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Evaluating Complete Streets

The Value of Designing Roads For Diverse Modes, Users and Activities
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Original four-lane arterial designed to maximize motor vehicle traffic speeds.

Complete street with center turn lane, bike lane and pedestrian refuge island at bus stop.

Summary
Complete streets refers to roads designed to accommodate diverse modes, users and activities including walking, cycling, public transit, automobile, nearby businesses and residents. Such street design helps create more multi-modal transport systems and more livable communities. This report discusses reasons to implement complete streets and how it relates to other planning innovations. Complete streets can provide many direct and indirect benefits including improved accessibility for non-drivers, user savings and affordability, energy conservation and emission reductions, improved community livability, improved public fitness and health, and support for strategic development objectives such as urban redevelopment and reduced sprawl. Net benefits depend on the latent demand for alternative modes and more compact development, and the degree that complete streets projects integrate with other planning reforms such as smart growth, New Urbanism and transportation demand management.

Introduction

My city, Victoria, British Columbia, is a popular place to visit and live. We attract millions of visitors who spend more than a billion dollars annually. They often recommend Victoria to friends, and some return to live. When we ask visitors to describe the activities that made their Victoria visits so enjoyable, a common response is, "We walked around."

Like many older cities, Victoria has relatively narrow arterials with low traffic speeds, good sidewalks, shops oriented to pedestrians, and relatively good public transit, making it easy to get around without a car, which provides independence for seniors and people with disabilities, and financial savings, health and enjoyment for physically-able people.

Figure 1 **Victoria, Canada Arterial**

Victoria, Canada is a popular place to visit and live due partly to its narrow arterials with low traffic speeds, with relatively good walking and cycling conditions and public transit services.

These are valuable features which make our city an attractive place to visit and live, and generates significant economic activity. Yet, these features exist *despite* rather than because of conventional planning practices. For many decades, roadway planning favored mobility above other planning objectives, often to the detriment of other modes, activities and objectives. This type of planning evaluated transport system performance based primarily on arterial traffic speeds. It assumed that *transportation* means driving, that the most important planning goal is to increase automobile traffic speeds, often to the detriment of other transport modes and planning goals. Many planning professionals, and the general public, increasingly realize that this type of planning can have undesirable, unintended consequences; it creates automobile dependent transportation system and sprawled development patterns, degrades walking and cycling conditions and creates unattractive streetscapes.

In response, communities increasingly apply a new transport planning paradigm which considers a wider range of planning objectives, impacts and options. It recognizes the need to balance the needs of diverse modes, users and activities. This new paradigm has many implications for transport planning. This report investigates how it relates to *complete streets*, a policy which commits a community to design streets accommodate diverse users and activities.

Complete Streets

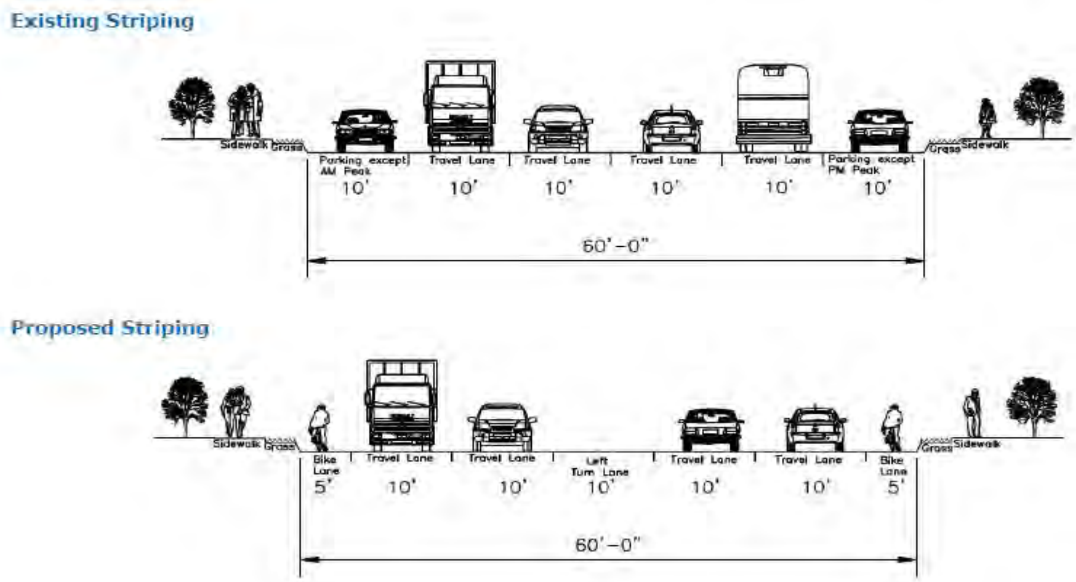
Complete streets refers to roadways designed to safely accommodate diverse modes, users and activities including walking, cycling, driving, public transport, people with disabilities, plus adjacent businesses and residents. Complete streets planning recognizes that roadways serve diverse functions including mobility, accessibility, recreation, business activities and community, and that road users range from freight trucks to pedestrians with impairments.

