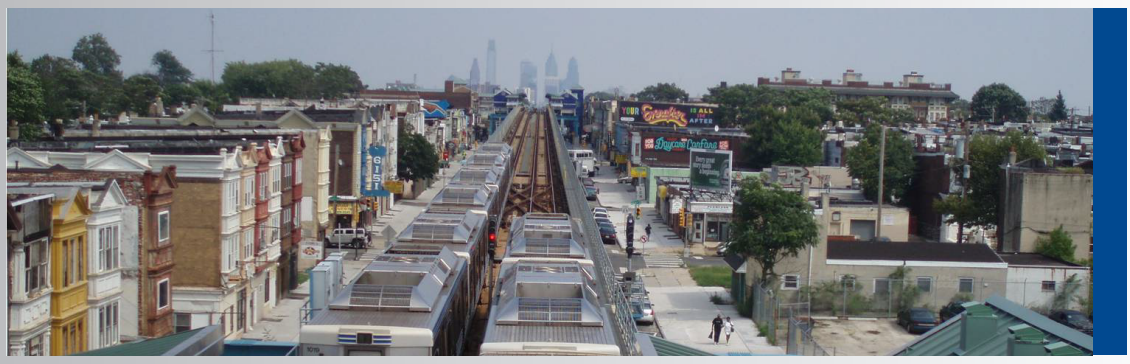
The Hidden Traffic Safety Solution:
Public Transportation



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Quick Facts

The Hidden Transportation Safety Solution: Public Transportation

Public transportation can help save lives by reducing traffic crashes

Public transportation is one of the safest ways to travel. It is ten times safer per mile than traveling by car because it has less than a tenth the per-mile traffic casualty (injury or death) rate as automobile travel. Public transit-oriented communities are five times safer because they have about a fifth the per capita traffic casualty rate as automobile-oriented communities. In addition, crash rates tend to decline as public transit travel increases in a community. Contrary to popular perceptions, public transit travel is significantly safer than automobile travel.

Credible research indicates that many planning practices that improve public transportation and encourage its use also tend to increase traffic safety. However, these benefits are often overlooked: individuals tend to exaggerate public transit risks; planners tend to overlook safety benefits when evaluating public transit improvements; and traffic experts seldom consider pro-transit policies as safety strategies.

Key takeaways:

- Transit-supportive policies can provide substantial traffic safety benefits, which result in saving lives and reducing injuries.
- Modest increases in public transit mode share can provide disproportionally larger traffic safety benefits.
- Safety strategies intended to reduce higher-risk driving become more effective if implemented in conjunction with public transportation improvements.
- Public transportation investment is among the most cost effective ways to enhance traffic safety for a community.

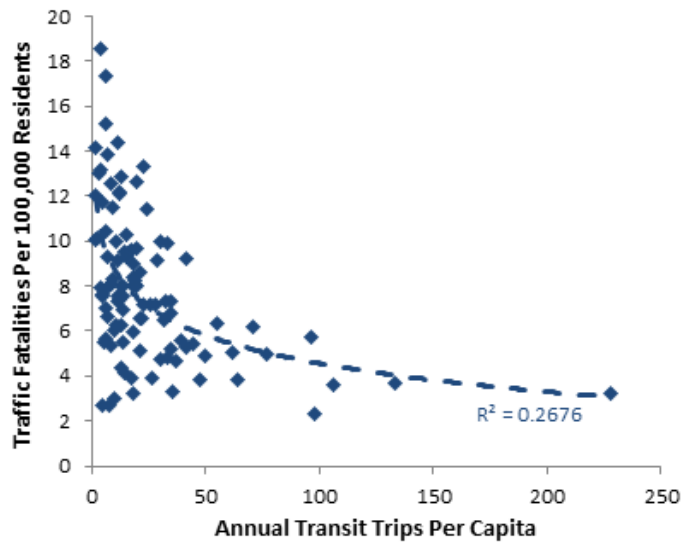
Executive Summary

This report investigates the impacts that public transportation has on *traffic safety* (crash risk), and the potential for transit-supportive policies (policies that improve and encourage public transit travel, and create more transit-oriented communities) to help achieve traffic safety goals.

Public transportation is overall a very safe form of travel. Its passengers have less than a tenth the per-mile crash rates as automobile occupants, and transit-oriented communities have less than a fifth the total (pedestrian, cyclist, automobile and transit passenger) per capita traffic fatality rates as in automobile-dependent communities.

Traffic casualty rates tend to decline in a community as transit ridership increases. In fact, cities where residents average more than 50 annual transit trips have about half the average traffic fatality rates as cities where residents average fewer than 20 annual transit trips, making public transportation a cost-effective traffic safety strategy.

Figure ES-1 - Traffic Fatalities Versus Transit Ridership for U.S. Urban Regions

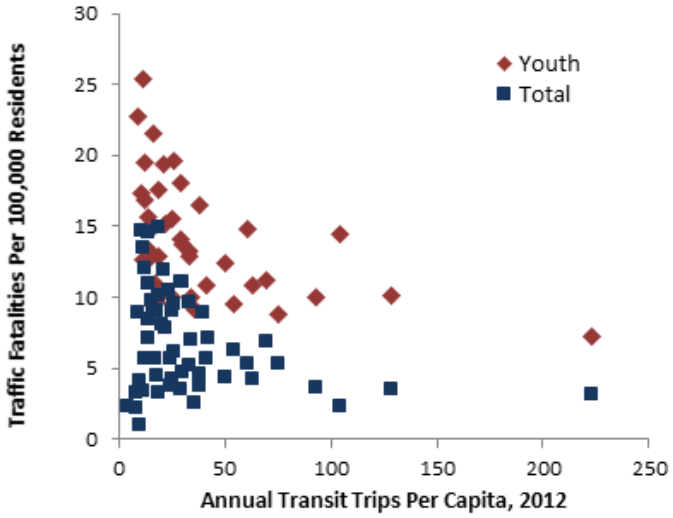


This graph illustrates the relationship between per capita transit ridership and total (including pedestrian, cyclist, automobile occupant and transit passenger) traffic fatalities for 101 U.S. cities.

As transit travel increases, per capita traffic fatality rates tend to decline. Cities where residents average more than 50 annual transit trips have about half the average traffic fatality rates as cities where residents average fewer than 20 annual transit trips.

Two factors help explain these large safety impacts. First, many factors that increase public transportation use, such as good walking and cycling conditions, and compact development, also tend to increase traffic safety. Second, higher-risk groups, including youths, seniors, alcohol drinkers and compulsive texters, are more likely to reduce their driving if alternatives, such as public transit, are convenient and attractive. As a result, efforts to reduce higher-risk driving, such as graduated licenses, senior driver testing, and impaired- and distracted-driving reduction campaigns, become more effective if implemented in conjunction with public transit improvements.

Figure ES-2 - Youth and Total Traffic Fatality Rates



Youths (15-25 years old) tend to have about twice the traffic fatality rates as the total population average. Both total and youth fatality rates tend to decline with increased transit ridership. Transit-oriented cities have about half the average youth and total traffic fatality rates as more automobile-oriented cities.

Public transportation investment and supportive policies increase traffic safety in several ways, including reduced crash risk to travelers who shift from automobile to transit, community-wide crash reductions due to less total vehicle travel, and safer traffic speeds. Since most casualty crashes involve multiple vehicles, *even responsible drivers who always observe traffic laws and never use public transit benefit from public transportation improvements that help reduce higher-risk driving*, and therefore their risk of being the victim of other drivers' mistakes.

Table ES-1 - Types of Public Transportation Safety Strategies

Public Transit Safety Improvements	Public Transit Service Improvements	Targeted Vehicle Travel Reductions	TDM Incentives	Transit-Oriented Development
Reduces risk to public transit passengers and operators	Improves service quality including convenience, comfort, speed, etc.	Reduces higher risk (by youths, seniors and impaired) driving	Incentives for travelers to shift from automobile to transit	Helps create Transit-Oriented Development.
• Improved operator training and supervision. • New vehicles. • New station design. • Grade separation.	• More service (more routes, frequency, etc.) • Faster (grade separation and faster loading) • Better vehicles, stops and stations. • Improved access (better walking, park & ride, etc.) • Improved information and payment options. • Improved economic opportunity for at-risk residents.	• Late-night service to entertainment districts. • Services oriented at youths and seniors. • Marketing oriented at youths and seniors. • More affordable student and senior housing in transit-oriented areas.	• Transport pricing reforms (efficient road, parking, fuel & vehicle insurance pricing). • Efficient parking management, reduced parking subsidies. • TDM marketing. • School and campus transport management.	• More compact and mixed development. • More efficient utility and development fees. • Complete streets roadway design. • More connected sidewalks and paths. • More passive surveillance (“eyes on the street”).

Public transportation investment and supportive policies increase traffic safety in important ways.

Travel by public transportation is far safer than automobile travel. Intercity and commuter passengers have about one-20th, urban rail and bus passengers about one-30th, per billion passenger-miles as automobile travel (Table 3).

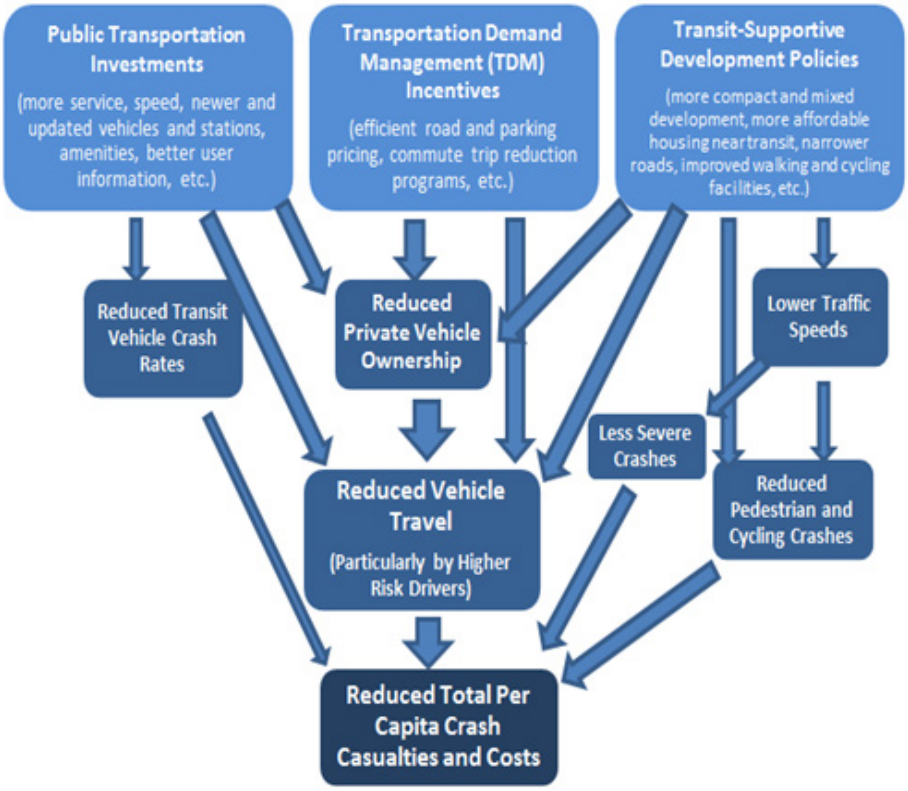
Table ES-2 - Passenger Fatalities per Billion Passenger-Miles, 2000-2014 (BTS)

Travel Mode	Deaths Per Billion Passenger-Miles
Motorcycle	237.57
Car or light truck driver or passenger	6.53
Local ferry boat	2.46
Commuter rail and Amtrak	0.36
Urban mass transit rail (subway or light rail)[1]	0.33
Bus (transit, intercity, school, charter)	0.2
Commercial aviation	0.02

Public transit passengers have far lower traffic casualty rates than automobile occupants.

1 *Only a minor portion of reported rail transit deaths resulted from vehicle crashes: during the ten year period there were on average 8 passenger deaths onboard trains, 15 passenger deaths at stations, and 3 employee deaths each year*

Figure ES-3 - Public Transportation's Traffic Safety Impacts



Public transportation service improvements, transportation demand management (TDM) incentives, and transit-supportive development policies help reduce traffic risk in a variety of ways.

Conventional traffic safety analysis tends to overlook many of these impacts and so undervalues the full safety benefits of pro-transit policies.

Traffic safety is just one of many benefits provided by such policies. When all impacts are considered, transit investments are often very cost effective traffic safety strategies.

Public transportation investments and transit-supportive policies tend to increase traffic safety in several ways, as illustrated in Figure ES-3. *As a result, integrated programs to improve and encourage public transit, and support transit-oriented development, can provide significant traffic safety benefits.*

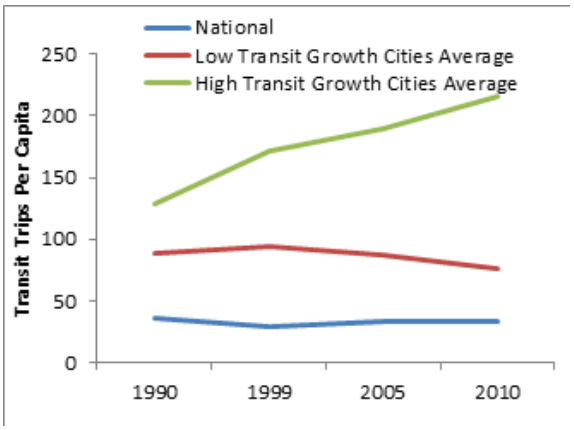
Conventional traffic safety analysis tends to evaluate risks using distance-based units, such as fatalities per 100 million vehicle-miles, which ignores the safety benefits of vehicle travel reductions. *When evaluated per capita, as with other health risks, the traffic safety benefits of public transportation investments and transit supportive policies become more obvious.*

U.S. cities which significantly improved their public transportation services and increased transit ridership experienced large reductions in traffic casualty rates compared with peer cities with less transit-supportive policies. The ridership gains in the high transit-growth cities did not require substantial increases in total transportation funding nor restrictions on automobile travel. Public transit services were improved by shifting resources (funding and road right-of-way) from highways to public transportation, and implementing various support policies including pedestrian and cycling improvements, more efficient parking management, transportation demand management, complete streets roadway design, and smart growth policies. These changes were not specifically intended as safety strategies, *they were justified for other reasons, but provide substantial traffic safety benefits.*

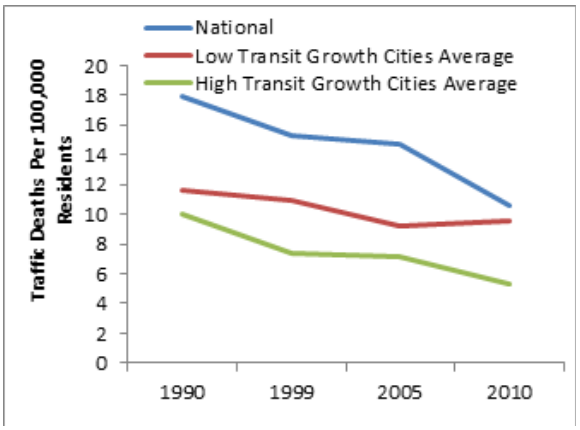
Many people have misconceptions about these risks: they exaggerate automobile safety and transit travel danger. To correct these misconceptions, transit organizations can help develop a more accurate and positive narrative that emphasizes the overall

Figure ES-4 - Trend Analysis (FTA and NHTSA data)

Transit Ridership Trends



Traffic Fatality Trends



The high-transit-growth cities (shown by the green line) experienced far larger traffic fatality reductions than the low-transit-growth cities and national trends (blue line). This suggests that pro-transit policies can significantly increase traffic safety.

safety of public transit travel. This information can be incorporated into all types of communications including newsletters, websites, media contacts, advertising, employee training, planning documents and performance evaluation.

A review of eleven major traffic safety programs found only two that recognize transit as a possible safety strategy, and these provide only minimal information or support. They generally assume that transit can only provide modest safety benefits, reflecting little understanding of the ways that pro-transit policies can leverage large crash reductions. However, transportation professionals, including traffic safety experts, are starting to apply more comprehensive and multi-modal analysis, including innovative TDM solutions. This is an opportunity for public transit organizations to build partnerships with traffic safety professionals.

Despite various obstacles discussed in this report, it is likely that pro-transit policies will be increasingly recognized as traffic safety and community strategies. We now have good, credible evidence that pro-transit policies can increase traffic safety. Many transportation professionals and traffic safety experts are ready to apply more comprehensive and multi-modal planning. Many will probably agree that efforts to discourage higher-risk driving will be more effective and acceptable if implemented with improved mobility options. Surveys indicate that many people want to drive less and rely more on walking, cycling and public transit, provided these options are convenient, attractive and integrated. Transportation planning is becoming more comprehensive and multi-modal. Experiences in various types of communities demonstrate that pro-transit policies can play an important role in achieving a community's traffic safety goals. These trends support a new public transit/traffic safety paradigm.

This is good news. This report identifies new safety strategies that are currently overlooked in most traffic safety planning. Because transit supportive policies provide many benefits besides safety, they are an opportunity to build coalitions among diverse groups including those concerned with traffic congestion problems, affordability, mobility for non-drivers, public health and environmental protection.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Introduction

Automobile crashes are a major cause of death, disability and destruction. These crashes result in death and disable younger people more than most other major health risks, such as heart disease and cancer, and so cause more potential years of life lost. Automobile crashes are the most common cause of children dying before their parents, and for every traffic death, eight people are hospitalized with significant injuries and 100 are treated in an emergency room (Bergen, et al. 2014). Although the analysis in this report is based on hundreds-of-thousands of traffic fatalities, it is important to see beyond the numbers: every one of these deaths and disabilities is a major tragedy, often leaving families emotionally and economically devastated.

Although there is nearly universal agreement that traffic safety is a prime planning goal for communities, incorporating public transportation into an overall traffic safety strategy has been overlooked. For the last half-century, there have been gains made through strategies of making the vehicle, driver and the road safer. Although distance-based (per 100 million vehicle-mile or billion vehicle-kilometer) crash casualty rates declined substantially between 1950 and 2000, per capita vehicle travel increased significantly during this period, *offsetting much of the safety gains*. Many of the most effective safety strategies, such as seatbelt and motorcycle helmet use, could be made even more compelling when paired with public transportation. While major investments in safer vehicles and roads, and various traffic safety strategies, have yielded positive outcomes, the U.S. still has the highest auto fatality rate amongst peer countries. Current traffic safety strategies should include public transportation and the land-use policies necessary to fully leverage public transit's impact.

This report describes a new approach that in addition to significantly reducing traffic crashes can provide other economic, social and

environmental benefits. Most broadly, it can be described as *transportation demand management* (TDM), which refers to a variety of strategies that change how and how much people travel in order to increase overall transportation system efficiency. This report focuses on a subset of these strategies, called *transit supportive policies*, which improve and encourage public transportation and help create more transit-oriented communities.

