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Introduction to Multi-Modal Transportation Planning

Principles and Practices

18 November 2008

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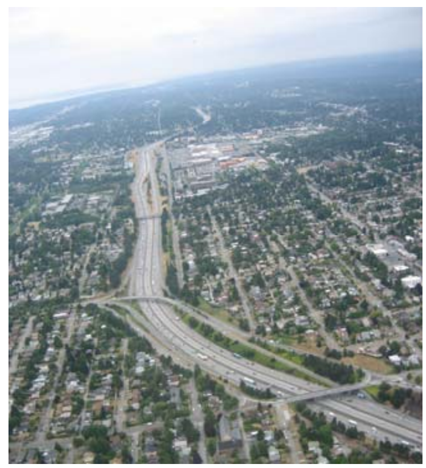


Abstract

This paper summarizes basic principles for transportation planning. It describes conventional transport planning, which tends to focus on motor vehicle traffic conditions, and newer methods for more multi-modal planning and evaluation.

Conventional Transportation Planning

Conventional (also called *traditional* or *business as usual*) transportation planning refers to current practices for making transport policy, program and investment decisions. *Multi-modal* planning refers to decision making that considers various modes (walking, cycling, automobile, public transit, etc.) and connections among modes so each can fill its optimal role in the overall transport system. There are several specific types of transport planning for reflecting different scales and objectives:

- *Traffic impact studies* evaluate traffic impacts and mitigation strategies for a particular development or project.
- *Local transport planning* develops municipal and neighborhood transport plans.
- *Regional transportation planning* develops plans for a metropolitan region.
- *State, provincial and national transportation planning* develops plans for a large jurisdiction, to be implemented by a transportation agency.
- *Strategic transportation plans* develop long-range plans, typically 20-40 years into the future.
- *Transportation improvement plans (TIPs)* or *action plans* identify specific projects and programs to be implemented within a few years.
- *Corridor transportation plans* identify projects and programs to be implemented on a specific corridor, such as along a particular highway, bridge or route.
- *Mode- or area-specific transport plans* identify ways to improve a particular mode (walking, cycling, public transit, etc.) or area (a campus, downtown, industrial park, etc.).

Figure 1 **Transport Planning Process**
(FHWA and FTA, 2007)

A transport planning process typically includes the following steps:

- Monitor existing conditions.
- Forecast future population and employment growth, and identify major growth corridors.
- Identify current and projected future transport problems and needs, and various projects and strategies to address those needs.
- Evaluate and prioritize potential improvement projects and strategies.
- Develop long-range plans and short-range programs identifying specific capital projects and operational strategies.
- Develop a financial plan for implementing the selected projects and strategies.

Conventional transportation planning tends to focus on a specific set of options (primarily automobile travel) and impacts (summarized in Table 1). Commonly-used transportation economic evaluation models, such as *MicroBenCost*, were designed for highway project evaluation, assuming that total vehicle travel is unaffected and is unsuitable for evaluating projects that include alternative modes or demand management strategies.

Table 1 **Impacts Considered and Overlooked**

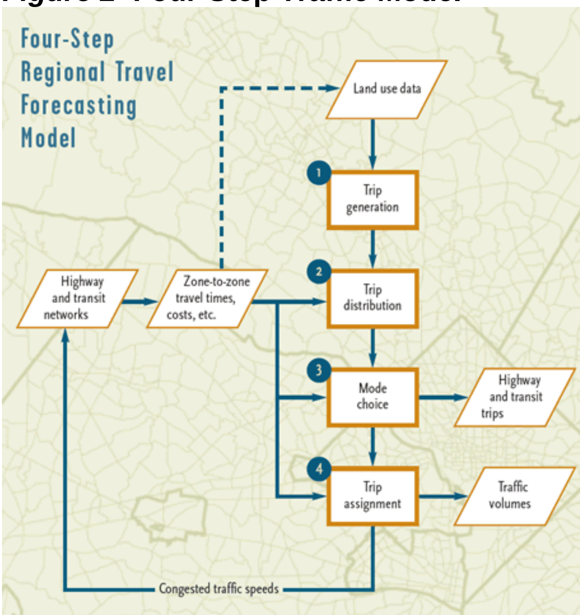
Usually Considered	Often Overlooked
Financial costs to governments	Downstream congestion impacts
Vehicle operating costs (fuel, tolls, tire wear)	Impacts on non-motorized travel
Travel time (reduced congestion)	Parking costs
Per-mile crash risk	Vehicle ownership and mileage-based depreciation costs.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

Conventional transportation planning tends to focus on a limited set of impacts. Other impacts tend to be overlooked because they are relatively difficult to quantify (e.g., equity, indirect environmental impacts), or simply out of tradition (e.g., parking costs, vehicle ownership costs, construction delays).

