Telecommuting promotion.	Reduced commute travel. Some increases in other types of travel.
Transportation-efficient land use.	Reduced vehicle trips and trip lengths.
Comprehensive TDM programs.	Various combinations of reduced travel, mode shifts, and changes in travel time.

This table describes the travel impacts of common mobility management strategies.

Conventional traffic models models tend to be insensitive to many mobility management strategies, such as improvements in transit comfort and convenience, improved walking and cycling conditions, marketing programs, and changes in land use development patterns, and they often incorporate various biases favoring automobile transportation. The travel surveys they are based on tend to ignore or undercount nonmotorized travel and so undervalue nonmotorized transportation improvements for achieving transportation planning objectives (Stopher and Greaves, 2007). Most conventional traffic models do not accurately account for the tendency of traffic to achieve equilibrium (congestion causes travelers to shift when, how and where they travel) and the effects of *generated traffic* that results from roadway capacity expansion.,They tend to exaggerate the congestion problems that result if roadway capacity is not expanded and the benefits that result if roadway capacity is expanded. These models are not sensitive to the impacts many types of TDM strategies have on trip generation and traffic problems, and so undervalue TDM benefits.

Some models are particularly appropriate for evaluating mobility management strategies, such as the *TRIMMS* (Trip Reduction Impacts of Mobility Management Strategies) *Model* (www.nctr.usf.edu/abstracts/abs77704.htm), the *CUTR_AVR Model* (www.cutr.usf.edu/tdm/download.htm), the *Business Benefits Calculator* (BBC) (www.commuterchoice.gov) and the *Commuter Choice Decision Support Tool* (www.ops.fhwa.dot.gov/PrimerDSS/index.htm). DKS Associates (2003) illustrates an example of impact analysis on a specific corridor.

The travel impacts of a mobility management program can be predicted by extrapolating results from other similar programs (often referred to as *comps*). For example, the travel impacts and expected benefits of a commute trip reduction program can be predicted based on the mode shifts achieved at other worksites with similar geographic conditions, demographics, and management programs.

Monetizing Benefits

It is often helpful to *monetize* (measure in monetary units) nonmarket impacts so they can be incorporated into standard economic evaluation and compared with market impacts. Economists have long monetized impacts such as travel time and accident damages for evaluating transportation projects, and in recent years have developed techniques for monetizing many social and environmental impacts (Delucchi, 1998; Litman, 2006).

Mobility management economic analysis often deals with cost differences (the difference in cost between different types of travel, such as driving and public transit travel) per unit of travel. For example, the net benefit of a transit service improvement depends on the number of automobile trips reduced per transit vehicle trip. Table 16 illustrates monetized estimates of net benefits for six mobility management strategies under urban-peak conditions. It indicates that a trip shifted from urban peak to urban off-peak provides benefits averaging about 25¢ per mile, a shift from driving to bus transit provides benefits of 66¢ per mile, and shifting to cycling provides benefits averaging 77¢ per mile.

Table 16 **Monetized Benefits - 1996 U.S. Cents per Mile** (Litman, 2006)

Impact Category	Off-Peak Shift	Rideshare	Bus Transit	Bicycle	Walk	Tele-commute
Vehicle Ownership	$0.00	$0.21	$0.21	$0.16	$0.21	$0.01
Vehicle Operating	$0.02	$0.14	($0.00)	$0.13	$0.11	$0.15
Operating Subsidies	$0.00	$0.00	($0.13)	$0.00	$0.00	$0.00
Travel Time	$0.06	$0.05	($0.05)	($0.12)	($0.77)	$0.23
Internal Accident	$0.00	$0.00	$0.05	$0.00	$0.00	$0.05
External Accident	$0.00	$0.04	$0.03	$0.03	$0.03	$0.04
Internal Parking	$0.00	$0.05	$0.05	$0.05	$0.05	$0.05
External Parking	$0.00	$0.12	$0.12	$0.11	$0.12	$0.12
Congestion	$0.15	$0.17	$0.16	$0.16	$0.17	$0.17
Roadway Facilities	$0.00	$0.02	$0.01	$0.02	$0.02	$0.02
Roadway Land Value	$0.00	$0.02	$0.02	$0.02	$0.02	$0.02
Municipal Services	$0.00	$0.02	$0.01	$0.01	$0.01	$0.01
Equity & Option Value	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01
Air Pollution	$0.01	$0.06	$0.06	$0.06	$0.06	$0.06
Noise	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01
Resource Consumption	$0.00	$0.03	$0.02	$0.03	$0.03	$0.03
Barrier Effect	$0.01	$0.02	$0.01	$0.01	$0.02	$0.02
Land Use Impacts	$0.00	$0.07	$0.07	$0.07	$0.07	$0.00
Water Pollution	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01
Waste Disposal	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Totals	*$0.25*	*$1.03*	*$0.66*	*$0.77*	*$0.18*	*$0.99*

This table shows estimated monetized benefits under urban peak conditions.

