Valuing Transit Service Quality Improvements

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Abstract

This article investigates the value transit travelers place on qualitative factors, such as comfort and convenience, and practical ways to incorporate these factors into transport planning and project evaluation. Conventional evaluation practices generally assign the same time value regardless of travel conditions, and so undervalue comfort and convenience impacts. More comprehensive analysis of transit service quality tends to expand the range of potential transit improvement options, and justify more investments in transit service quality improvements. This article examines the value passengers place on transit service quality, summarizes research on travel time valuation, explores how transit service quality factors affect travel time values and transit ridership, and discusses implications of this analysis.

Introduction

Albert Einstein once illustrated the relativity of time by saying, "When a man sits with a pretty girl for an hour, it seems like a minute. But let him sit on a hot stove for a minute and it's longer than any hour." Similarly, a minute spent in unpleasant conditions waiting for a bus may seem like an hour, while an hour spent working, resting, or conversing while traveling on a comfortable bus or train may seem pleasant or even delightful.

Qualitative factors such as travel convenience, comfort, and security affect travel time unit costs, the value users assign to their travel time, measured in cents per minute or dollars per hour. Various studies summarized in this article indicate that inconvenience and discomfort often double or triple average travel time costs. This has important implications for transportation planning since travel time costs are a major factor in transport project evaluation. How travel time is measured can significantly affect planning decisions.

Unfortunately, conventional planning practices tend to overlook and undervalue service quality impacts. The indicators used to identify transportation problems (such as roadway level-of-service ratings) and the models used to evaluate potential transport improvements focus on quantitative factors (speed, operating costs, and crash rates), and ignore qualitative factors (convenience, comfort, and prestige).

This is particularly important for transit planning because transit service quality varies from awful to good, and sometimes even delightful, and because nearly all transit service quality decisions are made in a formal planning process. A motorist who values convenience and comfort can pay extra for a vehicle with features such as automatic navigation systems, extra comfortable seats, optional safety equipment, sophisticated sound systems, and even heated cupholders. On the other hand, public transit is usually provided as a basic level of service. It is not usually possible to pay extra for higher quality service, such as a nicer waiting area or a less crowded vehicle. Such service quality improvements are made only if planners are able to demonstrate their value.

These omissions undervalue many cost-effective transit service improvements, such as more comfortable vehicles, reduced crowding, nicer stations, improved walkability, better user information, improved security, and marketing and promotion. Improving transit service quality:

- benefits existing transit passengers (who would use transit even without the improvements);
- benefits new transit passengers (who would only use transit if service is improved);
- benefits society by reducing traffic problems (congestion, roadway and parking costs, consumer costs, accidents, energy consumption, and pollution emissions);
- provides scale economies (increased ridership can create a positive feedback cycle of improved service, increased public support, more transit-oriented land use, and further ridership increases); and
- benefits transit agencies by increasing fare revenue.

This article investigates the value passengers place on transit service quality, summarizes research on travel time valuation, examines how transit service quality factors affect travel time values, discusses implications of this analysis, and recommends additional research. This information should be useful for planners interested in finding cost-effective ways to improve transit service and increase transit ridership.

Quantifying Travel Time Values

Numerous studies have quantified and *monetized* (measured in monetary units) travel time costs (Mackie et al. 2003; Wardman 2004). Travel time unit costs are generally calculated relative to average wages, with variations reflecting different factors discussed below (Waters 1992; Litman 2006).

- Commercial (paid) travel costs should include driver wages and benefits, and the time value of vehicles and cargo reflecting efficient use of assets and ability to meet delivery schedules.
- Personal (unpaid) travel time unit costs are usually estimated at 25 to 50 percent of prevailing wage rates.
- Travel time costs tend to be higher for uncomfortable, unsafe, and stressful conditions (Brundell-Freij 2006).
- Travel time costs tend to increase with income, and tend to be lower for children and people who are retired or unemployed (put differently, people with full-time jobs usually have more demands on their time and so tend to be willing to pay more for travel time savings).
- A moderate amount of daily travel often has little or no time cost, since people generally seem to enjoy a certain amount of daily travel (Mokhtarian 2005). Recreational travel and errands that involve social activities often have minimal cost or positive value.
- Unit time costs tend to increase if trips exceed about 20 minutes in duration or total personal travel exceeds about 90 minutes per day.
- Travel time costs increase with variability and arrival uncertainly (Cohan and Southworth 1999), and tend to be particularly high for unexpected delays (Small et al. 1999).
- Walking and waiting time unit costs are two to five times higher than in-vehicle transit travel time (Pratt 1999, Table 10-12). Transfers tend to

