

Evaluating Transportation Equity

Guidance For Incorporating Distributional Impacts in Transportation Planning

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Abstract

Equity refers to the fairness with which impacts (benefits and costs) are distributed. Transportation planning decisions often have significant equity impacts. Transport equity analysis can be difficult because there are several types of equity, many potential impacts to consider, various ways to measure impacts, and many possible ways to categorize people. This report provides practical guidance for evaluating transportation equity. It defines various types of equity and equity impacts, and describes practical ways to incorporate equity evaluation and objectives in transport planning.

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Executive Summary

Equity refers to the distribution of impacts (benefits and costs) and whether that distribution is considered fair and appropriate. Transportation equity analysis is important and unavoidable; transport planning decisions often have significant equity impacts, and equity concerns often influence planning debates. Most practitioners and decision-makers sincerely want to achieve equity objectives. However, transport equity can be difficult to evaluate because there are various types, impacts, measurement units, and categories of people to consider, as summarized in Table ES-1.

Table ES-1 Equity Evaluation Variables

Types of Equity	Impacts	Measurement	Categories of People
Horizontal Equal treatment of equals Vertical With-Respect-To Income And Social Class Transport affordability Housing affordability Impacts on low-income communities Fare structures and discounts Industry employment Service quality in lower-income communities Vertical With-Respect-To Need And Ability Universal design Special mobility services Disabled parking Service quality for non-drivers	Public Facilities and Services Facility planning and design Public funding and subsidies Road space allocation Public involvement User Costs and Benefits Mobility and accessibility Taxes, fees and fares Service Quality Quality of various modes Congestion Universal design External Impacts Congestion Crash risk Pollution Barrier effect Hazardous material and waste Aesthetic impacts Community cohesion Economic Impacts Economic opportunities Employment and business activity Regulation and Enforcement Traffic regulation Regulations and enforcement Regulation of special risks	Per capita Per adult Per commuter or peak-period travel Per household Per Unit of Travel Per vehicle-mile/km Per passenger-mile/km Per trip Per commute or peak-period trip Per dollar Per dollar user fees Per dollar of subsidy Cost recovery	Demographics Age and lifecycle stage Household type Race and ethnic group Income class Quintiles Poverty line Lower-income areas Ability People with disabilities Licensed drivers Geographic location Jurisdictions Neighborhood and street Urban/suburban/rural Mode and Vehicle Type Pedestrians People with disabilities Cyclists & motorcyclists Motorists Public transit Industry Freight Public transport Auto and fuel industries Trip Type Emergency Commutes Commercial/freight Recreational/tourist

There are various types, impacts, measurement units and categories to consider in equity analysis.

How equity is defined and measured can significantly affect analysis results. It is important that people involved in transport planning understand these issues. There is no single way to evaluate transport equity; it is generally best to consider various perspectives and impacts. A planning process should reflect each community's concerns and priorities, so public involvement is important for equity analysis.

Introduction

Equity (also called *justice* and *fairness*) refers to the distribution of impacts (benefits and costs) and whether that distribution is considered fair and appropriate. Transportation planning decisions can have significant and diverse equity impacts:

- The quality of transportation available affects people's economic and social opportunities.
- Transport facilities, activities and services impose various indirect and external costs, such as congestion delay and accident risk imposed on other road users, infrastructure costs not funded through user fees, pollution, and undesirable land use impacts.
- Transport expenditures represent a major share of most household, business and government expenditures.
- Transport facilities require significant public resources (tax funding and road rights of way), the allocation of which can favor some people over others.
- Transport planning decisions can affect development location and type, and therefore accessibility, land values and local economic activity.
- Transport planning decisions can affect employment and economic development which have distributional impacts.

Transportation equity analysis can be difficult because there are several types of equity to consider, numerous impacts and ways of measuring those impacts, and various ways that people can be grouped for equity analysis. A particular decision may seem equitable when evaluated one way but inequitable when evaluated another.

Equity analysis is important and unavoidable. Equity concerns often influence transportation policy and planning decisions, and most practitioners and decision-makers sincerely want to address these concerns. However, there is little guidance for performing comprehensive transport equity analysis. Many existing evaluation tools focus on a narrow set of impacts on a particular group of people. Transport equity analysis is often ad hoc, based on the concerns and values of the stakeholders involved in a planning process; other, equally significant impacts may be overlooked or undervalued

This report provides an overview of transport equity issues, defines various types of transportation equity, discusses methods of evaluating equity impacts, and describes ways to incorporate equity analysis into transportation decision-making.

Transportation Equity Evaluation

This section discusses various ways to define and measure transportation equity impacts.

Types of Transportation Equity

There are three major categories of transportation equity.

1. Horizontal Equity

Horizontal equity (also called *fairness* and *egalitarianism*¹) concerns the distribution of impacts between individuals and groups considered equal in ability and need. According to this definition, equal individuals and groups should receive equal shares of resources, bear equal costs, and in other ways be treated the same. It means that public policies should avoid favoring one individual or group over others, and that consumers should “get what they pay for and pay for what they get” from fees and taxes unless a subsidy is specifically justified.²

2. Vertical Equity With Regard to Income and Social Class

Vertical equity (also called *social justice*, *environmental justice*³ and *social inclusion*⁴) is concerned with the distribution of impacts between individuals and groups that differ in abilities and needs, in this case, by income or social class. By this definition, transport policies are equitable if they favor economically and socially disadvantaged groups, therefore compensating for overall inequities.⁵ Policies favoring disadvantaged groups are called *progressive*, while those that excessively burden disadvantaged people are called *regressive*. This definition is used to support affordable modes, discounts and special services for economically and socially disadvantaged groups, and efforts to insure that disadvantaged groups do not bear excessive external costs (pollution, accident risk, financial costs, etc.).

3. Vertical Equity With Regard to Mobility Need and Ability

This is concerned with the distribution of impacts between individuals and groups that differ in mobility *ability and need*, and therefore the degree to which the transportation system meets the needs of travelers with mobility impairments. This definition is used to support *universal design* (also called *accessible* and *inclusive design*), which means that transport facilities and services accommodate all users, including those with special needs.

These different types of equity often overlap or conflict. For example, horizontal equity requires that users bear the costs of their transport facilities and services, but vertical equity often requires subsidies for disadvantaged people. Therefore, transport planning often involves making tradeoffs between different equity objectives.

¹ *Egalitarianism* means treating everybody equally, regardless of factors such as race, gender or income.

² Neutral public policies and cost-based pricing are also *economic efficiency* principles, as discussed later.

³ *Environmental justice* is defined as the “equitable distribution of both negative and positive impacts across racial, ethnic, and income groups, with the environment defined to incorporate ecological, economic, and social effects” (Alsnih and Stopher 2003).

⁴ *Social inclusion* means everybody can participate adequately in important activities and opportunities, including access to services, education, employment, and decision-making (Litman 2003b; Lucas 2004).

⁵ Rawls (1971) provides a theoretical basis for vertical equity. He argued that primary social goods (liberty, opportunity and wealth) should be distributed equally or to favor less advantaged people.

Impact Categories

Transport equity can involve various impacts (costs and benefits), such as those listed below.

Public Facilities and Services

- Amount and distribution of public funds for transport facilities and services.
- Parking requirements imposed on developers, businesses and residents.
- Government subsidies and tax exemptions for transportation industries.
- Use of tax-exempt public land for transportation facilities.
- Planning and design of transportation facilities.
- Degree of public involvement in transport planning.

User Costs and Benefits

- Overall level of mobility and accessibility (passenger-miles, trips, ability to reach activities).
- Vehicle ownership and operating expenses.
- Vehicle taxes and government fees, and fuel taxes.
- Road tolls and parking fees (including exemptions and discounts).
- Public transportation fares (including exemptions and discounts).
- Fitness (use of physically active modes, such as walking and cycling).
- Cost recovery and subsidies (portion of costs borne by a particular activity or group).

Service Quality

- Number of travel modes available in an area (walking, cycling, private automobile, vehicle rentals, public transportation, taxi, rail, air travel, delivery services, etc.).
- Roadway quality (traffic speeds, delay, safety, physical condition, etc.).
- Parking facility supply, location, regulation, price and design.
- Public transportation service quality (frequency, speed, reliability, safety, comfort, etc.).
- Land use accessibility (density, mix, connectivity, location of activities, etc.).
- Universal design (accommodation of people with disabilities and other special needs).

External Impacts

- Traffic congestion and risk an individual or vehicle class imposes on other road users.
- Air, noise and water pollution emissions.
- Barrier effect (delay that roads and railroads cause to nonmotorized travel).
- Transport of hazardous material and disposal of hazardous waste.
- Aesthetic impacts of transportation facilities and traffic activity.
- Impacts on community livability.

Economic Impacts

- Access to education and employment, and therefore economic opportunities.
- Impacts on business activity, property values, and economic development in an area.
- Distribution of expenditures and employment (who gets contracts and jobs).

Regulation and Enforcement

- Regulation of transport industries (public transportation, trucking, taxis, etc.)
- Traffic and parking regulation and enforcement.
- Regulation of special risks (railroad crossings, airport security, hazardous material, etc.).

Measurement Methods

Transportation impacts can be measured in various ways that affect equity analysis.

Definition of Transportation (Mobility- Versus Accessibility-Based Planning)

Transportation analysis is affected by how transport is defined and evaluated (CTS 2006). Conventional planning tends to evaluate transport based on *mobility* (physical travel), using indicators such as traffic speed and roadway level-of-service. However, mobility is seldom an end in itself, the ultimate goal of most transport activity is *accessibility*, which refers to people’s ability to reach desired services and activities. Various factors can affect accessibility including mobility, transport network connectivity and affordability, the geographic distribution of activities, and mobility substitutes such as telecommunications and delivery services (Litman 2003a).

This has important equity implications. Mobility-based planning tends to favor faster modes and longer trips over slower modes and shorter trips, and therefore motorists over non-drivers. For example, evaluating transport system performance based on roadway level-of-service tends to justify roadway expansion projects, despite the tendency of wider roads and increased traffic speeds to degrade walking and cycling conditions (called the *barrier effect*), and since most public transit trips include walking links, to reduce transit access. Only by using accessibility-based evaluation can such tradeoffs, and their equity impacts, be considered.

Table 1 Transportation Evaluation Perspectives (Litman 2003)

	Mobility	Accessibility
Definition of <i>Transportation</i>	Vehicle travel	Ability to obtain desired services and activities
Measurement units	Vehicle-miles/kms	Trips, generalized costs
Modes considered	Automobile, truck and transit	Non-motorized, motorized, mobility substitutes
Common indicators	Vehicle traffic speeds, roadway Level of Service, costs per vehicle-mile	Quality of available transport options, average trip distances, costs per trip
Favored transportation improvement strategies	Roadway and parking facility expansion	Improvements to various modes, transport demand management, smart growth development policies

This table compares mobility- and accessibility-based transport planning.