These represent generic cost values. Such values should be adjusted to reflect specific conditions and perspectives. For example, if parking costs are particularly high at a particular worksite the benefits of reduced automobile travel would also be higher.

Values can also be adjusted to better reflect user impacts. For example, conventional analysis often assumes that mode shifts increase travel time costs, which is appropriate if such alternatives really are slower and shifts results from negative incentives, such as higher vehicle user fees or driving restrictions. However, alternative modes are sometimes as fast as driving, and people sometimes prefer to spend time walking, cycling or riding public transit rather than driving (that is, they have lower unit travel time costs). Travel shifted from driving to alternative modes in response to positive incentives (parking cash out or improved cycling facilities) must benefit users overall, even if travel times increase, further increasing mode shift benefits.

The "rule of half" (described on the next page) can help evaluate consumer welfare impacts of price changes. This states that the consumer surplus impacts of travel behavior resulting from a price change are worth, on average, half the price change. For example, if a $2 daily parking fee increase induces 1,000 trips to shift from driving to transit, the consumer surplus *loss* is $2 x 1,000 x ½ = $1,000 per day. Similarly, if a $2 per day transit subsidy has the same travel effect, the consumer surplus *gain* is worth $1,000 per day. It is more difficult to quantify the consumer surplus impacts of a TDM program which includes various positive and negative incentives (such as increased parking fees, parking cash out, a rideshare program and bicycle facility improvements), but in general, the more positive incentives provided, the more likely participants benefit directly from their travel changes.

Table 17 summarizes external mode shift benefits. A community should be willing to spend up to this amount on average to reduce travel demand, given "typical" costs.

Table 17 **External Benefits - 1996 U.S. Cents per Mile** (Litman, 2006)

	Off-Peak Shift	Rideshare	Diesel Bus	Bicycle	Walk	Tele-Commute
Operating Subsidies	$0.00	$0.00	($0.13)	$0.00	$0.00	$0.00
External Accident	$0.00	$0.04	$0.03	$0.03	$0.03	$0.04
External Parking	$0.00	$0.12	$0.12	$0.11	$0.12	$0.12
Congestion	$0.15	$0.17	$0.16	$0.16	$0.17	$0.17
Road Facilities	$0.00	$0.02	$0.01	$0.02	$0.02	$0.02
Roadway Land Value	$0.00	$0.02	$0.02	$0.02	$0.02	$0.02
Municipal Services	$0.00	$0.02	$0.01	$0.01	$0.01	$0.01
Equity & Option Value	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01
Air Pollution	$0.01	$0.06	$0.06	$0.06	$0.06	$0.06
Noise	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01
Resource Consumption	$0.00	$0.03	$0.02	$0.03	$0.03	$0.03
Barrier Effect	$0.01	$0.02	$0.01	$0.01	$0.02	$0.02
Land Use Impacts	$0.00	$0.07	$0.07	$0.07	$0.07	$0.00
Water Pollution	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01
Waste Disposal	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Totals	*$0.17*	*$0.60*	*$0.41*	*$0.55*	*$0.58*	*$0.52*

This table shows estimated external monetized benefits (i.e. benefits to somebody other than the user) of six types of mode shifts under urban peak conditions.

Explanation of the "Rule of Half"
Economic theory suggests that the net change in consumer value from a price change that reduces vehicle travel equals half the monetary change (called the *rule of half*). This takes into account the trade-offs consumers make between factors such as money, time, convenience and mobility.

