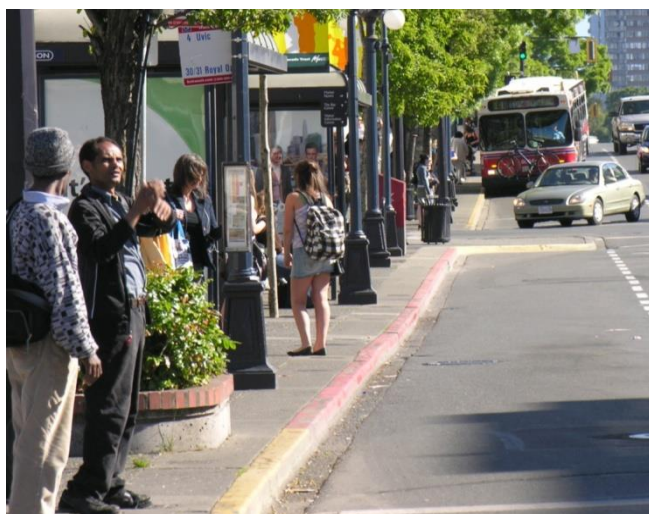

Safer Than You Think!

Revising the Transit Safety Narrative

9 May 2022

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Abstract

Public transportation is overall a relatively safe (low crash risk) and secure (low crime risk) mode of transport. Transit travel has about a tenth the traffic casualty (death or injury) rate as automobile travel, and transit-oriented neighborhood residents have about a fifth the per capita crash casualty rate as in automobile-oriented areas. Transit also tends to have lower overall crime rates than automobile travel, and many transit service improvements can further increase security by improving surveillance and economic opportunities for at-risk populations. Despite its relative safety and security, many people consider public transit dangerous, and so are reluctant to use it or support service expansions in their communities. Various factors contribute to this excessive fear, including the nature of public transit travel, heavy media coverage of transit-related crashes and crimes, and conventional traffic safety messages which emphasize danger rather than safety. Transit agencies can help create a new safety narrative by better measuring and communicating transit's overall safety and security impacts, and providing better guidance concerning how users and communities can enhance transit safety and security.

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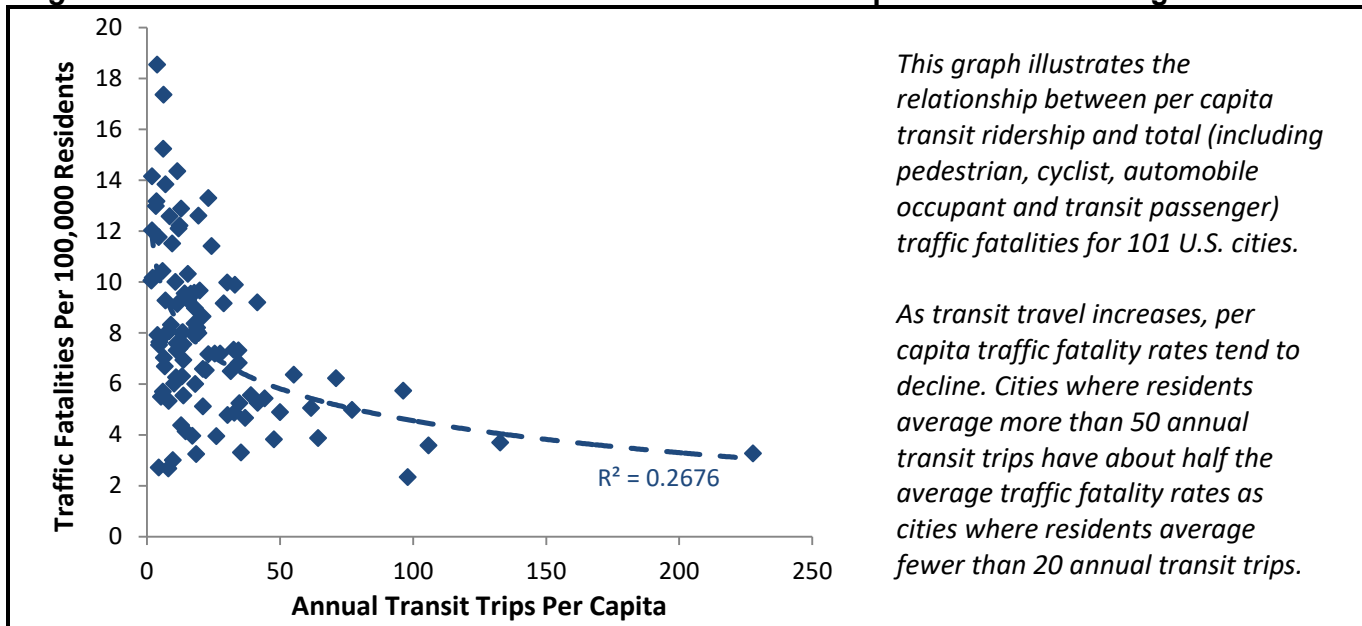
Executive Summary

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

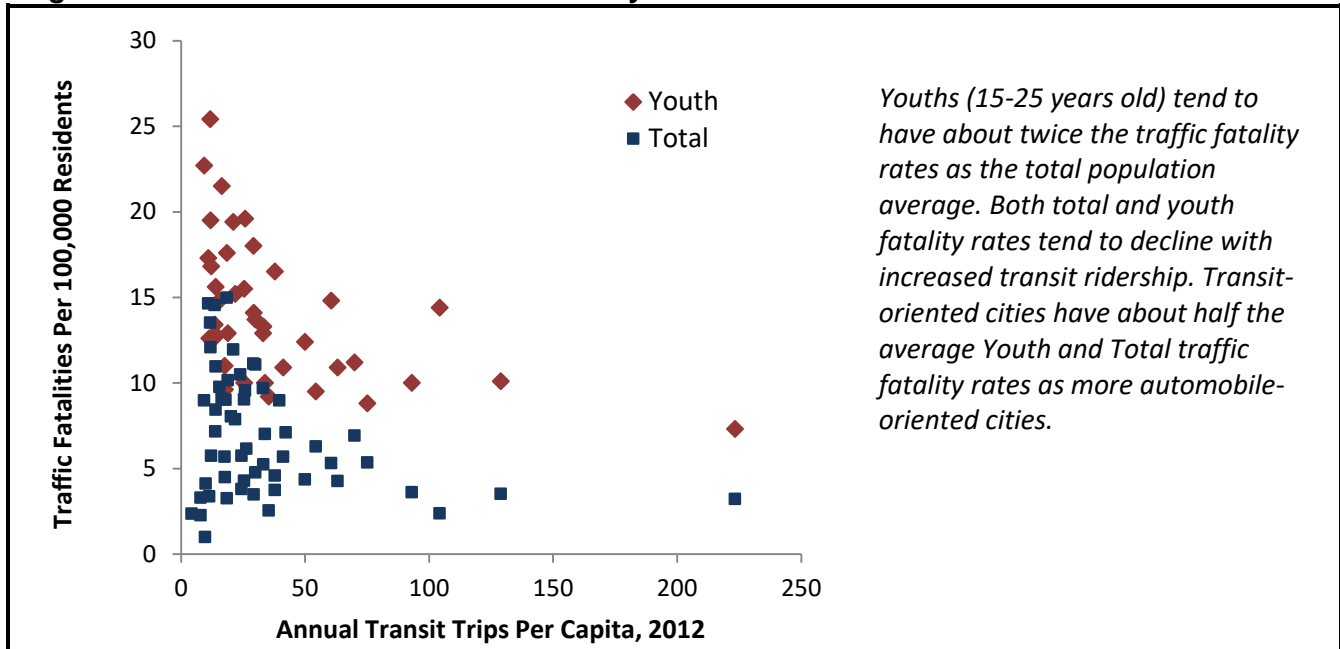
Figure ES-1 Traffic Fatalities Versus Transit Ridership For U.S. Urban Regions



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

Research described in this report indicates that public transit investments coupled with transit-supportive policies also tend to increase overall community security by increasing community cohesion (positive interactions among neighbors) and passive surveillance (more by-passers who can report threats), reducing concentrated poverty and increasing economic opportunities for at-risk residents, and by reducing vehicle crimes (road rage, vehicular assault, vehicle thefts and vandalism). As a result, all else being equal, transit-oriented communities tend to have lower overall crime rates than automobile-oriented communities.

Figure ES-2 Youth and Total Traffic Fatality Rates



Public transportation investment and supportive policies increase traffic safety and personal security 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.

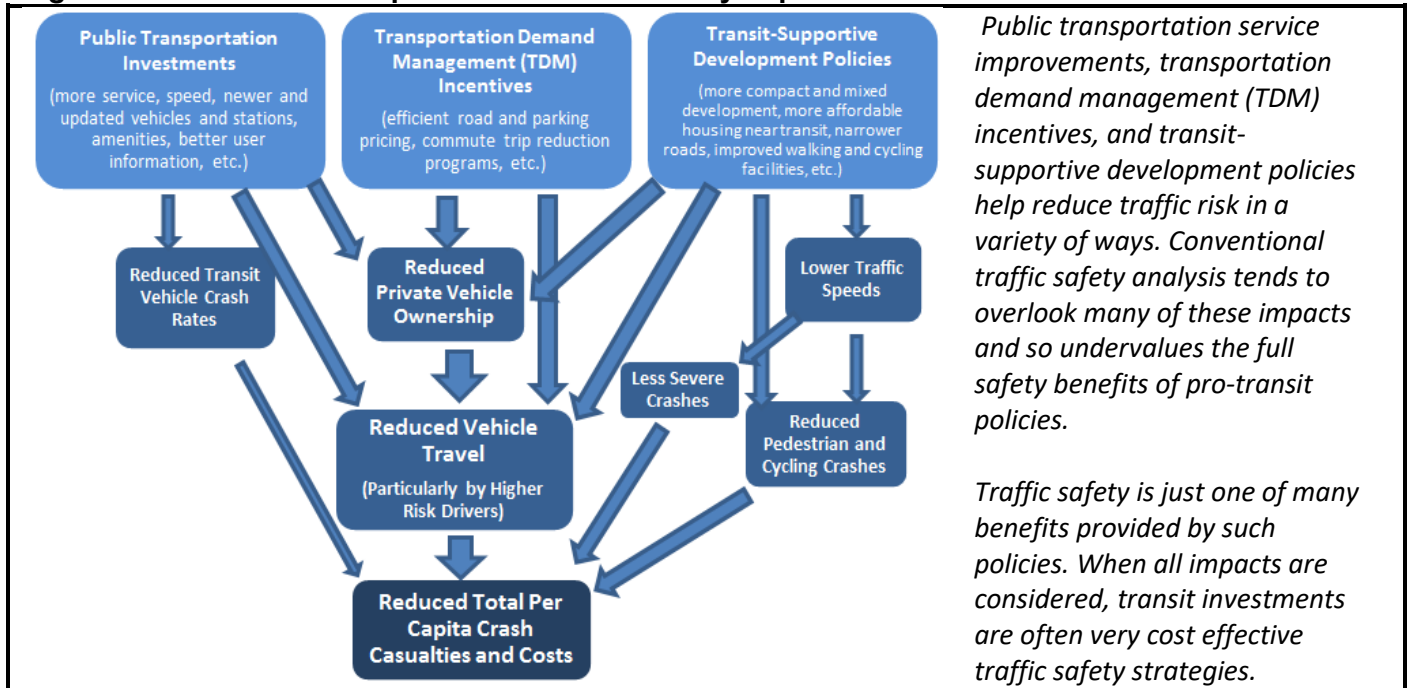
Table ES-1 Types of Public Transportation Safety Strategies

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.
<ul style="list-style-type: none"> Improved operator training and supervision. New vehicles. New station design. Enhanced transit security. Grade separation. 	<ul style="list-style-type: none"> More service (more routes, frequency, etc.) More speed (grade separation and faster loading) Better vehicles, stops and stations. Better access (walking, park & ride, etc.). Improved information and payment options. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> Transport pricing reforms (efficient road, parking, fuel & vehicle insurance pricing). Efficient parking management, reduced parking subsidies. TDM marketing. School and campus transport management. 	<ul style="list-style-type: none"> 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 and security in important ways.

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.