Accessibility-based analysis expands the range of impacts and options considered in planning. It recognizes the important roles that non-motorized and public transport can play in an efficient and equitable transport system, considers impacts such as the barrier effect and dispersed development on accessibility, and expands transport improvement options to include improvements to alternative modes, increased transport network connectivity, more accessible land use development, and improved telecommunications and delivery services. This provides more comprehensive equity evaluation.

Basic Accessibility and Mobility

Basic (also called *essential* or *lifeline*) *accessibility* refers to people's ability to reach activities that society considers basic or essential, such as those listed below. *Basic mobility* refers to travel that provides basic access.

Basic Goods, Services and Activities

- Emergency services (police, fire, ambulances, etc.).
- Public services and utilities (garbage collection, utility maintenance, etc.).
- Health care (medical clinics, rehabilitation services, pharmacies, etc).
- Basic food and clothing.
- Education and employment (commuting).
- Some social and recreational activities.
- Mail and package distribution.
- Freight delivery.

Basic access can be considered a “merit good” and even a right (Hamburg, Blair and Albright 1995). This is why, for example, emergency, service and high occupant vehicles are often given priority in traffic and parking, why public transit services are often subsidized, and why there are standards to insure that transport systems accommodate people with disabilities.

The concept of basic access is important for transport equity analysis. It means that transport activities and services can be evaluated and prioritized according to the degree to which they provide basic access. Transport equity analysis often requires determining which goods, services and activities are considered basic, and the quality of transport services can be considered adequate to satisfy basic access needs. These standards can be based on the quality of service that people would consider adequate if they were ever mobility disadvantaged, for example, becoming a non-driver due to physical disability or financial constraints (Rawls 1971).

Measurement Units

Transportation activities and impacts can be measured in various ways that can affect analysis results. Impacts are often compared using various *reference units*, such as per-capita, per-trip, per-passenger-mile, or per-dollar. The scope of impacts considered in analysis can vary significantly. For example, costs can include capital, operating or total expenditures; for a single year or several years; expenditures by a particular agency, a particular level of government, all levels of government, or by society overall (for example, including parking subsidies and pollution damages). Geographic areas and demographic groups can be defined in various ways.

Reference units reflect various assumptions and perspectives. For example, *per capita* analysis assumes that every person should receive an equal share of resources. *Per-mile* or *per-trip* analysis assumes that people who travel more should receive more resources. *Cost recovery* analysis assumes that people should receive public resources in proportion to how much they pay in fees and taxes. Table 2 summarizes the equity implications of various reference units often used for transport impact analysis.

Table 2 Equity Implications of Different Reference Units

Unit	Description	Equity Implications
Congestion impacts	Transport system performance is evaluated based on roadway level-of-service (LOS) or estimated congestion costs, and improvements are evaluated based on their cost efficiency in reducing congestion delays	Favors people who most often drive on congested roads over people who seldom or never use such facilities
Vehicle Miles Traveled (VMT)	Transport investments are evaluated according to which route or mode can increase vehicle travel at the least cost	Favors people who drive their automobile more mileage than average
Passenger Miles Traveled (PMT)	Transport investments are evaluated according to the most cost-effective way of increasing personal mobility	Favors people who travel more than average. Tends to favor motor vehicle travel
Passenger Trips	Transport investments are evaluated according to the costs of each trip.	Provides more support for transit and nonmotorized travel
Access	Transport investments are evaluated according to where improved access can be accommodated at the lowest cost.	Depends on how access is measured
Mobility Need	Transport investments are evaluated according to which provides the greatest benefits to disadvantaged people.	Favors disadvantaged people
Affordability	Transport user fees are evaluated with respect to users' ability to pay.	Favors lower-income people
Cost Recovery	Transport expenditures are evaluated according to whether users pay their costs.	Favors wealthier travelers because they tend to spend more and deserve the least equity-justified subsidies

Equity analysis is affected by the units used for comparison. Some units only reflect motor vehicle travel and so undervalue alternative modes and the people who rely on such modes.

It is therefore important that people who analysis equity impacts or user analysis results understand the assumptions and perspectives of different measurement units. Horizontal equity analysis should be usually be based on *per capita* rather than *per-mile* comparison, with adjustments to reflect differences in user need and ability to for vertical equity objectives. For example, when comparing two geographic areas or demographic groups with comparable incomes and abilities, it would be most fair if they each receive equal annual per capita allocations of public resources, but if one area or group is economically, socially or physically disadvantaged, it should receive a greater allocation. Similarly, if one group or travel activity imposes greater costs, it should be charged higher user fees or taxes until per capita subsidies are about equal, unless one group deserves extra subsidy on vertical equity grounds.

Categorizing People

Equity evaluation requires that people be categorized by demographic and geographic factors to identify people who are transport disadvantaged (Fan and Huang 2011; Hine and Mitchell 2001; Jiao and Dillivan 2013; Karner and Niemeier 2013). Such categories vary depending on how they are defined. For example, although people are often categorized as *motorists*, *transit users* and *pedestrians*, many use multiple modes, particularly over the long-term. Although only a small portion of households rely entirely on public transit at a particular time, many have members who use transit, and many people who do not currently use it may sometime their life and so value having it available. Similarly, most people can expect to experience mobility impairments sometime during their lives and so benefit from universal design. For this reason, it is often most appropriate to use a household or lifecycle analysis for equity analysis. Sustainability is concerned with *intergenerational equity*, that is, insuring that impacts on future generations are considered in decision-making. This represents an additional perspective for categorizing people.

Factors That Can Contribute to Transportation Disadvantaged Status

- Low Income
- Non-driver/car-less
- Disability
- Language barriers
- Isolation (in an inaccessible location)
- Caregiver (responsible for dependent child or disabled adult)
- Obligations (requires frequent medical treatments, attends school or is employed)

Various sources can be used to identify the size of these groups. For example, the U.S. Census has data on the number of residents with low incomes, driver's licenses and disabilities in a community.

Disadvantaged status is multi-dimensional. Disadvantaged status evaluation should take into account the degree and number of these factors that apply to an individual. The greater their degree and the more factors that apply, the more disadvantaged an individual or group can be considered. For example, a person who has a low income but is physically able, has no caregiving responsibilities, and lives in an accessible community is not significantly transportation disadvantaged, but if that person develops a disability, must care for a young child, or moves to an automobile-dependent location, their degree of disadvantage increases.

Equity of Opportunity Versus Equity of Outcome

There is an ongoing debate about how to measure vertical equity. There is general agreement that everybody deserves "equity of opportunity," meaning that disadvantaged people have adequate access to education and employment opportunities. There is less agreement concerning "equity of outcome," meaning that society insures that disadvantaged people actually succeed in these activities. Transportation affects equity of opportunity. Without adequate transport it is difficult to access education and employment. It therefore meets the most "conservative" test of equity.

Equity Evaluation Summary

Table 3 summarizes key variables that affect transportation equity analysis. How equity is defined, impacts considered and measured, and people categorized can significantly affect result. There is no single correct way to evaluate transportation equity. It is generally best to consider various perspectives, impacts and analysis methods. It is important that people involved in equity analysis understand how the selection of variables can affect results.

Table 3 Equity Evaluation Variables

Types of Equity	Impacts	Measurement	Categories of People
<p>Horizontal Equal treatment of equals</p> <p>Vertical With-Respect-To Income And Social Class Transport affordability Housing affordability Impacts on low-income communities Fare structures and discounts Industry employment Service quality in lower-income communities</p> <p>Vertical With-Respect-To Need And Ability Universal design Special mobility services Disabled parking Service quality for non-drivers</p>	<p>Public Facilities and Services Facility planning and design Public funding and subsidies Road space allocation Public involvement</p> <p>User Costs and Benefits Mobility and accessibility Taxes, fees and fares</p> <p>Service Quality Quality of various modes Congestion Universal design</p> <p>External Impacts Congestion Crash risk Pollution Barrier effect Hazardous material and waste Aesthetic impacts Community cohesion</p> <p>Economic Impacts Economic opportunities Employment and business activity</p> <p>Regulation and Enforcement Traffic regulation Regulations and enforcement Regulation of special risks</p>	<p>Per capita Per adult Per commuter or peak-period travel Per household</p> <p>Per Unit of Travel Per vehicle-mile/km Per passenger-mile/km Per trip Per commute or peak-period trip</p> <p>Per dollar Per dollar user fees Per dollar of subsidy Cost recovery</p>	<p>Demographics Age and lifecycle stage Household type Race and ethnic group</p> <p>Income class Quintiles Poverty line Lower-income areas</p> <p>Ability People with disabilities Licensed drivers</p> <p>Geographic location Jurisdictions Neighborhood and street Urban/suburban/rural</p> <p>Mode and Vehicle Type Walkers People with disabilities Cyclists & motorcyclists Motorists Public transit</p> <p>Industry Freight Public transport Auto and fuel industries</p> <p>Trip Type Emergency Commute Commercial/freight Recreational/tourist</p>

There are various types impacts, measurement units and categories to consider in equity analysis.

Programmatic Versus Structural Solutions

There are two general approaches for addressing transport inequity: *programmatic* solutions which target special protections and services at particular disadvantaged groups, or *structural* changes that affect overall policies and planning activities (Litman and Brenman 2012). For example, special mobility services for people with severe disabilities, and special facilities such as wheelchair ramps are examples of programmatic strategies. Broad policy reforms intended to increase transport system affordability and diversity (better walking, cycling, public transit, taxi, delivery services, and development policies that help create more accessible, multi-modal communities) are examples of structural solutions. Many programs involve a combination of both.

Programmatic solutions often appear to be most cost effective since they focus resources on people who are most disadvantaged, but structural reforms often provide significant co-benefits and so are often most beneficial overall. For example, most communities can only afford to provide a small amount of special mobility services, but planning reforms that help create more multi-modal transportation systems and more accessible land use development may improve access for physically, economically and socially disadvantaged people, including those who not fit into standard “disadvantaged” categories such as people with moderate incomes or mild disabilities.

Trade-offs Between Equity And Other Planning Objectives

Transportation planning often involves tradeoffs between equity objectives and other planning objectives. For example, improving pedestrian safety may reduce traffic speeds and therefore economic productivity, and providing public transit services may require tax subsidies, and in some cases may increase local air and noise pollution.

There is no standard way to determine how much weight to give a particular equity objective; such planning decisions should reflect community needs and values. Some communities may place a higher or lower value on a particular equity objective. For example, some communities may place a higher value on providing basic mobility for non-drivers. Some communities may consider road tolls and parking fees unfair because they are regressive, while others consider them fair because they charge motorists directly for the facilities they use and so increase horizontal equity.