impose extra costs (called a *transfer penalty*) due to the additional effort they require, typically equivalent to 5 to15 minutes of in-vehicle travel time (Horowitz and Zlosel 1981; Evans 2004).

- Under pleasant conditions walking, cycling, and waiting can have low or positive value, but under unpleasant conditions (walking along a busy highway or waiting for a bus in an area that seems dirty and dangerous) their costs are significantly higher than in-vehicle time.
- People have diverse mobility needs and preferences, so improved options allows individuals to choose the best one for each trip. For example, some people prefer driving while others prefer transit travel; having both available allows people to select the option that minimizes costs, including travel time costs, and maximizes benefits (Novaco and Collier 1994).

The following two factors are particularly important for analysis in this article:

1. Transit travel conditions, and therefore transit travel time unit cost values, are extremely variable. Under pleasant conditions (comfortable, clean, quiet, and safe vehicles and waiting areas), transit travel time unit costs are lower than driving because passengers experience less stress and are able to rest or use their time productively. However, if transit conditions are unpleasant, transit travel times are significantly higher than automobile travel.
2. In most communities a portion of transit travelers are captive—people who are unable to drive and so are forced to use transit regardless of service quality. However, transit will only attract discretionary travelers (those who could drive for a particular trip, also called *choice riders*) if high service quality reduces unit travel time costs relative to automobile travel.

These factors have significant implications for transit project evaluation, as summarized in Table 1. More accurate analysis of these impacts tends to increase the recognized costs of degraded transit service quality, and increase the recognized benefits of transit service quality improvements.

Li (2003) describes how these factors tend to favor automobile commuting:

> An auto commute is attractive in most courses of perceived travel time, compared to a public transportation commute. It is most likely a door-to-door service, thus minimizing the number of commute stages [transfers]. It spends time predominantly on the ride episode, usually with seats secured and even entertainment (e.g., music) of the commuter's choice. It demands the

Table 1. Factors Affecting Travel Time Costs

Factor	*Description*	*Transit Evaluation Implications*
Waiting	Waiting time is usually valued higher than in-vehicle travel time.	Transit travel usually requires more waiting, often along busy roads, with little protection.
Walking links	Time spent walking to vehicles is usually valued higher than in-vehicle travel time.	Transit travel usually requires more walking for access.
Transfers	Transfers impose a time cost penalty.	Transit travel often requires transfers.
Trip duration	Unit costs tend to increase for trips that exceed about 40 minutes.	Transit travel tends to require more time than automobile travel for a given distance.
Unreliability (travel time variance)	Unreliability, particularly unexpected delays, increase travel time costs.	Varies. Transit is often less reliable, except where given priority in traffic.
Waiting and vehicle environments	Uncomfortable conditions (crowded, dirty, insecure, cold, etc.) increase costs.	Transit travel is often less comfortable than private vehicle travel.
Sense of control	A person's inability to control their environment tends to increase costs.	Transit travel is often perceived as providing little user control.
Cognitive effort (need to pay attention)	More cognitive effort increases travel time costs.	Varies. Driving generally requires more effort, particularly in congestion.
Variability	Transit travel conditions are extremely variable, depending on the quality of walking, waiting, and vehicle conditions.	Transit benefit analysis is very sensitive to qualitative factors that currently tend to be overlooked and undervalued.
Captive vs. discretionary travelers	Some transit users are captive and so relatively insensitive to convenience and comfort, but discretionary travelers tend to be very sensitive to these factors.	Achieving automobile-to-transit mode shifts requires comprehensive analysis to identify service quality factors that attract discretionary travelers.