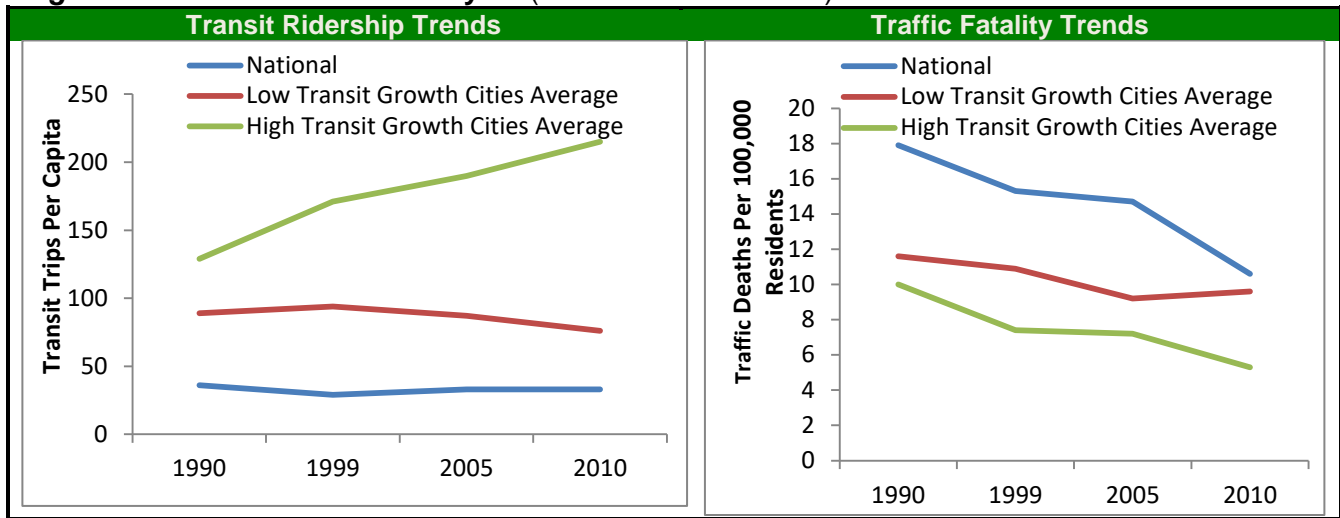
Figure ES-3 Public Transportation's Traffic Safety Impacts



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.*

Comparisons of major U.S. cities indicates that those 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.*

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



Traffic fatality rates decline far more in the four high-transit-growth cities (Denver, Los Angeles, Portland and Seattle: green line) than the four low-transit-growth cities (Cleveland, Dallas, Houston and Milwaukee: red line), and national trends (blue line). This suggests that pro-transit policies can increase traffic safety.

Many people have misconceptions about transport risks: they exaggerate transit travel danger and automobile safety. To correct these misconceptions transit organizations can help develop a new, more accurate and positive safety narrative which can be incorporated into communications including newsletters, websites, media contacts, advertising, employee training, planning documents and performance evaluation.

A review of twelve major traffic safety programs found only three that recognize transit as a possible safety strategy, and these provide only minimal information or support. They generally assume that transit provides only modest safety benefits, reflecting little understanding of the ways that pro-transit policies can leverage large crash reductions. This reflects the institutional status of these organizations. Most were established to support *highway* safety, and so tend to be unfamiliar with public transit and other Transportation Demand Management (TDM) strategies. However, transportation professionals, including traffic safety experts, are starting to apply more comprehensive and multi-modal analysis, including innovative TDM solutions.

Despite obstacles discussed in this report, it is likely that pro-transit policies will be increasingly recognized as traffic safety and community security strategies. We now have good, credible evidence that pro-transit policies can increase safety, and many transportation professionals are ready to apply more comprehensive and multi-modal planning. Many safety experts 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 alternative modes, 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 traffic safety and community security goals. These trends support a new transit safety paradigm.

This is good news overall. It 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.

Introduction

Risk refers to exposure to undesirable events. It is the opposite of safety. Some risks, such as standing near a high ledge or facing an angry wild animal, are perceived directly and so invoke rational fear. Other risks are less tangible; they are measured statistically and communicated through mass media. People's perception of such risks is significantly affected by the nature of this communication. Failure by experts to accurately communicate risks can cause individuals and communities to fear the wrong dangers and make irrational decisions.

This is certainly true of transportation safety (crash) and security (crime) risks. Many people have exaggerated fears of public transit risks, which can be a major obstacle to efforts to encourage transit travel, improve transit services, and implement transit-oriented development (more compact, mixed, walkable development around transit stations and routes), and therefore achieve strategic planning objectives such as reduced congestion, increased affordability, and improved accessibility for non-drivers. More accurate and positive information about transit's safety benefits can help individuals choose safer and healthier communities, and create more efficient and equitable transportation systems.

Conventional safety programs can reduce crash rates per vehicle-mile or -kilometer, but their overall benefits are modest as indicated by the fact that, despite huge traffic safety investments the United States has, by far, the highest per capita traffic fatality rate among peer countries (Sauber-Schatz, et al. 2016), due to high per capita vehicle travel and automobile-oriented urban design (Schmitt 2016). Conventional safety programs assume that motor vehicle travel is overall very safe, and traffic crashes result from special risks such as youth and impaired driving, and special high-risk "black spots." As a result, they apply targeted solutions that focus on specific risks, and ignore structural risk factors that affect how and how much people travel. A new transportation safety paradigm considers the impacts of all transportation policies and urban planning decisions. For example, the new paradigm considers how roadway and public transit investments, road and parking pricing, and land use development policies affect travel activity and crash rates. This paradigm expands the range of traffic safety strategies to include more investments in alternative modes, transport pricing reforms, TDM strategies, and Smart Growth development policies, in addition to conventional targeted traffic safety programs.

This report discusses these issues. It evaluates various public transit risks including accidents, crimes and terrorism; compares these risks with other transport modes; examines evidence of excessive and irrational fear of transit; investigates how transit agencies currently communicate risks; and recommends better ways to communicate transit safety benefits and strategies. This analysis complements recent research on public transit health impacts (Lachapelle, et al. 2011; Litman 2011). This should be of interest to people involved in transport planning, transit promotion, and transportation safety and security analysis.

Evaluating Transportation Risks

Transportation risks can be challenging to evaluate because there are several types of risks and perspectives. Which risks are considered and how they are measured can significantly affect analysis results. For example, traffic accident statistics can measure based on collisions, casualties (somebody is injured or killed) or fatalities, and may include passengers, vehicle occupants (passengers plus employees), all crash victims (including other road users hit by a transit vehicle), plus non-collision injuries such as falls in transit stations, and employee workplace injuries. Whether or not suicides and falls (for example, if a passenger slips while walking up the stairs in a train station) are included can significantly affect casualty statistics, particularly for rail transit.

Similarly, crime statistics may include violent crimes, all crimes against passengers and employees, or all transit-related crimes, a major portion of which involve trespassing, transit property vandalism and fare evasion. Risks are considered *internal* if imposed on mode users, and *external* if imposed on other people. Table 1 summarizes these various risk categories.

Table 1 Types of Transportation Risks

Perspectives	Accidents	Crime	Other Risks
Internal (impacts on a mode's users).	Crash damages to vehicle occupants. Falls (e.g., in a train station). Worker injuries.	Crime risk to vehicle occupants. Crime risk when accessing vehicles.	Pollution exposure to mode users. Sedentary living (inadequate exercise) by mode users.
External (impacts on non-users).	Crash risk to other people.	Crime risk that users of a mode impose on other people (the travel mode used by criminals).	Air pollution a mode imposes on other people. Self-harm (such as suicides)

Transportation activities can affect various types of risks, including internal and external risks.

Which perspective is used can also affect results. For example, driving a larger vehicle reduces internal but increases external crash risks (Anderson and Auffhammer 2014). Similarly, excluding poor households from a neighborhood may reduce local crime risks, but by concentrating poverty and reducing disadvantaged people's economic opportunity, it may increase total regional crime risk.

Risk analysis is also complicated by various confounding factors. For example, transit service and ridership, vehicle crash rates, poverty and some types of crime tend to increase with city size and urban density, but such correlations do not necessarily indicate causation; they do not really mean that crashes and crime would increase with more transit travel.

Public Transit Risk Data Sources

This section summarizes public transit risks and how those compare with other modes.

Various sources provide data for transit risk analysis:

- The *National Transportation Statistics* report, by the Bureau of Transportation Statistics (BTS) provides data on crash fatalities, injuries, accidents and crime, by year, agency, mode and transit type (bus, rail, demand response).
- The U.S. Federal Transit Administration's *National Transit Database* (NTD) contains accident and crime statistics from each U.S. transit agency. The Safety and Security Module contains data on safety- and security-related incidents, as defined in Table 2 (Yang 2004).

Table 2 NTD Safety and Security Incident Categories (Federal Transit Administration)

Major Incident (require special reports)	Non-Major Incident (included in monthly reports)
<ul style="list-style-type: none"> • Fatalities • Two+ injuries transported for treatment • Total property damage exceeding \$25,000 • Main-line derailments • Evacuations due to life safety • Grade Crossing collisions with injury or \$7,500 damage • Rail transit vehicle collisions with personal or vehicle, resulting in one or more injuries 	<p>Safety</p> <ul style="list-style-type: none"> • Incidents causing injury (not qualifying as major incidents) requiring transport for immediate medical treatment • Property damage exceeding \$7,500 • All non-arson fires <p>Security</p> <ul style="list-style-type: none"> • Standard FBI Uniform Crime Reporting (UCR) categories. • Other threats (e.g. bomb, chemical, biological, cyber, etc.) • Suicides

The U.S. National Transit Database defines safety and security incidents that should be reported.

- The FTA *Safety and Security Statistics* website (<http://transit-safety.volpe.dot.gov/Data/samis.aspx>) provides some safety and security incident data by transit mode. Some transit agencies use these or similar statistics to track trends and peer comparisons, but they are unsuited for comparing risks with other modes (automobile travel).
- *Mass Transit's* annual *Transit Safety and Security Reports* (www.masstransitmag.com/safety-security).
- American Public Transportation Association (www.apta.com/research/stats) provides annual statistics on transit infrastructure, services, use and funding.
- The Canadian Urban Transit Association (www.cutaactu.ca) *Canadian Transit Fact Book* provides various statistics for each transit agency, but no crash or crime data.
- The *International Road Traffic and Accident Database* (OECD 2012), and the *Mobility In Cities Database* (UITP 2005) provide transit crash data, but it is difficult to compare risk between travel modes, the relative safety of transit does not seem to be widely communicated.
- *CrimeReports* (www.publicengines.com/products/crimereports.php) uses police crime data to produce geocoded crime maps for many jurisdictions, and *Neighborhood Scout* (www.neighborhoodscout.com) uses this information to rate neighborhoods.
- *Public Transport Victimisation* (www.ucl.ac.uk/jdibrief/analysis/public-transport-victimisation) provides information on the risk exposure to various types of public transit users.

Measuring Transit Risk

This section discusses how various transit risks are measured.

Crash Risk

Crash risk refers to property damages, injuries and deaths caused by vehicle crashes.

Crash Risk Per Unit of Travel (Passenger-mile or –kilometer)

Public transit has relative low crash rates per unit of travel, as indicated in Table 3 and Figure 1.

