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Comprehensive Transport Planning Framework

Best Practices for Evaluating All Options and Impacts

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Abstract

Efficient and equitable planning requires comprehensive evaluation of impacts and options. This report describes principles for comprehensive transportation planning, evaluates conventional transport planning practices with regard to these principles, identifies common planning distortions, recommends practical methods for correcting these distortions and improving transport decision-making, and discusses the likely impacts of these reforms. Conventional planning tends to favor mobility over accessibility and automobile transport over other modes. More comprehensive planning is particularly important for evaluating alternative modes and mobility management strategies.

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Preface – Expanding Our Vision

Humans have five senses: sight, sound, touch, smell, and taste. We often take them for granted, and seldom consider how they affect our understanding of the world. Yet, our perception of an object is affected by whether we see it during the day or night, whether or not we can touch it, and our ability to smell or taste it. Much of human progress results from technologies that expand our senses, including microscopes, telescopes, sound recording, cameras, x-ray machines, and radar. Just as these tools allow scientists to more accurately evaluate physical conditions, better economic evaluation tools can help decision-makers more accurately evaluate resources and activities.

This report describes comprehensive evaluation techniques that improve our ability to understand transport planning decision impacts. This can expand and augment existing planning practices just as microscopes, telescopes, cameras and audio recording systems add to our natural senses.

Executive Summary

Conventional transport planning tends to focus on a limited set of *evaluation criteria* (the factors considered in the planning process). For example, conventional transport project evaluation models consider facility costs, travel speeds, vehicle operating costs and distance-based crash risk. Other impacts tend to receive less consideration, as indicated in Table ES1. Some of these omissions reflect impacts that are difficult to quantify, such as social equity and indirect environmental impacts, but others are ignored simply out of tradition (parking costs, long-term vehicle costs, construction delays). These omissions tend to favor mobility over accessibility, and automobile travel over other modes.

Table ES1 **Scope of Conventional Planning Analysis**

Usually Considered	Often Overlooked
	Downstream congestion impacts
	Traffic impacts on non-motorized travel
	Parking costs
	Vehicle ownership and mileage-based depreciation
Financial costs to governments	Indirect environmental impacts
Travel speed (reduced congestion delays)	Strategic land use impacts
Vehicle operating costs (fuel, tolls, tire wear)	Transportation diversity value (e.g., mobility for non-drivers)
Per-mile crash risk	Equity impacts
Project construction environmental impacts	Impacts on physical activity and public health

Conventional transportation planning tends to focus on a limited set of impacts.

Tables ES2 illustrates a more comprehensive evaluation framework. This framework identifies various *planning objectives* (things that a community wants to achieve). Many transport improvement strategies can only achieve a few of these objectives. For example, expanding highways increases user comfort and reduces traffic congestion, and increasing vehicle fuel efficiency conserves energy and pollution emissions, and provides fuel savings. Some strategies provide a broader range of benefits.

Table ES2 **Comparing Strategies** (Litman 2005)

Planning Objective	Roadway Expansion	Fuel Efficient Vehicles	Transport Options	Price Reforms	Smart Growth
User convenience and comfort	✓		✓	✓	✓
Congestion reduction	✓		✓	✓	✓
Improved pedestrian access			✓	✓	✓
Roadway cost savings			✓	✓	✓
Parking cost savings			✓	✓	✓
Consumer cost savings		?	✓	✓	✓
Reduced traffic accidents			✓	✓	✓
Improved mobility options			✓	✓	✓
Energy conservation		✓	✓	✓	✓
Pollution reduction		✓	✓	✓	✓
Physical fitness & health			✓	✓	✓
Land use objectives			✓	✓	✓

(✓ = Achieve objectives.) Roadway expansion and more fuel efficient vehicles provide few benefits. Win-Win Solutions improve travel options and encourage more efficient travel patterns, which helps achieve many planning objectives.

These impacts become more evident if long-term travel impacts are considered, as in Table ES3. For example, roadway expansion often induces additional vehicle travel. This reduces congestion reduction benefits and increases downstream congestion (for example, increased congestion on surface streets), increases road and parking facility costs, accidents, energy consumption, pollution emissions and sprawl.

Similarly, more fuel-efficient vehicles tend to reduce energy consumption, pollution emissions and fuel cost (although these savings are often offset by increased vehicle purchase costs). However, because they cost less to drive, owners of fuel efficient vehicles tend to drive more annual miles, which can increase traffic problems including road and parking facility costs, accidents, and sprawl.

Some strategies, called *win-win solutions*, can help achieve many planning objectives. For example, improving transport options (walking, cycling, ridesharing, public transit, carsharing, etc.) tends to directly benefit the people who use the improved mode, and by reducing total vehicle travel it benefits other residents from reduced traffic congestion, accident risk, pollution exposure.

Pricing reforms can also provide many benefits. Although some consumers pay higher prices, their overall cost impacts depend on how revenues are used. For example, road pricing and parking fees do not necessarily harm consumers compared with other financing options, for example, if general taxes or building rents pay for roads and parking facilities. Smart growth development policies reduce the distances people must travel to access services and activities, which provide direct and indirect benefits.

Table ES3 **Comparing Strategies Including Travel Impacts**

Planning Objective	Roadway Expansion	Fuel Efficient Vehicles	Transport Options	Price Reforms	Smart Growth
Motor Vehicle Travel Impacts	*Increased*	*Increased*	*Reduced*	*Reduced*	*Reduced*
User convenience and comfort	✓		✓		✓
Congestion reduction	✓/×	×	✓	✓	✓
Improved pedestrian access	×	×	✓	✓	✓
Roadway cost savings	×	×	✓	✓	✓
Parking cost savings	×	×	✓	✓	✓
Consumer cost savings	✓	?	✓	✓/×	✓
Reduced traffic accidents	×	×	✓	✓	✓
Improved mobility options			✓	✓	✓
Energy conservation	×	✓	✓	✓	✓
Pollution reduction	×	✓	✓	✓	✓
Physical fitness & health			✓	✓	✓
Land use objectives	×	×	✓	✓	✓

(✓ = Achieve objectives. × = Contradicts objective.) Roadway expansion and more fuel efficient vehicles provide few benefits, and by increasing total vehicle travel they can exacerbate other problems such as congestion, accidents and sprawl. Some transport improvement strategies improve travel options, encourage use of alternative modes and create more accessible communities, which helps achieve many planning objectives.

The most insidious form of ignorance is misplaced certainty.
-Robert Costanza

Introduction

When shopping for a vehicle, consumers need comprehensive information on available options, and the impacts (costs and benefits) of each option. Some information, such as new vehicle price and performance data, is easily obtained from advertisements and consumer magazines. However, smart buyers should consider other options (e.g., used vehicles, vehicle rentals and carsharing) and other impacts, (e.g., long-term operating costs, resale value, reliability and safety record, and ability to accommodate special needs—passengers with disabilities, large loads and inclement weather). Comprehensive analysis often reveals that an option that seemed best based on advertised information actually ranks lower overall when all impacts are considered.

Similarly, communities want comprehensive information when making transportation planning decisions. When considering possible ways to address transport problems, decision-makers should consider more than just roadway costs and traffic impacts. They should investigate other options, such as alternative modes and management strategies, and indirect and long-term impacts. These impacts include consumer costs, accident rates, community development patterns, equity objectives, energy dependency and various environmental effects. More comprehensive analysis often results in significantly different and better decisions.

Transportation planning decisions have diverse economic, social and environmental impacts. Poor planning can cause significant harm by reducing transport system efficiency and equity. Current planning practices tend to be distorted in favor of traditional solutions and easy-to-measure impacts (e.g., congestion delays, traffic accidents), at the expense of innovations and more difficult to measure impacts (e.g., carpooling demand, bike safety, public fitness, or quality of life). More comprehensive analysis is needed to respond to changing travel demands and expanding planning goals (ITF 2022). Aging population, urbanization, rising traffic congestion and roadway construction costs, and growing concern about public physical fitness and environmental quality all increase the value of alternative modes and mobility management.

Described more positively, more comprehensive planning can provide tremendous benefits by helping create transport systems that best meet community needs. Better analysis allows individual, short-term decisions to support long-term, strategic goals. For example, comprehensive analysis can identify the congestion reduction strategies that also support a community's social and environmental goals, and the emission reduction strategies that also support economic development goals.

This report provides guidance for improving transport planning. It identifies various principles for good planning, evaluates how well conventional transport planning reflects these principles, identifies various planning distortions, recommends reforms, and discusses how these reforms would affect planning practices and travel patterns.

Planning Principles, Distortions and Corrections

Planning is the process of deciding what to do and how to do it. To be efficient and equitable, planning must reflect certain basic principles, including *comprehensive analysis* (so decision-makers can consider all significant options and impacts), and *neutrality* (decisions are not arbitrarily biased to favor one option or group). Violations of these principles are considered *planning distortions*. This report examines *technical distortions*, which are unintended biases that limit the options considered or misrepresent an impact's value in ways that cause rational decision-makers to choose options they would consider suboptimal given more comprehensive and accurate information.

A *planning framework* defines the planning process basic structure, including its perspective, scope, impacts considered, and analysis methodologies (Litman, 2006). The framework affects planning decisions, which influence travel options and impacts provided, which help shape travel behavior and various impacts (see Figure 1).

Figure 1 **Steps Between Planning Framework And Impacts**

Planning Framework
(perspective, scope, impacts considered, analysis methods, etc.)
⇩
Planning Decision
(project funding, roadway design, price structure, etc.)
⇩
Travel Options and Incentives
(relative quality and price of walking, cycling, driving, public transit, prices, etc.)
⇩
Travel Behavior
(per capita vehicle mileage, mode split, etc.)
⇩
Impacts
(transportation costs, accidents, energy consumption and pollution emission, etc.)

The planning framework defines which options are considered and how they are evaluated. This affects planning decisions, options and incentives, travel behavior and ultimate impacts.

Planning decisions determine the variety and quality of options available. If consumers lack adequate transport options the resulting mobility patterns may be inefficient. For example, high levels of automobile travel can only be considered optimal if consumers have viable options. Some people who currently drive may actually prefer an unavailable alternative. This is not to say that every option must be available everywhere, but in general, consumers benefit from having more options so they are more likely to find the combination that best meets their needs. In an efficient market all cost-effective options should be available, including options that would be self-financing (user fees could cover costs), or more cost effective than those that are subsidized (e.g., if vanpool subsidies are more cost effective than expanding roads and parking facilities). Even options not cost effective in terms of economic returns may still be justified if they provide other benefits, such as equity, public health or enjoyment.

The Case For Economic Neutrality in Transport Planning

Imagine that a teacher favored tall students over short students. This is both unfair and inefficient, because some smart tall students may be discouraged from preparing for higher education, leaving less qualified but taller students to fill those slots. As a result, the pool of physicians, lawyers and engineers would be less than optimal.

Similarly, it is both unfair and inefficient for planning decisions to arbitrarily favor one transport mode over others, for example, driving over walking, cycling and public transit, because this would favor some people (those who drive a lot) over others (those who drive little or prefer alternative modes), and results in sub-optimal planning decisions. For example, if a community would spend a total of $5.00 on road and parking facilities to accommodate an automobile trip, it would be inefficient and inequitable if it were unwilling to spend a comparable amount to accommodate the same trip by other modes. Such bias would result in economically-excessive automobile travel, and less walking, cycling and public transit travel than is optimal.

There are many possible causes of bias in transportation decision-making, some of which may be subtle. For example, a particular mode may receive extra support because it tends to be relatively easy to measure, is used more by influential people, or because it has dedicated funding that is unavailable to other modes. Even modest bias can have large cumulative effects. For example, zoning codes that mandate generous parking supply not only create more automobile-oriented, dispersed land use development, but it also tends to reduce parking pricing (a basic rule of economics is that increased supply reduces prices), reducing the feasibility of access by other modes.

Transportation planners often act as advocates of transportation improvements and so tend to emphasize direct benefits of increased mobility while sometimes overlooking indirect costs. This may results in a world in which mobility, particularly motor vehicle travel, is relatively cheap but other goods – housing, safety, health, education, community and environmental quality – become more expensive, as summarized in the table below.