Assume a 10¢-per-vehicle-mile price change (such as parking or road pricing, or pay-as-you-drive insurance) causes you to drive 1,000 fewer annual miles. You would not give up highly valuable vehicle travel, but there are probably some vehicle-miles that you can reduce by shifting modes, choosing closer destinations, or because a trip itself is not very important. The mileage foregone has incremental value to you, the consumer, between 0¢ and 10¢. If you consider the additional mile worth less than 0¢ (i.e., it has no value), you would not have taken it in the first place. If it is worth 1-9¢ per mile, a 10¢ per mile incentive will convince you to give it up – you'd rather save the money. If the additional mile is worth more than 10¢ per mile, a 10¢ per mile incentive is inadequate to convenience you to give it up – you'll keep driving. Of the 1,000 miles foregone, we can assume the average user value (called *consumer surplus*) is the mid-point of this range, that is, 5¢ per vehicle mile. Thus, we can calculate that miles foregone by a 10¢ per mile financial incentive have average consumer surplus value of 5¢. If motorists drive 1,000 fewer vehicle miles due to higher fees the *net consumer cost* of $50, while a $100 financial reward that convinces motorists to drive 1,000 miles less provides a *net consumer benefit* of $50.

In general, the most effective mobility management programs integrate both positive incentives (such as walking, cycling, rideshare and public transit improvements)) and disincentives (road and parking pricing, traffic calming, etc.). Since individuals have diverse and variable travel needs, more comprehensive and flexible programs tend to be most effective. For example, employer subsidized transit passes will probably reduce automobile travel less than commuter benefits that also reward walking, cycling and ridesharing. Since commuting represents only about 25% of all trips, incentives that also affect other trips are more effective. Programs that rely only on persuasion tend to become less effective over time as participants' enthusiasm declines, but programs that offer financial incentives tend to become more effective over time as they affect long term decisions, such as housing and employment locations.

The following guidelines can be used for evaluating the consumer costs of specific mobility management policies and programs:

1. Strategies that are optional to consumers and rely on positive incentives (such as improvements in alternative modes and positive financial incentives such as Parking Cash Out) that directly benefit consumers, or they would not accept them. Any travel reduction therefore represents increased consumer surplus.
2. To the degree that consumers have a variety of transport options to choose from and are able to decide which travel to shift or forego, they will reduce the least beneficial vehicle travel, resulting in small reductions in consumer surplus.
3. Road and parking pricing are economic transfers (money shifted). Their overall impacts depend on how revenues are used. For example, road pricing costs may be offset by reductions in taxes or public service improvements financed by the additional revenue.

Program Evaluation

Whenever possible, mobility management should include evaluation programs in order to determine actual travel impacts and benefits. A typical evaluation program includes collection of statistics on program costs, participation and travel impacts, and participant surveys. Evaluation activities should continue for several years to determine long-term impacts. Finke and Schreffler (2004) describe the following levels of assessment:

1. *Awareness.* Measuring the target audiences' (residents, business leaders, public officials, etc.) overall awareness of mobility management strategies and programs.
2. *Attitudes.* The degree to which the target audience supports mobility management strategies and programs.
3. *Participation.* The amount that the target audience participates in mobility management programs, such as applying for ridematching services or purchasing discounted transit passes.
4. *Satisfaction.* The degree to which the target audience is satisfied with mobility management strategies and programs, particularly those that they have used.
5. *Utilization.* The degree to which the target audience has changed their travel patterns in response to mobility management strategies and programs.
6. *Impacts.* The degree to which mobility management changes overall vehicle traffic, traffic congestion, road and parking costs, traffic accidents, etc., compared with what would have occurred otherwise.

Mobility management evaluation often involves comparing different modes, such as:

- The ratio of automobile and transit travel time for various trips.
- The ratio of automobile operating costs and transit fares for various trips.
- The difference is Level of Service ratings for various modes.
- The relative attractiveness of automobile dependent and transit-oriented locations.
- The perceived comfort and convenience of various modes.

For most of the last half-century, automobile travel speeds, affordability and comfort have improved relative to transit travel, in part due to public policies such as transportation investment practices that favored highway expansion over transit service improvements, generous minimum parking requirements in zoning codes, low fuel taxes, minimal investment in new transit equipment, and little effort to improve nonmotorized travel conditions. Mobility management includes various strategies that make alternative modes relatively more attractive. Comparisions between modes can help prioritize strategies for achieving mobility management objectives. For example, if commuters are shifting from transit to automobile travel on a particular area, it may be useful to compare automobile and transit travel times, financial costs and comfort factors, in order to identify which of these factors is most responsible, and may be most suitable for change. It may turn out that fare discounts are most effective in some circumstances, while speed improvements are most important in others.