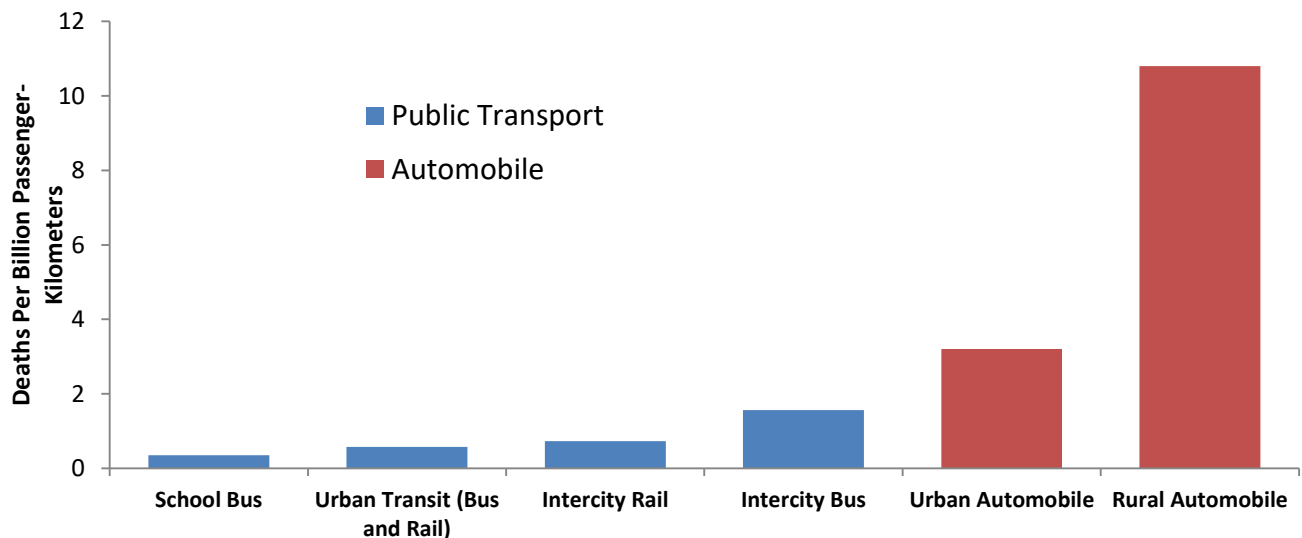
Table 3 Passenger Fatalities per Billion Passenger-Miles, 2000-2009 (Savage 2013)

Travel Mode	Deaths Per Billion Passenger-Miles
Car or light truck driver or passenger	7.28
Commuter rail and Amtrak	0.43
Urban mass transit rail (subway or light rail)	0.24
Bus (transit, intercity, school, charter)	0.11
Commercial aviation	0.07

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

Compared with automobile travel, intercity and commuter passengers have about one-20th, urban rail passengers about one-30th, and bus passengers about one-60th the fatality rate per 100 million passenger-miles. Of course, many factors affect an individual's risk and there are many ways that motorists can increase their safety. For example, drivers can reduce their risks by staying sober and observing speed limits since about 31% of fatal traffic accidents involve an impaired driver and 30% involve speeding (NHTSA 2012), but there are still significant risks beyond drivers' control, such as errors by other road users and mechanical failures, so even law-abiding motorists face greater crash risks than transit passengers.

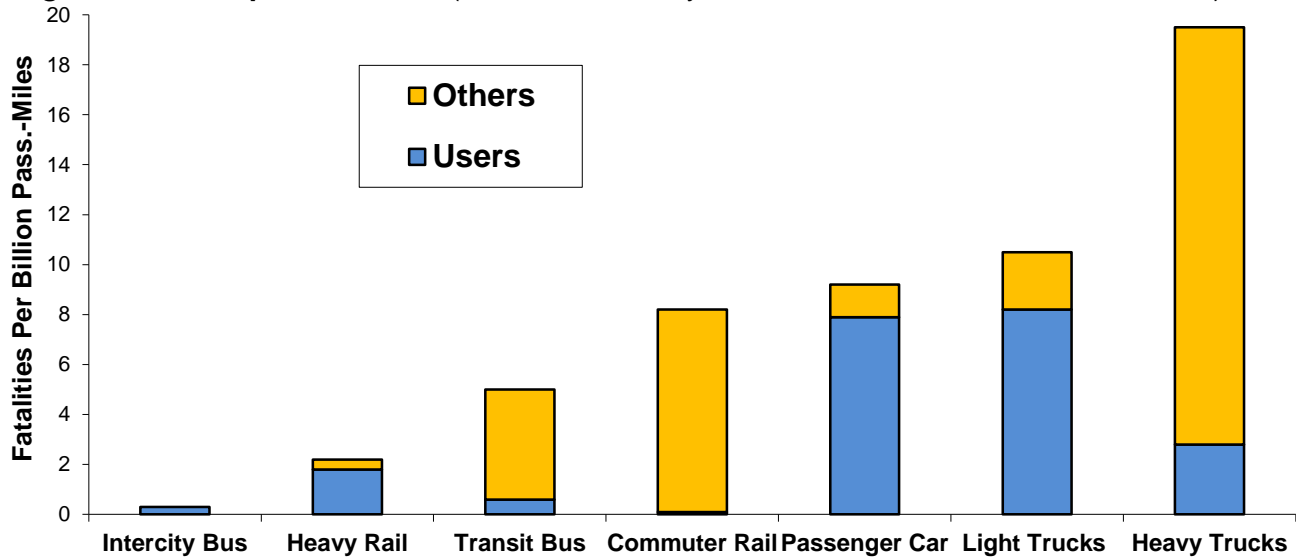
Figure 1 Canadian Fatality Rate By Mode (CUTA 2010)



Public transit tends to have much lower traffic fatality rates than automobile travel.

Although transit vehicles are large and so impose risk on other road users, even considering these external risks transit travel has less than half the total death rate as automobile travel (Figure 2). Crash rates per passenger-mile or –kilometer are higher on transit systems with low load factors (fewer passengers per transit vehicle-mile or –km) but decline as load factors increase.

Figure 2 Transport Fatalities (Litman and Fitzroy 2012, based on FHWA and APTA data)



Transit tends to have lower crash casualty rates than automobile travel, considering risks to transit vehicle occupants and other road users.

Most transit trips include active transport (walking and cycling) links, and transit users tend to walk and bike more in total than motorists (Lachapelle, et al. 2011). These modes have relatively high per-mile casualty rates, although this risk is largely offset by reduced risks to other travelers and improved public fitness and health (Jacobsen 2003; Litman 2011; Rojas-Rueda, et al. 2011).

Community (Per Capita) Crash Risks

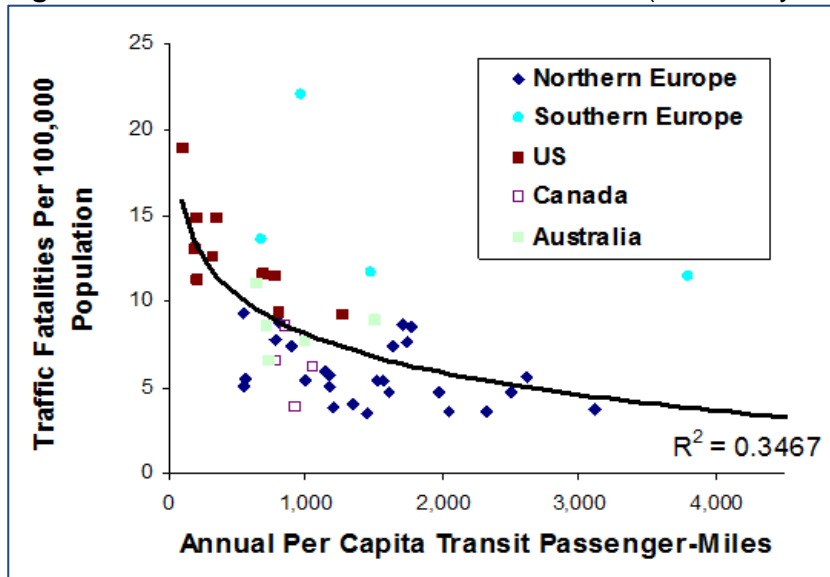
As public transit travel increases in a community total (pedestrians, cyclists, motorists and transit passengers) per capita traffic casualty rates tend to decline (Karim, Wahba and Sayed 2012; Scheiner and Holz-Rau 2011; Truong and Currie 2019). Various studies using diverse analysis methods and data sets indicate that relatively small transit ridership gains are associated with proportionately larger reductions in per capita crash rates (Duduta, et al. 2012). For example, 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, a 0.4% increase in total crashes, and a 13.8% reduction in traffic fatalities.

Truong and Currie's (2019) study of crash rates in Sydney, Australia found that shifts from private vehicle to public transport (i.e. train, tram, and bus) commuting tend to reduce both total crashes and severe injury crashes. They estimate that, holding all other variables (including proportions of commuting by tram, bus, walking, cycling, and motorbike) constant each percentage point increase in the proportion of commuting from a zone by train reduce 2.2 total crashes and 0.86 severe

crashes, and a percentage point increase in bus mode share reduces an even larger 5.7 total crashes and 1.8 severe crashes. Increases in walking, bicycle and motorcycle mode shares, higher speed roads and industrial areas all tend to increase crashes in a zone.

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 transit is associated with 1.5% reduction in total traffic deaths. Since only about 2% of total person-miles are currently by transit, 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. Figures 3 (international data) and 4 (U.S. data) illustrate this relationship.

Figure 3 Traffic Fatalities Vs. Transit Travel (Kenworthy and Laube 2000; UITP 2020)



International data indicate that per capita crash rates decline with increased transit ridership.

The U.S. cities with more than 50 annual transit 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 (NHTSA 2012). Since Americans average about 1,350 annual person-trips, this represents an increase from about 1.5% to 4% transit mode share, but the transit-oriented 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. This indicates that transit-oriented development leverages additional vehicle travel reductions and traffic fatalities then just the individual trips shifted from automobile to transit. Duduta, et al. (2014) and Allen (2013) show that public transport service improvements that incorporate high quality infrastructure and safety features can provide significant safety benefits, reducing injuries and fatalities as much as 50%.

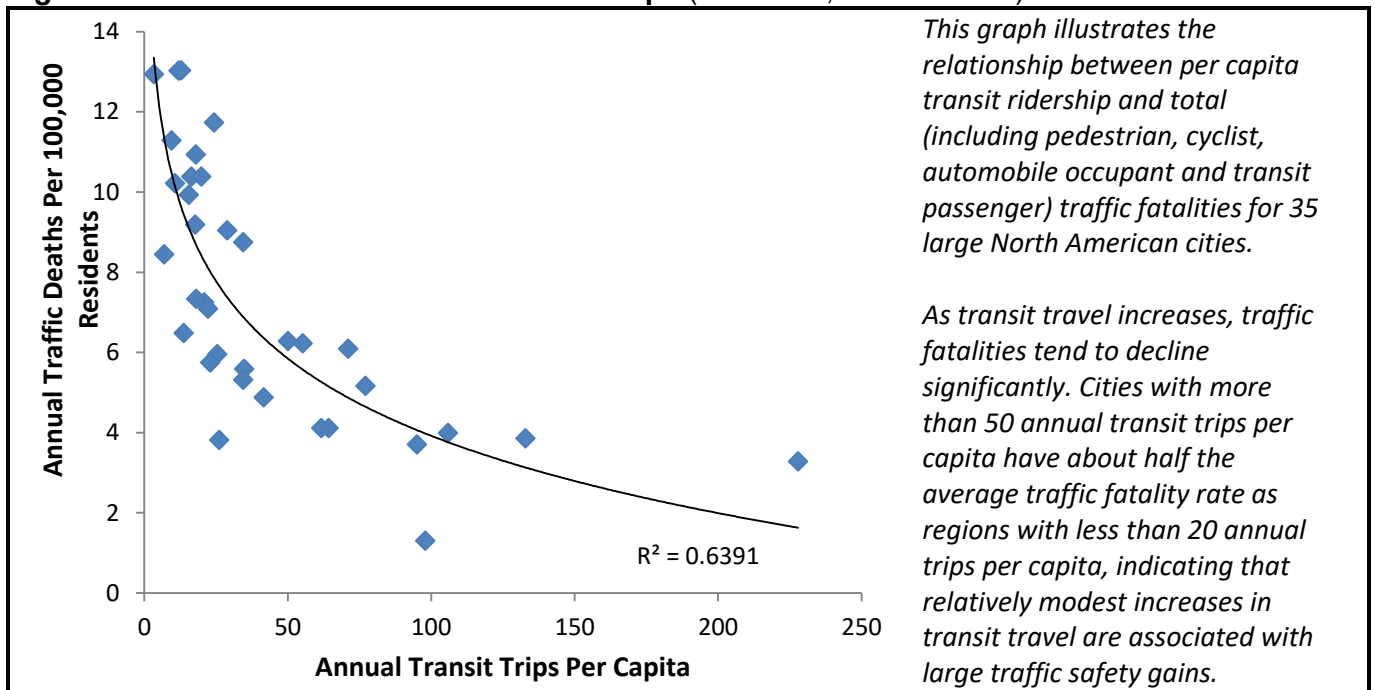
These safety benefits probably reflect, in part, better travel options for higher-risk drivers, such as youths, seniors, drinkers and drug users. Jackson and Owens (2010) investigated how late-night service on Washington DC's Metro system affected impaired driving rates. In 1999, train service was extended from midnight to 1:00am hour on Fridays and Saturdays, to 2:00 am in 2002, and to 3:00 am in 2003. The later service hours increased drinking in station-area restaurants and bars,

but reduced drunk driving and accidents: the researchers found that for each additional service hour driving under the influence (DUI) *arrests* declined 15.6%, and impaired driver *fatal accidents* 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 Metro stations experienced increased DUI arrest rates.

