Evaluating Transportation Equity
Guidance for Incorporating Distributional Impacts in Transport Planning
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by
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Abstract
Equity refers to the fairness with which impacts (benefits and costs) are distributed. Transportation planning decisions can have large and diverse equity impacts. Evaluating these can be challenging because there are several types of equity and impacts to consider, and various ways to measure them. Horizontal equity assumes that people with similar needs and abilities should be treated equally; vertical equity assumes that disadvantaged groups should receive a greater share of resources. Social justice addresses structural inequities such as racism and sexism. This report provides guidance for transportation equity analysis. It describes various perspectives and impacts, and practical ways to incorporate transportation equity goals into planning.
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Executive Summary
Social equity (also called fairness and justice) refers to the distribution of benefits and costs, and whether that is considered fair and appropriate. Transportation planning decisions have significant equity impacts: they affect the allocation of public resources, people’s quality of life and economic opportunities, and external costs that travellers impose on their communities. People care about these impacts – they want planning decisions to reflect equity goals. As a result, practitioners have a responsibility to evaluate equity impacts in transportation planning.

Transportation equity is a timely issue. In the past, transportation system performance was evaluated based primarily on travel speeds, which favored faster but more expensive and resource-intensive modes, such as driving, over slower but more affordable, inclusive and efficient modes such as walking, bicycling and public transit. Equity debates mainly considered the fairness of transportation funding, such as how fuel taxes should be collected and allocated, and the degree that different vehicles pay their share of roadway costs. There was little consideration of whether transportation systems served non-drivers, or how planning decisions affected external traffic such as congestion, crash risk and pollution imposed on other people. The results were often unfair. For example, many highway projects degraded multimodal urban neighborhoods because the planning process recognized the benefits that those projects provided to motorists, but gave little consideration to the reduced accessibility, livability and economic opportunity they imposed on residents. Those highways are now widely criticized and some are likely to be removed, but the damage they caused is irreversible.

Consider another example. Most jurisdictions have off-street parking minimums which add tens of thousands of dollars to the cost of a home and few dollars to a typical household’s weekly grocery bills. This is unfair, since it forces households that drive less than average to subsidize the parking costs of neighbors who drive more than average. However, these equity impacts often overlooked; when evaluating parking minimums planners seldom analyze who ultimately bears the costs or how they affect housing and food affordability.

These examples illustrate the need for more comprehensive equity analysis in transport planning. However, that can be challenging. How equity is defined, impacts considered and measured, and people categorized can significantly affect results. A decision may seem equitable when evaluated one way but not if evaluated another. There is no single correct way to evaluate transportation equity. It is generally best to consider various perspectives, impacts and analysis methods. Equitable planning that people involved in transportation decision-making understand these issues.

This report provides an overview of key transportation equity concepts and describes practical ways to incorporate equity goals into planning.
Types and Impacts

There are various types of equity. *Horizontal equity* assumes that people with similar needs and abilities should be treated similarly. *Vertical equity* assumes that disadvantaged people should receive favorable treatment. This report considers the five types listed below.

**Table ES-1  Types of Transportation Equity**

<table>
<thead>
<tr>
<th></th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>A fair share of resources</em> (also called fairness or equality). It implies that people should “get what they pay for and pay for what they get,” unless subsidies are specifically justified.</td>
</tr>
<tr>
<td>2.</td>
<td><em>External costs.</em> Costs that travel activities impose on other people, such as the delay, risk and pollution, are unfair. Fairness requires minimizing or compensating for such impacts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td><em>Inclusivity - vertical equity with regard to need and ability.</em> This considers how transportation systems serve people with disabilities and other special mobility needs. This justifies multimodal planning and universal design requirements.</td>
</tr>
<tr>
<td>4.</td>
<td><em>Affordability - vertical equity with regard to income.</em> This considers how transportation systems affect lower-income people. Policies that favor lower-income people are called progressive and those that favor higher-income people are called regressive. This justifies policies that improve affordable modes and subsidize low-income travellers.</td>
</tr>
<tr>
<td>5.</td>
<td><em>Social justice.</em> How transportation systems serve disadvantaged and underserved groups, and address structural injustices such as racism and sexism.</td>
</tr>
</tbody>
</table>

The table below lists possible types, impacts, metrics and groups to consider in equity analysis.

**Table ES-2  Transportation Equity Evaluation Factors**

<table>
<thead>
<tr>
<th>Types of Equity</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A fair share of resources.</strong></td>
<td>“Get what you pay for and pay for what you get.”</td>
</tr>
<tr>
<td>External costs</td>
<td>Facilities and Services. Funding and subsidies. Planning and design. Involvement in planning.</td>
</tr>
<tr>
<td></td>
<td>Regulation and Enforcement. Regulations and enforcement.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Impacts</td>
<td>Demographics</td>
</tr>
<tr>
<td>Inputs (funding, road space, etc.)</td>
<td>Age and household type.</td>
</tr>
<tr>
<td>Outputs (amount of mobility and accessibility)</td>
<td>Physical ability.</td>
</tr>
<tr>
<td>Outcomes (destinations accessed, cost burdens, crash casualties, etc.)</td>
<td>Income and poverty.</td>
</tr>
<tr>
<td></td>
<td>Location</td>
</tr>
<tr>
<td></td>
<td>Race and ethnicity.</td>
</tr>
<tr>
<td></td>
<td>Jurisdiction and neighborhood.</td>
</tr>
<tr>
<td></td>
<td>Urban/suburban/rural.</td>
</tr>
<tr>
<td>Units of People</td>
<td>Mode</td>
</tr>
<tr>
<td>Per adult, household, commuter, or peak-period travel.</td>
<td>Active (walking &amp; bicycling).</td>
</tr>
<tr>
<td></td>
<td>Industries</td>
</tr>
<tr>
<td></td>
<td>Shippers.</td>
</tr>
<tr>
<td></td>
<td>Employees.</td>
</tr>
<tr>
<td>Units of travel</td>
<td>Trip type</td>
</tr>
<tr>
<td>Per vehicle-mile/km.</td>
<td>Commutes and errands.</td>
</tr>
<tr>
<td>Per passenger-mile/km.</td>
<td>Commercial/freight.</td>
</tr>
<tr>
<td>Per trip (by type).</td>
<td>Recreational/tourist.</td>
</tr>
<tr>
<td>Financial</td>
<td></td>
</tr>
<tr>
<td>Per dollar.</td>
<td></td>
</tr>
<tr>
<td>Subsidies.</td>
<td></td>
</tr>
<tr>
<td>Cost recovery.</td>
<td></td>
</tr>
</tbody>
</table>
This section describes ways to evaluate the various types of equity.

**A Fair Share of Resources**
Horizontal equity assumes that people with similar needs and abilities should receive similar shares of public resources and bear similar costs, and people should “get what they pay for and pay for what they get” unless subsidies are specifically justified. This is the basis of most traditional transportation equity debates, such as the allocation of government funds, and the appropriate user fees to charge for various vehicle types.

How impacts are measured affects equity analysis. For example, in the U.S., user fees finance less than half of what governments spend on roads and a smaller portion of what businesses spend on government-mandated parking facilities. Walking, bicycling and public transit services receive small portions of total transportation spending. Public transit travel is highly subsidized, but since users travel relatively few annual miles so their annual subsidy is smaller than for motorists. You could argue:

- It is unfair to “divert” road user fees to other modes (motorists should “get what they pay for”), or conversely it is unfair that motorists only pay a small portion of total road and parking costs (motorists should “pay for what they get”).
- Motorists pay a greater share of government expenditures, but a smaller share of total expenditures (considering parking as well as roadway costs) than transit users.
- Motorists receive smaller subsidies per vehicle-mile but greater subsidies per capita than travelers who rely on walking, bicycling or public transit.

Since equity is concerned with *people* it should generally be measured per capita, instead of per-mile which would assume that people who travel more should receive a larger share of resources. Public spending on a travel option should generally reflect its share of demand: if 10% of travellers would use a mode it should receive 10% of investments. Figure ES-1 compares spending by mode. Automobiles receive the most.

**Figure ES-1** Infrastructure Spending (APTA 2020; FHWA 2018; LAB 2018; Litman 2020)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Parking subsidies</th>
<th>Traffic services</th>
<th>Roads and paths</th>
<th>Operating subsidies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bike</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit</td>
<td>7%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automobile</td>
<td>91%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This graph compares infrastructure investments for various modes. Automobiles currently receive far more investments than other modes.
Figure ES-2 compares the portion of transportation infrastructure spending on non-auto modes with indicators of their demand (their shares of trips, fatalities, and targets). By this metric, non-auto modes should receive 10% to 30% of infrastructure investments. This suggests that non-drivers receive less than their fair share of spending.

**Figure ES-2 Demand Indicators and Public Spending** (APTA 2017; LAB 2018)

External Costs
Horizontal equity analysis can also be applied to external costs such as congestion, crash risk and pollution that vehicle traffic imposes on other people. Horizontal equity requires minimizing and compensating for these costs, so one group does not impose excessive burdens on others. Because they are larger, faster and more energy intensive, automobiles impose larger external costs than other modes, as illustrated below.

**Figure ES-3 Estimated External Costs** (Kockelman, et al. 2013; Litman 2020)

Travel activity imposes various external costs on other people. (”Barrier effect” refers to the delay and risk that motor vehicle traffic imposes on walking and bicycling.) Automobile travel imposes larger external costs than other modes, particularly under urban-peak travel conditions.
External costs are unfair; they benefit some people at others expense. For example:

- It is unfair that travellers using space-efficient modes such as carpools and buses bear congestion delays caused by space-intensive modes such as low-occupant automobiles. Fairness justifies HOV and bus-lanes, and decongestion tolls to internalize this cost.

- It is unfair that pedestrians and bicyclists bear excessive barrier effects (delays and crash risk) imposed by motor vehicle traffic. Fairness justifies roadway designs that minimize these risks such as protected sidewalks, paths, bikeways and traffic calming, financed with road user fees to internalize these costs.

- It is unfair that communities bear traffic noise and air pollution. Fairness justifies pollution reduction policies, such as electric vehicle mandates, fossil-fuel traffic restrictions and speed reductions, plus emission fees to internalize these costs.

Inclusivity: Serving Disadvantaged Travellers

Inclusivity requires that transportation systems serve disadvantaged groups. Accomplishing this goal requires multimodal planning, to serve diverse travel demands, and universal design, to ensure that transportation facilities and services are designed to accommodate travellers with disabilities and other special needs. The table below indicates the modes used by various disadvantaged groups. Since many disadvantaged travellers rely on non-auto modes, or would do so if they were convenient and affordable, multimodal planning helps increase inclusivity.

**Table ES-3** Disadvantaged Groups' Travel Demands

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>People with mobility impairments (5-10%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Youths, 12-22 years old (15-20%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Low-income households (20-40%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Zero-vehicle households (5-15%)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Adults who lack a driver’s license (5-15%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>People impaired by alcohol or drugs (?).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

Disadvantaged groups have diverse travel needs. (Uni. Des. = Universal Design; RH = Ride Hailing)

Vertical equity justifies giving priority to higher value travel (called basic or essential), disadvantaged users, and the modes they use. The table below shows typical priorities.

**Table ES-4** Prioritizing Travel

<table>
<thead>
<tr>
<th>Social Value</th>
<th>Type of Trip</th>
<th>Type of Traveller</th>
<th>Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
<td>Urgent errands</td>
<td>People with disabilities</td>
<td>Walking</td>
</tr>
<tr>
<td></td>
<td>Healthcare access</td>
<td>Seniors</td>
<td>Bicycling</td>
</tr>
<tr>
<td></td>
<td>Basic shopping</td>
<td>Children and families</td>
<td>Public transit</td>
</tr>
<tr>
<td></td>
<td>Commuting to jobs or school</td>
<td>Public service providers</td>
<td>Freight and service vehicles</td>
</tr>
<tr>
<td></td>
<td>Non-essential shopping</td>
<td>Low-income motorist</td>
<td>Taxi/Ridehail</td>
</tr>
<tr>
<td></td>
<td>Entertainment and recreation</td>
<td>Higher-income motorist</td>
<td>Private automobile</td>
</tr>
</tbody>
</table>

Vertical equity justifies planning that favors higher value trips, more vulnerable travellers and their modes.
Inclusivity can be evaluated by establishing standards, targets or rights which define the minimal quality of transportation for disadvantaged travellers or the mode they use. Inclusivity can also be evaluated by comparing disparities in mobility and accessibility between advantaged and disadvantaged groups, such as differences in the number of services and jobs that can be reached within a given time by various groups.

**Affordability: Serving Travellers with Low Incomes**

Another type of vertical equity is *affordability*, which refers to costs relative to incomes, and therefore people’s ability to purchase basic goods within their limited budgets. Experts define affordability as households spending less than 45% of their budgets on transportation and housing combined, so a typical household that spends 30% of its budget on housing has 15% to spend on transportation; more if their housing costs are low and less if housing costs are more than 30% of income.

Figure ES-4 compares the annual user costs of various modes. Although lower-income motorists use various strategies to minimize their vehicle expenses, by purchasing older vehicles and minimum insurance, and performing their own maintenance, it is difficult to legally operate a vehicle for less than $4,000 annually, or $6,000 if it is driven high annual miles. Automobile travel sometimes imposes large unexpected costs due to mechanical failures, crashes or traffic violations.

![Typical Annual Costs by Mode](image_url)

Conventional transportation planning often gives little consideration to affordability impacts. If considered at all, affordability is evaluated based on individual costs such as fuel prices, road tolls or transit fares, rather than total transportation cost. To increase affordability communities can improve lower-cost modes and increase affordable housing in accessible, multimodal neighborhoods. New tools, such as the *Location Affordability Index* and the *Housing and Transportation Affordability Index*, calculate total housing and transportation costs, and therefore the savings provided by more affordable modes and more accessible, multimodal locations.
Social Justice
Social justice considers structural inequities (also called discrimination) such as racism, sexism, and classism. It can be addressed by defining basic rights for disadvantaged groups, such as pedestrians and people with disabilities, and by establishing affirmative action policies, programs and targets.