Conventional transportation planning strives to maximize traffic speeds, minimize congestion and reduce crash rates (generally measured per vehicle-mile) using a well developed set of engineering, modeling and financing tools. Many jurisdictions codify these objectives in *concurrency requirements* and *traffic impact fees*, which require developers to finance roadway capacity expansion to offset any increase in local traffic. Alternatives to roadway expansion, such as *transportation demand management* and *multi-modal* transport planning, are newer and so have fewer analysis tools. As a result, conventional planning practices support *automobile dependency*, which refers to transport and land use patterns favoring automobile travel over alternative modes (in this case, *automobile* includes cars, vans, light trucks, SUVs and motorcycles).

In recent years transportation planning has expanded to include more emphasis on non-automobile modes and more consideration of factors such as environmental impacts and mobility for non-drivers. One indication of this shift is that over the last two decades, many *highway agencies* have been renamed *transportation agencies*, and have added departments and experts related to environmental analysis, community involvement and nonmotorized planning. Transportation modeling techniques are improving to account for a wider range of options (such as alternative modes and pricing incentives) and impacts (such as pollution emissions and land use effects). In addition, an increasing portion of transport funds are flexible, meaning that they can be spent on a variety of types of programs and projects rather than just roadways.

Figure 2 **Four-Step Traffic Model**



www.mwcog.org/transportation/activities/models/4_step.asp

Most regions use *four-step models* to predict future transport conditions (see Figure 2). The region is divided into numerous *transportation analysis zones* (TAZs) each containing a few hundred to a few thousand residents. *Trip generation* (the number and types of trips originating from each TAZ) is predicted based on generic values adjusted based on local travel surveys that count zone-to-zone peak-period trips. These trips are assigned destinations, modes and routes based on their *generalized costs* (combined time and financial costs), with more trips assigned to relatively cheaper routes and modes, taking into account factors such as travel speeds, congestion delays and parking costs. Transport models are being improved in various ways to better predict future travel activity, including the effects of various transport and land use management strategies.

This predicts future peak-period traffic volumes on each route, and identifies where volumes will exceed capacity (based on the *volume/capacity ratio* or *V/C*) of specific roadway links and intersections. The intensity of congestion on major roadways is evaluated using *level-of-service* (LOS) ratings, a grade from *A* (best) to *F* (worst).

Table 2 summarizes highway LOS ratings. Similar ratings are defined for arterial streets and intersections. Roadway level-of-service is widely used to identify traffic problems and evaluate potential roadway improvements. Figure 3 illustrates a typical model output: a map showing LOS ratings of major regional roadways.

Figure 3 **Highway LOS Map** (PSRC, 2008)

