VICTORIA Transport Policy INSTITUTE
EFFICIENCY • EQUITY • CLARITY

www.vtpi.org
Info@vtpi.org
250-360-1560

Economic Value of Walkability

24 July 2018

By
Todd Litman
Victoria Transport Policy Institute

Abstract

This paper describes ways to evaluate the value of walking (the activity) and walkability (the quality of walking conditions, including safety, comfort and convenience). Walking and walkability provide a variety of benefits, including basic mobility, consumer cost savings, cost savings (reduced external costs), efficient land use, community livability, improved fitness and public health, economic development, and support for equity objectives. Current transportation planning practices tend to undervalue walking. More comprehensive analysis techniques, described in this paper, are likely to increase public support for walking and other nonmotorized modes of travel.

Presented at the Transportation Research Board, 82nd Annual Meeting
January 2003, Washington, DC, Paper 03-2731, where it won the TRB Committee on Pedestrian's 2003 Outstanding Paper Award. Published in *Transportation Research Record 1828*, Transportation Research Board (www.trb.org), 2003, pp. 3-11 and in Volume 10, Number 1, 2004, of *World Transport Policy & Practice* (www.eco-logica.co.uk/WTPPhome.html).

Introduction

Non-motorized transport (walking, cycling and their variants) plays important and unique roles in an efficient transport system:

- Walking is a nearly universal human activity that provides mobility, exercise and pleasure.
- Typically 10-20% of trips are entirely by non-motorized modes, and most motorized trips involve non-motorized links, to access public transit and between parked cars and destinations. Parking lots, transport terminals, airports, and commercial centers are all pedestrian environments. Improving non-motorized is often one of the most effective ways of improving motorized transport.
- Walking and cycling provide affordable, basic transport. Physically, economically and socially disadvantaged people often rely on walking and cycling, so improving non-motorized transport can help achieve social equity and economic opportunity objectives.
- Active transport is the most common form of physical exercise. Increasing walking and cycling is often the most practical way to improve public fitness and health.
- Non-motorized modes can achieve transport planning objectives including reduced traffic and parking congestion, energy consumption and pollution emissions. They can also help achieve land use planning objectives, such as urban redevelopment and more compact "smart growth" development.
- Pedestrian environments (sidewalks, paths and hallways) are a major portion of the public realm. Many beneficial activities (socializing, waiting, shopping and eating) occur in pedestrian environments, and so are affected by their quality. Shopping districts and resort communities depend on walkable environments to attract customers.
- Walking and cycling are popular recreational activities. Improving walking and cycling conditions provides enjoyment and health benefits to users, and it can support related industries, including retail, recreation and tourism.

Conventional planning tends to assume that transport progress is linear, with newer, faster modes replacing older, slower modes. This *series model* assumes that the older modes are unimportant, and so, for example, there is no harm if walking and cycling conditions decline provided that automobile travel conditions improve. From this perspective it is always undesirable to give walking priority over automobile travel.

Walk → Bike → Train → Bus → Car → Airplane

Walk + Bike + Train + Bus + Car + Airplane

Conventional planning often assumes a series model in which newer, faster modes replace slower modes, leading to reduced investment in walking and cycling facilities. In reality, slower modes such as walking and cycling continue to be important even as faster modes develop.

But there is plenty of evidence that even as motorized travel increases, people continue to walk and bicycle for both transportation and recreational purposes. In many situations the best way to improve urban transport is to improve walking and cycling conditions and restrict automobile travel. Although this does not increase travel speeds it improves the overall convenience, comfort and affordability of access to destinations.

Nonmotorized transportation tends to be more affordable and resource efficient than alternative forms of transportation and recreation, as summarized in Table 1. This is not to suggest that walking and cycling can serve every purpose, but it does highlight the potential financial and resources savings it can provide.

Table 1 **Non-motorized Transport Is Generally Cheaper Than Alternatives**

Affordable and Efficient	Expensive and Resource Intensive
Walk and bike for transport	Own and operate an automobile
Walk and bike for exercise	Join a health club
Walk and bike children to school	Chauffeur children to school
Build sidewalks	Build roads and parking facilities

Walking and cycling tend to be affordable compared with alternatives.

This high value placed on driving and low value placed on walking in conventional planning reflects how transport is measured (Litman, 2003). Most travel surveys undercount nonmotorized travel because they ignore short trips, non-work travel, travel by children, recreational travel, and nonmotorized links. For example, most travel surveys classify "auto-walk," or "walk-transit-walk" trips simply as "auto" or "transit" Walking links are often ignored even if they take place on public rights-of-way and involve as much time as motorized links. If instead of asking, "What portion of trips *only* involve walking," we ask, "What portion of trips involves *some* walking," walking would be recognized as a common and important mode. For example, although only 7% of Canadian urban commutes are entirely by walking, about three times as many involve a walking link (Table 2). Similarly, in Germany only 22% of trips are completely by walking, but 70% include some walking (Brog, Erl and James 2003).

Table 2 **Commute Trips By Mode** (Statistics Canada 1992)

	Car Only	Walking All or Part	Transit All or Part
Winnipeg	73%	16%	15%
Vancouver	72%	20%	12%
Calgary	72%	21%	12%
Canada	69%	22%	10%
Toronto	61%	24%	20%
Ottawa	60%	33%	16%
Average	*68%*	*23%*	*14%*

Although only 7% of urban commutes are entirely by walking, about 23% involve a walking link.

Similarly, conventional traffic surveys tend to ignore many types of pedestrian activity. For example, they often ignore people who are sitting or waiting on sidewalks, skaters and skateboarders, and people walking from cars or buses to buildings (Haze 2000). Some newer travel surveys attempt to record all nonmotorized travel (although participants often have trouble recording short walking trips, so they still tend to be undercounted). According to the 2009 *National Household Travel Survey*, 10.9% of personal trips are by walking and 1.0% are by bicycle, a 25% increase since 2001, and about twice as much as indicated by most travel surveys (Litman 2010b). One study found that the actual number of nonmotorized trips is six times greater than indicated by conventional surveys (Rietveld 2000).

According to a U.K. survey, walking represents 2.8% of total mileage, 17.7% of travel time, and 24.7% of trips, as indicated in Table 3. If measured simply in terms of distance, walking seems insignificant, but not if evaluated in terms of trips, travel time, or exposure to street environments. For example, on a particular street, nonmotorized travelers may constitute only 5% of person-trips but 40% of the person-minutes of exposure, due to their slower speeds, and taking into account people waiting at bus stops and standing in front of shop windows. Walking conditions therefore have a major impact on how people perceive the transportation system and the local environment, since we experience activities by the amount of time they take, not just distance traveled.

Table 3 **Average Annual Travel By Mode** (DfT 2003)

	Travel		Travel Time		Trips	
	Miles	*Percent*	*Hours*	*Percent*	*Trips*	*Percent*
Walk	192	2.8%	64	18%	245	25%
Bicycle	34	0.5%	5	1.3%	14	1.5%
Motorcycle/Moped	36	0.5%	1	0.4%	3	0.3%
Car or Truck Driver	3,466	51%	140	39%	401	41%
Car or Truck Passenger	2,047	30%	82	23%	226	23%
Other private vehicles	162	2.4%	7	1.9%	8	0.8%
Public Transit	897	13%	62	17%	92	9.3%
Totals	*6,833*	*100%*	*361*	*100%*	*990*	*100%*

Walking represents just 2.8% of personal mileage, but a much larger portion of travel time and trips.

This tendency to undervalue nonmotorized travel can be particularly harmful because transportation decisions often involve tradeoffs between different travel modes (Litman 2003b). Wide roads, high traffic speeds and large parking facilities create barriers to walking, so evaluation practices that undervalue walking tend to create automobile dependent communities ("Evaluating Nonmotorized Transportation," VTPI 2008).

Transportation planners have standard ways to evaluate motor vehicle traffic conditions and improvements. For example, computer models such as the *Highway Design and*

Maintenance Model (World Bank) and *MicroBENCOST* (TTI 1997) calculate the monetized (measured in monetary units) value of vehicle operating cost savings, safety benefits and travel time savings from roadway improvements. These economic evaluation models generally assume that society is better off if a person spends 5 minutes driving for an errand than 10 minutes walking or cycling, since it applies an equal or greater cost value to nonmotorized trips than motorized trips, only considers vehicle operating costs (vehicle ownership costs, and external impacts such as congestion and parking costs are ignored), and no value is assigned to the health and enjoyment benefits of nonmotorized travel. Such assumptions tend to skew countless planning decisions toward motorized travel at the expense of non-motorized travel. For example, it justifies expanding roadways to increase vehicle traffic capacity and speeds, requiring generous amounts of parking at destinations, and locating public facilities along busy suburban roadways, in order to facilitate automobile transportation although each of these tends to reduce walking accessibility.