Social justice can be evaluated by identifying structural inequities, such as differences in job access between non-drivers and drivers or between low- and higher-income residents, or inadequate participation by disadvantaged groups in a planning process. It can also consider historical inequities, such as damages that urban highways imposed on minority communities.

Equity Objectives
Transportation equity evaluation is challenging because there are many possible perspectives and impacts to consider. Because of this complexity, the best way to incorporate equity into planning is usually to define a set of measurable objectives, such as those in Table ES-5. A planning process can evaluate specific policies and planning decisions based on whether they support or contradict them.

Table ES-5 Typical Transportation Equity Objectives

<table>
<thead>
<tr>
<th>Horizontal Equity</th>
<th>Vertical Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fair Share</strong></td>
<td><strong>External Costs</strong></td>
</tr>
<tr>
<td>Everybody contributes to and receives comparable shares of public resources.</td>
<td>Minimized external costs.</td>
</tr>
<tr>
<td>Planning serves non-drivers as well as drivers.</td>
<td>Favor resource-efficient modes that impose less congestion, risk and pollution on other people.</td>
</tr>
<tr>
<td>Affected people are involved in planning.</td>
<td>Compensate for external costs.</td>
</tr>
</tbody>
</table>

This table identifies typical measurable equity objectives. A planning process can evaluate specific policies and decisions based on whether they support or contradict these objectives. (WRT = With Respect To)
Programmatic verses Structural Reforms

There are two general approaches to achieving equity objectives. *Programmatic* (or *categorical*) solutions are special programs or benefits targeting designated groups. These include, for example, universal design standards to ensure that transportation facilities accommodate wheelchair users, transit fare discounts for seniors and people with disabilities, and special commuter bus services in high poverty areas. *Structural* (or *functional*) solutions reform planning practices to achieve equity objectives. These include multimodal planning that improves affordable and inclusive transport options, pricing reforms to internalize external costs, and Smart Growth development policies that create more affordable housing options in multimodal neighborhoods. Table ES-6 evaluates whether various strategies support or contradict various equity objectives.

### Table ES-6  Transportation Equity Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Fair Share</th>
<th>External Costs</th>
<th>Inclusivity</th>
<th>Affordability</th>
<th>Social Justice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive data and analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Accessibility-based analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Multimodal planning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Smart Growth policies</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Subsidize public transportation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Complete streets policies</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Universal design</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Prioritize affordable-efficient modes</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Vehicle travel reduction targets</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Commute trip reduction programs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Efficient road &amp; parking pricing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Parking cash out and unbundling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Subsidize electric car</td>
<td>x</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidize cars for low-income motorists</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Improve public engagement</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Affirmative action programs</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Compensate for past harms</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This matrix indicates whether strategies support (✓) or contradict (×) various equity goals.*

This analysis indicates that some strategies can help achieve multiple equity objectives by making planning respond to unmet travel demands, favoring affordable and low-impact modes, and creating more compact and multimodal communities that offer good non-auto accessibility. Targeted strategies tend to achieve fewer equity goals and can have negative equity impacts. For example, automobile subsidies are unfair to travellers who don’t receive them, and by increasing total vehicle travel exacerbate traffic problems. These programs should be designed to minimize inequities. For example, electric vehicle subsidies can target public transit, carsharing and taxi vehicles, and subsidies for low-income motorists can be balanced with subsidies for other modes.
Conclusions and Recommendations

Transportation planning decisions often have significant equity impacts. It is important to apply comprehensive equity analysis. Equity analysis is challenging because there are several types, impacts, metrics, and groups of people to consider, so it is generally best to consider multiple perspectives, impacts and objectives. Planning decisions should reflect a community’s concerns and priorities, so public involvement is important.

How impacts are measured can significantly affect analysis results. For example, public transit travel has relatively high subsidies per passenger-mile, but most users travel relatively few miles per year. Automobile infrastructure subsidies are smaller per vehicle-mile, but motorists travel more miles per year and automobile travel imposes large congestion, crash risk and pollution costs, so motorists tend to impose larger external costs per capita than people who rely on other modes. Because equity is concerned with people, impacts should generally be measured per capita; measuring impacts per mile favors wealthier people who travel greater distances.

Many current planning practices contradict equity objectives. For example, planning that prioritizes speed over other goals favors faster but more expensive and resource-intensive modes, such as automobile and air travel, over more inclusive, affordable and low external cost modes such as walking, bicycling, and public transit. Similarly, some land use planning practices create automobile-dependent, sprawled communities where it is difficult to get around without a car. The results are unfair to people who cannot, should not or prefer not to rely on automobiles for most of their travel.

The table below summarizes equity analysis and optimization strategies for various equity types. New tools can help with equity evaluations. They require fine-grained data on travel demands, the quality of various modes, user and external costs, public spending, affirmative action programs, and affected groups’ engagement in planning.

<table>
<thead>
<tr>
<th>Table ES-7</th>
<th>Transportation Equity Analysis Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Horizontal – Fair Share</td>
<td>Each person receives a fair share of public resources</td>
</tr>
<tr>
<td>Horizontal – External costs</td>
<td>Travellers minimize and compensate for external costs.</td>
</tr>
<tr>
<td>Vertical – Inclusivity</td>
<td>Transportation systems provide basic mobility to disadvantaged groups.</td>
</tr>
<tr>
<td>Vertical – Affordability</td>
<td>Lower-income households can afford basic mobility.</td>
</tr>
<tr>
<td>Social Justice</td>
<td>Policies address structural inequities.</td>
</tr>
</tbody>
</table>

This table summarizes transportation equity types, ways to measure them, and optimization strategies.
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 have large and diverse equity impacts. For example:

- Transport expenditures are a major share of household, business and government spending.
- The quality of transportation options available affects people’s quality of life, and economic and social opportunities.
- Transport facilities and activities impose various external costs including infrastructure subsidies, congestion delay, crash risk and pollution damages imposed on other people.
- Transport planning decisions can affect development location and type, and therefore accessibility, land values and local economic activity.

Equity analysis is important and unavoidable. Equity concerns often influence transportation policy and planning decisions, and most decision-makers sincerely want to address these concerns. However, there is currently little guidance for comprehensive transport equity analysis. Most transportation equity analysis considers a narrow set of perspectives and impacts. It is often ad hoc, based on the concerns and values of the stakeholders involved in a planning process, which often results in important impacts being overlooked.

Many common transportation planning practices lead to inequitable outcomes. For example, conventional planning evaluates transportation system performance based primarily on vehicle traffic speeds and delay, which favors faster modes, such as automobile travel, over slower but more inclusive and affordable modes with lower external costs, such as walking, bicycling and public transit. This favors motorists over non-drivers, and since vehicle travel tends to increase with ability and income, is unfair to disadvantaged groups.

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

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.
Equity Analysis Concepts
This section discusses key concepts for evaluating transportation equity. Also see Pereira, Schwanen and Banister (2016); Romero-Lankao and Nobler (2021); and Verlinghieri and Schwanen (2020).

Types of Transportation Equity
There are two main types of equity. Horizontal equity (also called fairness and equality) is concerned with the distribution of impacts between people with similar needs and abilities. Vertical equity is concerned with the distribution of impacts between people who differ in needs and abilities. There are five main categories of transportation equity:

1. A Fair Share of Resources
   Horizontal equity requires that people with similar needs and abilities receive similar shares of resources and bear similar shares of costs. It implies that consumers should “get what they pay for and pay for what they get” unless subsidies are specifically justified.

2. External Costs
   External costs, such as infrastructure subsidies, congestion delays, crash risk and pollution that one person imposes on others are horizontally inequitable. Fairness requires minimizing or compensating for these costs.

3. Inclusivity – Vertical Equity With Regard to Mobility Need and Ability
   Vertical equity requires that transportation systems serve travelers with mobility impairments. This supports multimodal planning, to accommodate people who cannot or should not drive, plus universal design (also called accessible and inclusive design), which ensures that transportation facilities and services accommodate all users, including those with disabilities and other special needs.

4. Affordability – Vertical Equity With Regard to Income
   Vertical equity assumes that public policies should favor economically disadvantaged groups, and ensure that lower-income people can afford basic mobility. Policies are called progressive if they favor disadvantaged groups and regressive if they harm such groups. This definition supports affordable mode improvements, affordable housing in multimodal neighborhoods, plus special transportation services and discounts for lower income groups.

5. Social Justice
   Social justice (also called environmental justice\(^1\) and social inclusion\(^2\)) objectives address structural social inequities such as racism, sexism, and unfair disparities. It is usually addressed by establishing affirmative action programs and targets, plus employee training.

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\(^1\) 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).

\(^2\) 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).
Impact Categories
Transport equity can involve various impacts (costs and benefits), such as those listed below. Which are considered and how they are measured, affects planning analysis results.

Public Facilities and Services
- Amount and distribution of public resources (money and land) for transportation facilities and services.
- Government subsidies and tax exemptions for transportation activities and industries.
- Parking requirements imposed on developers, businesses and residents.
- Transportation facility planning and design.
- Degree of public involvement in a planning process.

User Costs and Benefits
- Vehicle ownership and operating expenses.
- Vehicle fees, road tolls, parking fees and fuel taxes.
- Public transportation fares.
- Cost recovery and subsidies (portion of costs borne by a particular activity or group).

Service Quality
- Mobility and accessibility (amount that people travel and their ability to reach desired services and activities).
- 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 Issues

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

Mobility- Versus Accessibility-Based Planning

Transportation planning is undergoing a paradigm shift that changes the way problems are defined and potential solutions are evaluated. This involves a change from mobility-based to accessibility-based analysis. Mobility-based analysis evaluates transportation system performance based on vehicle travel speeds, using indicators such as roadway level of service (LOS) and hours of congestion delay. The new paradigm recognizes that the ultimate goal of most travel activity is access to services and activities, and that many factors affect accessibility including vehicle travel, the quality of non-auto modes, transport system connectivity, development density, and affordability (SSTI 2021).

This has important implications for equity analysis. Mobility-based planning tends to favor faster modes and longer trips over slower modes and shorter trips, and therefore favors motorists over people who cannot, should not, or prefer not to drive. For example, conventional planning recognizes the costs to motorists of traffic congestion, which justifies roadway expansions, but ignores the costs that wider roads and higher traffic speeds impose on walking and bicycling trips (called the barrier effect), and since most public transit trips include walking links, this reduces transit access. Accessibility-based evaluation considers such tradeoffs.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Transportation Evaluation Perspectives (Litman 2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition of Transportation</strong></td>
<td><strong>Mobility</strong></td>
</tr>
<tr>
<td></td>
<td>Vehicle travel</td>
</tr>
<tr>
<td><strong>Measurement units</strong></td>
<td>Vehicle-miles/kms</td>
</tr>
<tr>
<td><strong>Modes considered</strong></td>
<td>Automobile, truck and transit</td>
</tr>
<tr>
<td><strong>Common indicators</strong></td>
<td>Vehicle traffic speeds, roadway Level of Service, costs per vehicle-mile</td>
</tr>
<tr>
<td><strong>Favored transportation improvement strategies</strong></td>
<td>Roadway and parking facility expansion</td>
</tr>
</tbody>
</table>

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

Accessibility-based analysis recognizes the importance of slower modes and shorter trips, and the effects that land use factors, such as density and mix, have on access. This allows more comprehensive equity analysis. For example, mobility-based planning justifies highway projects that destroy high-accessibility urban neighborhoods because it recognizes the benefits that faster vehicle travel provides to suburban commuters but ignores the loss of access to urban residents (Brown, Morris and Taylor 2009).
Basic Mobility and Accessibility

Basic (also called essential or lifeline) mobility and accessibility refers to people’s ability to reach activities that society considers basic or essential, such as those listed below. Basic mobility can be considered a merit good and even a right (Caywood and Roy 2018). This is why, for example, emergency, service and high occupant vehicles often receive priority in traffic, why public transit services are often subsidized, and why transport systems are required to accommodate people with disabilities. Equity can justify prioritizing transportation activities and services to favor basic access (Pereira, Schwanen and Banister 2016; Hamburg, Blair and Albright 1995).

Basic Goods, Services and Activities

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

Measurement Units

Transportation impacts can be measured in various ways that can affect analysis results. For example, infrastructure costs can consider expenditures by a particular government agency, a level of government, all governments, or governments and businesses that are required by law to provide off-street parking.

Impacts are compared using various reference units, such as per-capita, per-trip, per-passenger-mile, or per-dollar. These 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 public resources. Cost recovery analysis assumes that people should receive public resources in proportion to how much they pay in fees and taxes.

Consider how different measurement units can affect equity analysis:

- Public transit services experience economies of density and scale, so cities tend to have higher service quality and ridership, and lower subsidies per trip than in suburban and rural areas. In addition, suburban and rural areas have higher roadway subsidies per capita than in cities. As a result, if equity is evaluated based on transit service quality or transit subsidies per capita, suburban and rural residents seem to receive less than their fair share. However, if measured based on transit subsidies per trip, or total road and transit subsidies per capita, urban residents seem to receive less than their fair share. Because land prices and design requirements tend to increase with density, costs per road lane-mile or parking space tend to be higher in cities than in suburbs and rural areas, but costs per user tend to be lower due to intense use. Because they are relatively inexpensive to maintain but are costly to expand, peak-period users who demand larger facilities impose larger costs than off-peak drivers. As a result, urban-peak trips have high marginal costs that are cross-subsidized by off-peak users.
Vehicle travel requires costly roads and parking facilities. User fees finance about half of roadway costs and a tiny portion of parking costs. Since motorist travel far more annual miles than non-drivers, motorists pay a larger portion of their roadway costs measured per mile of travel but a smaller portion of their total infrastructure costs per capita, and the more people drive the larger their total annual road and parking subsidy.