Source: Pratt 1999; Li 2003; Litman 2006.

> commuter's (i.e., driver's) continuous attention to road conditions and motor operation, rather than temporal cues or information, and hence exploits the cognitive resource for nontemporal information processing. Also, it avoids the temporal and monetary losses due to unreliable public transportation services. All these may result in a given journey perceived as shorter for an auto commute, and hence the commute experience to be more positively evaluated than for a commute with public transportation.

However, under optimal conditions transit travel can have lower unit time costs than driving, particularly if travelers can select the mode that best meets their needs and preferences. A survey of New Jersey commuters found that train users experienced less stress and fewer negative moods than drivers making similar trips, indicating the reduced effort and greater predictability of train travel (Wener, Evans, and Lutin 2006). Train commuter stress levels declined significantly after service improvements reduced their need to transfer.

A survey of U.K. rail passengers found that many use their time for productive activities such as working or studying (30% some of the time and 13% most of the time), reading (54% some of the time and 34% most of the time), resting (16% some of the time and 4% most of the time), and talking to other passengers (15% some of the time and 5% most of the time), and so place positive utility on such time (Lyons, Jain, and Holley 2007). When asked to rate their travel time utility, 23 percent indicated that "I made very worthwhile use of my time on this train today," 55 percent indicated that "I made some use of my time on this train today," and 18 percent indicated that "My time spent on this train today is wasted time." The portion of travel time devoted to productive activity is higher for business travel than for commuting or leisure travel, and increases with journey duration.

Service Quality Valuation

The value transit users (and potential users) place on service quality can be measured using stated preference surveys (which ask people how much they value a particular feature) and revealed preference studies (which evaluate the choices people actually make when facing trade-offs between various attributes). One example of this type of analysis is described below.

Research for RailCorp (an Australian rail company) surveyed train riders to assess the value they place on various service attributes. Table 2 summarizes vehicle service values, measured by the additional fares or time travelers would willingly bear in exchange for a 10 percent improvement (from 50%–60% acceptability ratings). For example, travelers indicated that they would willingly pay 5.6¢ per minute or tolerate a 0.38-minute increase in onboard travel times in exchange for such a 10-point improvement in train layout and design.

Table 3 presents the additional fare or onboard time train travelers would be willing to pay for a 10 percent improvement of various station attributes. For example, travelers expressed willingness to pay 2.4¢ per minute or tolerate a 16-minute increase in their onboard travel times in exchange for such a 10-point improvement in train layout and design.

Table 2. Value of Train Improvements

Type of Train Improvement	Additional Fares (2003 Aust. Cents per Minute)	Additional Onboard Time (Additional Time in Minutes)
Layout and design improvements	5.6¢ (2.2%)	0.38 (1.0%)
Cleanliness	3.8¢ (1.5%)	0.26 (0.7%)
Ease of train boarding	3.2¢ (1.2%)	0.22 (0.6%)
Quietness	3.2¢ (1.2%)	0.22 (0.6%)
Train outside appearance	2.3¢ (0.9%)	0.15 (0.4%)
On-train announcements improved	2.3¢ (0.9%)	0.16 (0.4%)
Heating and air-conditioning	2.2¢ (0.8%)	0.15 (0.4%)
Improved lighting	1.9¢ (0.7%)	0.13 (0.4%)
Smoothness of ride	1.5¢ (0.6%)	0.10 (0.3%)
Graffiti removed	1.2¢ (0.5%)	0.08 (0.2%)
Seat comfort	1.1¢ (0.4%)	0.07 (0.2%)

Source: Douglas Economics 2006.