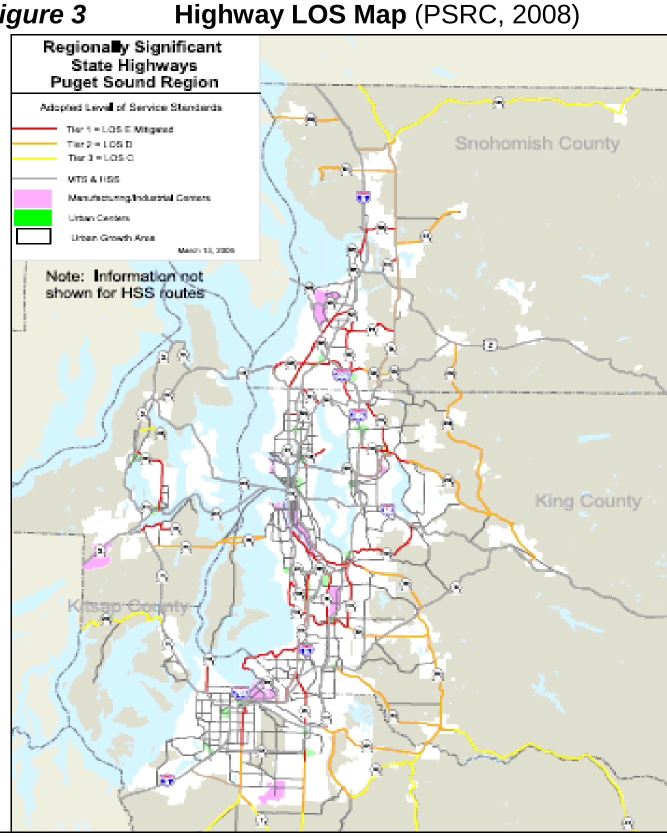


Table 2 **Highway Level-Of-Service (LOS) Ratings** (Wikipedia)

LOS	Description	Speed (mph)	Flow (veh./hour/lane)	Density (veh./mile)
A	Traffic flows at or above posted speed limit. Motorists have complete mobility between lanes.	Over 60	Under 700	Under 12
B	Slightly congested, with some impingement of maneuverability. Two motorists might be forced to drive side by side, limiting lane changes.	57-60	700-1,100	12-20
C	Ability to pass or change lanes is not assured. Most experienced drivers are comfortable and posted speed is maintained but roads are close to capacity. This is the target LOS for most urban highways.	54-57	1,100-1,550	20-30
D	Typical of an urban highway during commuting hours. Speeds are somewhat reduced, motorists are hemmed in by other cars and trucks.	46-54	1,550-1,850	30-42
E	Flow becomes irregular and speed varies rapidly, but rarely reaches the posted limit. On highways this is consistent with a road over its designed capacity.	30-46	1,850-2,000	42-67
F	Flow is forced, with frequent drops in speed to nearly zero mph. Travel time is unpredictable.	Under 30	Unstable	67-Maximum

This table summarizes highway Level of Service (LOS) rating, an indicator of congestion intensity.

Under optimal conditions a *grade separated highway* (no cross traffic) can carry up to 2,200 vehicles per hour (VPH) per lane. An arterial with intersections can carry about half that. Table 3 indicates units commonly used to measure traffic. These are generally measured during *peak hours*. Speed is generally based on the *85th percentile* (the speed below which 85% of vehicles travel). Traffic volumes are also sometimes measured as *Annual Average Daily Traffic* (AADT), indicating traffic volumes averaged over a year.

Table 3 **Basic Traffic Units**

Parameter	Typical Units	Reciprocal	Typical Units
Flow	Vehicles per hour (Veh/h)	Headway	Seconds per vehicle (s/veh)
Speed	Kilometers or miles per hour (Km/h)	Travel time	Seconds per km or mi (s/km)
Density	Vehicles per lane-km or mi (veh/lane-km)	Spacing	Feet or meters per vehicle (m/veh)

This table summarizes units commonly used to measure vehicle traffic.

Terms and Concepts

- Traffic congestion can be *recurrent* (occurs daily, weekly or annually, making it easier to manage) or *non-recurrent* (typically due to accidents, special events or road closures).
- *Design vehicle* refers to the largest and heaviest vehicle a roadway is designed to accommodate. *Passenger Car Equivalents* (PCE) indicate the traffic impacts of larger vehicles compared with a typical car.
- A *queue* is a line of waiting vehicles (for example, at an intersection). A *platoon* is group of vehicles moving together (such as after traffic signals turn green).
- *Capacity* refers to the number of people or vehicles that could be accommodated. *Load factor* refers to the portion of capacity that is actually used. For example, a load factor of 0.85 indicates that 85% of the maximum capacity is actually occupied.