These practices help justify roadway projects. Walkability is not as easily quantified and so tends to be undervalued in planning and economic evaluation. This:

- Shifts resources from walking facilities to roads and parking.
- Favors automobile-oriented land use patterns (wide roads, generous parking, low density, single-use) over pedestrian-oriented development.
- Undervalues traffic management practices that support walking, such as traffic calming.
- Undervalues pedestrian safety investments.

To their credit, many transportation professionals support walking more than is justified by their own evaluation practices. They intuitively know that transport diversity in general, and walking in particular, are important to society and so favor walkability improvements. Although most travel surveys indicate that only about 5% of trips are by walking, many local transportation agencies devote 10-15% of their resources to nonmotorized facilities and services. However, this occurs despite, rather than as a result of, conventional transportation survey data and evaluation methods.

This is a timely issue because there is increased recognition of the benefits of transportation diversity (Litman 2001a), and support for creating more walkable communities. Better tools for evaluating walkability can help with many transportation and land use planning decisions (Sælensminde 2002; Litman 2002).

This paper investigates the value of walking (the activity) and walkability (the quality of walking conditions, including factors such as the existence of walking facilities and the degree of walking safety, comfort and convenience). It identifies categories of economic benefits, describes how they can be measured, and the degree to which these are reflected in current transportation and land use planning. This paper can only provide a

general review of these issues – more research is needed to create practical tools that can be used by transport planners to quantify the full benefits of walkability.

Most analysis in this paper applies to any form of nonmotorized transportation, including cycling and skating and wheelchair use. For simplicity I use the term "walking" and "walkability", but readers may wish to substitute "nonmotorized travel" and "nonmotorized travel conditions" to be more inclusive.

How Walking Is Undervalued

There are several reasons that walking and walkability tend to be undervalued in conventional transport planning. Some of these are discussed below.

Difficult to Measure

Walking tends to be more difficult to measure than vehicle travel, and walkability tends to be more difficult to evaluate than motor vehicle traffic. As mentioned earlier, travel surveys often collect little information on total walking activity, and it is relatively easy to count vehicles, measure traffic speeds and incorporate vehicle travel into travel models. Walking is given little attention in most travel models. As a result, most walking is invisible to transportation planners. However, travel surveys can collect more detailed information on nonmotorized travel (for example, asking respondents to identify any walking trip on public right-of-way), and in recent years new techniques have been developed to better evaluate walkability ("Evaluating Nonmotorized Transport," VTPI 2008).

Low Status

Walking is generally considered a lower status activity compared with motorized travel. Civic leaders and transportation professionals generally prefer to be associated with improvements to air travel, driving conditions, and major transit service, since they are perceived as more important. Because it is used by lower-income people, walking tends to be stigmatized while motorized transport tends to be associated with success and progress.

Low Cost

One of the reasons that walking tends to be overlooked is that it is so inexpensive. As a result there is not an organized walking industry as with automobile, transit and air transport, and there is little dedicated funding. Improved walkability can provide consumer cost savings, but such avoided costs are difficult to predict and are often given little consideration.

Benefits Ignored

Conventional planning tends to ignore or undervalue benefits such as fitness and public health benefits of active transportation, enjoyment of walking and cycling, and improved mobility options for non-drivers. The role that nonmotorized travel plays in supporting public transit and rideshare travel is often overlooked. Many transportation economic evaluation models even ignore benefits such as reduced congestion, parking cost savings and consumer cost savings that result when travel shifts from driving to nonmotorized modes.

Taken For Granted ("It Will Take Care of Itself")

Decision-makers often take walking for granted and assume that it can take care of itself (Goodman and Tolley 2003). For example, it is possible to walk along roads that lack sidewalks, either in the roadway or on dirt paths that develop along road shoulders. As a result, walk and cycling facilities are often given low priority. Such insensitivity to walking conditions is misplaced: areas with poor walkability tend to have significantly less walking and more driving than more walkable areas.

Categories of Economic Impacts

Economics refers to the allocation of valuable resources. This can include both market resources (money, labor and land) and nonmarket resources (safety, clean air, wildlife habitat and aesthetic features). *Economic impacts* refers to benefits and costs, that is, an increase or reduction in resource value.

This section describes major categories of economic impacts associated with walking, the degree to which they are recognized in current transport evaluation, and how they can be evaluated (Litman 2002a; "TDM Evaluation," VTPI 2008; Litman 2009). The *Active Transport Quantification Tool* (ICLEI 2007) provides a methodology for valuing the active transportation benefits, including savings from avoided driving, increased happiness, and reductions in coronary heart disease, diabetes risk, congestion, pollution and crash risk. The report, *Evaluating Public Transit Benefits and Costs* (Litman 2004b) provides similar analysis for transit economic evaluation, which provides a model and useful information for evaluating non-motorized transportation.

Accessibility

Accessibility (or just *Access*) refers to the ability to reach desired goods, services and activities (Litman 2003b). Walking is an important form of access, both by itself and in conjunction with other modes (transit, driving, air travel, etc.). Walking provides basic mobility, that is, many people rely on walking to access activities with high social value, such as medical services, essential errands, education and employment ("Basic Mobility," VTPI 2008). It is particularly important for people who are transportation disadvantaged (people with disabilities, elders, children, and people with low incomes). Poor walking conditions can contribute to *social exclusion*, that is, the physical, economic and social isolation of vulnerable populations. Pedestrian access to public transit is an important accessibility factor.

Evaluation Methods

Several methods can be used to evaluate walkability, taking into account the quality of pedestrian conditions and the geographic distribution of destinations (FDOT 2002; "Evaluating Nonmotorized Transportation," VTPI 2008). Accessibility can be evaluated using resident surveys, field surveys and Geographic Information Systems (GIS) to determine the portion of important destinations (medical services, shops, schools, jobs, government offices, etc.) that can be conveniently reached by walking or walk-transit-trips, particularly by disadvantaged populations. The value of marginal changes in walking conditions can be quantified using contingent valuation surveys to determine the value people place on improved pedestrian accessibility, and cost savings compared with other access options (such as driving).

Consumer Cost Savings

Walkability affects consumer transport costs. Improved walkability allows consumers to save on vehicle expenses ("Affordability," VTPI 2008). For example, one study found that households in automobile-dependent communities devote 50% more to transportation (more than $8,500 annually) than households in communities with more accessible land use and more multi-modal transportation systems (less than $5,500 annually) (McCann 2000).

Evaluation Methods

Consumer savings from improved walkability can be evaluated based on potential transportation cost savings. For example, walkability improvements that allow more people to walk or ride transit, rather than drive, can reduce vehicle ownership and operating costs.

At a minimum, shifting reduced driving saves fuel and oil, which typically total about 10-15¢ per vehicle-mile reduced, and more under congested conditions. Vehicle operating cost savings can be particularly large because walking tends to substitute for short trips when vehicle engines are cold, during which they are less efficient. In addition, depreciation, insurance and parking costs are partly variable, since increased driving increases the frequency of vehicle repairs and replacement, reduces vehicle resale value, and increases the risks of crashes, traffic and parking citations. These additional mileage-related costs typically average 10-15¢ per mile, so cost savings total 20-25¢ per mile reduced. Savings are greater if improved travel options allow a household to own fewer vehicles. Potential savings are summarized in the table below.

Table 4 **Potential Vehicle Cost Savings** ("Vehicle Costs," VTPI 2008)

Category	Description	How It Can Be Measured	Typical Values
Vehicle Operating Costs	Fuel, oil and tire wear.	Per-mile costs times mileage reduced.	10-15¢ per vehicle-mile. Higher in congestion.
Long-Term Mileage-Related Costs	Mileage-related depreciation, mileage lease fees, user costs from crashes and tickets.	Per-mile costs times mileage reduced.	10¢ per vehicle-mile.
Special Costs	Tolls, parking fees, Parking Cash Out, PAYD insurance.	Specific market conditions.	Varies.
Vehicle Ownership	Reductions in fixed vehicle costs.	Reduced vehicle ownership times vehicle ownership costs.	$3,000 per vehicle-year.
Residential Parking	Reductions in residential parking costs due to reduced vehicle ownership.	Reduced vehicle ownership times savings per reduced residential parking space.	$100-1,200 per vehicle-year.

Reducing automobile travel can provide a variety of consumer savings. (2001 U.S. dollars).

The "Costs of Driving" and "Affordability" chapters of the *Online TDM Encyclopedia* (VTPI 2008), and the "Vehicle Costs" chapter of *Transportation Cost and Benefit Analysis* (Litman 2009) provide additional information on potential cost savings.