Policy	Economic Impacts	Ultimate Cost Burden
Abundant, unpriced roads	Roadway costs borne through general taxes	Higher property taxes increases housing costs and the costs of other goods
Abundant, unpriced parking	Parking financed by development cost and general taxes	Higher development costs and property taxes increase costs of housing and other goods.
Unpriced road rights-of-way	Road users pay no rent or property taxes on land used for public roads and parking facilities	Less land available for other uses. Higher property taxes on other land uses, such as housing, commercial buildings and farms
Increased roadway capacity and design speeds	Increased motorized mobility, degraded walking and cycling conditions	More difficult and dangerous walking and cycling. Less use of alternative modes. Reduced public fitness and health.
Low fuel prices	Fuel use and driving are inexpensive	More motor vehicle travel, more fuel consumption and increases in associated economic and environmental costs.
Consolidated services (schools, post offices, etc.)	Lower agency costs but higher costs to users to access services.	Higher transport costs, particularly for non-drivers.

Reducing transportation costs increases the costs of other goods. Many of these economic transfers are overlooked in conventional transport planning.

This is not to suggest that mobility provides no benefits, but planning requires countless decisions involving tradeoffs between possible uses of resources such as money, land and time. Planning bias can result in economically excessive, inefficient and inequitable mobility patterns.

Many planning professionals are working to make their planning frameworks more comprehensive and neutral. This is sometimes called *sustainable transportation planning*, which is intended to account for long-term impacts such as non-renewable resource depletion and irreversible ecological degradation. However, rather than add a special new type of planning that incorporates these impacts it is often better to make all transport planning more comprehensive.

Information Resources

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Perspective: Mobility Versus Accessibility

The Issue
A *paradigm shift* (a fundamental change in the way problems are defined and solutions evaluated) is occurring in transport planning which involves changing from *vehicle-based* and *mobility-based analysis*—which evaluates transport system quality based only on physical movement—to *accessibility-based analysis* which evaluates the transport system based on people's ability to reach desired goods, services and activities (Levinson and El-Geneidy 2006; Litman 2013). Accessibility is the ultimate objective of most transport activity (excluding mobility that is an end in itself, with no destination, such as jogging and cruising), so accessibility-based analysis more accurately reflects ultimate planning goals.

There are often conflicts between different forms of accessibility. For example, a destination (such as a school, worksite or store) located to maximize automobile access will be located on a major roadway with generous parking supply, often at the urban fringe, although such a location provides poor access by other modes. It is important that decision-makers understand these tradeoffs and such impacts are considered in analysis.

Accessibility-based planning expands the range of solutions that can be applied to transportation problems. Conventional planning often assumes that *transportation* means *mobility*, so improving transport requires increasing mobility. Accessibility-based planning allows other transport improvement options to be considered, for example, by improving walking conditions and transit service, creating more accessible land use, and providing mobility substitutes such as telecommunications and delivery services.

In other words, mobility-based planning cannot recognize savings and benefits that result if the need to travel is reduced. Accessibility-based planning recognizes that reducing travel is sometimes the most efficient solution to transport problems.

Current Practices
Many conventional planning practices are based on mobility rather than accessibility, that is, they assume that mobility is an end in itself rather than a way to achieve accessibility, and so unintentionally overlook or undervalue other factors that affect accessibility, such as land use patterns, alternative modes and prioritization. For example, indicators such as average traffic speeds, roadway level of service, volume/capacity, and parking supply ratios only indicate mobility, not accessibility.

Recommended Practices
Use accessibility-based transport planning. Educate decision-makers and the general public about differences between accessibility- and mobility-based transport planning, and their implications. Define planning goals in terms of accessibility rather than mobility, and take into account all factors that affect accessibility, including impacts on alternative modes, land use accessibility, and mobility management (Litman 2007).

Information Resources

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Options Considered

The Issue
The scope of options considered in the planning process determines which policies and programs are ultimately implemented. The scope of *potential* transportation improvement strategies is expanding due to broader goals, improved understanding of impacts, and new technologies. For example, telecommuting, road and parking pricing and real-time transit vehicle arrival information are increasingly feasible due to new electronic systems and should be considered to address specific problems.

Current Practices
For various reasons, current transport planning tends to overlook some potential options, particularly alternative modes and mobility management strategies. This is particularly true of planning to address narrowly defined problems such as local traffic or parking congestion, or accidents, which often focus on a narrow set of options.

Recommended Practices
Transport planning should consider the widest possible range of potential options, including alternative modes and mobility management strategies (Poorman, 2005). For example, when evaluating solutions to traffic or parking congestion, analysis should generally consider, in addition to facility expansion, improvements to alternative modes (such as passenger rail service and converting an existing lane to HOV), mobility management programs (such as road pricing, commute trip reduction programs, and subsidies for ridesharing and transit services), and combinations, for example, transit improvements in conjunction with road pricing and commute trip reduction programs.

Information Resources

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Planning Integration

The Issue
A basic principle of good planning is that individual, short term decisions should support strategic, long-term goals. Optimal transport planning therefore requires coordination among different levels of government, jurisdictions and sectors.

Current Practices
Many planning decisions that affect transport are made with little consideration of their indirect effects. There is often no mechanism to coordinate decisions among different levels of government, jurisdictions and agencies. For example, transportation and land use planning decisions are often poorly coordinated, and planning decisions are often uncoordinated between nearby jurisdictions, preventing the development of alternative modes and mobility management programs. Where strategic plans exist, incentives to follow them are often weak. This results in a *tyranny of small decisions*, in which potential improvements are not implemented due to poor coordination.

Recommended Practices
Establish strategic transportation and land use planning goals and objectives. Coordinate planning decisions among different jurisdictions and agencies. Establish implementation programs that support coordinated planning. Higher levels of government can establish incentives to improve planning coordination among lower levels of government, and transport agencies can provide incentives for more accessible land use development.

Information Resources
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Financing Practices

The Issue

Efficiency requires that transportation funding be allocated based on cost-effectiveness, taking into account all options and impacts ("Least-cost Planning," VTPI, 2007). For example, it would be inefficient and unfair to dedicate funds to road and parking facility expansion if improvements to alternative modes, such as cycling and public transit, or mobility management strategies such as commute trip reduction programs, are more cost effective an better overall.

Efficient investment practices are particular important for higher levels of government, since their funding policies often have large leverage effects. For example, a million dollars in federal or state funding often leverages several million dollars in regional and local funding, which may leverage tens of millions of dollars in private development and hundreds of millions of dollars in consumer expenditures over its lifetime. If federal or state policies favor highway expansion over other types of transport improvements, the result may be more automobile-oriented transport system than is optimal, reducing efficiency and exacerbating problems such as accidents, inaffordability, high energy consumption, increased pollution emissions, and reduced accessibility for non-drivers.

Current Practices

Currently, a significant portion of transportation funding is dedicated to highways and cannot be used for alternative modes and mobility management strategies (Puentes and Prince 2003; Colins 2009). Regional and local governments can often obtain match funding for roadway improvements, but not for other types of transport improvements. This encourages local officials to define their transportation problems as traffic problems, rather than mobility problems or accessibility problems.

Highways are considered interregional facilities that serve long-distance travel, and so, are considered to deserve state/provincial and federal funding even if much of their traffic is local. In contrast, walking, cycling and public transit are considered local services. As a result, more funding is available to accommodate local trips made by automobile than for local trips made by other modes.

Current transportation planning and investment practices tend to favor major capital projects over operations, maintenance and management activities (Meyer 2001; Sussman 2001). As a result, facilities are being expanded even when there is insufficient funding to maintain current assets, and implementation of management strategies that result in more efficient use of existing capacity is discouraged.

Parking facility funding is even less flexible, since most jurisdictions require developers to provide parking facilities but do not allow the funds to be used to improve alternative modes or parking management programs, even if they are more cost effective overall.

Recommended Practices

Transportation financing should apply least-cost planning principles, so that management strategies, operational management, and incremental projects can be implemented whenever they are most cost effective overall ("Least-cost Planning," VTPI 2007). Financing should give priority to maintenance and operations over capacity expansion (called *fix-it-first*). Economic evaluation should take into account all significant options and impacts, including a community's strategic planning objectives.

Information Resources

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Definition of Demand

The Issue

Demand refers to the quantity of goods (such as the amount of vehicle travel) consumers would choose at a particular price. Transport planners use estimates of traffic and parking demand (also called trip and parking *generation*) to determine how much road and parking capacity to supply.

Current Practices

Conventional transportation planning generally defines travel and parking demand assuming that roads and parking facilities will be unpriced. In other words, existing planning practices attempt to accommodate existing levels of vehicle travel demand despite various forms of underpricing. It overlooks alternative options (such as pricing reforms) and many of the negative impacts that result from accommodating this demand (such as increased facility costs, accidents, sprawl and pollution emissions). This creates a self-fulfilling prophecy; it results in economically excessive road and parking supply (larger than what would be required if users paid efficient prices), making efficient pricing infeasible. For example, conventional parking standards result in generous parking supply at most destinations, so there is little incentive to price parking or encourage alternative modes, since those parking spaces would be unoccupied.

Recommended Practices

Planners should not report travel demand as a fixed value ("traffic volumes will grow 20% over the next decade"), but rather as a variable ("traffic volumes will grow 20% over the next decade if current policies continue, 10% if significant improvements are made to alternative modes, and 0% if additional mobility management strategies are implemented"). Similarly, parking demand should be defined as a variable ("This building will require 80 parking spaces if they are unpriced and unmanaged; 60 spaces if they are moderately priced and managed; or 40 spaces if they are priced at cost and managed for maximum efficiency"). This helps identify how planning decisions affect demand, and expands the options considered to include demand management strategies.

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Modeling Practices

The Issue

Transportation models are used to predict impacts and evaluate options. The quality of modeling and how results are presented, affects planning decisions. Biased planning can result in poor planning decisions.

Current Practices

Commonly used transport models (such as *MicroBENCOST* and HDM 4) are primarily designed to evaluate vehicle traffic conditions and roadway improvements. They are biased in various ways that exaggerate the benefits of roadway expansion and undervalue alternative modes and mobility management, as described below (some of these distortions are discussed in more detail in other sections of this report):

- Most travel statistics undercount short trips, non-work travel, travel by children, recreational travel, and nonmotorized links of motorized travel. This favors motorized travel over nonmotorized travel and longer trips over local trips. For example, conventional travel surveys generally indicate that walking and cycling represent only 5-10% of total trips, implying that it is relatively unimportant and only deserves modest public support, but more comprehensive surveys typically indicate that 10-20% of urban trips include at least some nonmotorized travel on public sidewalks, paths or roadways.
- Most models only account for a portion of generated and induced travel impacts. As a result they exaggerate the benefits of wider roads and ignore negative impacts, such as reduced pedestrian accessibility, more dispersed land use, and increased externalities due to generated vehicle traffic.
- Travel models tend to focus on quantitative factors (travel speed, operating costs and crash rates) and undervalue qualitative factors such as travel convenience, comfort and security (Ellis, Glover, and Norboge 2012; Litman 2007). Most models apply the same value of travel time regardless of travel conditions and so undervalue qualitative improvements. This tends to favor automobile travel over improvements to alternative modes.
- Elasticity values commonly used in transport models are largely based on studies of short- and medium-run impacts. As a result, most models significantly understate the potential of transit fare reductions and service improvements to reduce problems such as traffic congestion and vehicle pollution, and understate the long-term negative impacts that fare increases and service cuts would have on transit ridership, transit revenue, traffic congestion and pollution emissions.

Recommended Practices

Use more advanced, integrated models that incorporate feedback and are sensitive to pricing, mode choice and micro-scale land use factors. If such a model is unavailable, insure that decision-makers are aware of the limitations of any predictions from the model, such as any tendencies to overestimate future traffic congestion problems, and undervalue mobility management strategies. Table 1 summarizes various ways to improve current transportation models so they are more accurate and comprehensive.