A typical transport planning process defines the minimum level-of-service considered acceptable (typically LOS C or D). Roads that exceed this are considered to *fail* and so deserve expansion or other interventions. This approach is criticized on these grounds:

- It focuses primarily on motor vehicle travel conditions. It assumes that transportation generally consists of automobile travel, often giving little consideration to travel conditions experienced by other modes. As a result, it tends to result in automobile dependency, reducing modal diversity.
- It defines transportation problems primarily as traffic congestion, ignoring other types of problems such as inadequate mobility for non-drivers, the cost burden of vehicle ownership to consumers and parking costs to businesses, accident risk, and undesirable social and environmental impacts.
- It ignores the tendency of traffic congestion to maintain equilibrium (as congestion increases, traffic demand on a corridor stops growing), and the impacts of *generated traffic* (additional peak-period vehicle travel that results from expanded congested roadways) and *induced travel* (total increases in vehicle travel that result from expanded congested roadways). As a result, it exaggerates the degree of future traffic congestion problems, the congestion reduction benefits of expanding roads, and the increased external costs that can result from expanding congested roadways.
- It can create a self-fulfilling prophecy by directing resources primarily toward roadway expansion at the expense of other modes (widening roads and increasing traffic speeds and volumes tends to degrade walking and cycling conditions, and often leaves little money or road space for improving other modes).
- Short trips (within TAZs), travel by children, off-peak travel and recreational travel are often ignored or undercounted in travel surveys and other statistics, resulting in walking and cycling being undervalued in planning.

In recent years transportation planning has become more multi-modal and comprehensive, considering a wider range of options and impacts. Transport planners have started to apply Level-of-Service ratings to walking, cycling and public transit, and to consider demand management strategies as alternatives to roadway capacity expansion.

Green Transportation Hierarchy

1. Pedestrians
2. Bicycles
3. Public Transportation
4. Service and Freight Vehicles
5. Taxis
6. Multiple Occupant Vehicles
7. Single Occupant Vehicles

The Green Transportation Hierarchy favors more efficient (in terms of space, energy and other costs) modes.

Some urban areas have established a transportation hierarchy which states that more resource efficient modes will be given priority over single occupant automobile travel, particularly on congested urban corridors. This provides a basis for shifting emphasis in transport planning, road space allocation, funding and pricing to favor more efficient modes.

Table 4 Mode Profiles

Mode	Availability	Speed	Density	Loads	Costs	Potential Users			Limitations	Appropriate Uses
	Portion of locations and times served	typical speeds	space requirements	ability to carry baggage	user costs	Non-Drivers	Poor	Handi-capped		
Walking	Wide (nearly universal)	2-5 mph	High	Small	Low	Yes	Yes	Varies	Requires physical ability. Limited distance and carrying capacity. Sometimes difficult or unsafe.	Short trips by physically able people.
Wheelchair	Limited (requires suitable facilities)	2-5 mph	Medium	Small	Med.	Yes	Yes	Yes	Requires suitable sidewalk or path. Limited distance and carrying capacity.	Short urban trips by people with specific physical disabilities.
Bicycle	Wide (feasible on most roads and some paths)	5-15 mph	Medium	Small to medium	Med.	Yes	Yes	Varies	Requires bicycle and physical ability. Limited distance and carrying capacity.	Short to medium length trips by physically able people on suitable routes.
Taxi	Moderate (in most urban areas)	20-60 mph	Low	Medium	High	Yes	Limited	Yes	High costs and limited availability.	Infrequent trips, short and medium distance trips.
Fixed Route Transit	Limited (major urban areas)	20-40 mph	High	Small	Med.	Yes	Yes	Yes	Limited availability. Sometimes difficult to use.	Short to medium distance trips along busy corridors.
Paratransit	Limited	10-30 mph	Medium	Small	High	Yes	Yes	Yes	High cost and limited service.	Travel for disabled people.
Auto driver	Wide (nearly universal)	20-60 mph	Low	Medium to large	High	No	Limited	Varies	Requires driving ability and automobile. Large space requirements. High costs.	Travel by people who can drive and afford an automobile.
Ridesharing (auto passenger)	Limited (requires motorist, matching services)	20-60 mph	High	Medium	Low	Yes	Yes	Yes	Requires cooperative motorist. Consumes driver's time if a special trip (chauffeuring).	Trips that the driver would take anyway (ridesharing). Occasional special trips (chauffeuring).
Carsharing (vehicle rentals)	Limited (requires nearby services)	20-60 mph	Low	Medium to large	Med.	No	Limited	Varies	Requires convenient and affordable vehicle rentals services.	Occasional use by drivers who don't own an automobile.
Motorcycle	Wide (nearly universal)	20-60 mph	Medium	Medium	High	No	Limited	No	Requires riding ability and motorcycle. High fixed costs.	Travel by people who can ride and afford a motorcycle.
Telecommute	Wide (nearly universal)	NA	NA	NA	Med.	Yes	Varies	Varies	Requires equipment and skill.	Alternative to some types of trips.