Table 1 - Examples of Transit-Supportive Policies

• Increased services (more routes, frequency and operating hours). • Grade separation (rail lines and bus lanes separated from general traffic). • New transit vehicles and rehabilitated stations.	• Enhanced user information. • Improved payment systems. • Introduction of amenities such as washrooms and on-board Internet services. • Fare discounts and affinity programs. • More efficient road, parking and vehicle insurance pricing.	• Enhanced walking and cycling access. • Park-and-ride facilities • More compact, mixed use development near transit stations. • More affordable housing in transit-oriented communities

Public transportation is a very safe travel mode. Its passengers are ten times as safer per mile because they have about a tenth the per-mile fatality rate as automobile occupants. Transit-oriented development (TOD) residents have about a fifth the per capita traffic fatality rate as residents in automobile-dependent communities. Evidence described in this report indicates that *even newer cities that developed during the Interstate Highway period can achieve significant reductions in traffic risk with transit supportive policies*. Many traffic safety strategies, such as graduated licenses and anti-drunk-driving campaigns, depend on travelers having suitable alternatives to driving, public transportation improvements and transit-oriented development help make this happen. As a result, traffic safety programs become more successful and politically acceptable if implemented in conjunction with public transit supportive policies.

However, when it comes to traffic safety, there are gaps between perception and reality. Most motorists consider themselves safer than average drivers (Allstate 2011) and many people have exaggerated fears of public transportation use (Litman 2014). Crashes are, fortunately, infrequent events; most drivers seldom have a crash and never cause an injury through one. As a result, our perception of traffic risk depends largely on how dangers

are communicated by experts and the media, and these messages are often distorted in ways that create excessive fear of public transportation. Automobile crashes are generally local stories, while bus and train accidents are unusual and dramatic, and so tend to receive much wider coverage. Popular movies and television also tend to show motorists surviving extraordinary risks, for example, in car chases, while public transit vehicles and stations are often used to portray gritty urban conditions.

Some transportation professionals also tend to understate automobile travel risks. Conventional traffic safety programs emphasize that, because most crashes can be blamed on special risks such as impaired driving or speeding, and modern vehicles offer significant occupant protection, a responsible driver in a modern vehicle is very safe. As a result, conventional traffic safety programs promote targeted strategies intended to reduce special risks, such as impaired and distracted driving. In this respect, deterrence is a key strategy because it dissuades most from these behaviors.

Yet, the effectiveness of these targeted safety programs is muted, in part, because *it is unrealistic to expect higher-risk travelers to reduce driving if they lack suitable alternatives*. As this report shows, pro-transit policies complement conventional traffic safety strategies such as efforts to reduce youth, senior, impaired and distracted driving. Because transit supportive policies provide many benefits besides safety, they are an opportunity to build coalitions with other interest groups such as those concerned with traffic congestion problems, affordability, mobility for non-drivers, public health and environmental protection.

This report investigates these issues. It compares the risks of various transportation modes and evaluates public transportation's impact on traffic safety. It describes ways that public transit improvements, incentives and transit-oriented development can increase safety. It evaluates the degree to which public transportation safety benefits are considered in conventional traffic safety program planning and when public transit investments are evaluated. It identifies specific ways that traffic safety programs, transportation agencies, municipalities and individuals can take advantage of public transportation safety strategies.

Evaluating Traffic Risk

This section describes how transportation risks are measured and how they compare between different modes.

Measuring Risk

Transportation risk analysis can be challenging because there are various types of risks and ways to measure them. Which risks are considered and how they are evaluated can significantly affect analysis results. Statistics can reflect crashes (also called *accidents*, *collisions* or *incidents*), *fatalities* and *casualties* (human injuries and fatalities). Some statistics only reflect damages and injuries to the users of a mode, such as pedestrians and cyclists, or automobile and transit vehicle occupants. Others also include injuries to others, such as when a train damages an automobile or an automobile injures a pedestrian. Public transportation risk statistics may include, in addition to crash injuries, falls (passengers or employees injured while walking through stations, boarding or alighting vehicles, and during vehicle acceleration or stops). Whether or not suicides are included can significantly affect transit risk statistics. Table 2 summarizes these various risk categories.

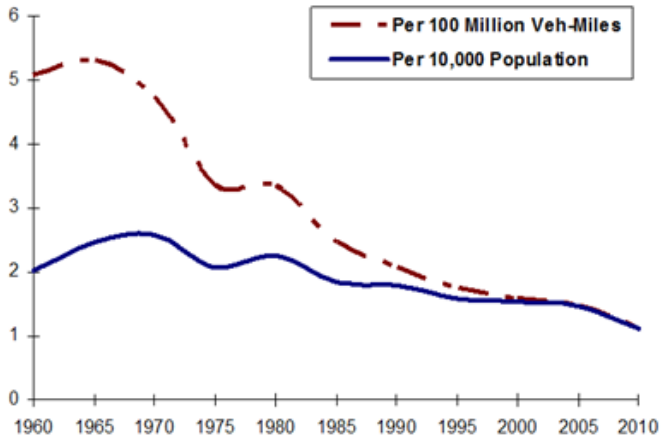
Table 2 Types of Transportation Risks

Perspectives	Crashes/Collisions
Internal (impacts on a mode's users).	• Crash damages to vehicle occupants. • Falls (e.g., in a train station). • Worker injuries.
External (impacts on non-users).	• Crash risk to other people (pedestrians, cyclists and occupants of other vehicles).

Transportation can impose a variety of crash risks. Which ones are considered can significantly affect analysis results.

Risk analysis is also affected by which measurement units are used. When measured using *distance-based units*, such as deaths per 100 million vehicle-miles or billion vehicle-kilometers, traffic fatality rates declined more than two thirds during the last half century (red line in Figure 1). However, per capita vehicle travel increased significantly during that period. When measured *per capita*, as with other health risks, (blue line in Figure 1), one sees a different picture. The successes that are evident from the use of seat belts and other interventions, will be boosted by offering alternatives to driving.

Figure 1 - U.S. Traffic Fatalities



During the last half-century per mile traffic fatality rates declined substantially, but growth in per capita vehicle mileage during that period shows a different picture.

Although the U.S. has about average traffic fatality rates *per vehicle-mile*, it has *highest traffic fatality rates per capita amongst peer countries* (Figure 2). Despite declining crash rates in recent decades, the U.S. is maintaining its poor ranking (IRTAD 2014) because we drive more than peer countries.

Figure 2 - International Traffic Fatality Rates (Wikipedia 2009; based on WHO and OECD data)

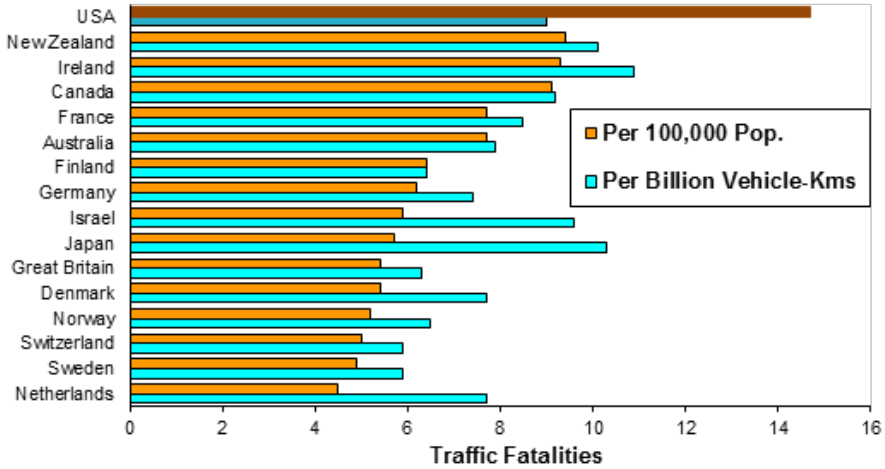
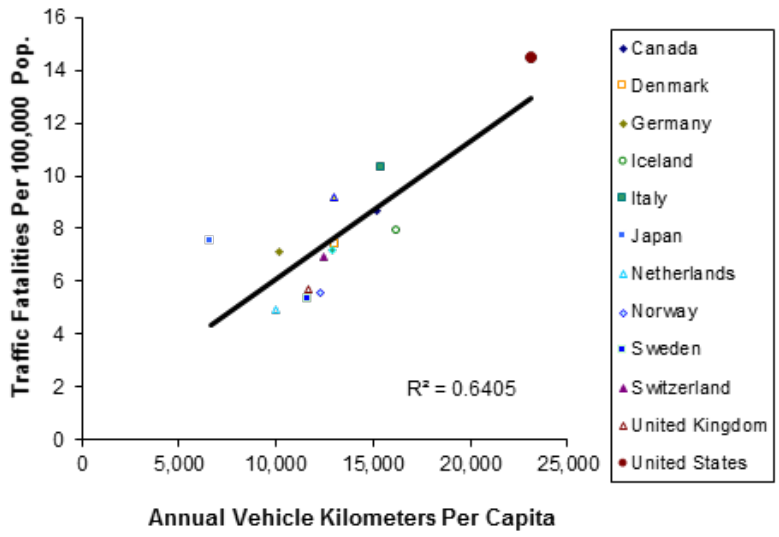


Figure 3 - Vehicle Mileage and Traffic Fatality Rates In OECD Countries (OECD Data)



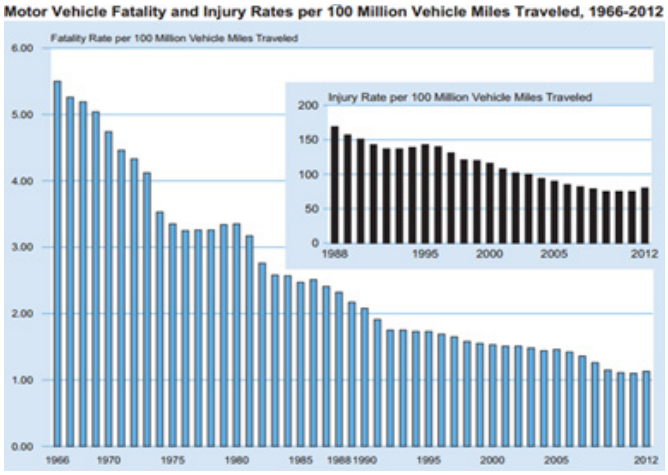
Among economically similar countries there is a strong positive relationship between per capita vehicle travel and traffic deaths. This can explain why the U.S. has the highest per capita traffic fatality rate, because we drive more than peer countries.

This high crash fatality rate can be explained by high per capita vehicle mileage in the U.S. Among peer countries there is a strong positive relationship between vehicle travel and traffic deaths (Figure 3).

This has important implications for traffic risk analysis. If risk is evaluated using distance-based units, increased vehicle travel is not considered a risk factor and the safety benefits of public transportation are invisible. Measuring risk *per capita*, as with other health risks, recognizes the additional crashes caused by policies that increase vehicle travel and underfund public transportation strategies. Most casualty crashes involve multiple vehicles, so even responsible motorists who observe all traffic rules are safer if other travelers reduce their mileage since this reduces their chance of being the victim of other drivers' errors (Edlin and Karaca-Mandic 2006).

Conventional traffic safety analyses tend to overlook these factors. For example, the National Highway Traffic Safety Administration (NHTSA), *Traffic Safety Facts Report* includes a graph (Figure 4) showing the dramatic decline in crashes per 100 million vehicle-miles, but no comparable graph showing per capita crash rates. Similarly, a table titled, "Motor Vehicle Traffic Fatalities and Fatality Rates, 1899-2012" (page 232) reports distance-based traffic death rates, but no comparable per capita death data. The Report includes no comparison of crash rates by mode which would show the relative safety of public transportation. These practices tend to ignore the potential safety benefits of vehicle travel reduction strategies such as public transit

Figure 4 - Distance-based Traffic Crash Statistics (Traffic Safety Facts, NHTSA, 2014)



The NHTSA Traffic Safety Facts annual report includes these graphs showing the dramatic declines in crash fatality and injury rates per 100 million vehicle miles, but no comparable graph showing per capita fatalities and injuries. Distance-based indicators ignore the additional crashes resulting from policies that stimulate auto use and the safety benefits of vehicle travel reduction strategies such as public transportation and transit-oriented development. Measuring crash rates per capita, as with other health risks, better recognizes public transit's safety benefits.

improvements, transportation demand management strategies, and transit-oriented development.

Similarly, the U.S. Department of Transportation's traffic safety targets are all distance-based (IRTAD 2014, p. 518). For example, the 2012 target is to have fewer than 1.05 deaths per 100 million vehicle-miles, and its 2014 targets are to have fewer than 1.02 deaths per 100 million vehicle miles travelled, fewer than 0.16 non-occupant deaths per 100 million vehicle miles, fewer than 63 motorcycle fatalities per 100,000 motorcycle registrations, fewer than 0.82 passenger vehicle fatalities per 100 million vehicle miles, and fewer than 0.114 fatalities per 100 million large truck and bus vehicle miles travelled. Because they are distance-based, public transportation's safety benefits are not measured.

Comparing Risks by Mode

Travel by public transportation is far safer than automobile travel. Intercity and commuter passengers have about one-20th, urban rail and bus passengers about one-30th, per billion passenger-miles as automobile travel (Table 3). Of course, many factors affect an individual's crash risk, and there are many ways that motorists can increase their safety. For example, drivers can reduce their risks by observing speed limits, staying sober and avoiding distractions, since about 30% of fatal traffic crashes involve speeding, 31% involve an impaired driver, and distracted driving contributes to a significant

portion of crashes (NHTSA 2012), but there are still significant risks beyond individual drivers' control, such as mechanical failures and errors by other road users, so even law-abiding motorists face much greater crash risks than public transportation's passengers.

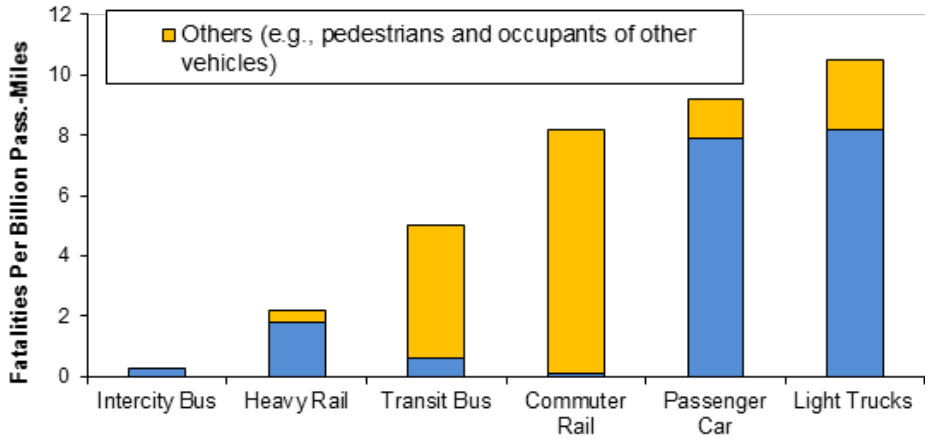
Table 3 - Passenger Fatalities per Billion Passenger-Miles, 2000-2014 (BTS)

Travel Mode	Deaths Per Billion Passenger-Miles
Motorcycle	237.57
Car or light truck driver or passenger	6.53
Local ferry boat	2.46
Commuter rail and Amtrak	0.36
Urban mass transit rail (subway or light rail)[1]	0.33
Bus (transit, intercity, school, charter)	0.2
Commercial aviation	0.02

Public transit passengers have far lower traffic casualty rates than automobile occupants.

Even considering external risks (danger to other road users) public transportation has lower crash rates per passenger-mile than automobile travel (Figure 5). Since more than 90% of transit bus and commuter rail risks are external, total crash rates tend to decline as vehicle load factors increase (more passengers per transit vehicle-mile), so incentives for travelers to shift from automobile to transit tend to impose minimal additional risk.

Figure 5 - Transport Fatalities (Litman and Fitzroy 2012, based on FHWA and APTA data)



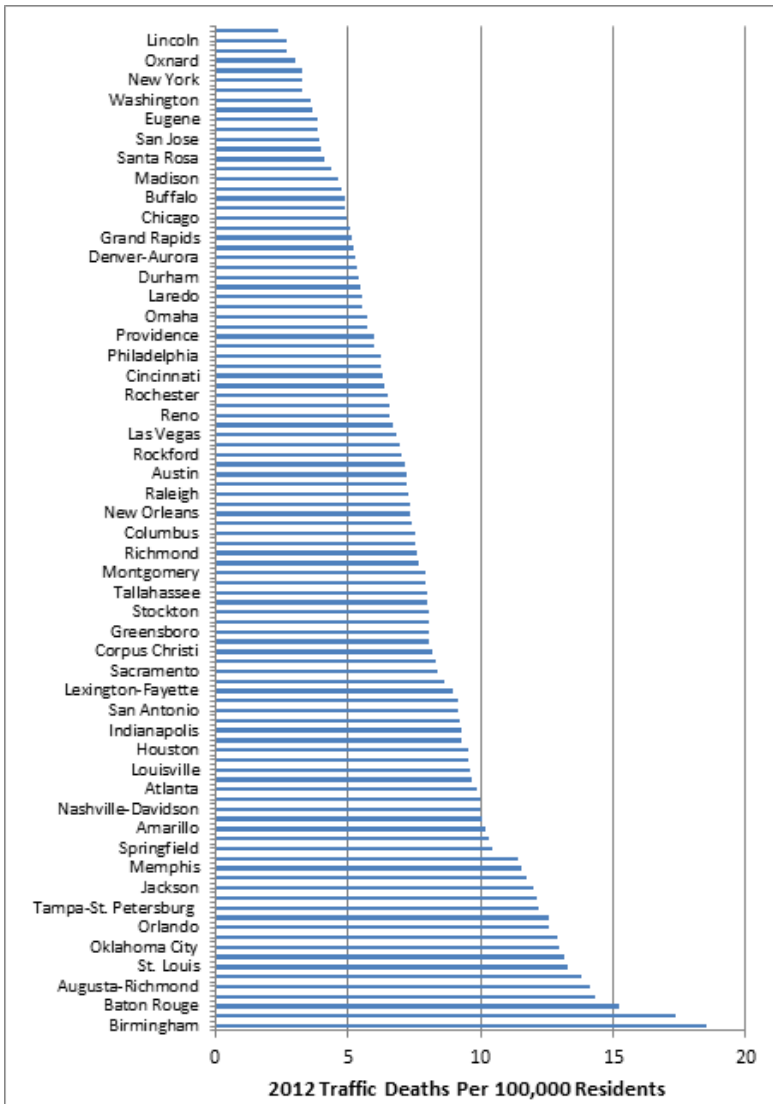
Transit travel tends to have lower total crash rates than automobile travel, even taking into account risks to other road users, and these crash rates tend to decline as transit ridership and load factors increase.

1 *Only a minor portion of reported rail transit deaths resulted from vehicle crashes: during the ten year period there were on average 8 passenger deaths onboard trains, 15 passenger deaths at stations, and 3 employee deaths each year.*

Regional Analysis

Regional analysis measures crash risks to people in a particular city or urban region. In order to analyze these risks the Victoria Transport Policy Institute assembled a unique database that integrates public transportation ridership, vehicle travel and traffic crash statistics for 101 U.S. urban regions, including all the largest cities plus a representative sample of smaller cities.[2] Figure 6 compares total (pedestrian, cyclist, automobile and bus passenger) traffic fatality rates of these regions. The range is significant: from 2.33 to 18.53 deaths per 100,000 residents; the five highest ranking cities have more than five times the fatality rate as the lowest five ranking cities.

Figure 6 - Urban Region Traffic Fatalities (Traffic Safety Facts, NHTSA, 2014)



This graph compares per capita traffic fatality rates for 101 U.S. cities. Only about half the cities included in the study are named in this graph.