Care is needed when calculating the cumulative impacts of multiple strategies. Some factors overlap. For example, commute trip reduction programs often include guaranteed ride home services and parking cash out. It would be wrong to add these strategies together. When evaluating the impacts of factors that overlap, use professional judgment to determine how much of each to apply.

Total impacts are multiplicative not additive, because each additional factor applies to a smaller base. For example, if one strategy reduces trips by 20%, and a second strategy reduces trips an additional 15%, their combined effect is calculated 80% x 85% = 68%, a 32-point reduction, rather than adding 20% + 15% = 35%. This occurs because the 15% reduction applies to a base that is already reduced 20%. If a third strategy reduces demand by another 10%, the total reduction provided by the three factors together is 38.8% (calculated as (100% - [80% x 85% x 90%]) = (100% - 61.2%) = 38.8%), not 45% (20% + 15% + 10%).

However, some strategies have synergistic effects (total impacts are greater than the sum of their individual impacts). For example, by itself, providing rideshare matching may reduce trips to a particular location by just 5%, and by itself a parking fee may reduce trips by just 10%, but together they may reduce demand by 20% because they provide complementary incentives to change.

Examples

The four examples described below demonstrate how mobility management program benefits can be evaluated using different perspectives and methods.

1. Community Benefit Perspective

Consider the evaluation of a program that shifts 50 typical commuters from driving to public transit. Start by surveying participants to determine the average number of days shifted, which may be a high as 200 commute days a year. If the average round-trip commute is 24 miles, the program might shift 240,000 (50 employees x 200 days x 24 miles) total peak period miles per year from driving to transit. Table 20 shows estimated benefits from reductions in ten costs. This indicates average daily savings to society of $11.16 per commute day (46.5¢ x 24 miles), and total savings of $111,600 per year.

Table 20 **Benefits of SOV to Transit Mode Shift (Cents Passenger Mile)**

Cost	SOV Cost	Transit Cost	Savings
Accidents	3.5¢	0.8¢	2.7¢
Parking	12¢	0	12¢
Congestion	17¢	1.4¢	15.6¢
Roadway Facilities	1.6¢	0.3¢	1.3¢
Roadway Land	2.4¢	0.1¢	2.3¢
Municipal Services	1.5¢	0.1¢	1.4¢
Air Pollution	8.2¢	1.5¢	6.7¢
Noise	1.0¢	0.2¢	0.8¢
Resource Consumption	2.9¢	0.4¢	2.5¢
Water Pollution	1.3¢	0.1¢	1.2¢
Total Savings per Passenger Mile			*46.5¢*

This example calculates savings for a shift from driving to bus transit.

A survey indicates that 25% of participants drive alone to transit stops (park-and-ride), 25% are driven (kiss-and-ride), 25% bicycle, and 25% walk. Table 10 summarizes the external costs of these access trips, assuming that a typical park-and-ride trip imposes external costs averaging $2.50, kiss-and-ride trips cost society an average of $1.25, and bicycling and walking each cost society an average of $0.50 per trip. Access trip costs should be subtracted from calculated savings, for a total community benefit of almost $88,000 ($111,600 - $23,625 = $87,975). If the program increases travel choices or service quality for existing transit users, these represent additional benefits.

Table 21 **Community Costs for Transit Access Trips**

Access Mode	Cost Per Trip	Trips Per Year	Total Access Trip Costs
Park-and-Ride	$2.50	5,000	$12,500
Kiss-and-Ride	$1.25	5,000	$6,125
Bicycle	$0.50	5,000	$2,500
Walk	$0.50	5,000	$2,500
Total of All Access Trips			*$23,625*

2. TDM Program Benefits Analysis

A study by Winters, et al. (2007) evaluates commute trip reduction (CTR) program impacts on transportation system performance in the Puget Sound region.

The Washington State Department of Transportation (WSDOT) maintains comprehensive databases of CTR plans and employee travel characteristics. The CTR programs include various bicycle, carpool, vanpool and transit incentives. These databases were used to calculate the impacts of these programs on vehicle traffic in the Seattle downtown area. WSDOT compared two scenarios: Scenario A “With TDM” represented existing traffic conditions on the network with current CTR programs, and Scenario B “Without TDM” represented traffic conditions after trips reduced because of CTR programs added onto the network, i.e., as though CTR did not exist in the study area. The comparison used a microscopic simulation model, CORSIM, to evaluate the impacts of CTR programs on roadway traffic. WSDOT conducted the analysis for the duration of the peak periods defined for this study from 5:30 AM to 10:15 AM for AM peak and from 3:00 PM to 7:45 for PM peak.