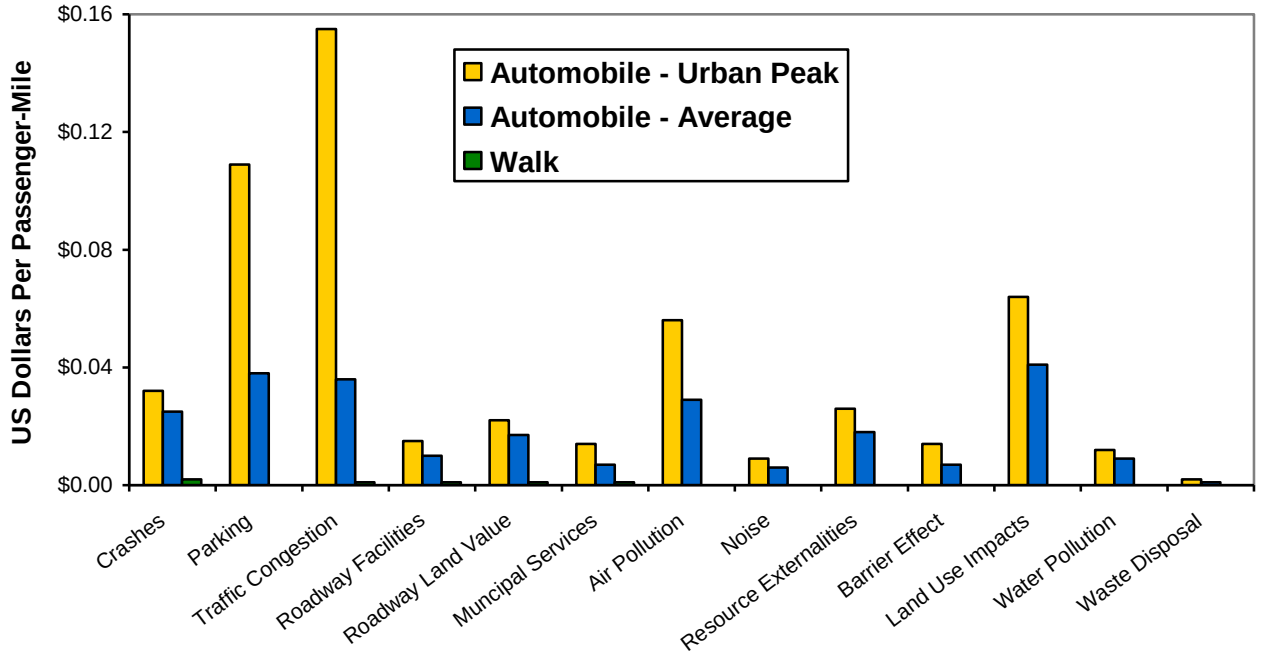
Public Cost Savings (Reduced Transport Externalities)

Motor vehicle use imposes various public costs for road and parking facilities, traffic congestion, crash risk, and environmental damages (Murphy and Delucchi 1998; Litman 2010). Shifting travel from motorized to non-motorized modes reduces these external costs. Walking substitutes for relatively short vehicle trips, which tend to have high costs per vehicle-mile. In particular, energy consumption and pollution emissions are several times higher than average for short trips when engines are cold, and parking costs are high when measured per vehicle-mile, since these costs are divided into few miles. A short walking trip often substitutes for a longer motor vehicle trip. As a result, each percentage shift of vehicle trips to walking can reduce transport external costs by several percentage points, particularly under urban-peak conditions when emission and parking costs are high.

Evaluation Methods

A variety of methods are used to calculate the external cost savings that result when travel shifts from driving to non-motorized modes (Litman 2009). Figure 1 illustrates one comparison of the estimated external costs of driving and walking. Shifting travel from driving to walking can help reduce various external costs, providing savings estimated to average approximately 25¢ per vehicle-mile reduced, and 50¢ per vehicle-mile reduced under urban-peak conditions.

Figure 1 **Estimated External Costs of Automobile Travel and Walking** (Litman 2009)



This figure compares the estimated external costs of automobile and pedestrian travel. Shifting from driving to walking provides savings averaging approximately 25¢ per vehicle-mile reduced, and 50¢ per vehicle-mile reduced under urban-peak conditions.

Land Use Efficiency

Low-density development with large amounts of land paved for roads and parking imposes various economic, social and environmental costs (Appleyard 1981; Burchell 1998; Litman 2002; "Land Use Evaluation," VTPI 2008; USEPA 2001). Walkability improvements can help reduce these costs by reducing the amount of land required for transport facilities and encouraging more accessible, clustered land use patterns, and supporting Smart Growth development patterns (Ewing, Pendall and Chen 2002; "Smart Growth," VTPI 2008). This provides economic, social and environmental benefits.

Evaluation Methods

There are many factors to consider when evaluating the impacts of transportation decisions on land use patterns. Evaluating these impacts requires:

1. An understanding of how transportation in general, and walkability in particular, affect land use patterns (Litman 2002). Compared with driving, walking requires far less space for travel and parking, does not require building setbacks to mitigate traffic noise, and encourages more clustered development patterns. As a result, walkable communities can devote less land to pavement and tend to result in higher development densities than is common with more automobile-oriented transport systems, reducing per capita land consumption.
2. An understanding of the economic impacts of different types of land use patterns, including the economic, social and environmental benefits from reduced impervious surface (Arnold and Gibbons 1998) and more clustered development patterns (Burchell, et al. 1998). The table below summarizes various land use benefits from improved walkability. Not every walkability improvement provides every one of these benefits, but in general, a more walkable community will achieve most of them.

Table 5 **Land Use Benefits of Improved Walkability**

Economic	Social	Environmental
Improved accessibility, particularly for non-drivers.		
Reduced transportation costs.		
Increased parking efficiency (parking facilities can serve more destinations).	Improved accessibility for people who are transport disadvantaged.	
Can increase local business activity and employment.	Reduced external transportation costs (crash risk, pollution, etc.).	Reduced land needed for roads and parking facilities.
Support for transit and other alternative modes.	Increased neighborhood interaction and community cohesion.	Openspace preservation.
Special support for some businesses, such as walking tourism.	Improved opportunities to preserve cultural resources (e.g., historic buildings).	Reduced energy consumption and pollution emissions.
Health cost savings from improved exercise.	Increased exercise.	Improved aesthetics.
		Reduced water pollution.
		Reduced "heat island" effects.

This table summarizes various benefits from a more walkable community.

Community Livability and Cohesion

Description

Community Livability refers to the environmental and social quality of an area as perceived by residents, employees and visitors (Weissman and Corbett 1992; "Livability," VTPI 2008). *Community cohesion* (also called *social capital*) refers to the quality of relationships among people in a community, as indicated by the frequency of positive interactions, the number of neighborhood friends and acquaintances, and their sense of community connections, particularly among people of different economic classes and social backgrounds (Forkenbrock and Weisbrod, 2001). These are valuable themselves and can provide indirect benefits including increased safety and health, and increased property values and economic development (CTE 2007; Litman 2011).

Walkability has major impacts on community livability. Streets are a major portion of the public realm, that is, places where people interact with their community. More attractive, safe and walkable streets increase community livability (Forkenbrock and Weisbrod 2001). Residents on streets with higher traffic volumes and speeds are less likely to know their neighbors, and show less concern for their local environment, than residents on streets with less vehicle traffic (Appleyard 1981).

Evaluation Methods

Community livability and cohesion provide various direct and indirect benefits. It can affect property values and business activity in an area, which can be measured with various techniques such as hedonic pricing and contingent valuation (LGC 2001; Litman 2009). This may not reflect total livability benefits, since benefits to non-residents are not necessarily reflected in property values. The value of walkability varies, depending on several factors:

- Pedestrian-friendly, new urbanist community design tends to increase property values (Eppli and Tu 2000).
- In automobile dependent areas, sidewalks may have little effect on adjacent property values.
- Reduced vehicle traffic can increase adjacent property values, in part, because it improves walking safety and comfort (Bagby 1980).
- Proximity to public trails often increases residential and commercial property values (NBPC 1995).

To the degree that improved walkability increases community cohesion, it may help reduce crime and other social problems in an area (Litman 2002). However, such relationships are difficult to measure and walkability is just one of many related factors that affects community cohesion.

Health

Physical Activity refers to physical exercise. Inadequate physical activity is a major contributor to health problems (Litman 2004). Health experts recommend at least 30 minutes of moderate exercise a day, at least 5 days a week, in intervals of ten-minutes or more (Surgeon General 1999).

Diseases Associated With Physical Inactivity (Killingsworth and Lamming 2001)

- Heart disease
- Hypertension
- Stroke
- Diabetes
- Obesity
- Osteoporosis
- Depression and dementia
- Some types of cancer

An increasing portion of the population, including many children, lack regular physical activity. Although there are many ways to be physically active, walking is one of the most practical ways to increase physical activity among a broad population. Walking tends to be particularly important for elderly, disabled and lower-income people who have few opportunities to participate in sports or formal exercise programs. Health experts believe that more balanced transportation systems can contribute to improved public health by accommodating and encouraging active transport (Sallis, et al. 2004; Bassett, et al. 2008).