This table summarizes the performance of various transportation modes.

Multi-modal transportation planning is complicated because modes differ in various ways, including their availability, speed, density, costs, limitations, and most appropriate uses (Table 4). They are not equal substitutes; each is only appropriate for specific users and uses.

Such analysis is even more complex because each mode includes various subcategories with unique characteristics. For example, “pedestrians” include people standing, walking alone and in groups, using canes and walkers, jogging and running, playing, walking pets, carrying loads, and pushing hand carts. Their actual needs, abilities, impacts and value to society can vary significantly, as indicated in Table 5.

Table 5 **Nonmotorized Facility Uses Compared**

Mode or Activity	Facility Requirements	Risk to Others	Basic Mobility
	Quality and quantity of pedestrian facilities	Danger these users impose on others	Whether the mode provides basic mobility benefits)
People standing	Minimal	None	NA
People sitting at benches or tables	Seats or benches	None	NA
Individual walkers	Minimal	Low	High
Walkers in groups	Medium	Low	High
Walkers with children	Medium	Low	High
Children playing	Medium to large	Medium	Medium
Walkers with pets	Medium to large	Low	Medium
Human powered wheelchairs	Medium	Low	Very High
Motor powered wheelchairs	Medium to large	Medium to high	Very High
Joggers and runners	Medium to large	Medium	Medium
Skates and push-scooters	Large	Medium	Low
Powered scooters and Segways	Large	Medium	Low to high
Human powered bicycle	Medium to large	Medium to high	Medium
Motorized bicycle	Large	High	Low
People with handcarts or wagons	Medium to large	Low to medium	Medium
Vendors with carts and wagons	Medium to large	Low	Sometime (if the goods sold are considered ‘basic’).

This table compares various nonmotorized facility users.

Similarly, *public transit* (also called *public transportation* or *mass transit*) includes various types of services and vehicles. Table 6 summarizes the performance of various types of public transit. Actual performance depends on specific circumstances; for example costs per trip can vary depending on which costs are included (for example, whether major new road or rail improvements are required, whether park&ride facilities are included in transit budgets, construction and operating costs, load factors and types of trips.

Table 6 **Transit Modes Compared**

Name	Description	Availability	Speed	Density	Costs
		Destinations served	Passenger travel speeds	Passenger volumes	Cost per trip
Heavy rail	Relatively large, higher-speed trains, operating entirely on separate rights-of-way, with infrequent stops, providing service between communities.	Limited to major corridors in large cities	High	Very high	Very high
Light Rail Transit (LRT)	Moderate size, medium-speed trains, operating mainly on separate rights-of-way, with variable distances between stations, providing service between urban neighborhoods and commercial centers.	Limited to major corridors	Medium	High	High
Streetcars (also called trams or trolleys)	Relatively small, lower-speed trains, operating primarily on urban streets, with frequent stops which provide service along major urban corridors.	Limited to major corridors	Medium	High	High
Fixed route bus transit	Buses on scheduled routes.	Widely available in urban areas	Low to medium	High	Low to medium
Bus Rapid Transit (BRT)	A bus system with features that provide a high quality of service.	Limited to major corridors	Medium to high	High	Low to medium
Express bus	Limited stop bus service designed for commuters and special events.	Limited to major corridors	High	High	Low to medium
Ferry services	Boats used to transport people and vehicles.	Limited to major corridors	Low to medium	Low to medium	Medium to high
Paratransit	Small buses or vans that provide door-to-door, demand-response service.	Widely available	Low	Low	High
Personal Rapid Transit (PRT)	Small, automated vehicles that provide transit service, generally on tracks.	Limited to major corridors	Low to medium	Low to medium	Medium to high
Vanpool	Vans used for ridesharing.	Widely available	Medium to high	High	Low
Shared taxi.	Private taxis that carry multiple customers.	Limited to busy corridors	Medium to high	Low to medium	Medium to high
Taxi	Conventional taxi service.	Widely available	Medium to high	Low	High

Multi-modal transport planning requires tools for evaluating the quality of each mode, such as Level-of-Service standards which can be used to indicate problems and ways to improve each mode. Tables 7 and 8 indicate factors that can be considered when evaluating different modes.