WSDOT estimated the cumulative delay reduction to be 152,489 and 169,486 vehicle-minutes for the AM and PM periods respectively due to programs in the analyzed corridor . The CTR programs caused a total reduction of 102 lane-miles of spatial congestion in the AM peak period and 143 lane-miles in the PM peak period. the study reported a significant total reduction in travel time of 60 and 45 minutes for the AM and PM peak periods respectively. The average speed increased up to 19 mph for the AM and up to 11 mph for the PM peak period. The cumulative VMT reductions ranged from 17,297 vehicle-miles in the AM to 14,511 vehicle-miles in the PM peak period. Fuel savings for all travelers, not just those using non-single occupant vehicles, were estimated (passive) to be 3,489 gallons during the AM peak period and 4,314 gallons during the PM periods. The total estimated peak hour emission reductions due to improved traffic flow were 16.4 and 21.7 kilograms of hydrocarbon (HC) emissions and 1,109 and 1,545 kilograms of carbon monoxide (CO) emissions for the AM and PM peak periods, respectively. These results indicate that the CTR programs provide significant benefits, including reduced traffic delay, reduced spatial and temporal extent of congestion, reduced emissions and fuel savings.

These results do not encompass all the impacts. The analysis was limited to an 8.6-mile corridor and the study only takes into account the impact of 189 CTR employers in the region. However, there might be more worksites with CTR programs. Therefore, CTR programs might provide even greater regional benefits. In many areas of the study corridor and/or times of day, mobility management made a significant impact on congestion, but TDM, like every other transportation solution, will not eliminate delay for every congested segment or time period. Sensitivity analysis indicates that even a small reduction (4%) in vehicle trips could provide significant benefits.

3. Oil-Smart Commute Performance Test Example

The Bullitt Foundation's Oil-Smart campaign encourages use of alternative travel modes. Thousands of Puget Sound area residents participate each year. During four days in March, 1994, a sample of the total Oil-Smart participants recorded their travel. The foundation surveyed a total of 62 trips, about half of which consisted of two links, such as walking to a transit stop, and analysed a total of 92 links. Table 23 summarizes the distances, times, costs, and savings for one day's trips.

Table 23 **Capitol Hill to Pioneer Square Trip Summary** (Urban Peak Costs)

	Mode	Dist-ance	Travel Time	Internal Cost	External Cost	Total Cost	Savings Over SOV
		miles	minutes	per trip	per trip	per trip	per day
1	Walk	2.2	41	$2.76	$0.01	$2.77	$4.58
2	Bike	2.75	10	$0.96	$0.06	$1.02	$8.07
3	Bike	3.5	16	$1.43	$0.08	$1.51	$7.10
4	Van Pool Driver	2.7	18	$2.99	$0.28	$3.27	$3.57
5	Van Pool Passenger	2.7	18	$1.95	$0.29	$2.24	$5.63
6	Van Pool Passenger, Walk	2.8	24	$2.30	$0.29	$2.58	$6.01
7	Van Pool Passenger, Walk	2.8	24	$2.30	$0.29	$2.58	$6.01
8	Van Pool Passenger, Walk	2.8	24	$2.30	$0.29	$2.58	$6.01
9	Van Pool Passenger, Walk	2.8	24	$2.30	$0.29	$2.58	$6.01
10	Bus Rider, Walk	3.2	35	$3.92	$0.96	$4.88	$0.35
11	Bus Rider, Walk	2.5	30	$3.65	$0.85	$4.50	$1.12
12	Car Pool Driver	3.4	15	$2.81	$0.61	$3.42	$3.28
13	Car Pool Passenger, Walk	3.3	20	$2.19	$0.62	$2.81	$4.49
14	Car Pool Passenger, Walk	3.3	20	$2.19	$0.62	$2.81	$4.49
15	SOV Driver	3.4	10	$3.00	$2.06	$5.06	$0.00
	Totals	*44.15*	*329*	*$37.05*	*$7.56*	*$44.61*	*$66.72*

One test involved short (less than 1-mile each way) Saturday afternoon shopping trips. Short urban automobile trips are relatively inefficient due to cold starts and high parking costs. The study used Urban Peak cost values since traffic congestion is a problem at that time, and doubled automobile user costs, parking subsidies, and environmental impacts to reflect higher costs per mile for such short trips.