A few published studies have quantified the health benefits of transport and land use planning decisions that increase physical activity ("Safety and Health," Litman 2009). Boarnet, Greenwald and McMillan (2008) develop a framework for quantifying the value of reduced mortality from urban design improvements that increase walking activity. The table below summarizes the estimated benefits of various changes in neighborhood walkability factors from a median to the seventy-fifth (lower value) and ninety-fifth (higher value) percentile, for example, if the number of intersections within ½ mile increased by 0.3816 (lower value) or 1.1844 (higher value), for a hypothetical 5,000 resident neighborhood.

Table 6 **Health Benefits From Various Neighborhood Walkability Changes** (Boarnet, Greenwald and McMillan 2008)

Neighborhood Walkability Changes	Total Benefits		Per Capita Benefits	
	Lower	Higher	Lower	Higher
Increase number of intersections within ½ mile	$2,255,107	$23,205,007	$451	$4,641
Increased retail employment density	$466,574	$18,331,955	$93	$3,666
Increased employment density	$155,525	$19,492,206	$31	$3,898
Increased Population density	$1,555,247	$8,353,802	$311	$1,671
Distance from central business district	$4,510,215	$61,725,318	$902	$12,345

This table summarizes the estimated value of health benefits from neighborhood design changes that increase per capita walking activity. "Lower" and "Higher" values indicate the range from sensitivity analysis using higher- and lower-bound assumptions.

Of people with safe places to walk within ten minutes of home, 43% achieve recommended activity levels, compared with just 27% of those who lack safe places to walk (ECU 2004b). Tomalty and Haider (2009) evaluated how community design factors (land use density and mix, street connectivity, sidewalk supply, street widths, block lengths, etc.) and a subjective *Walkability Index* rating (based on residents' evaluations) affect walking and biking activity, and health outcomes in 16 diverse neighborhoods. The analysis reveals a statistically significant association between improved walkability and more walking and cycling activity, lower body mass index (BMI), and lower hypertension. Regression analysis indicates that people living in more walkable neighbourhoods are more likely to walk for at least 10 daily minutes and are less likely to be obese than those living in less walkable areas, regardless of age, income or gender.

Stokes, MacDonald and Ridgeway (2008) developed a model to quantify public health cost savings from a new light rail transit system in Charlotte, NC. Using estimates of future riders, the effects of public transit on physical activity (daily walking to and from the transit stations), and area obesity rates they estimate the potential yearly public health cost savings from this project. They estimate that the light rail system would provide cumulative public health cost savings of $12.6 million over nine years. Land Transport New Zealand's *Economic Evaluation Manual* (EEM) provides monetary values for the health benefits of active transportation resulting from both TDM measures and active transportation infrastructure (LTNZ 2010). It assumes that half of the benefit is internal to the people who increase their activity level by walking or cycling, and half are external benefits to society such as hospital cost savings. The values for cyclists and pedestrians are shown in the table below.

Table 7 **Active Transportation Health Benefits** (LTNZ 2010)

		Internal	External	2007 USD/mile
Cycling	low	0.05	0.05	0.10
	mid	0.10	0.10	0.19
	high	0.19	0.19	0.38
Walking	low	0.12	0.12	0.24
	mid	0.24	0.24	0.48
	high	0.48	0.48	0.96

These values reflect the health benefits of increased walking and cycling for economic analysis.

Walking has a relatively high crash fatality rate per mile of travel, but this is offset by reduced risk to other road users and by the fact that pedestrians tend to travel less overall than motorists (for example, a walking trip to a local store often substitutes for a longer car trip to a more distant shopping center). International research suggests that shifts to nonmotorized transport increases road safety overall (Litman and Fitzroy 2005; "Safety Evaluation," VTPI 2008). For example, the Netherlands has a high level of

nonmotorized transport, yet per capita traffic deaths and the cyclist death rate per million km ridden is much lower than in more automobile dependent countries (Pucher and Dijkstra 2000).

Evaluation Methods

Public surveys can be used to determine the degree that people in an area rely on walking for exercise, and the degree to which improved walkability would increase physical activity by otherwise sedentary people (Boarnet, Greenwald and McMillan 2008). The "Safety and Health" chapter of *Transportation Cost and Benefit Analysis* (Litman 2009) contains more information on methods for quantifying these benefits.

Economic Development

Economic Development refers to progress toward a community's economic goals, including increases in economic productivity, employment, business activity and investment (Litman 2011). Walkability can affect economic development in several ways (LGC 2001; Leinberger and Alfonzo 2012).

Tolley (2011) evaluated the impacts on to retailers and local residents from improving commercial street walking and cycling conditions. He found that streetscape enhancements that improve walking and cycling conditions tend to increase property values and rents, attract new businesses, and increase local economic activity. Analyzing bicycle and automobile parking space requirements he concluded that bicycle parking can produce much higher levels of retail spend than the same space devoted to car parking. He also concluded that a large proportion of retail expenditure comes from local residents and workers, many of whom walk or bicycle, in contrast to car-borne customers who are more likely to be "drive-through" shoppers, stopping to pick up one item on the way to another destination.

The New York City Department of Transportation includes indicators of economic vitality (sales tax receipts, commercial vacancies, number of visitors) when evaluating street redesigns that add walking, cycling and public transit facilities, change traffic speeds or change vehicle parking conditions (NYCDOT 2013). In several examples, walking, cycling and public transit improvements have improved economic performance:

- Establishing bike paths on 8th and 9th Avenues in Manhattan increased local business retail sales up to 49% compared with 3% borough-wide.
- Expanding walking facilities in Union Square North (Manhattan) reduced commercial vacancies 49%, compared to a 5% increase borough-wide.
- Converting an underused parking lot into a public park on Pearl Street (Brooklyn) increased nearby retail sales volumes by 172%, compared to 18% borough-wide.
- Converting a curb lane into a public seating area on Pearl Street (Manhattan) increased sales volumes at adjacent businesses by 14%.
- Establishing a bus lane and other bus transit improvements on Fordham Road (Bronx) increased nearby retail sales 71% compared to 23% borough-wide.

- Developing bus- and bike-lanes on First and Second Avenue reduced commercial vacancy rates 47%, compared with 2% borough-wide.

Pedestrian-friendly commercial districts ("Mainstreets") can be important for urban revitalization (Tyler 1999; Bohl 2002; "Downtowns," VTPI 2008). Research by Hack (2013) indicates that walkable shopping areas are often economically successful, improved walkability tends to increase commercial and residential land values, many want to live within walking distances of commercial services, and that current market trends are likely to increase demand for walkable shopping districts.

People often overestimate the importance of shoppers motor vehicle access, and therefore vehicle parking, and underestimate the value of access by walking, cycling and public transport. For example, a survey of customers at New York City shopping street found that a minority drive, and that shifting street space from vehicle parking to pedestrians would likely increase total business activity in the area. Shoppers who value wider sidewalks over parking spent about five times as much money, in the aggregate, as those who value parking over sidewalks (Schaller Consulting 2006).

Rowe (2013) used retail sales data (based on sales tax receipts) to analyze the impacts that development of bike lanes, and the resulting loss of some on-street parking spaces, had on local business districts in Seattle, Washington neighborhoods. The results indicated substantial (up to 400%) increases in sales volumes after bicycle lane installation.

Another study (Sztabinski 2009) examined the impacts of proposed bike lanes on retailers along Toronto, Canada's Bloor Street. The analysis indicated that expanding sidewalks, and adding bicycle and bus lanes tends to support local economic development, even if it reduces on-street parking. It found that:

- 90% of customers walk, bike or travel by public transit to shops.
- Even during peak periods no more than about 80% of metered parking spaces on the street are occupied.
- Although customers who arrive by automobile spend more per trip on average, customers who arrive by foot and bicycle visit the most often and spend most per month on average.
- More merchants who believe that a bike lane or widened sidewalk would increase business than merchants who think those changes would reduce business.
- The loss of on-street parking required for a bike lane or wider sidewalks could easily be accommodated in nearby off-street parking lots.

A study of consumer expenditures in British towns found that customers who walk spend more per week than those who drive, and transit and car travelers spend similar amounts.

Table 8 **Consumer Expenditure by Mode** (Accent Marketing & Research)

Mode	Weekly Expenditures
Bus	£63
Car	£64
On foot	£91
Train/tube	£46
Other (taxi, cycle...)	£56

This survey found higher weekly expenditures by consumers who travel by walking than those who drive or rider transit to downtown shopping districts in the UK.

Expenditures on fuel and vehicles tend to provide relatively little employment and business activity compared with other common consumer expenditures ("TDM and Economic Development," VTPI 2008; Litman, 2004b). Walking that substitutes for driving, and therefore reduces fuel consumption and dependency on fuel and vehicles imported from other regions tends to provide economic development benefits.

Evaluation Methods

Walkability can affect economic development in several ways, each must be considered separately (Litman 2002; "TDM and Economic Development," VTPI 2008). Market surveys and property assessments can be used to identify how walkability factors affect commercial activity (such as retail sales), consumer satisfaction, competitiveness, employment, tax revenue, and property values in an affected area. Economic analysis techniques using input-output tables can be used to determine how changes in consumer expenditures affect regional employment and business activity (Weisbrod 2000).