Transportation equity issues are sometimes evaluated based on performance targets, such as annual per capita expenditures on special mobility or public transit services, that transit fares should be less than a certain maximum portion of low-income workers’ income, or that a certain portion of housing in transit-oriented areas should be affordable. Setting such targets usually require some sort of public involvement process to help incorporate community needs and values into planning and funding decisions (FHWA 1996).

Transportation Equity Indicators

Indicators are measurable variables selected to reflect progress toward planning objectives. To be useful and practical the selected indicators should be easy to understand and require data that is reasonably easy to obtain.

Five equity objectives and their indicators are described below. These can be expanded, elaborated and disaggregated to meet specific planning requirements.

Horizontal Equity

1. *Treats everybody equally, unless special treatment is justified for specific reasons.*

- Policies and regulations are applied equally to all users.
- Per capita public expenditures and cost burdens are equal for different groups.
- Service quality is comparable for different groups and locations.
- Modes receive public support in proportion to their use.
- All groups have opportunities to participate in transportation decision-making.

2. *Individuals bear the costs they impose.*

- Users bear all costs of their travel unless subsidies are specifically justified.

Vertical Equity

3. *Progressive with respect to income.*

- Lower-income households pay a smaller share of their income, or gain a larger share of benefits, than higher income households.
- Affordable modes (walking, cycling, ridesharing, transit, carsharing, etc.) receive adequate support and are well planned to create an integrated system.
- Special discounts are provided for transport services based on income and economic need.
- Transport investments and service improvements favor lower-income areas and groups.
- Affordable housing is available in accessible, multi-modal locations.

4. *Benefits transportation disadvantaged people (non-drivers, disabled, children, etc.).*

- Transport policies and planning decisions support access options used by disadvantaged people.
- Development policies create more accessible, multi-modal communities.
- Transportation services and facilities (transit, carsharing, pedestrian facilities) reflect *universal design* (they accommodate people with disabilities and other special needs, such as using strollers and handcars).
- Special mobility services are provided for people with mobility impairments.

5. *Improves basic access: favors trips considered necessities rather than luxuries.*

- Transportation services provide adequate access to medical services, schools, employment opportunities, and other “basic” activities.
- Travel is prioritized to favor higher value travel, such as emergency and HOV trips.

Incorporating Equity Analysis Into Transportation Planning

Transport equity analysis is usually performed as part of other planning activities. This chapter describes techniques for incorporating equity analysis into transport planning.

Data Sources

Various tools and resources are available to help evaluate the distribution of transport impacts and their equity impacts (FHWA 1997; ICLEI 1997). These provide information on the distribution of impacts between different groups of people. New data sources are available to help evaluate people by income and ability (FHWA and FTA 2002), and new GIS (Geographic Information System) tools facilitate geographic analysis of impacts.

It is often possible to collect information for transportation equity analysis in surveys performed for other purposes, by including questions concerning income and mobility constraints in regular travel surveys, and by including transportation questions in surveys related to other issues (Schmocker, et al. 2005). For example, a survey of social service clients can include questions concerning how they normally travel, their ability to use an automobile, and whether inadequate transportation is a significant problem.

Below are examples of potential data sources useful for equity analysis.

1. Government agency budgets and reports that indicate public expenditures by jurisdiction and mode, and on facilities and programs targeted to serve particular groups.
2. Census and surveys can provide the following data, disaggregated by geographic, demographic, and income category:
 - People's level of mobility (e.g. person-trips and person-miles of travel during an average day, week or year).
 - The portion of the population with disadvantaged status (low income, physical disability, elderly, single parents, etc.) (Schmocker, et al. 2005).
 - The portion of their time and financial budgets devoted to travel.
 - The problems people face using transportation facilities and services.
 - The degree to which people lack basic access.
 - Residents' desire for transportation options (AARP 2009).
3. Traffic accident injury and assault rates for various groups.
4. Audits of the ability of transport facilities and services to accommodate people with disabilities and other special needs.
5. Analysis of the degree to which disadvantaged people are considered and involved in transport planning.
6. Reports on the frequency of special problems by disadvantaged travelers (faulty equipment, inaccurate information, inconsiderate treatment by staff, etc.), the frequency of complaints by disadvantaged travelers, and the responsiveness of service providers to such complaints.

Horizontal Equity

Horizontal equity requires that public resources be allocated equally to each individual or group unless a subsidy is specifically justified. However, exactly what constitutes an equal share depends on which resources are considered and how they are measured. For example, comparisons can be made per household, per resident, per adult or per vehicle. This requirement applies to allocations of *general taxes* but not to *user fees*, so equity analysis may depend on how certain revenue sources are categorized.

Adjustments may be required to account for geographic differences (such as greater dependence on walking and transit in cities, and greater dependency on highways in suburbs and rural areas), differences in costs (such as higher costs of facilities and services in dense urban areas), and the extra costs of serving people with disabilities and other special needs. In most jurisdictions, transportation facilities and services are financed by several levels of government (local, regional, state/provincial, national), the total of which should be considered in analysis. Many transportation projects involve large budget expenditures certain years for major investments, so expenditures may vary significantly from year to year. Some public resource allocations are not reflected in transportation budgets, including tax discounts and exemptions for particular groups, land allocations (for example, public land devoted to transportation facilities), or are incorporated into other budgets, such as traffic services provided by police and parking facility costs borne in building budgets. Comprehensive analysis is therefore required to accurately determine the distribution of public resources for transportation facilities and services.

Various *roadway cost allocation* (also called *cost responsibility*) studies have calculated the share of roadway costs imposed by different types of vehicles (motorcycles, automobiles, buses, light trucks, heavy trucks, etc.), and how these costs compare with roadway user payments by that vehicle class (Jones and Nix 1995; FHWA 1997). This reflects the principle of horizontal equity, assuming that users should bear the costs they impose unless a subsidy is specifically justified. *User payments* refers to special fees and taxes charged to road users, including tolls, fuel taxes, registration fees and weight-distance fees, but does not include general taxes applied to vehicles and fuel.⁶

⁶ Although highway cost allocation principles specify that only *special* roadway taxes beyond *general* taxes should be considered user fees, some advocacy groups argue that all taxes on vehicles and fuel should be considered user fees and allocated based on payments. For discussion see Morris and DeCicco 1997; “Evaluating Criticism of Transportation Cost Analysis” in Litman, 2005a.

Vertical Equity

Vertical equity requires that disadvantaged people be identified and given special consideration in planning, to insure that they are not made worse off, and that their needs are accommodated. Ng (2005) describes the following steps for doing this.

1. Identify disadvantaged groups (minority, low income, car-less, disabled, single parents).
2. Identify disadvantaged geographic areas using census data (“Environmental Justice Areas”).
3. Identify degrees of disadvantage in each geographic area, with five levels of severity.
4. Identify location of important public services and destinations (transit, highways, employment centers, hospitals, daycare centers, etc.).
5. Evaluate specific transportation plans according to how they affect accessibility between disadvantaged communities and important destinations.

The study *Measuring Accessibility as Experienced by Different Socially Disadvantaged Groups* (TSG 2005) examines the quality of transportation services provided to various groups, and recommends standards for their services. Gullo, et al. (2008) used the STELLA model to quantify and compare the quality of accessibility to employment in the city of Detroit by various demographic groups, including transit dependent populations, taking into account financial and time costs, and the effects of congestion. The results indicate that under current conditions, non-drivers are significantly disadvantaged compared with drivers, but this can be changed with more transit-oriented transportation and land use planning.

The degree to which non-drivers are disadvantaged relative to drivers can be measured using *mobility gap* analysis (LSC 2001), which measures the different in motorized travel (automobile, public transit, taxi, etc.) between households with and without automobiles (called “zero-vehicle households”). This can be determined using travel survey data to compare the average daily trips generated by different types of households, taking into account factors such as the smaller average size and lower employment rates of zero-vehicle households. After taking these factors into account, zero-vehicle households are generally found to generate 30-50% fewer personal trips. This methodology may understate real transportation needs by assuming that automobile-owning households have no unmet mobility needs, which ignores the mobility problems facing non-drivers in vehicle-owning households. For example, a household that owns one vehicle shared by two or three adults, or households with adults who cannot drive due to disabilities or other problems, may face mobility gaps similar to zero-vehicle households.

Specific techniques can be used to quantify vertical inequity with respect to income (Marshall and Olkin 1979; Ramjerdi 2006). The Dalton Principle assumes that resource transfers from high- to lower-income people that maintain their overall income ranking is considered to improve equity. The *Gini-index*, the *Theil Coefficient* and the *Coefficient of Variation* are used to quantify inequity. Since these only consider income they may need adjustment to reflect other factors, such as people’s mobility needs and physical ability.

Transportation Equity Analysis Examples

This section describes examples of transport equity analysis. Also see FHWA and FTA (2002).

Smart Growth Equity Impacts

Ewing and Hamidi (2014) developed a sprawl index which reflects development density, mix, centrality and roadway connectivity. They evaluated the relationships between these and various social equity indicators. Their research indicates that more compact, multi-modal smart growth development patterns tend to increase integration (poor and racial minorities are less geographically isolated), economic opportunity (disadvantaged people's ability to access education and employment opportunities), and economic mobility (children born in low-income families are more likely to achieve higher incomes). As the compactness index doubles (increases by 100%), the probability that a child born to a family in the bottom quintile of the national income distribution will reach the top quintile of the national income distribution by age 30 increases by about 41%.

Transit Dependency and Transit Deserts (Jiao and Dillivan 2013)

This study used Geographic Information Systems (GIS) methods to measure the number of transit dependent people (those too young, too old, or too poor, or who are physically unable to drive) in urban neighborhoods, and identify "transit deserts," defined as areas with relatively large numbers of transit dependent people that have poor public transit service. The following formula is used to calculate transit dependency rates (demand):

Household drivers = (population age 16 and over) – (persons living in group quarters)

Transit-dependent household population = (household drivers) – (vehicles available)

Transit-dependent population = (transit-dependent household population) + (population ages 12–15) + (non-institutionalized population living in group quarters)

Transit service (supply) was determined by four criteria:

1. number of bus and rail stops in each block group
2. frequency of service for each bus and rail stop per day (weekday service) in each block group
3. number of routes in each block group
4. length of bike routes and sidewalks (miles) in each block group

Each criterion was divided by acres to get a density value, and the values for each criterion were aggregated to determine the level of supply in each area. Demand and supply are subtracted and a final numerical value was calculated, and used to determine an excess or lack of supply for each census block group. This study mapped transit deserts in four cities: Charlotte, North Carolina; Chicago, Illinois; Cincinnati, Ohio; and Portland, Oregon. The methods can be applied in any community.