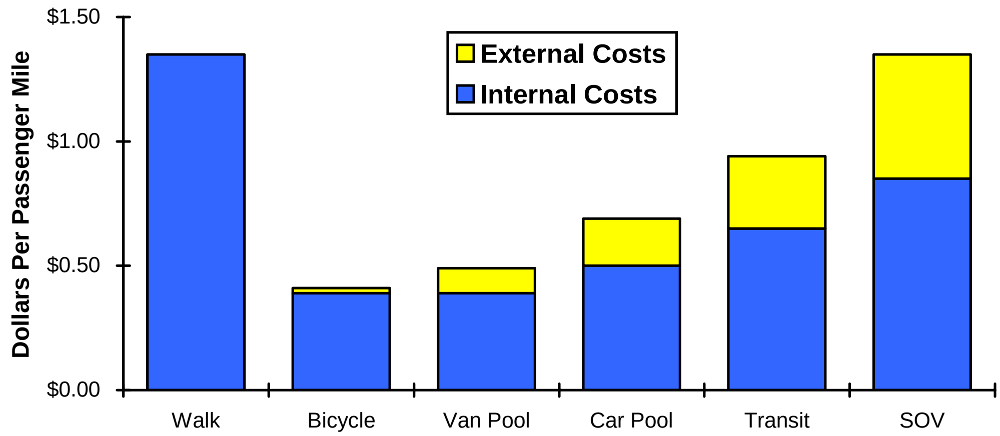
Table 24 summarizes trip statistics. SOV drivers impose about 37% of their costs on society, averaging $0.62 per mile for the trips in this study. The large portion of external costs incurred by SOV drivers indicates that this mode is highly subsidized. This is more than double the external costs of transit, van and car pooling, and many times higher than bicycling or walking. Bicycling and walking impose minimal external costs. Walking has the second highest total cost per passenger mile (after driving alone) due to travel time costs. However, as described earlier, this is based on average values of time which may not apply when users are able to decide which trips they will shift to alternative modes.

Table 24 **Summary Statistics for 93 Oil Smart Test Trip Links**

	Totals	Walk	Bicycle	Van Pool	Car Pool	Public Transit	SOV
Number of Trips	93	20	7	31	8	6	21
Total miles	489.9	14.4	45	269.1	52.9	40.2	68.3
Internal Costs	$256.43	$19.44	$17.47	$104.49	$26.55	$26.15	$58.20
Internal Costs Per Pass. Mile		$1.35	$0.39	$0.39	$0.50	$0.65	$0.85
External Costs	$101.59	$0.05	$0.99	$31.56	$13.57	$12.19	$41.91
External Costs per Pass. Mile		$0.00	$0.02	$0.12	$0.26	$0.30	$0.61
Total Costs	$358.01	$19.49	$18.46	$136.05	$40.12	$38.34	$100.11
Total Costs per Pass. Mile		$1.35	$0.41	$0.51	$0.76	$0.95	$1.47

Figure 1 shows the average cost per passenger mile for each of the 6 modes, and the distribution of these costs.

Figure 1 **Cost Per Mile by Mode, Indicating Internal and External Costs**



This graph illustrates the estimated magnitude of costs per mode, and the distribution of costs between internal and external impacts.

Commute Performance Test Highlights:

- Total estimated savings by the 55 non-drivers was $477 compared with the same trips made by solo driving. This averages $8.67 daily savings per person.
- The external costs of the 55 non-drivers averaged only about 25% of a solo driver. External cost savings totaled $176 compared with the same trips made by SOV.
- The greatest savings per trip resulted from van pool riders who did not drive to their van pool stop. Total costs of van pool, car pool, and transit trips were sensitive to how the traveler got to their transit stop or rideshare meeting place.
- The greatest savings per mile resulted from bicyclists, since they had low operating and external costs but travel faster than pedestrians. The costs of bicycle and pedestrian trips are extremely sensitive to the time value assigned to travel.

4. *Least Cost Transportation Planning Example*

Least Cost Planning (also called *Integrated Planning*) refers to planning that:

- Considers supply and demand investments on an equal basis.
- Uses a standard measurement of costs and benefits for evaluating investments.
- Incorporates all costs, including environmental and social costs as much as possible.