Table 1 **Improving Transport Models** ("Model Improvements," VTPI, 2007)

Factor	Problems With Current Models	Appropriate Corrections
Accessibility	Most transportation models primarily evaluate *mobility* (movement), and fail to reflect *accessibility* (people's ability to obtain desired goods and activities).	Develop multi-modal models which indicate the quality of nonmotorized and transit travel, and integrated transportation/land use models which indicate accessibility.
Modes considered	Most current models only consider automobile and public transit.	Expand models to evaluate other modes, including walking and cycling.
Travel data	Travel surveys often undercount short trips, non-motorized travel, off-peak travel, etc.	Improve travel surveys to provide more comprehensive information on travel activity.
Consumer Impacts	Most economic evaluation models apply relatively crude analysis of consumer impacts. For example, they assume that shifts from driving to slower modes increase costs.	Use consumer surplus analysis to measure the value to users of transport system changes. Recognize that shift to slower modes in response to positive incentives provide overall benefits.
Travel time	Most models apply the same travel time value to all travel, regardless of conditions.	Vary travel time cost values to reflect travel conditions, such as discomfort and delay.
Generated traffic and induced travel	Traffic models fail to account for the tendency of roadway expansion to generate additional peak-period traffic, and the additional costs from induced travel.	Incorporate various types of feedback into the traffic model. Develop more comprehensive economic analysis models which account for the economic impacts of induced travel.
Qualitative impacts	Focus on quantitative factors such as speed and user fees, and undervalues qualitative factors such as convenience and comfort.	Develop methods for measuring qualitative factors and incorporating them into planning and economic evaluation.
Nonmotorized travel	Most travel models do not accurately account for nonmotorized travel and so undervalue nonmotorized improvements.	Modify existing models or develop special models for evaluating nonmotorized transportation improvements.
Impacts Considered	Current models only measure a few impacts (travel time and vehicle operating costs).	Consider all significant impacts, including crash risk, pollution emissions, pedestrian delays, land use impacts, etc.
Transit elasticities	Transit elasticity values are largely based on short- and medium-run studies, and so understate long-term impacts.	Use more appropriate values for evaluating long-term impacts of transit fares and service quality.
Self-fulfilling prophesies	Modeled traffic projections are often reported as if they are unavoidable. This creates self-fulfilling prophecies of increased roadway capacity, generated traffic, increased traffic problems and sprawl.	Report travel demand as a variable ("traffic will grow 20% if current policies continue, 10% if parking fees average $1 per day, and 0% if parking fees average $3 per day.") rather than a fixed value ("traffic will grow 20%").
Construction impacts	Economic models often fail to account for the traffic congestion costs during construction periods.	Take congestion delays into account when evaluating projects and comparing capacity expansion with TDM solutions.
Transportation diversity	Models often underestimate the benefits of improved travel options, particularly those used by disadvantaged people.	Recognize the various benefits that result from improving accessibility options.
Impacts on land use	Models often fail to identify how transport decisions will affect land use patterns, how this affects accessibility and strategic	Develop integrated transportation and land use planning models which predict how transport decisions affect land use patterns and how land

	planning objectives.	use decisions affect accessibility.

This table summarizes ways of improving computer models used in transportation planning.

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Generated Traffic Impacts

The Issue

Urban traffic congestion tends to maintain self-limiting equilibrium: traffic grows until congestion discourages additional peak-period vehicle travel. People shift their travel time, route, mode and destination to avoid congestion. If roadway capacity increases, they will take additional peak-period trips, including some that represent an overall increase in vehicle mileage (as opposed to simply shifts in travel time and route).

Generated traffic is a name for this additional vehicle travel that occurs when roadway capacity increases (Litman, 2001). This consists of a combination of *diverted travel* (vehicle trips shifted from other times and routes), and *induced travel* (travel shifted from other modes and destinations, and increased vehicle trip making). Under typical urban conditions, more than half of added capacity is filled within five years of project completion by generated traffic, with additional but slower growth in later years. Generated traffic has significant implications for transportation planning:

1. Generated traffic tends to reduce the predicted congestion reduction benefits of increased road capacity.
2. Induced travel increases external costs, including downstream congestion, parking costs, crashes, pollution, and other environmental impacts, particularly if it leads to more automobile dependent transport systems and land use patterns. These external costs can be quite significant, often exceeding the magnitude of congestion reduction benefits.
3. The additional travel that is generated provides relatively modest user benefits, since it consists of marginal value trips (travel that consumers are most willing to forego).

This is not to suggest that increasing road capacity provides no benefits, but generated traffic affects the nature of these benefits. It means that project benefits consist more of increased mobility and less of reduced traffic congestion. Failing to consider generated traffic impacts can significantly reduce the accuracy of transport project evaluation. Modeling and planning practices that ignore these impacts tend to exaggerate the benefits of highway projects and understate the benefits of alternative modes and mobility management solutions. Ignoring generated traffic impacts overstates the benefits of urban roadway capacity expansion project by 50% or more (Williams and Yamashita, 1992).

Current Practices

Most current traffic models account for changes in routes and modes, and some account for changes from off-peak to peak periods that result from roadway improvements. However, few account for long-term changes in trips destinations, trip frequency, transportation diversity, and land use patterns. As a result, they cannot account for a significant portion of generated traffic and the majority of induced travel that results from increasing the capacity of congested urban highways. Current models also tend to ignore the demand-limiting effect of congestion, implying that increased travel demand will lead to "gridlock," although congestion discourages further growth in peak-period travel demand, resulting in moderate, but never extreme levels of congestion on urban roads.

As a result, most current models overestimate future congestion costs and the potential congestion reduction benefits of increased highway capacity. They also tend to ignore or underestimate the additional downstream congestion and parking problems, consumer costs, pollution emissions and sprawl that results from highway capacity expansion.

Recommended Practices

Traffic models can be upgraded to predict the amount of vehicle traffic that would be generated by a highway project (Harvey and Deakin 1993; Loudon, Parameswaran and Gardner 1997). Such models can provide more realistic predictions of future congestion problems and the congestion reduction benefits of increased roadway capacity. They can also indicate the amount of additional vehicle travel that will be induced, allowing the incremental external costs to be estimated.

Information Resources

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Service Quality Evaluation

The Issue
Most consumers place a high value on convenience and comfort. Automobiles are continually improving convenience and comfort with features such as electronic navigation, comfortable seats and sophisticated sound systems. Service quality improvements are often cost-effective ways to improve alternative modes, attract discretionary travelers, and achieve equity objectives by benefiting disadvantaged people. Motorists can choose the service quality they want when renting or purchasing a vehicle, but alternative mode service quality is determined through public planning decisions. To satisfy consumers and be competitive with automobile travel, alternative mode planning must accurately account for quantitative factors.

Current Practices
Most current planning and modeling focuses on quantitative factors, such as speed and price, and overlooks or undervalues qualitative factors such as convenience and comfort. This tends to favor faster modes over slower modes, and undervalues often cost-effective qualitative improvements to alternative modes such as nicer transit stations and vehicles, better user information, on-board refreshments and Internet access, walking and cycling improvements, and marketing programs that raise the prestige of alternative modes.

Recommended Practices
The planning process should pay as much attention to qualitative as quantitative factors. This can be done by developing level-of-service standards and indicators that incorporate comfort, convenience and status factors, and use these to adjust travel time cost values. Planning practices should allow qualitative improvements to compete equally for funding as quantitative improvements (for example, policies and programs that, by increasing user convenience and comfort, reduce unit time costs by 20%, should receive the same funding as those that increase vehicle travel speeds by 20%).

Information Resources

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Downstream Congestion

The Issue
Relieving a traffic bottleneck at one location may increase congestion problems elsewhere in the road network. For example, highway expansion often stimulates additional traffic volumes, which may increase surface streets congestion. On the other hand, a transit service improvement or mobility management strategy that reduces total vehicle traffic on the corridor avoids this impact, providing additional benefits by reducing surface street congestion.

Current Practices
Roadway capacity expansion project evaluation only considers direct effects, congestion impacts on other roads. Regional traffic models that fail to account for induced traffic (described above) will understate downstream congestion impacts. Such practices tend to exaggerate roadway capacity expansion benefits and undervalue alternative modes and mobility management solutions.

Recommended Practices
Transportation projects should be evaluated using comprehensive regional models that incorporate generated traffic impacts, or simply by estimating the portion of additional roadway capacity that will be filled with generated and induced travel, and assigning this additional traffic congestion cost value.

Information Resources
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Consumer Impacts Analysis

The Issue

Transportation planning decisions often involve tradeoffs between factors such as travel service quality and price. Transport economists use *consumer surplus analysis* to value these impacts. These techniques can calculate the net benefits or costs to consumers when they change travel behavior in response to changes in fares, tolls and travel service quality, as summarized in the following box.

Explanation of the Rule-of-Half

Economic theory suggests that when consumers change travel patterns in response to a financial incentive, the net consumer surplus is half of their price change (called the "rule of half"). This takes into account total changes in financial costs and mobility as perceived by consumers.

Let's say that the price of driving (perceived variable costs, or *vehicle operating costs*) increased by 10¢ per mile, either because of an additional fee (e.g., paid parking) or a financial reward, and as a result you reduce annual vehicle travel by 1,000 miles. You would not give up highly valuable vehicle travel, but there are probably some vehicle-miles that you would reduce, either by shifting to other modes, choosing closer destinations, or because the trip itself does not seem particularly important.

These vehicle-miles foregone have an incremental value to you, the consumer, between 0¢ and 10¢. If you consider the additional mile worth less than 0¢ (it has no value), you would not take it in the first place. If you consider it worth 1-9¢, a 10¢ per mile incentive will convince you to give it up – you'd rather have 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 that the average net consumer benefit (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 vehicle-mile financial incentive have an average consumer surplus value of 5¢. Similarly, a $100 increase in vehicle operating costs that reduces vehicle travel by 1,000 miles imposes *net consumer costs* of $50, while a $100 financial reward that reduces 1,000 vehicle-miles provides *net consumer benefits* of $50.

Some people complicate this analysis by trying to track changes in consumer travel time, convenience and vehicle operating costs, but that is unnecessary. All we need to know to determine net consumer benefits and costs is the perceived change in price, either positive or negative, and the resulting change in consumption. This incorporates all the trade-offs consumers make between money, time and mobility.

Current Practices

Transport system quality is often evaluated primarily based on travel speeds, assuming that any speed increase provides benefits and any speed reduction imposes costs. This ignores the possibility that travelers sometimes prefer slower modes, for example, because walking and cycling are enjoyable and have health benefits or public transit travel is less stressful than driving. The assumption that slower travel speeds harm consumers is clearly incorrect if mode shifts result from positive incentives. With such incentives, travelers only change mode if they are directly better off overall. Treating all travel time increases as a cost favors mobility over accessibility, faster modes over slower modes, and undervalues mobility management strategies.

Recommended Practices

Economic analysis should use consumer surplus analysis. This is particularly important when evaluating alternative modes, land use management and pricing policies. Evaluation practices should recognize the benefits to consumers from strategies that improve consumer options or use positive incentives, even if they result in slower travel or reduced mobility.

Information Resources

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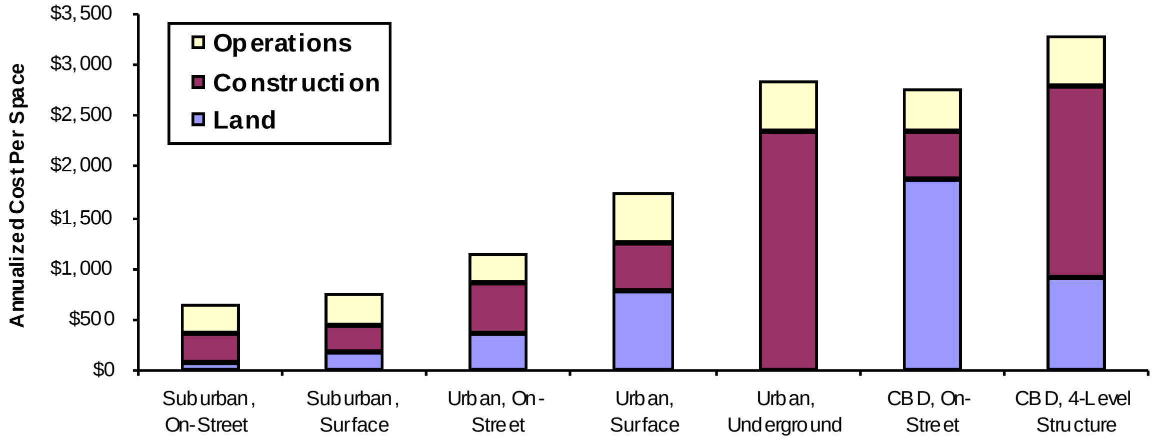
Parking Costs

The Issue

Planning decisions that affect vehicle ownership and use influence parking costs. These can be significant, as illustrated in Figure 2. Planning decisions that reduce vehicle ownership and use can provide significant parking cost savings.