Quality of Mobility Options for Disadvantaged Groups

Stanley, et al. (2011) identify five social exclusion risk factors, including income, employment, political engagement, participation in selected activities and social support (being able to get help when needed). The researchers estimate the marginal rate of substitution between household income and trip making, taking into account social exclusion factors. Because of the way trip are defined, an additional trip is equivalent to undertaking an additional activity, which indicates their value to users. Applying this analysis approach in Melbourne, Australia they find that residents aged over 15 average 3.8 daily trips (all modes), but decline as the number of social exclusion risk factors increase: people with 2 or more risk factors take 2.8 or fewer daily trips, indicating a significant decline in community involvement. This analysis estimates an additional trip (and activity) is valued at approximately \$20 at an average income, and higher values are accorded to additional trip making by lower income households. This \$20 value is about four times the value ascribed to such trips using traditional economic evaluation (what economists would call the generated traffic benefit, measured using the “rule-of-a-half”).

The report *Measuring Accessibility as Experienced by Different Socially Disadvantaged Groups* (TSG 2005) evaluates the quality of accessibility by people with varying needs and abilities. It evaluates local accessibility (e.g. access to local bus stops) and regional accessibility (e.g. access to employment opportunities) for seven socially disadvantaged groups: young people (16-24), older people (60+), Black and Minority Ethnic (BME) people, disabled people (physically disabled and people with mental health illness), people traveling with young children (aged 11 or under), unemployed people and shift workers. The results indicate similar concerns across the different groups. Participants’ mobility opportunities are constrained. It found that individuals’ travel opportunities are affected by factors including their existing experiences, perceptions, knowledge, and the ease with which they can travel, and that many disadvantaged people seldom leave their neighborhoods. The WALC (Weighted Access for Local Catchments) was developed to reflect perceived walk access conditions, taking into account local terrain (e.g. steep hills), provision of seating and shelters at bus stops, difficulties in crossing busy roads due to high traffic volumes and speeds, and inadequate street lighting. User surveys identified the weights different groups attach to these features, and to audit streets. The results support use of an unweighted 5 minutes walk time to a bus stop and 10 minutes to an underground station as an acceptable level of accessibility.

Women’s Employment Access

Dobbs (2005) performed a detailed survey of women’s travel behavior in North East England. The results indicate that access to a car is often a significant factor in women's ability to obtain a job (*economic inclusion*). The survey shows that women have diverse travel needs, including high rates of errands and chauffeuring trips (driving children and senior relatives). Even in car-owning households women typically have second priority in car access. The analysis indicates that women with full access to a car have greater employment options and are more likely to be employed than those who do not, implying that in automobile-dependent areas, car access helps achieve equity objectives such as economic opportunity and social independence, and that efforts to reduce automobile use must respond to needs of more vulnerable groups.

Civil Rights Analysis (Karner and Niemeier 2013)

In their article, “Civil Rights Guidance And Equity Analysis Methods For Regional Transportation Plans: A Critical Review Of Literature And Practice,” Karner and Niemeier (2013) critically evaluate the methods currently used to evaluate transportation impacts on minority populations. They conclude that, “prevailing methods of equity analysis are more likely to obfuscate than to reveal and that there are no standards for agencies to follow in order to a rigorous equity analysis.” They recommend more integrated transport modeling and geographic information systems to provide better information to decision-makers and the general public on the ways that specific planning decisions affect the mobility and accessibility disadvantaged groups, such as low-income, minority communities.

Public Funding Allocation

Horizontal equity requires that public policies and investments treat people equally unless subsidies are specifically justified. But funding practices often violate this principle, resulting in more per capita funding in some jurisdictions than others. This is sometimes justified, for example, if a jurisdiction has greater economic or social needs than others, but sometimes these reflect unintended consequences of outdated funding practices.

For example, Georgia state law requires that state highway funds be allocated equally among the state’s 13 Congressional Districts, resulting in more spending per capita in rural districts. Chen (1996) also found that cities receive far less per capita transport funding due to planning practices that favor spending on automobile-oriented facilities over other modes. There are three possible justifications for these cross-subsidies.

1. If highways are considered user funded (vehicle fees, fuel taxes and tolls), funding could be allocated based on where these fees are paid. However, urban regions contain about half of all registered vehicles and generate about half of all fuel tax revenues, so the funding discrepancy is not justified from this perspective. In other words, rural roads receive more funding per vehicle-mile than urban roads.
2. It could be argued that urban residents often drive on rural highways, and rely on interregional freight services, and so benefit from rural highway expenditures. However, rural residents also travel in urban areas and rely on urban services.
3. It could be argued that rural residents are economically disadvantaged and have fewer travel options compared with urban residents. Such subsidies are only justified for truly disadvantaged rural motorists, it does not justify subsidizing all rural vehicle travel.

This suggests that highway funding is inequitable. Only by providing significant urban transit funding can transportation budgets be considered fair.

Non-Drivers Accessibility

Case (2011) developed a model that evaluates nondrivers’ accessibility based on non-drivers trip generation rates. This technique can help identify the best neighborhoods to focus non-automobile transportation improvement efforts, including targeted walking, cycling and public transport improvements, more accessible land use development, and increased affordability.

Table 4 compares automobile-dependent and multi-modal transport systems ability to meet various transport demands. In a multi-modal community motorist can still drive (although somewhat slower), but in an automobile-dependent community non-drivers are significantly disadvantaged. This indicates that a diversified, multi-modal transport system is most vertically equitable (Sharp and Tranter 2010).

Table 4 Meeting Travel Demands: Auto-Dependent Versus Multi-Modal

Type of Travel	Size	Automobile Dependent	Multi-Modal	Consequences
Driver commute	85-95% of commuters	Drives	Sometimes drives, but can use alternative modes when preferred.	Multi-modalism allows drivers to choose the best option for each trip
Non-driver commute	5-15% of commuters	Requires chauffeuring	Can use alternative modes	Multi-modalism gives non-drivers options, and reduces chauffeuring costs.
Travel by youths (10-20 years of age)	10-15% of population	Requires chauffeuring	Can use alternative modes, mainly walking and cycling.	Multi-modalism provides independence and exercise, reduces chauffeuring
Seniors (people over 65 years of age)	10-15% of population and growing	Must drive, even if high risk, or must be chauffeured	Can rely on alternative modes.	Multi-modalism gives seniors independence, reduces chauffeuring costs
Teenage males	Small portion of total population, but high risk	Must drive, even if high risk, or must be chauffeured	Can rely on alternative modes. Is less likely to drive.	Multi-modalism reduces high risk driving and chauffeuring costs.
Lower-income households	20-40% of the population	Relies on automobile travel, despite high financial burdens and risks.	Relies on a mix of modes.	Multi-modalism lets lower-income people save money and improve access.

This table indicates how various types of trips are made in automobile dependent and multi-modal transport systems. “Driver” refers to somebody who is able to drive and has an automobile. “Non-driver” refers to somebody who for any reason cannot drive a motor vehicle.

A survey of Vermont residents found that many want alternatives to automobile travel, particularly better walking and cycling conditions, ridesharing and public transit services (AARP 2009). Even people who do not currently use such services value having them available for possible future use (option value) and to help reduce environmental impacts.

Inclusive Planning Analysis

Many jurisdictions are committed to *sustainable development* and *sustainable transport* which balance economic, social and environmental objectives. However, social sustainability is less clearly defined than economic and environmental sustainability. Social sustainability is often defined in terms of avoiding excessive burdens on disadvantaged groups (the basis of *environmental justice*), or in terms of general social goals such as poverty reduction, community cohesion and accountability.

Researcher Rebecca Mann recommends applying *inclusive* impact assessment for evaluating urban transport project equity impacts (Mann 2011). Inclusive development is defined as “growth that reduces disadvantage.” Applied to transport decision-making, *inclusive transport planning* refers to policies and projects that enhance the wellbeing of physically, economically and socially disadvantaged groups. Mann recommends considering these factors when evaluating specific transport policies and projects:

1. Who will benefit and who is excluded as a beneficiary?
2. How does the project help poor or disadvantaged people access employment and income opportunities, education, and health services? How will they benefit in terms of time savings, comfort and safety?
3. How does it affect the travel costs of different households? Will a subsidy be necessary to make public transport affordable to disadvantaged groups?
4. How will it impact (in terms of safety, desirability, affordability and modal share) public and non-motorized transport? How will it affect the pedestrian environment?
5. How will it affect disadvantaged people’s environment and health.

Mann developed an *Inclusive Transport Impact Assessment Tool* which includes:

- Spatial analysis of poverty and poor people’s economic opportunities various impacts that a policy or project may have on social and economic impacts (where disadvantaged people live, attend school, work and shop).
- Identification of various affected “stakeholder” groups (by income, gender, age, physical ability, employment status, racial or ethnic minority, or other vulnerabilities).
- Analysis of impact “transmission channels” through which the project will affect disadvantaged groups (access, prices, subsidies, health and safety, and employment in transport sector)
- An impact matrix which summarizes how various disadvantaged groups are affected.
- A checklist of special factors to consider when evaluating accessibility, affordability, safety and health.

Smart Growth Equity (USEPA 2013)

The report, *Creating Equitable, Healthy, And Sustainable Communities: Strategies For Advancing Smart Growth, Environmental Justice, And Equitable Development*, by the U.S. Environmental Protection Agency, describes smart growth policies that can help achieve social equity objectives by creating communities with more affordable housing, more diverse transport options, and better community involvement.

Transportation Improvement Benefit Distribution

A study by Fruin and Sriraj (2005) uses GIS modeling to identify *environmental justice* (economically and socially disadvantaged) neighborhoods, and uses this information to evaluate the distribution of transit investments benefits. The study found that current transit improvements allocate more funds to non-environmental justice neighborhoods than to environmental justice neighborhoods, and so can be considered inequitable.

Parking Requirement Equity Impacts

Parking requirements are an example of transport planning decisions that have significant, unintended, and often overlooked equity impacts. Most jurisdictions have regulations that specify the minimum number of parking spaces that must be supplied at each destination. These requirements tend to be generous, designed to insure that motorists can almost always find convenient at any destination (Litman 2000). They are even justified on equity grounds, to insure that each development bears the costs of the parking demand it generates, to avoid spillover parking problems at nearby sites.

These parking requirements represent a subsidy of vehicle ownership and use worth hundreds of dollars annually per motorist (Shoup 2005; “Parking Costs,” Litman 2005a). They encourage parking to be unpriced, causing parking costs to be borne indirectly through mortgages and rents, retail prices, and taxes. People bear these costs regardless of how many vehicles they own and how much they drive. As a result, households that own fewer than average vehicles or drive less than average tend to pay more than the parking costs they impose, while those who own more than average vehicles or drive more than average tend to underpay. Since vehicle ownership and use tend to increase with income, these regulations and subsidies tend to be regressive, that is, they place a relatively large burden on lower-income people. Because parking requires paving large amounts of land, they tend to encourage sprawl and create less walkable communities. These changes reduce mobility and accessibility for non-drivers, and increase total transportation costs, which tends to be particularly harmful to disadvantaged people.