Table 3. Value of Station Improvements

Type of Station Improvement	Additional Fares (2003 Aust.Cents per Minute)	Additional Time (Increased Onboard Time in Minutes)
Tickets	2.4¢ (0.9%)	16 (43.2%)
Cleaning	1.9¢ (0.7%)	13 (35.1%)
Station building	1.4¢ (0.5%)	10 (27.0%)
Staff	1.3¢ (0.5%)	9.0 (24.3%)
Ease of train on and off	1.1¢ (0.4%)	8.0 (21.6%)
Platform surface	1.0¢ (0.4%)	7.0 (18.9%)
Station announcements	0.8¢ (0.3%)	5.0 (13.5%)
Safety	0.8¢ (0.3%)	6.0 (16.2%)
Signing	0.7¢ (0.3%)	5.0 (13.5%)
Graffiti	0.7¢ (0.3%)	5.0 (13.5%)
Retail	0.7¢ (0.3%)	5.0 (13.5%)
Platform seating	0.6¢ (0.2%)	4.0 (10.8%)
Lifts/escalators	0.4¢ (0.2%)	3.0 (8.1%)
Information	0.4¢ (0.2%)	3.0 (8.1%)
Station lighting	0.4¢ (0.2%)	3.0 (8.1%)
Bus	0.3¢ (0.1%)	2.0 (5.4%)
Bike	0.3¢ (0.1%)	2.0 (5.4%)
Toilets	0.2¢ (0.1%)	1.0 (2.7%)
Car park	0.2¢ (0.1%)	1.0 (2.7%)
Car park drop-off	0.2¢ (0.1%)	1.0 (2.7%)
Platform weather protection	0.1¢ (0.0%)	0.4 (1.1%)
Subway/overbridge	0.1¢ (0.0%)	0.1 (0.3%)
Taxi	0.1¢ (0.0%)	0.1 (0.3%)
Telephone	0.1¢ (0.0%)	0.1 (0.3%)

Source: Douglas Economics 2006.

Riders were also surveyed concerning their perceived cost of crowding. Crowded seating increases travel time costs by 17 percent, as shown in Table 4. Thus, 20 minutes of crowded seating would increase the generalized journey time by 3.4 minutes (20 x 0.17). In dollar terms, crowded seating adds 2¢ per minute if time is valued at $9.46/hr.

Table 4. Value of On-Train Crowding

Crowding	Crowding Cost (2003 Aust. Cents per Minute)	Crowding Factor (Additional Time)
Crowded seat	2.0¢	17%
Stand 10 mins or less	5.0¢	34%
Stand 20 mins or longer	11¢	81%
Crush stand 10 mins or less	11¢	104%
Crush stand 20 mins or longer	17¢	152%

Source: Douglas Economics 2006.

Crowding factors were expressed as a function of train passenger *load factors* (passengers divided by seats). Below an 80 percent load factor (80 passengers per 100 seats) no crowding costs are incurred. At 80 percent, crowding begins to impose costs. At 100 percent, the additional crowding factor is 0.1, increasing onboard travel time unit costs by 10 percent, from 14.08¢ per minute (the uncrowded seating value of time) to 15.49¢ per minute, an increase of 1.41¢ per minute. Loads of 160 percent add an additional crowding factor of 0.6 minutes or 8.45¢. At 200 percent loading (the maximum number of passengers CityRail trains are considered to be able to carry), the additional crowding factor is 0.74 or 10.43¢ per minute. Above 200 percent, passengers must wait for another train.

The UK Passenger Demand Forecasting Council reached similar conclusions concerning the costs of passenger discomfort and delay (PDFC 2002). The PDFC recommends that train load factors of 1.20 to 1.40 (120–140 passengers per 100 seats) result in crowding factors of 0.14 to 0.26, compared with a 0.17 crowding factor calculated for Sydney (Douglas Economics 2006).

Crowding in accessways, stations, and platforms makes walking and waiting time less pleasant. Table 5 indicates adjustment factors for low, medium, high, and very high crowding conditions. A minute of time spent waiting under high crowding conditions is valued at 3.2 minutes of onboard train time whereas walking time is valued at 3.5 times higher (reflecting the additional discomfort and effort involved, but not the reduced walking speed caused by crowding).

Table 5. Value of Platform Waiting and Access Time

Activity	Crowding Level			
	Low (<0.2 PSM)	*Medium (0.2–0.5 PSM)*	*High (0.5–2 PSM)*	*Very High (>2 PSM)*
Waiting vs. onboard train time factor	190%	150%	320%	550%
Walking vs. onboard train time factor	220%	220%	350%	620%
Waiting value of time (2003 AU$/hr)	$18.30	$14.20	$30.30	$51.90
Walking value of time (2003 AU$/hr)	$21.00	$21.00	$32.70	$58.90

PSM = Passengers per square meter.
Source: Douglas Economics 2006.