Figure 2 **Typical Parking Facility Financial Costs** (Parking Spreadsheet)



Parking facility costs vary depending on location and design. (CBD = Central Business District)

Current Practices

Current planning often ignores or undervalues parking costs. For example, when comparing a highway expansion and transit improvements, the additional parking costs to businesses and local governments that result from highway expansion, and the avoided parking costs from the transit alternative, are often ignored in economic evaluation.

Recommended Practices

Parking costs should be considered when evaluating transportation policies and projects that affect vehicle ownership, vehicle trips and destinations.

Information Resources

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Vehicle Costs

The Issue
Vehicle costs include short-term *operating costs* (fuel, oil, tire wear, tolls and parking fees), *mileage-based depreciation* (representing vehicle wear-and-tear, causing more frequent repairs, reduced operating life and lower resale value), vehicle ownership costs (time-based depreciation, financing, insurance and registration fees), plus residential parking costs if paid directly by vehicle owners.

Planning decisions that affect vehicle ownership and use rates affect all of these costs. Even small reductions in per household vehicle ownership can provide significant savings. For example, if a transit improvement allows 10% of users to reduce their household vehicle ownership, the savings average $200-400 annually per user or 4-8¢ per transit passenger-mile (assuming 20 miles of daily transit travel, 250 days per year).

Current Practices
Most current transportation evaluations only consider vehicle operating costs and ignores other vehicle costs, including mileage-based depreciation, vehicle ownership expenses, and residential parking costs.

Recommended Practices
When evaluating transportation planning decisions that affect vehicle ownership and use, all affected vehicle expenses should be considered, including:
- Operating costs.
- Mileage-based depreciation.
- Opportunity costs if a vehicle could otherwise be used by another household member.
- Vehicle ownership costs.
- Residential parking costs if users pay directly.

Information Resources
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Construction Impacts

The Issue

Transportation project construction often causes significant traffic delays and crash risks; displaces residents and reduces nearby business activity; and produces environmental impacts such as noise, air and water pollution, habitat loss, increased impervious surface, and wildlife barriers. Although such impacts are generally mitigated, there are usually residual, uncompensated costs. Failing to consider these impacts in economic evaluation understates total project costs and the relative value of alternative modes and strategies that avoid or reduce construction projects. In a study evaluating highway impacts on nearby property values, ten Siethoff and Kockelman (2002) found that construction impacts reduced annualized land values by $0.05 to $0.50 per square foot and structure values by $0.50 per square foot, although once construction was completed the corridor's property values increased.

Current Practices

Current transportation project evaluation often ignores construction impacts. There is often an assumption that these costs will be mitigated or offset by benefits. Uncompensated, residual costs are often ignored.

Recommended Practices

The evaluation of transportation projects should incorporate:

- Traffic delays and crash risk to both motorized and non-motorized traffic.
- Environmental impacts.
- Uncompensated community impacts.
- Uncompensated business losses.

Information Resources

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Transportation Diversity Impacts

Transportation diversity (also called *transportation options* or *transportation choice*) refers to the quantity and quality of accessibility options available in a particular situation, including modes, services, prices, routes and destinations. Increased diversity lets consumers choose the combination of options that best meet their needs. If consumers lack adequate options, the transport patterns that result are not necessarily optimal. For example, high levels of automobile travel can only be considered optimal if consumers have viable alternatives. Motorists might sometimes prefer unavailable options. This is not to say that every possible option must be available everywhere, but increased transport diversity can provide benefits that should be considered in planning:

- *Transportation Problems Reduced.* Improving options, such as walking and cycling conditions, and rideshare and public transit service, can often help reduce specific problems such as congestion, accidents and pollution.
- *Consumer benefits*. Improving transportation options allows consumers to choose the most efficient option for each trip, allowing them to save money, avoid stress, and reduce the need to chauffeur non-drivers.
- *Equity.* Improving accessibility options for physically, economically or socially disadvantaged people helps achieve equity objectives by improving their opportunities and reducing their costs.
- *Public health and livability.* Increased walking and cycling improve public fitness and health, and tends to increase community livability.
- *Resilience*. A more diverse transport system can accommodate variable and unpredictable conditions. Even people who do not currently use an option may value its availability, for example, if their needs change, fuel prices increase, or a major disaster occurs.

Current Practices

Although many communities have planning objectives supporting increased transport system diversity and improved accessibility options for disadvantaged people, economic evaluation often assigns no value to these objectives, or only considers one of several related benefits. Ignoring transport diversity in project evaluation tends to favor automobile-oriented improvements, and undervalues improvements to alternative modes.

Recommended Practices

The planning process should define objectives related to improving transport system diversity, and consider the various categories of benefits. These benefits can be quantified by assigning a *transportation diversity* factor to each planning option that indicates the degree to which it supports or contradicts transport diversity objectives. For example, improvements to walking, cycling, public transit and taxi modes would typically receive a relatively high rating since they increase diversity and serve disadvantaged people.

Martens (2006) argues that current transport evaluation practices undervalue improvements to alternative modes by ignoring the additional welfare gains provided by accessibility improvements for transportation disadvantaged people. As he explains:

> "Both transport modeling and cost-benefit analysis are driven by distributive principles that serve the highly mobile groups, most notably car users, at the expense of the weaker groups in society. Transport modeling is implicitly based on the distributive principle of demand. By basing forecasts of future travel demand on current travel patterns, transport models are reproducing the current imbalances in transport provision between population groups. The result is that transport models tend to generate suggestions for transport improvements that benefit highly mobile population groups at the expense of the mobility-poor. Given the importance of mobility and accessibility in contemporary society for all population groups, the paper suggests to base transport modeling on the distributive principle of need rather than demand. This would turn transport modeling into a tool to secure a minimal level of transport service for all population groups." (Martens, 2006)

To correct these biases he recommends the following changes to transportation modeling and economic evaluation techniques to reflect equity objectives:

- Evaluate transport improvements primarily in terms of *accessibility* rather than *mobility*.
- Assign accessibility gains for the mobility-poor (who travel lower annual miles) higher value than comparable gains for mobility-rich (high annual mile travelers), since accessibility-constrained people tend to gain relatively more from a given transportation improvement. For example, travel time savings for mobility-poor people should be valued higher than for the mobility-rich. This helps increase consumer welfare and efficiency, not just social justice objectives. For example, it helps disadvantaged people access education and employment opportunities that increase productivity.

Information Resources

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Equity Analysis

The Issue

Equity refers to the fairness with which impacts (benefits and costs) are distributed. Transportation planning decisions often have significant equity impacts. These can be difficult to evaluate because there are several types of equity, several impacts to consider, various ways to categorize people for analysis, and many ways of measuring impacts.

Current Practices

Transportation planning often considers a few equity indicators, such as roadway cost allocation (analysis of the degree to which fees for various user groups reflect their roadway costs), regressivity (whether fees are borne excessively by lower income consumers), or the quality of services for disadvantaged users (such as wheelchair accommodation in facility design and public transit services).

Recommended Practices

Techniques can be used to evaluate various transport equity impacts:

- Degree to which users bear the costs they impose, unless a subsidy is specifically justified.
- Distribution of benefits and costs between different geographic areas.
- Impacts on non-drivers' accessibility.
- Impacts on people with disabilities.
- Impacts on low-income households and communities.

Information Resources

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Environmental Impacts

The Issue
Roads and vehicle traffic impose various environmental costs, including noise, air and water pollution; non-renewable resource consumption, waste creation, hydrologic impacts, habitat loss, road kills, and aesthetic degradation. These impacts are cumulative, so even small projects can cause significant total environmental degradation.

Current Practices
Current transportation planning often considers some environmental impact analysis, such as air pollution and direct land use impacts, but other types of pollution (non-criteria pollutants, noise and water pollution) and indirect environmental impacts (such as stimulation of sprawl and resulting environmental costs) are often ignored, particularly for relatively small projects, such as an individual road or parking facility expansion. Some roadway expansion project evaluations claim they reduce energy consumption and pollution emissions by reducing congestion delays, but such reductions are often temporary and overwhelmed in the long-term by induced vehicle travel.

Recommended Practices
Transportation project evaluation should include comprehensive environmental impact analysis that accounts for cumulative and indirect impacts. In particular, the long-term environmental impacts of policies and projects that induce additional vehicle travel or sprawled land use should be considered.

Information Resources

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Land Use Impacts

The Issue
Many jurisdictions have various strategic land use development objectives, generally called *smart growth* or *new urbanism*. For example, many communities have objectives to redevelop older urban neighborhoods, encourage more cohesive communities, increase walkability and land use accessibility, preserve farmland and wildlife habitat, protect special cultural and environmental resources, reduce impervious surface area, and discourage sprawl. Transportation planning decisions significantly affect these objectives.

Current Practices
Most current transportation evaluation only considers a few land use impacts. Long-term and indirect impacts, such as increased sprawl caused by roadway expansion, are generally ignored in individual project analysis.

Recommended Practices
Strategic land use objectives should be explicitly considered in transportation planning, including individual project evaluations, particularly the degree to which projects support sprawl or smart growth. Monetary values can be assigned to impacts such as impervious surface area, dispersed development, and induced vehicle travel.

Information Resources
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NEMO Project (www.nemo.uconn.edu) provides information on impervious surface economic and environmental impacts.

Toolbox for Regional Policy Analysis Website (www.fhwa.dot.gov/planning/toolbox/index.htm) by the US Federal Highway Administration, describes analytical methods for evaluating regional economic, social and environmental impacts of various transportation and land use policies.

Economic Development Impacts

The Issue
Economic development refers to progress toward a community's economic goals, such as increased productivity, employment, business activity, wealth and tax revenue. Transport planning decisions can have large economic impacts, and many transport policies and projects are justified based on claimed economic benefits. However, economic impacts can be difficult to model, and many assumptions about these impacts are outdated and inaccurate. In particular, many people assume that any increase in motor vehicle travel is economically beneficial and reductions in vehicle travel are economically harmful. These assumptions are used to justify policies that encourage automobile use, including roadway and parking facility expansion, fuel production subsidies and various forms of motor vehicle underpricing. Research indicates that once a region has a basic road system, marginal increases in roadway capacity generally provide little or no overall economic development benefits. Alternative modes and mobility management strategies often provide larger economic returns by increasing transport system efficiency.

Current Practices
Transport evaluation often uses simplistic economic analysis methods that exaggerate benefits, treat economic transfers as economic benefits, overlook inefficiencies, and ignore the additional costs to consumers, businesses, governments and the economy of increased automobile dependency and urban sprawl (Ellis, Glover and Norboge 2012).

Recommended Practices
Transportation planning should use comprehensive, objective and critical evaluation of economic impacts.

Information Resources

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Glen Weisbrod (2000), *Synthesis of Current Practice for Assessing Economic Development Impacts from Transportation Projects*, NCHRP Study 20-5, TRB (www.trb.org).

Public Safety and Health Impacts

The Issue
Transportation projects often impact public safety and health by affecting traffic crash risk, pollution exposure, physical fitness, and mental health. These impacts should be considered in transport project evaluation.

Current Practices
Current transport planning often evaluates traffic crash risk per unit of travel (per 100 million vehicle-miles, per billion vehicle-kilometers, or per 100 million vehicles driving through an intersection). This ignores the effects of changes in vehicle travel, such as additional crashes and emissions from increased mileage. Proponents often claim that roadway expansion increases safety although such projects frequently increase per capita casualty rates by increasing vehicle travel and traffic speeds. As described earlier, air emission impacts are often considered in major project analysis but not for smaller projects such as individual roadway expansion. Transport planning usually ignores fitness and health impacts that result from changes in walking and cycling activity. These omissions tend to exaggerate the safety and health benefits of roadway expansion and understate the benefits of alternative modes and mobility management strategies.

Recommended Practices
The impacts that planning decisions have on per capita crash risk, pollution emissions, physical fitness and health should be described and, as much as possible quantified. Planning options that increase driving and reduce use of alternative modes should be assigned negative values, and options that improve walking and cycling conditions and increase nonmotorized travel should be assigned positive values. Mobility management strategies and smart growth development policies, which affect travel activity (how and how much people travel), should be considered as possible solutions to transportation problems such as traffic and parking congestion, excessive consumer costs, and inadequate mobility for non-drivers.

Information Resources
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Summary of Principles, Distortions and Reforms

Table 2 summarizes the planning principles described in this report, and compares conventional practices with what is required for comprehensive transport planning. This can be used to evaluate a particular planning process and identify ways to improve it.