These equity impacts are often overlooked when parking requirements are established. This is not because the people involved are immoral or uncaring, rather they generally have not considered all the equity impacts resulting from such decisions, particularly indirect and long-term impacts on other groups.⁷

⁷ Since decision-makers tend to be busy, middle-class professionals who drive automobiles, they are likely to perceive the benefits of generous parking requirements and are less sensitive to the unfair costs such requirements impose on non-drivers.

Transportation Cost Analysis

Both horizontal equity and economic efficiency require that users bear the costs they impose on society, unless a subsidy is specifically justified (“Market Principles,” VTPI 2005).⁸ *Highway cost allocation* (also called *highway cost responsibility*) refers to analysis of the costs imposed by various types of vehicles and the degree to which they are recovered by user fees (Jones and Nix 1995; FHWA 1997). Most cost allocation studies only consider direct roadway expenditures, and categorize users according to vehicle size and type (automobiles, buses, light and heavy trucks). The table below summarizes the results of a major U.S. highway cost allocation study. It indicates that about a third of roadway costs are subsidies (costs not borne directly by user fees).

Table 5 Roadway Cost Responsibility, 1997 US Dollars Per Mile (FHWA 1997)

Vehicle Class	VMT (millions)	Federal Costs	State Costs	Local Costs	Total Costs	Total User Payments	External Costs
Automobiles	1,818,461	\$0.007	\$0.020	\$0.009	\$0.035	\$0.026	\$0.009
Pickups and Vans	669,198	\$0.007	\$0.020	\$0.009	\$0.037	\$0.034	\$0.003
Single Unit Trucks	83,100	\$0.038	\$0.067	\$0.041	\$0.146	\$0.112	\$0.034
Combination Trucks	115,688	\$0.071	\$0.095	\$0.035	\$0.202	\$0.157	\$0.044
Buses	7,397	\$0.030	\$0.052	\$0.036	\$0.118	\$0.046	\$0.072
<i>All Vehicles</i>	<i>2,693,844</i>	<i>\$0.011</i>	<i>\$0.025</i>	<i>\$0.011</i>	<i>\$0.047</i>	<i>\$ 0.036</i>	<i>\$0.010</i>

This table summarizes the results of a major cost allocation study which found that user fees fund only about two-thirds of roadway facilities.

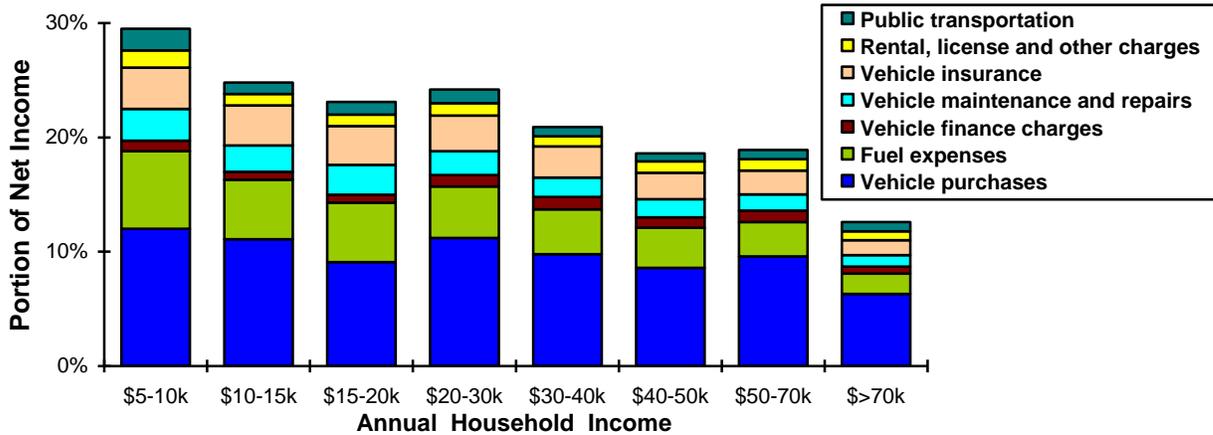
More comprehensive transportation cost studies include additional costs such as parking subsidies, traffic services, congestion delay, accident risk and pollution damages (INFRAS and IWW 2004; Litman 2005a). Considering more costs tends to indicate greater inequity. For example, considering just roadway costs not borne by user fees, automobile travel is subsidized about 1¢ per mile, but much greater subsidies are found if traffic services, parking subsidies, accident externalities and environmental impacts are also considered. These external costs mean that people who drive more than average receive greater public subsidies than people who drive less than average. Since driving tends to increase with income, this is both horizontally and vertically inequitable. Considering just financial costs, this inequity is partly offset by the additional taxes paid by higher-income people, but this offset is smaller when non-market costs such as accident risk and pollution damages are also considered.

⁸ Equity and efficiency definitions of optimal pricing differ somewhat. Horizontal equity focuses on *average* costs, often measured at the group level, while economic efficiency focuses on *marginal* costs per trip, which ignores sunk costs such as past construction investments. However, average and marginal costs tend to converse over the long run since over time most costs become variable.

Transportation Cost Burdens

Transportation is a major financial burden to many consumers, particularly for lower-income households. Figure 1 illustrates transport expenditures relative to total household income by income class. Lower-income households spend a far higher portion of income on transport than wealthier households, indicating that these costs are regressive.⁹

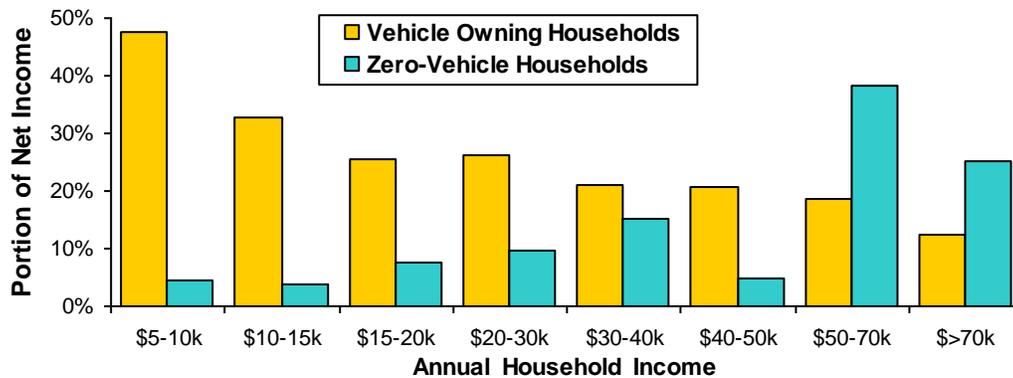
Figure 1 Portion of Household Income Spent on Transport (BLS 2000)



Transportation expenditures are highest as a portion of net (after tax) income for lower-income households, indicating that transportation costs are regressive.

Households that own a motor vehicle tend to spend far more of their income on transportation than zero-vehicle households, as illustrated in Figure 2.

Figure 2 Portion of Household Income Devoted to Transport (BLS 2003)¹⁰



Transport costs tend to be regressive for vehicle-owning households, but not zero-vehicle households.

⁹ Equity impacts can also be evaluated with respect to *expenditures* rather than *income*. Expenditures are less volatile and include other types of wealth such as savings and benefits such as foodstamps.

¹⁰ This figure assumes that all vehicle costs are borne by vehicle-owning households and all public transport costs are borne by zero-vehicle households. This is not exactly accurate since vehicle-owning households do use public transport and zero-vehicle households pay some vehicle expenses, but is consistent with other research showing much lower transport expenditures in vehicle-owning than zero-vehicle households.

This financial burden is significantly affected by the type of transport system in an area. Low-income residents of automobile-dependent communities tend to spend much more of their income on transport than residents of communities with more diverse, multi-modal transport systems.¹¹ This suggests that automobile dependency is regressive, and that policies and programs that improve travel options tend to be progressive (Frumkin, Frank and Jackson 2004).

The consumer costs and regressivity of automobile transport are even greater than these figures indicate when indirect costs are also considered, particularly residential parking, which averages about 10% of housing costs and more for lower-priced, urban housing (Jia and Wach 1998). High parking costs reduce housing affordability, imposing additional burdens on lower-income households, which are often forced to choose between suburban housing with lower rents but higher transportation costs, and more costly urban housing with lower transportation costs.

Although automobiles are expensive and their costs are regressive, studies indicate that vehicle ownership can be an important contribution to helping disadvantaged people obtain and maintain employment (Sawicki and Moody 2001). This has several equity implications. It suggests that strategies that help poor people obtain access to automobiles may provide equity benefits, for example, as part of welfare-to-work programs. Carsharing and other vehicle rental services, special vehicle and insurance purchase loan programs, and Pay-As-You-Drive insurance can help some disadvantaged people increase their mobility and economic opportunities (VTPI 2005).

Because driving is costly, regressive and difficult (particularly for some disadvantaged people, such as people with disabilities and immigrants who do not speak English), automobile-oriented solutions create additional equity problems. Cheap automobiles affordable to poor people tend to be unreliable, and are sometimes unsafe. Lower-income drivers often share vehicles with other household members. Even poor people who own an automobile often rely somewhat on other modes. As a result, disadvantaged people tend to benefit from a more diverse transport system. In other words, disadvantaged people may benefit from policies that help them drive, but they can benefit even more overall from policies and programs that increase total travel options.

Similarly, land use strategies that improve community accessibility, such as locating affordable housing, public services and jobs in more accessible, multi-modal locations provides equity benefits by reducing cost burdens on disadvantaged households (“Location Efficient Development,” VTPI 2005).

¹¹ For example, households in communities with high quality transit systems spend a smaller portion of their income on transport than residents of more automobile dependent communities (Litman, 2004).

Traffic Impacts

The physical impacts of vehicle traffic can have significant equity impacts. For example, the congestion impacts that motor vehicles impose on other road users is horizontally inequitable to the degree that higher-occupant vehicle (carpools, vanpools and buses) passengers are delayed by congestion, although they use less road space and so impose less delay on others per passenger-mile. Similarly, motor vehicle use imposed delay and accident risk on pedestrians and cyclists, and noise and air pollution on nearby residents. Horizontal equity therefore suggests that a bus carrying fifty passengers should be able to use up to fifty times as much road space as a car carrying one passenger, that pedestrians and cyclists should be protected from risks imposed by motorists, and that people who seldom or never use automobiles should avoid subsidizing motorists parking facilities.