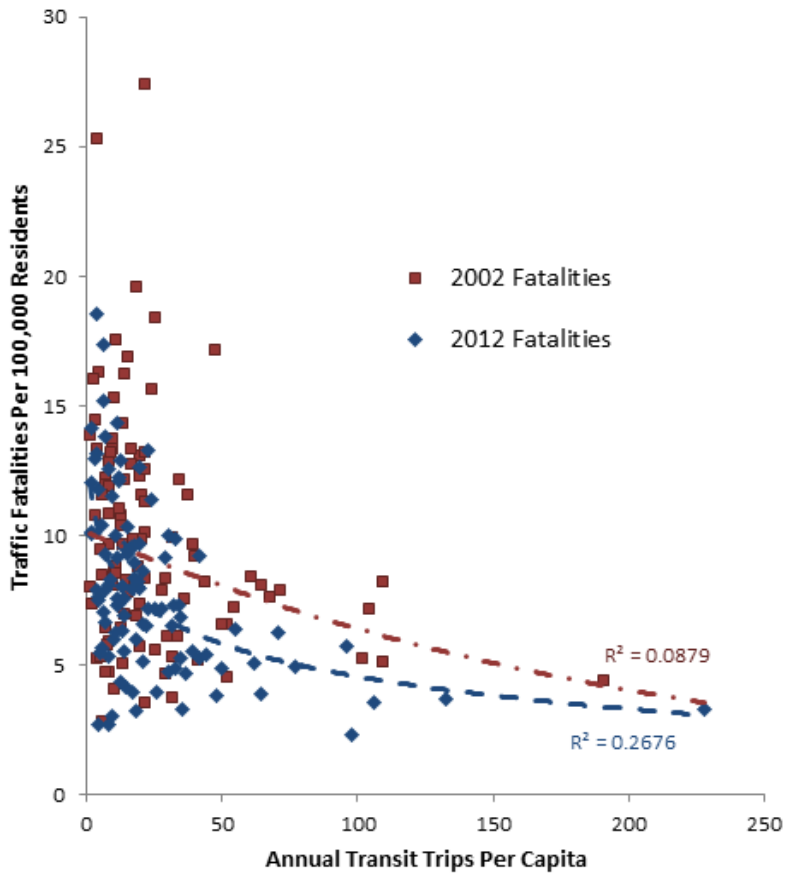
Total (pedestrian, cyclist, automobile and bus passenger) traffic fatality rates vary from less than 3 to more than 18 deaths per 100,000 residents. Fatality rates are even higher in many rural areas.

2 *Risk Analysis Spreadsheet, Victoria Transport Policy Institute, at www.vtpi.org/transit-risk.xls.*

What explains this large variation? Although many factors can affect traffic risk, most of these are similar among these regions. For example, there is little variation in roadway design, vehicle safety standards, traffic law enforcement practices, emergency response or medical care between U.S. cities. In fact, some impacts are the reverse from what would be expected. For example, safety experts often assume that increased density, smaller vehicles and freezing weather increase traffic casualties, but traffic fatality rates tend to be higher in less dense Southern urban regions where residents drive larger vehicles and experience little snow and ice, than in denser Northern cities where vehicles are smaller and travel conditions more hazardous.

Figure 7 illustrates the relationship between transit trips and traffic fatality rates for these cities in 2002 and 2012. Total fatality rates declined 21% between 2002 and 2012, but in both time periods higher-transit-ridership regions (more than 50 annual transit trips per capita) have about half the average traffic fatality rates as low-transit-ridership cities (less than 20 annual trips per capita). *Since Americans average about 1,350 annual person-trips, this increase from less than 20 to more than 50 annual transit trips represents a small increase in transit mode share, from about 1.5% up to about 4% (Santos, et al. 2011)*.

Figure 7 - U.S. Traffic Deaths (Litman 2004)

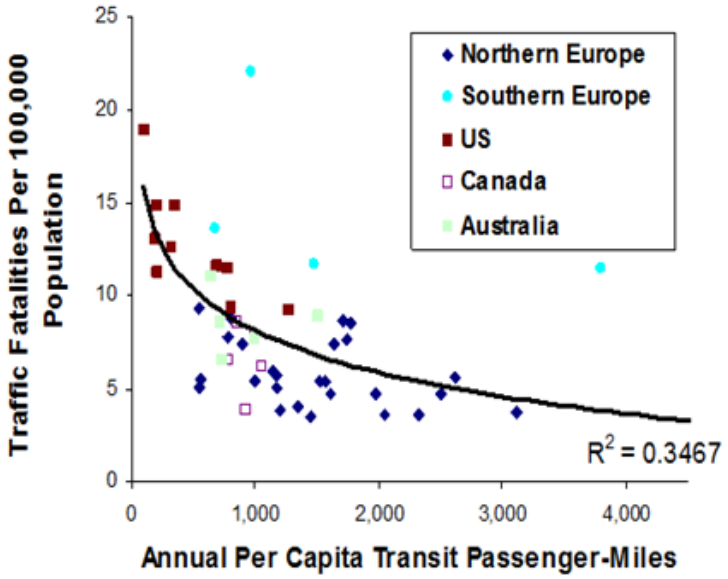


This graph illustrates the relationship between per capita transit ridership and total (including pedestrian, cyclist, automobile occupant and transit passenger) traffic fatalities for 101 U.S. cities in 2002 and 2012.

During this 10-year period, traffic fatality rates declined 21%. In both periods, traffic fatality rates tend to decline as transit travel increases. Regions with more than 50 annual transit trips per capita have about half the average traffic fatality rate as cities with less than 20 annual trips per capita, indicating that relatively modest increases in transit ridership are associated with very large traffic safety gains.

International data show a similar negative relationship between transit travel and crash rates (Figure 8).

Figure 8 - Traffic Fatalities Vs. Transit Travel (Kenworthy and Laube 2000)



International data indicate that per capita crash rates tend to be lower in more transit-oriented cities. (Each dot indicates a major city)

To help understand this relationship it is interesting to analyze exceptions: low-transit-ridership cities with low traffic fatality rates, and higher-transit-ridership cities with relatively high traffic fatality rates. Table 4 lists the 10 cities in this sample with the lowest traffic fatality rates. Many are large, high-transit-ridership cities as expected, but some smaller cities with low-transit-ridership cities, averaging fewer than 20 annual transit trips per capita. These tend to have relatively low per capita vehicle mileage (5,540-9,618 annual VMT per capita, compared with 10,036 average annual VMT for the sample overall) which helps explain their low crash rates.

Table 4 - Low Traffic Fatality Rate Urban Regions

City	2010-2012 Avg. Death Rate	2012 Public Transportation Trips Per Capita	Public Transportation Mode Share	2012 Annual VMT Per Capita	2012 Population
Boston, MA	2.3	98.0	5.92%	8,768	636,479
Lincoln, NE	**2.7**	**8.0**	0.52%	**8,085**	**265,404**
Boise City, ID	**2.7**	**4.4**	0.25%	**9,481**	**212,303**
Oxnard, CA	**3.0**	**9.7**	0.61%	**8,425**	**201,555**
Springfield, MA	**3.2**	**18.5**	1.02%	**9,618**	**153,552**
New York, NY	3.3	227.9	20.30%	5,949	8,336,697
Minneapolis-St Paul, MN	3.3	35.4	2.08%	9,035	392,880
Washington, DC	3.6	105.8	6.23%	9,002	632,323
San Francisco, CA	3.7	132.8	8.10%	8,692	825,863
Eugene, OR	3.8	47.8	3.67%	6,906	157,986
Averages	3.33	61	4.27%	8,280	1,056,227

Among the lowest-crash-rate cities, some (bold) have low transit ridership (less than 20 annual trips per capita). These tend to be small cities with relatively low annual vehicle travel per capita.

Among the 10 highest transit ridership cities (more than 50 annual trips per capita), all have relatively low traffic fatality rates (4.6 average and 6.4 maximum deaths per 100,000 residents), as indicated in Table 5.

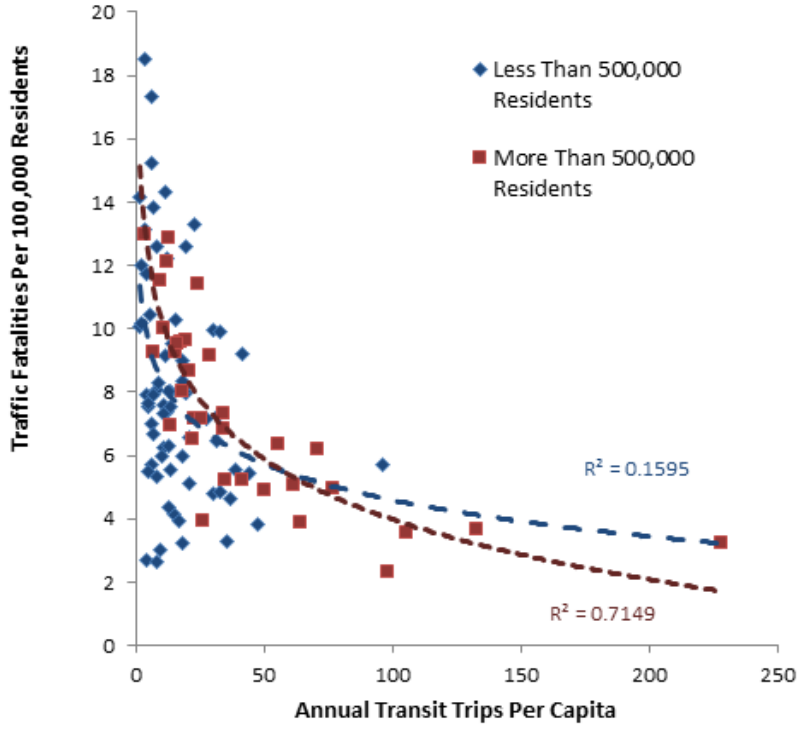
Table 5 - High Transit Ridership Urban Regions

City	2010-2012 Avg. Death Rate	2012 Transit Trips/Ca	Transit Mode Share	2012 Annual VMT Per Capita	2012 Population
Los Angeles-Long Beach	6.4	55.3	3.47%	8,447	3,857,799
Portland, OR	5.0	61.7	4.09%	8,005	603,106
Seattle, WA	3.9	64.3	3.61%	9,448	634,535
Philadelphia	6.2	71.1	5.21%	7,231	1,547,607
Chicago, IL	5.0	77.1	5.29%	7,719	2,714,856
Honolulu	5.7	96.3	7.78%	6,564	345,610
Boston, MA	2.3	98.0	5.92%	8,768	636,479
Washington, DC	3.6	105.8	6.23%	9,002	632,323
San Francisco, CA	3.7	132.8	8.10%	8,692	825,863
New York, NY	3.3	227.9	20.30%	5,949	8,336,697
Averages	4.55	95	6.62%	8,101	1,886,929

Among the higher-transit ridership cities (more than 50 annual trips per capita), all have low traffic fatality rates.

The negative relationship between public transportation use and traffic risk is particularly strong (R^2 = 0.7149) in larger cities, those with more than a half-million residents, as indicated in Figure 9.

Figure 9 - Transit Travel Versus Traffic Fatalities By City Size (Traffic Safety Facts, NHTSA, 2014)



For the 32 cities with more than 500,000 residents, the negative relationship between transit travel and traffic fatality rates is statistically very strong (R^2 is a very high 0.71). Nearly all large cities with less than 30 average annual transit trips per capita have more than 6 traffic fatalities per 100,000 residents, and nearly all with more than 50 transit trips per 100,000 have less than 6 fatalities per 100,000 residents.

Other studies using various methods of analysis also indicate that relatively small public transportation ridership gains are associated with proportionately larger reductions in per capita crash rates (Duduta, et al. 2012). For example, analyzing 29 years of traffic data for 100 U.S. cities, Stimpson, et al. (2014) found that a 10% increase in the portion of passenger-miles made by public transit is associated with 1.5% reduction in total traffic deaths. Since only about 2% of total person-miles are currently by public transportation, this means that a 1% increase in transit mode share is associated with a 2.75% decrease in fatalities per 100,000 residents, which translates into a 5% decrease in total traffic fatalities in the 100 cities included in their study.[3] They conclude,

> *"We found that increased use of mass transit was associated with fewer fatalities from motor vehicle crashes after accounting for climate and the economic costs of driving. Therefore, reduced traffic deaths may be counted among the benefits of mass transit use in addition to already reported benefits such as economic development, reduced traffic congestion, and lower emissions." (Stimpson, et al. 2014, p. 6)*

This raises an interesting research question: why are relatively modest mode shifts associated with such large reductions in traffic risk? Even the 13 lowest-crash-rate cities only average 4.27% transit mode share and approximately 534 annual transit passenger-miles per capita, compared with an overall average of 1.57% transit mode share and 160 transit passenger-miles per capita for the other regions. Although, as previously described, public transportation travel has far lower per-mile traffic fatality rates than automobile travel, a shift of 2.70-percentate points or 374 annual passenger-miles from automobile to transit cannot explain a 50% reduction in traffic fatalities.

One explanation is that many of the factors that tend to increase travel by public transportation also tend to increase traffic safety (Ewing and Dumbaugh 2009; Garrick and Marshall 2011), as summarized in Table 6. For example, active transport (walking and cycling) improvements, more compact and mixed development, lower traffic speeds, and higher fuel and parking prices all tend to encourage public transit travel and increase traffic safety. Transit-supportive policies "leverage" vehicle travel reductions beyond the mileage shifted from automobile to public transportation, many traffic safety

3 *Personal communications with Dr. Jim P. Stimpson, 3 October 2014*

Table 6 - Factors That Increase Public Transit Travel and Traffic Safety

Urban Design	Transport System	Economic
• Development density and mix • Reduced parking supply	• High quality transit (convenient, fast, comfortable, affordable) service • Good walking and cycling conditions • Lower traffic speeds • More connected roadway network • Transportation demand management	• High fuel taxes, parking fees and road tolls

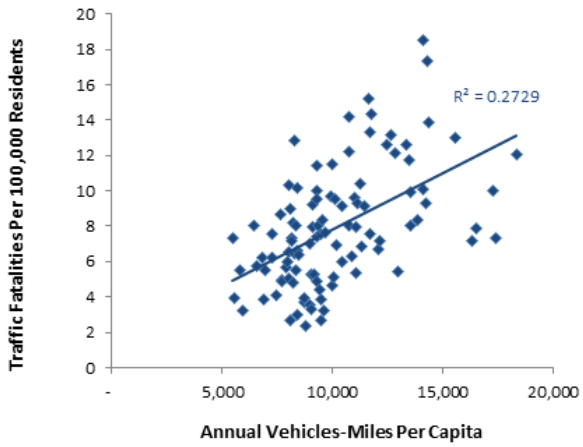
Several factors tend to encourage public transit travel, reduce automobile travel and increase traffic safety. If implemented together they help create "transit-oriented" communities.

strategies encourage transit ridership (for example, graduated drivers licenses and anti-drunk driving campaigns tend to shift some travel from automobile to transit), and compact, mixed, transit-oriented development tends to have low crash rates due to lower traffic speeds and reduced total driving. These factors help explain why relatively small increases in public transit usage are associated with proportionately larger reductions in per capita automobile travel and crash rates.

These factors reduce traffic crashes, in part, by reducing per capita vehicle travel. There is a strong positive relationship between per capita vehicle travel and traffic fatality rates, as illustrated in Figure 10. The 17 cities where residents drive less than 8,000 annual vehicle-miles average 6.0 traffic fatalities per 100,000 residents, nearly half the 11.1 traffic fatalities per 100,000 residents in the 16 regions where residents drive more than 13,000 annual vehicle-miles on average. Residents of higher-annual-mileage cities tend to drive more, drive at higher speeds, and have fewer ways to avoid higher-risk (youth, senior and impaired) driving, as discussed later.

Several recent studies have investigated how urban development patterns affect transport activity and traffic safety. Using sophisticated statistical analysis, Ewing and Hamidi (2014) found that more compact communities had significantly higher transit ridership, slightly higher total crash rates, but much lower *fatal* crash rates than sprawled communities: each 10% increase in their compact community index is associated with an 11.5% increase in transit commute mode share,

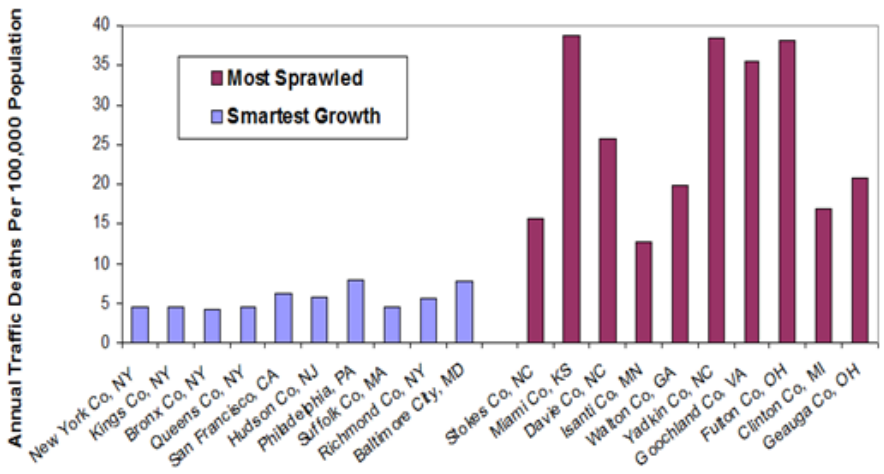
Figure 10 - Vehicle Travel Versus Traffic Fatality Rates (Traffic Safety Facts, NHTSA, 2014)



This graph shows the relationship between vehicle travel and traffic fatality rates for 101 U.S. urban cities. This and other research indicate that traffic casualty rates increase with vehicle travel. All cities with less than 4 annual deaths per 100,000 residents have less than 10,000 annual vehicle-miles per capita.

a 0.4% increase in total crashes, and a 13.8% reduction in traffic fatalities. Figure 11 compares smart growth and sprawled community traffic fatality rates. Overall, urban residents have lower per capita traffic fatality rate, compared with suburban and rural residents (Lucy 2003; Myers, et al. 2013; NCSA 2014).

Figure 11 - Annual Traffic Death Rate (Ewing, Schieber and Zegeer 2003)



Of 280 U.S. counties, the ten with the highest smart growth ratings have approximately a fifth the per capita traffic fatality rate as the ten with the highest sprawl ratings.

Local Impacts

Traffic engineers often analyze local crash patterns to identify "black spots," roadways with high crash rates. This reflects a conventional paradigm which assumes that automobile travel is overall safe, so safety improvements should target special hazards. However, this approach has weaknesses: it requires extended crash history (interventions are only implemented after numerous crashes occur at a location), it fails to support systematic safety strategies such as transportation demand management, and some strategies intended to reduce crash rates at one location, such as expanding roads and intersections, can increase total, area-wide crashes by encouraging more and faster driving (Dumbaugh and Rae 2009). If targeted interventions truly reduced total crash risks, the U.S., which is a world leader in vehicle and roadway safety engineering, should not have the highest crash rate among peer countries. A new traffic safety paradigm applies more preventive, integrated traffic safety strategies based on more comprehensive analysis of factors that affect crash rates.

Macro-level collision prediction models (CPM) evaluate how roadway and neighborhood design factors affect neighborhood crash rates, and

therefore how local policies and planning practices can increase traffic safety (Lovegrove, Lim and Sayed 2010). This research indicates that more compact, mixed, multi-modal neighborhoods with denser street networks, lower traffic speeds, more transit service, and more walking, cycling and public transit travel have lower crash rates than more sprawled, automobile-dependent neighborhoods (Garrick and Marshall 2011; Karim, Wahba and Sayed 2012). Higher-risk groups (youths, seniors and alcohol drinkers) are especially likely to reduce driving, as described below.