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 commercial and entertainment districts. Similarly, Lichtman-Sadot (2019) found that young driver traffic crash rates declined an average of 37%, and their crash injuries decrease 24%, after late-night buses began operating in Israeli cities in 2007. The results are robust to various models, indicating that public transit, particularly late-night services, can significantly reduce traffic risk.

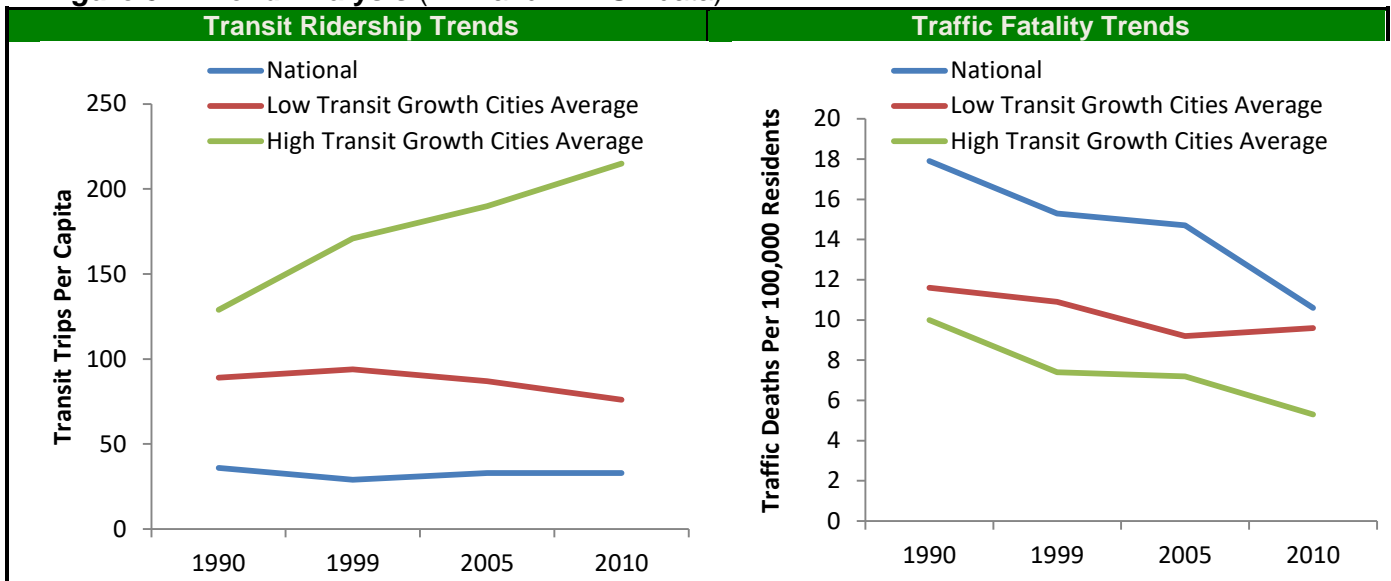
Figure 4 illustrates the relationship between per capita transit ridership and total traffic fatalities for 35 large North American cities. As transit travel increases, traffic fatalities tend to decline significantly. Cities with more than 50 annual transit trips per capita have about half the average traffic fatality rate as regions with less than 20 annual trips per capita, indicating that relatively modest increases in transit travel are associated with large traffic safety gains. This increase in safety is much larger than could be explained by automobile travel shifted to transit, which suggests that high quality transit is a catalyst for other transport and land use patterns, such as more walkable communities with lower traffic speeds, and less driving by higher risk groups such as youths, seniors, drinkers and drug users, which significantly increase safety.

Figure 4 Traffic Fatalities Versus Transit Trips (FTA 2012; NHTSA 2012)



Some of these high-transit-ridership-low-VMT cities are compact and transit-oriented because they developed prior to the Interstate Highway era, but some newer cities have achieved significant transit ridership and traffic safety gains by implementing transit improvements and support strategies. Figure 5 compares transit travel and traffic fatality trends for four cities with pro-transit policies (Denver, Los Angeles, Portland and Seattle) with four peer cities with more automobile-oriented policies (Cleveland, Dallas, Houston and Milwaukee). The pro-transit cities had more than double the transit ridership growth, and reduced average traffic fatality rates to nearly half those of the U.S. overall and of the automobile-oriented cities. This suggests that pro-transit policies can increase traffic safety in newer cities.

Figure 5 Trend Analysis (FTA and NHTSA data)



The four high-transit-growth cities (Denver, Los Angeles, Portland and Seattle, shown by the green line) achieved far higher transit ridership growth and 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 cities.

Several factors help explain the large crash reductions associated with modest transit ridership increases. Many of the transport system and built environment (urban design) features that tend to increase transit travel also reduce crashes, as summarized in Table 4. Communities that reflect these features are often called *new urban*, *smart growth* or *transit-oriented development*.

Table 4 Factors That Increase Traffic Safety (Ewing and Dumbaugh 2009)

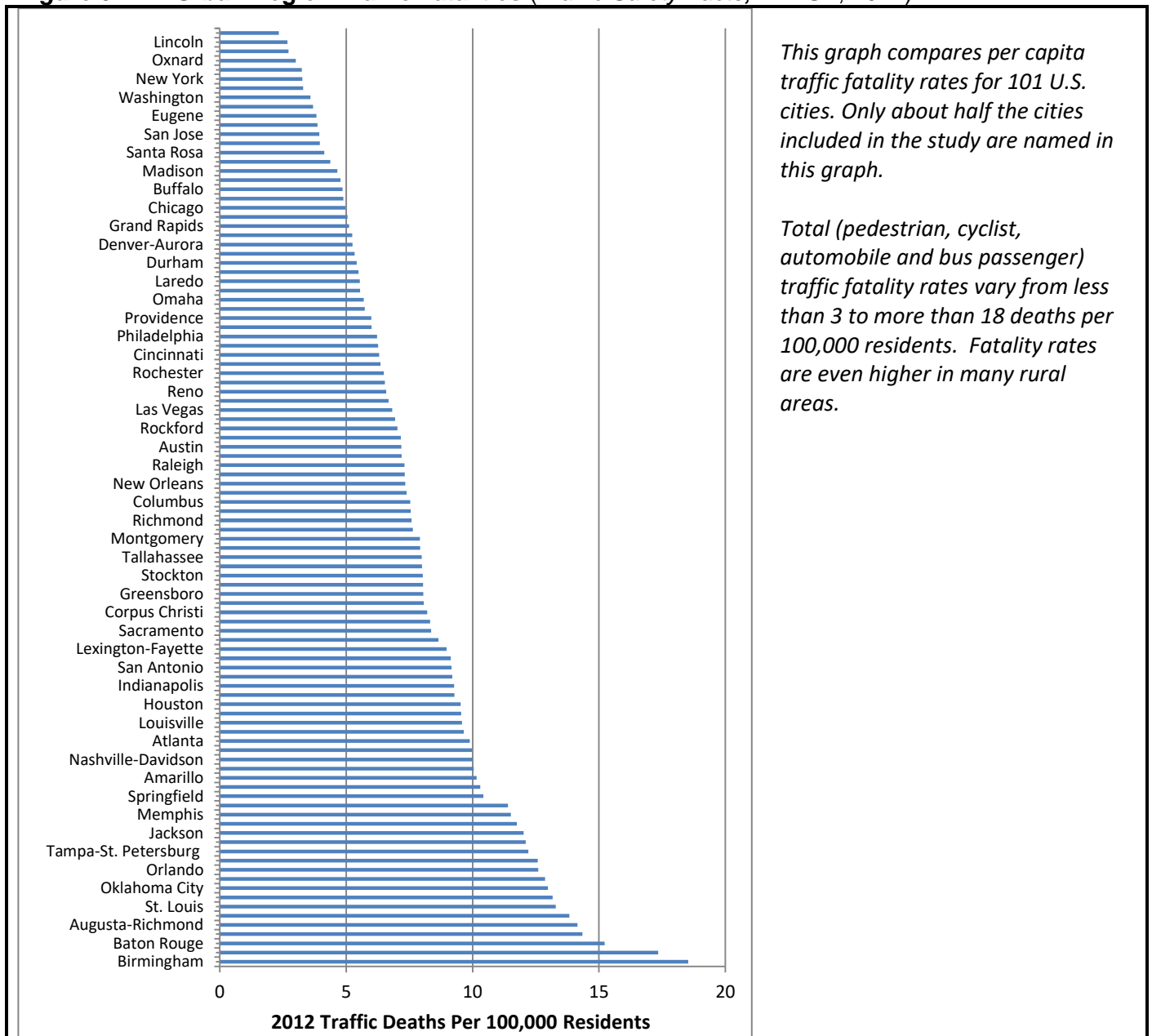
Transport System	Built Environment
<ul style="list-style-type: none"> • High quality transit (convenient, comfortable, affordable) service • Good walking and cycling conditions • Lower traffic speeds • More connected roadway network • Transportation demand management • High fuel taxes, parking fees and road tolls 	<ul style="list-style-type: none"> • Development density and mix • Reduced parking supply

Several factors tend to encourage transit travel, reduce automobile travel and increase traffic safety

Regional Analysis

Regional analysis measures crash risks in a particular city or urban region. 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. Figure 6 compares total (pedestrian, cyclist, automobile and bus passenger) traffic fatality rates of these regions. Crash rates range from 2.3 to 18.5 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)¹

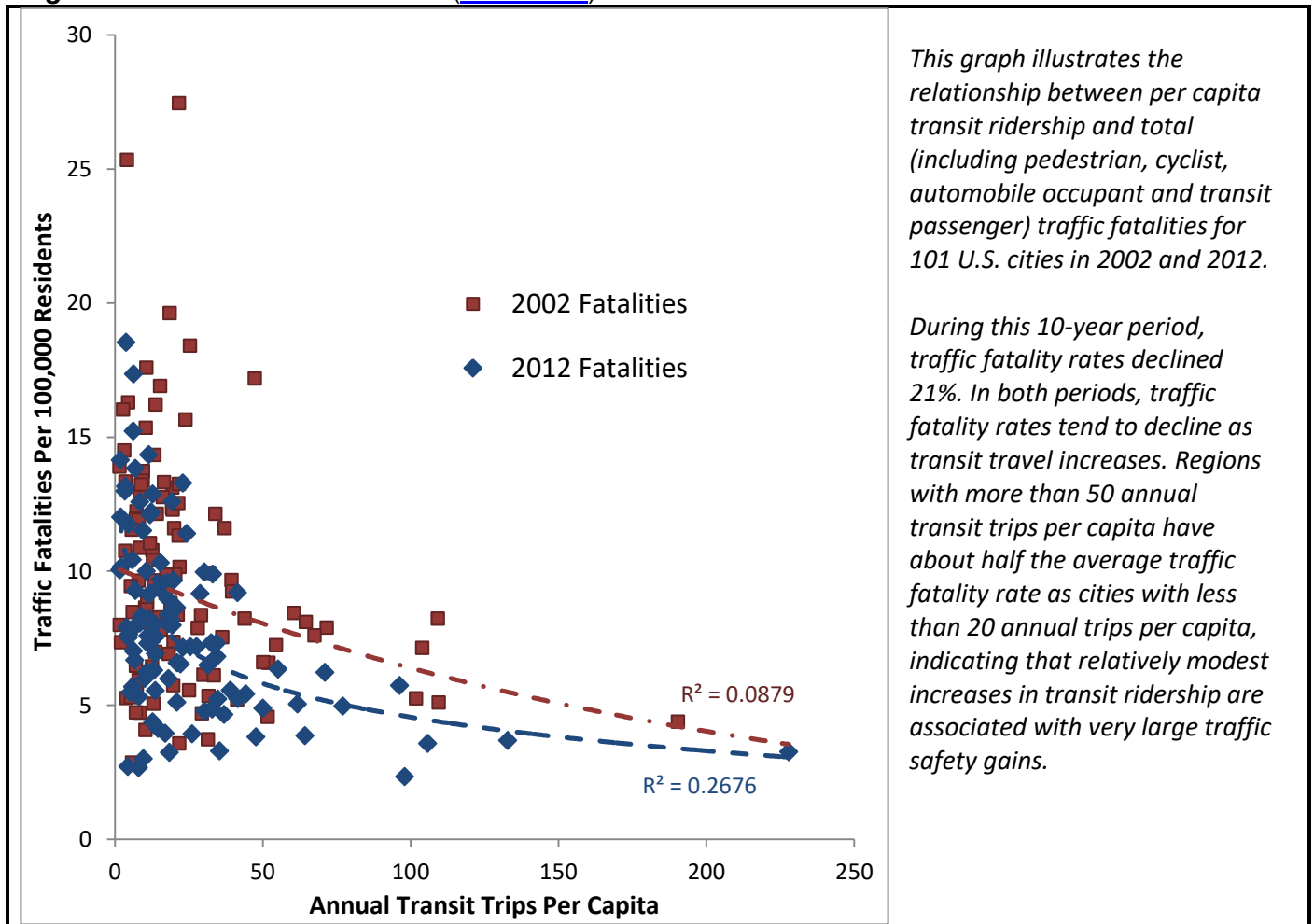


¹ Risk Analysis Spreadsheet, Victoria Transport Policy Institute, at www.vtpi.org/transit-risk.xls.