Typical Complete Streets Design Features

- Wider and better sidewalks
- Universal design features (curbcuts and ramps)
- Crosswalks with pedestrian refuge islands
- Bike lanes
- Bus shelters and bus lanes where justified
- Center left turn lanes
- Lower traffic speeds
- Landscaping

A typical complete street project redesigns roadways to include better sidewalks and crosswalks, pedestrian refuge islands (so pedestrians need only cross half the street at a time), bike lanes, and center turn lanes, as illustrated in Figure 2. It sometimes involves reducing traffic and parking lanes, traffic calming, and replacing traffic signals with roundabouts. This tends to reduce maximum traffic speeds but smoothes flow so total vehicle traffic volumes are not reduced.

Figure 2 **Typical Complete Streets Design** (Cincinnati DOTE)



Complete streets projects typically include better sidewalks and crosswalks, bike lanes, center turn lanes, fewer and narrower general traffic and parking lanes.

This reflects a new planning paradigm which emphasizes accessibility and multi-modalism, as summarized in Table 1. Complete streets integrate with other planning innovations including sustainable development, smart growth, New Urbanism, context oriented planning, traffic calming and transportation demand management. It is the practical way that transport planners and engineers can help create more diverse transport systems and more livable communities.

Table 1 **Conventional Versus Multi-Modal Planning**

	Conventional (Old Paradigm)	Multi-Modal (New Paradigm)
Definition of *transportation*	*Mobility* – physical travel (primarily motor vehicle travel)	*Accessibility* – peoples' ability to reach desired services and activities
Transport planning goal	Maximize travel speeds	Maximize overall accessibility
Transport system performance indicators	Roadway level-of-service (LOS), average traffic speed, congestion delay	Multi-modal LOS, time and money required by various people to access services and activities
Roadway design priority	Maximize vehicle traffic speeds and volumes	Accommodate multiple modes and activities
Typical design speed	30-50 miles (50-80 kilometers) per hour	20-30 miles (30-40 kilometers) per hour
Roadway network type	Hierarchical with low connectivity	Highly connected roads and sidewalks
Design vehicle	Heavy truck (fire truck or moving van)	Heavy truck for size, impaired pedestrians for universal design standards

Conventional planning favors roadway design that maximizes vehicle traffic speeds. Multi-modal planning considers other modes important and so favors complete streets designs.

The new planning paradigm recognizes that motor vehicle travel is seldom an end in itself; the ultimate goal of most transport activity is *accessibility* (people's ability to reach desired services and activities) and that various factors affect accessibility including mobility, the quality of transport options, transport network connectivity and affordability, the geographic distribution of activities, and mobility substitutes such as telecommunications and delivery services. Conflicts often exist between different forms of access, for example, wider roads and increased vehicle traffic create barriers to non-motorized access (called the *barrier effect*), and locations that are most accessible by automobile are often difficult to access by other modes. Complete streets planning recognizes these trade-offs and so can optimize accessibility overall.

Table 2 **Impacts on Accessibility Factors**

Accessibility Factors	Automobile-Oriented Streets	Complete Streets
Automobile access	Maximize arterial travel speeds	May reduce traffic speeds and parking convenience
Non-motorized access	Wider roads and increased traffic tend to create barriers to non-motorized access	Significantly improves walking and cycling access
Public transport access	Since most transit trips include non-motorized links, auto-oriented streets can reduce transit access	Improves walking and cycling access, and may include bus lanes and other transit support features
Roadway connectivity (number of connections between roads)	Hierarchy road systems require limiting access which reduces connectivity	Supports more connected roadway networks
Transport affordability (quality of affordable modes such as walking, cycling and transit)	May reduce vehicle operating costs but reduces access by affordable modes	Significantly improves walking and cycling access, and may include public transit service improvements
Land use accessibility (distances between activities)	Tends to stimulate more dispersed, urban-fringe development (sprawl)	Encourages more compact, accessible land use development

Complete streets tend to reduce vehicle traffic speeds but increase other accessibility factors including non-motorized access, transit access, road network connectivity, and land use accessibility.