Fruin developed six station environment crowding levels-of-service (LOS) ratings, ranging from A (no crowding) to F (extreme crowding). These costs begin to increase significantly when crowding exceeds LOS D, which occurs at a density of 0.7 passengers per square meter (PSM). Crowding has an even greater impact on walking, since it both increases costs per minute and reduces walking speeds. Level of service F, characterized by the breakdown of passenger flow, imposes crowding costs 10 times greater than level of service A.

In some situations, increased crowding costs may reduce the benefits of other transit improvements or incentives that increase peak-period ridership. For example, transit fare reductions or improved rider information may increase ridership, increasing crowding costs. These additional costs should be considered when evaluating such strategies.

Valuing Transit Passenger Information Improvements

Transit user information includes bus stop signs, printed and posted schedules, conventional and automated telephone services, transit websites (including websites designed to accommodate cellular telephones and PDAs), changeable signs or monitors at stations and stops, and announcements. Some newer systems use real-time information on the location of individual buses and trains, so signs, monitors, and websites can predict when the next vehicle will arrive at a particular stop or destination.

Many transit systems now offer real-time information (Infopolis 2 Consortium 2000; CIty-VITAlity-Sustainability 2006). This information reduces waiting stress and allows passengers to better use their time and coordinate activities (Turnbull and Pratt 2003). Dziekan and Vermeulen (2006) evaluated the effects real-time information has on tram passenger perceived wait time, feelings of security, and use in The Hague, the Netherlands. One month before, 3 months, and 16 months after implementation, the same sample of travelers completed a questionnaire. The researchers found that perceived wait time decreased by 20 percent and noted no effects on perceived security and ease of use.

Turnbull and Pratt (2003) tested real-time information signs in 1984 at several platforms on the London Underground Northern Line. The signs gave order of arrival information for the next three trains, route and terminal destination, and the number of minutes before expected arrival. The previous signs had supplied the first two of these elements of information, but not predicted arrival time. Passenger value these systems: 95 percent of respondents indicated it was useful and 65 percent reported it helped reduce waiting uncertainty. The information was used by 12 percent to select what train to take, with passengers reporting that they employed the time until arrival in selecting transfer points or choosing to wait for a close behind train that might be less crowded.

Travel Time Valuation Summary

This analysis indicates that if transit service is convenient and comfortable, unit transit travel costs are lower than for driving, since transit travelers experience less stress and can use their time to rest or work. Under such conditions, transit travel time is typically valued at 25 to 35 percent of prevailing wages, compared with 35 to 50 percent for drivers. However, disamenities such as crowding, noise, and dirt significantly increase travel time unit costs. For example, transit travel time can be valued at about 25 percent of wage rates when sitting, 50 percent of wages when standing, 100 percent of wages in a crowded bus or train, and 175 percent of wages when waiting under unpleasant conditions, such as an unsheltered bus stop adjacent to a busy roadway.

Increased transit travel speeds can be valued based on average time costs, but improvements in reliability should be valued at a higher rate, reflecting the higher unit costs of unexpected delay. Each minute of delay beyond the published schedule should be valued at three to five times the standard in-vehicle travel time (perhaps excepting a two- or three-minute grace period considered to be a "normal" delay).

Time spent walking to and waiting for transit vehicles generally has unit costs averaging two to five times higher than in-vehicle time, or 70 percent to 175 percent of prevailing wages. Improved walking and waiting conditions, such as transit area pedestrian improvements, and improved transit stop area cleanliness and security, reduces these relatively high unit costs, such as from 175 percent down to 70 percent of wage rates (from the higher to the lower end of the typical estimated cost range of these activities) or even lower, to 50 percent of wage rates if conditions are particularly pleasant, such as at an attractive transit station with real-time information, shops and services, and other convenience features. Although the value of travel time is generally lower for children than for adults, reflecting the lower opportunity cost of their time, discomfort should be valued at the same rate as adults or even higher. For example, under poor waiting conditions children's time should probably be valued at 175 percent of wage rates, or even greater, the same value applied to adult travelers under the same conditions, reflecting adults concern for their children's comfort and security.