Economic Opportunity and Resilience

Gilderbloom, Riggs and Meares (2015), and Won, Chanam and Li (2017) indicate that more walkable neighborhoods have lower housing foreclosure rates.

Social Equity

Equity refers to the distribution of resources and opportunities. Transport decisions can affect equity in various ways. There are several different equity issues, including *horizontal equity* (which assumes that people should generally be treated equally), and *vertical equity* (which assumes that society should provide extra support to disadvantaged people) (Litman 2001). Walkability can help achieve various equity objectives including a fair distribution of public resources to non-drivers, financial savings and improved opportunity for people who are physically and economically disadvantaged, and basic mobility.

Evaluation Methods

Because there are different types of equity, several factors should be considered when evaluating transportation equity impacts. The table below describes five equity

indicators that can be used to evaluate the overall equity impacts of changes in walkability.

Table 9 **Equity Summary** ("Equity Evaluation," VTPI 2008)

Indicator	Description
Treats everybody equally.	This reflects whether a policy treats each group or individual equally.
Individuals bear the costs they impose	This reflects the degree to which user charges reflect the full costs of a transportation activity.
Progressive with respect to income	This reflects whether a policy makes lower-income households better or worse off.
Benefits transportation disadvantaged	Whether a policy makes people who are transportation disadvantaged better off by increasing their options or providing financial savings.
Improves basic mobility and access	This reflects whether a policy favors more important transport (emergency response, commuting, basic shopping) over less important transport.

This table describes five indicators of transportation equity that can be used when evaluating walkability equity impacts.

The most practical approach to evaluating equity impacts is to define equity objectives and performance indicators, and then evaluate the degree to which a particular policy or project helps achieve them ("Transportation Planning," VTPI 2008). Equity benefits are difficult to monetize (there is no easy way to add equity benefits to other benefits such as vehicle cost savings or increased property values), but most communities seem to place a high value on achieving equity objectives (Forkenbrock and Weisbrod 2001).

Summary of Economic Impacts

Table 10 summarizes the categories of economic benefits described above that should be considered when evaluating walking. In most situations, several impacts should be considered, with results added to determine total benefits. For example, a particular walkability improvement may improve accessibility, provide consumer cost savings, increase community livability (and therefore local property values), improve public fitness and health, benefit the local economy (increasing employment, tax revenue and property values), and support strategic land use and equity objectives. The project's full value is the sum of these individual benefits.

Table 10 **Walkability Economic Impacts**

Name	Description	Measuring Techniques
Accessibility	Degree that walking provides mobility options, particularly for people who are transportation disadvantaged.	Travel modeling, analysis of travel options.
Consumer cost savings	Degree to which walking provides consumer transportation cost savings.	Consumer expenditure surveys
Public cost savings (reduced external costs)	Degree that walking substitutes for vehicle travel and reduces negative impacts.	Determine to what degree walking reduces motor vehicle travel, and the economic savings that result.
Efficient land use	Degree that walking helps reduce the amount of land used for roadway and parking facilities, and helps create more accessible, clustered land use.	Identify the full economic, social and environmental benefits of more pedestrian-oriented land use.
Livability	Degree that walking improves the local environment.	Property values, business activities, consumer preference surveys.
Public fitness and health	Degree that walking provides physical exercise to people who are otherwise sedentary.	Travel and health surveys to determine the number of people who benefit from walking exercise.
Economic development	Degree to which walking makes commercial areas more attractive and shifts consumer expenditures to goods that provide more regional economic activity and employment.	Market surveys and property assessments. Input-output table analysis.
Equity	Degree that walkability helps achieve various equity objectives.	Various indicators of horizontal and vertical equity.

This table summarizes various categories of impacts to consider when evaluating walking.

Planning Applications

The value of walkability can be incorporated into transport planning decisions in various ways, reflecting various perspectives and assumptions. Three approaches are described below.

Proportional Share

One approach that many people seem to consider fair and efficient is to allocate transport resources (money, land, public services, etc.) based on each mode's share of travel activity. For example, a mode which represents 2% of travel should receive about 2% of resources, and a mode which represents 20% of travel should receive 20% of resources.

As discussed earlier in this paper, conventional travel surveys undercount walking. Although only about 5-10% of trips are made completely by walking, 15-30% of urban trips involve at least one walking link. By this measure, a major share of transport resources should be devoted to walking.

Walking only represents a small portion of total person-mileage. However, a short walking trip often substitutes for a longer automobile trip. For example, consumers may choose between walking to a nearby store or driving to a supermarket. Motorists tend to travel far more (about 3 times as much on average) as non-motorists. There is no obvious reason that society should subsidize automobile trips and motorists at a greater rate than walking trips and non-drivers.

It is difficult to know exactly what portion of transport funds are devoted to non-motorized facilities, since this is not usually separated in transportation budgets. Local governments devote a relatively large portion of infrastructure funds to walking facilities, perhaps 5-15% of transportation agency budgets, and somewhat more if recreational trail expenditures are also included. However, other levels of government provide much less support. For example, the state of Oregon is considered a leader in nonmotorized planning because it devotes 2% of state transport funds to walking and cycling facilities. Most states probably spend less than 1% of their transport budgets on walking facilities. The table below illustrates the estimated portion of transport expenditures devoted to walking, using upper-bound values (actual numbers are probably smaller). By this estimate, walking receives somewhat less than its proportion of trips as measured by conventional travel studies, and far less than indicated by more comprehensive counts.

Table 11 **U.S. Roadway Expenditures** (Based on FHWA 2000; FHWA 2004)

	Roadway Expenditures (billions)	**Walking Facility Expenditures** (billions)	**Estimated Portion Devoted To Walking**
Federal	$30.8	$0.42 ÷ 2 = $0.21	0.6%
State	$66.4	$0.7	1%
Local	$31.3	$3.1	10%
Totals	*$128.5*	*$4.6*	*3.5%*

This table shows the estimated portion of roadway expenditures devoted to walking. Federal Bike/Ped projects total $423 million. Assuming half is devoted to walking, this represents 0.6%.

This discrepancy between the portion of travel by walking and the portion of resources devoted to walking becomes far larger when other public resources devoted to transport are included, such as expenditures on parking facilities and traffic services, and the opportunity cost of public lands devoted to roadways.

There are many reasons to criticize the assumption that each mode should receive its proportional share of transport resources. It is backward looking, reflecting the transportation patterns resulting from past decision, rather than forward looking, reflecting the transportation system society wants in the future. Some modes provide special social benefits, bear special costs, or reduce externalities. There are several reasons that walkability improvements might deserve *more* than a proportional share of transportation resources:

- As described earlier, walking provides basic mobility and serves trips with high social value.
- Walking is particularly important for people who are transportation disadvantaged. Walkability improvements provide equity benefits, and bear special costs associated with serving people with disabilities.
- Some walking facility improvements can be included in other transport budgets (e.g., transit facilities, airports, parking facilities, ferry terminals, etc.) because they serve these modes.
- Walking provides both transportation and recreation benefits. It therefore deserves funding from both transportation and recreation budgets. For example, it may be appropriate to devote 10% of a jurisdiction's transportation budget *and* 20% of its recreation budget to pedestrian facilities.

If we apply the principle that each mode should receive its proportional share of transportation resources, this suggests that walking should receive 10-20% of *total* transportation resources (not just municipal transport agency funds), five to ten times what is currently devoted to walking facilities and services, in addition to a significant share of recreational funding.

Cost Allocation

Transportation cost allocation evaluates to what degree each user group pays its share of transportation facilities and services through special user charges such as road tolls, fuel taxes and vehicle registration fees (FHWA 1997; Litman 2009). This reflects the principles of horizontal equity (consumers should pay for what they get and get what they pay for unless a subsidy is specifically justified), and economic efficiency (prices should equal marginal costs) ("Market Principles," VTPI 2008).

Many people assume that because motorists pay fuel taxes and other roadway fees, nonmotorized modes underpay their fair share of transportation costs. This is not necessarily true. Although vehicle use fees fund major highways, local roads are funded through general taxes that residents pay regardless of how they travel, and motor vehicles impose other public costs besides roadway expenditures. An average household pays several hundred dollars annually in general taxes for local roads and traffic services, and pays hundreds of dollars in parking subsidies. When all impacts are considered, motorists generally underpay their share of costs, while walking receives less than its fair share of resources (Litman 2005; Litman 2009). The example below illustrates this point.

Example

Two neighbors each pay $300 annually in local taxes that fund transport facilities and services. Mike drives 10,000 miles annually on local roads, while Frances walks 3,000 miles. The table below compares their tax payments and transportation costs.