The old planning paradigm evaluates transport system performance based primarily on vehicle traffic speeds and so favors wider roads with higher design speeds. The new paradigm recognizes that these features improve automobile access but reduce other forms of access by creating barriers to non-motorized travel and stimulating dispersed development. The new paradigm recognizes the important roles that walking, cycling and public transport play in an efficient and equitable transport system, and therefore supports multi-modal planning. The old paradigm does not completely ignore alternative modes, but often treats them as luxuries to be accommodated where convenient, for example, if a wider sidewalk or bike lane can easily fit into available road rights-of-way and project budgets. Where conflicts exist between motorized and non-motorized access the old paradigm considers it acceptable to block pedestrian and bicycle access and require those modes to make significant detours. The new transport planning paradigm considers non-motorized access and safety essential design objectives. It reverses the planning hierarchy to favor non-motorized over non-motorized modes as illustrated in Table 3.

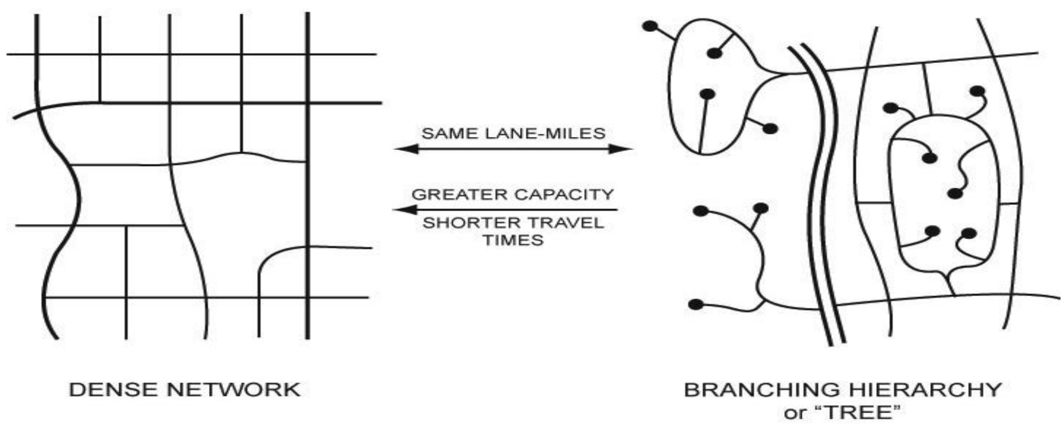
Table 3 **Conventional Versus Complete Streets Planning Hierarchy**

Conventional Planning	Complete Streets Planning
1. Freight/service vehicle	1. Pedestrian
2. Automobile traffic	2. Bicycle
3. Automobile parking	3. Bus
4. Bus	4. Freight/service vehicle
5. Bicycle	5. Automobile traffic
6. Pedestrian	6. Automobile parking

Conventional planning favors faster travel and therefore motorized modes over slower travel and therefore non-motorized modes. Complete streets planning reverses this to favor sustainable modes.

Conventional planning favors hierarchical road networks, where traffic is channeled from narrow, lower-speed streets onto wider, higher-speed arterials that have 6-10 lanes 30-50 mile (50-80 kilometer) per hour speed limits. This increases travel distances and creates barriers to non-motorized travel. Complete streets planning favors more connected road networks with only 2-4 lanes and 20-30 mile (30-40 kms) per hour speed limits, which reduces traffic speeds but allows more direct travel and improves non-motorized travel convenience, safety and comfort.

Figure 3 **Dense Versus Hierarchical Road Networks** (Kelbaugh 2011)



Dense, connected road networks allow more direct travel to destinations, which reduces travel distances, increases non-motorized accessibility, and improves overall safety. Hierarchical road networks channel traffic onto higher speed arterials which increases travel distances, congestion and crashes.

How these new priorities are applied depends on circumstances. Complete streets do not prohibit automobile travel, they generally reduce traffic speeds (see box), and sometimes reduce the number of traffic and parking lanes, but by providing center turn lanes, smoothing traffic flow and encouraging mode shifts, they often carry as many people as previously. According to a research by the U.S. Federal Highway Administration, "Under most annual average daily traffic (AADT) conditions tested, road diets appeared to have minimal effects on vehicle capacity because left-turning vehicles were moved into a common two-way left-turn lane (TWLTL). However, for road diets with AADTs above approximately 20,000 vehicles, there is an increased likelihood that traffic congestion will increase to the point of diverting traffic to alternative routes." (HSIS 2010).