Analysis of the relationships between transit travel and local traffic safety is complicated by confounding factors. Both transit ridership and crash rates are positively associated with youth, income and urban density. Larger cities tend to have higher traffic densities (more vehicles per lane-mile) which increases total crash frequency, and therefore insurance costs per vehicle, but these are mostly property-damage-only crashes. Denser cities also tend to have more transit travel, less vehicle travel, and lower traffic speeds, which reduce traffic casualty rates (injuries and deaths). As a result, some analyses may show positive associations between transit use and crashes, but these are spurious relationships; they do not actually indicate that increased transit travel increases crash risk. For example, transit-oriented areas often have more crashes involving public transportation vehicles and passengers than more automobile-oriented areas, but this simply reflects the increased public transit travel in the area. It does not indicate that public transit travel is dangerous. Similarly, public transportation services often operate on crowded urban roads where crash rates are relatively high, but automobiles would also have high crash rates under those conditions, and shifts from automobile to transit can reduce total crash risks. Table 7 summarizes factors that contribute to differences in crash rates between transit-oriented and automobile-dependent areas, which should be considered when evaluating risks.

Table 7 - Comparing Compact and Sprawled Regions (Litman 2014; Ewing and Hamidi 2014)

Compact and Transit-Oriented	Sprawled and Automobile-Dependent
• More walking, cycling and public transportation travel.	• Less walking, cycling and public transportation travel.
• Less automobile ownership and use.	• More automobile ownership and use.
• Higher traffic density and more intense congestion.	• Lower traffic density and less intense congestion.
• Less time spent driving and less per capita congestion delay.	• More time spent driving and higher congestion delay.
• Lower traffic speeds.	• Higher traffic speeds.
• Higher per vehicle crash rates (mainly property damage only), and higher insurance premiums.	• Lower per vehicle crash rates and lower insurance premiums.
• Lower per capita traffic casualty (death or injury) rates.	• Higher per capita traffic casualty (death or injury) rates.

Compact, transit-oriented areas tend to have higher total crash rates, but these are mostly lower-speed collisions. Per capita traffic casualty (death and injury) rates tend to be higher in sprawled, automobile dependent areas with higher speeds.

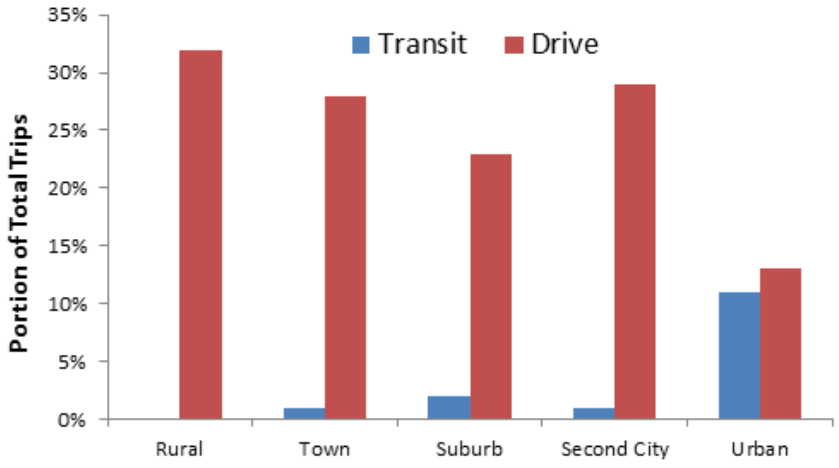
High-Risk Driving Impacts

This section investigates how public transportation affects higher-risk (youth, senior, impaired and distracted) driving.

Young Drivers

Some traffic safety strategies, including graduated driver's licenses, high insurance premiums for younger drivers, and campus transport management programs, discourage driving by youths (IIHS 2009; SR4T 2014). This tends to reduce young driver crashes but increases their demands for alternative modes (Van Heeke, Sullivan and Baxandall 2014; Weiss 2012). Surveys indicate that many young people want to drive less and rely more on alternatives, provided they are convenient and affordable (APTA 2014; Davis, Dutzik and Baxandall 2012). Serving these demands, by improving walking, cycling and public transit services, can provide many benefits, including financial savings, improved health and fitness, in addition to increased traffic safety.

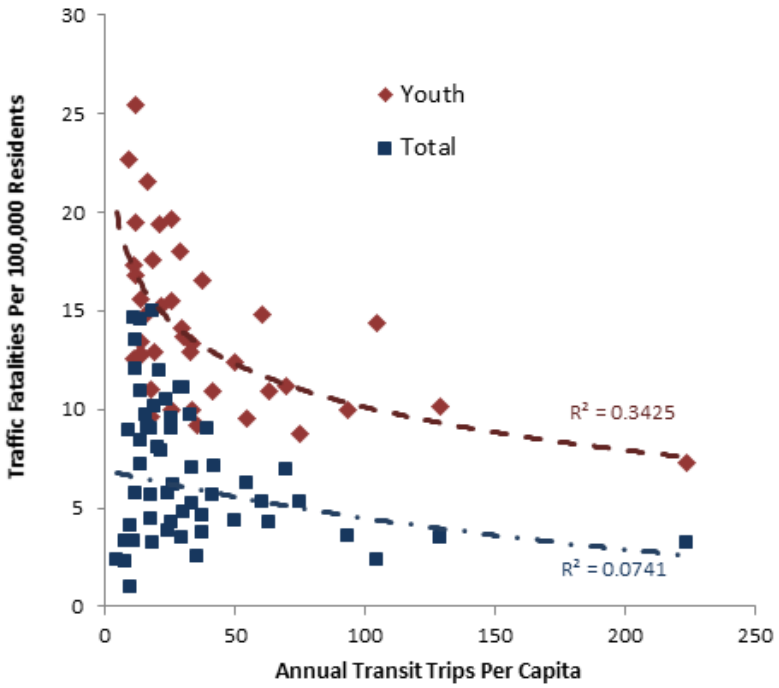
Figure 12 - Teens' Mode Share When Traveling Without Parents (McDonald 2005, Table 3)



Urban teens use public transit much more and drive much less than non-urban teens. This suggests that many young people will reduce the amount they drive, and associated traffic risks, if they have suitable mobility options, including quality public transit and transit-oriented development.

On average, urban teens take five times as many transit trips and drive half as much (Figure 12), and have about half the per capita traffic fatality rate as rural teens (NHTSA 2009). Nationwide, youths aged 15-25 average 17.3 traffic fatalities per 100,000 population, 56% higher than 11.1 overall rate, and urban youths had 10.9 deaths per 100,000, 38% higher than the 7.9 overall urban rates. Both youth and overall traffic fatality rates tend to decline as public transportation travel increased in their community,

Figure 13 - Youth and Total Traffic Fatality Rates (CDC 2012)



Youths (15-25 years old) have about twice the average traffic fatality rates as the overall population.

Both youth and total traffic fatality rates decline significantly with increased transit travel: cities where residents take more than 50 transit trips have about half the average traffic fatality rate as cities where residents average fewer than 20 annual transit trips.

The statistical relationship between transit ridership and traffic safety is particularly strong for youths (R2 = 0.3425), suggesting that many young people are willing to reduce their higher-risk driving if given suitable alternatives.

they are about half as high in urban regions where residents take more than 50 annual transit trips compared with those that do not, as illustrated in Figure 13.

In addition to previously-mentioned factors that discourage youth driving, many in this age group attend colleges and universities with campus transportation management programs which often include walking and cycling improvements, transit service improvements, U-Passes (students ride transit fare-free, so a student-body card becomes a transit pass), special night transport services, and efficient parking fees (Van Heeke, Sullivan and Baxandall 2014). Such policies tend to reduce the portion of students who bring motor vehicles to campus, and make it convenient and socially acceptable to use public transportation when traveling to events that involve alcohol or drug consumption, which reduces high-risk driving.

Even campuses in relatively automobile-dependent communities are implementing public transportation improvements and transportation management programs that reduce risky driving. For example, twenty bus routes serve West Virginia University, including one to downtown Morgantown which operates until midnight. This service is free to university and local high school students. The University of Arkansas has ten bus routes that are free for students, plus a *Safe Ride* program that provide students who feel threatened or too impaired to drive a free ride home from any location within the Fayetteville city limits. The Illinois State University has two local bus routes, plus *Nite Ride* and *Late Night Ride* bus service between campus and downtown Bloomington which operates as late as 2:25 a.m. on weekends. Late-night transit services can help reduce impaired driving, and associated crash risks, as described below.

Senior Drivers

There is growing concern about the risks older drivers (particularly those over 75 years of age) cause themselves and others. Although per capita crash rates tend to be relatively low for drivers 60-70 years of age, this reflects the reduction in driving that occurs when people retire; crash injury rates per vehicle-mile tend to increase after age 70 (CDC 2011). In 2012, people over 65 years of age represent 12% of U.S. residents but 17% of traffic deaths, and their numbers are growing (NHTSA 2012). Individuals, organizations and governments use various strategies to reduce these risks (AARP 2011; Saisan, White and Robinson 2014):

- Many seniors avoid driving on busy roads or at night, and some voluntarily surrender their driver's licenses.
- Many organizations provide self-assessment and family-member-assessment guidelines to help seniors and their family members determine whether their driving ability is unsafe.
- Many organizations offer senior driver skills training.
- Many jurisdictions have special testing requirements or older drivers, or programs to identify and restrict higher risk senior drivers.
- Some programs encourage seniors to shift from driving to alternative modes.

Many of these strategies become more effective if seniors have suitable alternatives to driving. Transit service improvements and transit-oriented development (for example, housing appropriate for seniors located in walkable neighborhoods with frequent transit service) helps seniors reduce their driving and associated risks.

Many seniors want better alternatives to driving. For example, a survey of Hennepin County, Minnesota senior residents found more than 60% are "concerned" or "very concerned" about their driving safety, 38% reported being unable to travel to necessary or desired activities, and many who currently drive want better travel options in anticipation of their future needs (Wasfi, Levinson and El-Geneidy 2012). Some traffic safety programs help seniors continue driving, such as special driving refresher courses and guidance on selecting safer (i.e., crash protecting) vehicles, but there is no independent research demonstrating that they actually reduce crashes;

they may encourage higher-risk seniors to continue driving. Some traffic safety organizations encourage seniors to consider shifting from driving to alternative modes, including walking, ridesharing and transit travel (AAA 2011), and a few advocate improvements in these modes. For example, the American Association of Retired Persons advocates general transit service improvements, special services for seniors, and more transit-oriented development as part of their *livable communities* program (AARP 2014).

Impaired Distracted Drivers

Drinking alcohol is common at social events, and some people consume legal or illegal drugs that affect driving judgment and skill. It is therefore unsurprising that many people admit to at least sometimes driving while impaired by alcohol or drugs (SAMHSA 2011). Similarly, many drivers use distracting devices such as mobile telephones and computers (NSC 2012). These are major traffic risks. In response, many governments and traffic safety organizations have policies and programs to discourage impaired and distracted driving, including stricter enforcement and punishment of driving under the influence (DUI) violations, laws prohibiting certain types of distracted driving, and campaigns to discourage these risky behaviors (NHTSA 2012b), but such programs generally provide only vague and unrealistic guidance concerning alternatives to driving (White 2014).

For example, some anti-impaired-driving programs encourage drinkers to rely on designated drivers (a group member who stays sober in order to chauffer home friends who have been drinking), although this is often impractical and unsuccessful (Broyles 2014). Designated drivers tend to drink less than designated drinkers, but still often exceed legal limits (Timmerman et al. 2003). Other campaigns encourage drinkers to use taxis or rent a hotel room, but many drinkers find this unaffordable. Some jurisdictions subsidize rides for impaired restaurant and bar patrons, but such programs tend to be complicated and costly and so they can only satisfy a small portion of needs (Decina, et al. 2009). For example, during a 12-month period the *Wisconsin Saferide* program cost $153,820 in state funds to subsidize 25,028 rides (mostly taxi trips, some volunteer chauffeur trips) at 860 drinking establishments, which represents just 0.56 weekly rides per establishment, and in addition to the $6.15 per ride state subsidy the program required

substantial local funds plus user fees ranging from $5 to $20 per trip (WDOT 2004). Because of their small scale and high costs such programs can only reduce impaired driving a small amount.

Public transportation and transit-oriented development can provide much larger reductions in impaired and distracted driving. The quality of travel options in an area affects the social acceptability of using alternative modes, which affects how people travel to higher risk activities. In automobile dependent communities it is common to drive to parties, restaurants, and bars,[4] but in multi-modal communities it is common to walk or use transit. Traveling to such destinations by walking, cycling and public transit eliminates the possibility of driving home drunk; even if they stay later than transit service operates they will usually take a taxi or SafeRide home. Transit-oriented development creates communities where residents can walk to local restaurants and bars, further reducing the need to drink and drive (Mathis 2014). Many public transit systems experience relatively high transit demand to and from local entertainment districts on Friday and Saturday nights (Sandor 2012). Although limited, there is compelling evidence that appropriate transit services reduce impaired driving and resulting crashes.

Jackson and Owens (2009 and 2011) investigated the effects that later service on Washington DC's Metro system had on impaired driving rates. Prior to 1999 the last train departed the city center at midnight. In 1999, the service was extended one additional hour on Fridays and Saturdays, and finding that there was sufficient ridership during the added period, the service was extended to 2:00 am in 2002, and to 3:00 am in 2003. The research indicates that the later service hours increased drinking in station-area restaurants and bars but reduced drunk driving and crashes: they found that *for each additional service hour DUI arrests declined 15.6%*, and *fatal crashes involving intoxicated drivers declined 70% near Metro stations*. With only one exception, they found that every neighborhood with more than 2 bars located within 100 meters of a Metro station saw DUI arrest rate decline at least 10% per additional hour of Metro service (i.e., the three hour extension reduced DUI arrest 30% compared with what would otherwise have occurred). In contrast, most neighborhoods with bars not located close to

4 *Ironically, bars have among the highest parking requirements of any land use types (de Place 2010), indicating that conventional transport planning assumes that it is normal for drinkers to drive, and encourages this practice.*

Metro stations experienced increased DUI arrest rates.[5] Similarly, Broyles (2014) found that Phoenix, Arizona university students are significantly less likely to drink and drive if they live close to the city's light rail transit system which connects student housing with various campuses, commercial districts and entertainment centers.

Public transportation can also reduce distracted driving. Many passengers report that they shift from driving to public transportation in part because they can work, rest and play while traveling, including use of mobile telephones, computers and portable movie players (Schwieterman, et al. 2014; Thompson 2010). Surveys of Millennials (people born between 1982 and 2003) indicate that many value having premium public transportation available in part because it allows them to rest, read and use electronic devices while traveling (APTA 2014).

Unlicensed Drivers

The National Highway Traffic Safety Administration report, *Driver License Compliance Status in Fatal Crashes* (NHTSA 2014b), indicates the portion of fatal crashes involved unlicensed drivers. Although it only reports state rather than city rates, and so provides imperfect information on the influence that public transit service quality has on unlicensed driving rates, the results indicate significantly lower in more urbanized states such as Illinois (12%), New Jersey (11%) and New York (13%) compared with the national average (19%), which suggests that many people who drive without a license in an automobile-dependent community will reduce their driving if located in a more multi-modal community.

Higher Risk Driving Impacts - Summary

This analysis indicates that pro-transit policies can help reduce higher-risk (youth, senior, impaired and distracted) driving. This helps explain why relatively small shifts from automobile to public transportation often provide proportionately larger crash reductions: a relatively large portion of the increased public transit travel substitutes for higher-risk driving. This

5 *Jackson and Owen's 2009 report provided detailed results. Their 2011 summary article stated that "overall there was little effect on DUI arrests, alcohol related fatal traffic and alcohol related arrests," which implies there were no measureable benefits. The study actually found significant drunk driving rate reductions in the affected areas but lacked sufficient data to prove that these represented reductions in total regional impaired driving and crashes since it is difficult to isolate local and regional effects.*

analysis indicates that many youths, seniors, drinkers and texters are willing to reduce driving if they have suitable alternatives. As a result, to be effective and fair, higher-risk driving reduction programs such as graduated licenses, senior driver testing, and impaired-driving reduction campaigns, should be coupled with efforts to improve alternative modes. Although public transit cannot serve all these demands, it plays important roles in reducing high-risk driving by providing mobility to youths, seniors, drinkers and compulsive texters and being a catalyst for more compact, multi-modal communities where residents have diverse travel options and the use of alternative modes is socially acceptable.

Public transportation service improvements, pedestrian and cycling improvements, smart growth development policies, transportation pricing reforms, efficient parking management, and more affordable housing in multi-modal neighborhoods can all help youths, seniors, drinkers and texters reduce their driving. Reducing higher-risk driving does not necessarily require special transit services; it often involves incremental improvements to conventional services such as bus routes to suburban areas that have large youth and senior populations, and later night services between entertainment and residential districts.

Most current high-risk driving reduction campaigns give little consideration to providing alternatives to driving. A few encourage walking, cycling, ridesharing, and public transit, but their recommendations are generally vague. Only a few support transit service improvements, and most that do promote targeted services, such as demand response services for seniors, or late-night bus service to entertainment districts (ATX Safer Streets 2014). Very few traffic safety programs provide general support for public transit improvements. They seldom partner with transit agencies to evaluate youth, senior and drinker travel demands, investigate ways to better serve those demands, or support overall transit service improvements.

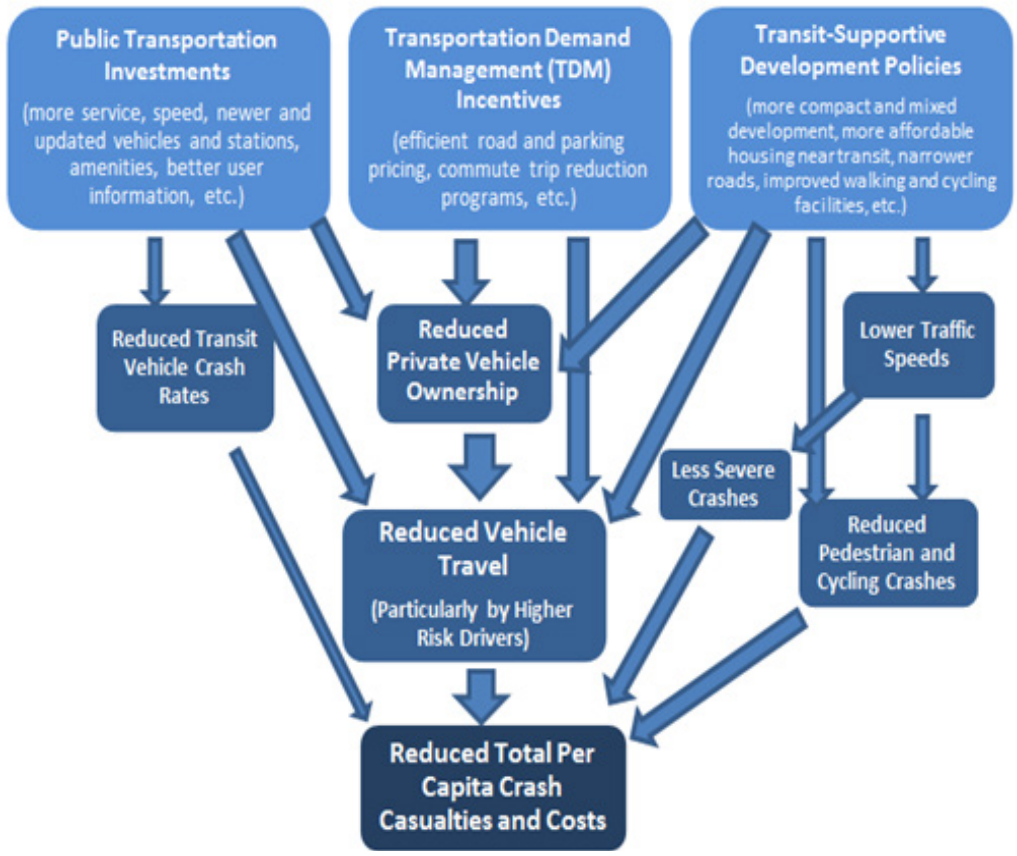
Overall Summary of Public Transportation's Traffic Safety Impacts

This analysis indicates that relatively modest shifts from automobile to transit can provide relatively large reductions in traffic casualty rates.