Table 7 **Nonmotorized Level-Of-Service Rating Factors**

Feature	Definition	Indicators
Network continuity	Whether sidewalks and paths exist, and connect throughout an area.	• Portion of streets with nonmotorized facilities. • Length of path per capita. • Network connectivity and density (kilometers of sidewalks and paths per square kilometer).
Network quality	Whether sidewalks and paths are properly designed and maintained.	• Sidewalk and path functional width. • Portion of sidewalks and paths that meet current design standards. • Portion of sidewalks and paths in good repair.
Road crossing	Safety and speed of road crossings	• Road crossing widths. • Motor vehicle traffic volumes and speeds. • Average pedestrian crossing time. • Quantity and quality of crosswalks, signals and crossing guards.
Traffic protection	Separation of nonmotorized traffic from motorized traffic, particularly high traffic volumes and speeds.	• Distance between traffic lanes and sidewalks or paths. • Presence of physical separators, such as trees and bollards. • Speed control.
Congestion and user conflicts	Whether sidewalks and paths are crowded or experience other conflicts.	• Functional width of sidewalk and paths. • Peak-period density (people per square meter) • Clearance from hazards, such as street furniture and performers within the right-of-way. • Number of reported conflicts among users. • Facility management to minimize user conflicts.
Topography	Presence of steep inclines.	• Portion of sidewalks and paths with steep inclines.
Sense of Security	Perceived threats of accidents, assault, theft or abuse.	• Reported security incidents. • Quality of visibility and lighting.
Wayfinding	Guidance for navigating within the station and to nearby destinations.	• Availability and quality of signs, maps and visitor information services.
Weather protection	User protected from sun and rain.	• Presence of shade trees and awnings.
Cleanliness	Cleanliness of facilities and nearby areas.	• Litter, particularly potentially dangerous objects. • Graffiti on facilities and nearby areas. • Effectiveness of sidewalk and path cleaning programs.
Attractiveness	The attractiveness of the facility, nearby areas and destinations.	• Quality of facility design. • Quality of nearby buildings and landscaping. • Area Livability (environmental and social quality of an area). • Community cohesion (quantity and quality of positive interactions among people in an area). • Number of parks and recreational areas accessible by nonmotorized facilities.
Marketing	Effectiveness of efforts to encourage nonmotorized transportation.	• Quality of nonmotorized education and promotion programs. • Nonmotorized transport included in Commute Trip Reduction programs.

This table summarizes factors to consider when evaluating walking and cycling conditions.