For example, in the U.S. governments spend about $800 annually on roadways, about $400 of which is funded by user fees, and businesses spend more than $2,000 per vehicle-year subsidizing government-mandated parking facilities (FHWA 2018, Table HM-72; Litman 2020; Scharnhorst 2018). Walking, bicycling and public transit receive less than 20% of government transportation spending and less than 10% of total (including parking subsidy) transportation infrastructure spending. You could argue:

- It is unfair to “divert” road user fees to other modes (motorists should “get what they pay for”), or conversely it is unfair that motorists only pay a small portion of total road and parking facility costs (motorists should “pay for what they get”).
- Motorists pay a greater share of government expenditures but a smaller share of total expenditures (including parking subsidies) than transit users.
- Motorists receive smaller subsidies per vehicle-mile but greater subsidies per capita than travellers who rely on walking, bicycling or public transit.

Table 2 summarizes the equity implications of various transport reference units. It is important that people who analyze equity understand these factors.

**Table 2: Equity Implications of Different Measurement Units**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
<th>Equity Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion Impacts</td>
<td>Transportation funds are allocated based on their expected congestion reductions.</td>
<td>Favors people who frequently drive on congested roads.</td>
</tr>
<tr>
<td>Vehicle Miles Traveled (VMT)</td>
<td>Transportation funds are allocated based on vehicle-miles driven in an area.</td>
<td>Favors people who drive their automobile more mileage than average.</td>
</tr>
<tr>
<td>Passenger Miles Traveled (PMT)</td>
<td>Transportation funds are allocated based on passenger-miles travelled in an area.</td>
<td>Favors people who travel by any mode, with more funding for longer trips.</td>
</tr>
<tr>
<td>Passenger Trips</td>
<td>Transport investments are evaluated according to where trips occur.</td>
<td>Provides more support for shorter trips, including active modes and local travel.</td>
</tr>
<tr>
<td>Access</td>
<td>Transport investments can support many types of transport improvements.</td>
<td>Can benefit the largest range of users, particularly non-drivers.</td>
</tr>
<tr>
<td>Mobility Need</td>
<td>Transport investments maximize benefits to people with mobility impairments.</td>
<td>Favors people with disabilities and other special needs.</td>
</tr>
<tr>
<td>Affordability</td>
<td>Transport user fees are evaluated with respect to users’ ability to pay.</td>
<td>Favors more affordable modes and lower-income people.</td>
</tr>
<tr>
<td>Cost Recovery</td>
<td>Transport expenditures are evaluated according to whether users pay their costs.</td>
<td>Favors wealthier travelers because they tend to spend the most.</td>
</tr>
</tbody>
</table>

How travel is measured can have equity impacts. Some units favor people who drive more than average.
Because equity is concerned with *people*, impacts should generally be measured *per capita*. For example, although public transit travel receives larger subsidies than automobile travel measured per passenger-mile, because motorists typically travel about five times as many annual miles as public transit users, motorists receive more total annual infrastructure subsidies, as illustrated in Figure 1.

**Figure 1**  **Infrastructure Spending** (APTA 2020; FHWA 2018; LAB 2018; Litman 2020)

This graph compares infrastructure investments for various modes. Automobiles currently receive far more investments than other modes.

**Level of Analysis**

Planning decisions can be evaluated at various levels, as illustrated below. For example, transportation safety can be evaluated based on the amount of money governments spend on safety programs (an input), whether crashes decline (an output), or whether per capita crash causalities decline (the ultimate desired outcome).

**Figure 2**  **Steps Between Policy and Planning Decisions and Ultimate Outcomes**

There are often several steps between a policy or planning decision and ultimate economic, social and environmental outcomes. It is necessary to model these relationships for evaluation.

There is ongoing debate about how to measure equity. There is general agreement that everybody deserves *equity of opportunity*, meaning that disadvantaged people can access basic services and opportunities. There is less agreement concerning *equity of outcome*, meaning that disadvantaged people achieve improved health, education and employment goals. Opportunity can be considered a useful but incomplete metric since commonly used indicators of opportunity, such as whether disadvantaged people have public transit services, may overlook critical factors such as whether those services are
sufficiently accessible, reliable and affordable. At a minimum, opportunity indicators should reflect the total door-to-door travel conditions as experienced by users. Newer equity indicators tend to measure outputs and outcomes, such as whether workers actually use transportation services, whether they obtain and retain jobs, and their net increases in incomes. This requires more integrated planning that identifies and corrects obstacles, and more multifaceted analysis which measures progress toward goals.

**Categorizing People**

Equity evaluation often categorizes people into groups according to their needs, abilities, demographics and geography (Jiao and Dillivan 2013; Pereira, Schwanen and Banister 2016). For example, planning analysis often divides people into walkers, bicyclists, transit users and motorists to determine who benefits from a project. However, such categories can be overly simplistic since most people use multiple modes, and even people who don’t currently use a mode may benefit from improvements; for example, non-auto improvements reduce motorists’ chauffeuring burdens and may be useful to them in the future. Similarly, many rural residents work in or visit cities and so benefit from urban transportation improvements.

Vertical equity considers ways that people can be physically, economically or socially disadvantaged. Table 3 indicates various mobility disadvantaged groups and the travel modes they typically demand (they use it, or would use it if available).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>People with mobility impairments (5-10%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Youths, 12-22 years old (15-20%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Low-income households (20-40%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Zero-vehicle households (5-15%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Adults who lack a driver’s license (5-15%).</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>People impaired by alcohol or drugs (?)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Disadvantaged groups have diverse travel needs. (Uni. Des. = Universal Design; RH = Ride Hailing)

Disadvantaged status is multi-dimensional so its evaluation should take into account the degree and number of disadvantaged factors: 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. Since these factors can be difficult to measure, planning often uses surrogates. For example, being over 65 years of age is often used as an indicator of physical disability.
Equity Evaluation Summary

How equity is defined and measured can affect planning results. The table below summarizes key variables affecting transportation equity analysis.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Equity Evaluation Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Types of Equity</strong></td>
<td><strong>Impacts</strong></td>
</tr>
<tr>
<td>A fair share of resources. “Get what you pay for and pay for what you get.”</td>
<td>Facilities and Services</td>
</tr>
<tr>
<td>External costs</td>
<td>Funding and subsidies. Planning and design. Involvement in planning.</td>
</tr>
<tr>
<td>Inclusivity</td>
<td>User benefits and costs Costs and affordability. Service quality (convenience, comfort, speed, safety). Fares, fees and taxes.</td>
</tr>
<tr>
<td>Social Justice</td>
<td>Economic Impacts Economic opportunities. Job and business impacts.</td>
</tr>
</tbody>
</table>

There are various types, impacts, metrics and groups to consider in equity analysis.

The table below lists various transportation equity research questions.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Transportation Equity Research Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Horizontal Equity</strong></td>
<td><strong>Vertical Equity</strong></td>
</tr>
<tr>
<td>Fair Share</td>
<td>External Costs</td>
</tr>
<tr>
<td>What demand exists for various modes and accessibility options?</td>
<td>What external costs do various travellers impose and bear?</td>
</tr>
<tr>
<td>What are the costs of serving those options?</td>
<td>What are the net external costs imposed or borne by various groups?</td>
</tr>
<tr>
<td>How much do users pay toward their transport facilities and services. What subsidies do they receive? Are those subsidies justified?</td>
<td>How can external transport costs be mitigated?</td>
</tr>
</tbody>
</table>

This table summarizes research questions for transportation equity analysis.
There is no single way to evaluate transportation equity; it is generally best to consider various perspectives and impacts. The most practical approach is to identify a set of measurable equity objectives, such as those in the table below. Planning can evaluate specific policies and decisions based on whether they support or contradict them.

**Table 6  Typical Transportation Equity Objectives**

<table>
<thead>
<tr>
<th>Horizontal Equity</th>
<th>Vertical Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fair Share</strong></td>
<td><strong>External Costs</strong></td>
</tr>
<tr>
<td>Everybody receives a comparable share of resources.</td>
<td>Minimized external costs.</td>
</tr>
<tr>
<td>Planning serves non-drivers as well as drivers.</td>
<td>Favor resource-efficient modes that impose less congestion, risk and pollution on other people.</td>
</tr>
<tr>
<td>Affected people are involved in planning.</td>
<td>Compensate for external costs.</td>
</tr>
</tbody>
</table>

This table identifies typical measurable equity objectives. A planning process can evaluate specific policies and decisions based on whether they support or contradict these objectives. (WRT = With Respect To)

Many current planning practices contradict these objectives. For example, planning that prioritizes speed over other goals favors faster but more exclusive and expensive modes with greater external costs, such as automobile and air travel, over more inclusive, affordable and low external cost modes such as walking, bicycling, and public transit. Similarly, parking minimums and limits on development density create automobile-dependent, sprawled communities where it is difficult to get around without a car. The results are unfair to people who need or prefer non-auto transportation.

There are sometimes conflicts between equity objectives. For example, horizontal equity requires roadway user fees, but vertical equity may justify underpricing and subsidies for lower income travellers. Comprehensive analysis recognizes such conflicts and identifies ways to address them, such as price structures that address both horizontal and vertical equity objectives. The worksheet below can help stakeholders identify equity conditions, objectives and mitigation strategies.

**Table 7  Multifaceted Equity Analysis Worksheet**

<table>
<thead>
<tr>
<th></th>
<th>Fair Share of Resources</th>
<th>External Costs</th>
<th>Inclusivity</th>
<th>Affordability</th>
<th>Social Justice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mitigation strategies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This worksheet can help identify current equity conditions, objectives and mitigation strategies.
There is no standard way to select equity mitigation strategies; they should reflect community needs and values. It is therefore important that affected stakeholders, particularly disadvantaged communities, be involved in these decisions.

There are two general types of equity mitigation strategies. Programmatic (or categorical) solutions are special, targetted programs or benefits targetted at designated disadvantaged groups. These include universal design standards to ensure that transportation facilities accommodate wheelchair users, transit fare discounts for seniors and people with disabilities, and special commuter bus services in high poverty areas. Structural (or functional) solutions reform planning practices to address equity goals. These include multimodal planning that improves affordable and inclusive transport options, pricing reforms to internalize external costs, and Smart Growth development policies that create more affordable housing options in walkable neighborhoods. The table below compares these approaches.

**Table 8** Programatic versus Structural Solutions (Litman and Brenman 2012)

<table>
<thead>
<tr>
<th></th>
<th>Programatic (Categorical)</th>
<th>Structural (Functional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Programs that provide targetted benefits to people with special needs.</td>
<td>Reforms that correct unfair planning practices.</td>
</tr>
<tr>
<td>Examples</td>
<td>Special facilities for people with disabilities, targetted discounts and subsidies, special transit services to disadvantaged areas.</td>
<td>Multimodal planning that favors affordable and resource-efficient modes, least-cost funding, pricing reforms, Smart Growth development policies.</td>
</tr>
<tr>
<td>Additional impacts</td>
<td>Often increases total vehicle travel which increases external impacts.</td>
<td>Improves affordable and resource-efficient accessibility options, which reduces total vehicle travel and provides many co-benefits.</td>
</tr>
<tr>
<td>Scope</td>
<td>Provides large, measurable benefits to a relatively small group.</td>
<td>Provides diverse but sometimes difficult to measure benefits to many groups.</td>
</tr>
</tbody>
</table>

*This table compares different types of solutions.*

Programatic solutions often seem easier and more cost effective because they provide clearly-defined benefits to a small group, but structural reforms tend to provide larger and more diverse benefits and so generally provide more total benefits. For example, universal design standards are of little benefit in an automobile-dependent community that has few sidewalks, transit fare discounts are of little value in communities with minimal public transit services, and special bus services for low-income workers tend to be inconvenient and inefficient in sprawled areas. Structural solutions tend to be more challenging to implement but provide larger and more diverse benefits, including economic, social and environmental benefits in addition to equity goals. Comprehensive equity planning generally applies both programmatic and structural solutions, with emphasis on structural reforms that create more diverse, affordable and efficient transportation systems.
Analysis Methods
This chapter describes techniques for incorporating equity analysis into transport planning. Also see Shah and Wong (2020); Fan, et al. (2019); and Toole, Butler and Chrzan (2020).

A Fair Share of Public Resources
Many traditional transportation equity debates concern the allocation of public resources. For example:

- State officials complain if they receive less federal highway funding than their motorists pay in fuel taxes (CRS 2011). However, most experts recommend that public funds be allocated based on cost efficiency or user needs; allocation based on tax payments can result in inefficient and regressive planning decisions.

- Highway advocates complain when fuel taxes are spent on non-highway projects, which they call diversions (Winters 2019). These critics ignore the fact that those taxes only fund about half of total roadway costs; their argument that motorists should “get what they pay for” ignores the corollary that motorists should also “pay for what they get.”

- Highway cost allocation studies examined whether the road user fees paid by various vehicle types reflect their share of roadway costs (Balducci and Stowers 2008). But the U.S. federal government has not commissioned a cost allocation study since 1997 because their conclusions – that fairness requires higher taxes on heavy vehicles plus new fees to reflect congestion, crash risk and pollution costs – faced political opposition.

These examples reflect a narrow scope, such as particular budget. More comprehensive analysis considers total expenditures and payments by mode or user groups. For example, the figure below compares total estimated infrastructure expenditures, including roads and government-mandated parking facilities, by mode.

**Figure 3 Infrastructure Spending** (APTA 2020; FHWA 2018; LAB 2018; Litman 2020)

This graph compares infrastructure spending by mode. Automobiles receive the most by far.
This type of analysis can exclude the portion of infrastructure costs funded by users. For example, in 2018, user fees (fuel taxes, vehicle registration fees and road tolls) paid less than half of the $800 governments in the U.S. spend on roads per vehicle-year, and less than 10% of the estimated $2,000 in government-mandated, non-residential off-street parking facility costs (FHWA 2018, Table HM-72; Litman 2020).

Figure 4 compares expenditures on non-auto mode with indicators of their demand: mode shares, traffic fatalities, the portion of travelers who use those modes at least occasionally, and mode share targets. This indicates that people who rely on non-auto modes, or would like to, receive less than their fair share of investments.