Figure 14 illustrates the various ways that public transit improvements, transportation demand management strategies, and transit-supportive development strategies help increase traffic safety. It is the combination of these impacts which explains the large traffic safety benefits associated with pro-transit policies.

This has important implications for traffic safety planning. It indicates that public transportation can play important roles in reducing traffic risks, far more than would be indicated by measuring transit mode share, because high quality transit provides a catalyst for other changes which provide additional traffic safety benefits. This analysis suggests that any traffic safety policy or program that discourages higher risk driving will be more effective and acceptable if implemented in conjunction with efforts to improve alternative modes, public transit and transit-oriented development.

Figure 14 - Public Transit Traffic Safety Impacts



Public transportation service improvements, transportation demand management (TDM) incentives, and transit-supportive development policies help reduce traffic risk in a variety of ways. Conventional traffic safety analysis tends to overlook many of these impacts and so undervalues the full safety benefits of pro-transit policies.

Traffic safety is just one of many benefits provided by such policies. When all impacts are considered, transit investments are often very cost effective traffic safety strategies

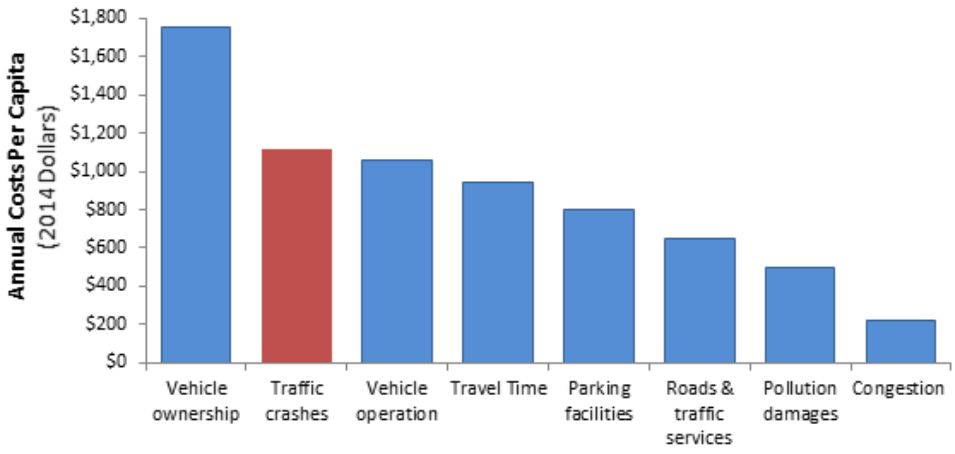

DANGER
6
4
YOUR
IS ALL
AFTER
Daycare
Fanfare

Traffic Crash Costs

Traffic crashes impose huge costs. Although cardiovascular disease and cancer cause more total deaths, traffic crashes tend to kill and disable people at younger ages and so cause large potential years of life lost (PYLLs), plus property damages, and so impose relatively large economic costs. Several studies have monetized traffic crash costs (Blincoe, et al. 2014; IRAP 2009; Litman 2009; Trottenberg 2011). A recent National Highway Traffic Safety Administration report (Blincoe, et al. 2014) estimated that in 2010 crashes cost between $277 billion (considering just financial costs, such as property damages, medical expenses and lost wages) and $871 billion (considering all costs, including pain and lost quality of life) in the U.S., which averages approximately $0.09 to $0.30 per vehicle-mile, or $900 to $3,000 per vehicle-year. This is larger than most other transport costs including roadway expenditures and congestion (Figure 15).

This has important implications for transportation planning. Because crashes impose large social costs, transportation improvement strategies provide smaller net benefits if they increase crashes, and provide much greater total benefits if they provide even modest crash reductions. For example, a congestion reduction strategy that increases traffic speeds or induces additional vehicle travel may increase total crash costs, while TDM strategies and transit improvements can provide significant safety benefits in addition to congestion and pollution reduction benefits. It is therefore important to account for all these impacts when evaluating potential transport system improvements.

Figure 15 - Estimated Automobile Costs (Litman 2009)



Crashes are among the largest transportation costs, making traffic safety an important planning objective.

Despite its high value, economic evaluations of public transportation often ignore safety impacts. If included at all, safety benefits are evaluated based only on the crashes avoided by travelers who shift from automobile to transit, the additional vehicle travel and crash reductions provided by transit-oriented development are generally ignored. As a result, conventional analysis undervalues transportation demand management, public transportation improvements and transit-oriented development. More comprehensive evaluation that considers all safety impacts would increase the justification for these strategies, due to their large safety benefits.

Public Transportation's Traffic Safety Strategies

Public transit improvement and encouragement strategies can increase traffic safety in a variety of ways. Some strategies increase safety for transit passengers, others reduce automobile travel, or provide a catalyst for transit-oriented development. Table 8 identifies various types of pro-transit strategies that can increase traffic safety.

These strategies often have synergistic effects (implemented together their total impacts are greater than the sum of their individual impacts). For example, if implemented alone a transit service improvement or efficient parking pricing (charging motorists directly for using parking facilities) might each cause a 10% automobile to transit mode shift, but if implemented together cause a 30% shift. Because of these synergistic effects, transit improvements often leverage additional vehicle travel reductions, so an additional transit passenger-mile reduces 2-10 automobile vehicle-miles (ICF 2010). As a result, public transportation improvements, TDM strategies and transit-oriented

Table 8 Public Transit Traffic Safety Strategy Categories (VTPI 2014)

Public Transit Safety Improvements	Public Transit Service Improvements	Targeted Vehicle Travel Reductions	TDM Incentives	Transit-Oriented Development
Reduces risk to public transit passengers and operators	Improves service quality including convenience, comfort, speed, etc.	Reduces higher risk (by youths, seniors and impaired) driving	Incentives for travelers to shift from automobile to transit	Helps create Transit-Oriented Development.
• Improved operator training and supervision. • New vehicles. • New station design. • Grade separation.	• More service (more routes, frequency, etc.) • Faster (grade separation and faster loading) • Better vehicles, stops and stations. • Improved access (better walking, park & ride, etc.) • Improved information and payment options. • Improved economic opportunity for at-risk residents.	• Late-night service to entertainment districts. • Services oriented at youths and seniors. • Marketing oriented at youths and seniors. • More affordable student and senior housing in transit-oriented areas.	• Transport pricing reforms (efficient road, parking, fuel & vehicle insurance pricing). • Efficient parking management, reduced parking subsidies. • TDM marketing. • School and campus transport management.	• More compact and mixed development. • More efficient utility and development fees. • Complete streets roadway design. • More connected sidewalks and paths. • More passive surveillance ("eyes on the street").

Public transit improvements and encouragement strategies can increase traffic safety in various ways.

development all tend to be more effective if implemented as an integrated package.

Although public transportation quality and ridership tend to be greatest in larger cities, improvements and encouragement strategies can support safety in small towns and rural communities (Mattson 2013), particularly if it helps reduce higher-risk driving. For example, a Washington State program supports intercity and local bus services in rural communities (Lynott 2014). Users include youths who would otherwise hitchhike, and seniors, some of whom can drive but prefer to use buses for longer trips on higher-speed highways. Although their safety impacts have not been studied, crash reductions may be among their largest benefits.

Table 9 identifies methods that can be used to quantify the transportation safety impacts of various pro-transit strategies. Models are available to help predict some of these impacts, such as the local crash reductions that are likely to result from improving transit service or increasing parking fees in a particular area (Karim, Wahba and Sayed 2012; Lachapelle, et al. 2011), although more research is needed to better understand these effects, and to incorporate other impacts. This is important because transportation safety benefit predictions are available for other safety strategies (NCHRP 2010; NHTSA 2014); the *lack of such predictive models for public transit strategies puts them at a disadvantage in obtaining support and funding*.

Table 9 Evaluating The Safety Impacts Of Pro-Transit Strategies

Strategy	Examples	Quantification Methods
• Public transportation safety improvements	• Improved vehicles and control systems, better station design, and grade separation.	• Reductions in crash, and casualty rates per public transit trip.
• Pedestrian and cycling improvements	• Better sidewalks, crosswalks and paths; traffic calming and speed control; improved street lighting.	• Safer walking and cycling. Reduced crash risk if this leads to reduced automobile travel.
• Public transportation service improvements that attract discretionary travelers (people who would otherwise drive).	• More service, reduced crowding, grade separation, more comfortable vehicles and stations, improved user information and payment systems, and amenities such as on-board Internet services.	• Safety impacts depend on the amount that automobile travel is reduced. Each one-point mode shift typically reduces automobile travel 2-10%, providing comparable reductions in crashes and casualties.
• Public transportation improvements targeting higher-risk drivers.	• Improved transit serving youths, seniors and drinkers. Late-night service to entertainment districts.	• Reductions in higher-risk driving (by young, old and impaired drivers). Can provide large crash reductions relative to the portion of travel shifted. For example, a 1% reduction in mileage by young drivers may provide a 2-5% reduction in crashes.
• Transportation demand management strategies.	• Improved travel options, commute trip reduction programs, road and parking pricing reforms, and mobility management marketing.	• Safety benefits are likely to be proportionate or larger than vehicle travel reductions.
• Transit-oriented development, which creates compact, multi-modal communities	• Compact and mixed development close to high quality transit services, with good walking and cycling conditions, and other features that maximize transit accessibility.	• Transit-oriented development residents tend to own 20-60% fewer vehicles, drive 20-40% fewer miles, and have a fifth the total traffic casualty rate as in automobile-dependent communities.

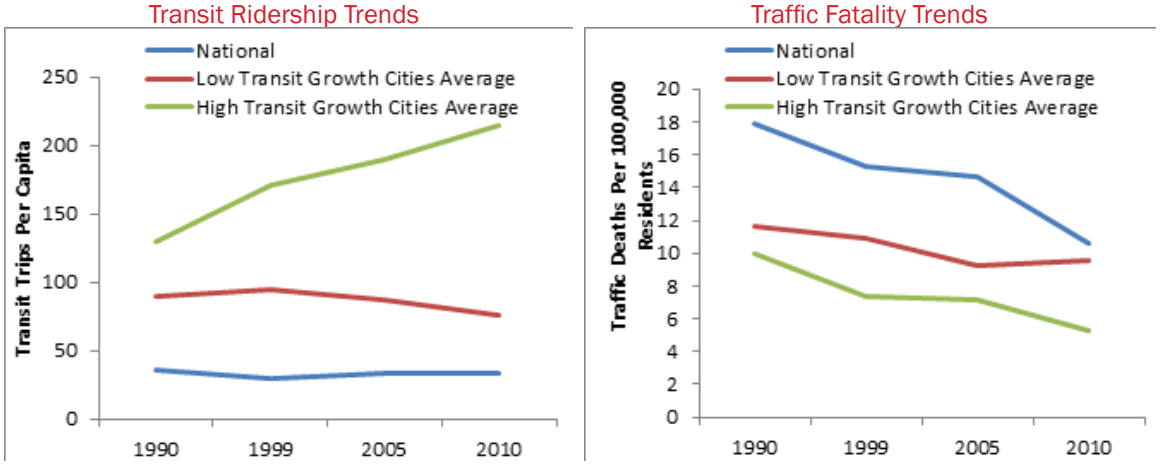
Transit improvement and encouragement strategies have various traffic safety impacts.

How Much Safety Can Public Transportation Strategies Achieve?

How much safety can public transportation improvement and encouragement strategies reasonably achieve? Analysis in this report indicates that cities with more than 50 annual transit trips per capita have about half the average traffic fatality rate as regions with less than 20 annual trips per capita. Cities with more than 50 annual trips per capita include Boston, Chicago, Denver, Honolulu, Los Angeles, New York, Portland and Seattle. Some smaller cities with just 10-40 annual trips per capita also achieved low traffic fatality rates, including Baltimore, Buffalo, Eugene, Madison, Minneapolis, Pittsburgh, Providence, Rochester, Santa Rosa, Spokane and Springfield (Massachusetts). All of the smaller, safer cities have relatively low per capita vehicle mileage (5,540-9,618 average annual vehicle-miles traveled, compared with 10,036 overall) which helps explain their low crash rates.

Some high-transit-ridership, low VMT cities are compact and transit-oriented because they developed prior to the Interstate Highway era, but some newer cities achieve large transit ridership and traffic safety gains in recent years with pro-transit policies. Figure 16 compares transit travel and traffic fatality trends for four pro-transit cities (Denver, Los Angeles, Portland and Seattle) with four peer cities with more automobile-oriented policies (Cleveland, Dallas, Houston and

Figure 16 - Trend Analysis (NHTSA and APTA data)[1]



The four high-transit-growth cities (Denver, Los Angeles, Portland and Seattle, shown by the green line) achieved far more transit ridership growth and larger traffic fatality reductions than the four low-transit-growth cities (Cleveland, Dallas, Houston and Milwaukee, shown by the red line), and national trends (blue line). This suggests that pro-transit policies can significantly reduce traffic fatality rates even in newer, automobile-oriented cities.

Milwaukee), and national trends. The pro-transit cities had more than double the transit ridership growth and achieved nearly half the average traffic fatality rates of the automobile-oriented cities and national averages. This suggests that pro-transit policies can increase traffic safety in newer cities.

The ridership gains in the high-transit-growth cities did not require substantial increases in total transportation funding or restrictions on automobile travel; services were improved by shifting resources (money and road right-of-way) from highways to transit, and implementing various support policies including pedestrian and cycling improvements, more efficient parking management, commute trip reduction programs, complete streets roadway design, and smart growth policies. These were not specifically intended as safety strategies, they were justified for other reasons, but provide substantial risk reduction benefits.

Current demographic and economic trends are increasing transit demand. Although few Americans want to give up driving altogether, surveys indicate that many would prefer to drive less, rely more on alternative modes, and live in more multi-modal communities (NAR 2013). In addition to their safety benefits these policies can help achieve other planning objectives including consumer cost savings, improved mobility for non-drivers, economic development and improved public health (FHWA 2014; Litman 2012).

This suggests that typical *U.S. urban regions can reduce their traffic fatality rates 10-40% by shifting a portion of resources (money and land) currently devoted to urban highways and parking facilities to improve transit services*, in conjunction with various support strategies such as pedestrian and cycling improvements, commute trip reduction programs, efficient parking management, and transit-oriented development policies.

The largest benefits are likely to be achieved in the most automobile-dependent communities. For example, if such policies typically reduce traffic fatalities by 40%, they would avoid 20 annual deaths if implemented in a one million population region that currently has 5 deaths per 100,000 residents, but would avoid 80 annual deaths if implemented in a million population region with 20 deaths per 100,000 residents. A moderate set of pro-transit policy reforms should be able to change automobile-dependent, high-traffic-fatality-rate cities such as Oklahoma City (15,556 VMT per capita and 13.9 deaths per 100,000) and Knoxville (12,812 VMT per capita and 17.6 deaths per 100,000) into more multi-modal cities with moderate traffic fatality rates, such as Akron (9,291 VMT per capita and 7.1 deaths per 100,000) and Stockton (8,352 VMT per capita and 5.0 deaths per 100,000). The travel changes would be modest – most residents would continue to live in single-family homes and travel primarily by automobile, but travel distances would be shorter, traffic speeds lower, and non-drivers would have much better travel options which reduces higher-risk driving and chauffeuring burdens.

1 *Data from the NHTSA's Traffic Safety Facts and the APTA Public Transit Fact Book for various years*

Potential Obstacles and Objectives

This section examines potential obstacles and objections to treating public transportation improvements as traffic safety strategies.

Beyond Organizational Scope

Most traffic safety programs are sponsored primarily by roadway agencies and automobile industries. As a result, they tend to assume that their goal is to make driving safer, and perceive vehicle travel reduction strategies and efforts to improve alternative modes as beyond their scope. These programs tend to frame risks and safety in ways that overlook or undervalue demand management strategies. For example, Table 13 shows the Haddon Matrix, a framework commonly used to identify traffic risks and potential safety strategies. It ignores *exposure*, how and how much people travel, as a risk factor (it would be a Human/Pre-crash factor), and so does not recognize vehicle travel reductions, mode shifting, or improvements to lower-risk modes as potential traffic safety strategies; those are outside the scope of analysis. Highway professionals and traffic safety experts are often unfamiliar with TDM strategies and transit planning.

Table 13 Haddon Matrix (WHO 2004)

Phase	Human	Equipment	Environment
Pre-crash (Crash prevention)	• Information • Attitudes • Impairment • Police Enforcement	• Roadworthiness • Lighting • Braking • Speed Management	• Road design and road layout • Speed limits • Pedestrian facilities
Crash (Injury prevention)	• Use of restraints • Impairments	• Occupant restraints • Other safety devices • Crash-protective design	• Crash-protective roadside objects
Post-crash (Life sustaining)	• First-aid skills • Access to medics	• Ease of access • Fire risk	• Rescue facilities • Congestion

The Haddon Matrix is often used to identify traffic risks and potential safety strategies. It generally ignores vehicle travel as a risk factor and VMT reductions as potential safety strategies.

Solution: This obstacle can be addressed by providing credible evidence that pro-transit policies can reduce traffic risks, and possibly help achieve other organizational planning objectives such as congestion reductions, government savings and improved mobility for non-drivers. Transit advocates can build coalitions that include existing traffic safety organizations and other interests such as public health, youth and senior advocacy groups.

Dueling Statistics

It is possible to assemble statistics which provide very different conclusions about transit safety impacts. Transit ridership and vehicle collisions both tend to increase with urban density, so simplistic analysis can imply that increased transit ridership increases crash rates. Most of these collisions are minor "fender-benders" causing property damage only. As this report demonstrates, there is good evidence that in most situations, transit is overall safer than automobile travel, shifts from automobile to transit reduce total crash rates, and per capita traffic casualty (injury or death) rates tend to decline as transit travel increases.

Solution: This objection can be addressed by providing more accurate information concerning crash risks, and challenging false claims.

Not Cost Effective

Another possible objection is that transit may appear to be a relatively expensive safety strategy. This might be true if major transit projects are evaluated based on their safety benefits alone, but is generally untrue when all impacts are considered. Table 14 compares the range of benefits provided by various traffic safety strategies. Transit improvements and transit-oriented developments can provide many types of benefits. Vehicle and roadway safety strategies provide fewer co-benefits and may have indirect costs. For example, crash-resistant bumpers, airbags, and larger vehicles increase vehicle production costs and weight, and therefore fuel costs and pollution emissions. Roadway grade-separation and larger clearzones tend to increase roadway costs, and often induce additional vehicle travel (*a rebound effect*) that increases total crashes and pollution emissions. Public transit

encouragement strategies and transit-oriented development tend to provide a wide range of co-benefits including traffic and parking congestion reductions, consumer savings, improved mobility for non-drivers, energy conservation, emission reductions, and others. When all impacts are considered, transit encouragement and transit-oriented development are often relatively cost effective.