Box 1 Traffic Speed Evaluation

Vehicle traffic speeds affect mobility and safety so it is important that planners understand how to evaluate and manage speeds. Roadway speeds can be evaluated in various ways:

- *Design speed* refers to the maximum speed the roadway is designed to accommodate, taking into account lane widths, sightlines, intersection design, and traffic management.
- *Average* and *85th percentile* speeds refer to the actual measured traffic speeds.
- *Speed limits* refers to the maximum legal speeds allowed on a roadway.

As traffic speeds increase so does the distance drivers need to react to unexpected conditions (potholes, vehicles or pedestrians in their path), and higher traffic speeds increase the severity of injuries that result from crashes, particularly those involving pedestrians and cyclists. As a result, walking and cycling become uncomfortable and unsafe when adjacent road traffic speeds exceed about 20 miles (30 kms) per hour. Multi-modal transport planning therefore requires high quality sidewalks set back from traffic, crosswalks, and bike lanes on road with higher traffic speeds. Thirty kilometers per hour is the maximum speed appropriate in areas with numerous pedestrians. Traffic speeds can be controlled by redesigning roads with traffic calming strategies such as narrower lanes, textured crosswalks, traffic islands and speed humps, plus effective traffic law enforcement.

Travel and Land Use Impacts

Complete streets tends to have various impacts on travel activity and local land use conditions.

- *Lower motor vehicle traffic speeds – reduced mobility.* Complete streets often reduce maximum traffic speeds, typically from about 30-50 miles (50-80 kms.) down to 20-30 miles (30-40 kms.) per hour. This reduces mobility, the distances motorists can travel in a given amount of time.
- *Reduced crash risk* - Lower traffic speeds tend to reduce traffic collision rates and severity, and therefore crash costs, particularly injury risk for pedestrians and cyclists (HSIS 2010).
- *Improved non-motorized conditions* - Complete streets generally include wider sidewalks, better crosswalks, bike lanes and reduced traffic speeds, which improve walking and cycling convenience, comfort and safety.
- *Improved public transit conditions* - Complete streets often include better bus stops and pedestrian access, and sometimes bus lanes which increase bus travel speeds.
- *Mode shifts from automobile to alternative modes* - By improving walking, cycling and public transit conditions, and reducing motor vehicle travel speeds, complete streets can help shift travel to alternative modes and reduce total automobile travel.
- *Reduced local air and noise pollution* - By reducing traffic speeds and encouraging mode shifting, complete streets tend to reduce local air and noise pollution.
- *Improved aesthetics* - Complete streets often include landscaping and facility aesthetic improvements.
- *Supports community livability and local business activity* - By improving pedestrian conditions and aesthetics, complete streets tend to improve community livability and local business activity.
- *Increase local property values* - Improved livability and increased business activity can increase local property values.

Not every complete streets project has all of these impacts but most have several. These impacts provide benefits and impose costs to different road user types, as summarized below. Motorists tend to be worse off when they want to travel quickly, but also benefit from reduced driving stress, reduced crash risk and improved aesthetics, so impacts on motorists are mixed overall.

Table 4 **Impacts Distribution**

Better Off	Worse Off
Motorists who prefer slower traffic speeds and improved roadway aesthetics Motorists from reduced crash risk Pedestrians, cyclists and transit users Anybody who benefits from reduced automobile traffic Local residents and businesses Local property owners	Motorists who prefer to drive faster Urban fringe residents and property owners

Complete streets directly benefits some people and can make others worse off. Motorists benefit in some ways and are worse off in others.

Complete Streets Benefits and Costs

Complete streets can involve various benefits and costs, as summarized in Table 5. These include direct benefits alternative mode users, direct and indirect benefits if motorists shift from to alternative modes, plus various benefits if complete streets support smart growth development. There can also be costs including planning and implementation expenses, reduced traffic speeds, and changes in local business activities (such as fewer drive-throughs and more sidewalk cafes).

Table 5 **Complete Streets Benefits and Costs** (Litman 2010)

	Improved Transport Options	Increased Use of Alternative Modes	Reduced Automobile Travel	Smart Growth Development
Potential Benefits	• Improved user convenience and comfort • Improved accessibility, particularly for non-drivers, which supports equity objectives • Option value • Increased local property values	• User enjoyment • Improved public fitness and health • Increased community cohesion (positive interactions among neighbors due to more walking on local streets) which tends to increase security	• Reduced traffic congestion • Road and parking savings • Consumer savings • Reduced traffic crashes • Reduced chauffeuring burdens • Energy conservation • Reduced air and noise pollution	• Improved land use accessibility • Transport cost savings • Infrastructure savings • Openspace preservation • Improved aesthetics • Urban redevelopment • Support for local businesses
Potential Costs	• Planning and implementation • Lower traffic speeds	• Additional user costs (shoes, bikes, fares, etc.)	• Increased travel times (slower travel)	• Increases in some development costs • Business activity changes

Complete streets involve various benefits and costs.