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.

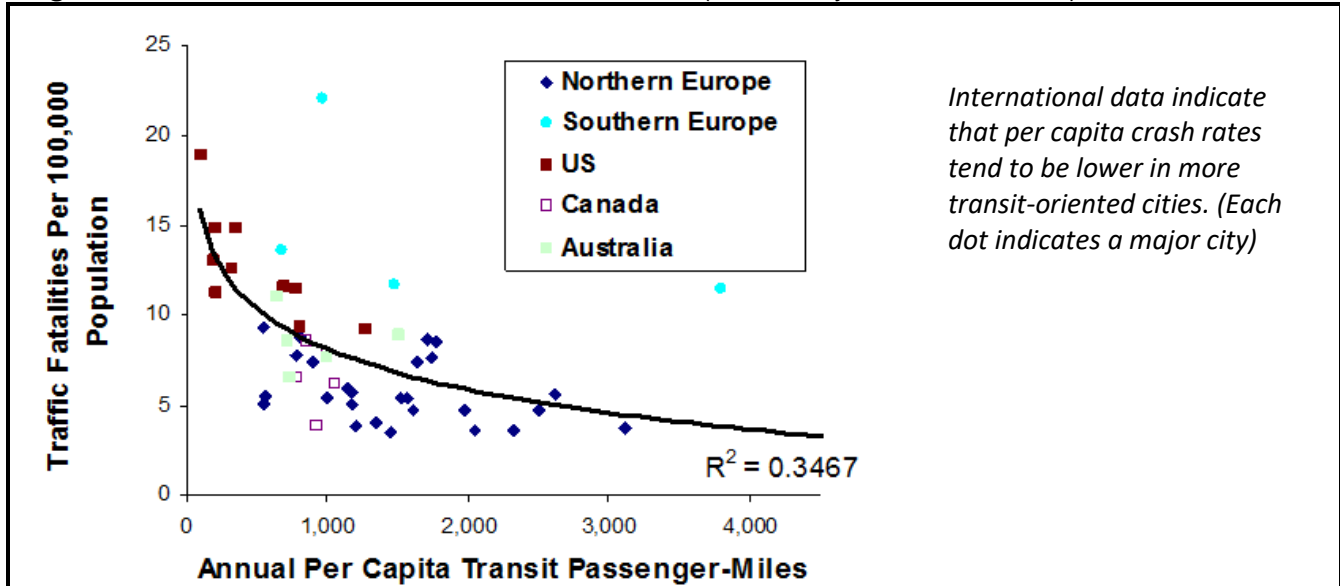
Figure 7 illustrates the relationship between transit trips and traffic fatality rates for these cities in 2002 and 2012. Total fatality rates declined 21% between 2002 and 2012, but in both time periods higher-transit-ridership regions (more than 50 annual transit trips per capita) have about half the 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 only about a two-percentage point shift, yet it associated with a 50% reduction in average crash rates (Santos, et al. 2011).

Figure 7 U.S. Traffic Deaths (CDC 2012)



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)



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. It includes large, high-transit-ridership cities as expected, but also some smaller cities with low-transit-ridership cities, averaging fewer than 20 annual transit trips per capita. However, 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. There are two interesting exceptions to consider. New Orleans has relatively high transit ridership (33 annual trips per capita), very low vehicle travel rates (5,466 annual VMT per capita), but middle-level traffic safety (7.3 fatalities per 100,000 residents). This can partly be explained by New Orleans's high poverty rate, which tends to reduce vehicle travel but increases crash rates (Male 2009). This suggests that high public transport ridership and low vehicle travel caused by poverty provide less safety benefit than ridership gains and vehicle travel reductions resulting from premium public transit that attracts choice riders. Another interesting exception is Atlanta, which has relatively high transit ridership (33.1 annual trips per capita), high vehicle travel rates (13,531 annual VMT per capita) and relatively high traffic fatality rates (9.9 deaths per 100,000 residents). This can be explained by the city's sprawled development pattern which more than offset the public transportation's traffic safety benefits. This suggests that public transportation service improvements provide less benefit if implemented without supportive land use policies, although it is likely that Atlanta's high traffic fatality rate would be even higher if it had lower transit ridership.

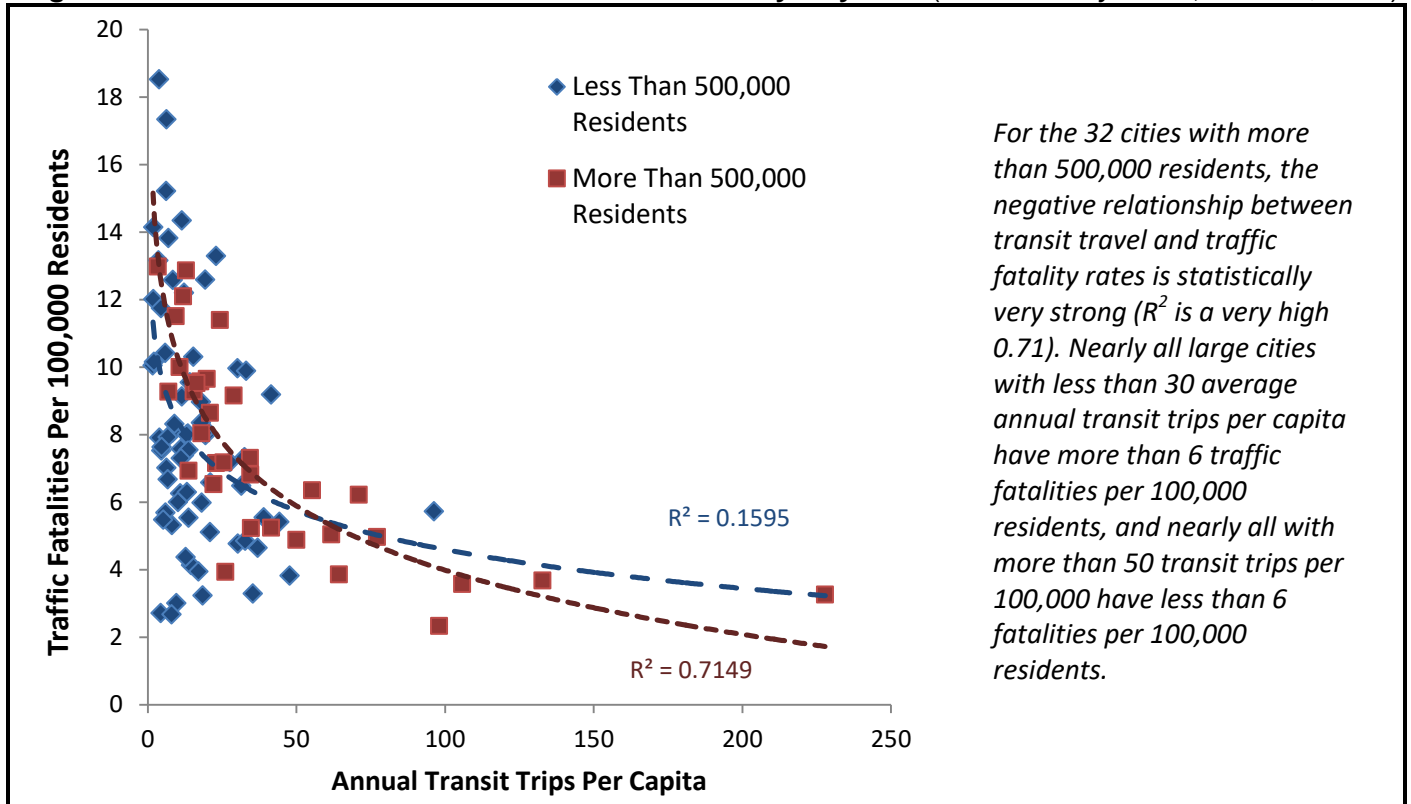
Table 5 High Transit Ridership Urban Regions

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
<i>Averages</i>	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)



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.² 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)

² Personal communications with Dr. Jim P. Stimpson, 3 October 2014.

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-percentage points or 374 annual passenger-miles from automobile to transit cannot explain a 50% reduction in traffic fatalities.

One explanation is that many factors that tend to increase public transit travel 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 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.

Table 6 Factors That Increase Public Transit Travel and Traffic Safety

Urban Design	Transport System	Economic
<ul style="list-style-type: none"> • Development density and mix • Reduced parking supply 	<ul style="list-style-type: none"> • High quality transit (convenient, fast, comfortable, affordable) service • Good walking and cycling conditions • Lower traffic speeds • More connected roadway network • Transportation demand management 	<ul style="list-style-type: none"> • 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.

These factors reduce traffic accidents, 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.

Crime Risk

Transit crimes include assaults and thefts against employees and passengers, plus theft, vandalism, trespassing and fare evasion against transit providers (DfT 2010; Martin 2011).

Transit Crime

Table 5 summarizes crimes on transit properties (in vehicles, and at stations, stops and park-and-ride lots) reported to the FTA between 2000 and 2010. During this period violent transit crimes (murder, rape, robbery and assaults) declined, while ridership increased about 10%. Reported trespassing and fare evasion incidents are numerous and increased during this period, so including these categories in analysis gives an exaggerated sense of transit risks.

Table 5 Transit Crime Reports (BTS 2013, Table 2-38)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Transit trips (billions)	9.3	9.7	9.6	9.4	9.6	9.8	10.0	10.2	10.5	10.4	10.2
Murder	12	16	0	4	1	1	2	4	9	9	14
Rape	37	37	65	25	24	23	5	1	4	3	6
Robbery	3,480	3,308	1,641	1,408	1,561	1,656	2,222	2,634	2,799	2,849	2,077
Assaults	5,016	4,727	4,149	3,390	2,876	2,862	3,909	4,332	3,058	3,002	2,139
Theft	13,393	13,636	12,843	8,146	7,847	6,007	6,409	7,943	8,446	9,267	5,959
Vehicle theft	2,112	1,909	2,117	1,800	1,584	1,361	1,051	1,756	1,442	1,008	1,008
Vandalism	7,312	2,971	1,130	953	994	1,298	1,748	1,751	1,493	1,184	843
Trespassing	4,303	4,597	2,278	4,126	3,162	3,220	4,503	4,919	6,402	6,296	4,863
Fare evasion	53,863	47,258	74,385	69,950	103,156	129,590	126,092	135,602	197,819	249,004	167,746

Serious crimes (murder, rape, robbery and assault) on transit properties are small in number and declining.

Only a tiny portion of total violent crimes occur in transit vehicles and stations, as indicated in Table 6. Transit passengers also face crime risk when walking or cycling to and from stops and stations. Such trips usually occur on urban streets with passive surveillance (by-passers who might report threats and intervene in conflicts). Only when walking or cycling in isolated areas are transit passengers likely to incur high crime risk.

Table 6 Transit Versus Total National Crime, 2010 (FBI 2012, Table 1)

	Murder	Rape	Robbery	Assault
Transit crime	14	6	2,077	3,002
Total crime	14,722	85,593	369,089	781,844
Transit to Total Crime Ratios	1/1,051	1/14,265	1/178	1/260

A tiny portion of violent crimes (murders, rapes, robberies and assaults) occur on transit properties.