Least Cost transportation planning allows mobility management programs to be compared equally with roadway capacity expansion. As an example, consider a transport problem facing Olympia, Washington. Travel between the city's downtown and its Westside neighborhood was limited by the capacity of a bridge. A $10 million widening project was proposed to increase bridge capacity by 1,200 vehicles per peak-hour, or 1,248,000 additional annual trips. The project's annualized cost was $1,018,522, or $0.81 per additional peak period vehicle trip. The project would have the following travel impacts:

1. Shorten some trips by allowing more direct routes. Although shorter trips usually reduce external costs, downtown Olympia is very sensitive to traffic impacts (congestion, noise, barrier effect, etc.) so this is unlikely to provide overall savings.
2. Encourage some longer trips which increase external costs.
3. Generate some new trips. This increases external costs, especially due to downtown Olympia's sensitivity to increased traffic.
4. Shift trips to peak periods. This increases costs, including congestion on other roads.

The external costs of the generated traffic can be calculated, assuming the additional trips are divided equally among the four effects described above, as summarized in Table 25. The annualized costs of bridge widening include the $1,018,522 in direct construction costs, plus $2,982,720 in external costs, totaling over $4 million per year, $3.20 per additional trip, or more than $7.40 per additional round trip commute. A mobility management option should be chosen if it can reduce traffic congestion on the corridor for less than $4 million. Various mobility management programs could be evaluated and the most cost effective options implemented until a goal (such as 1,200 peak hour trips reduced) or budget constraint is reached.

Table 25 External Traffic Cost Impacts from Increased Bridge Capacity

Effect	Mileage Change	External Cost Per Mile	Additional External Cost
1. Average trip length reduced by 4 miles.	-1,248,000	None	$0
2. Average trip length increase by 4 miles.	1,248,000	$0.61	$761,280
3. Generated trips, average 8 miles.	2,496,000	$0.61	$1,522,560
4. Shift from off-peak	2,496,000	$0.28	$698,880
Totals	*4,992,000*		*$2,982,720*

Increasing road capacity increases total motor vehicle use. The additional external costs should be considered when evaluating transportation investments.

Criticisms

This section examines various criticisms of mobility management. For more discussion see "Evaluating TDM Criticism," in VTPI, 2006.

Critics sometimes claim that mobility management has been tried but failed, with statements such as, "Despite huge expenditures on HOV lanes, buses and other transportation alternatives, transit's market share and carpooling have declined." (GPPF, 2005). However, such criticism is often misplaced for the following reasons:

- In most communities only a small portion of trips are directly influenced by specific strategies, such as commute trip reduction programs and HOV lanes. However, there are often significant travel changes by affected trips. For example, many HOV lanes carry far more peak-period travelers than general purpose lanes, and many of the passengers who ride new transit routes would otherwise drive alone. The relatively small total impacts reflect the low level of implementation.
- Critics generally only consider one or two mobility management strategies. Comprehensive programs that include a combination of appropriate incentives (such as parking pricing or cash out) and improved travel options (such as significantly improved ridesharing and transit services) often have significant impacts.
- Critics often misrepresent impacts, costs and benefits. For example, when critics claim that HOV facilities are underperforming they often use daily average rather than peak-period vehicle traffic counts. When they claim that transit trips are more costly than automobile trips, they are generally only considering a limited set of costs (such as just roadway costs, ignoring parking costs, vehicle costs and external costs such as congestion, accident risk and pollution emissions imposed on others), and ignore the large portion of transit costs that are justified by equity objectives (such as providing basic mobility during off-peak times and lower-density areas, and providing extra services such as wheelchair lifts). When all impacts are considered, a combination of incentives and investments in alternative modes often turn out to be the most cost effective way to address transportation problems and improve transportation in an area.

Critics sometimes assume that any reduction in vehicle travel harms consumers. However, many mobility management strategies involve positive incentives, such as improved transport options or financial rewards to reduce vehicle travel, as summarized in Table 26. Consumers only reduce mileage if they consider themselves better off overall. Even strategies that involve negative incentives, such as increased road and parking fees, benefit most consumers overall, because reductions in vehicle travel are offset by improved transport and land use options (for example, road pricing reduces bus and carpool congestion delays) and provides revenues. Only after all of these factors are considered is it possible to determine whether an individual is worse off overall.