Table 14 Comparing Strategies (Litman 2005)

Benefits	Transit Encouragement	Transit-Oriented Development	Vehicle Safety Strategies	Roadway Safety Strategies
	more service, transit priority, amenities, incentives	Smart growth development policies	stronger bumpers, airbags, larger vehicles	grade separation, larger clearzones, speed reductions
Traffic safety	✓	✓	✓	✓
Congestion reduction	✓	Mixed[1]		Mixed[2]
Roadway cost savings	✓	✓		✗
Parking cost savings	✓	✓		
Consumer savings	✓	✓	✗	
Improved mobility options	✓	✓		
Energy conservation	✓	✓	✗	
Pollution reduction	✓	✓	✗	
Physical fitness and health	✓	✓		
Land use objectives	✓	✓		

(✓ = Achieves; ✗ = contradicts) Transit encouragement and TODs tend to provide a variety of benefits. Most vehicle and roadway safety strategies provide few co-benefits (besides safety) and many impose significant indirect costs.

Solution: This objection can be addressed by applying more comprehensive impact analysis which accounts for transit improvement co-benefits, and any indirect costs of other safety strategies.

1 *More compact development may increase local congestion, but by reducing total automobile travel it reduces regional congestion.*

2 *Grade separation tends to reduce congestion; traffic speed reductions may increase it.*

Public Transportation Safety Benefits are "Unpredicatble"

Some widely-used guidance documents, such as the National Highway Traffic Safety Administration's *Countermeasures That Work* (NHTSA 2014), the *Transportation Planner's Safety Desk Reference* (NCHRP 2010), and the Institute of Transportation Engineer's *Desktop Reference for Crash Reduction Factors* (ITE 2007), describe how to evaluate the impacts of various traffic safety strategies. Because they ignore pro-transit policies, they imply that such policies are either ineffective at increasing safety or their safety impacts are unpredictable. This increases the effort required to incorporate pro-transit policies into traffic safety programs.

Solution: This obstacle can be addressed by providing credible evidence of public transit traffic safety benefits, by developing evaluation tools for predicting such impacts, and by working to incorporate pro-transit strategies into future traffic safety guidance documents and evaluation tools.

Transit Travel "Harms" Users

Critics sometimes argue that because automobile travel is superior (faster, more convenient, more comfortable, etc.) to public transit, shifting travel from automobile to transit must harm users (Cox 2010). This ignores the various ways that transit travel can benefit users (reduced stress, ability to rest and work while traveling, financial savings, physical exercise while walking or cycling to and from transit), and evidence of growing latent transit travel demand (some travelers want to use transit but cannot due to inadequate service). To the degree that transit improvements and positive incentives increase ridership, the additional transit users must be better off or they would not make the change. Only if travelers shift in response to negative incentives, such as increased road or parking fees, could they be worse off, but even then the overall impacts of such strategies depend on how revenues are used. For example, consumers can benefit from road tolls and parking fees overall if the revenues reduce taxes or finance useful public services. Similarly, to the degree there is latent demand for housing in transit-oriented development, satisfying this demand benefits consumers directly.

Solution: This objection can be addressed by identifying latent demand for public transportation and transit-oriented development, improving public transit services and using positive incentives to encourage public transit travel, and by applying comprehensive impact analysis which accounts for direct and indirect benefits from pro-transit policies.

Safety Benefits Are "Insignificant"

Since most North American communities have low transit mode shares, critics may argue that realistic transit improvements can provide only tiny safety benefits. Such criticism generally assumes that one additional transit passenger-mile reduces, at most, one automobile vehicle-mile with proportionate crash reductions, so doubling transit ridership from 2% to 4% only reduced crashes by at most 2%. However, as discussed in this report, pro-transit policies tend to leverage large additional vehicle travel and crash reductions, so each percentage-point increase in transit mode share often provides several percent reductions in total crashes. Transit improvements can be particularly effective at increasing safety if they help reduce higher risk driving or provide a catalyst for transit-oriented development. Experiences in cities such as Denver, Los Angeles, Portland and Seattle demonstrate that a reasonable combination of pro-transit policies can provide substantial crash reductions, cutting crash rates nearly in half, and provide other significant co-benefits.

Solution: This objection can be addressed by providing credible evidence of public transportation's leverage effects, examples of successful crash reductions, and models that can predict the safety benefits of specific transit improvements and incentives.

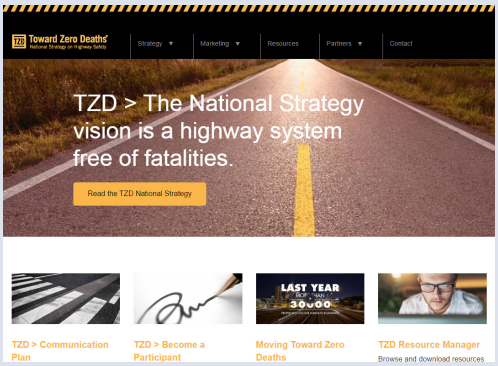
Incorporating Public Transportation Into Traffic Safety Programs

This section investigates how current traffic safety programs treat transit safety impacts, and identifies ways that they can better incorporate pro-transit policies as traffic safety strategies.

Table 14 Comparing Strategies (Litman 2005)

Program	Consideration of Public Transit
National Highway Traffic Safety Administration (www.nhtsa.gov)	
	The NHTSA is the lead U.S. traffic safety agency. It supports safety research and various programs, and is multi-modal to the degree that these programs include pedestrian, bicycle and school bus safety. As previously mentioned, its annual *Traffic Safety Facts* and various fact sheets tend to report crash statistics using distance-based rather than per capita units, which ignore the safety benefits of vehicle-travel-reduction strategies. The NHTSA report, *Countermeasures That Work*, describes and evaluates various traffic safety strategies but includes no information on public transit improvements, transportation demand management (TDM), smart growth strategies. This emphasis on targeted programs may seem justified because the NHTSA is a highway safety organization with a mandate to increase driving safety, so reducing driving may seem inappropriate. However, because some of its strategies involve discouraging higher-risk driving, it should recognize that improving travel options helps achieve these objectives. Organizations such as APTA and the Federal Transit Administration might partner with NHTSA to research and promote pro-transit policies that increase traffic safety.

Toward Zero Deaths: A National Strategy on Highway Safety (www.towardzerodeaths.org)



Toward Zero Deaths is a coalition of government agencies and private organizations to promote traffic safety. It supports various types of safety strategies (safer drivers and passengers; safer vulnerable users; safer vehicles; safer infrastructure; enhanced emergency medical services; improved safety management) but includes no mention of transit, TDM or smart growth strategies.

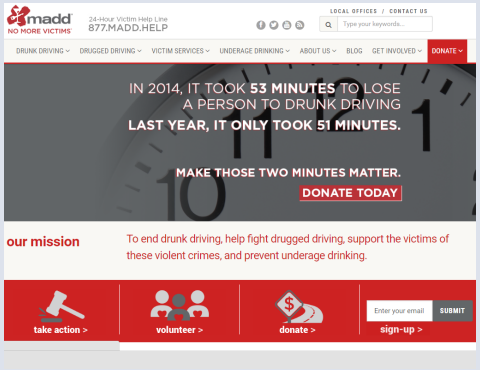
As with NHTSA, this program is also mandated to reduce highway crashes so its focus on targeted risk reduction strategies is understandable, but it may be amenable to some transit, TDM and smart growth strategies if the organization's leaders are presented with credible evidence that these are effective safety strategies that complement their current efforts.

The Injury Research Foundation (www.tirf.ca)

The Traffic Injury Research Foundation is a Canadian non-profit organization with public and private members that develops traffic safety information and programs. It has sponsored dozens of studies and programs targeting youths, seniors, impaired and distracted driving, but none that support transit, TDM or smart growth.

It may be amenable to new approaches if presented with credible evidence of their effectiveness, and acceptance by other traffic safety organizations.

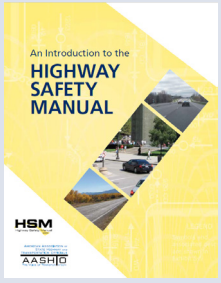
Mothers Against Drunk Driving (www.madd.org)



Mothers Against Drunk Driving advocates policies and programs to stop drunk driving. It currently emphasizes three strategies: high-visibility law enforcement; require ignition interlock devices; and develop technology to determine automatically whether or not a driver exceeds the legal blood alcohol limit. Although it claims that these are "evidence-based," the website provides no analysis of these strategies' effectiveness. MADD promotes "Safe Ride Programs" which encourages drinkers to use alternative modes, including public transportation, but provides no support for transit.

This organization may be amenable to credible evidence that transit strategies can reduce drunk driving risks.

AASHTO Highway Safety Manual (www.highwaysafetymanual.org)



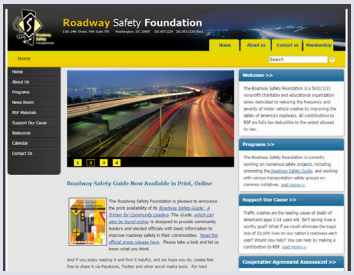
The HSM is intended to provide best available information and tools to facilitate roadway planning, design, operations, and maintenance decisions based on precise consideration of their safety consequences. The Manual is primarily concerned with highway design and operations; it includes no transit, TDM or smart growth strategies.

Because it is intended for highway planning it may be necessary to demonstrate ways that transit can help reduce highway crash risk.

Global Road Safety Partnership (www.grsproadsafety.org)

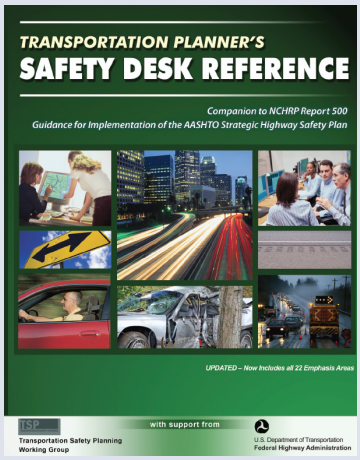
The GRSP is an international partnership of private companies, government agencies and research organizations working to improve road safety in developing countries. Most of its documents emphasize targeted safety programs, such as motorcycle helmet encouragement and improved traffic law enforcement, but some, such as the World Report on *Road Traffic Injury Prevention* (WHO 2004) recommend demand management safety strategies. Their *Drinking And Driving: A Road Safety Manual For Decision-Makers And Practitioners* (GSP 2007) recommends that, "public transport must be easily accessible and available to deter people from driving after drinking" (p. 58).

Road Safety Foundation (www.roadwaysafety.org)



The Roadway Safety Foundation (www.roadwaysafety.org) is a non-profit organization created by automobile and allied industries to coordinate highway safety activities. It receives support from the Federal Highway Administration to promote traffic safety programs, including distribution of their, *Roadway Safety Guide: A Primer for Community Leaders*. This Guide describes various roadway engineering strategies and traffic safety programs which can increase traffic safety, but includes no mention of transit, TDM or smart growth strategies.

Transportation Planner's Safety Desk Reference (http://tsp.trb.org/assets/FR1_SafetyDeskReference_FINAL.pdf)



The *Transportation Planner's Safety Desk Reference* (NCHRP 2010) discusses the planner's role in transportation safety and ways to incorporate safety into the planning process. It includes 22 emphasis areas, each with an overview of the problem, descriptions of appropriate safety strategies, crash modification factors that can be used to predict the crash reductions from specific safety improvements, additional resources, and best practices.

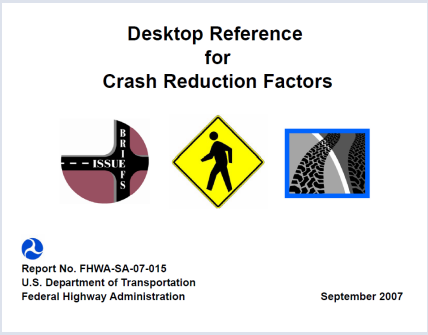
Although it focuses on targeted safety programs, it does recommend vehicle travel reduction strategies. The Introduction states, "By providing mobility alternatives to the auto, transit reduces vehicle miles traveled (VMT), resulting in fewer traffic incidents, injuries, and fatalities. Transit ridership can be encouraged among the groups with the highest crash rates, such as young and older drivers, to reduce the potential for crashes. Guaranteed ride home programs at events can help prevent impaired driving."

Governors Highway Safety Association (www.ghsa.org)

This organization provides information on state traffic safety programs. All of the programs identified in its *Highway Safety Program Guidelines* are targeted strategies; none include transit, TDM or smart growth strategies, or any discussion of reducing crashes by reducing vehicle travel.

This organization may be amenable to new approaches if presented with credible evidence of their effectiveness, and acceptable by other traffic safety organizations.

Desktop Reference for Crash Reduction Factors, Institute of Transportation Engineers (www.ite.org)



This report documents estimates of the crash reduction that might be expected if specific countermeasures are implemented in a specific situation. These estimates are known as Crash Reduction Factors (CRFs). The strategies considered are all roadway physical design (including signs and marking) strategies, plus increased traffic law enforcement.

The ITE includes a diverse range of members, including some that support multi-modalism, TDM and smart growth. It may be amenable to new approaches if presented with credible evidence of their effectiveness, and if members are encouraged to support these innovations.

Motor Vehicle PICCS (www.cdc.gov/motorvehiclesafety/calculator)

The Motor Vehicle PICCS (Prioritizing Interventions and Cost Calculator for States) identifies a dozen possible state-level traffic safety strategies and the casualties that could be prevented by their implementation. It includes a fact sheet for each intervention, a final report and user guide. None of the strategies considered involve public transit or demand management.
The CDC may be amenable to new approaches if presented with credible evidence of their effectiveness and cost effectiveness, and that they support other CDC goals such as improved fitness and reduced pollution.

In summary, most current traffic safety programs focus on targeted strategies intended to reduce specific risks. Only two programs evaluated here (the *Global Road Safety Partnership* and the *Transportation Planner's Safety Desk Reference*) mention TDM and transit as possible traffic safety strategies, and they provide only minimal information about those strategies, with little guidance on how to predict their impacts or evaluate their full benefits (including co-benefits). They generally assume that transit can only provide modest safety benefits, reflecting little understanding of the ways that pro-transit policies can leverage additional crash reductions.

This emphasis reflects the institutional status of these organizations. Most were established to support *highway* safety, so they consider their primary clients to be motorists, and their primary goal is to facilitate mobility. From this perspective, vehicle travel reduction efforts may be considered harmful to their clients and contradictory to their goals. However, transportation professionals, including traffic safety experts, are starting to apply more comprehensive and multi-modal analysis, including consideration of innovative solutions such as transportation demand management.

Traffic safety experts and policy makers can present a more specific justification to incorporate pro-transit policies in traffic safety programs: many existing traffic safety strategies involve reducing higher-risk driving.

As this report demonstrates, such strategies tend to be more effective and acceptable if targeted populations (youths, seniors, drinkers and texters) have appropriate alternatives to driving. Table 15 indicates the traffic safety strategies that are likely to become more effective with pro-transit policies.

Table 15 Role of Transit in Traffic Safety Strategies

Strategies Supported By Transit	Strategies Not Supported By Transit
• Restricted teen drivers licenses	• Seat belt and helmet use
• Senior driver reductions	• Crash resistant vehicles
• Impaired driver reductions	• Roadway clear zones
• General vehicle travel reductions	
• Smart growth development patterns	
• Traffic calming and speed reductions	

Public transit improvements and encouragement help support many traffic safety strategies.

This suggests that there are opportunities to encourage traffic safety experts and organizations to consider and support pro-transit policies in their work. The *Transportation Planner's Safety Desk Reference* (NCHRP 2010) shows that traffic safety experts can consider TDM and transit safety strategies. This probably occurred because the Federal Transit Administration helped develop this document and was able to share new research concerning public transit safety benefits. Such partnerships can help achieve the paradigm shift needed for transit strategies to be incorporated into traffic safety programs.

Improving Public Transportation Safety Communication

Many people have misconceptions about transport risks: they exaggerate automobile safety and transit travel danger. Public transit organizations sometimes exacerbate these misconceptions with messages that emphasize fear (e.g., “Watch for potential terrorists” and “Protect yourself from pickpockets!”) without providing information about the overall safety of transit travel. To correct these misconceptions transit organizations can help develop a new, more accurate and positive transit safety narrative (Litman 2014). In many situations, this new narrative can help increase transit ridership, and therefore a way to achieve strategic planning objectives such as reducing congestion and pollution emissions, and encouraging more compact, smart growth development.

This new public transportation safety narrative can be incorporated into various communications including newsletters, websites, media contacts, advertising, employee training, planning documents and performance evaluation. These messages should use appropriate perspectives and wording for various audiences. For example, transit passengers and potential passengers, neighborhood residents and businesses want realistic assessments of their risks and practical ways to reduce them. Public officials want reliable evidence that public transportation improvements and transit-oriented development can provide measurable safety and public health benefits. Table 16 evaluates actual and perceived transit risks, and how they can be addressed in the new narrative.

Table 16 Actual and Perceived Transit Risks (Litman 2014)

Type of Risk	Actual Magnitude	Perceived Magnitude	New Narrative
Transit passenger crash risk	Very low. An order of magnitude lower than automobile travel.	Although infrequent, transit crashes receive heavy media coverage which exacerbates fear.	Emphasize the overall safety of transit travel and ways to further increase this safety.
Crash risk while accessing transit	Walking and cycling have relatively high crash rates per mile/km, but per capita crashes tend to decline with increased use of these modes.	Pedestrian and cyclist crash injuries sometimes receive heavy media attention.	Acknowledge this risk and describe practical ways that individuals and communities can reduce it.
Crash risk to other road users	Moderate. Risk to other road users declines as transit mode share increases.	Transit vehicle crashes receive heavy media coverage which exacerbates fear.	Communicate transit's relative safety to other road users and ways to reduce these risks.
Overall community crash rates	Decline with increased transit mode share and very low in transit-oriented developments.	This impact is seldom considered in media coverage or planning analysis.	Communicate the safety of TOD and quantify if for planning analysis.

Public transportation professionals can apply a new narrative which emphasizes the overall safety of public transit, and corrects common misconceptions that lead to excessive fear.

Implications for Various Stakeholders

This section discusses the implications of this research to various organizations and interest groups.

Traffic Safety Experts

This analysis indicates that pro-transit policies can provide large safety benefits, both alone and in conjunction with other traffic safety strategies such as efforts to reduce youth, senior, impaired and distracted driving. In addition to safety, this tends to provide significant co-benefits and so can be supported by a broad coalition of interest groups. However, to consider pro-transit safety strategies, experts will need to change the way they define risks and evaluate traffic safety strategies. To fully account for transit safety benefits, traffic safety programs should make the following changes.