Transfers are estimated to impose penalties equivalent to 5 to 15 minutes of in-vehicle time. This implies, for example, that a typical passenger would choose a 40-minute transit trip over a 30-minute trip that requires a transfer. This premium reflects the physical and mental effort involved, plus the relative discomfort and insecurity at a typical transit stop or station, and so may be reduced with more comfortable waiting conditions and better user information.

Table 6 illustrates "default" travel time unit cost values. These values are calculated relative to prevailing wages, adjusted to reflect LOS ratings. Roadway LOS rates are widely used for evaluating automobile travel conditions. In recent years similar rating systems have been developed for walking, cycling, and public transit service (Phillips, Karachepone, and Landis 2001; Kittleson & Associates 2003a and 2003b; Litman 2005; Victoria Transport Policy Institute 2006). The Florida Department of Transportation (2002) developed the LOSPLAN computer program to automate these calculations.

Real-time transit vehicle arrival signs reduce perceived wait times by approximately 20 percent. These signs also reduce unit costs of the time spent waiting because passengers experience less stress and are better able to organize their trips. A 20 percent savings therefore represents the lower bound value of cost savings from such systems, provided that the information is easy to access and reliable.

Table 6. Recommended Travel Time Values

Category	LOS A-C	LOS D	LOS E	LOS F	Waiting		
					Good	Average	Poor
Commercial vehicle driver	120%	137%	154%	170%		170%	
Commercial vehicle passenger	120%	132%	144%	155%		155%	
City bus driver	156%	156%	156%	156%		156%	
Personal vehicle driver	50%	67%	84%	100%		100%	
Adult car passenger	35%	47%	58%	70%		70%	
Adult transit passenger—seated	35%	47%	58%	70%	35%	50%	125%
Adult transit passenger—standing	50%	67%	83%	100%	50%	70%	175%
Child (<16 years)—seated	25%	33%	42%	50%	25%	50%	125%
Child (<16 years)—standing	35%	46%	60%	66%	50%	70%	175%
Pedestrians and cyclists	50%	67%	84%	100%	50%	100%	200%
Transit transfer premium					5-min.	10-min.	15-min.

Source: Based on Waters 1992; Litman 2006.

Table 7 describes how to value the travel time savings of various types of transit service improvements. Such improvements can be particularly effective at shifting travel from automobile to transit if implemented in conjunction with other incentives such as commute trip reduction programs, parking cash-out, and marketing programs (Victoria Transport Policy Institute 2006).

Table 7. Valuing Service Improvements

Improvement	Methodology
Faster travel	Travel time savings.
Reduced crowding	Reduce time unit costs from high to average.
More comfortable vehicles	Reduce in-vehicle time unit costs.
Improved waiting conditions	Reduce the high time unit costs typically assigned to waiting.
Improved walking conditions	Reduce the high time unit costs typically assigned to walking.
Improved coverage area	Reduced walking travel time.
Real-time arrival information	Reduce waiting time unit costs.
Faster vehicle loading	Reduce wait and travel time costs.
More frequent service	Reduce wait time costs.
Reduced transfers	Eliminate transfer premium.
Increased travel reliability	Reduce the high time unit costs assigned to unpredictable delays.
Improved user information	Surveys to determine their value and impacts on ridership.
Improved status	Surveys to determine their value and impacts on ridership.

Travel Impacts

Many examples exist of specific service improvements that increase transit ridership and reduce automobile travel (Evans 2004; Wall and McDonald, 2007). Discretionary transit users (people who have the option of driving) tend to be particularly sensitive to comfort and convenience improvements (Phillips, Karachepone, and Landis 2001; Litman 2004; DfT 2006).