**Figure 4  
Expenditures Compared with Demands (APTA 2017; LAB 2018)**

This figure compares the portion of infrastructure spending devoted to walking, bicycling and public transit with various indicators of their demand. This indicates that people who rely on non-auto modes receive less than their fair share of public investments. (ACS = American Community Survey. NHTS = National Household Travel Survey)

Some highway advocates that motorists receive less than their fair share of investments, based on incomplete analysis (O’Toole 2019; Winters 2019). For example, they may consider spending on state highways, which are mostly funded by user fees, but ignore spending on local road that are mainly funded by general taxes. They generally ignore the costs of government-mandated parking facilities. They compare costs per passenger-mile, which does not account for the greater distance travelled, and greater infrastructure costs, imposed by motorists. Since horizontal equity is concerned with fairness between people, analysis should be comprehensive and measure impacts per capita rather than per unit of travel.

Transportation models can be used to evaluate the distribution of benefits from transportation improvements in specific situations (Bills and Walker 2017). This can determine whether various groups, including non-drivers, receive a share of benefits proportional to their share of residents or travellers.
Horizontal Equity: External Costs

External costs, such as the congestion, risk and pollution damages that travellers impose on other people are unfair. They violate the horizontal equity requirement that people should “get what they pay for and pay for what they get,” so one person does not impose excessive costs on others. For example:

- It is unfair that travellers using space-efficient modes, such as carpools and buses, bear traffic congestion caused by space-intensive modes such as automobiles. Fairness justifies HOV and bus-lanes, and congestion tolls to internalize this cost.

- It is unfair that walkers and bicyclists bear barrier effects (delays and crash risk) imposed by automobile traffic. Fairness justifies that motorists pay for protected sidewalks and paths, traffic calming and traffic speed reductions to reduce and internalize these costs.

- It is unfair that communities bear traffic noise and air pollution. Fairness justifies pollution reduction policies, such as electric vehicle mandates, fossil-fuel traffic restrictions and speed reductions, plus emission fees to internalize these costs.

Various studies have quantified and monetized (measured in monetary units) these costs (DfT 2020; Litman 2020; Ricardo-AEA 2014; TTI 2019). The figure below illustrates estimates. Because they are large, fast and resource intensive, automobiles impose more congestion, risk and pollution per passenger-mile than most other modes, particularly under urban-peak conditions. As a result, people who drive more than average impose net external costs on people who drive less than average. Since vehicle travel tends to increase with income, the external costs that automobiles impose on non-drivers tend to be regressive (McNeil and Roll 2021).

[Skeptics may claim that these estimates are exaggerated because road users both impose and bear congestion, insurance compensates crash damages, and new technologies are eliminating vehicle pollution, but those claims are themselves exaggerations. Motorists impose an order to magnitude more congestion costs than other modes, a major portion of crash costs are uncompensated, and although electric vehicles reduce some emissions their production and the electricity they use produce significant pollution.]
Inclusivity: Accommodating People with Special Mobility Needs

To be equitable, a transportation system must serve diverse users including people with disabilities and other special needs, such as those listed to the right. Although these groups often travel by automobile, they can benefit from improvements to other modes that provide more independent mobility. Accommodating their needs requires multimodal planning to provide diverse travel options, plus universal design to accommodate travellers with disabilities and other special needs, and priority parking. Some can benefit from suitable housing options located in high accessibility areas where most common services are available within a short walk.

About 8% of the U.S. population has self-reported travel-limiting disabilities, about half of whom are seniors (Brumbaugh 2018). People with disabilities tend to make fewer trips, travel less by automobile and more by other modes, and have lower employment rates and lower incomes than comparable non-disabled people. As a result, people with mobility impairments tend to rely on non-auto modes, as illustrated below, and so can benefit significantly from their improvement.

**Figure 6 Mode Share by Worker and Disability Status** (Brumbaugh 2018)

Inclusivity can be evaluated by defining service quality standards and targets to accommodate people with disabilities and special needs. For example, targets could include accessible sidewalks on all streets, wheelchair accommodation on all transit vehicles, and that 90% of households can access basic services within 15 minutes without a car. It can also be evaluated by comparing accessibility disparities between people with and without impairments, and between drivers and non-drivers (Martens, Golub and Robinson 2012). These factors can be analyzed using universal design standards (Saha, et al. 2019), multimodal level-of-service ratings (Dowling, et al. 2008), and comprehensive accessibility models that measure travellers’ ability to access services and activities by various modes (Levinson and King 2020; SSTI 2021).
Affordability: Serving Travellers with Low Incomes

Affordability refers to costs relative to incomes, and therefore people’s ability to pay for basic goods within their limited budget. Surveys indicate that many travellers want more affordable mobility options (Mattson 2012), but conventional planning gives little consideration to this goal. If considered at all it is evaluated based on individual costs such as fuel prices, tolls and transit fares rather than total transportation expenses.

Affordability is defined as households spending no more than 45% of their budgets on transportation and housing combined (CNT 2018), so a typical household that spends 30% of its budget on housing should spend no more than 15% on transportation (Litman 2018). Most households spend more than is considered affordable as illustrated below. When households are unable to purchase healthy food, healthcare or education, the root reason is often excessive housing and transportation expensive which leave insufficient money for these other essential goods.

**Figure 7** Portion of Household Spending on Housing and Transport (BLS 2020)

Most households, particularly those with lower incomes, spend a larger share of their budgets on housing and transportation (45% maximum) than is considered affordable.

Figure 8 compares typical costs of various modes. Active modes are cheapest, public transit costs are moderate, and automobiles are most expensive.

**Figure 8** Typical Direct User Costs by Mode (Litman 2020)

Walking, bicycling and public transit are the most affordable modes. Automobiles are more expensive and sometimes impose large, unpredictable costs.
Although lower-income motorists often try to minimize their vehicle expenses by purchasing older cars and minimal insurance, and performing their own maintenance, it is difficult to spend less than $4,000 annually, or $6,000 if driven high annual miles, including sometimes large, unexpected costs due to mechanical failures, crashes or traffic violations that can cause financial shocks (Agrawal, et al. 2011). This indicates that automobile ownership is unaffordable (it requires more than 15% of their budget) for many low-income households, and multiple-car ownership is unaffordable to many low- and moderate-income households.

Transportation planning decisions can be evaluated based on their impacts on the availability, quality and price of affordable modes. New tools can evaluate these impacts (Lavery 2019). Since households often make trade-offs between housing and transport costs, for example, between a cheaper but isolated house with more expensive transportation or a higher cost house in an accessible location with cheaper transport, it is important to evaluate these costs together. The Location Affordability Index (HUD 2019) and the Housing and Transportation Affordability Index (CNT 2008), calculate the total housing and transportation costs for various neighborhoods, and therefore the savings provided by more affordable modes and more accessible, multimodal locations.

**Figure 9**  
**H+T Affordability Index** ([https://htaindex.cnt.org/compare-affordability](https://htaindex.cnt.org/compare-affordability))

These two maps compare two views of affordability for Nashville, Tennessee. The left indicates in yellow areas where housing is affordable (less than 30% of moderate-income household budgets). The right map shows in yellow the much smaller areas where housing and transportation together total less than 45% of budgets.

Transportation investments can also be evaluated based on their impacts on lower-income communities. For example, highways tend to improve access for affluent households that can afford suburban homes and automobiles, but often displace or price out lower-income households (Brinkman and Lin 2019; Fretz, Parchet and Robert-Nicoud 2021). The Gini-index, the Theil Coefficient and the Coefficient of Variation quantify inequity by comparing impacts between different income groups.
Social Justice

Social justice considers structural inequities such as racism, sexism, and classism (Martens 2016; Romero-Lankao and Nobler 2021). It is often addressed by establishing affirmative action policies, programs and targets, plus employee training and professional development (Raleigh 2021). It can be evaluated by identifying extra costs and risks borne by disadvantaged groups, biases that result in infrastructure underinvestment in inclusive modes and disadvantaged communities, inadequate participation by disadvantaged groups in decision-making, and disparities in outputs and outcomes between advantaged and disadvantaged groups, such as differences in access between non-drivers and drivers, lower- and higher-income travellers, and minority and non-minority communities. It can also include analysis of user satisfaction and complaints related to transportation facilities and services.

Transportation equity analysis requires comprehensive information on the impacts that planning decisions would have on minority and low-income people. Analysis can compare the quality of mobility and accessibility options, and user satisfaction with the transportation experienced by different groups. This can include transportation-related questions in surveys concerning other issues (Schmocker, et al. 2005). For example, a survey of social services clients can include questions concerning their mobility and accessibility options, costs and obstacles.

Health Equity and Social Justice

Equity can be evaluated based on health as well as economic impacts. Planning decisions affect disadvantaged people’s health in many ways. Transportation quality and affordability affect their ability to access healthcare, healthy food and exercise. Vehicle traffic imposes barriers, risk and pollution on communities. Travel comfort and convenience affect daily stress and mental health.

Various studies (Ewing and Hamidi 2014; Lachapelle, et al. 2011; Mindell 2018; Rachele, et al. 2018) indicate that people, particularly disadvantaged groups, tend to be healthier living multimodal neighborhoods and travelling by active and public transport modes. Publications such as the Toolkit to Integrate Health and Equity Into Comprehensive Plans (Shah and Wong 2020) and Investing in Health (Jones 2021) provide guidance for incorporating health into transport planning.

Social justice analysis should also examine structural biases in transportation planning and funding practices that favor advantaged over disadvantaged groups, and ways to correct and mitigate those biases, as discussed in the following box. A century of automobile-oriented planning left a substantial legacy of injustice in many areas, including destroyed and degraded communities, and reduced economic opportunities for physically, economically and socially disadvantaged residents. At a minimum, this justifies reforms to ensure that future planning supports and protects disadvantaged communities. It could also justify mitigation and compensation, for example, urban highway removals and targeted programs to improve livability and economic opportunity in areas harmed by previous transportation planning decisions.
Equity Analysis: Lessons from Urban Highways

During the Twentieth Century highways displaced many low-income, minority urban neighborhoods. The article, *Interstate Injustice: Plowing Highways Through Minority Neighborhoods* (Problogic 2018) identifies more than fifty. These projects are a good case study for understanding how incomplete and biased planning can lead to unfair and harmful outcomes.

Those highways harmed communities and reduced accessibility. High-speed highways are not really needed in urban areas: many cities function efficiently with moderate-speed surface streets, and the displaced neighborhoods generally had much better access to jobs and services than the suburbs those highways were built to serve. Some cities are now replacing highways with surface roads and improvements to other modes (CNU 2019).

The planning process that created these highways was classist and racist, as described in Deborah Archer’s recent article, *White Men’s Roads Through Black Men’s Homes*: Advancing Racial Equity Through Highway Reconstruction. Urban planners described low-income and minority community as *blight* to be displaced when possible. For example, a Transportation Research Board report, *Beneficial Effects Associated with Freeway Construction* (Gamble and Davinroy 1978) stated that “Old housing of low quality occupied by poor people often serves as a reason for the destruction of that housing for freeway rights of way.” It claimed that freeways improve safety, environmental quality, economic productivity and aesthetics:

“Blighted or substandard housing, junkyards, dumps, and other sources of ugliness may be eliminated through condemnation, eminent domain, out-right purchase, and other procedures. The effect is a reduction in visual discontinuity to the highway viewer and a possible improvement in the entire visual quality of the affected area and the community.”

The motivation may have been classism and racism, the mechanism through which transportation agencies and practitioners achieved these goals was a planning process which valued mobility over accessibility, and therefore prioritized vehicle traffic over walking, bicycling and public transit. The planning process placed a high value on projected vehicle travel time and cost savings, and ignored the reduction in access and increased costs imposed on urban residents. If considered at all, harms to urban communities were described as *intangibles*, with the implication that they are difficult to quantify and not very important. Federal and state governments offered large and generous grants for urban highways but virtually no support for affordable and resource-efficient modes.

The article, “Paved with Good Intentions: Fiscal Politics, Freeways, and the 20th Century American City” (Brown, Morris and Taylor 2009) concluded that these highways were not cost effective. Consider an example. A six-lane (three lanes each direction) city-to-suburb freeway typically serves 5,000 to 10,000 automobile commuters, assuming 2,000 vehicles per lane-hour during one to three peak hours, a third of which are local trips. Assuming the freeway corridor is five-miles long and 600 feet wide, with 30 average residents per acre, it displaced about 10,000 residents. By reducing the supply of affordable homes in high-accessibility neighborhoods the project forced many households to shift from multimodal to automobile-dependent communities. In addition, urban freeways create barriers to local travel, particularly for non-drivers, making trips that could previously be made by a short and pleasant walk or bike ride longer and less pleasant, and imposing noise and air pollution on urban neighborhoods.

By measuring the mobility benefits of faster traffic but ignoring the accessibility value of compact, multimodal neighborhoods this planning process favored motorists over non-drivers, wealthy over lower-income travellers, and suburban over urban residents. To be more equitable, transportation planning must correct these structural biases.
Evaluation Examples

Incorporating Equity Goals into Transportation Planning
These examples describe how transportation agencies and practitioners can address equity goals.

Illustrated Equity and Mobility Article (https://issuu.com/cite7/docs/tt40.2-summer2018/24)
Transportation engineer Ryan Martinson’s “Equity and Mobility” article published 2018 in Transportation Talk, provides an overview of equity concepts including equality (the state of being equal) and equity (the quality of being fair, taking into account differing needs and abilities), and how they are reflected in common planning decisions such as funding allocation and roadway design. It also discusses ways to include diverse perspectives in transportation planning activities. This is an excellent way to introduce these concepts to practitioners, public officials, and other stakeholders.