Table 2 **Conventional and Comprehensive Planning Compared**

Principle	Description	Conventional	Comprehensive
Perspective	Whether analysis is based on mobility or accessibility.	Mobility	Accessibility
Options Considered	Range of solutions considered, including various alternative modes and mobility management solutions.	Favors automobile-oriented options	Includes alt. modes and mobility mangt.
Planning Integration	Whether planning is coordinated among various levels of government, jurisdictions and sectors.	Weak coordination	Strong coordination
Public Participation	Degree to which various groups and perspectives are included in the planning process.	Minimal or token participation	Significant partcipation
Financing Practices	How transport funds are allocated, and the flexibility with which it can be used for the best overall option.	Favors roadway investments	Applies least-cost planning
Definition of Demand	Whether planning assumes that all vehicle travel demand should be accommodated without constraint.	Tries to serve all potential demand	Manages demand for efficiency
Modeling Practices	Whether transport modeling uses best practices for evaluating travel impacts and economic effects.	Generally limited	More comprehensive
Generated Traffic & Induced Travel	Whether planning accounts for generated traffic and induced travel.	Limited analysis	Comprehensive analysis
Service Quality	How well qualitative factors such as comfort and convenience are considered in transport planning.	Limited analysis	Comprehensive analysis
Downstream Congestion	Whether planning considers the additional surface street congestion resulting from expanded highways.	Ignores for individual projects	Considers this impact
Consumer Impacts	How impacts on consumers caused by changes in the transport system are evaluated.	Only considers travel time changes	Uses consumer surplus analysis
Parking Costs	Which parking costs are considered.	Few parking costs	All parking costs
Vehicle Costs	Which vehicle costs are considered (operating, mileage-based, ownership, residential parking).	Only operating costs	Comprehensive analysis
Construction Impacts	Whether construction period congestion delays are considered.	Ignores	Includes
Transportation Diversity	Whether value is assigned to transport diversity impacts (the value of having diverse mobility options).	Little or no consideration	Comprehensive
Equity Analysis	Whether value is assigned to equity impacts.	Limited analysis	Comprehensive
Environmental Impacts	Range and detail of environmental impacts considered in analysis.	Limited analysis	Comprehensive analysis
Land Use Impacts	Whether analysis considers impacts with regard to strategic land use objectives.	Limited analysis	Comprehensive analysis
Economic	How well economic development impacts are	Limited and	Comprehensive,

Development	considered.	outdated analysis	current analysis
Safety and Health Impacts	How safety and health risks are measured.	Per vehicle-mile crash risks	Per-capita health risks

This table summarizes differences between current conventional and comprehensive planning. Conventional planning tends to overlook and undervalue significant impacts, options and objectives.

Planning Impacts

This indicates that conventional planning tends to overlook and undervalue many options and impacts. Table 3 summarizes how these distortions typically affect planning decisions. For example, several distortions undervalue alternative modes and exaggerate roadway expansion benefits, leading planning decisions to favor automobile transport over alternative modes and demand management strategies.

Table 3 **Travel Impacts of Conventional Planning Distortions**

Principle	Planning Distortions	Typical Travel Impacts
Perspective	Favors mobility over accessibility.	Increases motorized travel.
Options Considered	Favors established solutions. Discourages innovations.	Increases motorized travel, reduces alternatives.
Planning Integration	Favors established solutions.	Increases automobile travel.
Financing Practices	Favors automobile-oriented solutions.	Increases automobile travel.
Definition of Demand	Favors automobile-oriented solutions.	Increases automobile travel.
Modeling Practices	Exaggerates benefits of increased vehicle travel.	Increases automobile travel.
Generated Traffic	Exaggerates roadway expansion benefits.	Increases automobile travel.
Service Quality	Undervalues service quality impacts.	Reduces use of alternative modes.
Downstream Congestion	Exaggerates roadway expansion benefits.	Increases automobile travel.
Consumer Impacts	Undervalues improvements to alternative modes.	Increases automobile travel.
Parking Costs	Underestimates motor vehicle travel costs and savings from reduced driving.	Increases automobile travel.
Vehicle Costs	Underestimates savings from reduced driving.	Increases automobile travel.
Construction Impacts	Exaggerates roadway expansion benefits.	Increases automobile travel.
Transportation Diversity	Undervalues alternative modes.	Increases automobile travel.
Equity Analysis	Undervalues alternative modes.	Increases automobile travel.
Environmental Impacts	Underestimates motor vehicle travel costs and savings from reduced driving.	Increases automobile travel.
Land Use Impacts	Favors more dispersed and automobile-oriented land use development.	Increases automobile travel. Reduces accessibility options.
Economic Development	Overvalues policies and projects that favor motor vehicle transport. Discourages pricing reforms.	Increases automobile travel.
Safety and Health Impacts	Undervalues nonmotorized travel and the costs of more automobile-oriented solutions.	Increases automobile travel, reduces walking and cycling.

This table indicates how conventional planning distortions affect planning decisions and travel activity. Most distortions favor accessibility over mobility and automobile travel over alternative modes, increasing automobile travel and sprawl, and reducing alternative modes and land use accessibility.

These are technical distortions, meaning that they cause decision-makers to reach conclusion that would change had they more comprehensive and accurate information. Many of these distortions result from outdated perspectives, assumptions and technologies, which justified automobile-oriented planning.

These distortions have various specific impacts on planning decisions:

- They reduce support for improving land use accessibility, such as locating schools and stores close to residential neighborhoods.
- They reduce support for walking and cycling improvements, such as sidewalks, paths, crosswalks, and traffic calming.
- They reduce support for public transit, and result in transit being considered only a way to provide basic mobility for disadvantaged users, reducing the justification for service quality improvements that could attract travelers who would otherwise drive.
- They increase minimum parking requirements and reduce support for parking management strategies, increasing sprawl and automobile dependency.
- They create reluctance for road and parking pricing reforms.

This analysis indicates that more comprehensive and neutral transport planning could significantly change planning decisions. It would tend to increase support for alternative modes and mobility management strategies that increase transport system efficiency, providing significant economic, social and environmental benefits.

Critics sometimes argue that a similar set of distortions favor alternative modes. In particular, they point out that:

- Public transit receives a proportionately large share of funding. Although transit only serves about 2% of total passenger trips, it receives about 20% of total transportation agency budgets, and an even larger share of some regional capital budgets. However, several factors can justify such funding practices:
    - Transit budgets include vehicles, terminals and (for some systems) rail lines. Transport agency budgets only include roadway expenditures. When these additional costs are considered, transit's share of expenditures turns out to be more proportionate. Transit expenditures represent about 10% of road and parking expenditures, and only about 3% of road, parking and vehicle expenditures.
    - Transit provides basic mobility for non-drivers which requires special vehicles to accommodate people with disabilities and service in areas with low demand.

  - Major transit systems are concentrated in large cities where any form of transportation is costly to provide. Transit expansion is often compared or cheaper than accommodating additional automobile trips on such corridors.

- Vehicle taxes sometimes finance alternative modes, such as paths and transit services. However, those are more than offset by general taxes used to finance roadway improvements and parking facilities.
- Vehicle travel is sometimes restricted, such as car-free days. However, these are uncommon and justified on various grounds. Most roadway systems are dominated by automobile transportation.

Travel Impacts

This analysis indicates that more comprehensive planning should lead to improved transport options, more accessible land use, and more incentives to reduce motor vehicle travel (such as road and parking pricing). As a result, consumers would drive less and rely more on alternative modes. These reductions would probably be large.

Various case studies indicate that more efficient and neutral planning tends to increase travel options and reduce automobile travel. Cost-effective strategies (unit costs are equal or less than that of accommodating additional automobile travel) that rely primarily on positive incentives (improved travel options and new financial rewards for those who reduce driving, but travelers who continue driving are not significantly worse) can reduce automobile trips by 10-30%. For example ("Success Stories," VTPI, 2006):

- *Transit service improvements and commute trip reduction programs* reduced drive-alone commute rates in downtown Bellevue, Washington from 81% in 1990 to 57% in 2000, and in downtown Boulder from 56% in 1995 to 36% in 2005, and more than doubled transit mode share from 15% to 34%.
- *Individualized marketing programs*, which offer residents detailed travel option information have reduced automobile travel by 5-15% in various communities.
- Households that shift from private car ownership to *carsharing* typically reduce their annual vehicle mileage by 20-60%.
- *Campus transport management programs* with parking management and transit discounts often reduce student automobile trips by 10-20%.
- Tax policy reforms that reduce incentives for businesses to provide company cars and generous mileage allowances could reduce both business and personal travel. One study estimates that such reforms could reduce 2.4% of UK car mileage (IEEP, 1999).

Transport modeling in various U.S. metropolitan regions summarized by Johnston (2006) indicates that more comprehensive regional planning designed to maximize cost efficiency and consumer surplus would reduce VMT by 10% to 20% compared to trend scenarios, while supporting the same level of job and housing growth and providing comparable or better highway levels-of-service. The optimized plans include pricing reforms (such as road and parking pricing), increased investment in alternative modes (such as busways and rail transit services), and land use policies that improve accessibility (such as more compact and transit-oriented development). However, these only included a portion of the reforms described in this paper, and only at one geographic scale (regional, not national or local), so these represent the lower-bound range of travel changes that would result from truly optimal transport planning.

People who live or work in areas with good mobility options tend to drive 10-30% less than national averages ("Land Use Impacts on Transport," VTPI, 2006). This suggests that comprehensive, least-cost transport planning would significantly improve travel options and reduce automobile travel by at least 20-40%, and more if implemented with additional cost-effective pricing and land use reforms.

Economic Impacts

Existing planning distortions violate basic economic principles, including consumer sovereignty (markets should supply the goods that consumers demand), cost-based prices (prices should reflect marginal costs unless a subsidy is specifically justified), and economic neutrality (public policies should not arbitrarily favor a particular product or group). As a result, these distortions tend to reduce economic efficiency and equity objectives. This suggests that a significant portion of perceived consumer preference for automobile travel results from current market distortions.

The reforms recommended in this report will increase support for alternative modes, more efficient land use patterns, and mobility management strategies. The pricing reforms that result (such as road and parking pricing) test consumer demand based on their willingness-to-pay; higher value travel will continue, but travel that provides benefits less than its total costs will be reduced. These reforms are widely endorsed by economists. For example, most economists support road pricing, parking pricing, comprehensive evaluation that considers indirect and external costs, least-cost planning (so resources can be allocated to the most cost effective solution, including demand management strategies) and associated reforms such as flexible funding, and planning that responds to consumer demands.

The planning reforms described in this paper should increase overall economic efficiency and productivity. For example, they should reduce costs to consumers (due to improved transport options), improve economic opportunities to disadvantaged people, reduce road and parking facility costs to governments and businesses, improve freight transport efficiency (for example, by giving higher value vehicles priority in congested traffic) and reduce social costs such as traffic accidents.

Some of these reforms, such as road and parking pricing increase user costs, but these are economic transfers: increased fees that provide revenues which reduce the need to collect other fees and taxes. For example, it is more economically efficient and equitable to charge motorists for using roads and parking facilities than to finance these facilities through general taxes or increased building rents.

Evidence that reforms are justified:

- *Latent Demand.* There is evidence that consumers will use alternative modes when they are of adequate service quality. For example, where walking and cycling conditions are improved, walking and cycling activity often increases significantly. This suggests that there is often latent demand for alternatives.

- *Willingness-To-Pay.* Consumers are often willing to pay a premium for additional options, and under some conditions, these can be self-financing.
- Cost Effectiveness. Evidence that alternative options are overall more cost effective than current investments.

Scope of Analysis

Conventional transport planning tends to focus on a limited set of *evaluation criteria* (the factors considered in the planning process). For example, conventional transport project evaluation models, such as MicroBenCost and HDM-4 consider facility costs, travel speeds, vehicle operating costs and distance-based crash risk. Other impacts tend to be given less consideration. Some of these omissions reflect impacts that are difficult to quantify, such as social equity and indirect environmental impacts, but others are ignored simply out of tradition (parking costs, long-term vehicle costs, construction delays). In general, these omissions tend to favor mobility over accessibility, and automobile travel over other modes.