Table 12 **Local Transportation Payments and Costs**

	Mike	Frances
A. Annual local mileage	10,000	3,000
B. Household's general taxes used for road related services.	$300	$300
C. Motorist user fees spent on local road (0.2¢ per mile).	$24	$0
D. Total road system contribution (B + C)	$324	$300
E. Tax payment per mile of travel (B/A).	3.2¢	10¢
F. Roadway costs (cars = 5¢/ml, walking = 0.2¢/ml)	$500	$48
Net (D – F)	*Underpays $176*	*Overpays $252*

Non-drivers pay almost as much as motorists for local transportation facilities and services, but impose lower costs. As a result, they tend to overpay their fair share.

Although an *average* household pays its share of transport taxes, those who drive less than average subsidize their neighbors who drive more than average. These subsidies can be significant, totaling hundreds of dollars annually for somebody who relies primarily on nonmotorized transport. These cross subsidies are far greater when other external motor vehicle costs are also considered, such as public resources devoted to parking facilities, uncompensated crash damages, and environmental damages (Litman, 2009).

This suggests that applying cost allocation principles, motorists should pay significantly more than they currently do in user fees, and more resources should be devoted to nonmotorized transport facilities or nondrivers should receive tax discounts ("Market Reforms," VTPI 2008).

Benefit-Cost Analysis

A third approach to evaluating transportation policies and programs, and the approach that is considered best for maximizing efficiency, is benefit-cost analysis (Litman 2001b). This compares the incremental costs and benefits of a policy or project.

Benefit-cost analysis is applied to individual policies and projects, so it is difficult to make broad conclusions as to what effect its application would have on transport decision making. However, for reasons described below, it is likely that more rigorous application of benefit-cost analysis would tend to increase the resources devoted to walking.

- As described earlier, current transportation planning practices tend to undercount walking. Better counting of walking trips will tend to recognize more demand, and therefore greater potential benefits from walkability improvements.
- Few economic analyses account for the full range of benefits from improved walkability and increased walking described in this paper. More comprehensive analysis is likely to identify greater benefits and so justify greater investments.
- Only recently have nonmotorized evaluation tools been developed, such as pedestrian level-of-service rating. Applying such tools can improve our ability to predict how a particular policy or project will affect nonmotorized travel, which can justify greater investments in walkability.
- There is increasing recognition of the diminishing economic benefits from increased highway investments (Boarnet and Haughwout, 2000; "TDM and Economic Development," VTPI 2008), the significant social costs of automobile dependency, and the large potential social benefits of a more diverse transportation system (Litman, 2001a).
- There is increasing recognition of the value of smart growth land use management to achieve social objectives ("Smart Growth," VTPI 2008). These strategies place a high value on walkability.
- Current transportation funding is biased against nonmotorized modes. Only a small portion of total transport funds may be used for nonmotorized facilities, and financial match requirements are sometimes higher. More neutral investment policies would increase the amount of money available for walking.

More comprehensive benefit-cost analysis requires better techniques to measure and predict travel impacts of improved walkability, and to evaluate the full economic impacts that result, including indirect and nonmarket impacts that are not usually quantified in transport planning such as environmental, economic development and equity impacts.

Examples

The study, *Walking the Walk: How Walkability Raises Housing Values in U.S. Cities*, by Joseph Cortright (2009) found that improved walkability tends to increase home values. It analyzed 94,000 residential real estate transactions in 15 major U.S. markets to evaluate how various factors affect sale values, including conventional factors such as size, number of bedrooms and bathrooms, age, neighborhood income, distance from Central Business District, and access to jobs, plus Walk Score (www.walkscore.com), which calculates proximity to amenities (restaurants, coffee shops, schools, parks, stores, libraries, etc.) and assigns a rating from 0 (least walkable) to 100 (most walkable). Walk Scores of 70+ indicate neighborhoods where it's possible to get by without a car.

The study found that a one-point Walk Score increase is typically associated with an increase of $700 to $3,000 in house values, depending on the market. Shifting from average to above-average Walk Scores typically increased a home's value by $4,000 to $34,000, depending on the metro area. The gains were larger in denser, urban areas like Chicago and San Francisco and smaller in less dense markets like Tucson and Fresno.

For example, in Charlotte, NC, houses in the Ashley Park neighborhood, with Walk Score values averaging 54 have median prices of$280,000, while an otherwise similar home in the Wilmore neighborhood, which has Walk Scores averaging 71, would be valued at $314,000. Controlling for all other factors including size, number of bedrooms and bathrooms, age, neighborhood income levels, distance from the Central Business District and access to jobs, shifting a house from Ashley Park to more walkable Wilmore would increase its value by $34,000 or 12%.

Similarly, in analysis of Washington DC neighborhoods, Leinberger and Alfonzo (2012) found that as the number of urban design features that facilitate walkability and attract pedestrians increase, so do office, residential, and retail rents, retail revenues, and for-sale residential values. For example, a place with good walkability, on average, commands $302 per month more in residential rents and has for-sale residential property values of $82/sq. ft. more relative to the place with fair walkability, holding household income levels constant.

Balsas (2017) analyzed walking activity and recent efforts at augmenting walkability conditions in various cities using a WPPFUS framework which considers Walking levels, Purposes, Primacy of walking, Facilities, Unique features and Safety concerns. It recommends policies to make cities for people and not for automobiles and commitment to resolving pedestrian safety concerns, including improved design, planning, building and maintenance of streets and public spaces.

Conclusions

Conventional transportation planning practices treat walking as a minor transport mode and recognize only modest benefits from improved walkability and increased walking activity. This results from evaluation practices that undercount nonmotorized travel and undervalue walking benefits.

From other perspectives it is clear that walking is a critical component of the transport system, and that improved walkability and increased walking can provide significant benefits to society. Improved walkability increases accessibility, provides consumer and public cost savings, increases community livability, improves public health and supports strategic economic development, land use and equity objectives. A variety of methods can be used to evaluate these impacts.

Conventional planning practices may conclude that walking currently receives a fair and efficient share of transportation resources. However, this reflects an undercounting of walking trips, an undervaluation of walking benefits, and undervaluation of motor vehicle costs. More comprehensive evaluation indicates that walking receives less than its appropriate share of transportation resources, and that walkability improvements can provide a high economic return on investment.

Greater appreciation of the full benefits of walking could change planning priorities. It would justify devoting more government funding to walking facilities and programs, shifting road space from traffic and parking lanes to sidewalks and paths, policies to create more walkable land use patterns, and greater efforts to manage motor vehicle traffic to improve walking safety and comfort. These shifts support and are supported by other transport and land use management reforms that improve transportation options, reduce automobile dependency and create more accessible land use.

References

ABW (2010), *Bicycling and Walking in the U.S.: 2010 Benchmarking Report*, Alliance for Biking & Walking, (www.peoplepoweredmovement.org); at www.peoplepoweredmovement.org/site/index.php/site/memberservices/C529.

Donald Appleyard (1981), *Livable Streets*, University of California Press (Berkeley).

Chester Arnold and James Gibbons (1996), "Impervious Surface Coverage: The Emergence of a Key Environmental Indicator," *American Planning Association Journal*, Vol. 62, No. 2, Spring 1996, pp. 243-258. Also see *NEMO Project* (www.canr.uconn.edu/ces/nemo).

Austin (2000), *Transportation User Fee*, City of Austin Texas (www.ci.austin.tx.us/development/ldc1.htm).

Gordon Bagby (1980), "Effects of Traffic Flow on Residential Property Values," *Journal of the American Planning Association*, Vol. 46, No. 1, January, pp. 88-94.

Carlos J.L. Balsas (2017), "The Right to Walk in Cities, a Comparative Review of Macau, Lisbon and Las Vegas," *International Journal of Law in the Built Environment*, Vol. 9 Issue: 2, pp.123-142, (doi.org/10.1108/IJLBE-03-2017-0012); at https://doi.org/10.1108/IJLBE-03-2017-0012.

David Bassett, John Pucher, Ralph Buehler, Dixie L. Thompson, and Scott E. Crouter (2008), "Walking, Cycling, and Obesity Rates in Europe, North America, and Australia," *Journal of Physical Activity and Health*, Vol. 5 (www.humankinetics.com/jpah/journalAbout.cfm), pp. 795-814; at http://policy.rutgers.edu/faculty/pucher/JPAH08.pdf.

C.C. Bohl (2002), *Place Making: Developing Town Centers, Main Streets and Urban Villages*, Urban Land Institute (www.uli.org).

Marlon Boarnet (1995), "New Highways & Economic Productivity: Interpreting Recent Evidence," *Journal of Planning Literature*, Vol. 11, No. 4, May 1997, pp. 476-486, also available as Working Paper 291, University of California Transportation Center (www.uctc.net).

Marlon G. Boarnet, Michael Greenwald and Tracy E. McMillan (2008), "Walking, Urban Design, and Health: Toward a Cost-Benefit Analysis Framework," *Journal of Planning Education and Research*, Vol. 27, No. 3, pp. 341-358; at http://jpe.sagepub.com/cgi/content/abstract/27/3/341.