Figure 10  Equity and Mobility (https://issuu.com/cite7/docs/tt40.2-summer2018/24)

The report, Advancing Transportation Equity: Research and Practice (Fan, et al. 2019) identified practical ways that transportation agencies can address equity goals. The study included detailed research and stakeholder consultation concerning ways to define transportation equity and incorporate equity into policy and planning decisions. It developed the following working definition of equitable transportation:

- Transportation systems support multi-modal options that are affordable, sustainable, reliable, efficient, safe, and easy to use.
- Quality transportation services that are accessible to all populations for reaching destinations independently.
- Transportation decision-making processes that incorporate inclusive public engagement to reduce the longstanding socioeconomic disparities experienced by underserved and underrepresented communities.
Equity Evaluation Indicators

Understanding Transport-Related Social Exclusion (TRSE): A Multidimensional Approach (Yigitcanlar et al. 2018) developed a framework for evaluating the Transport-Related Social Exclusion that individuals face, using 15 key indicators and 47 sub-indicators reflecting physical, economic, temporal, spatial, psychological, and information factors. Creger, Espino and Sanchez (2018) propose a framework for evaluating mobility equity and addressing inequities. They identify the twelve equity indicators summarized below.

Table 9 Transportation Equity Indicators (Creger, Espino and Sanchez 2018)

<table>
<thead>
<tr>
<th>Increase Access to Mobility</th>
<th>Reduce Air Pollution</th>
<th>Enhance Economic Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Affordability</td>
<td>6. Air quality and health impacts</td>
<td>9. Connectivity to employment, education, services and recreation</td>
</tr>
<tr>
<td>3. Efficiency</td>
<td>8. Total vehicle travel (less is better)</td>
<td>11. Transport-related employment opportunities</td>
</tr>
<tr>
<td>4. Reliability</td>
<td></td>
<td>12. Inclusive local business &amp; economic activity</td>
</tr>
<tr>
<td>5. Safety</td>
<td></td>
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</tbody>
</table>

Several indicators should be used when evaluating transportation equity.

Ciommo (2018) developed an inaccessibility index which indicates the number of desirable activities (such as jobs, healthcare and shopping) that a particular demographic group cannot reach. It is used to evaluate the social equity impacts of strategic planning decisions in Barcelona, Spain, such as city center vehicle restrictions, parking policy changes, public transit service improvements, and park-and-ride services. The results indicate that the inaccessibility index analysis provides a practical way to consider equity impacts in planning decisions. Adli and Donovan (2018) developed a “justice test” for transportation planning decisions which measures how changes in accessibility affect different socioeconomic groups.

Golub and Martens (2014) define an access ratio, as the ratio of automobile and public transit employment access, and define the access poverty line as a ratio of 0.33, which implies that transit users can access one third the number of jobs as by car. This is used to evaluate the equity of San Francisco’s regional transportation plan scenarios. They investigate and map how access and access poverty rates vary by demographic groups. The analysis shows that virtually all neighborhoods suffer substantial disparities between car and public transit accessibility, but some scenarios reduce access poverty.

Critical Evaluation of Transportation Equity Analysis

Manaugh, Badami and El-Geneidy (2015) evaluate how social equity is conceptualized, operationalized, and prioritized in 18 urban region transportation plans in North America. They critically analyze the quality of the related objectives, how meaningfully their achievement is assessed through the choice of performance measures or indicators, and their prioritization relative to other objectives. They find good examples of social equity objectives and measures in several plans, but those goals are often not translated into specified objectives and targets.
Two studies, *Transportation Equity Project Prioritization Criteria* (Krapp 2021), and *Transportation-Related Equity Indicators to Improve Mobility and Transportation System Access for Low-Income and Disadvantaged Communities* (DRISI 2021) examine how transportation agencies incorporate equity goals in their prioritization and planning. They identify two major shortcomings: first, analyses seldom consider all the relevant equity factors, and second, equity is seldom given enough weight to significantly influence decisions. To correct this they recommend giving equity more priority with the aim of correcting existing disparities and past discrimination, and better opportunities to disadvantaged communities to participate in planning processes.

Martens (2006) argues that current transportation evaluation methods exaggerate the benefits of automobile-oriented improvements and undervalue improvements to alternative modes, which is regressive because it favors physically, economically and socially advantaged people, who tend to have high mobility and accessibility, at the expense of disadvantaged groups who tend to be less mobile and rely on non-auto modes. He concludes that “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...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.”

To achieve equity goals he recommends applying accessibility-based planning, and valuing accessibility gains inversely to people’s current levels of accessibility to reflect diminishing marginal benefits, so accessibility gains for the mobility-poor should be valued more than for mobility-rich, because accessibility-constrained people tend to benefit more from additional mobility. Similarly, he recommends valuing travel time savings for mobility-poor people higher than for the mobility-rich to maximize consumer welfare, efficiency and social justice objectives.

**Transit Equity Analysis** ([https://dashboard.transitcenter.org](https://dashboard.transitcenter.org))

The Transit Center’s *Transit Equity Dashboard* measures how well transit networks connect disadvantaged populations (racial minorities, people with low incomes, single mothers, etc.) to jobs, services, and amenities. It can be used to identify disparities and track progress toward equity. The article, “Meeting the Public’s Need For Transit Options: Characteristics of Socially Equitable Transit Networks,” (Krameer and Goldstein 2015) provides guidance for evaluating public transit social equity impacts, and specific strategies for achieving equity goals. Lubitow, Rainer and Bassett (2017) identify ways that conventional public transit planning may underserve vulnerable groups, such as mothers with young children and people with disabilities. Farber and Allen (2019) evaluate the fairness of public transport service in Toronto, Canada. They find that central areas have better transit accessibility, reflecting the greater efficiency of transit services in compact, multimodal neighborhoods, but that many carless households live in outer areas, so additional transit services may be justified on vertical equity grounds.
Tools for Measuring Multimodal Accessibility

New tools use various approaches to measure multimodal accessibility, taking into account the time and money required to reach basic services and activities (Levinson and King 2020; SSTI 2021). This supports equity analysis by measuring the quality of access available to people with various abilities and needs (mobility impaired and mobile, non-drivers and drivers, low- and high-income). These can evaluate impacts that planning decisions will have on various groups, and resulting disparities. These include:

- **Access Across America** ([http://ao.umn.edu/research/america](http://ao.umn.edu/research/america)) measures accessibility to jobs via various modes of transportation in major metropolitan areas across the United States.

- **Accessibility Observatory** ([http://ao.umn.edu](http://ao.umn.edu)) is a leading resource for the research and application of accessibility-based transportation system evaluation.


- **COST Accessibility Instruments** ([www.accessibilityplanning.eu](http://www.accessibilityplanning.eu)) provides access analysis tools.

- **Opportunity Score** ([www.redfin.com/news/introducing-opportunity-score](http://www.redfin.com/news/introducing-opportunity-score)) maps the number of jobs that can be accessed within a 30-minute walk or transit ride in U.S. cities.

- **Smart Location Mapping** ([www.epa.gov/smartgrowth/smart-location-mapping](http://www.epa.gov/smartgrowth/smart-location-mapping)) by the US EPA provides interactive maps and data for measuring access to jobs by public transit.


- **Walkscore** ([www.walkscore.com](http://www.walkscore.com)) rates the number of common destinations that can be reached by walking and public transit.

The study, *The Impact of Transit Monetary Costs on Transport Equity Analyses* (Herszenhut, et al. 2021) shows that indicators that measure accessibility based only on travel time exaggerate economic opportunity for lower-income travellers by failing to account for monetary cost. El-Geneidy, et al. (2016) developed new transit accessibility indicators that account for both travel time and fare costs.

**Land Use Development Policies**

Because land use factors such as density and mix affect accessibility, particularly for non-drivers, they have significant equity impacts: disadvantaged people tend to have much better access in compact, multimodal areas. As a result, development policies that create automobile-dependent sprawl tend to be inequitable (Beard, Mahendra, Westphal 2016), and Smart Growth policies that increase affordable housing options in walkable urban neighborhoods tend to support transportation equity goals (Ewing and Hamidi 2014; Semuels 2017). Guthrie, et al. (2019) used sophisticated surveys to assess transportation needs and abilities in Areas of Concentrated Poverty (ACPs) that have majority minority populations. They found that pedestrian environments around transit stops significantly affect public transit travel experience, leading to the conclusion that transit- and pedestrian-oriented community design can help achieve equity goals.
Transportation Equity Theories
Various equity theories, or principles, can be used to determine how resources should be allocated, as described in Table 10. Resources can include money or road space, and with accessibility-based planning can also include development priorities, such as the portion of land in high-accessibility areas devoted to affordable housing.

Table 10 Equity Theories (Bills and Walker 2017; Levinson 2010; Martens 2012; Pereira, Schwanen and Banister 2016)

<table>
<thead>
<tr>
<th>Equity Theory</th>
<th>Description</th>
<th>Resource Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egalitarianism/Equality</td>
<td>Each person receives an equal share of resources regardless of differences in need.</td>
<td>Per capita.</td>
</tr>
<tr>
<td>Proportionality</td>
<td>Each group receives a share of resources proportional to its share of the population.</td>
<td>Allocated to each mode based on the portion of users in that community.</td>
</tr>
<tr>
<td>Payment-Based</td>
<td>“You get what you pay for.” Resources are allocated in proportion to user payments.</td>
<td>Based on the amount that each group pays.</td>
</tr>
<tr>
<td>Utilitarianism/Pareto Optimal</td>
<td>Resources are distributed to maximize benefits for the most people.</td>
<td>Based on a comprehensive benefit-maximizing formula.</td>
</tr>
<tr>
<td>Basic Needs</td>
<td>Each group’s basic mobility or accessibility needs are satisfied.</td>
<td>Allocated to ensure that everybody can achieve a basic level of mobility or access.</td>
</tr>
<tr>
<td>Social Equity/Rawls</td>
<td>Resources are allocated to provide the greatest benefits to the most disadvantaged groups.</td>
<td>Based on indicators of special mobility needs, such as disability and poverty rates.</td>
</tr>
<tr>
<td>Mini-Max</td>
<td>Average benefits are maximized while keeping disparities within an acceptable range.</td>
<td>Allocated to maximize benefits and correct disparities to disadvantaged groups.</td>
</tr>
<tr>
<td>Capability/Equal Opportunity</td>
<td>Resources are allocated to allow people achieve equality of opportunity.</td>
<td>To improve economic opportunities for disadvantaged groups.</td>
</tr>
<tr>
<td>Restorative Justice</td>
<td>Distribute benefits to equalize differences between groups and remediate disparities.</td>
<td>Allocated to correct disparities facing disadvantaged groups.</td>
</tr>
<tr>
<td>Libertarianism</td>
<td>Free markets provide the most just allocation of resources through consumer choice.</td>
<td>Considers taxes, so minimizes public subsidies and relies on private transport services.</td>
</tr>
</tbody>
</table>

This table summarizes various theories of equity that can be applied to transportation planning.

As an example, consider how these equity theories would affect the allocation of public transit funds between jurisdictions. Egalitarianism would allocate funds equally per capita. Proportionality would allocate based on the number of transit users or trips. Payment-based would allocate according to an area’s tax payments, so wealthier communities would receive more. Utilitarianism would allocate to transit programs with the highest return on investments. Basic needs would allocate sufficient funds to provide basic mobility to people who need it. Social equity, Mini-max and Capability would allocate more funds to areas with more disadvantaged travellers. Restorative justice would allocate more to areas that suffered past discrimination. Libertarianism would provide no public transit funding.
Because transit service efficiency increases with density (more passenger-trips per dollar), input-based theories such as egalitarianism, proportionality and utilitarianism direct more funds to urban areas, while output-based indicators such as basic needs and capability direct more to suburban and rural areas, giving them more money per user.

Ideally, this analysis should be comprehensive, considering all modes and impacts. For example, an ideal equity analysis would compare all public expenditures on roads, parking facilities and public transit services. However, in practice, analysis often only considers a specific budget, such as municipal or regional agency spending, or public transit subsidies. This limited perspective can bias results. For example, active and public transport receive a relatively large portion of municipal transportation expenditures, so considering those budgets alone, non-drivers would seem to receive their fair share of spending. However, non-auto modes receive a small portion of regional, state/provincial and federal transportation spending, and municipal governments require businesses to provide costly parking facilities that subsidize automobile use. More comprehensive analysis can research very different conclusions about transportation funding equity.

Palmateer and Levinson (2018) used advanced transportation models to evaluate transit job access equity based on four theories: Absolute Need (provide basic access), Equality of Opportunity (access is equal between groups), Maxi-Min (disadvantaged groups should have better access than advantaged groups), and Relative Need (the differences in access between drivers and non-drivers). They conclude that the Absolute Minimum measure is suitable for gauging local job access and the overall distribution of transportation services. Equality of Opportunity analysis is suitable for comparing services between groups in various geographic areas. The Maxi-Min Theory works well for comparing regions but does poorly for comparing groups. Relative Need compares groups within and between modes, or within and between regions.

Transportation Equity in Developing Countries
The report, From Mobility to Access for All: Expanding Urban Transportation Choices in the Global South (Venter, Mahendra and Hidalgo 2019) evaluates the quality of access by lower-income residents in developing countries. They find that up to half of urbanites experience restricted access leading to excessive cost burdens or limited opportunities. Many cities are experiencing declining accessibility due to rapid motorization. It recommends more multimodal planning and TDM policies that favor space-efficient modes over private car use. The study, Urban Access Across the Globe: An International Comparison of Different Transport Modes (Wu, et al. 2021) evaluated 30-minute access to jobs by four modes in 117 global cities. Chinese and European cities tend to have the best overall accessibility due to their combination of compact development and multimodal transport networks. Australian, Canadian and European cities have better transit access than in the United States. They quantified the disparities in access provided by different modes.
Fair Share of Resources
These studies evaluate whether transportation resources are equitably distributed.