- Integrate transit improvement and encouragement strategies with risky-driver reduction programs. For example, identify ways that transit improvement and encouragement strategies can help reduce driving by youths, seniors, alcohol drinkers and compulsive texters, and ways to implement these strategies.
- Shift from distance-based to per capita risk measurement (e.g., deaths per capita rather than per 100 million vehicle-miles) in order to account for the safety benefits of vehicle travel reduction strategies.
- Consider risks to all road users, not just vehicle occupants.
- Learn about transportation demand management (TDM) and how to create integrated TDM programs.
- Consider co-benefits (besides traffic safety) when evaluating pro-transit safety strategies, including traffic and parking congestion reductions, road and parking infrastructure savings, consumer savings and affordability, improved mobility

for non-drivers and therefore progress toward social equity objectives, improved public fitness and health, energy conservation and emission reductions.

- Form partnership with other stakeholders who have reasons to support transit.

Transportation Professionals (Planners, Engineers and Economists)

This analysis indicates that transportation planning decisions affect crash rates by influencing how and how much people travel. Good research indicates that planning decisions which create automobile-dependent transportation systems tend to increase total traffic risks, while transit improvements, TDM strategies and transit-oriented development tend to increase traffic safety. Many transportation professionals are familiar with some of these concepts, for example, many communities are implementing commute trip reduction programs to reduce traffic and parking congestion, and many have adopted complete streets policies that improve transport options, but few transportation professionals are familiar with the full range of these strategies, and their safety impacts. As a result, transportation professionals and organizations seldom consider the long-term impacts of many of their decisions on crash risk. To fully account for transit safety benefits, traffic safety programs should make the following changes.

- Research the relationships between transit quality and crash rates, and identify specific ways that pro-transit policies can help reduce a community's crash risk.
- Develop guidance tools for predicting the traffic safety impacts of various transit improvement and encouragement strategies.
- Develop comprehensive evaluation tools in order to help identify win-win solutions, such as identifying which congestion reduction strategies also reduce traffic risk, and which traffic safety programs also improve mobility options for non-drivers
- Form partnerships with other stakeholders who have reasons to support transit.

Public Transportation Professionals

The substantial potential safety benefits that pro-transit provide can help public transportation organizations gain support for service improvements and encouragement incentives. Public transit is generally

perceived as a way to provide basic mobility for non-drivers and to reduce traffic congestion and pollution emissions. Incorporating safety benefits can significantly expand the justification for pro-transit policies.

Public transportation organizations can do more to communicate the relative safety of public transit to current and potential passengers, planning professionals and decision-makers; incorporate these benefits into formal economic evaluations; and build partnerships with traffic safety and public health officials. They can incorporate positive messages about public transportation's relative safety into all forms of communication including signs, newsletters, planning documents and presentations, staff training and performance evaluations. Even when dealing with undesirable incidents such as a crash or crime, it is possible to incorporate positive messages concerning the overall safety of public transportation, and reassurances that agencies are working with communities to further reduce risks. Official documents, such as annual reports and transit improvement plans, can highlight the relative safety of public transit and transit-oriented development. Presentations to decision makers and the general public concerning transit improvements should include information about the safety benefits these projects are likely to provide. Public transit agencies should work with traffic safety and public health experts to educate other transportation professionals about the roles that public transit can play in increasing traffic safety, and to ensure that pro-transit policies are included in transportation safety programs.

Public transportation professionals and organizations can:

- Become involved in transportation safety program development, such as those by the National Highway Traffic Safety Administration, the Institute of Transportation Engineers and state departments of transportation. For example, *APTA could have representatives on national traffic safety planning committees*, and state and regional transit agencies could join appropriate state and regional traffic safety committees.
- Work to promote transportation demand management and pro-transit policies as traffic safety strategies.
- Work to change from distance-based to per capita risk measurement.
- Sponsor data collection, research and analysis tool development to better understand and predict the safety, and public health impacts of specific public

transportation policies and programs.

- Educate the general public, including users and potential users, about the relative safety of public transportation travel and transit-oriented communities.
- Include traffic safety when evaluating the benefits of public transportation improvements and encouragement strategies.
- Develop guidance documents to help public transportation advocates appointed to traffic safety organizations promote public transportation improvements and transit-oriented development as safety strategies.
- Develop guidance documents to help planners and agency communications specialists emphasize the safety benefits of public transportation and better respond to community traffic safety concerns in their activities.

Local Officials

Local officials, planners and developers can recognize the safety benefits of pro-transit policies and transit-oriented development in their community's transport and land use policies. They can:

- Become familiar with the various benefits of transit-oriented development, including increased safety.
- Identify and reform current policies that discourage public transportation improvements and transit-oriented development, such as biased funding practices (which favor roads and parking over walking, cycling and public transit improvements), limits on infill development, excessive restrictions on density and mix, excessive minimum parking requirements, excessive roadway size and traffic speeds, and funding practices that favor automobile investments over walking, cycling and public transportation investments.
- Work with community organizations to implement community traffic safety programs, including pedestrian and cycling improvements, and traffic calming.
- Market transit-oriented developments as safe and healthy communities, in addition to other benefits.

Individuals

Individual travelers and households tend to be safer if they use public transportation and live in transit-oriented communities. In addition to safety, living in a transit-oriented community can provide additional benefits

including financial savings, improved fitness and health, and the ability to recharge or work while traveling.

Below are recommendations for individuals to take advantage of increased safety and other benefits of public transportation and transit-oriented developments.

- Learn to understand true transportation traffic safety and public health risks people face.
- Rely on walking, cycling, public transportation, ride hailing services (i.e. Uber and Lyft) and taxi travel as much as possible.
- Choose a home in a transit-oriented community. It is generally far safer and healthier than living in an automobile-dependent community.
- Work with public transportation agencies, local governments and community organizations to implement community traffic safety programs, including pedestrian and cycling improvements, and traffic calming.

Research Recommendations

This section describes research that can help improve our understanding of ways that public transportation can increase traffic safety, and ways to apply this information in transport policy and planning decisions.

There is much to learn about the specific mechanisms by which pro-transit policies increase traffic safety. For example, what portion of these crash reduction results from reductions in overall vehicle travel? What portion consists of reductions in higher risk (youth, senior, impaired and distracted) driving? What features of transit-oriented development (density, mix, complete streets roadway designs, improved walking and cycling conditions, reduced parking supply, etc.) contribute most to traffic safety?

Using travel surveys such as the NHTS we can evaluate how much and under what conditions higher risk groups reduce their driving in response to public transit improvements and transit-oriented development. It would be useful to measure the impacts of transit service quality and transit-oriented development driver's licensure rates, driving activity, and crash casualty rates by youths, seniors and drinkers. It would also be useful to survey members of these groups to determine how transit improvements could help them drive less, and to identify appropriate marketing messages to promote transit as an alternative to higher-risk driving.

This analysis should recognize the diverse conditions and needs of different types of communities. For example, it will be useful to investigate the role that public transportation can play in supporting traffic safety in smaller cities, college towns, retirement and resort communities, and areas with high poverty rates. It will be useful to identify examples of successful pro-transit traffic safety programs in these different types of communities.

There is a need for better information and analysis tools for evaluating the travel impacts of pro-transit policies, and the various benefits and costs that result, including increased traffic safety.

There is also a need for research concerning obstacles to implementing pro-transit policies as traffic safety strategies, and ways to overcome them. This can include analysis of traffic safety program assumptions, goal definitions, evaluation methods, organizational structures, funding practices, communication practices and institutional relationships (such as the formal and informal relationships between transportation professional organizations such as ITE and AASHTO, transportation agencies, traffic safety, and public transit organizations). These should be examined to identify ways that transit may be excluded and undervalued, and practical ways to correct these omissions and biases.

Research is also needed to identify effective ways to communicate public transportation's safety benefits to various audiences including people making short- and long-term travel decisions, households making home location decisions, traffic safety experts, planners, policy makers, and the general public. Marketing research can help identify how messages about traffic safety benefits are best integrated with other public transportation and transportation planning programs, such as those that promote traffic safety, transit safety, public fitness and health, commute trip reduction, and public transportation ridership, to name a few; each of these could incorporate messages concerning public transportation traffic safety benefits.

Conclusions

This study investigates the role that public transportation can play in increasing traffic safety. Credible research indicates that public transit is overall a very safe form of travel, that all else being equal, transit-oriented communities have low per capita traffic fatality rates than in more automobile-dependent communities, and that that various transit-supportive policies can reduce traffic fatality and injury rates. This is good news for transportation professionals, communities and travelers; it identifies new ways to increase traffic safety and are currently overlooked. Although these policies often require investments, they tend to provide large additional benefits, besides safety, and so are often very cost-effective when all impacts are considered.

Public transportation is a very safe form of travel. Its passengers have less than a tenth the per-mile crash rates of automobile travel, and transit-oriented community residents have a fifth the total (pedestrian, cyclist, automobile and transit passenger) crash casualty rates per capita as in automobile-dependent communities. Increasing public transportation usage tends to provide proportionately larger reductions in per capita highway casualties. Transit-oriented cities where residents average more than 50 annual transit trips have about half the highway fatality rate as more automobile-oriented cities where residents average less than 20 annual transit trips.

Two factors help explain why relatively small public transit ridership increases provide such large crash reductions. First, many transport and urban design factors that increase transit travel also tend to increase safety. Second, higher-risk groups, including youths, seniors and drinkers, are particularly likely to use public transit if it is available. Described differently, high- and low-risk driving are complements: many factors that increase

low-risk driving also increase high-risk driving. Efforts to reduce higher-risk driving, such as graduated licenses, senior driver testing, and drunk-driving discouragement campaigns, are more effective if implemented with public transit investments and other transit-supportive policies. Since most casualty crashes involve multiple vehicles, even responsible drivers who always observe traffic laws and never use public transit can benefit from transportation improvements that reduce total vehicle traffic and higher-risk driving, and therefore their risk of being the victim of another drivers' mistake.

Crash statistics can be analyzed in various ways that lead to very different conclusions about traffic risks. Conventional analysis tends to favor distance-based units such as crashes per hundred million vehicle-miles. This ignores the additional crashes that result from increases in per capita vehicle travel and safety benefits of vehicle travel reductions. Evaluating traffic risk per capita, such as deaths per 100,000 residents, recognizes the safety benefits of transportation demand management strategies, including transit-supportive policies.

People tend to exaggerate automobile safety and public transportation risks. This results, in part, from the nature of public transit travel, which requires passengers to share a ride oppose to the feeling of being in control of the ride that results from driving, and from exaggerated news coverage of public transit crashes. In addition, conventional public transit safety messages tend to highlight risks and fear, such as warnings to passengers about dangers from falls, crime and terrorism. Industry professionals can help offset this by providing more accurate safety information. Although agencies should acknowledge legitimate risks, they can promote a more positive narrative which emphasizes their product's overall safety and provide practical guidance on how to reduce risks.

Current traffic safety programs generally ignore public transportation as a potential safety strategy. Any support is usually limited to general statements encouraging youths, seniors and alcohol drinkers to use alternative modes rather than drive. Very few advocate pro-transit policies, or provide specific analysis of the potential safety benefits of transit improvements as they do with other traffic safety strategies. Research in this report indicates that many traffic safety strategies become more effective and acceptable if implemented with improvements to alternative modes such as

public transit. Better information on these benefits can help build support for pro-transit policies as traffic safety strategies. This requires a new traffic safety paradigm, as summarized in Table 17.

Table 17 A New Traffic Safety Paradigm

Factor	Old	New
Goal	Make driving safer.	Make mobility safer.
How risks are measured	Distance-based crash rates (per 100 million vehicle-miles or billion vehicle-kilometers)	Per capita crash casualties (injuries and deaths)
Modes considered	Focuses on motor vehicle travel. Considers pedestrians, cyclists and transit passengers high risk groups to be minimized.	Considers all modes and road users. Recognizes that shifts from automobile to alternative modes can help increase overall safety.
Consideration of TDM and pro-transit policies	Generally ignored. The standard traffic safety narrative is that automobile travel is overall very safe, so there is no need to reduce total driving to increase safety.	Considers TDM and pro-transit policies as potential safety strategies. Recognizes the safety impacts of transport and land use planning decisions.
Consideration of other impacts	Uses reductionist analysis which considers traffic safety impacts in isolation.	Uses comprehensive analysis which recognizes indirect impacts and non-safety benefits.

A more comprehensive and multi-modal paradigm supports public transportation as a traffic safety strategy.

Despite various obstacles, it is likely that pro-transit policies will be increasingly recognized as traffic safety strategies. We now have good, credible evidence that pro-transit policies can increase traffic safety which leads to reduced fatalities and industry. Many transportation professionals and traffic safety experts are ready to apply more comprehensive and multi-modal planning. Many will probably agree that efforts to discourage higher-risk driving are likely to be more effective and acceptable if implemented with improved mobility options. Surveys indicate that many people want to drive less and rely more on walking, cycling and public transit, provided they are convenient, attractive and integrated. Transportation planning is becoming more comprehensive and multi-modal. Experiences in various types of communities demonstrate that pro-transit policies can play an important role in achieving a community's traffic safety goals.

References

AAA (2011), *Senior Driving: Helping Seniors Drive Safer & Longer*, American Automobile Association (www.aaa.com); at http://seniordriving.aaa.com.

AARP (2011), *Ensuring Transportation For Those Who Don't Drive*, American Association for Retired Persons (www.aarp.org); at http://tinyurl.com/p8onojv.

AARP (2014), *Livable Communities*, American Association for Retired Persons (www.aarp.org/livable-communities).

Allstate (2011), *New Allstate Survey Shows Americans Think They Are Great Drivers - Habits Tell A Different Story: Survey Shows Drivers Quick To Tout Skills, Slow To Practice Responsible Driving*, Allstate Digital Newsroom (www.allstatenewsroom.com); at http://tinyurl.com/7hmdwr8.

APTA (annual publications), *Public Transit Fact Book*, American Public Transit Association (www.apta.com/research/stats).

APTA (2014), *Millennials & Mobility: The Millennial Mindset*, American Public Transit Association (www.apta.com); at www.apta.com/resources/reportsandpublications/Documents/APTA-Millennials-and-Mobility.pdf.

ATX Safer Streets (2014), *Advocates For Expanded Late Night Transportation And Parking Options As An Alternative To Impaired Driving*, (www.atxsaferstreets.org); at www.atxsaferstreets.org/pdf/Presentation.pdf.

ABW (2010 and 2014), *Bicycling and Walking in the U.S.: 2010 Benchmarking Report*, Alliance for Biking & Walking, (www.peoplepoweredmovement.org); at www.bikewalkalliance.org/resources/benchmarking.

Victoria Basolo (2013), "Examining Mobility Outcomes in the Housing Choice Voucher Program: Neighborhood Poverty, Employment, and Public School Quality," *Cityscape*, Vol. 15, No. 2; at www.huduser.org/portal/publications/Cityscape_Jul2013.pdf.

Gwen Bergen, et al. (2014), "Vital Signs: Health Burden and Medical Costs of Nonfatal Injuries to Motor Vehicle Occupants — United States, 2012," *Morbidity and Mortality Weekly Report* (www.cdc.gov/mmwr), Vol. 63, No. 40, 10 October; at http://tinyurl.com/p633mn8.

Lawrence Blincoe, et al. (2014), *The Economic And Societal Impact Of Motor Vehicle Crashes, 2010*, Report No. DOT HS 812 013, National Highway Traffic Safety Administration (www-nrd.nhtsa.dot.gov); at www-nrd.nhtsa.dot.gov/Pubs/812013.pdf.

Joshua Broyles (2014), *Drinking and Driving and Public Transportation: A Test of the Routine Activity Framework*, Master's Degree Thesis, Arizona State University (www.asu.edu); at http://repository.asu.edu/attachments/135054/content/Broyles_asu_0010N_13784.pdf.

BTS (2013), *National Transportation Statistics*, Bureau of Transportation Statistics (www.rita.dot.gov); at www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/NTS_Entire_13Q3.pdf.

CDC (2010), *CDC Recommendations for Improving Health through Transportation Policy*, Center for Disease Control (www.cdc.gov); at www.cdc.gov/transportation/recommendation.htm.

CDC (2011), *Older Adult Drivers: Get The Facts*, Center for Disease Control (www.cdc.gov); at www.cdc.gov/motorvehiclesafety/older_adult_drivers/adult-drivers_factsheet.html.

CDC (2012), "Motor Vehicle Crash Deaths in Metropolitan Areas — United States, 2009," *Morbidity and Mortality Weekly Report*, Vol. 61, No. 28, , 20 July 2012, pp. 523-528, Center for Disease Control (www.cdc.gov/mmwr); at www.cdc.gov/mmwr/preview/mmwrhtml/mm6128a2.htm.

CDC (2014), *Motor Vehicle Safety*, Center for Disease Control (www.cdc.gov); at www.cdc.gov/motorvehiclesafety.

CDC (2014), "Motor Vehicle Crash Injuries: Costly but Preventable," *VitalSigns*, Division of Unintentional Injury Prevention, Center for Disease Control (www.cdc.gov); at www.cdc.gov/vitalsigns/pdf/2014-10-vitalsigns.pdf.

Robert Cervero and G. B. Arrington (2008), "Vehicle Trip Reduction Impacts of Transit-Oriented Housing," *Journal of Public Transportation*, Vol. 11, No. 3, pp. 1-17; at www.nctr.usf.edu/jpt/pdf/JPT11-3.pdf.

Robert Chirinko and Edward Harper Jr. (1993), "Buckle Up or Slow Down? New Estimates of Offsetting Behavior and their Implications for Automobile Safety Regulation," *Journal of Policy Analysis and Management*, Vol. 12, No. 2, pp. 270-296.

Wendell Cox (2010), *Washington's War on Cars and the Suburbs: Secretary LaHoods False Claims on Roads and Transit*, Reason Foundation (www.heritage.org); at http://tinyurl.com/lcdf9qq.

CTOD (2010), Transit-*Oriented Development: Tools for Metropolitan Planning Organizations*, Center for Transit-Oriented Development and Reconnecting America (www.reconnectingamerica.org); at http://reconnectingamerica.org/public/display_asset/ctod_mpotod_final.

CUTA (2010), *Transit Fact Book*, Canadian Urban Transit Association (www.cutaactu.ca).

Benjamin Davis, Tony Dutzik and Phineas Baxandall (2012), *Transportation and the New Generation: Why Young People Are Driving Less and What It Means for Transportation Policy*, Frontier Group (www.frontiergroup.org); at http://tinyurl.com/76ndnak.

Eric de Place (2010), *Forcing Bars To Provide Parking Is Not A Good Idea*, Sightline Institute (www.sightline.org); at http://daily.sightline.org/2010/06/28/forcing-bars-to-provide-parking.

Lawrence E. Decina, et al. (2009), *Alternative Transportation Programs: A Countermeasure for Reducing Impaired Driving*, National Highway Traffic Safety Administration (www.nhtsa.gov); at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811188.pdf.

Nicolae Duduta, Claudia Adriazola, Carsten Wass, Dario Hidalgo, Luis Antonio Lindau (2012), *Traffic Safety on Bus Corridors: Guidelines For Integrating Pedestrian And Traffic Safety Into The Planning, Design, And Operation Of BRT, Busways and Bus Lanes*, EMBARQ (www.embarq.org); at http://tinyurl.com/lg2cdk6.

Eric Dumbaugh and Robert Rae (2009), "Safe Urban Form: Revisiting the Relationship Between Community Design and Traffic Safety," *Journal of the American Planning Association*, Vol. 75, No. 3, Summer (DOI: 10.1080/01944360902950349); at http://actrees.org/files/Research/dumbaugh_urbanform.pdf.