Transport modelers use *generalized cost* (total monetary and time costs) coefficients to predict how changes in vehicle operating costs, fares, and travel speeds affect travel behavior. The Transportation Research Laboratory (2004) calculates generalized cost elasticities of −0.4 to −1.7 for urban bus transit, −1.85 for London underground, and −0.6 to −2.0 for rail transport. Dowling Associates (2005) estimate that in Portland, Oregon, the elasticity of transit travel with respect to transit travel time is −0.129, and the cross elasticity with car travel is 0.036, meaning that a 10 percent reduction in transit travel time increases transit ridership by 1.29 percent and reduces automobile travel by 0.36 percent. Such elasticities tend to be highly variable, depending on specific demographic and geographic factors. Additional analysis is therefore needed to calibrate the impacts of transit service quality improvements on transit ridership and automobile travel in specific situations.

The elasticity of transit use with respect to service frequency (called a *headway elasticity*) averages about 0.5, meaning that each 1 percent increase in transit service frequency increases ridership by 0.5 percent. This can be used to evaluate how reductions in waiting time unit costs are likely to affect ridership.

Currently, public transit is usually supplied with low service quality and fares to provide basic mobility for physically, economically, and socially disadvantaged people. Because most public transit service relies on direct public financial subsidies (unlike automobile travel, which relies on more indirect subsidies, such as the value of public lands devoted to road rights-of-way, free parking provided by governments and businesses, and external accident risk and pollution costs), public officials are reluctant to fund transit service improvements that may be considered excessive and wasteful.

As a result, transit fails to satisfy the demands of travelers willing to pay more for higher service quality. Market studies indicate that a portion of current automobile users will shift to transit if the service is comfortable and convenient (Project for Public Spaces and Multisystems 1999; TranSystems Corporation 2005), and are willing to pay higher fares. Where public transit offers basic quality service with low fares, it is used mainly by transit-dependent people, typically representing 5 to 10 percent of its potential market. However, where service quality is high (comfortable vehicles and stations, reliable and frequent service, walkable neighborhoods, etc.), a significant portion of discretionary travelers (people who could drive) will choose transit.

Example

Table 8 summarizes the cost reductions that result from improving the convenience and comfort of a transit trip from LOS E to LOS C by improvements such as adding sidewalks and attractive bus stop shelters, and providing seats in vehicles. As a result, the generalized cost of the trip declines 41 percent, from $14.66 to $6.69, compared with $10.14 for an automobile trip on the same corridor. Such improvements reduce the ratio of transit to automobile costs from 145 percent down to 86 percent. This represents the upper bound of cost savings from comfort and convenience improvements alone, since not all transit trips require transfers or involve travel on crowded vehicles.

Table 8. Travel Time Cost Reductions from Service Quality Improvements

	Walk	Wait	In Vehicle	Transfer	In Vehicle	Walk	Total	Fare	Generalized Cost
Transit–Current									
Minutes	5	10	20	5	15	5	60		
LOS rating	E	E	E	E	E	E			
Portion of wages	84%	70%	70%	175%	70%	84%			
Travel time costs	$1.05	$1.75	$3.50	$2.19	$2.63	$1.05	$12.16	$2.50	$14.66
Transit–Improved									
Minutes	5	10	20	5	15	5	60		
LOS rating	C	C	C	C	C	C			
Portion of wages	50%	50%	35%	50%	35%	50%			
Travel time costs	$0.63	$1.25	$1.75	$0.63	$1.31	$0.63	$6.19	$2.50	$8.69
Difference	*$0.43*	*$0.50*	*$1.75*	*$1.56*	*$1.31*	*$0.43*	*$5.98*	*$0.00*	*$5.98*
Percent change	*40%*	*29%*	*50%*	*71%*	*50%*	*40%*	*49%*	*0%*	*41%*
Automobile trip									
Minutes	1	0	30	0	0	3	34		
LOS rating	E	E	E	E	E	E			
Portion of wages	84%	0%	84%	0%	84%	84%			
Travel time costs	$0.21	$0.00	$6.30	$0.00	$0.00	$0.63	$7.14	$3.00	$10.14
Transit–current/auto									*145%*
Transit–improved/auto									*86%*