Residents sometimes oppose transit services (such as new lines and stations) in their neighborhood due to fears that improving low-income people's access will increase crime rates. Before-and-after studies indicate that new transit services do not generally increase total crime rates (Blum 2012; Tay, et al. 2013). They may attract more people and business activity which may increase local crimes, but crimes per transit passenger, total regional crime, and risks to individuals seldom increase (Billings, Leland and Swindell 2011).

Comparing Transit Versus Automobile Crime

Crime risk comparisons are challenging because different modes involve different types of risks (Table 7). For example, transit passengers face risks of assault and theft, while motorists face larger risks from road rage, vehicle assault, vehicle theft and vandalism, and both face assault and theft risks when walking to and from transit stations and stops, or parked automobiles (AAA 2009; Burd-Sharps and Bistline 2022; FBI 2012). Most statistics only consider a subset of these risks, making comprehensive risk analysis difficult.

Table 7 Transit And Automobile Crime Categories

Transit	Automobile
<ul style="list-style-type: none"> • Passengers and employee assaults on transit properties • Passengers assaults while accessing transit stations and stops • Thefts against employees, passengers and agencies • Transit agency property vandalism • Fare evasion 	<ul style="list-style-type: none"> • Road rage and vehicular assault (intentional harm by drivers) • Smash and grab assaults when vehicles are stopped • Assaults walking to or in parking lots • Thefts of vehicles and from vehicles • Vehicle, road and parking facility vandalism

Transit and automobile travel involve different types of crime risks.

Public transit travel has far lower property crime rates than automobile travel. In 2012 there were 5,959 thefts and 1,184 vandalism incidents reported on transit properties (BTS 2012, Table 2-38), compared with 2,332,604 motor vehicle-related thefts (638,964 vehicle thefts, 406,309 accessory thefts, and 1,287,331 non-accessory thefts from vehicles), plus numerous vehicle vandalism incidents (FBI 2012, Table 23). This indicates that property crimes are five hundred times more common for motorists than transit passengers, and accounting for exposure, public transit travel has significantly lower crime rates per passenger trip, mile and hour, as indicated in Table 8.

Table 8 Automobiles Versus Transit Travel Theft Rates, 2010 (FBI and NHTS Data)

Mode	Thefts	Pass.-Trips	Rate	Pass.-Miles	Rate	Pass.-Hours	Rate
Units		Millions	Per M trips	Millions	Per M Miles	Millions	Per M Pass-hrs
Transit	5,959	7,520	0.8	54,393	0.1	6,071	1.0
Household vehicles	2,332,604	327,118	7.1	3,298,168	0.7	105,823	22.0

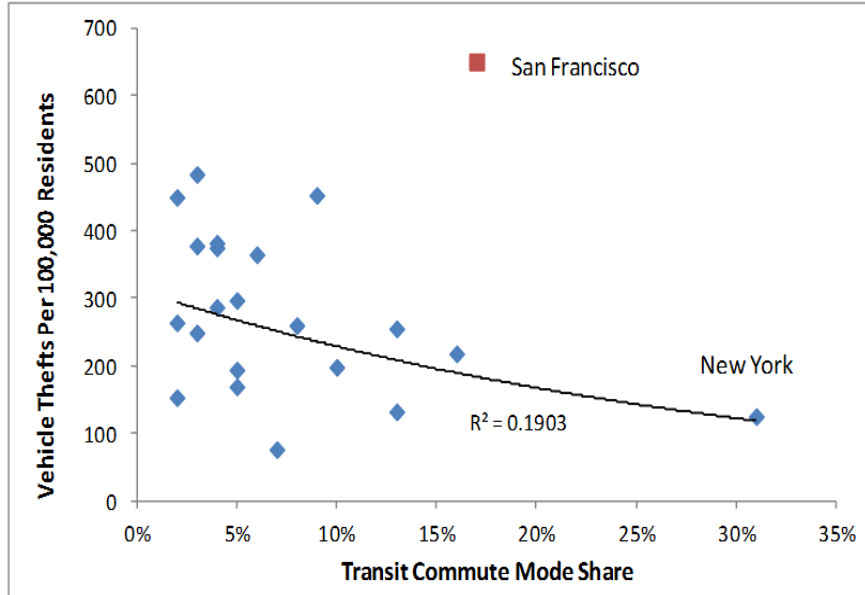
Transit travel has significantly lower crime rates per passenger-trip, -mile and -hour than driving.

In addition to being more frequent, automobile property crimes also tend to be more costly. A typical transit passenger theft involves a telephone, wallet or briefcase worth a few hundred dollars. Automobile thefts costs average \$6,019, over six times the \$987 average cost of non-automobile thefts (FBI 2012, Table 23). As a result, automobile crime costs are much higher per trip, mile or hour than transit travel.

Vehicle theft rates tend to decline with increased transit travel (Roberts and Block 2013), as illustrated in Figure 6 (San Francisco's high vehicle crime rate is a notable exception) which provide significant financial savings. For example, the New York City Region averages 125 annual vehicle thefts per 100,000 residents, costing about \$7.50 per capita (assuming \$6,019 per theft), compared with 476 vehicle thefts per 100,000 residents in automobile-oriented San Bernardino County, costing about \$29 per capita. Because automobiles are expensive and dangerous, automobile ownership and use tend to increase overall crime frequency and severity. For example, Stillman (2014) describes how lower-income people cited for minor crimes become caught in a cycle of debt

and incarceration due to mounting court fees: in three of the four examples cited the initial crime was an unpaid traffic citation (the fourth involved stealing a can of beer) by a lower-income person, who, due to mounting court fees and inadequate mobility options, are forced to drive unlicensed and uninsured vehicles, exposing themselves to more severe crimes and punishments. Many of these crimes would not have occurred in more transit-oriented communities because lower-income residents are not forced to drive for transportation.

Figure 6 Vehicle Thefts Versus Transit Mode Share In U.S. Cities (FBI and FTA Data)

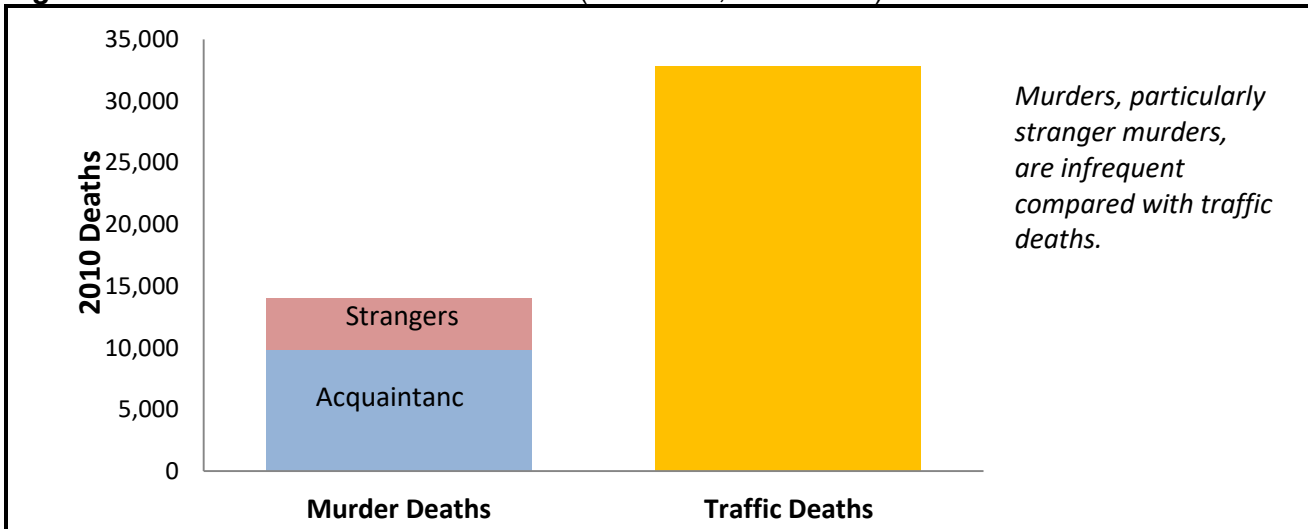


Vehicle theft rates, and probably rates of other vehicle-related crimes, tend to decline as transit ridership increases in a community, due to lower per capita vehicle ownership. As a result, residents of transit oriented communities bear lower per capita crime costs.

Crime Versus Traffic Casualties

Transit travel violent crime risks are small compared with traffic accidents risk. For example, in 2010 in the U.S. there were 14,043 murders (FBI and NHTSA data), compared with 32,788 traffic deaths, as illustrated in Figure 7. Most murders (about 70%) resulted from conflicts among acquaintances (WSJ 2013); only a small portion reflect risks that could increase with transit ridership such as deaths during robberies, random assaults or inter-gang cross-fire. Only 14 murders occurred on transit properties.

Figure 7 Traffic Versus Murder Deaths (BTS 2013, Table 2-38)



Terrorism Risks

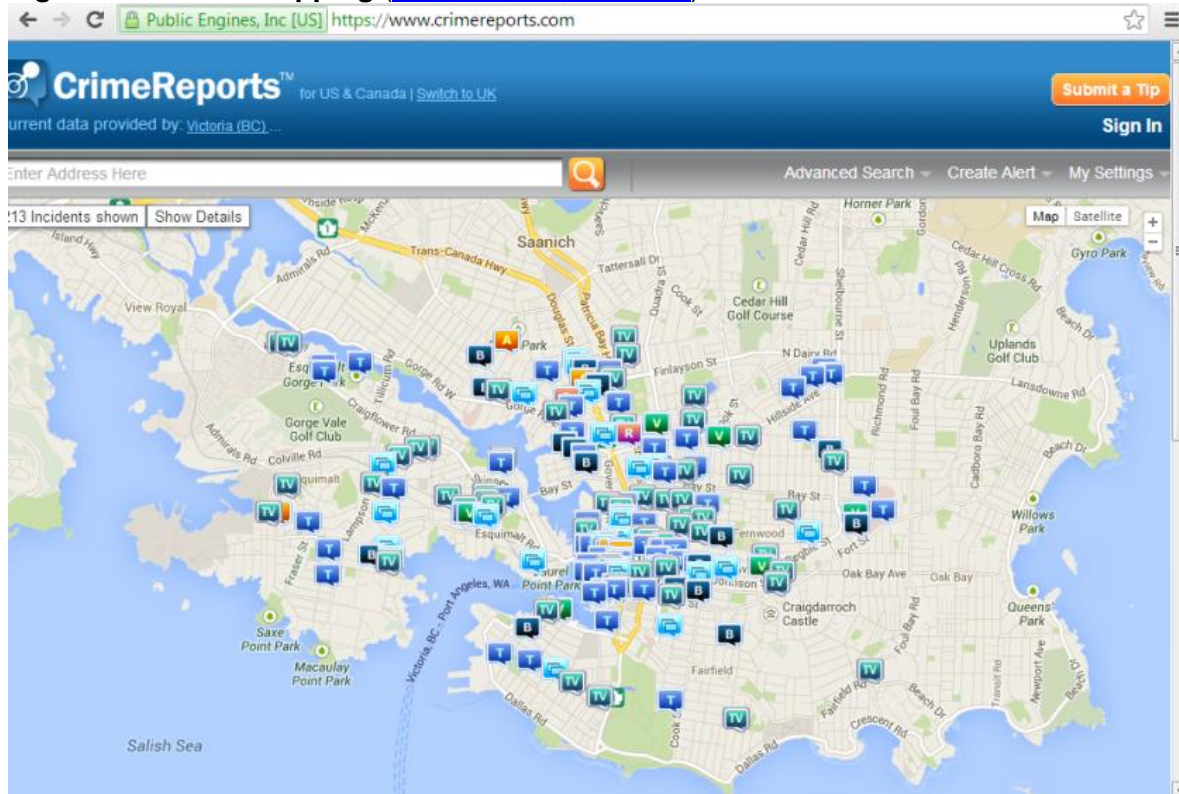
Terrorism has become a major transit security concern although the risk is actually small (Litman 2005; Rabkin, et al. 2005). Even including events such as the 2004 Madrid rail bombing which killed nearly two hundred people, and the 2005 London subway attack which killed about fifty people, traffic crashes kill hundreds of times as many people as terrorism. In 29 Organization for Economic Cooperation and Development (OECD) countries for which data were available, traffic deaths were approximately 390 times that of international terrorism (Wilson and Thomson 2005).