Table 4 **Scope of Conventional Planning Analysis**

Usually Considered	Often Overlooked
Financial costs to governments	Downstream congestion impacts
Travel speed (reduced congestion delays)	Barrier effects (impacts on non-motorized travel)
Vehicle operating costs (fuel, tolls, tire wear)	Parking costs
Per-mile crash risk	Vehicle ownership and mileage-based depreciation costs.
Project construction environmental impacts	Project construction traffic delays
	Generated traffic impacts
	Indirect environmental impacts
	Strategic land use impacts
	Transportation diversity value (e.g., mobility for non-drivers)
	Equity impacts
	Per-capita crash risk
	Impacts on physical activity and public health
	Some travelers' preference for transit (lower travel time costs)

Conventional transportation planning tends to focus on a limited set of impacts.

Correction: More comprehensive analysis can take into account a wider range of impacts. This type of analysis can be considered at various stages in a planning process.

Transport planning often starts by defining various transport system *problems* (or *costs*), which describe the conditions that people consider undesirable. *Planning objectives* (or *benefits*) describe desirable outcomes. These are the inverse of problems. For example, if traffic congestion is a problem then congestion reduction is a planning objective, and if traffic accidents are a problem then improved traffic safety is a planning objective. This describes what a community wants to achieve.

Table 5 lists various planning objectives (outcomes that people consider desirable) and the degree that they are considered in conventional planning. Conventional transport planning tends to focus on certain planning objectives and overlook others, particularly in formal economic evaluation in which impacts are quantified and monetized (measured in monetary values).

Table 5 **Comprehensive Planning Objectives** (Litman 2010)

Planning Objective	Definition	Consideration in Conventional Planning
Increased user convenience and comfort	More convenient and comfortable conditions for transport system users, such as better user information, nicer walking facilities and transit waiting areas, and less crowded transit vehicles.	Although often recognized as desirable, not generally quantified or included in benefit-cost analysis.
Congestion reduction	Reduced delays, and associated reductions in travel time, fuel costs and pollution emissions.	Motor vehicle congestion costs are widely recognized and quantified, but delays to non-motorized travel (called the "barrier effect") is generally ignored.
Roadway cost savings	Reduced costs for building and maintaining roadways.	Generally considered.
Parking cost savings	Reduced costs for building and maintaining parking facilities.	Generally ignored. For example, the parking cost savings that result when travel shifts from automobile to alternative modes is not generally considered when evaluating transport polices and projects.
Consumer cost savings	Reduced costs to users to own and operate vehicles, and for public transit fares.	Operating cost savings are generally recognized but vehicle ownership savings (such as if improved travel options allows households to reduce their vehicle ownership) are generally ignored.
Reduced traffic accidents	Reduced per capita traffic crashes and associated costs.	Crash risk, measured per vehicle-mile, is often considered, but impacts of changes in vehicle mileage are generally ignored.
Improved mobility options	Improved quantity and quality of transport options, particularly affordable modes that serve non-drivers.	Sometimes recognized as a planning objective but seldom quantified or included in formal economic evaluation.
Energy conservation	Reduced energy consumption, particularly petroleum products.	Sometimes recognized.
Pollution reduction	Reduced emissions of harmful air, noise and water pollution.	Sometimes recognized.
Physical fitness and health	Improved physical fitness and health, particularly more walking and cycling by otherwise sedentary people.	Not usually considered in the past, but is increasingly recognized, although seldom quantified.
Land use objectives	Support for various land use planning objectives (called "smart growth"), including more compact, mixed development (which improves accessibility and reduces public service costs), openspace preservation, and community redevelopment.	Sometimes recognized as a planning objective but seldom quantified or included in formal economic evaluation.

"Planning objectives" are desirable outcomes, the opposite of "problems." This table lists various transport planning objectives and the degree they are considered in conventional planning.

Many transport improvement strategies can only achieve a few planning objectives. For example, expanding highways increases motorist comfort and reduces traffic congestion.[1] More efficient and alternative fueled vehicles conserve energy and reduce pollution emissions.[2] Other strategies tend to provide a broader range of benefits. For example, improving transport options (better walking and cycling conditions, improved public transit, taxi services and delivery services, and improved user information about transport options) tends to provide a variety of benefits, including direct benefits to users (improved convenience and comfort, and financial consumer savings) plus various external benefits, particularly if these improvements cause travelers to shift from driving to more efficient alternatives.

Pricing reforms can also tend to provide many benefits. With increased fuel, road and parking prices, and distance-based insurance and registration fees, some motorist will pay more, but overall cost impacts depend on how revenues are used. Increased road and parking facility user fees do not necessarily harm consumers compared with other financing options, for example, if general taxes must increase to finance public roads or if building rents increase to finance parking facilities. Smart growth development policies also provide a variety of benefits to users and society by reducing the distances people must travel to access services and activities, reducing the costs of providing public services such as water, sewage, schooling and policing, and by preserving openspace. Table 6 summarizes these impacts.

Table 6 **Comparing Strategies** (Litman 2005)

Planning Objective	Roadway Expansion	Fuel Efficient Vehicles	Transport Options	Price Reforms	Smart Growth
User convenience and comfort	✓		✓	✓	✓
Congestion reduction	✓		✓	✓	✓
Reduced barrier effect[3]			✓	✓	✓
Roadway cost savings			✓	✓	✓
Parking cost savings			✓	?	✓
Consumer cost savings		?	✓	✓	✓
Reduced traffic accidents			✓	✓	✓
Improved mobility options			✓	✓	✓
Energy conservation		✓	✓	✓	✓
Pollution reduction		✓	✓	✓	✓
Physical fitness & health			✓	✓	✓
Land use objectives			✓	✓	✓

(✓= Achieve objectives.) Roadway expansion and more fuel efficient vehicles provide few benefits. Win-Win Solutions improve travel options and encourage more efficient travel patterns, which helps achieve many planning objectives.

[1] Congestion reductions tend to reduce energy consumption and pollution emissions per vehicle-mile, but these are included in most monetized estimates of congestion reduction benefits, and some congestion reduction strategies induce additional vehicle travel which offsets some of these savings.

[2] More efficient and alternative fuel vehicles reduce vehicle operating costs, but generally increase ownership costs, so consumer cost impacts are uncertain.

[3] *Barrier effect* refers to the delay and discomfort that wider roads and higher vehicle traffic speeds and volumes have on pedestrian and bicycle travel.

These impacts become more evident if long-term impacts are considered, as indicated in Table 7. For example, over the long-run, roadway expansion often induces additional vehicle travel, as previously described, which reduces congestion reduction benefits and increases total traffic problems including downstream congestion (for example, expanding highways often increases surface street congestion), road and parking facility costs, accidents, energy consumption, pollution emissions and sprawl.

Similarly, more fuel-efficient vehicles tend to reduce energy consumption, pollution emissions and fuel cost (although these savings are often offset by increased vehicle purchase costs). However, because they cost less to drive, owners of fuel efficient vehicles tend to drive more annual miles, which can increase traffic problems including road and parking facility costs, accidents, and sprawl.

Table 7 **Comparing Strategies Including Travel Impacts**

Planning Objective	Roadway Expansion	Fuel Efficient Vehicles	Transport Options	Price Reforms	Smart Growth
Motor Vehicle Travel Impacts	*Increased*	*Increased*	*Reduced*	*Reduced*	*Reduced*
User convenience and comfort	✓		✓		✓
Congestion reduction	✓/✗[4]	✗	✓	✓	✓
Roadway cost savings	✗	✗	✓	✓	✓
Parking cost savings	✗	✗	✓	✓	✓
Consumer savings	✓	✗/✓[5]	✓	✗/✓[6]	✓
Reduced traffic accidents	✗	✗	✓	✓	✓
Improved mobility options	✗		✓	✗/✓[7]	✓
Energy conservation	✗	✓	✓	✓	✓
Pollution reduction	✗	✓	✓	✓	✓
Physical fitness and health			✓	✓	✓
Land use objectives	✗	✗	✓	✓	✓

(✓ = Achieve objectives. ✗ = Contradicts objective.) Roadway expansion and more fuel efficient vehicles provide few benefits, and by increasing total vehicle travel they can exacerbate other problems such as congestion, accidents and sprawl. Win-Win Solutions improve travel options, encourage use of alternative modes and create more accessible communities, which reduces total vehicle travel and increases economic efficiency. This helps achieve many planning objectives.

[4] Congestion is reduced on the expanded facility but often increases downstream, such as on surface streets.
[5] More fuel efficient vehicles tend to have higher purchase costs but lower operating costs.
[6] User fees increases driving costs but reduce general taxes used to finance roads and parking facilities.
[7] Higher fuel, road and parking prices make driving less affordable, but distance-based pricing and lower public transit fares make travel more affordable, and by encouraging use of alternative modes, pricing reforms tend to improve the quality of alternatives, such as improved walking and cycling conditions, improved public transit services, and increasing the social status of alternative modes.

Addressing Structural Obstacles

This analysis indicates that, in various ways, conventional planning tends to favor mobility over accessibility and automobile transport over alternative modes and mobility management strategies. This asymmetry occurs because motor vehicle travel tends to be easier to measure, better understood, and more prestigious than alternative modes.

Evaluation Methods

Mobility, particularly motor vehicle travel, is easier to evaluate than accessibility. For example, it is relatively easy to measure vehicle mileage, vehicle traffic speeds, congestion delays and operating costs, and to use indicators such as roadway level-of-service ratings to identify problems and evaluate improvements. Accessibility evaluation requires measuring various factors and perspectives, including mobility options, land use factors, roadway connectivity, mobility substitutes, and transport affordability. As a result, mobility benefits are easier to quantify than accessibility benefits.

Correction: Transport planning should be based on accessibility rather than mobility, employ accessibility as well as mobility indicators, and convey to decision-makers any residual biases in the evaluation process that favors mobility over accessibility and automobile travel over alternative modes and mobility management strategies.

Decision-Makers' Experience

Most transportation decision-makers (planners, engineers, economists, elected officials, etc.) are physically able professionals with demanding jobs and active lifestyles, who tend to rely heavily on automobile travel and seldom depend on alternative modes due to physical disabilities or financial constraints. As a result, transportation decision-makers tend to be most familiar with the problems facing motorists and less familiar with problems facing transportation disadvantaged people. This is not to suggest that transport professionals are insensitive to non-drivers' needs. Most have friends or family members who depended on alternative modes and many demonstrate a sincere commitment to assisting disadvantaged people, for example, by supporting special programs to improve mobility for people with disabilities. However, they tend to focus on narrowly defined problems and solutions. They seldom perceive the structural problems that result from policies and practices that incrementally increase automobile dependency.

Corrections: The transport planning process should include effective opportunities for public participation, including people with special transportation needs. Transportation decision-makers should be encouraged to experience the transportation system from various perspectives, such as spending a few days using a wheelchair and a few weeks without driving. They should be encouraged to use this experience to identify practical ways to improve non-automotive transportation.

Prestige

Automobile and air travel are often favored because they are considered modern and prestigious, while alternative modes they are considered outdated and stigmatized. Many people assume that transportation modes follow a linear progression, with older, slower modes being displaced by newer, faster modes. These assumptions are often outdated. Several trends are increasing the future value of alternative modes, including aging population, rising energy costs, increasing traffic congestion and roadway expansion costs, urbanization, and shifting consumer preferences. Many people walking and cycling for transportation, and many commuters prefer using alternative modes such as vanpooling and public transit, provided that they have high service quality. Many older, slower modes continue to be important.

Correction: Educate decision-makers and the general public about the value of alternative modes and the role they can play in solving future transportation problems.

Economic Development Justifications

In the past, particularly during the first half of the Twentieth Century, vehicle production and roadway infrastructure experienced significant efficiencies of scale and provided industrial development benefits. For example, you benefited if your neighbors purchased more vehicles and drove more miles because that helped reduce the prices you would pay for vehicles and fuels, stimulated the construction of more and higher quality roads, and helped develop the economy. These circumstances justified public policies that encouraged automobile travel. However, such policies are now outdated. Vehicle and fuel industries are now mature, offering no efficiencies of scale. The road system is now well developed, suffering from congestion and overuse. Other industries now provide much higher economic returns and development benefits. Policies and planning practices that favored automobile and fuel industries, stimulated roadway expansion and minimized road and parking user fees can no longer be justified on economic development grounds.

Biased Planning Assumptions and Language

Numerous common planning assumptions and terms are unintentionally biased in favor of mobility and automobile travel.

Corrections: Transport planning assumptions and terminology should be reviewed to identify those that unintentionally favor mobility over accessibility and automobile travel over alternative modes, as described in the box below.