Some traffic impacts, such as congestion delay and accident risk, are monetized (measured in monetary units) for economic evaluation (Litman 2005a). However, adjustments may be needed for equity evaluation. For example, most monetized congestion cost estimates only consider impacts on motor vehicles. Impacts on nonmotorized travel, including delay and travel foregone, are usually ignored, although they are often significant compared with costs that are considered, particularly in urban areas (“Barrier Effects,” Litman 2005a). They represent a horizontal inequity (motorists impose far more delay and risk on nonmotorized travelers than nonmotorized travelers impose on motorists), and to the degree that people who are transportation disadvantaged drive less and rely more on nonmotorized modes, this represents a vertical inequity.

Described in a more positive way, current evaluation practices tend to underestimate the full benefits and equity impacts of strategies that reduce vehicle traffic and improve nonmotorized travel conditions because they ignore benefits from improved nonmotorized travel, which are particularly important to many disadvantaged people.

Road space allocation and traffic management decision have various, sometimes overlooked distributional impacts. For example, traffic calming tends to reduce automobile traffic speeds while improving safety for motorist and nonmotorists, and neighborhood livability (Bellefleur 2013). HOV priority strategies benefit rideshare and transit passengers, and motorists if they reduce traffic congestion (“HOV Priority,” VTPI 2005). Bicycle lanes benefit cyclists and motorists to the degree that they reduce conflicts. Parking regulations, such as parking duration limits, benefit some users, trips and businesses at the expense of others.

Special analysis may be justified to determine whether transportation planning decisions violate environmental justice principles. For example, geographic analysis can help determine whether lower-income and minority communities contain an excessive portion of hazardous waste sites, or undesirable transportation facilities such as major highways and freight terminals (Bullard and Johnson 1997). Special programs may be justified to clean up brownfields, insure that regional transportation facilities meet local community needs, mitigate traffic impacts, and compensate for external costs imposed on disadvantaged populations.

Planning Biases and Distortions

Current planning practices contain biases and distortions that tend to be both horizontally inequitable (they favor one mode or user over others), and vertically inequitable (they tend to harm disadvantaged people). Examples are described below (Beimborn and Puentes 2003; Litman 2003b; “Comprehensive Transport Planning” VTPI 2005).

- Emphasis on mobility rather than accessibility. Conventional planning measures mobility rather than accessibility, which favors motorized modes, and undervalues alternative modes and land use policies to increase accessibility.
- Undervaluation of nonmotorized travel. Conventional travel surveys tend to undercount short trips, non-commute trips, travel by children and walking links of motorized trips, which undervalues nonmotorized travel. This skews planning and funding toward motorized modes, reducing transport quality for nondrivers.
- Incomplete evaluation. Conventional economic evaluation tends to overlook many indirect costs of roadway capacity expansion and the full benefits of alternative modes and mobility management solutions (Litman 2005a).
- Fragmented and incremental planning, that allows individual decisions that contradict strategic planning objectives. For example, it is common for planning agencies to impose generous parking requirements on development, even in areas that want to encourage infill development, more compact development, and use of alternative modes.
- More funding and lower local matching requirements for roadway and parking facilities than for other modes. This encourages decision-makers to define transportation problems as highway problems and underinvest in alternative modes and management solutions.
- Automobile underpricing, including free parking, fixed insurance and registration fees, general taxes funding roadways, and lack of congestion pricing. These market distortions increase vehicle ownership and use, and therefore reduce development of other modes.
- Environmental injustice. There is evidence that lower income and minority neighborhoods bear more than their share of undesirable transport facilities, and receive less than a fair share of transport investments and services (Bullard and Johnson 1997).
- Land use policies that favor sprawl, such as generous parking and setback requirements, density restrictions, and single-use zoning. This leads to more automobile-dependent communities that provide poor access for non-drivers.

Although individually these biases and distortions may seem modest and justified, their impacts are cumulative, resulting in large total subsidies for automobile travel and significant harm to society. For example, parking subsidies total hundreds of dollars annually per vehicle (Shoup 2005), far higher than public subsidies per transit rider. Automobile travel also imposes costs for local road and traffic services, congestion, accident costs and environmental damages worth hundreds of dollars annually per vehicle (“Transportation Costs,” VTPI 2005). These impacts are widely dispersed through the economy, incorporated into taxes, rents and retail prices, and so are generally ignored in individual planning decisions. By reducing transport system diversity and land use accessibility, these distortions harm disadvantaged people, which is vertically inequitable.

Economic Opportunity

Some studies indicate that economically disadvantaged workers (such as former welfare recipients) tend to work and earn more if they have an automobile (Blumenberg and Ong 2001; Pendall, et al. 2014; Wachs and Taylor 1998), and have better access to basic services such as medical care and shopping. This leads some people to conclude that increased vehicle ownership increases social equity, that vehicle subsidies (subsidized vehicles, low fuel prices, unpriced roads and parking, etc.) help achieve equity objectives, and efforts to reduce vehicle travel are regressive (Pisarski 2009). This misinterprets the issues.

Most of these studies were performed in automobile-dependent regions, such as Los Angeles, where non-drivers are particularly disadvantaged. Other studies indicate that high quality public transit also increases labor participation (CTS 2010; Sanchez, Shen and Peng 2004), even in automobile-oriented cities (Yi 2006). Analysis by Gao and Johnston (2009) indicates that transit improvements provide greater total benefits to all income groups than subsidizing automobiles for lower-income groups. Researches Talen and Koschinsky (2013) found strong correlations between neighborhood accessibility (based on WalkScores) and high income mobility (the chance that child in a low-income household will eventually earn a high income). They found that a child born to the bottom fifth income group in a walkable neighborhood has a much better chance of becoming financially prosperous than a poor child born in a non-accessible area.

Automobile subsidies only benefit a subset of disadvantaged people, those able to drive, and impose significant direct and indirect costs. Low income motorists must typically spend \$250 to \$500 per month to own and operate a vehicle. Their insurance premiums tend to be high, and the older vehicles they own tend to be unreliable, imposing large repair costs. As a result, much of the additional income provided by automobile ownership must be spent on vehicle expenses, reducing net gains. Automobile travel also tends to increase users' accident risks and health problems associated with sedentary living (APHA 2010; Lachapelle, et al. 2011), and increases external costs imposed on local communities including traffic congestion, road and parking facility costs, accident risk, and pollution emissions.

Increased vehicle travel does not necessarily increase overall economic productivity or employment. On the contrary, productivity rates (per capita GDP) tend to increase with transit ridership and decline with automobile use, indicating that a more multi-modal transport system support community economic development (Litman 2009).

An automobile dependent transportation system is inherently inefficient and inequitable. Subsidies intended to help lower-income people own and operate automobiles treat one symptom but exacerbate other problems. Creating a more diverse and efficient transport system addresses the root of the problem, which provides the greatest total benefits to society, including increased social equity by improving mobility and accessibility for physically, economically and socially disadvantaged people.

This analysis indicates that although automobile use can benefit some disadvantaged people, other transport improvement strategies are often more cost effective and beneficial overall. These include improved walking and cycling conditions, improved rideshare and public transit services, carsharing, distance-based vehicle insurance and registration fees, and more affordable housing in accessible locations (Sullivan 2003; Litman 2010). These solutions tend to benefit all residents, and especially those who are physically, economically or socially disadvantaged.

Transportation Pricing Reforms

Horizontal equity requires that as much as possible, consumers pay the costs imposed by their activities. Reforms such as higher fuel tax, road and parking pricing, and distance-based fees, can increase equity by making prices more accurately reflect costs, taking into account factors such as vehicle type, time and location (“Pricing Evaluation” VTPI 2005).

There is often debate over the equity of road and parking pricing, particularly when fees are introduced on previously unpriced facilities. Pricing is criticized on horizontal equity grounds, since most roads and parking facilities are currently unpriced. Motorists ask, “Why should I pay while other motorists do not?” But this argument can be reversed: unpriced roads and parking can be considered unfair if motorists must pay elsewhere. Critics argue that road pricing represents “double taxation” since they already pay fuel taxes that fund roads. However, road and parking pricing is usually applied in areas where the costs of providing facilities is particularly high, such as in city centers and new highways. Such fees can be considered a surcharge for these higher-than-average costs.

Pricing proponents emphasize that motorists receive benefits, such as reduced traffic congestion, and that pricing is optional. For example, motorists may have a choice between free but congested highway lanes, and uncongested but priced lanes. Similarly, they may be able to choose between convenient but priced parking, and less convenient but free parking. This is called *value pricing*. Whether motorists have adequate alternatives is often an important issue in pricing equity analysis. Pricing reforms can also benefit disadvantaged people (increase vertical equity) if they reduce negative impacts on disadvantaged neighborhoods or improve travel options for non-drivers. For example, Kain (1994) predicts that congestion pricing can benefit lower income commuters and non-drivers overall by improving transit and rideshare services.

Transportation price increases are often criticized as being regressive, since a particular fee represents a greater portion of income for lower-income people than for higher-income people. Overall equity impacts depend on how prices are structured, the quality of transport alternatives available (Golub 2010), how revenues are used, and whether driving is considered a necessity or a luxury (Litman 1996; Rajé 2003; TRB 2011). If there are good alternatives, revenues are used to benefit the poor, and disadvantaged people are given discounts, price increases can be progressive overall.

There is a long history of incorporating vertical equity objectives into transport pricing with targeted discounts that benefit lower-income people. Adam Smith (1976), the founder of modern economics, wrote that, “*When the toll upon carriages of luxury coaches, post chaises, etc. is made somewhat higher in proportion to their weight than upon carriages of necessary use, such as carts, wagons, and the indolence and vanity of the rich is made to contribute in a very easy manner to the relief of the poor, by rendering cheaper the transportation of heavy goods to all the different parts of the country.*”

Transportation Equity Spatial Analysis

The report, *Equity Analysis of Land Use and Transport Plans Using an Integrated Spatial Model* (Rodier, et al. 2010), used the Activity Allocation Module of the PECAS (Production, Exchange, and Consumption Allocation) Model to evaluate the equity effects of land use and transport policies intended to reduce greenhouse gas emissions. This model compared a *Business-As-Usual* and *Preferred Blueprint* scenarios for the Sacramento region. The model quantifies the distributions various transport and economic interactions, including wages, rents, productivity, and consumer surplus, for segments of households, labor, and industry. It evaluates the equity impacts of different transport and land development patterns. The results indicate that a more compact urban form designed around transit stations may reduce travel costs, wages, and housing costs by increasing accessibility, which can lead to substantial net benefits for industry categories and lower income households. Higher income households may be net losers, since their incomes are more dependent on reduced wages, they are less willing to switch to higher density dwellings, and they are more likely to own their own home.