Because traffic accidents are a much greater risk than terrorism, total deaths can increase if terrorism fear causes travelers to shift from public transport to automobile. Such shifts do occur. In the three months after the 11 September 2001 terrorist attacks, shifts from air to automobile travel caused several hundred additional traffic fatalities (Gigerenzer 2004; Sivak and Flannagan 2004). Had these trends continued for more than a year, the additional traffic deaths would have exceeded the terrorist attack deaths. Similarly, there is evidence that the 7 September 2005 London subway terrorist attack caused mode shifts that increased total traffic deaths (Ayton, Murray and Hampton 2009).

Urban Crime Rates

People often assume that crime rates increase with city size and density, and therefore with transit travel and transit-oriented development. These assumptions are partly true but largely inaccurate. Simplistic analysis may lead to false conclusions concerning these factors. For example, crime mapping (Figure 8) and real estate guides such as [Neighborhood Scout](#) often show more crimes in denser, mixed city centers than lower-density suburbs, implying that urban environments increase crime risks, but this is not really what the data indicate (1000 Friends 1999). Dense, mixed urban areas have more of just about everything per area (acre, hectare, square-mile or -kilometer), good and bad: more people, businesses, wealth, poverty, social services, productivity, tragedy, generosity and crime, and some types of crime are associated with certain land use types, such as banks and bars. Contrary to the impressions made by this type of crime mapping, crime density does not really reflect the risk to individuals; the relatively high number of crimes reported in city centers does not really indicate that denser development causes responsible people to become criminals or increases the risk a typical person faces of becoming a crime victim (Lerner 2014).

Figure 8 Crime Mapping (www.crimereports.com)

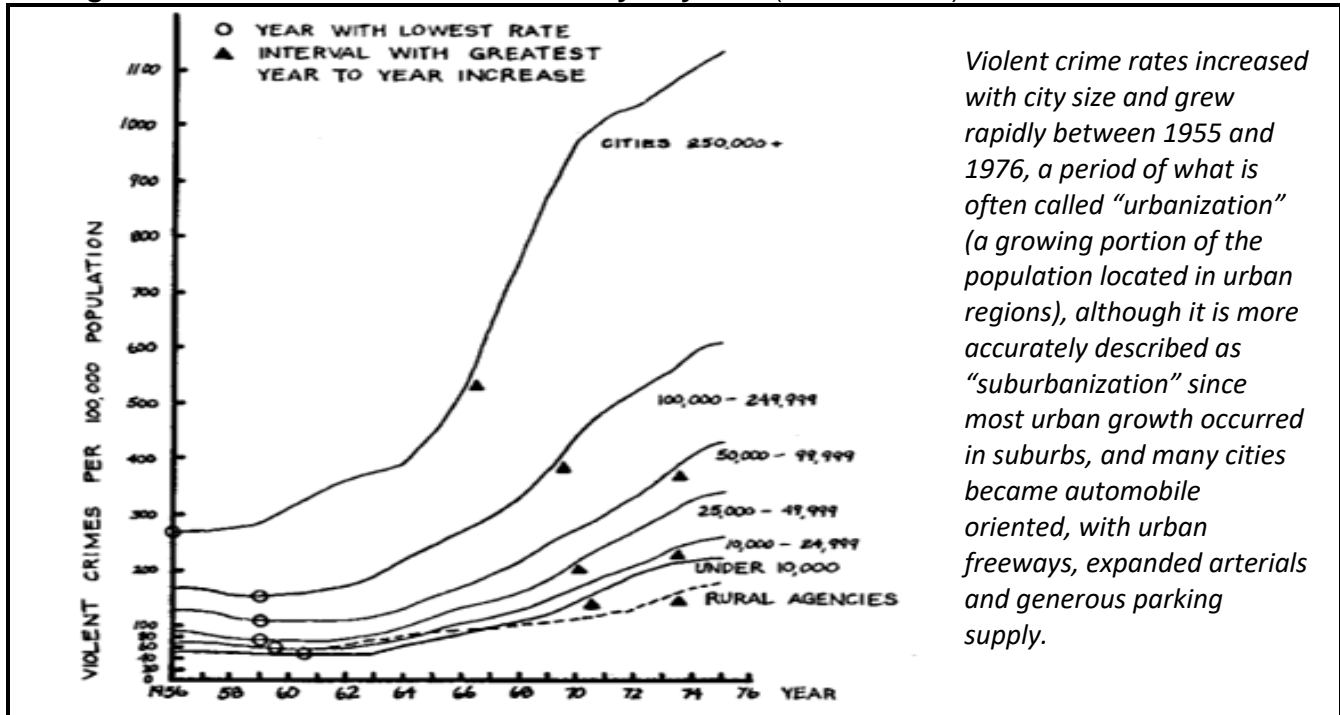


Crimes tend to concentrate near city centers due to the concentration of people, businesses, entertainment districts, motor vehicles, poverty and social services. This does not mean that increased development density increases total crime or that individuals face greater risk by living or visiting such areas.

Similarly, per capita crime rates tend to increase as a community grows in size from a village to a town, to a city, and all types of crime increased between 1955 and 1976, as indicated in Figure 9. Several factors can help explain these patterns. The positive association between community size and crime rates probably reflects community cohesion (the quality of relationships between

community residents): smaller community residents are more likely to know and befriend their neighbors, or described differently, city residents tend to experience more anonymity and alienation.

Figure 9 Violent Crime Rates By City Size (Fischer 1980)



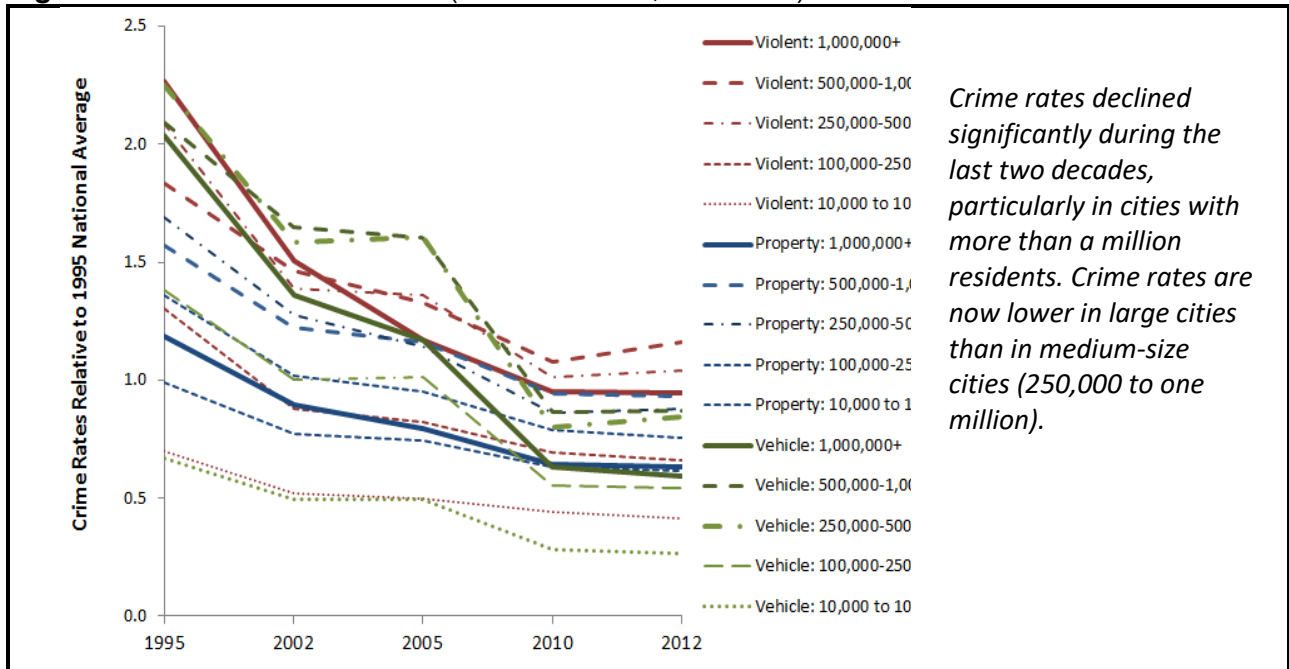
The growth in crime rates during this period were probably caused by a combination of increased mobility and urbanization (people traveled more and were less connected to their community), young Baby Boomers (young people tend to commit more crimes), urban poverty concentration (many non-poor families moved to suburbs), and possibly high blood lead levels from gasoline and paint (Reyes 2014).

However, these patterns reflect association, not causation; they do not indicate that total crimes or crime risk to individuals necessarily increase as more households located in cities. Most urban violence, particularly murders (about 70%), result from conflicts between acquaintances; the risk of random violence to transit passengers is low.

Because of the correlations between density, poverty and crime, individual households and neighborhoods often attempt to reduce their crime risk by distancing themselves from higher risk populations: households moved from cities to suburbs, and neighborhoods discouraged affordable housing and public transit in order to exclude lower-income households. Such solutions may appear successful from an individual perspective but fail to address the root causes of crime such as poverty and alienation; on the contrary, they may increase total crime risk by concentrating poverty, increasing social isolation, reducing passive surveillance, and increasing police response times.

During the last two decades, U.S. crime rates declined significantly (Figure 10). Rates declined for virtually all types of crime in virtually all size communities, but the declines were particularly dramatic in the largest cities (more than a million residents), resulting in their rates being lower than in medium-size cities (250,000 to 1,000,000 residents).

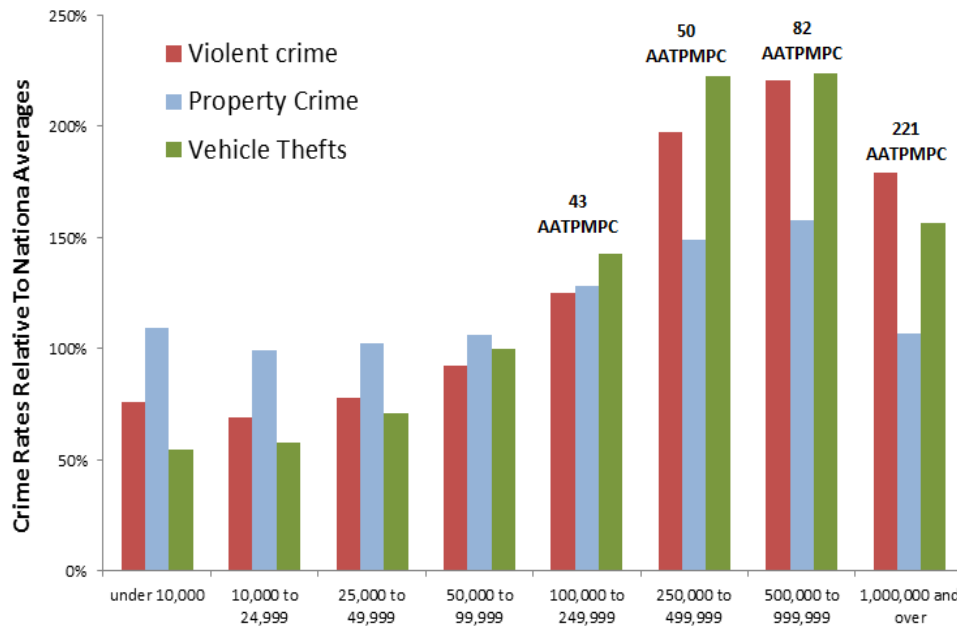
Figure 10 Crime Rates Trends (FBI 1995-2012, Tables 16)



As a result of these trends, the largest cities now have significantly lower crime rates (23% lower for violent crimes and 32% lower for property crimes) than medium-size cities, as illustrated in Figure 11.

Overall, total violent death risks tend to decline with development density, since any increase in urban murder risks, where it exists, is more than offset by lower traffic fatality rates (Myers, et al. 2013).

Figure 11 Crime Rates By Community Population Group (FBI 2012, Table 16)



Crime rates tend to increase as community population grows, peaks at 500,000-1,000,000 residents, and is significantly lower for cities with over a million population, which also have the highest transit ridership rates (AATPMPC = Average Annual Transit Passenger-Miles Per Capita).