Neutral Transport Planning Language (Lockwood 2004)
Many transport planning terms unintentionally favor motor vehicle travel over other forms of access. For example, increased road and parking capacity is often called an "improvement," although wider roads and larger parking facilities tend to degrade walking conditions by increasing vehicle traffic volumes and speeds, and dispersing destinations. Calling such changes "improvements" is a bias favoring driving over walking (and therefore transit, since most transit trips involve walking links). Objective language uses neutral terms, such as "added capacity," "additional lanes," "modifications," or "changes."

The terms "traffic," "flow," and "trip" often refer only to motor vehicle travel. Short trips, non-motorized trips, travel by children, and non-commute trips are often undercounted or ignored in transport surveys, models, and analysis. Although automobile and transit trips often begin and end with a pedestrian or cycling link, they are often classified simply as "auto" or "transit" trips. Walking and cycling conditions are often evaluated inadequately or not at all.

The term "efficient" is frequently used to mean increased vehicle traffic speeds. This assumes that faster vehicle traffic always increases overall efficiency. However, higher vehicle speeds can reduce total traffic capacity, increase resource consumption, increase user costs, increase crash risk, reduce walkability, and create less accessible land use patterns, reducing overall system efficiency.

Transportation professionals often use level-of-service (LOS) ratings to evaluate vehicle travel conditions, but apply no comparable rating for other travel modes. It is important to indicate which users are considered when level of service values are reported.

Biased Terms	Neutral Terms
Traffic	Motor vehicle traffic, pedestrian, bike traffic, etc.
Trips	Motor vehicle trips, person trips, bike trips, etc.
Improve	Change, modify, expand, widen
Enhance	Change, increase traffic speeds
Deteriorate	Change, reduce traffic speeds
Upgrade	Change, expand, widen, replace
Efficient	Faster, increased vehicle capacity
Level of service	Level of service for…

Examples:
Biased: *Level of service* at this intersection is rated "D." The proposed *improvement* will cost $100,000. This *upgrade* will make our transport system more *efficient* by *enhancing* capacity, preventing *deterioration* of *traffic* conditions.

Neutral: *Level of service* at this intersection is rated "D" *for motorists* and "E" *for pedestrians*. A *right turn channel* would cost $100,000. This *road widening project* will *increase motor vehicle traffic speeds and capacity* but may *reduce safety and convenience to pedestrian travel*.

Examples and Case Studies

This section illustrates how more comprehensive analysis affects transport planning decisions.

Highway Congestion Reduction Analysis (Litman 2006b)
The narrow and winding Malahat Highway, north of Victoria, British Columbia, is facing increased traffic congestion delay and crash risk. The provincial government funded a study to evaluate possible solutions (MoT 2007). The study considered various options, including an expanded or new highway, a major new bridge to provide a shortcut, or rail service improvements. However, it initially did not include any options based on bus service (there is currently no bus transit service over the route) and vanpool services and mobility management incentives to encourage use of those modes, such as commute trip reduction programs, parking pricing and cash out, HOV priority (so bus and vanpool travel would be relatively faster), vanpool subsidies, or road pricing.

In response to public input the consultants added a bus service option, but their analysis calculated transit demand without any mobility management incentives, and so concluded that transit use would be small and provide little benefit.

The government and consultants defined the problem narrowly, as peak period traffic congestion, unreliability (particularly when a crash blocks the highway), and possible excessive crash risk. For example, they did not consider the lack of mobility options for non-drivers, nor the stress and financial costs to commuters who drive regularly over the highway, to be problems. As a result, their analysis assigned no benefit for planning options that improve mobility options (such as public transit and vanpooling).

The analysis did not consider the impacts that result from changes in total vehicle traffic, for example, if highway improvements induce additional vehicle travel on the corridor, and if improvements to alternative modes reduce total vehicle travel. There was no consideration of downstream traffic and parking congestion impacts. Safety impacts were evaluated based only on crash rates on the highway itself, there was no consideration of increased downstream crashes that would result from induced travel, and the crash reductions that would result from automobile-to-transit mode shifting.

The study ultimately recommended a combination of incremental roadway improvements and basic bus transit service, because all other options were much more expensive. Because bus service is being provided without new incentives to encourage its use there is unlikely to be significant mode shifting, so transit service cost efficiency will be low and highway traffic problems will probably increase in the future.

Table 8 summarizes a comparison of these options. The conventional analysis used by the government only considered three categories of impacts (indicated in grey), congestion, safety and reliability on the facility. Other types of impacts were ignored, or described but not quantified for economic evaluation. Because the Ministry of Transportation has no experience with mobility management programs, or institutional structure to support such programs, their potential impacts and benefits were not considered in the analysis.

Table 8 **Comparing Options** (Litman 2006b)

	Widen or New Highway	Saanich Bridge	Rail Service	Bus/Vanpool/TDM
Malahat congestion	Large reduction, but declines due to generated traffic.	Moderate to large reduction.	Small to moderate reduction.	Small to moderate reduction.
Downstream congestion	Increased due to increased total traffic.	Increased due to increased total traffic.	Reduced by reducing total regional traffic.	Reduced by reducing total regional traffic.
Parking costs	Increased by increasing regional vehicle trips.	Increased by increasing regional vehicle trips.	Reduced by reducing total vehicle trips.	Reduced by reducing total vehicle trips.
Malahat traffic safety	Increased on new or improved highway.	Moderate to large safety increase.	Increased safety.	Moderate safety increase.
Downstream traffic safety	Reduced safety by increasing total regional vehicle traffic.	Reduced safety by increasing total regional vehicle traffic.	Increased safety by reducing total regional vehicle traffic.	Increased safety by reducing total regional vehicle traffic.
Reliability	Large increase by increasing travel lanes and routes.	Large increase by increasing travel lanes and routes.	Moderate increase by providing grade-separated route.*	Small increase due to reduced traffic crashes.
Consumer costs	Reduces vehicle operating costs.	Reduces distance for some trips.	Moderate savings due to moderate fares.	Large savings due to low fares.
Mobility for non-drivers	No benefit. May reduce accessibility by causing sprawl.	No benefit. May reduce accessibility by causing sprawl.	Moderate benefit.	Significant benefit.
Pollution impacts	Increased by increasing total vehicle travel.	Increased by increasing total vehicle travel.	Reduced by reducing total vehicle travel.	Reduced by reducing total vehicle travel.
Facility environmental impacts	Increased by expanding roadway area.	Increased by expanding roadway area.	No impact.	No impact.

This table evaluates Malahat Highway improvement options. Conventional analysis only considers the green shaded impacts. Rail, bus and vanpool benefits depend on the portion of automobile trips shifted to these modes, and so depend on the mobility management incentives provided.

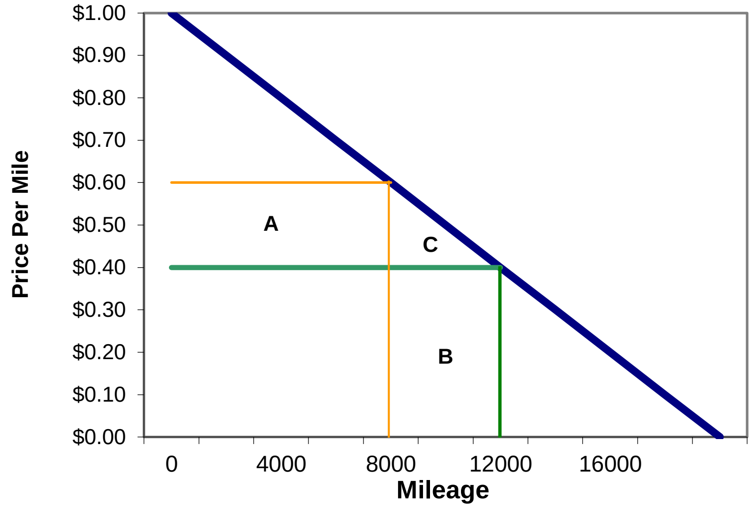
More comprehensive analysis would consider more options and impacts, which would probably justify an integrated package of bus transit improvements and mobility management strategies.

Ultimately, the government chose limited bus transit improvements. It helped finance four daily commuter bus trips from Duncan to downtown Victoria. Because service is so limited, fares are relatively high and there are few support incentives, ridership has been low, representing only about 1% of total daily trips on the route.

Consumer Surplus Analysis

Consumer surplus analysis can be used to calculate the value of changes in price and consumption (in this case vehicle travel). For example, Figure 3 illustrates the consumer surplus value of vehicle operating cost increases from 40¢ to 60¢ per vehicle-mile that reduce vehicle travel from 12,000 to 8,000 annual vehicle-miles. Rectangle **A** represents the additional annual payments, which is an economic transfer from motorists to whoever collects the revenue, minus any additional transaction costs (incremental costs of collecting the fees). Rectangle **B** represents the money consumers save from reduced mileage. Triangle **C** represents the net consumer surplus losses from the reduced mileage.

Figure 3 **Calculating Consumer Surplus Using The Rule-of-Half**



*This figure illustrates the change in consumer surplus (net value to users) from a price increase that reduces vehicle travel. Rectangle **A** represents the value of additional payments, an economic transfer from motorists to whoever collects the fee (minus any additional costs of collecting the fees). Rectangle **B** represents the money that consumers previously paid for the additional 4,000 annual miles they now forego. Triangle **C** represents the net loss of consumer surplus from the reduced mileage.*

There are three important points that should be considered in this analysis:

1. Mileage reductions that result from increased prices represent lost consumer surplus, but mileage reductions that result from positive incentives (financial or improved service quality) represent increased consumer surplus. For example, any vehicle travel reductions from optional incentives such as parking cash out and pay-as-you-drive insurance represent consumer surplus gains, since motorists can continue their current mileage without penalty.

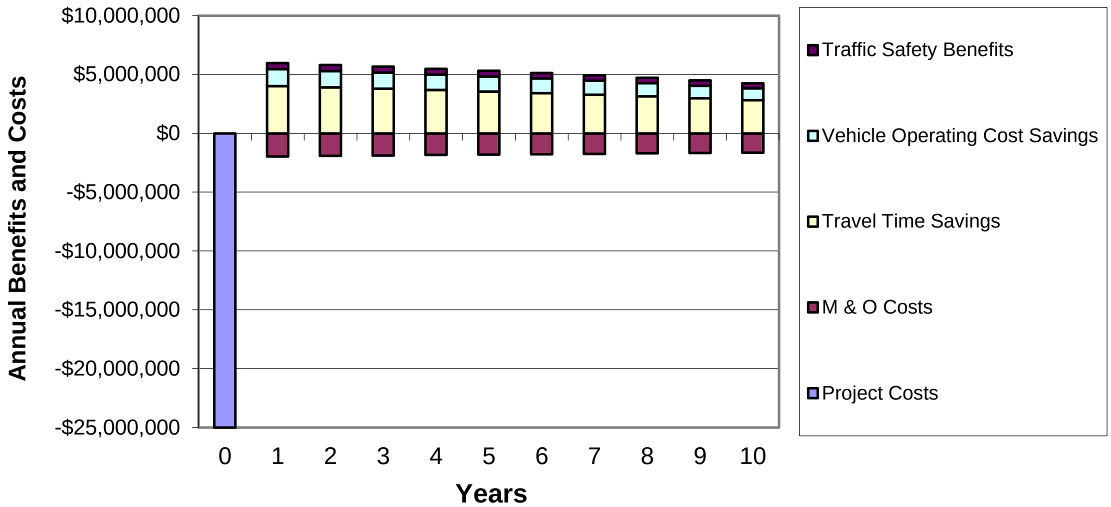
2. Payments or incentives are economic transfers; costs to consumers but benefits to those who collect the revenues. Net costs are any additional transaction costs.

3. The net cost or benefit to consumers is calculated using the rule-of-half (half of mileage times the change in price).

Conventional Versus Comprehensive Economic Evaluation

Figures 1 and 2 illustrate conventional economic evaluation of hypothetical road expansion project and transit projects. They only consider a few impacts.