Advocates often claim that roadway expansions will reduce accidents, fuel consumption and pollution emissions, which implies that roadway narrowing will exacerbate these problems, but this is often untrue. Roadway expansion sometimes reduces per-mile fuel consumption and emission rates but this is generally offset over the long run by induced travel (Noland and Quddus 2006). Narrower streets with lower design speeds tend to have fewer and less severe accidents (Dumbaugh 2005; Frith 2012; HSIS 2010). More connected, multi-modal street design can significantly reduce traffic injury and fatality rates (Marshall and Garrick 2011; Wei and Lovegrove 2010). To the degree that complete streets shift travel to alternative modes, protect pedestrians, smooth traffic or reduce sprawl they tend to reduce crash risk, conserve fuel and reduce emissions overall.

Conventional transport economic evaluation tends to overlook or undervalue many of these impacts. It generally only monetizes (measure in monetary values) project costs, travel time and vehicle operating savings, and sometimes changes in accident and emission rates. Conventional planning tends to exaggerate roadway expansion benefits. It generally ignores ways that wider roads and increased traffic reduce accessibility by creating barriers to non-motorized travel and stimulating sprawl. It generally assigns no value to improved non-drivers accessibility, comfort and enjoyment; option or equity values; reduced chauffeuring burdens; improved public fitness and health; parking cost savings; vehicle savings; energy conservation; reduced noise; improved aesthetics; or reduced sprawl. As a result, conventional evaluation tends to overvalue roadway expansion and undervalue complete streets.

Methods exist for quantifying and monetizing (measuring in monetary units) many often-overlooked complete streets benefits. For example, the costs of pedestrian delays caused by wider roads and increased motor vehicle traffic, called the *barrier effect*, can be monetized using methods similar to those currently used to monetize delays to motorists caused by traffic congestion. Guidance on these methods is available from various research organizations and transport agencies, including the U.K. Department for Transport (Dft 2006) and the New Zealand Transport Agency (NZTA 2011). Table 6 summarizes some of these methods.

Table 6 **Quantification and Monetization Methods** (DfT 2006; Litman 2009; NZTA 2011)

Often Overlooked Impact	Quantification Methods
Direct user benefits – improved convenience, comfort and enjoyment from improved walking, cycling and public transit, and reduced driver stress	Survey travelers to determine their preferences. Adjust travel time unit costs downward as travel conditions improve.
Reduced barrier effects – reduced pedestrian and cyclist delay	Quantify and monetize the incremental delays and shifts from active to motorized modes
Vehicle cost savings – reduced vehicle ownership and operating costs if residents own fewer vehicles and drive less	Use vehicle ownership surveys to determine whether residents tend to own fewer vehicles and drive less in areas with more multi-modal transport systems
Parking savings – reduced parking problems and subsidy costs if travelers shift mode	Estimate parking cost savings from reduced vehicle ownership and use in areas with multi-modal transport
Safety benefits – reduced traffic crashes due to slower traffic speeds, improved facilities for alternative modes and reduced vehicle travel	Estimate crash cost reductions from reduced traffic speeds and reduced total vehicle travel
Improved public health – increased public fitness and health from more walking and cycling.	Estimate increases in walking and cycling activity and assign monetary values as indicated by NZTA (2011)
Energy conservation and emission reductions – from lower traffic speeds and reduced total vehicle travel.	Estimate energy conservation and emission reductions and assign dollar values
Supports more efficient land use (reduced sprawl) – encourages more compact, multi-modal development	Estimate the community savings and benefits from more compact development and reduced sprawl. Assign monetary values to each household that locates in existing urban areas and avoids urban expansion.
Supports social equity objectives – improves affordable modes and access for disadvantaged people	Weigh savings and benefits in favor of physically, economically and socially disadvantaged people (e.g., an hour saved by a person with an impairment, or a dollar saved by a lower-income household is worth several times more than the same savings by able and wealthy people)
More livable communities – improved local environmental quality	Measure increases in residential and commercial property values along complete streets

Methods exist for quantifying and monetizing many complete streets benefits that are not currently considered in transport economic evaluation.