Werner Brog, Erhard Erl and Bruce James (2003), "Does Anybody Walk Anymore?," *Sustainable Transport: Planning for Walking and Cycling In Urban Environments* (Rodney Tolley Ed.), Woodhead Publishing (www.woodhead-publishing.com), pp. 59-69

BTS (2004), *National Household Travel Survey*, Bureau of Transport. Statistics (www.bts.gov).

Robert Burchell, et al. (1998), *The Costs of Sprawl – Revisited*, TCRP Report 39, Transportation Research Board (www.trb.org).

Richard Campbell and Margaret Wittgens (2004), *Business Case for Active Transportation: The Economic Benefits of Walking and Cycling*, Go For Green; Active Living & Environment Program (www.goforgreen.ca).

D. Carlson, L. Wormser, and C. Ulberg (1995), *At Road's End; Transportation and Land Use Choices for Communities*, Island Press (www.islandpress.org).

Joseph Cortright (2009), *Walking the Walk: How Walkability Raises Housing Values in U.S. Cities*, CEOs for Cities (www.ceosforcities.org); www.ceosforcities.org/files/WalkingTheWalk_CEOsforCities1.pdf.

CTE (Center for Transportation and the Environment) (2008), *Improved Methods For Assessing Social, Cultural, And Economic Effects Of Transportation Projects*, NCHRP Project 08-36, Task 66, TRB (www.trb.org), American Association of State Highway and Transportation Officials (AASHTO); at www.statewideplanning.org/_resources/234_NCHRP-8-36-66.pdf.

Decima Research (2000), *City of Toronto 1999 Cycling Study* (presentation); at www.toronto.ca/cycling/pdf/decimareport.pdf.

Marie Demers (2006), *Walk For Your Life! Restoring Neighborhood Walkways To Enhance Community Life, Improve Street Safety and Reduce Obesity*, Vital Health Publishing (www.vitalhealthbooks.com/book/2414947630.html).

DfT (2003), *2003 National Travel Survey*, UK Dept. for Transport (www.transtat.dft.gov.uk).

ECU (2004a), *Physical Inactivity Cost Calculator* (www.ecu.edu/picostcalc), College of Health & Human Performance, East Carolina University (www.ecu.edu); documentation at www.ecu.edu/picostcalc/pdf_file/Methods.pdf.

ECU (2004b), *Physical Activity Facts and Figures*, College of Health & Human Performance, East Carolina University (www.ecu.edu); at www.ecu.edu/picostcalc/pdf_file/FactsandFigures.pdf.

Mark Eppli and Charles C. Tu (2000), *Valuing the New Urbanism; The Impact of New Urbanism on Prices of Single-Family Homes*, Urban Land Institute (www.uli.org).

Reid Ewing, R. Pendall and Don Chen (2002), *Measuring Sprawl and Its Impacts*, Smart Growth America (www.smartgrowthamerica.org).

FDOT (2002), *Quality/Level of Service Handbook,* Florida Department of Transportation (www11.myflorida.com/planning/systems/sm/los/los_sw2.htm).

FHWA (1997) *1997 Federal Highway Cost Allocation Study,* USDOT (www.fhwa.dot.gov).

FHWA (annual reports), *Highway Statistics*, FHWA, USDOT (www.fhwa.dot.gov/ohim).

FHWA (2004), "Appendix III, Spending on Bicycle and Pedestrian Facilities and Programs," *National Bicycling and Walking Study: Ten Year Status Report*, Federal Highway Administration (www.fhwa.dot.gov/environment/bikeped/study/index.htm#nbwftn5).

David Forkenbrock and Glen Weisbrod (2001), *Guidebook for Assessing the Social and Economic Effects of Transportation Projects*, NCHRP Report 456, TRB (www.trb.org).

Ann Forsyth, Kevin J. Krizek and Asha Weinstein Agrawal (2010), *Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Survey Method for Local Communities*, Mineta Transportation Institute, San Jose State University (www.transweb.sjsu.edu); at www.transweb.sjsu.edu/project/2907.html.

John I. Gilderbloom, William W. Riggs and Wesley L. Meares (2015), Does Walkability Matter? An Examination of Walkability's Impact on Housing Values, Foreclosures and Crime," *Cities*, Vol. 42, pp. 13–24 (http://dx.doi.org/10.1016/j.cities.2014.08.001); at http://daneshyari.com/article/preview/1008334.pdf.

Rachel Goodman and Rodney Tolley (2003), "The Decline of Everyday Walking In The UK: Explanations And Policy Implications," *Sustainable Transport: Planning for Walking and Cycling In Urban Environments* (Rodney Tolley Ed.), Woodhead Publishing (www.woodhead-publishing.com), pp. 70-83.

Thomas Gotschi (2011), "Costs and Benefits of Bicycling Investments in Portland, Oregon," *Journal of Physical Activity and Health*, Vol. 8, Supplement 1, pp. S49-S58; at http://journals.humankinetics.com/jpah-supplements-special-issues/jpah-volume-8-supplement-january/costs-and-benefits-of-bicycling-investments-in-portland-oregon.

Susan Handy (2009), "Walking, Bicycling, and Health," *Healthy, Equitable Transportation Policy: Recommendations And Research,* PolicyLink and the Prevention Institute Convergence Partnership (www.convergencepartnership.org/transportationhealthandequity).

G. Haze (2000), *Counting Pedestrians*, Walk San Francisco (www.walksf.org/essays/pedCountEssay.html).

Gary Hack (2013), *Business Performance in Walkable Shopping Areas*, Active Living Research (www.activelivingresearch.org); at http://activelivingresearch.org/files/BusinessPerformanceWalkableShoppingAreas_Nov2013.pdf .

ICLEI (2007), *Active Transportation Quantification Tool*, Cities for Climate Protection, International Council for Local Environmental Initiatives (http://att.ccp.iclei.org); at http://att.ccp.iclei.org/more/about.

LAW (2009), *Economic Benefits of Bicycle Infrastructure Investments*, League of American Bicyclists (www.bikeleague.org) and the Alliance for Biking & Walking (www.peoplepoweredmovement.org); at www.bikeleague.org/resources/reports/pdfs/economic_benefits_bicycle_infrastructure_report.pdf.

Christopher B. Leinberger and Mariela Alfonzo (2012), *Walk this Way: The Economic Promise of Walkable Places in Metropolitan Washington, D.C.*, Brookings Institute (www.brookings.edu); at www.brookings.edu/research/papers/2012/05/~/media/Research/Files/Papers/2012/5/25%20walkable%20places%20leinberger/25%20walkable%20places%20leinberger.pdf.

LGC (2001), *The Economic Benefits of Walkable Communities*, Local Government Commission (www.lgc.org).

Todd Litman (2001), "Evaluating Transportation Choice," *Transportation Research Record 1756*, Transportation Research Board (www.trb.org), pp. 32-41; revised version titled, *You Can Get There From Here: Evaluating Transportation System Diversity* is available at www.vtpi.org/choice.pdf.

Todd Litman (2001b), *What's It Worth? Life Cycle and Benefit/Cost Analysis for Evaluating Economic Value*, Presented at Internet Symposium on Benefit-Cost Analysis, Transportation Association of Canada (www.tac-atc.ca); at www.vtpi.org/worth.pdf.

Todd Litman (2002), *Evaluating Transportation Land Use Impacts*, VTPI (www.vtpi.org); at www.vtpi.org/landuse.pdf.

Todd Litman (2003b), "Measuring Transportation: Traffic, Mobility and Accessibility," *ITE Journal* (www.ite.org), Vol. 73, No. 10, October, pp. 28-32; available at www.vtpi.org.

Todd Litman (2004b), *Evaluating Public Transit Benefits and Costs* VTPI (www.vtpi.org); at www.vtpi.org/tranben.pdf.

Todd Litman (2004), *If Health Matters: Integrating Public Health Objectives into Transportation Decision-Making*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/health.pdf; previously published as, "Integrating Public Health Objectives in Transportation Decision-Making," *American Journal of Health Promotion*, Vol. 18, No. 1 (www.healthpromotionjournal.com), Sept./Oct. 2003, pp. 103-108; at www.vtpi.org/AJHP-litman.pdf.

Todd Litman (2005), *Whose Roads? Evaluating Bicyclists' and Pedestrians' Right to Use Public Roadways*, VTPI (www.vtpi.org); at www.vtpi.org/whoserd.pdf.

Todd Litman (2009), *Transportation Cost and Benefit Analysis*, VTPI (www.vtpi.org).

Todd Litman (2010), *Evaluating Active Transportation Benefits and Costs*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/nmt-tdm.pdf.

Todd Litman (2010b), *Short and Sweet: Analysis of Shorter Trips Using National Personal Travel Survey Data*, VTPI (www.vtpi.org); at www.vtpi.org/short_sweet.pdf.

Todd Litman (2011), *Evaluating Transportation Economic Development Impacts*, VTPI (www.vtpi.org); at www.vtpi.org/econ_dev.pdf.