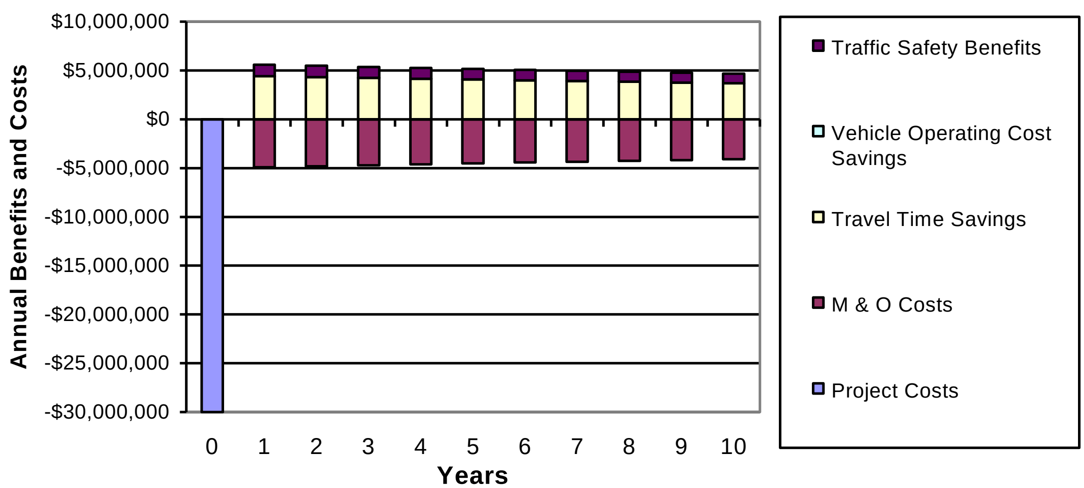
Figure 1 **Conventional Highway Project Benefit-Cost Evaluation**



This figure illustrates projected benefits and costs of a hypothetical highway project. Benefits are values above the baseline, costs are values below it.

As a result, this analysis concludes that the highway project has a Benefit/Cost ratio of 1.36, and only 0.78 for the transit project. From this perspective, the highway project appears more cost effective than the transit option.

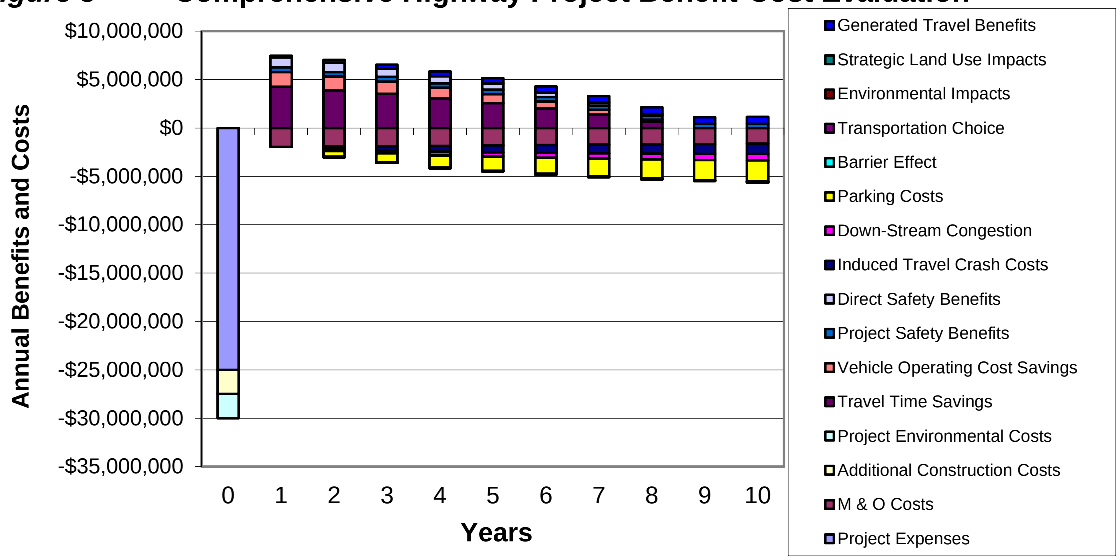
Figure 2 **Conventional Transit-TDM Project Benefit-Cost Evaluation**



This figure illustrates projected benefits and costs of a hypothetical transit project.

More comprehensive analysis incorporates a wider range of factors: generated traffic, additional vehicle operating costs, and external impacts. Figure 3 illustrates a comprehensive evaluation of the same roadway project. Figure 4 illustrates a comprehensive evaluation of the transit-TDM project.

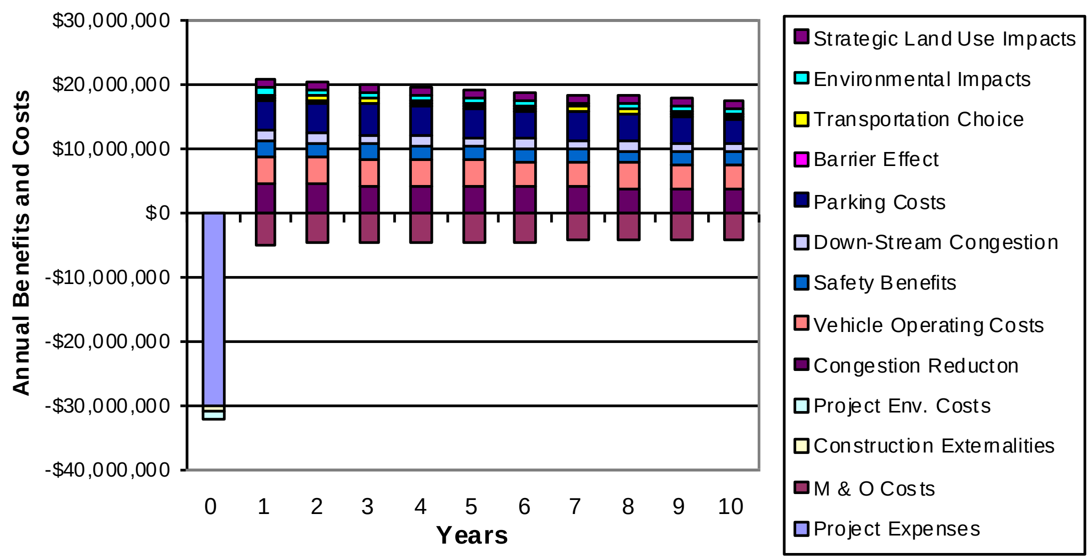
Figure 3 **Comprehensive Highway Project Benefit-Cost Evaluation**



This figure illustrates projected benefits and costs using a comprehensive evaluation model.

The comprehensive model accounts for the incremental costs of vehicle travel induced by highway expansion and additional benefits from the transit project due to increased mobility options and more efficient land use. As a result the comprehensive analysis concludes that the transit option is actually more cost effective than the highway project.

Figure 4 **Comprehensive Transit-TDM Project Benefit-Cost Evaluation**



This figure illustrates the projected benefits and costs of a hypothetical transit project.

Best Practices

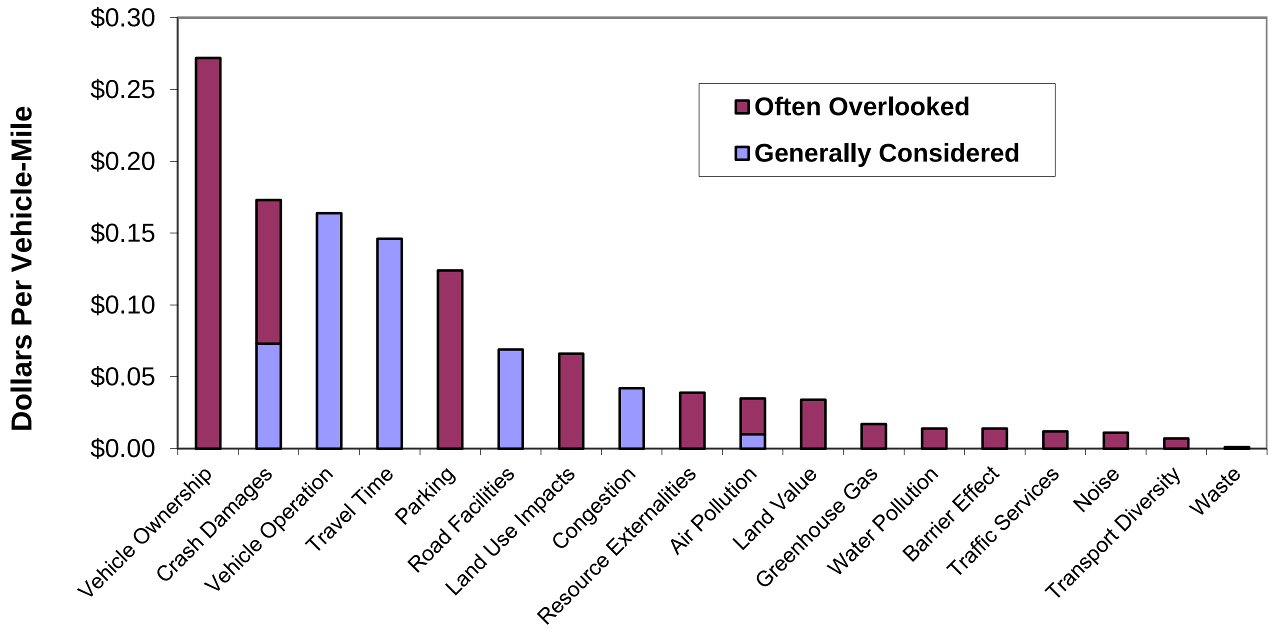
Best practices for comprehensive transportation evaluation are listed below.

1. Consider a wide range of possible solutions to transportation problems, including improvements to alternative modes, and transportation demand management strategies.
2. Use performance indicators that reflect access and personal mobility, rather than measuring transportation system quality only in terms of motor vehicle traffic. Develop indices that reflect access from various perspectives.
3. Correct planning and investment practices that favor large, capital investments over operations, maintenance and management expenditures, or which favor one mode over others. Use least-cost planning that allow the most cost-effective solutions to be selected.
4. Use up-to-date travel models that can forecast the traffic generated by increased roadway capacity and the effects this will have on downstream congestion, roadway costs, parking costs, pollution and sprawl.
5. Use consumer surplus analysis to evaluate consumer impacts, rather than simply measuring changes in travel time.
6. Consider all costs to consumers of owning and operating motor vehicles, and potential consumer savings that can result from transportation alternatives that reduce vehicle ownership and use.
7. Consider all construction impacts, including traffic congestion delays, crash risks, and lost business activity that occur during construction. Also, uncompensated losses to residents and businesses that are displaced by projects.
8. Consider impacts on nonmotorized travel, including reduced pedestrian access from inadequate walking facilities, wider streets, increased vehicle traffic speeds and volumes, and more dispersed destinations.
9. Consider equity impacts, including cross-subsidies and impacts on people who are economically, socially and physically disadvantaged.
10. Consider environmental and community livability impacts.
11. Consider impacts that transportation planning decisions can have on land-use patterns, including loss of greenspace from increased pavement, and higher public service costs from increased urban sprawl.
12. Evaluate the full safety, security and health impacts of transportation options, including additional benefits from mobility management strategies.

Conclusions

To be efficient and fair, planning must consider all significant options and impacts. Conventional planning tends to be biased in various ways that favor traditional solutions and easy-to-measure impacts, while undervaluing innovations and more difficult to measure impacts. This study identifies various technical distortions in conventional transport planning. These distortions tend to favor mobility over accessibility and automobile transport over other modes.

Figure 5 **Average Automobile Costs**



Conventional transport project evaluation generally considers roadway costs, travel time, vehicle operating costs, and some accident and air pollution costs. Other impacts are often overlooked.

Conventional transport planning practices were developed to make relatively simple decisions concerning highway route and design, and parking supply decisions. They are inadequate for more complex planning decisions, such as those that involve land use accessibility, multi-modal comparisons, pricing strategies, or which are concerned with additional economic, social, and environmental impacts.

A number of specific planning reforms described in this report can result in more comprehensive planning. Judgment is needed to apply these reforms. They are not necessarily appropriate or cost effective in every situation. In particular, modeling improvements can be difficult to implement. However, many of these reforms are relatively easy to apply. They involve redefining problems, expanding the range of solutions considered, considering additional impacts, or providing additional cautions when presenting evaluation results. This more clearly indicates what options and impacts have been excluded from quantitative analysis, and the general direction that such bias is likely to have on conclusions and recommendations.

More comprehensive planning tends to support alternative modes and mobility management strategies. With comprehensive planning, automobile travel would not disappear, but it would probably decline significantly. There is evidence that many people would prefer to drive less and rely more on alternatives, provided that those alternatives are convenient and comfortable. A variety of social and economic trends are likely to increase consumer preferences for more accessible, walkable communities, and improvements to alternative modes. These include an aging population, rising fuel prices, environmental concerns, and increased urbanization. More comprehensive analysis will therefore be necessary to help prepare for future transport demands.

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