Dodson, et al. (2011) apply cluster analysis to a large regional household travel survey to identify the geographic distribution and travel activity of low socioeconomic status (SES) groups. With this information, the study advanced a new origin–destination-based land use and transport accessibility model that can quantify the overall accessibility to goods and services for disadvantaged populations. District level census data (approximately 200 households) integrates with conventional transport models transport analysis zones.

Climate Change Emission Reduction Equity

Lin (2008) evaluated the equity impacts of climate change policies, including the distribution of damages from climate change and other pollutants, and the distribution of benefits from emission reduction efforts (such as whether energy conservation programs provide incentives and jobs to low income and minority populations). She critiques emission reduction policies, such as cap-and-trade, feebates and road pricing in terms of their impacts on disadvantaged populations, and recommends specific design principles, such as insuring adequate alternative travel modes if congestion pricing or carbon taxes are implemented, and use of revenues in ways that benefits disadvantaged populations.

Equitable VMT Reduction Strategies (Carlson and Howard 2010)

The report *Impacts Of VMT Reduction Strategies On Selected Areas And Groups*, sponsored by the Washington State Department of Transportation, investigates the equity impacts of the state's vehicle miles travelled (VMT) reduction targets (18% reduction by 2020, 30% reduction by 2035, and 50% reduction by 2050), and ways to minimize negative impacts on disadvantaged populations. It identified various VMT reduction strategies and evaluated their impacts on five groups and areas, including small businesses, low-income residents, farmworkers, distressed counties, and counties with more than half the land in federal or tribal ownership. It identified ways to implement VMT reduction programs with the most positive or least negative impacts on disadvantaged groups.

Equitable Road Funding (Schweitzer and Taylor 2008)

Opponents of efficient road pricing, such as congestion tolls, often argue that low-income, urban residents will suffer if they must pay to use congested freeways. This contention, however, fails to consider (1) how much low-income residents already pay for transportation in taxes and fees, or (2) how much residents would pay for highway infrastructure under an alternative revenue-generating scheme, such as a sales tax. Schweitzer and Taylor compare the cost burden of road toll and a local option transportation sales tax. The analysis indicates that although the sales tax spreads the costs of transportation facilities across a large number of people, it redistributes about \$3 million in revenues from less affluent residents to those with higher incomes. Low-income *drivers* individually save if they do not have to pay tolls, but low-income residents as a group pay more with sales taxes.

Fairness in a Car Dependent Society (SDC 2011)

The report, *Fairness in a Car Dependent Society*, by the U.K. Sustainable Development Commission (SDC) analyzes the costs of car dependency and the distribution of these costs to various groups. While recognizing that car travel can provide significant benefits, it also imposes significant costs, which tend to be particularly burdensome to physically, economically or socially disadvantaged people. These groups tend to benefit least from automobile travel and dispersed development patterns, and face major costs from accident risks and pollution emissions, and reduced accessibility.

This analysis concludes that a new approach to national transport policy is needed that better balances conflicting interests. This must recognize that transport planning decisions have significant indirect and external impacts, and so should consider effects on all members of society, not just motorists. It recommends that transport decision makers should adopt a transport hierarchy approach to ensure the most sustainable and fair transport solutions are prioritized:

1. Demand reduction for powered transport
2. Modal shift to more sustainable and space efficient modes
3. Efficiency improvements of existing modes
4. Capacity increases for powered transport (only when options 1-3 have been exhausted)

Right To Basic Transport (KOTI 2011)

Korea recognizes the right to basic transportation, which includes the right to move freely, conveniently and safely, the freedom to choose transport modes, the right to transport cargo, and the right to gain access to transport information regardless of economic, physical, social and regional barriers. It is a right based on the citizens' basic rights stipulated in the Korean Constitution such as freedom of residence and movement, freedom of occupation, assurance regarding human dignity and worth. Korean planners are developing minimum service policies based on indices and criteria to implement these rights within practical resource constraints.

Critical Evaluation of Indian Urban Transport (Mahadevia, Joshi and Datey 2013)

The report, *Low-Carbon Mobility in India and the Challenges of Social Inclusion* critically evaluates the degree that Indian urban transport systems serve low-income households and other disadvantaged groups. It uses travel demand survey to evaluate walking, cycling and public transit activity, and consumer expenditure survey data to evaluate transportation affordability. It discusses the quality and utility of Bus Rapid Transit (BRT) systems in various Indian cities, and identifies various problems and potential improvement strategies.

India's National Urban Transport Policy (NUTP) emphasizes the importance of building 'streets for people' rather than simply maximizing motor vehicle traffic speeds. It also emphasizes the need to improve transit service for disadvantaged groups. This offers an opportunity to improve public transit services and develop BRT systems, particularly because BRT tends to provide better service than buses operating in mixed traffic, but are cheaper and more flexible than metro rail systems. However, of the 63 cities eligible for national transportation funds, only about 10 built BRT systems, out of which only Ahmedabad, Delhi, Pune and Jaipur have dedicated bus lanes. Some roadway expansion projects that were planned as BRT lanes have been converted to general traffic lanes, and some BRT infrastructure badly designed, built or maintained, resulting in poor service quality. In Ahmedabad, there was no attempt to integrate the BRTS with existing municipal bus services and many previous bus lines were closed, and in Delhi there is political pressure to remove BRT lanes. Some Indian cities have developed well-used walking and bicycle facilities as part of transportation improvement programs, but others have failed to develop such facilities.

Indian cities experience major problems sharing road space amongst all users. Even facilities designed for pedestrians, cyclists and buses are often appropriated by motorised vehicles. For example, in Delhi, the traffic police control the signal cycle at the junctions, and they have designed it to favour the mixed traffic more than buses. Traffic police have also refused to limit motorised two-wheelers encroaching the cycle tracks. Sometimes inappropriate design of infrastructure has led to a lack of usage. For example, in Ahmedabad, footpaths and cycle tracks have not been designed and built for all the corridors, compromising the safety and access of pedestrians and cyclists, and some cycle tracks have faulty designs that discourages cyclists from using them. Another common conflict and barrier to efficient urban transportation involves motor vehicles parking on footpaths, cycle tracks and bus lanes. Most vehicle parking is unpriced.

Transport Policy Reforms To Help Low-Income Immigrant Families (Pollack, et al. 2013)

A Northeastern University study investigated policy solutions to address the transport needs of low-income and working Latino families in Massachusetts. The project conducted door-to-door surveys with more than 350 residents in targeted neighborhoods and held focus groups in each city to collect information on how residents get around, where they go using different transportation modes, what obstacles and issues they contend with, and solutions for overcoming transit-related problems. The study found that transportation takes a heavy toll on the time, budget, and stress level of low-income Latino Massachusetts residents. It found that:

- Low-income Latino residents lack good transport options and must often choose between expensive dependence on automobiles and inadequate, time-consuming public transit.
- Transportation challenges adversely affect people's access to basic needs, broader opportunities, and overall quality of life.
- Low-income urban Latino residents need better and more affordable transportation options, including more frequent public transit service that gets them to jobs and other important destinations in a reasonable amount of time and every day of the week.

The study provided various recommendations including improving walking, cycling and public transport; improve transportation affordability; increases in motor vehicle user charges should be implemented with improvements in alternative modes; major public services (such as education and medical care) should be located and managed to maximize pedestrian, bicycle and public transit access.

Women's Transportation Safety (Tiwari 2014)

The report, *Planning And Designing Transport Systems To Ensure Safe Travel For Women* uses detailed travel survey data concerning how Indian women travel and the obstacles they face to develop recommendations for improving women's travel safety, and to integrate these objectives into sustainable transportation planning in developing countries, including smart growth development patterns which insure that services and activities commonly used by women are located near homes, planning that places more emphasis on walking and public transit, and safer roadway design.

Automobile Ownership and Travel By Low-Income Households

Analyzing the 2009 U.S. National Household Travel Survey, Blumenberg and Pierce (2012) identified factors that affect vehicle ownership and travel, including income, age, gender, race-ethnicity, employment status (student, worker, retiree, homemaker), children in household, geographic location (density and urban region), vehicle insurance costs and vehicle ownership (as it affects personal travel). They found that low-income households are less likely to own cars and more likely to travel by alternative modes. As household incomes rise from low to medium levels, vehicle ownership and travel tend to increase proportionately faster than incomes, particularly households with workers and children, and decline with land use density. The authors conclude that these findings justify public policies that help lower-income households located in automobile-dependent communities own vehicles.

Strategies To Achieve Transportation Equity Objectives

This section identifies various ways of achieving transportation equity objectives.

Horizontal Equity – Planning and Investment Reforms

Horizontal equity requires that public resources be allocated equally to each individual or group unless a subsidy is specifically justified, although exactly what constitutes an equal share depends on which resources are considered and how they are measured. In general, resource allocations should be measured per capita, with adjustments made to account for special needs, such as extra costs to accommodate people with disabilities and to provide fare discounts for people with low incomes.

- Improved transport data to better understand disadvantaged people's travel demands, and the quality of walking, cycling and public transport.
- Improved information on indirect, external and non-market costs of transport.
- Least-cost planning, so resources (funding and road space) can be allocated to alternative modes and demand management strategies whenever they are cost effective, considering all costs and benefits.

Horizontal Equity – Pricing Reforms

Various transport pricing reforms can increase horizontal equity by making prices more accurately reflect costs (Litman 2005b; VTPI 2005). They can also tend to achieve vertical equity objectives by supporting alternative modes, improving affordability, and by prioritizing travel to favor basic mobility and HOV modes. These include:

- *Fuller cost recovery* – User fees such as fuel taxes and tolls increase to reflect costs imposed. For example, fuel taxes could be increased to fund a greater portion of roadway costs, and more parking facilities should be priced.
- *Weight-distance fees* – Fees that reflect the roadway costs imposed by a vehicle class.
- *Road Pricing* – Charge directly for road use, with rates vary to reflect how roadway and congestion costs vary by location, time and vehicle type.
- *Parking cash out* – Allow commuters to choose cash instead of subsidized parking.
- *Parking pricing* – Vary rates to reflect how costs vary by location, time and vehicle type.
- *Distance-based vehicle insurance and registration fees*, which converts fixed costs into variable costs with respect to annual vehicle travel.
- *Environmental taxes and emission fees*. Some economists recommend special fees based on the environmental imposed by an activity, such as vehicle air pollution emissions.

Ramjerdi (2006) evaluates the vertical equity impacts of various mobility management transport policies in Oslo, Norway, including road pricing, parking pricing and public transit service improvements. The analysis employs a range of equity measures reflecting different assumptions and perspectives, including the Gini coefficient and the Lorenz curve, which are measures of inequity.