Todd Litman and Steven Fitzroy (2005), *Safe Travels: Evaluating Mobility Management Traffic Safety Impacts*, VTPI (www.vtpi.org); at www.vtpi.org/safetrav.pdf.

Anastasia Loukaitou-Sideris And Renia Ehrefeucht (2010), "Vibrant Sidewalks in the United States: Re-integrating Walking and a Quintessential Social Realm," *Access 36* (www.uctc.net/access); Spring 2010, pp. 22-29; at www.uctc.net/access/36/access-36vibrantsidewalks.pdf.

LTNZ (2010), *Economic Evaluation Manual (EEM) – Volumes 1 & 2*, Land Transport New Zealand (www.landtransport.govt.nz); at www.landtransport.govt.nz/funding/manuals.html (Active transportation health benefits data is found in Volume 2, section 3.8, p 3-22).

Barbara McCann and B. DeLille (2000), *Mean Streets 2000*, Surface Transportation Policy Project (www.transact.org).

Barbara McCann (2000), *Driven to Spend; The Impact of Sprawl on Household Transportation Expenses*, Surface Transportation Policy Project (www.transact.org).

Measuring Walking (www.measuring-walking.org) describes internationally standardised monitoring methods of walking and public space.

Paul Mogush, Kevin J. Krizek and David Levinson (2005), *The Value of Trail Access on Home Purchases*, TRB Annual Meeting (www.trb.org).

J. Murphy and Mark Delucchi (1998), "A Review of the Literature on the Social Cost of Motor Vehicle Use in the U.S.," *Journal of Transportation And Statistics.* Vol. 1, No. 1 (www.bts.gov), January 1998, pp. 15-42.

Christopher Murray, et al. (1996), *Global Burden of Disease and Injury,* Center for Population and Development Studies, Harvard University School of Public Health (www.hsph.harvard.edu/organizations/bdu).

NBPC (1995), *The Economic and Social Benefits of Off-Road Bicycle and Pedestrian Facilities*, National Bicycle and Pedestrian Clearinghouse, No. 2 (www.bikefed.org).

NYCDOT (2012), Measuring the Street: New Metrics for 21st Century Streets, New York City Department of Transportation (www.nyc.gov/html/dot); at www.nyc.gov/html/dot/downloads/pdf/2012-10-measuring-the-street.pdf.

John Pucher and Lewis Dijkstra (2000), "Making Walking and Cycling Safer: Lessons from Europe," *Transportation Quarterly*, Vol. 54, No. 3, Summer 2000, at www.vtpi.org/puchertq.pdf.

John Pucher and Lewis Dijkstra (2003), "Promoting Safe Walking and Biking to Improve Public Health: Lessons From The Netherlands And Germany," *American Journal of Public Health*, Vol. 93, No. 9 (www.ajph.org), pp. 1509-1516.

P. Rietveld (2000), "Nonmotorized Modes in Transport Systems: A Multimodal Chain Perspective for The Netherlands," *Transportation Research D*, Vol. 5, No. 1, January, pp. 31-36.

Shannon H. Rogers, John M. Halstead, Kevin H. Gardner and Cynthia H. Carlson (2010), "Examining Walkability And Social Capital As Indicators Of Quality Of Life At The Municipal And Neighborhood Scales," *Applied Research In Quality of Life* (www.springerlink.com), DOI: 10.1007/s11482-010-9132-4; at www.springerlink.com/content/xtq06270p27r1v0h.

R. Rood (1999), *Local Index of Transit Availability*, Local Government Commission (www.lgc.org).

Collin Roughton, et al. (2012), *Creating Walkable and Bikeable Communities: A User Guide to Developing Pedestrian and Bicycle Master Plans*, Center for Transportation Studies at Portland State University (www.ibpi.usp.pdx.edu); at www.ibpi.usp.pdx.edu/media/IBPI%20Master%20Plan%20Handbook%20FINAL%20(7.27.12).pdf.

Kyle Rowe (2013), *Bikenomics: Measuring the Economic Impact of Bicycle Facilities on Neighborhood Business Districts*, University of Washington; at http://cep.be.washington.edu/wp-content/uploads/2013/07/bikenomics_v2.pdf.

K. Sælensminde (2002), *Walking and Cycling Track Networks in Norwegian Cities: Cost-Benefit Analysis Including Health Effects and External Costs of Road Traffic*, Institute of Transport Economics, Oslo (www.toi.no/toi_Data/Attachments/887/sum_567_02.pdf).

James F. Sallis, Lawrence D. Frank, Brian E. Saelens and M. Katherine Kraft (2004), "Active Transportation and Physical Activity," *Transportation Research A*, Vol. 38, Issue 4 (www.elsevier.com/locate/tra), May, pp. 249-268.

Schaller Consulting (2006), *Curbing Cars: Shopping, Parking and Pedestrian Space in SoHo*, Transportation Alternatives (www.transalt.org); available at www.transalt.org/campaigns/reclaiming/soho_curbing_cars.pdf

Donald Shoup (2010), "Fixing Broken Sidewalks," *Access 36* (www.uctc.net/access); Spring 2010, pp. 30-36; at www.uctc.net/access/36/access-36brokensidewalks.pdf.

Ryan Snyder (2005), The Economic Value of Active Transportation, Ryan Snyder Associates; at www.rsa.cc/images/EconomicValueOfActiveTransportation.pdf.

SQW (2007), *Valuing the Benefits of Cycling: A Report to Cycling England*, Cycling England, Department for Transport (www.dft.gov.uk); at www.dft.gov.uk/cyclingengland/site/wp-content/uploads/2008/08/valuing-the-benefits-of-cycling-full.pdf.

Statistics Canada (2004), *General Social Survey on Time Use*, 1992, reported in "Getting There," in *Perspectives on Labour and Income*, Statistics Canada (www.statcan.ca); at www.statcan.gc.ca/studies-etudes/75-001/archive/e-pdf/70-eng.pdf.

Robert J. Stokes, John MacDonald and Greg Ridgeway (2008), "Estimating The Effects Of Light Rail Transit On Health Care Costs," *Health & Place*, Volume 14, Issue 1, March, pp. 45-58.

Fred Sztabinski (2009), *Bike Lanes, On-Street Parking and Business A Study of Bloor Street in Toronto's Annex Neighbourhood*, The Clean Air Partnership (www.cleanairpartnership.org); at www.cleanairpartnership.org/pdf/bike-lanes-parking.pdf.

Rodney Tolley (2011), *Good For Busine$$ - The Benefits Of Making Streets More Walking And Cycling Friendly*, Heart Foundation South Australia (www.heartfoundation.org.au); at www.heartfoundation.org.au/SiteCollectionDocuments/GoodforBusinessFINAL_Nov.pdf.

Ray Tomalty and Murtaza Haider (2009), *Walkability and Health; BC Sprawl Report 2009*, Smart Growth BC (www.smartgrowth.bc.ca); at www.smartgrowth.bc.ca/Portals/0/Downloads/sgbc-sprawlreport-2009.pdf.

TTI (1997), *MicroBENCOST*, Texas Transportation Institute (http://tti.tamu.edu).

N. Tyler (1999), *Downtown Pedestrian Malls*, (www.emich.edu/public/geo/557book/d210.pedmalls.html) and *Pedestrians and Downtowns* (www.emich.edu/public/geo/557book/c125.pedes.html) 1999.

UTTIPEC (2009), *Delhi Pedestrian Design Guidelines; Don't Drive...Walk!*, Delhi Development Authority (www.uttipec.nic.in); at www.uttipec.nic.in/PedestrianGuidelines-30Nov09-UTTPEC-DDA.pdf.

USEPA (2001), *Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation and Environmental Quality*, US Environmental Protection Agency (www.epa.gov/smartgrowth/pdf/built.pdf).

VTPI (2008), *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org).

WalkIt: The Walking Resources Database (www.walkit.info) provides extensive resources for pedestrian planning in urban development, local transport, health and recreation.

Jay Walljasper (2013), *Walking As A Way Of Life Movement For Health & Happiness*, Everybody Walks ((www.everybodywalk.org); at www.everybodywalk.org/media_assets/WalkingAsAWayOfLife1_Final.pdf.

Glen Weisbrod (2000), *Synthesis of Current Practice for Assessing Economic Development Impacts from Transportation Projects*, NCHRP Study 20-5 (www.edrgroup.com/pages/summary-synthesis.html), TRB, National Academy Press, ISBN 0-309-06873-8, 2000.

Steve Weissman and Judy Corbett (1992), *Land Use Strategies for More Livable Places*, Local Government Commission (www.lgc.org).

Jaewoong , "Are Walkable Neighborhoods More Resilient to the Foreclosure Spillover Effects?" *Journal of Planning Literature*, pp. 1-14 (https://doi.org/10.1177/0739456X17702443); at http://journals.sagepub.com/doi/abs/10.1177/0739456X17702443.

World Bank, *Highways Design and Maintenance (HDM) 4 Model*, World Bank (http://hdm4.piarc.org/main/home-e.htm).