Improvements of this magnitude should increase transit ridership by about 20 percent, assuming an elasticity of transit travel to generalized costs of –0.5, about half of which would probably substitute for automobile travel. For example, an urban corridor has 12,000 total daily trips, of which 2,000 are by transit, half of which occur during peak periods. Table 9 illustrates the benefits from improving transit service LOS from E to C. These benefits include travel time cost reductions to current transit users (off-peak traveler benefits include no in-vehicle benefits, since these consist largely of reduced crowding, which is a peak-period problem), consumer surplus gains to travelers who shift mode (calculated by dividing monetized unit benefits by two, based on the rule-of-half), and reduced external costs (traffic congestion, parking subsidies, and accident risk) from reduced driving, estimated at $5.00 per trip during peak periods and $2.00 during off-peak periods (Litman 2005). The results indicate that these improvements would provide benefits that average more than $10,000 per day, or more than $350,000 annually.

Table 9. Monetized Benefits from Service Quality Improvements

Travel Changes	*Number*	*Unit Benefits*	*Total Benefits*
Peak-period riders	1,000	$5.98	$5,980
Off-peak riders	1,000	$2.92	$2,920
New peak riders	200	$2.99	$598
New off-peak riders	200	$1.46	$292
Reduced peak automobile trips	100	$5.00	$500
Reduced off-peak automobile trips	100	$2.00	$200
Total			*$10,490*

Although vehicle traffic reductions may appear small (about 2%), these service quality improvements can be implemented with other mode shift incentives, such as improved transit speeds, fare reductions, parking pricing, and commute trip reduction programs to achieve additional travel impacts and benefits (Victoria Transport Policy Institute 2006). These strategies tend to be synergistic, resulting in larger total benefits when implemented together than the sum of their individual impacts.

This illustrates how convenience and comfort improvements can significantly reduce travel time costs and provide benefits that are virtually invisible to most current transportation economic evaluation models.

Conclusions

There are many possible ways to improve transit service quality, including reduced crowding, increased service frequency, nicer waiting areas, and better user information. Current transport evaluation methods tend to focus on quantitative factors such as speed and price, and undervalue qualitative factors such as comfort, convenience and reliability. As a result, cost-effective transit improvement strategies are overlooked and undervalued, resulting in underinvestment in transit service quality improvements, making transit less attractive relative to automobile travel.

Service quality improvements that reduce travel time unit costs (cents per minute or dollars per hour) provide benefits comparable to speed improvement that reduce total travel time. For example, a service quality improvement that reduces travel time unit costs by 20 percent provides benefits equivalent to an operational improvement that increases travel speeds by 20 percent. Techniques described in this article allow service quality to be incorporated into transport planning by adjusting travel time unit costs to reflect convenience and comfort factors. The values recommended in this article can be used as defaults, although they should be calibrated for specific conditions.

This analysis indicates that with high service quality, transit travel unit time costs are lower than for driving. If service is comfortable and convenient, many people will choose transit rather than driving for some trips, even if it takes somewhat more time, since transit travel is less stressful and passengers can rest or work while traveling. However, transit is often inconvenient and uncomfortable, resulting in unit travel time costs higher than driving, which reduces transit ridership.

In a modern, affluent society consumers are accustomed to high quality goods and services. Most travelers place a high value on comfort, convenience, and reliability. Motorists are able to express these values by paying extra for more luxurious vehicles, more convenient parking, and sometimes higher quality toll roads. In contrast, individual transit passengers are generally unable to purchase higher quality service. As a result, transit does not satisfy travelers willing to pay extra for higher service quality—so they generally shift to driving. Ultimately everybody loses, since consumer demand is unmet, transit ridership declines, transit becomes stigmatized, and traffic problems increase.

This is actually good news because it indicates that there are many cost-effective ways to improve transit service quality and increase ridership that tend to be overlooked. Many transit comfort and convenience improvements are relatively inexpensive and provide additional benefits such as improved walking conditions, improved mobility for nondrivers, and support for more compact, smart growth development.

With better evaluation techniques planners can identify policies and programs that more effectively respond to consumer needs and preferences, including transit service improvements.

Acknowledgments

This research was supported by TransLink, the Vancouver, BC regional transport agency. Special thanks to Neil Douglas of Douglas Economics for generously sharing information.

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