The following can affect complete streets program benefit evaluation:

Multi-Modal Evaluation
Conventional planning evaluates transport system performance using roadway level-of-service (LOS), which measures motor vehicle delays. The defines traffic congestion as the primary planning problem and assumes that road roadway widening is an *improvement*, that is, it is inherently desirable. Complete streets planning requires multi-modal evaluation which recognizes the trade-offs that exist between different forms of transport and the negative impacts that wider streets and increased vehicle traffic can have on access and community livability (Dowling Associates 2010; Litman 2012).

Demand
Complete streets benefits depend on future demands for alternative modes and for homes and businesses in compact, multi-modal urban neighborhoods. There is significant latent demand for these options in many communities: walking, cycling and public transport travel increase after their facilities and services are improved (ELTIS; VTPI 2012), and current demographic and economic trends (aging population, rising fuel prices, increasing health and environmental concerns, changing consumer preferences, etc.) are increasing such demand (Contrino and Mcguckin 2009; Litman 2006). This suggests that the justification for complete streets is likely to increase in the future.

Integration
Complete streets support and are supported by other transport and land use planning reforms, listed below. The effectiveness of complete streets programs therefore depends on the degree to which these reforms are implemented and integrated.

Planning Reforms That Complement Complete Streets

- *Sustainable development.* Development that balances economic, social and environmental objectives, including long-term and indirect impacts.
- *Smart growth/New Urbanism/transit-oriented development.* More compact, mixed development integrated with alternative modes.
- *New transport planning paradigm/multi-modalism.* Accessibility- rather than mobility-based transport planning which considers diverse modes and impacts.
- *Context oriented planning.* Roadway planning that is flexible and sensitive to community values.
- *Traffic calming and road diets.* Roadway design and management that limits traffic speeds.
- *Transportation demand management.* Various strategies that encourage use of efficient transport options.
- *Parking management.* Various strategies that result in more efficient use of existing parking resources.
- *Urban redevelopment.* Efforts to redevelop existing urban neighborhoods and commercial areas.

Social Equity Perspective

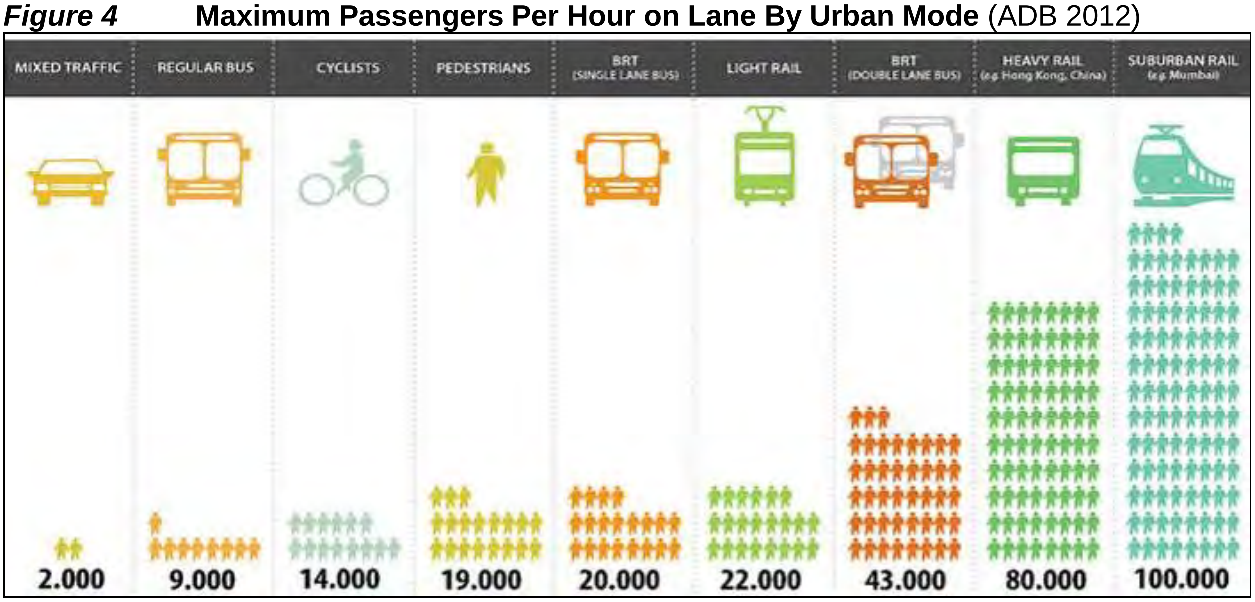
Social equity (also called *justice* and *fairness*) refers to the distribution of impacts (benefits and costs) and the degree that they are considered fair and appropriate. There are three general ways to evaluate transportation equity:

- *Horizontal equity* concerns the distribution of impacts between people and groups considered equal in ability and need. It assumes that equal individuals and groups should receive equal shares of resources, bear equal costs, and in other ways be treated the same. It means that public policies should avoid favoring one individual or group over others, and that consumers should "get what they pay for and pay for what they get" unless a subsidy is specifically justified.
- *Vertical equity with regard to income* is concerned with the distribution of impacts between different income classes. It assumes that policies should favor lower disadvantaged people, which are called *progressive*, while those that burden disadvantaged people are called *regressive*. This definition is used to support affordable modes, and efforts to protect disadvantaged groups from excessive accident risk, pollution or financial costs.
- *Vertical equity with regard to transport ability* is concerned with the degree to which a transport system meets the needs of travelers with mobility impairments. This definition is used to support *universal design* (also called *accessible* and *inclusive* design), which means that transport facilities and services accommodate all users, including those with special needs.

Road Space Analysis

Since automobile travel requires far more road space per passenger-mile or -kilometer than walking, cycling and public transport, it is equitable to shift road rights of way from parking and general traffic lanes wider sidewalks, bike- and bus-lanes if there is sufficient demand. Bus lanes that carry more than about 20 buses per peak hour carry more people than a general traffic lane.

Figure 4 **Maximum Passengers Per Hour on Lane By Urban Mode** (ADB 2012)



The maximum number of passengers that a 3.5-meter urban road lane can carry varies by mode, travel speed and load factor (passengers per vehicle). Automobiles are generally least space-efficient. This underestimates total automobile road space requirements where city streets also have parking lanes.

Risk Analysis

Motor vehicle traffic imposes risk and delay on non-motorized modes ("Barrier Effects," Litman 2009). Even if pedestrians and cyclists are not actually injured these risks reduce their comfort and require accommodation, forcing them to use less direct routes, or shifts from non-motorized to motorized modes. Roadway design factors such as road and lane widths; the presence and quality of sidewalks, paths and crosswalks; traffic signal cycles (such as whether they allow sufficient time for even slower walkers to cross streets); and traffic speeds often involve trade-offs between motor vehicle mobility and non-motorized safety.

Local Impact Analysis

Wider roads and increased motor vehicle traffic speed and volumes impose noise and air pollution, and accident risks on the neighborhoods through which they pass. These external costs (uncompensated costs that one person imposes on others) are unfair and inefficient. By favoring wider roads and faster motor vehicle travel, conventional planning favors through motorists over people who live and work in impacted neighborhoods, and tends to increase urban fringe property values at the expense of urban neighborhood property values. Complete streets tend to improve local access, safety, environmental quality and property values in existing urban areas, which tends to increase economic efficiency and social equity.

Planning practices which arbitrarily favor automobile travel over walking, cycling and public transport (for example, roadway level-of-service indicators that account for motor vehicle delays but ignore delays to pedestrians and cyclists; and funding practices that dedicate funds for roads and parking facilities that cannot be used for sidewalks, bike facilities or public transit) are inherently unfair, and are regressive since many non-drivers are physically, economically and socially disadvantaged people. Complete streets help achieve equity objectives by giving non-drivers a fair share of public road space, by reducing the risks that motor vehicles impose on pedestrians and cyclists, and by improving affordable mobility and accessibility options for disadvantaged people. In a typical community, 20-40% of the population cannot drive due to age, poverty or physical impairment and so depend significantly on walking, cycling and public transport. In automobile dependent communities, non-drivers often depend significantly on automobile travel – they are often chauffeured by family members and friends – but that is not optimal; there is usually significant latent demand for alternative modes. The conceptual test for the fair allocation of resources between non-drivers and motorists is the non-automobile mode share that *would occur* if walking, cycling and public transport received as much priority as automobile travel in roadway design and management.

People sometimes assume that roadway facilities are financed by motor vehicle user fees, such as fuel taxes and tolls, so roadway design and management should favor motorists, but this is untrue. User fees finance only about half of all roadway costs (Subsidy Scope 2009), and local roads, where most complete streets projects are implemented, are almost completely financed by local property and sales taxes, which all residents pay regardless of how they travel. As a result, complete streets help achieve horizontal equity objectives by giving non-drivers a greater share of the public roadways they help finance.