Non-Driver's Share of Investments
About 12% of total trips are made by active modes (walking and bicycling), with higher rates by people with disabilities and low incomes (BTS 2018). The study, The Multimodal Majority? (Buehler and Hamre 2015) found that during a typical week about 7% of Americans rely entirely on non-auto modes, 65% use a car and one other mode, and a quarter use a car and make at least seven trips by other modes. The Bicycling and Walking in the U.S.: Benchmarking Reports (ABW 2018) and Investing in Health, Safety and Mobility (Jones 2021) indicate that less than 2% of federal and state transportation funding and less than 10% of local budgets are spent on active modes, and less than 14% are spent on public transit (Davis 2021), which is less than the portion of travellers who are likely to use these modes if they are available. Holian and McLaughlin (2016) recommend more multimodal planning and project evaluation to ensure that non-drivers receive a fair share of infrastructure investments.

Policy Biases
Law professor Gregory H. Shill’s articles, “Americans Shouldn’t Have to Drive, but the Law Insists on It” and “Should Law Subsidize Driving?” (2019 and 2020) argue that current planning practices subsidize automobile travel to the detriment of non-drivers and lower-income motorists. These subsidies result from biased transport funding and planning practices; restrictions on compact development and parking minimums; high speed limits that favor motorists over pedestrians; tax laws that favor automobile commuters; plus un-priced health and environmental damages caused by vehicle traffic. A Federal Reserve Bank study Freeway Revolts! (Brinkman and Lin 2019), concluded that urban freeway projects intended to benefit affluent suburban commuters reduced central neighborhoods’ populations, incomes and property values, which degraded the quality of life and economic opportunities for poor and minority residents. The study concludes that urban freeway total costs exceed their benefits, contributed to sprawl, and are inequitable. It suggests that targeted mitigation policies could improve welfare.

Road Space Allocation
Gössling, et al. (2016) evaluated the fairness of urban road space allocation, traffic risk and pollution exposure, plus travel time valuation. They used high-resolution satellite images in combination with a geographical information system to derive area measurements in four German urban districts. They found that the majority of road space is devoted to private automobile travel, while space efficient modes (walking, bicycling and public transit) receive less than their share. They conclude that current practices that favor motorized modes and ignore the negative impacts that motor vehicle traffic imposes on communities are unfair. Similarly, the Transportation Alternatives campaign, NYC 25x25: A Challenge to New York City’s Next Leaders to Give Streets Back to People (TA 2020) argues that motor vehicles currently use an excessive and unfair portion of urban road space, and more balanced allocation can provide large economic, social and environmental benefits.
Active Travel Equity ([http://dx.doi.org/10.1080/01441647.2016.1239660](http://dx.doi.org/10.1080/01441647.2016.1239660))
The report, *Understanding the Role of Equity in Active Transportation Planning in The United States* (Lee, Sener and Jones 2016) identifies ways to reduce transportation inequities in underserved communities. An equity audit of Bloomington, Indiana’s sidewalks investments found that the current politically-biased process resulted in skewing sidewalk projects towards neighborhoods that were wealthier, less dense and had lower pedestrian demand. (Mark Stosberg 2020). *Signalling Inequity – How Traffic Signals Distribute Time to Favour the Car and Delay the Pedestrian* (Levinson 2018) argues that standard traffic signal control practices favor automobile traffic over pedestrian travel, and recommends various reforms to increase equity.

The U.S. Federal Highway Administration report, *Pursuing Equity in Pedestrian and Bicycle Planning* (Sandt, Combs and Cohn 2016), identifies practical ways to evaluate the travel demands of traditionally underserved populations (low income, minority, older adults, limited English proficiency and people with disabilities), and to ensure that active transport planning decisions serve those unmet needs. The research finds:

- Many older adults, children and people with disabilities are unable to drive and would use nonmotorized modes if they are convenient, comfortable and safe. Even those who do bicycle, such as immigrants and children, are less likely to practice safe bicycling techniques (such as riding with traffic, using lights, and wearing helmets and reflective clothing), and are often forced to ride on unsafe roads.

- Many underserved population groups live where public transit services are limited.

- Many people in the U.S., in particular traditionally underserved populations, suffer from problems associated with inactivity, many of which could be addressed through improved access to safe walking and wheeling facilities.

- Women and minorities feel significantly less safe traveling by bicycle than non-minority males in the U.S. A majority of women and minorities agreed or strongly agreed that, given more supportive infrastructure (e.g., sidewalks, bike lanes, and separated facilities), they would be much more likely to bicycle for transportation.

- Individuals with limited travel options (including nonmotorized modes) travel less overall, make fewer trips for shopping and socializing; have a harder time applying for and accepting employment; are less likely to access healthy foods, health care, and educational resources; and are more likely to experience social isolation.

The book, *The High Cost of Free Parking*, (Shoup 2005) argues that parking minimums in zoning codes, tax policies that favor parking subsidies, and unpriced or underpriced public parking are unfair and regressive since they increase costs of other goods, and favor motorists over people who travel by other modes.
External Costs

Various data sources and studies can help measure the external costs that transportation activities impose on other people.

External transportation costs include infrastructure subsidies, congestion delays, crash risk, noise and air pollution that vehicle travel imposes on other people. Although all travellers both impose and bear external costs, their magnitude varies significantly; automobile travel imposes far greater external costs than active and public transport modes, so people who drive more than average tend to impose net costs on people who drive less than average. External costs are horizontally inequitable to the degree that travellers impose net costs on others, and vertically inequitable to the degree that wealthier travellers impose net costs on those with lower incomes. For example, it is unfair that space-efficient bus passengers are delayed by congestion caused by motorists; it is unfair that motor vehicles impose risk on walkers and bicyclists; and it is unfair that out-of-town motorists impose pollution on urban residents (Gössling 2016).

Comprehensive Transportation Cost Studies (www.vtpi.org/tca)

Several studies provide comprehensive estimates of transportation costs. For example, Transport Canada’s Estimates of the Full Cost of Transportation in Canada (TC 2008) summarized vehicle ownership and operations, infrastructure, congestion, accident and environmental costs. The European Commission’s Handbook on Estimation of External Cost in the Transport Sector (CE Delft 2019) estimates traffic congestion, crash and pollution costs. Transportation Cost and Benefit Analysis (Litman 2020) provides estimates of twenty costs for eleven modes under three travel conditions (urban-peak, urban off-peak and rural). The figure below illustrates these costs per mile of travel.

*Figure 11* Annual Costs Per Mile of Travel (Litman 2020)

This figure compares total costs of six travel modes, many of which are external. Automobile travel imposes larger external costs per mile, and since motorists tend to travel far more annual miles than non-drivers they impose much larger total annual external costs. (Walking operating costs include $100 annual costs for shoes).
Figure 12 illustrates the distribution of total annual costs for these modes, taking into account differences in annual miles travelled by motorists.

**Figure 12 Cost Distribution (Litman 2020)**

This figure compares the distribution of annual costs, taking into account the higher annual miles travelled by motorists compared with other mode users.

### Comprehensive Economic Evaluation Guides


### Estimates of Individual Costs

Some studies estimate individual external costs. For example, the U.S. *Highway Statistics Reports*, Table 72, provides information on roadway user payments and expenditures. The report, *Quantified Parking: Comprehensive Parking Inventories for Five U.S. Cities* (Scharnhorst 2018) provides estimates of parking costs in typical U.S. urban regions. The *Economic and Societal Impact of Motor Vehicle Crashes* (Blincoe, et al. 2015) provides monetized estimates of traffic crash costs and discussion of the degree that they are external. Khayesi (2020) examines the risk that motorists impose on pedestrians and cyclists. These sources can be used to calculate the external costs that various modes impose and bear, how these vary by demographic and geographic factors, how policy and planning decisions affect these economic transfers, and in some cases, the appropriate prices to charge or compensation needed to internalize them.
Equitable Transportation Pricing

These studies examine the equity of transportation pricing.

As previously described, economic efficiency and horizontal equity require that consumers pay directly for the costs they impose unless subsidies are specifically justified. This requires variable pricing that reflects marginal congestion and infrastructure costs, fuel tax that reflect pollution costs, and distance-based vehicle insurance premiums to better reflect crash costs (Butner and Noll 2020; Litman 2021).

User charges are economic transfers, costs to the people who pay and benefits to those who receive the revenue. Although pricing debates are often framed as a choice between free or priced roads and parking, those facilities are never really free; the decision is really between paying directly through user fees, or indirectly through taxes, rents and higher prices for other goods. Paying directly can provide many benefits.

Efficient pricing gives travellers new opportunities to save money, increasing affordability. For example, if parking costs are incorporated into rents and retail prices, everybody pays regardless of how much they travel. If instead, users pay for parking directly, households save money if they reduce their vehicle ownership and vehicle travel, or choose less costly parking facilities. For example, with current policies a typical apartment rents for $2,500 per month with one parking space; with efficient pricing the apartment rents for $2,250 per month plus $250 per month for each parking space used, giving car-free households a 10% savings on rents.

Efficient pricing can give priority to higher-value trips and more resource-efficient modes on congested facilities. For example, efficient road tolls allows urgent errands, freight vehicles and buses to travel unimpeded by congestion, while travellers making less urgent trips receive incentives to choose less congested times, modes and routes. Efficient parking prices ensures that motorists making urgent trips can always find convenient parking spaces, while giving motorists with less urgent trips an incentive to choose cheaper but less convenient options. Cost-recovery road and parking pricing (user fees repay the facility costs) typically reduces affected vehicle travel by 10-30%, reducing external costs including congestion, crash risk and pollution emissions (CARB 2014). Efficient road pricing increases bus transit operating speeds and reliability, and increases demand for transit services, benefiting transit users (Cortright 2018).

Table 11 indicates efficient transportation pricing burdens and benefits. Pricing debates often focus on just one or two of these impacts, such as higher costs to lower-income motorists, while ignoring the large potential benefits from faster and more reliable bus service, and reduced taxes, rents and retail prices. Since lower-income households tend to own fewer vehicles, drive less and rely more on non-auto modes, they tend to benefit significantly. Their costs can be further reduced with targeted discounts. For example, the Los Angeles Metro Expresslane toll road offers discounted fees to low-income residents.
Table 11  Transportation Pricing Impacts

<table>
<thead>
<tr>
<th>Burdened</th>
<th>Benefited</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Motorists who bear the inconvenience of paying tolls (which is greatly reduced with new pricing systems).</td>
<td>• Motorists who value the reduced congestion and increased convenience more than the fee.</td>
</tr>
<tr>
<td>• Lower-income motorists who pay the fee and bear major cost burdens.</td>
<td>• Public transit passengers who are no longer delayed by congestion and benefit from increased transit demand.</td>
</tr>
<tr>
<td>• Lower-income travellers priced off the road or parking facility to less desirable alternatives.</td>
<td>• Residents who benefit from reduced traffic risk, noise, pollution and sprawl-related costs.</td>
</tr>
<tr>
<td></td>
<td>• Consumers who pay lower taxes, rents and prices that would otherwise subsidize road and parking facilities.</td>
</tr>
</tbody>
</table>

Comprehensive analysis considers all ways that price changes affect people, including those who bear costs, and those who benefit from increased efficiency and reduced subsidy cost burdens. Because lower-income households tend to own fewer vehicles, drive less, rely more on walking, bicycling and public transit, and live in urban neighborhoods, they tend to benefit significantly.

Efficient pricing is often criticized as being regressive, since a particular fee represents a greater portion of income for wealthy than poorer households. Automobile advocates often argue that fuel tax increases, road tolls and parking fees harm low-income households, although higher-income motorists gain most of the savings. Overall equity impacts depend on who pays, price structures, the quality of alternatives, how revenues are used, and whether driving is considered essential or a luxury (Levinson 2010). User fees can be progressive if revenues reduce regressive revenue sources, are spend in ways that benefit lower-income households, or if lower-income motorists receive discounts.

Some transportation price reforms are particularly effective at achieving equity goals. For example, since vehicle ownership and use tend to increase with ability and income, parking cash out (non-drivers receive the cash equivalent to parking subsidies provided to motorists), parking unbundling (parking spaces are rented separately from building space, so occupants are no longer required to pay for costly parking spaces they don’t need), and distance-based pricing (vehicle insurance and registration fees are prorated by mileage) tend to increase both horizontal and vertical equity.

Equitable Road Funding
Schweitzer and Taylor (2008) evaluated the cost distribution of various highway funding options. They found that sales taxes are more regressive than tolls. Low-income drivers pay more with tolls, but low-income residents as a group pay more with sales taxes. Leung, et al. (2018) found that fuel taxes tend to be regressive but often less so than other transportation funding options, and their progressivity declines if lower-income travellers have better mobility options. Cortright (2017) found that peak-period automobile commuters have about twice the average incomes as commuters who use other modes. Manville (2017) finds that congestion pricing can benefit lower income commuters and non-drivers overall by improving transit and rideshare services.
Equitable VMT Reductions (www.wsdot.wa.gov/research/reports/fullreports/751.1.pdf)
The report *Impacts of VMT Reduction Strategies on Selected Areas and Groups* (Carlson and Howard 2010) investigated the equity impacts of Washington State’s vehicle miles travelled (VMT) reduction targets (30% reduction by 2035 and 50% reduction by 2050). Similarly, *Social Equity Impacts of Congestion Management Strategies* (Shaheen, Stocker and Meza 2019) examine the equity impacts of 30 congestion management strategies. They find that impacts on travel costs, commute times, housing, and accessibility vary significantly between different groups, and that these strategies can be designed to support equity goals. The article, *Low-Income Access to Employer-Based Transit Benefits*, evaluated how commute trip reduction programs affect lower-income workers, and how such programs can be improved to achieve equity goals (Hamre 2019).

### Research on Road Pricing Social Equity Impacts
Several recent studies investigate road pricing equity impacts. Most find that because (1) only a small portion of urban-peak highway users are low-income, (2) tolls are less regressive than most other funding sources, (3) urban-peak vehicle traffic imposes large external costs, and (4) lower-income travellers can benefit from improvements to affordable modes, road pricing tends to support equity goals, particularly if a portion of the revenues funds affordable mode improvements, and if disadvantaged travellers receive discounts.


Joe Cortright (2017), *Transportation Equity: Why Peak Period Road Pricing is Fair,* City Observatory.


Michael Manville (2017), *Is Congestion Pricing Fair to the Poor?*, 100 Hours.