Vertical Equity – Progressive With Respect To Income

There are many ways to increase transport system affordability and insure that transport policies and program are progressive with respect to income (“Affordability,” VTPI 2005)

- Transport policy and planning decisions should favor affordable modes (walking, cycling, public transit, ridesharing, carsharing and delivery services). This includes improved sidewalks and crosswalks, traffic calming and traffic speed control, HOV and bus lanes, and other transit service improvements.
- Support transportation demand management strategies that increase affordability including improvements to alternative modes, reduced and more flexible parking requirements, *parking cash out* (commuters who are offered a subsidized parking space can choose to receive the cash equivalent if they do not drive), parking unbundling (parking is rented separately from housing, so residents are not forced to pay for parking they do not need).
- Support policies that make automobile ownership more affordable, including targeted grants, loans and distance-based vehicle insurance (Blumenberg and Pierce 2012)
- Support carsharing (vehicle rental services located in residential areas, designed to provide an affordable alternative to private vehicle ownership), pay-as-you-drive insurance (insurance and registration fees based directly on how much a vehicle is driven), and other programs and pricing options that make occasional automobile use more affordable.
- Price transportation to favor economically, socially and physically disadvantaged people (Iacono and Lari 2006). For example, transit services, road tolls and other services can have discounts for people who qualify for low-income benefits. Each household can receive a limited number of free road toll or parking vouchers.
- Support development of affordable-accessible housing (affordable housing in accessible, multi-modal communities).

Vertical Equity – Benefiting Transportation Disadvantaged People

Because disadvantaged people tend to drive less than average and often rely on non-automobile modes, anything that increases transportation system diversity and land use accessibility tends to increase vertical equity (“Transportation Diversity,” VTPI 2005). Conversely, anything that increases automobile dependency tends to contradict vertical equity objectives by reducing travel options for non-drivers and increasing transportation costs (“Automobile Dependency,” VTPI 2005). As a result, planning and market distortions that favor automobile travel, described earlier in this report, tend to reduce vertical equity, while mobility management and smart growth strategies tend to increase vertical equity by creating more diverse and accessible transport systems.

Wasfi and David M. Levinson (2007) surveyed seniors and people with developmental disabilities to determine their travel activities and attitudes, in Hennepin County which includes the city of Minneapolis and inner suburbs. The survey asked questions about the difficulty of reaching desired destinations in order to attend medical appointments, work, shop, conduct business, visit family or friends and other activities. It found that senior’s

independence declines steadily with age. Those seniors who were not fully independent were unable to make all the trips they needed or wanted to make (or both) on a given day.

The most common transport mode for seniors is automobile. Approximately 77% of respondents travel primarily by automobile for shopping. Public transit was the second most-used mode. Seniors in the sample showed a willingness to use public transit, yet often did not because of a lack of service near their homes or destinations. Although some seniors have a difficult time using public transit (for example, getting up stairs), a bigger concern was fear of being a victim of a crime; more than half were also concerned about waiting for transit or the length of time of the trip.

The survey revealed that more than half of adults with developmental disabilities live in group homes, while about a quarter live with relatives. Despite not living independently, many (40%) consider themselves independent travelers, and 70% reported that the mode of transportation they used was their choice. Walking, public transit, and dial-a-ride were listed as the primary modes of transportation the participants used to meet their transportation needs.

About half of the trips these adults took were work related, with recreational and shopping trips cited as well. More than half of the sampled population worked every day, while recreation occurred at least once a week for about two-thirds of the population. About 30% reported being unable to make trips they wanted to make, and about 46% were unable to make trips they needed to make.

Certain modes and services are particularly important to transport disadvantaged people, including walking, ridesharing, public transportation, taxi, special mobility services, carsharing, public Internet services, and delivery services. It is important to provide good connections between these modes and destinations, for example, insuring that there are good walking and cycling conditions around transit stops, that transportation terminals accommodate people with disabilities, and that public transit serves airports. Because users have few alternatives, Nguyen-Hoanga and Yeung (2010) find that paratransit service benefits far exceed their costs.

Martens (2006) argues that current transport evaluation practices exaggerate the benefits of automobile-oriented improvements and undervalue improvements to alternative modes, which tends to be regressive because it skews planning and investment decisions to favor people who are economically, socially and physically advantaged (those who currently drive high mileage) and at the expense of those who are disadvantaged (who currently drive low mileage and rely on alternative modes). 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*. For example, improvements should be rated based on the number of public services and jobs accessible to people, taking into account their ability (i.e., ability to walk and drive), travel time and financial budgets, not simply travel time savings to vehicle travelers. This recognizes the value of non-automobile modes (walking, cycling, public transit and telecommuting) and land use improvements (such as more compact and transit-oriented development) to improve accessibility and achieve transport planning objectives.
- The monetary value assigned to accessibility gains should be inversely related to people’s current levels of accessibility to reflect the principle of diminishing marginal benefits. In other words, accessibility gains for the mobility-poor (who travel lower annual miles) should receive higher monetary value than for mobility-rich (high annual mile travelers), because accessibility-constrained people tend to gain relatively more from a given transportation improvement. This means that 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 allow them to be more productive.

Smart Growth Development Policies

Automobile dependency and sprawl tend to be inequitable because they make non-drivers (people who for any reason cannot rely on automobile transportation) relatively worse off compared with drivers, and tend to increase total per capita transportation costs by reducing the effectiveness of more affordable travel options (walking, cycling and public transit), and by increasing the total amount of travel required to maintain a given level of accessibility, imposing a financial burden on lower-income residents (Schneider and McClelland 2005). McCann (2000) found that households in sprawled regions devote more than 20% of their expenditures to surface transportation (more than \$8,500 annually), while those in communities with more efficient land use spend less than 17% (less than \$5,500 annually), representing savings of hundreds of dollars a year. Similarly, lower-income households that rely on automobile transportation tend to spend a relatively large portion of their income on basic transportation, while those that use other travel modes spend much less (Bernstein, Makarewicz and McCarty 2005).

Described more positively, transportation and land use policies that help create more multi-modal transportation systems and more accessible land use development help achieve equity objectives by improving accessibility for non-drivers and by making transportation more affordable to lower-income households (Rodier, et al. 2010).

Reforming current planning and investment practices that favor sprawl tends to support equity objectives (“Smart Growth Reforms,” VTPI 2005). Smart growth is sometimes criticized for being inequitable, on the grounds that it reduces housing affordability, but it can incorporate features to improve overall transportation and housing affordability (“Location Efficient Development,” VTPI 2005).

There is sometimes a conflict between a short-term perspective, which focuses on current cost burdens, and a long-term perspective that considers how current policies affect future transportation and land use patterns. For example, increased vehicle taxes and fees intended to discourage automobile travel and encourage use of alternative modes may seem inequitable from a short-term perspective, because they increase the unit costs of vehicle travel, but may increase equity overall if they help create a more diverse transportation system and more accessible land use patterns, which reduce total consumer transportation costs.

Transport Equity Objectives Summary

Table 6 identifies various transportation improvement strategies that help achieve specific equity objectives. This type of analysis can be modified to reflect the needs and values of a particular community. For example, different types of pricing reforms can have different equity impacts, depending on how they are structured and how revenues are used, so with thoughtful design, pricing reforms can achieve a maximum range of equity objectives.

Table 6 Strategies for Achieving Equity Objectives

Strategy	Treats Everybody Equally	People Bear the Costs They Impose	Progressive With Respect To Income	Benefits Transport Disadvantaged	Improves Basic Access
Direct user charges for road and parking pricing.	X	X			
Distance-based (rather than flat) insurance and registration fees		X			X
Increased transport system diversity (improvements to modes used by disadvantaged people).			X	X	X
More accessible land use, and location-efficient development.			X	X	X
More affordable automobile options (PAYD insurance, carsharing, need-based discounts, etc.)			X		X
Correct policies that favor automobile travel over other modes (planning and investment reforms).	X	X	X	X	
Improve public involvement in transport planning.	X			X	
Improve data collection (more information on disadvantaged people and alternative modes).	X		X	X	

This table indicates the equity objectives achieved by various transportation planning and management strategies. Many strategies support multiple equity objectives.

Conclusions

Transportation equity analysis is important and unavoidable. Transport planning decisions often have significant equity impacts and equity concerns often influence transportation planning activities. Most practitioners and decision-makers sincerely want to help achieve equity objectives.

Transportation equity can be difficult to evaluate because there are various types of equity, impacts, ways to measure impacts and categories of people, as summarized in Table 7.

Table 7 Transportation Equity Categories and Indicators

Types of Equity	Impacts	Measurement	Categories of People
<p>Horizontal Equal treatment of equals</p> <p>Vertical With-Respect-To Income And Social Class Transport affordability Housing affordability Impacts on low-income communities Fare structures and discounts Industry employment Service quality in lower-income communities</p> <p>Vertical With-Respect-To Need And Ability Universal design Special mobility services Disabled parking Service quality for non-drivers</p>	<p>Public Facilities and Services Facility planning and design Public funding and subsidies Road space allocation Public involvement</p> <p>User Costs and Benefits Mobility and accessibility Taxes, fees and fares</p> <p>Service Quality Quality of various modes Congestion Universal design</p> <p>External Impacts Congestion Crash risk Pollution Barrier effect Hazardous material and waste Aesthetic impacts Community cohesion</p> <p>Economic Impacts Economic opportunities Employment and business activity</p> <p>Regulation and Enforcement Traffic regulation Regulations and enforcement Regulation of special risks</p>	<p>Per capita Per adult Per commuter or peak-period travel Per household</p> <p>Per Unit of Travel Per vehicle-mile/km Per passenger-mile/km Per trip Per commute or peak-period trip</p> <p>Per dollar Per dollar user fees Per dollar of subsidy Cost recovery</p>	<p>Demographics Age and lifecycle stage Household type Race and ethnic group</p> <p>Income class Quintiles Poverty line Lower-income areas</p> <p>Ability People with disabilities Licensed drivers</p> <p>Geographic location Jurisdictions Neighborhood and street Urban/suburban/rural</p> <p>Mode and Vehicle Type Walkers People with disabilities Cyclists & motorcyclists Motorists Public transit</p> <p>Industry Freight Public transport Auto and fuel industries</p> <p>Trip Type Emergency Commute Commercial/freight Recreational/tourist</p>

There are various types, impacts, measurement units and categories to consider in equity analysis.

There is no single correct methodology. It is generally best to consider a variety of issues and perspectives. A planning process should reflect each community's equity concerns and priorities so public involvement is important for transport equity planning.

More comprehensive equity analysis allows planners to better anticipate problems, incorporate equity objectives in planning (for example, it can help identify congestion reduction strategies that also improve mobility for non-drivers and help lower-income people), and it can help optimize planning decisions to maximize equity objectives. New analysis tools and information resources are available to better evaluate equity and incorporate equity objectives into transport planning. Improved equity analysis in transport planning can reduce conflicts and delays, and better reflect a community's needs and values.

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