Complete streets are one of most practical ways that governments can improve transport equity: they insure that all residents enjoy safe, comfortable and affordable access.

Optimal Road Space Allocation

Urban road space is a scarce and valuable resource. How roads are designed and management represents an allocation of this resource to various uses that should balance various planning objectives:

- Overall accessibility
- Cost effective mobility
- Fairness and basic mobility for non-drivers
- Safety
- User experience and aesthetics
- Local economic development

Optimal balance should reflect long-term consumer demands (the type of travel that people would choose in a particular situation) and strategic planning objectives, such as improving accessibility, safety, economic development, and basic mobility. The optimal mode share for urban arterials is typically about a third each for automobile, bus and non-motorized travel, so approximately a third of road rights-of-way can be justified for each of these modes.

Current travel activity may fail to reflect true user demands since roadway planning often involves mutually-exclusive trade-offs between different types of travel. Conventional mobility-based planning has resulted in automobile-oriented transport and land use decisions which stimulate automobile travel and reduces the feasibility of other modes, creating a self-fulfilling prophecy. There is evidence of significant latent demand for alternative modes and more multi-modal neighborhoods, if the resources currently devoted to automobile traffic are reallocated to supporting other modes. This is not to suggest that in an optimal system automobile travel would disappear - but it would probably be significantly less than what occurs in most cities. In an optimal system, with efficient pricing, neutral policies and least-cost planning, people would probably drive less, rely more on alternative modes and choose more accessible, multi-modal neighborhoods than they do now.

More comprehensive planning supports complete streets policies. Design changes such as wider sidewalks, better crosswalks, lower traffic speeds, bike- and bus-lanes should be evaluated based on the levels of walking, cycling and public transit travel that would occur on those roadways *after* reforms are completed and supported by appropriate policy and planning reforms. For example, bus lanes are justified on arterials where more than 20 transit buses per peak-hour would be justified after the lanes are established and supported by policy reforms such as commute trip reduction programs, efficient parking management, and transit-oriented development - rather than based on current travel activity.

Conclusions

Conventional transport planning assumes that a street's users consist primarily of motorists driving through or parking on a roadway. Complete streets planning recognizes that users can also include pedestrians and cyclists who travel along or across the street; people standing, sitting and playing along a road; and nearby businesses, residents and property owners impacted by road traffic. It recognizes the full range of trade-offs involved in roadway design and space allocation, and so supports efforts to reduce the negative impacts of high traffic urban streets.

Complete streets planning is a practical way to create more multi-modal transport systems and more livable communities. Conventional planning evaluates transport system performance based primarily on motor vehicle traffic speeds, which favors hierarchical road networks, wider streets and higher traffic speeds. It overlooks the tendency of these features to increase travel distances and creates barriers to non-motorized travel, and therefore ways they reduce accessibility. Complete streets planning supports more connected road networks, narrower roadways, lower traffic speeds and improvements to alternative modes. This tends to reduce vehicle travel speeds and mobility, but improves other forms of accessibility by improving transport options and encouraging more compact development with shorter trip distances.

By reducing traffic speeds, improving transport options and supporting compact development, complete streets planning helps achieve various objectives including improved user comfort and enjoyment, improved accessibility for non-drivers, road and parking facility savings, consumer savings and affordability, improved public fitness and health, energy conservation, noise and air pollution emission reductions, and reduced sprawls. It can also help achieve social equity objectives: it insures that public roads serve all community members, reduces risks that motor vehicles impose on pedestrians and cyclists, and benefit physically, economically and socially disadvantaged people.

Conventional transport project economic evaluation tends to exaggerate the benefits of roadway expansion and undervalue many complete streets benefits. More comprehensive analysis that considers more objectives, impacts and options can help identify truly optimal urban street designs. Methods exist for quantifying and monetizing many currently overlooked complete streets benefits – they should be applied in roadway project economic evaluation.

Complete streets main cost is a reduction in arterial traffic speeds. Can cities function efficiently if arterial traffic speeds are reduced from 30-50 miles (50-80 kilometers) to 20-30 miles (30-40 kilometers) per hour? Yes, many of the world's most economically successful and livable cities operate with such speeds because lower automobile access is more than offset by improved access by other modes and more compact development that reduces travel distances required to reach services and activities.

Current demographic and economic trends are increasing demand for alternative modes and smart growth development which will increase complete streets benefits. Benefits can be further increased by integrating complete streets with other planning reforms including multi-modal transport planning, smart growth and New Urbanism, context-oriented planning, and transportation demand management.

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