PDOT (2020), *Pricing Options for Equitable Mobility (POEM),* Portland Department of Transportation.


Susan Shaheen, Adam Stocker and Ruth Meza (2020), *Social Equity Impacts of Congestion Management Strategies,* Transportation Sustainability Research Center.


Inclusivity (Serving Mobility-Disadvantaged Travellers)
These studies evaluate transportation inadequacies for disadvantaged groups.

The Transportation Security Index (Murphy, Gould-Werth and Griffin (2021), is a 16-item measure that captures travellers’ experience of transportation insecurity. It measures the degree that disadvantaged people are unable to access services and activities, or are delayed, inconvenienced, stressed or embarrassed due to inadequate transport options. This can be measured both absolutely and relative to other groups.

Social Exclusion Risk Factors
Stanley, et al. (2011) identify five social exclusion risk factors including income, employment, political engagement, participation in selected activities, and social support. Applying this approach in Melbourne, Australia they find that trip rates tend to 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. They estimate an additional trip (and activity) is valued at approximately $20 at an average income, and more by mobility-constrained households. This is a much higher value than assumed in traditional evaluation models. The World Economic Forum’s Inclusivity Quotient (WEF 2020) evaluates a mobility system based on five trackable factors: availability, affordability, performance, security and legacy.

The report, Measuring Accessibility as Experienced by Different Socially Disadvantaged Groups (TSG 2005) evaluates local (e.g. to bus stops) and regional accessibility (e.g. to employment opportunities) for seven disadvantaged groups: young people (16-24), older people (60+), Black and Minority Ethnic (BME) people, people with disabilities, travelers with young children, unemployed people, and shift workers. Many of these groups have significant mobility constraints. It developed the WALC (Weighted Access for Local Catchments) to reflect perceived walk access. Allen, et al. (2021) found that immigrants experience more social exclusion in automobile-dependent suburbs than in transit-oriented neighborhoods. Smeds, Robin and McArthur (2020) find that London’s transport planning underweights disadvantaged groups’ nighttime travel demands.

Women’s Transportation Security
The article “Paying to Stay Safe’: Why Women Don't Walk as Much as Men.” (Shadwell 2017) describes evidence that personal insecurity threats deter women from walking, reducing their independence, health and wealth. The disparity between women and men’s walking diminishes with increased walkability scores, suggesting that more compact and walkable communities increase women’s security. Building Sustainable Mobility for Women (FIA 2017), and Planning And Designing Transport Systems To Ensure Safe Travel For Women (Tiwari 2014) use detailed travel survey data South Africa, Ecuador, Argentina, Chile and India concerning how women travel and the obstacles they face to develop recommendations for improving women’s travel safety through better transportation and land use planning.
Child in the City (https://bit.ly/3yojMuL)
The report, Child in the City: Planning Communities for Children & their Families (Agnello 2020) asks, “If you could see the city from an elevation of 95 cm, what would you do differently?” It provides a toolbox of specific policies and planning practices for creating more child-friendly communities. It emphasizes the value of mixed-use and mixed-income neighborhoods with diverse and affordable housing, convenient and safe walking and bicycling conditions, and commonly-used services (stores, schools, parks, etc.) easy to access without driving. Similarly, a Northeastern University study found that transportation takes a heavy toll on the time, budget, and stress level of low-income latino residents (Pollack, et al. 2013). They often must choose between expensive automobile travel and inadequate, time-consuming public transit.

The report, The Inclusion Imperative: Towards Disability-inclusive and Accessible Urban Development by the Global Network on Disability Inclusive and Accessible Urban Development (DIAUD) Network provides specific, detailed information on universal design concepts and guidance for applying them in urban planning.

The report, Fairness in a Car Dependent Society, by the U.K. Sustainable Development Commission analyzes the costs of car dependency and the distribution of these costs to various groups. While recognizing that car travel provides benefits, it also imposes significant costs that tend to be particularly burdensome to physically, economically or socially disadvantaged people. These groups tend to benefit least from automobile travel and sprawl, and face major costs from accident risks and pollution emissions, and reduced accessibility. The study recommends national transport policy reforms to address these issues, recognizing that transport planning decisions have significant indirect and external impacts, which should be considered in analysis. It recommends that transport decision makers prioritize investments in non-auto modes.

Access to Opportunities (https://escholarship.org/uc/item/98g9d5p4)
The Urban Institute’s report, Access to Opportunities Through Equitable Transportation: Lessons from Four Metropolitan Regions (Stacy, et al. 2020) examines transportation equity and inclusion, taking into account spatial mismatch (proximity of lower-wage workers and jobs), access to jobs by public transit, and overall access to affordable and safe transportation. The Access to Opportunities Primer (Bhusal, Blumenberg and Brozen 2021) examines why access to opportunity is important, its determinants, and how it relates to other adjacent issues and policies in housing and economic development, and provides practical guidance for increasing opportunities and reducing disparities.
Affordability and Economic Opportunity

These studies examine ways to improve affordability (savings to lower-income households), economic opportunity (access to education, jobs and essential services), and economic mobility (the chance that children from low-income households become economically successful as adults).

Household Expenditure Surveys

The U.S. Bureau of Labor Statistics produces Consumer Expenditure Surveys (www.bls.gov/cex/home.htm) that reports spending grouped in various ways. Similar surveys are available in other countries, or vehicle expenses can be estimated using vehicle ownership and vehicle-travel data. These surveys do not account for indirect costs, such as residential parking, so actual cost burdens are generally higher. These data indicate that transportation spending tends to increase with vehicle travel and decline with transit travel, as illustrated below. Guerra and Kirschen (2016), and Isalou, Litman and Shahmoradi (2014) find similar patterns in developing countries.

Figure 13  Household Transport Expenditures Versus VMT (Garceau, et al. 2013)

The portion of household income devoted to transportation increases with per capita vehicle miles traveled (VMT). Each dot represents a U.S. state.

Figure 14  Transportation Spending Versus Transit Mode Share

The portion of household budgets devoted to transportation (vehicles, fuel and transit fares) declines as transit mode share increases. Regions with urban rail systems tend to have the highest transit mode shares and the lowest transportation spending.

Based on BLS “Consumer Expenditure Survey” and the US Census “2012 American Community Survey” data.
Housing and Transportation Affordability Indices
The **Location Affordability Index** ([https://bit.ly/3s1PeOo](https://bit.ly/3s1PeOo)) and the **Housing and Transportation (H+T) Affordability Index** ([https://htaindex.cnt.org](https://htaindex.cnt.org)) calculate total housing and transportation costs for various neighborhoods, and therefore the savings provided by more affordable modes and more accessible, multimodal locations. They present the analysis results in maps, charts and statistics for various locations and household types. This recognizes that a cheap house is not truly affordable if located in a less accessible area with high transportation costs, and households can rationally spend more for a home in a more accessible area where they can reduce their vehicle expenses, providing savings that can be invested in rents or mortgages.

Job Access by Income Class
Studies by Cui, et al. (2019), Rachele, et al. (2018), and Xia, et al. (2016), analyze how home locations, multimodal accessibility, transport-mode share, employment and income data affect economic outcomes. They find that improving public transit services for low income households, and increasing affordable housing and jobs in transit-oriented areas can significantly improve economic opportunity. Frederick and Gilderbloom (2018) found that increased commute mode diversity (lower automobile mode shares) tends to reduce income inequality. Turner (2019) concludes that bus service improvements and road pricing can do more to improve economic productivity and opportunity than expanding highways or subway systems. Researchers Manville, Monkkonen and Lens (2020) recommend allowing multifamily housing in economically successful neighborhoods in order to reduce income segregation and increase economic opportunity for disadvantaged groups. The [Urban Opportunity Agenda](https://opportunityagenda.org) identifies local policies for reducing poverty and increasing economic mobility by improving access to education, employment and basic services and improving housing affordability.

Low-Income Children's Economic Opportunity
Numerous studies (Bouchard 2015; Levy, McDade and Dumlao 2010) indicate that more compact, mixed-income development and multimodal transportation increases economic opportunity and mobility. This is particularly important for workers who lack a driver’s license or car (Kneebone and Holmes 2015). Living in a walkable and transit-oriented neighborhood tends to increase labor participation and improves fitness and health (CTS 2010). Ewing, et al. (2016) found that economic mobility increases in more compact and multimodal communities: doubling their compactness index increases by 41% the probability that a child born in a bottom income quintile family will reach the top quintile by age 30. Using income and travel data for more than 3.66 million Americans, Oishi, Koo and Buttrick (2018) found a statically robust positive relationship between walkability and economic mobility. Walkability reduced employment and income disparities between workers who could and could not drive. Corak (2017) found higher rates of economic mobility in Canadian urban areas compared with rural areas. Talen and Koschinsky (2013) also found strong correlations between neighborhood Walk Scores and economic mobility. Lens and Monkkonen (2016) find that more compact development tends to reduce economic segregation. Hsieh and Moretti (2015 and 2017)
estimate that allowing affordable infill in economically productive U.S. cities could increase national economic output 13%, equivalent to several thousand dollars per worker, and improve disadvantaged workers’ economic opportunity.

Spatial and Skills Mismatch of Unemployment and Job Vacancies
Fan, Guthrie and Vardhan Das (2016) evaluated disadvantaged residents’ job access through metropolitan areas. They find that non-drivers’ access to job vacancies varies widely. Targeted transit improvements can provide significant benefits by improving disadvantaged residents’ access to “sweet spots,” defined as in-demand occupations with low education requirements that are likely to pay a living wage. The report recommends job access metrics that consider every aspect of job availability including workers’ skills, available training, in addition to home to worksite travel. The report also recommends identifying employers with labor supply problems, considering disadvantaged workers’ complex schedules, and pursuing creative transportation solutions and transit-oriented development to improve low-income workers’ job access.

Transportation Cost Impacts on Household Affordability (http://tinyurl.com/kdrbtmo)
Weinstein Agrawal, et al. (2011) investigated how financial stresses affect low-income families’ travel and transportation expenditures, the costs and benefits of various travel modes, and users’ opinions about these factors. They found that most low-income households are concerned about their transportation costs. Some low-income individuals willingly accept higher transport expenditures, such as automobile ownership, but many of these strategies have negative effects on their lifestyles.

Automobile versus Multimodal Solutions
Because automobile ownership tends to improve low-income people’s economic opportunities, people sometimes propose providing disadvantaged people with automobile subsidies or underpricing to achieve social equity goals (Klein 2020). For example, a study by Smart and Klein (2015) found that formerly carless households that obtain a car typically earn approximately $2,300 more per year, but those households must spends more than $4,100 annually to own and maintain their vehicles, and so are financially worse off overall. Vehicle failures, crashes and vehicle crimes often cause financial crises for lower-income motorists. This suggests that more flexible subsidies that can be used for any mode, or to top-up rents for more accessible homes, are probably better overall, so lower-income households can choose the mobility options that is best for them, and communities benefit from less congestion, crash risk and pollution.
Evaluating Transportation Equity: Guidance for Incorporating Distributional Impacts in Transport Planning
Victoria Transport Policy Institute

Social Justice
Social justice considers how transportation systems serve disadvantaged and underserved groups, and address structural injustices such as racism and sexism.

Racial Equity Action Plan (Raleigh 2021)
Raleigh, North Carolina’s Office of Equity and Inclusion is developing a Racial Equity Action Plan that identifies specific objectives, indicators, targets and actions that the City will implement to address structural inequities. These include employee training, surveys, an organizational assessment, application of racial analysis to policies and programs, and public engagement regarding racial equity.

Civil Rights Analysis (https://bit.ly/2IDt10c)
The article, “Civil Rights Guidance and Equity Analysis Methods for Regional Transportation Plans,” (Karner and Niemeier 2013) evaluated the methods currently used to evaluate transportation impacts on minority populations. They conclude that prevailing equity analysis methods are more likely to obviate than to reveal, and that there are no standards for agencies to follow for rigorous equity analysis. They recommend more integrated modeling and Geographic Information Systems analysis to provide better information on the ways that planning decisions affect disadvantaged groups’ mobility and accessibility.

Transit-Oriented Development Displacement
The book, Transit-Oriented Displacement or Community Dividends? (Chapple and Loukaitou-Sideris 2019) uses quantitative and qualitative research to examine who benefits or loses from transit-oriented development (TOD). They found that TOD can provide many benefits, but by increasing land values and housing prices can increase gentrification (more affluent residents) and displacement (lower-income and minority residents forced to leave), harming individuals, communities and local businesses. The authors explain, “a dark side of TODs has emerged, as evidence suggests that they may not only be detrimental to the households that depend on transit the most but also could reinforce deeply embedded land use practices that lead to segregation by income and race.”

Gentrification Impacts
Howland (2020) interviewed lower-income working-age Black families with children in Portland, Oregon region neighborhoods including urban Albina and suburban East Portland, concerning how they are impacted by gentrification. He found that people in Albina were better resourced, on average, to accomplish their daily life maintenance due to better mobility and accessibility options. The cultural rootedness of Albina appeared to be eroding as more Black people left due to gentrification and perceived unsafety on public transit. The author concludes “As East Portland continues to grow with more low-income people of color, more attention needs to go to the urban development of the area to make life a little easier for them.”
A Human Rights Framework
Appleyard and Riggs (2021), developed a framework for incorporating pedestrian rights into planning decisions. They began with the assumption that equity requires that, “People have equal and comfortable access to opportunities to improve and/or maintain their desired quality of life,” and that public policy decisions “Prioritize the needs of the vulnerable and less powerful.” Based on these principles they identified functional priorities for applying pedestrian rights, considering the following factors:

- Getting people safely and comfortably across the street.
- Getting people safely and comfortably along the street.
- Calm traffic speeds and reduce flows - livability, health, amenities & aesthetics.
- Access & connectivity (land use and street network design).
- Professional prioritization of pedestrian needs.
- Driver and pedestrian ethics.
- Rules and laws, and their enforcement.

Planning Reforms
Planning reforms help evaluate equity impacts achieve equity objectives.