Case studies in worksites that implement commute trip reduction programs, and cities that implement transit improvements and road pricing indicate that public support tends to increase for these strategies after they are implemented, indicating that most consumers consider themselves better off overall ("Success Stories," VTPI, 2006)

Table 26 **Direct Consumer Impacts**

Positive Incentives	Mixed	Negative Incentives
Alternative work schedules	Access Management	Fuel tax increases
Parking cash out	Carfree Planning	Parking pricing
Security improvements	Comprehensive market reforms	Road pricing
New Urbanism	HOV priority	Vehicle use restrictions
Park & Ride facilities	Parking management	
Pay-As-You-Drive pricing	Smart growth	
Ridesharing	Traffic calming	
Telework		
Transit Improvements		
Walking and cycling improvements		

Most mobility management strategies provide positive incentives: they improve transport options or reward reduced driving. Motorists who continue their current travel patterns are no worse off, and those who reduce their mileage must be directly better off or they will not change their travel patterns. In addition, most consumers benefit from reduced traffic congestion, accidents, and pollution emissions, road and parking cost savings, and additional pricing revenues.

Critics sometimes argue that mobility management is an unjustified market intervention that reduces economic efficiency. This assumes that current markets are optimal, but existing transport and land use markets are distorted in various ways that result in economically excessive vehicle travel. Many mobility management strategies correct these distortions, increasing overall economic efficiency (Litman, 2007).

Critics sometimes claim that mobility management is unfair and regressive because some strategies (such as road and parking pricing) increase driving costs. However, the current transport system is unfair and regressive because it reduces accessibility options for non-drivers and financially burdens lower-income households. Many mobility management strategies improve accessibility options directly (for example, improving walk and cycling conditions, ridesharing and public transit services, and affordable housing locations), and indirectly by increasing public support for alternative modes (for example, by increasing ridesharing and transit demand among middle-class people, leading to more frequent service and higher social status for users). Some mobility management strategies provide financial benefits such as parking cash out.

The overall equity and regressivity of pricing strategies also depends on how revenues are used. If revenues are used to improve transportation services for disadvantaged populations or to reduce other taxes and fees, they can be progressive overall. It is therefore wrong to assume that travel reduction strategies are necessarily inequitable. Mobility management programs can be designed to support equity objectives.

This is not to suggest that mobility management is always optimal, but it does indicate that mobility management is often cost effective and justified, particularly if implemented as an integrated program based on efficient market and planning principles, designed to maximize benefits and address planning objectives (“Win-Win Solutions,” VTPI, 2006).

Conclusions

Mobility Management (also called *Transportation Demand Management*) consists of various policies and programs that increase transport system efficiency, by improving travel options, providing incentives to change travel behavior, and increasing land use accessibility. Mobility management can provide various benefits, including:

Congestion reduction	Improved transport diversity	Pollution reductions
Road and parking cost savings	Improved traffic safety	Efficient land use
Consumer cost savings	Energy conservation	Improved fitness & health

Conventional transport project evaluation models were designed primiarly to evaluate roadway investments. They undervalue many impacts (costs and benefits) caused by changes in total vehicle mileage and mode shifts. Such models tend to undervalue mobility management and exaggerate the benefits of automobile-oriented solutions, such as roadway capacity expansion and alternative fuels.

This guide describes more comprehensive ways to evaluate mobility management benefits. It describes ways of predicting how specific strategies affect travel behaviour, and the economic, social and environmental impacts that result. It defines various categories of benefits, describes how they can be quantified and monetized, discusses the degree they are considered in current transport planning, and identifies the mobility management strategies most effective at achieving specific planning objectives.

Several trends increase the value of mobility management, including increasing congestion, rising fuel costs to individuals and society, aging population, growing concern over sedentary living, and consumer preferences for more urban living and travel options. Older policies and planning practices that favor automobile-oriented transport and undervalue alternatives are increasingly outdated and inappropriate.

Mobility management tends to be particularly effective at solving some of the most difficult transport problems facing society, such as urban traffic congestion, inadequate mobility for non-drivers, and excessive energy consumption. These strategies tend to be particularly suitable under urban peak conditions, where there is adequate demand for alternative modes and the cost of accommodating more vehicle traffic is particularly high.

Many mobility management strategies reflect market principles such as efficient pricing and consumer sovereignty, and so tend to increase overall economic efficiency and equity. Critics sometimes argue that mobility management has been tried but failed, or that its costs exceed its benefits, but their analysis tends to overlook many mobility management benefits and the full costs of alternative solutions that increase total vehicle travel. When all impacts are considered, mobility management strategies often turn out to be the most cost effective and beneficial way to improve transportation.

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