Table 8 **Transit Level-of-Service Rating Factors**

Feature	Description	Indicators
Availability	Where and when transit service is available.	• Annual service-kilometers per capita. • Daily hours of service. • Portion of destinations located within 500 meters of transit service. • Hours of service.
Frequency	Frequency of service and average wait time.	• Trips per hour or day. • Headways (time between trips). • Average waiting times.
Travel Speed	Transit travel speed.	• Average vehicle speeds. • Transit travel speed relative to driving the same trip. • Door-to-door travel time.
Reliability	How well service actually follows published schedules.	• On-time operation. • Portion of transfer connections made. • Mechanical failure frequency.
Boarding speed	Vehicle loading and unloading speed.	• Dwell time. • Boarding and alighting speeds.
Safety and security	Users perceived safety and security.	• Perceived transit passenger security. • Accidents and injuries. • Reported security incidents. • Visibility and lighting. • Absence of vandalism.
Price and affordability	Fare prices, structure, payment options, ease of purchase.	• Fares relative to average incomes. • Fares relative to other travel mode costs. • Payment options (cash, credit cards, etc.). • Ticket availability (stations, stores, Internet, etc.).
Integration	Ease of transferring between transit and other travel modes.	• Quality of transit service to transport terminals. • Ease of accessing transit service information from transport terminals.
Comfort	Passenger comfort	• Seating availability and quality. • Space (lack of crowding). • Quiet (lack of excessive noise). • Fresh air (lack of unpleasant smells). • Temperature (neither too hot or cold). • Cleanliness. • Washrooms and refreshments (for longer trips).
Accessibility	Ease of reaching stations and stops.	• Distance from transit stations and stops to destinations. • Walkability (quality of walking conditions) in areas serviced by transit.
Baggage capacity	Accommodation of baggage.	• Ability, ease and cost of carrying baggage, including special items such as pets.
Universal design	Accommodation of diverse users including special needs.	• Accessible design for transit vehicles, stations and nearby areas. • Ability to carry baggage. • Accommodation of people who cannot read or understand the local language.
User information	Ease of obtaining user information.	• Availability and accuracy of route, schedule and fare information. • Real-time transit vehicle arrival information. • Information available to service people with special needs (audio or visual disabilities, inability to read or understand the local language, etc.).
Courtesy and responsiveness	Courtesy with which passengers are treated.	• How passengers are treated by transit staff. • Ease of filing a complaint. • Speed and responsiveness with which complaints are treated.
Attractiveness	The attractiveness of transit facilities.	• Attractiveness of vehicles and facilities. • Attractiveness of documents and websites.
Marketing	Effectiveness of efforts to encourage public transport.	• Popularity of promotion programs. • Effectiveness at raising the social status of transit travel. • Increases in public transit ridership in response to marketing efforts.

This table summarizes factors that can be considered when evaluating public transit services.

Automobile Dependency and Multi-Modalism

Automobile dependency refers to transportation and land use patterns that favor automobile travel and provide relatively inferior alternatives. Its opposite, *multi-modalism*, refers to a transport system that offers users diverse transport options that are effectively integrated, in order to provide a high degree of accessibility even for non-drivers. Table 9 compares automobile dependency and multi-modal transport systems.

Table 9 **Auto Dependency and Multi-Modal Transportation Compared**

Factor	Automobile Dependency	Multi-modal Transportation
Motor vehicle ownership	High per capita motor vehicle ownership.	Medium per capita motor vehicle ownership.
Vehicle travel	High per capita motor vehicle mileage.	Medium to low vehicle mileage.
Land use density	Low. Common destinations are dispersed.	Medium. Destinations are clustered
Land use mix	Single-use development patterns.	More mixed-use development.
Land for transport	Large amounts of land devoted to roads and parking.	Medium amounts devoted to roads and parking.
Road design	Emphasizes automobile traffic.	Supports multiple modes and users.
Street scale	Large scale streets and blocks.	Small to medium streets and blocks.
Traffic speeds	Maximum traffic speeds.	Lower traffic speeds.
Walking	Mainly in private malls.	Mainly on public streets.
Signage	Large scale, for high speed traffic.	Medium scale, for lower-speed traffic.
Parking	Generous supply, free.	Moderate supply, some pricing.
Site design	Parking paramount, in front of buildings.	Parking sometimes behind buildings.
Planning Practices	Non-drivers are a small minority with little political influence.	Planning places are high value on modal diversity.
Social expectations	Non-drivers are stigmatized and their needs given little consideration.	Non-drivers are not stigmatized and their needs are considered.

This table compares automobile dependency and multi-modal transport systems.

Automobile dependency is a matter of degree. Few places are totally automobile dependent (that is, driving is the *only* form of transport). Many relatively automobile dependent areas often have significant amounts of walking, cycling, and transit travel among certain groups or situations. Even ‘car free’ areas usually have some automobile travel by emergency, delivery and service vehicles.

Automobile dependency has many impacts. It increases total mobility (per capita travel), vehicle traffic, and associated costs. It makes non-drivers economically and socially disadvantaged, since they have higher financial and time costs or less ability to access activities. This tends to reduce opportunities, for example, for education, employment and recreation. In an automobile dependent community virtually every adult is expected to have a personal automobile (as opposed to a *household* automobile shared by multiple drivers), non-drivers require frequent chauffeuring, and it is difficult to withdraw driving privileges from unfit people since alternatives are inferior. Automobile dependency reduces the range of solutions that can be used to address problems such as traffic congestion, road and parking facility costs, crashes, and pollution.

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