Aaron Edlin and Pena Karaca-Mandic (2006), "The Accident Externality from Driving," *Journal of Political Economy*, Vol. 114, No. 5, pp. 931-955; at www.econ.yale.edu/~dirkb/teach/pdf/e/edlin/2006-accident%20externality.pdf.

Reid Ewing and Eric Dumbaugh (2009), "The Built Environment and Traffic Safety: A Review of Empirical Evidence," *Journal of Planning Literature*, Vol. 23 No. 4, May, pp. 347-367; at http://tinyurl.com/pkf4y63.

Reid Ewing and Shima Hamidi (2014), *Measuring Urban Sprawl and Validating Sprawl Measures*, University of Utah Metropolitan Research Center (www.arch.utah.edu/cgi-bin/wordpress-metroresearch), for the Na. Cancer Institute and Smart Growth America; at www.smartgrowthamerica.org/documents/measuring-sprawl-2014.pdf.

FHWA (Annual Reports), *Highway Statistics*, Federal Highway Administration (www.fhwa.dot.gov/ohim).

FHWA (2010), *Transportation Planner's Safety Desk Reference*, Federal Highway Administration (www.fhwa.dot.gov); at http://tsp.trb.org/assets/FR1_SafetyDeskReference_FINAL.pdf.

FHWA (2014), *A Multi-Modal Approach To Economic Development In The Metropolitan Area Transportation Planning Process*, Volpe National Transportation Systems for the Federal Highway Administration Office of Planning (www.planning.dot.gov); at www.planning.dot.gov/documents/EconDevelopmentFinal_8-11-14.pdf.

FTA (annual reports), *National Transit Database*, Federal Transit Administration (www.fta.dot.gov), at www.ntdprogram.gov/ntdprogram.

Shengyi Gao and Robert A. Johnston (2009), "Public vs. Private Mobility for Low Income Households: Transit Improvements vs. Increased Car Ownership in the Sacramento Region," *Transportation Research Record 2125* (www.trb.org), pp. 9-15.

Norman W. Garrick and Wesley Marshall (2011), "Does Street Network Design Affect Traffic Safety?" *Accident; Analysis and Prevention*, Vol. 43, No. 3, pp. 769-81, DOI: 10.1016/j.aap.2010.10.024.

GSP (2007), *Drinking And Driving: A Road Safety Manual For Decision-Makers And Practitioners*, Global Road Safety Partnership (www.grsproadsafety.org); at www.grsproadsafety.org/sites/grsp.drupalgardens.com/files/Drinking%26Driving_English.pdf.

Darío Hidalgo, Liliana Pereira, Nicolás Estupiñán and Pedro Luis Jiménez (2013), "TransMilenio BRT System In Bogota, High Performance And Positive Impact – Main Results Of An Ex-Post Evaluation," *Research in Transportation Economics*, Vol. 39, Is. 1, March, pp. 133–138; at www.sciencedirect.com/science/article/pii/S0739885912000777.

ICF (2010), *Current Practices in Greenhouse Gas Emissions Savings from Transit: A Synthesis of Transit Practice*, TCRP 84, TRB (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_84.pdf.

IIHS (2009), *Licensing Systems for Young Drivers*, Insurance Institute for Highway Safety (www.iihs.org).

IRAP (2009), *The True Cost Of Road Crashes: Valuing Life And The Cost Of A Serious Injury*, International Road Assessment Programme (www.irap.net); at http://tinyurl.com/kcnf9ut.

IRTAD (2014), *Road Safety Annual Report 2014*, International Traffic Safety Data and Analysis Group, International Transport Forum (www.internationaltransportforum.org) and the OECD (www.oecd.org); www.internationaltransportforum.org/pub/pdf/14IrtadReport.pdf.

ITE (2007), *Desktop Reference for Crash Reduction Factors*, Institute of Transportation Engineers (www.ite.org); at www.ite.org/safety/issuebriefs/Desktop%20Reference%20Complete.pdf.

Jane Jacobs (1961), *The Death and Life of Great American Cities*, Modern Library.

C. Kirabo Jackson and Emily Greene Owens (2009), *One for the Road: Public Transportation, Alcohol Consumption, and Intoxicated Driving*, IZA Conference; at www.iza.org/conference_files/riskonomics2009/owens_e4815.pdf.

C. Kirabo Jackson and Emily Greene Owens (2011), "One for the Road: Public Transportation, Alcohol Consumption, and Intoxicated Driving," *Journal of Public Economics*, Vol. 95, Is. 1-2, pp. pp 106-121; at www.nber.org/papers/w15872.pdf.

Jeffrey Kenworthy and Felix Laube (2000), *Millennium Cities Database For Sustainable Transport, Institute for Sustainability and Technology Policy*, Distributed by the International Union of Public Transport (www.uitp.com).

Md. Ahsanul Karim (2011), *Transit Operations, City Transportation Plans And Overall Transportation Network Safety*, Masters Thesis, University of British Columbia; at http://circle.ubc.ca/bitstream/handle/2429/33739/ubc_2011_spring_karim_mdahsanul.pdf

Md Ahsanul Karim, Mohamed M. Wahba and Tarek Sayed (2012), *Evaluating the Safety Estimates of Transit Operations and City Transportation Plans*, Transportation Research Board Annual Meeting (www.trb.org); at http://trid.trb.org/view.aspx?id=1130224.

Ugo Lachapelle, et al. (2011), "Commuting by Public Transit and Physical Activity: Where You Live, Where You Work, and How You Get There," *Journal of Physical Activity and Health* (http://journals.humankinetics.com/jpah), Vol. 8, Supplement 1, pp. S72-S82; at http://tinyurl.com/qa3knzu.

Diane K. Levy, Zach McDale and Kassie Bertumen (2013), "Mixed-Income Living: Anticipated and Realized Benefits for Low-Income Households," *Cityscape*, Vol. 15, No. 2; at www.huduser.org/portal/publications/Cityscape_Jul2013.pdf.

Todd Litman (2004), "Impacts of Rail Transit on the Performance of a Transportation System," *Transportation Research Record 1930*, TRB (www.trb.org), pp. 23-29; updated version at www.vtpi.org/railben.pdf.

Todd Litman (2009), *Transportation Cost and Benefit Analysis*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/tca.

Todd Litman (2011), *Evaluating Public Transportation Health Benefits*, American Public Transportation Association (www.apta.com); at www.vtpi.org/tran_health.pdf.

Todd Litman (2012), *Evaluating Public Transit Benefits and Costs*, VTPI (www.vtpi.org); at www.vtpi.org/tranben.pdf.

Todd Litman (2013), *Smart Congestion Relief: Comprehensive Analysis Of Traffic Congestion Costs and Congestion Reduction Benefits*, paper P12-5310, Transportation Research Board Annual Meeting (www.trb.org); at www.vtpi.org/cong_relief.pdf.

Todd Litman (2014), *Safer Than You Think! Revising the Transit Safety Narrative*, Transportation Research Board Annual Meeting paper 13-4357; at www.vtpi.org/safer.pdf.

Todd Litman and Steven Fitzroy (2012), *Safe Travels: Evaluating Mobility Management Traffic Safety Impacts*, VTPI (www.vtpi.org); at www.vtpi.org/safetrav.pdf.

Gordon Lovegrove, Clark Lim and Tarek Sayed (2010), "Community-Based, Macrolevel Collision Prediction Model Use with a Regional Transportation Plan," *Journal Of Transportation Engineering*, Vol. 136, No. 2, February 2010, pp. 120-128; abstract at http://cedb.asce.org/cgi/WWWdisplay.cgi?253404.

William H. Lucy (2003), "Mortality Risk Associated With Leaving Home: Recognizing the Relevance of the Built Environment," *American Journal of Public Health*, Vol 93, No. 9, September, pp. 1564-1569; at www.ajph.org/cgi/content/full/93/9/1564.

Jana Lynott (2014), *Reconnecting Small-Town America by Bus: New Federal Transit Rules Spur Investment,* AARP Public Policy Institute, American Association of Retired Persons (www.aarp.org); at http://tinyurl.com/pgtct9q.

Wesley E. Marshall and Norman W. Garrick (2011), "Evidence on Why Bike-Friendly Cities Are Safer for All Road Users," *Environmental Practice*, Vol. 13, No. 1, March (http://dx.doi.org/10.1017/S1466046610000566); at http://files.meetup.com/1468133/Evidence%20on%20Why%20Bike-Friendly.pdf.

Sommer Mathis (2014), *What If The Best Way To End Drunk Driving Is To End Driving? Tough DUI Laws Can Only Go So Far If We Don't Give People—Especially Young People—Reasonable Alternatives In The First Place*, City Labs (www.citylab.com); at http://tinyurl.com/n2vp45x.

Jeremy Mattson (2013), *Rural Transit Fact Book 2013*, Small Urban and Rural Transit Center (www.surtc.org), Upper Great Plains Transportation Institute; at www.surtc.org/transitfactbook/downloads/2013_rural_transit_fact_book.pdf.

Noreen McDonald (2005), "Does Residential Density Affect the 'Travel' Gender Gap?," *Research on Women's Issues in Transportation*, Transportation Research Board (www.trb.org), pp. 68-76; at http://onlinepubs.trb.org/onlinepubs/conf/CP35v2.pdf.

Mike Males (2009), "The Role of Poverty in California Teenagers' Fatal Traffic Crash Risk," *Californian Journal of Health Promotion 2009*, Vol. 7, Is. 1, pp. 01-13; at http://cjhp.fullerton.edu/Volume7_2009/Issue1/males.pdf.

Sage R. Myers, et al. (2013), "Safety in Numbers: Are Major Cities the Safest Places in the United States?" *Annals of Emergency Medicine*, Vol. 62, Is. 4, pp. 408-418.e3, American College of Emergency Physicians (http://dx.doi.org/10.1016/j.annemergmed.2013.05.030); at www.annemergmed.com/webfiles/images/journals/ymem/FA-5548.pdf.

NAR (2013), *National Community Preference Survey*, National Association of Realtors (www.realtor.org); at www.realtor.org/sites/default/files/reports/2013/2013-community-preference-analysis-slides.pdf.

NCHRP (2010), *Transportation Planner's Safety Desk Reference*, Federal Highway Administration (www.fhwa.dot.gov); at http://tsp.trb.org/assets/FR1_SafetyDeskReference_FINAL.pdf.

NCST (2009), *Hanging Up the Keys? Options When Driving Retirement Becomes a Crisis*, National Center on Senior Transportation (www.seniortransportation.net)

NCSA (2014), *Urban/Rural Comparison*, National Center for Statistics and Analysis, National Highway Traffic Safety Administration (www-nrd.nhtsa.dot.gov); at www-nrd.nhtsa.dot.gov/Pubs/812050.pdf.

NHTSA (annual reports), *Traffic Safety Facts: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, National Highway Traffic Safety Administration (www.nhtsa.gov); at www-nrd.nhtsa.dot.gov/CMSWeb/listpublications.aspx.

NHTSA (2009), *Fatal Crashes Involving Young Drivers*, National Highway Traffic Safety Administration (www.nhtsa.dot.gov); at www-nrd.nhtsa.dot.gov/Pubs/811218.pdf.

NHTSA (2012b), *Blueprint For Ending Distracted Driving*, National Highway Traffic Safety Administration (www.nhtsa.dot.gov); at www.distraction.gov/download/811629.pdf.

NHTSA (2013), *Countermeasures That Work: A Highway Safety Countermeasure Guide For State Highway Safety Offices*, National Highway Traffic Safety Administration (www.nhtsa.gov); at www.nhtsa.gov/Driving+Safety/Research+&+Evaluation.

NHTSA (2014), *Driving Safety Website*, National Highway Traffic Safety Administration (www.nhtsa.gov); at www.nhtsa.gov/Driving+Safety.

NHTSA (2014b), *Driver License Compliance Status in Fatal Crashes*, National Highway Traffic Safety Administration (www.nhtsa.gov); at www-nrd.nhtsa.dot.gov/Pubs/812046.pdf.

Robert Noland (2003), "Traffic Fatalities and Injuries: The Effects of Changes in Infrastructure and Other Trends," *Journal of Accident Prevention and Analysis* (www.elsevier.com/locate/aap), Vol. 35, pp. 599-611: at www.bikewalktwincities.org/sites/default/files/Noland-Traffic_Fatalities_and_Injuries.pdf.

NSC (2012), *Understanding The Distracted Brain: Why Driving While Using Hands-Free Cell Phones Is Risky Behavior*, National Safety Council (www.nsc.org); at www.nsc.org/safety_road/Distracted_Driving/Documents/Cognitive%20Distraction%20White%20Paper.pdf.

OECD (2006), *Young Drivers: The Road to Safety, Policy Brief*, Joint Transport Research Centre of the Organisation for Economic Co-operation and Development (OECD) and the European Conference of Ministers of Transport (ECMT); at www.internationaltransportforum.org/jtrc/safety/YDpolicyBrief.pdf.

OECD (2012), *International Road Traffic and Accident Database*, Organization for Economic Cooperation and Development (www.bast.de/htdocs/fachthemen/irtad//english/we2.html).

Reconnecting America (2009), *Realizing the Potential for Sustainable and Equitable TOD: Recommendations to the Interagency Partnership on Sustainable Communities*, Reconnecting America (http://reconnectingamerica.org); at http://tinyurl.com/phdz9gx.

RSF (2014), *Roadway Safety Guide: A Primer for Community Leaders*, Roadway Safety Foundation (www.roadwaysafety.org).

Joanna Saisan, Monika White and Lawrence Robinson (2014), *Age and Driving: Safety Tips and Warning Signs for Older Drivers*, Helpguide (www.helpguide.org); at www.helpguide.org/articles/aging-well/age-and-driving-safety-tips.htm.

SAMHSA (2011), *Results From The 2010 National Survey On Drug Use And Health: Summary Of National Findings, NSDUH Series H-41*, Substance Abuse and Mental Health Services Administration (www.samhsa.gov), U.S. Department of Health and Human Services; at www.samhsa.gov/data/nsduh/2k10nsduh/2k10Results.htm.

Tomas Sanchez, Q. Shen and Z. Peng (2004), "Transit Mobility, Jobs Access and Low-income Labour Participation in US Metropolitan Areas," *Urban Studies*, Vol. 41, No. 7, pp. 1313-1331.

A. Santos, et al. (2011), *Summary of Travel Trends: 2009 National Household Travel Survey*, Federal Highway Administration (http://nhts.ornl.gov); at http://nhts.ornl.gov/2009/pub/stt.pdf.

Ian Savage (2013). "Comparing The Fatality Risks In The United States Transportation Across Modes And Over Time," *Research in Transportation Economics*, Vol. 43, No. 1, pp. 9-22; at http://faculty.wcas.northwestern.edu/~ipsavage/436-manuscript.pdf.

Joachim Scheiner and Christian Holz-Rau (2011), "A Residential Location Approach To Traffic Safety: Two Case Studies From Germany," *Accident Analysis & Prevention* (www.sciencedirect.com/science/journal/00014575), Vol. 43, Is. 1, January, pp. 307-322

Joseph P. Schwieterman, et al. (2014), *The Personal Tech Tidal Wave: The Rising Use of Electronic Devices on Intercity Bus, Planes & Trains*, Chaddick Institute for Metropolitan Development, DePaul University (www.depaul.edu); at http://tinyurl.com/kvxeyyn.

SR4T (2014), *Graduated Licenses*, Safer Roads 4 Teens (www.saferoads4teens.org); at www.saferoads4teens.org/graduated-driver-licensing-0.

Jim P. Stimpson, et al. (2014), "Share of Mass Transit Miles Traveled and Reduced Motor Vehicle Fatalities in Major Cities of the United States," *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, (doi:10.1007/s11524-014-9880-9); at http://link.springer.com/article/10.1007%2Fs11524-014-9880-9.

Thomas D. Stucky and John R. Ottensmann (2009), "Land Use and Violent Crime," *Criminology*, Vol. 47, Is. 4, pp. 1009–1368; abstract at http://onlinelibrary.wiley.com/doi/10.1111/j.1745-9125.2009.00174.x/abstract.

Richard Tay, Abul Azad , S. C. (Chan) Wirasinghe and Stephen Hansen (2013), "Analysis Of The Influence Of Urban Rail Stations On Neighbourhood Crime," *International Journal of Urban Sciences*, Vol. 17, No. 2, ; summary at http://dx.doi.org/10.1080/12265934.2013.776289.

Clive Thompson (2010), "Clive Thompson to Texters: Park the Car, Take the Bus," *Wired Magazine* (www.wired.com); at www.wired.com/2010/02/st_clive_thompson_texting.

Mary Ann Timmerman, E. Scott Geller, Kent E. Glindemann and Angela K. Fournier (2003), "Do the Designated Drivers of College Students Stay Sober?" *Journal of Safety Research*, Vol. 34, pp. 127-133; at www.columbia.edu/cu/biology/courses/w3995x/do-designated-drivers-stay-sober.pdf.

TIRF (2014), Traffic Injury Research Foundation (www.tirf.ca).

Polly Trottenberg (2011), *Treatment of the Economic Value of a Statistical Life in Departmental Analyses*, Office of the Secretary of Transportation, U.S. Department of Transportation (www.dot.gov); at www.dot.gov/sites/dot.gov/files/docs/Value_of_Life_Guidance_2011_Update_07-29-2011.pdf.

TZD (2011), *Toward Zero Deaths: A National Strategy on Highway Safety*, (www.towardzerodeaths.org)

UITP (2005), *Mobility In Cities Database*, International Association of Public Transport (www.uitp.org); at www.uitp.org/publications/MCD2-order.

Tom Van Heeke, Elise Sullivan and Phineas Baxandall (2014), *A New Course: How Innovative University Programs Are Reducing Driving On Campus And Creating New Models For Transportation*, U.S. Public Interest Research Group (www.uspirg.org); at http://uspirg.org/reports/usp/new-course.

UVic (2010), *Reducing Drinking and Driving: Helping Municipal Governments*, Centre for Addictions Research, University of Victoria (www.carbc.ca); at http://carbc.ca/Portals/0/Community/Municipal/3ReduceDD(e).pdf.

VTPI (2014), *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org/tdm).

Rania Wasfi, David Levinson and Ahmed El-Geneidy (2012), "Measuring the Transportation Needs of Seniors in Hennepin County, Minnesota," *Journal of Transport Literature*, Vol. 6, No. 2, pp. 8-32; at http://tram.mcgill.ca/Research/Publications/Seniors_MN.pdf.

WDOT (2004), *Wisconsin SafeRide Annual Report and Evaluation*, Wisconsin Department Of Transportation (www.dot.wisconsin.gov); at www.dot.wisconsin.gov/library/publications/topic/safety/saferide.pdf.

Hank Weiss (2012), *Caution! Paradigm Shift Ahead: "Adolescent Mobility Health"*, Adolescent Mobility Health Consortium (https://blogs.otago.ac.nz/amc).

Jesse White (2014), *Drive Safe, Drive Sober*, Illinois Secretary of State, (www.cyberdriveillinois.com); at www.cyberdriveillinois.com/publications/pdf_publications/dsd_a245.pdf.

WHO (2004), *World Report on Road Traffic Injury Prevention*, World Health Organization and the World Bank (www.who.int); at http://tinyurl.com/23k5lfc.

Chang Yi (2006), "The Impact of Public Transit on Employment Status: Disaggregate Analysis of Houston," *Transportation Research Record 1986*, TRB (www.trb.org), pp. 137-144; at www.mdt.mt.gov/research/docs/trb_cd/Files/06-1558.pdf.

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