Comprehensive Evaluation
The article, “Looking Beyond the Mean for Equity Analysis: Examining Distributional Impacts of Transportation Improvements” (Bills and Walker 2017) recommends more disaggregated transportation modelling to better understand how planning decisions affect individuals, and to rank policies with regard to achieving equity objectives. The report, Equity Analysis of Land Use and Transport Plans Using an Integrated Spatial Model (Rodier, et al. 2010), evaluated the effects of various land use and transportation policies intended to reduce greenhouse gas emissions. The results indicate that a more compact, multi-modal development tends to reduce travel and housing costs by increasing accessibility, providing both economic productivity and social equity benefits.

Vehicle Travel Reduction Targets
Many jurisdictions have targets to reduce vehicle travel and increase active and public transport (Litman 2019). For example, California law requires reducing per capita vehicle travel 15% by 2050. Washington State requires 30% reductions by 2035 and 50% by 2050. British Columbia’s target is to reduce light-duty vehicle travel 25% by 2030, and approximately double the share of trips by active and public transport by 2050. The United Kingdom has a goal that by 2030, half of urban journeys will be by bicycle or walking. Many cities have similar targets.

Although these targets are primarily justified to reduce congestion and pollution problems, they can also help achieve equity objectives by creating more diverse transportation systems and more accessible communities. For example, California developed extensive guidelines and analysis tools to evaluate how transportation and land use development projects will affect vehicle travel and related costs (CalISTA 2021).
Strategies for Achieving Transportation Equity Objectives

This section identifies ways to achieve transportation equity objectives.

**Fair Share**

Current transportation planning and funding practices tend to favor automobile transportation over other modes. As a result, motorists tend to receive more public resources (money, road space and priority) than people who rely on other modes, particularly if measured annually per capita, accounting for differences in annual travel.

The following reforms can help ensure that all travellers receive a fair share:

- Collect comprehensive information on non-auto travel demands, activities and impacts, particularly by disadvantaged groups.
- Develop accessibility-based evaluation tools that measure the time and money costs required to reach basic services and activities from specific locations under various conditions, by various types of travellers.
- Compare the accessibility available between drivers and non-drivers, and wealthy versus poor. Identify transportation improvements that can reduce these disparities.
- Collect information on the resources allocated to various modes, including road space, transport infrastructure funding, and government-mandated vehicle parking facilities.
- Apply multimodal transportation planning, so non-auto facilities and programs are considered equally with those for automobile travel.
- Apply complete streets policies, streetscaping and traffic calming so that public roads safely accommodate all travellers, particularly walkers and bicyclists.
- Apply comprehensive impact analysis and least-cost funding, so non-auto modes receive investments whenever they are cost effective, considering all impacts.

**External Costs**

Due to its size, speed and energy use, motor vehicles tend to impose various external costs including facility subsidies, congestion and barrier effect, crash risk and pollution costs on other people. Many external costs increase with speed, and faster travel conditions tend to induce additional vehicle travel which increases total external costs. Roadway user charges, such as special fuel taxes, road tolls and parking fees, only cover a small portion of infrastructure costs. Public transit services are subsidized, but because most users travel far fewer annual miles than motorists their annual external costs tend to be smaller. As a result, people who drive more than average tend to impose net internal costs on people who drive less than average.

The following reforms can help reduce and compensate for external costs:

- Collect information on external costs (traffic delay, risk, noise and air pollution) that motor vehicles impose on other road users.
- Reduce total vehicle travel and traffic speeds, particularly in urban areas.
• Increase fuel taxes to recover more infrastructure and pollution costs, and to encourage motorists to choose less polluting vehicles.

• Apply variable road tolls and parking fees to reduce congestion and recover facility costs.

• Convert fixed vehicle insurance premiums, registration fees and sales taxes into distance-based charges to better reflect the facility, crash and pollution costs each vehicle imposes.

• Require or encourage employers to implement commute trip reduction programs.

• Create HOV- or bus-lanes on busy urban roads so rideshare vehicles and buses are no longer delayed by congestion created by automobile traffic.

• Eliminate parking minimums, cash out and unbundle free parking so non-drivers are no longer forced to pay for costly parking facilities they do not need.

• Reform transportation planning practices to recognize motor vehicle external costs, and therefore the external cost reductions from lower vehicle traffic speeds and volumes.

• Fund walking and bicycle improvements from road user fees as a mitigation for motor vehicle delay and risk.

*Inclusivity*

Inclusivity ensures that transportation systems serve people with disabilities and other special needs, particularly to access basic (essential) services and activities such as education, employment, healthcare, basic shopping, recreation, and civic activities.

• Collect information on non-auto travel demands and unmet needs of physically, economically and socially disadvantaged groups.

• Apply universal design to transportation facilities and services. Perform targeted surveys and field audits that evaluate their performance from disadvantaged users’ perspective.

• Favor inclusive modes (walking, bicycling, public transit, ridesharing, taxi/ridehailing and telework) over private automobile travel.

• Prioritize transportation investments and management to favor people with mobility impairments, and to favor basic access over other travel activities.

• Evaluate transportation system performance based on accessibility, taking into account the quality of various modes, geographic proximity, and affordability for disadvantaged groups.

• Apply multimodal planning and least cost funding so non-auto modes and demand management strategies receive equal consideration and funding as automobile facilities.

• Ensure that any household that wants can find suitable housing in a walkable and transit-oriented neighborhood.

*Affordability*

Transportation, particularly private automobiles, impose excessive cost burdens on many low- and moderate-income households, including sometimes large, unexpected costs caused by vehicle failures, crashes or traffic citations which can impose severe financial shocks. Because households often make trade-offs between housing and transportation costs, true affordability reduces both housing and transportation costs.
• Plan transportation systems to favor affordable modes. Ensure that all communities have good walking and bicycling conditions, efficient and affordable public transit services, convenient taxi/ridehailing and carsharing, and high-speed internet services.

• Implement Smart Growth policies to create more affordable housing options in walkable and transit-oriented neighborhoods.

• Offer targeted discounts for road tolls, parking fees, carsharing and ridesharing to low-income travellers who require automobile travel to access essential services.

**Social Justice**

Social justice requires that transportation planning addresses structural injustices such as racism and sexism.

• Evaluate transportation impacts (benefits and costs) on disadvantaged groups, including indirect and long-term impacts, including benefits to physically, economically and socially disadvantaged travellers of more multimodal planning, and the negative impacts that increased vehicle traffic imposes on urban communities.

• Implement affirmative action policies and programs.

• Ensure that traditionally underserved groups are effectively involved in transportation policy and planning decisions.

• Correct for past injustices such as the damages that urban highways imposed on minority communities.

**Common Strategies**

Planning practices that create more diverse, affordable and efficient transportation systems, and more compact, multimodal communities, tend to support horizontal and vertical equity objectives. Below are specific strategies.

• Develop planning practices, analysis tools and data collection to allow comprehensive evaluation of equity impacts.

• Establish vehicle travel reduction targets. This helps coordinate planning decisions between various levels of government and agencies to create more compact, multimodal, accessible communities.

• Apply accessibility analysis, multimodal planning and least-cost funding so transportation funds are spent on the most cost effective investments, considering all impacts and equity goals. This tends to support walking, bicycling and public transit, plus TDM incentives that increase transportation system efficiency.

• Implement Smart Growth policies that create more affordable housing options in accessible areas, so any family that wants can find suitable homes in a neighborhood where it is easy to get around without a car.

• Apply efficient transportation pricing, including decongestion road tolls, variable parking fees, and distance-based vehicle insurance and fees.
Summary of Equity Strategies
Table 12 evaluates whether various strategies support or contradict equity goals.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Fair Share</th>
<th>External Costs</th>
<th>Inclusivity</th>
<th>Affordability</th>
<th>Social Justice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive data and analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Accessibility-based analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Multimodal planning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Smart Growth policies</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Subsidize public transportation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Complete streets policies</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Universal design</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Prioritize affordable-efficient modes</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Vehicle travel reduction targets</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Commute trip reduction programs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Efficient road &amp; parking pricing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Parking cash out and unbundling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Subsidize electric car</td>
<td>X</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidize cars for low-income motorists</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Improve public engagement</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affirmative action programs</td>
<td>X</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensate for past harms</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

This matrix indicates whether strategies support (✓) or contradict (×) various equity goals.

This shows that some strategies can help achieve multiple equity goals by making planning respond to unmet travel demands; favoring affordable and resource-efficient modes; and creating more compact and multimodal communities where it is easy to get around without a car. Targetted strategies tend to achieve fewer equity goals. Some can have negative equity impacts. For example, automobile subsidies are unfair to travellers who don’t receive them, and by increasing total vehicle travel exacerbate traffic problems. These programs should be designed to minimize inequities. For example, electric vehicle subsidies can target public transit, carsharing and taxi vehicles, and subsidies for low-income motorists can be balanced with subsidies for other modes.

A good example of multifaceted equity analysis is, Changing Lanes: A Gender Equity Transportation Study (LADOT 2021). It identifies various disparities between women’s and men’s travel opportunities, and ways to reduce them. It recommends both structural reforms to improve affordable mobility options, plus targetted programs to provide special services, including access to automobiles, to disadvantaged groups.
Conclusions
Transportation planning decisions often have significant equity impacts. It is important to consider these in a planning process. Transportation equity analysis is challenging because there are several types, impacts, metrics, and groups of people to consider, so there is no single way to evaluate equity. It is generally best to consider several perspectives, impacts and objectives. Planning decisions should reflect a particular community’s equity concerns and priorities, so public involvement is important.

**Horizontal equity** requires that people with comparable needs and abilities be treated equally, for example, receiving similar benefits and bearing similar costs. It implies that people should “get what they pay for and pay for what they get,” unless a subsidy is specifically justified. It also justifies minimizing and compensating for external costs. **Vertical equity** requires favoring disadvantaged people. This justifies multimodal planning to serve diverse users, universal design to accommodate people with special mobility needs, favoring lower-cost modes to serve lower-income travellers, special benefits for disadvantaged groups, and targeted policies to support social justice goals.

Transportation equity analysis should be comprehensive, taking into account various perspectives, impacts and metrics. How impacts are measured can significantly affect analysis results. For example, public transit travel has relatively high subsidies per passenger-mile but most users travel relatively few miles per year. Infrastructure subsidies are smaller for motorists than transit users measured per mile of travel, but since motorists travel more annual miles and impose larger external costs, motorists tend to impose larger total external costs than people who rely on other modes. Because equity is concerned with *people*, impacts should generally be measured per capita; measuring impacts per mile favors wealthier people who travel longer distances.

Automobile travel is exclusive (not everybody can drive), expensive and imposes large external costs. Many of these costs tend to increase with speed: faster travel requires more space and therefore more costly infrastructure, imposes more risk, produces more pollution, and induces more vehicle travel which further increase external costs. As a result, planning practices that favor automobile travel over more inclusive, affordable and low-impact modes, increase traffic speeds, or create more automobile-dependent communities tend to be inequitable. Described more positively, planning reforms that create more diverse, affordable and efficient transportation systems, and more compact, multimodal communities, tend to support multiple equity objectives.

However, automobile travel also provides benefits and opportunities, and is the most efficient option for some trips. As a result, vertical equity can sometimes justify policies that help disadvantaged people use automobiles, for example, with carsharing and taxi or ridehailing subsidies. It may also justify discounted road tolls and parking fees for lower-income motorists. However, broad underpricing of automobile travel is unfair and ultimately harms disadvantaged households who gain a tiny portion of the benefits and bear many of the costs, and so is not justified on equity grounds.
A practical way to incorporate equity into transportation planning is to define various equity objectives. Planning decisions can then be evaluated based on the degree that they support or contradict these objectives. The table below identifies the metrics suitable for evaluating various types of equity impacts, and strategies for achieving related equity objectives.

**Table 13  Transportation Equity Analysis Summary**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Metrics</th>
<th>Optimization Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal – Fair Share</td>
<td>Each person receives a fair share of public resources</td>
<td>Per capita share of public resources (money, road space, etc.).</td>
<td>Multimodal transport planning.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Least-cost funding. Efficient pricing.</td>
</tr>
<tr>
<td>Horizontal – External costs</td>
<td>Travellers minimize and compensate for external costs.</td>
<td>Infrastructure costs, congestion, crash risk and pollution that travellers impose on other people.</td>
<td>Minimize and compensate for external costs. Favor resource-efficient modes.</td>
</tr>
<tr>
<td>Vertical – Inclusivity</td>
<td>Transportation systems provide basic mobility to disadvantaged groups.</td>
<td>Quality of travel for people with disabilities and other special needs. Disparities between groups.</td>
<td>Favor inclusive modes and accessible community development.</td>
</tr>
<tr>
<td>Vertical – Affordability</td>
<td>Lower-income households can afford basic mobility.</td>
<td>Transportation costs relative to incomes. Quality of affordable modes.</td>
<td>Favor affordable modes and housing in high-access areas.</td>
</tr>
<tr>
<td>Social Justice</td>
<td>Policies address structural inequities.</td>
<td>Whether organizations address inequities such as racism and classism.</td>
<td>Identify and correct structural inequities. Affirmative action.</td>
</tr>
</tbody>
</table>

This table summarizes transportation equity types, ways to measure them, and optimization strategies.

There are many possible ways achieve equity goals; some provide more total benefits than others. Programmatic solutions deliver special benefits to designated groups. Structural solutions reform planning practices to create more inclusive, affordable and resource-efficient transportation systems. Although programmatic solutions may seem most cost-effective, since they provide targeted and measurable benefits, structural solutions tend to provide larger and more diverse benefits and so are generally most cost-effective overall, considering all impacts.

Comprehensive equity analysis requires detailed data on travel demands, accessibility (the time and money required to reach services and activities), multimodal service quality, user and external costs, user satisfaction, and obstacles, disaggregated to measure disparities between advantaged and disadvantaged groups.
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Evaluating Transportation Equity: Guidance for Incorporating Distributional Impacts in Transport Planning
Victoria Transport Policy Institute


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