The 1995-2006 decline in urban crime rates probably resulted from a combination of aging population (older people commit fewer crimes), declining drug abuse, improved policing methods, and lower blood lead levels, but these do not explain why crime rates are lower in large compared with medium-size cities, which experienced similar demographic trends. Large cities' low crime rates can be explained by:

- Less concentrated poverty, as more middle- and higher-income residents move into inner neighborhoods. This can increase security and economic opportunity (better schools and local job opportunities) to low-income residents, which can help reduce poverty and crime rates.
- Large city neighborhoods tend to be dense, mixed and walkable, factors associated with reduced neighborhood scale crime rates, due to more passive surveillance and community cohesion as more responsible (non-criminal) people live, work, walk and travel on city streets.
- Large cities tend to offer residents who are at-risk of criminal behavior more economic opportunities due to better access to education and employment.
- Larger cities may have better policing and social services, including more specialists and targeted programs, and increased density reduces emergency response times.
- Large cities tend to have higher average incomes and education levels, although they also tend to have greater income disparities, with large numbers of both high- and low-income households.
- Larger cities may have more affluence and corporate headquarters, and therefore more charity funds and other support for social programs.
- Reduced vehicle ownership tends to reduce vehicle-related crime, which is a major portion of total crime.

These factors are discussed in more detail below.

Poverty Concentration

Crime and related problems such as drug and alcohol abuse, and mental illness are strongly correlated to poverty. Crime and delinquency rates tend to be high and durable (they continue for multiple generations) in neighborhoods with concentrated poverty, because residents have fewer positive role models and social support, inferior schools, and fewer economic opportunities (Fraser, Oakley and Levy 2013). As a result, development policies that result in more mixed-income communities are likely to reduce the social and crime problems caused by concentrated poverty (Basolo 2013; Levy, McDale and Bertumen 2013). Transit oriented development can be a catalyst for such development (Reconnecting America 2009).

Community Design (Surveillance and Control)

Crime Prevention Through Environmental Design (CPTED) applies research concerning how community design factors such as density and walkability affect crime rates to identify crime reduction strategies. There is debate concerning which strategies are most effective. Some experts emphasize *defensible space*, which assumes that crime risk declines if residents gain more control of their immediate area, which supports limiting public access, privatized spaces (fenced yards, shopping malls and gated communities), street closures, shops and homes set back from the street, single-use development (separating residential and commercial activities), and automobile travel. Others experts emphasize the importance of passive *surveillance* (also called *eyes on the street*, Jacobs 1961), which assumes that crime risk declines as more responsible (non-criminal) people live, work and walk in an area, which supports maximizing public access with well-connected streets and paths, mixed (commercial and residential) development, houses and shops close to sidewalks, and policies that encourage walking and cycling.

Until recently, most CPTED research consisted of before-and-after studies of interventions in high crime areas which indicated that defensible space strategies can reduce crime (Gardiner 1978), but this may simply reflect displacement of crime to other locations. Some recent studies use more comprehensive analysis of how various geographic and design factors affect crime rates (Anderson, et al. 2013).

For example, after adjusting for socioeconomic factors such as age, employment status and income, Browning, et al. (2010) found that in Columbus, Ohio, per capita violent crime rates increased with population and commercial density up to the city's median density, but above that crime rates decline significantly with increased density, with particularly large declines in the most economically disadvantaged neighborhoods. After adjusting for socioeconomic factors, Christens and Speer (2005) found a significant negative relationship between census block population density and per capita violent crime rates in Nashville, Tennessee and nearby suburban communities. Similarly, Gilderbloom, Riggs and Meares (2015) found that, normalizing for other factors, higher WalkScore ratings are associated with lower crime rates in Louisville, Kentucky neighborhoods.

Hillier and Sahbaz (2006) analyzed residential burglary and robbery rates in an economically and socially diverse London neighborhood. They found that, all else being equal, these crime rates were inversely related to the number and density of dwellings on a street, on both through streets and cul-de-sacs. For example, the mean cul-de-sacs burglary rate is 0.105, but those with fewer than 11 dwellings have a higher 0.209 rate. Similarly, grid street segments with more than 50

dwellings have a burglary rate of 0.142, but those with 100 dwellings have a much lower rate of 0.086. The researchers conclude that crime risk tends to decline on streets that have more through traffic, and crime are lower if commercial and residential buildings are located close together.

Li and Rainwater (2000) analyzed crime patterns in Irving, Texas. They found that crime rates are primarily explained by socioeconomic factors such as income, and land use factors that affect crime opportunity. For example, burglary, rape, assault and robbery rates are concentrated in areas with high poverty rates, residential burglary rates are higher in higher income neighborhoods where many residents are professionals who are away from home most days, and automobile thefts are highest in major commercial centers where large malls and shops are concentrated where high concentrations of vehicles and crowds provided auto theft opportunities.

These studies indicate that, all else being equal, crime rates are negatively associated with development density and mix, and increased pedestrian activity. They support Jane Jacob's hypothesis that more walkable and mixed development neighborhoods tend to increase public safety by providing more "eyes on the street" and daily interactions among neighbors. Although some of these effects may result from crimes shifted from one location to another, the results suggest that in many situations, more surveillance and neighborhood interactions may reduce total regional crime rates.

Affordable Accessibility

Some research indicates that, all else being equal, communities with more diverse transport options tend to have lower per capita crime rates (Jose and Garcia 2005). More affordable transport options (good walking, cycling and public transport) can reduce poverty (Gao and Johnston 2009). High quality public transit increases labor participation (CTS 2010; Sanchez, Shen and Peng 2004), even in automobile-oriented cities (Yi 2006). International experience also indicates that transit service improvements can reduce crime risks. For example, crime rates declined after Bus Rapid Transit (BRT) service was established in Bogotá, Columbia (José and Garcia 2005; Hidalgo, et al. 2013).

Summary

This analysis suggests that public transit travel usually has low crime risk due to passive surveillance by employees, fellow passengers and by-passers, and pro-transit policies can help reduce overall crime. Transit passengers face the greatest crime risk when walking or waiting in isolated areas (Kennedy 2008), although even these risks are not necessarily greater than those faced by motorists walking to and from parked vehicles. Transit agencies can reduce these risks by implementing crime prevention programs and security systems (patrols, cameras and emergency alarms), and individual passengers can increase their personal security by carrying a mobile telephone and avoiding risky situations (Loukaitou-Sideris 2009). Table 9 summarizes ways that transit improvements can increase security.

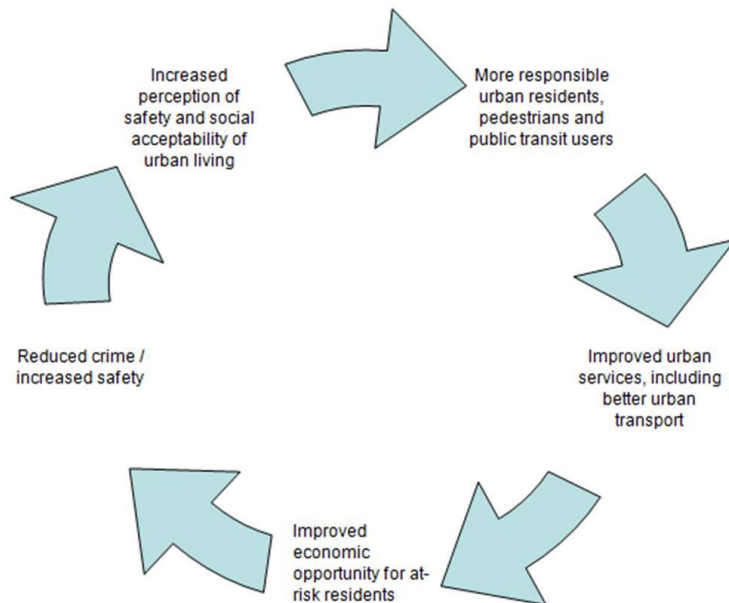
Table 9 How Transit and Transit-Oriented Development Can Reduce Crime

Crime Risk Factor	Transit and Transit-Oriented Development Impacts
Reduced poverty concentration and increased economic opportunity	More mixed development can reduce poverty concentration and increase economic opportunities for at-risk residents, particularly non-drivers.
Passive surveillance and community cohesion	More businesses, residents and by-passers provide surveillance and help build local social networks (neighbors who know and care about each other).
Policing efficiency and response times	Compact development allows more specialized policing and faster response times.
Transit security	Increased ridership makes transit policing more efficient (lower costs per passenger) and builds public support, leading to expanded programs.
Motor vehicle ownership	Reduced vehicle ownership reduces vehicle crimes (vehicle assaults, thefts and vandalism), which are more common and costly than transit crimes.

Improving transportation options and transit-oriented development (TOD) can reduce crime risk in several ways. These tend to reduce total per capita crime rates rather than simply shifting where crimes occur.

Figure 12 illustrates how transit improvements can contribute to a positive security cycle.

Figure 12 The Positive Security Cycle

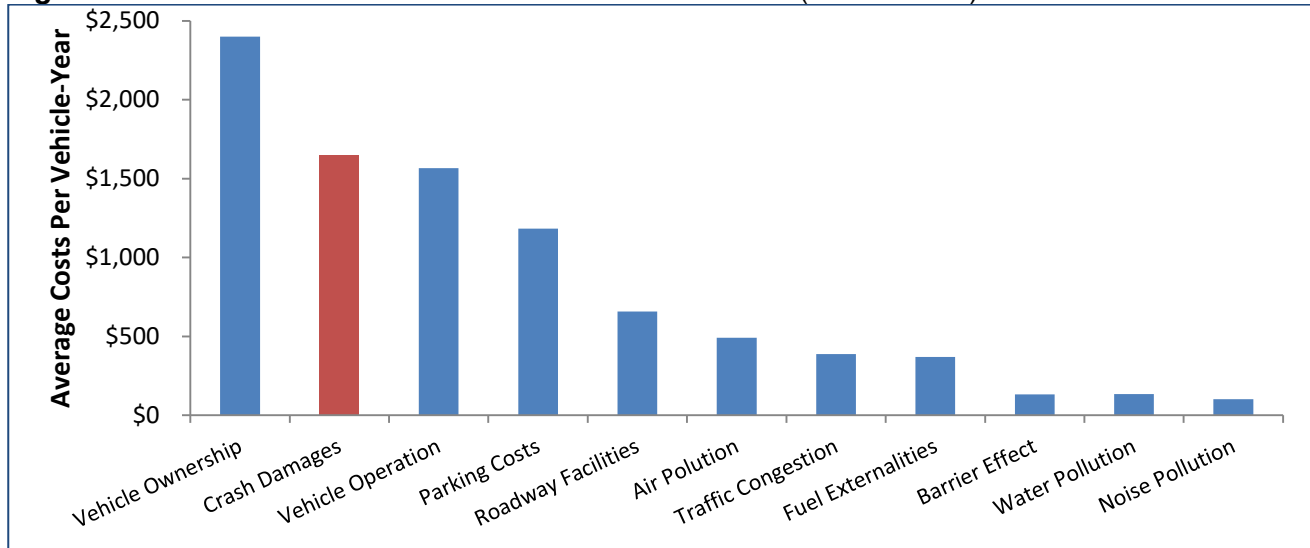


Communities tend to become safer as more non-criminals walk, bike and use public transit, and development is more compact and mixed, creating a positive feedback cycle.

Crash Costs Compared With Other Transportation Costs

Various studies have *monetized* (measure in monetary value) transport costs, including crash costs (Blincoe, et al, 2014; Litman 2009). Crashes are one of the largest categories of societal costs associated with motor vehicle use. Total annual U.S. vehicle crash costs are estimated to exceed \$500 billion, about five times greater than traffic congestion or vehicle air pollution costs, as illustrated in Figure 13.

Figure 13 Costs of Motor Vehicle Use in the U.S. (Litman 2009)



This figure illustrates the estimated magnitude of various transportation costs. Crash costs are one of the largest categories, greater than congestion or pollution costs.

This has important implications. It suggests that it is important to consider safety impacts when evaluating policy or planning options. For example, when comparing potential traffic congestion reduction strategies, a roadway expansion that reduces congestion costs by 10% but increases crash costs by 2%, due to higher traffic speeds or induced vehicle travel, is a poor investment; congestion cost savings are offset by increased crash costs. In contrast, a transit improvement that reduces congestion costs by 5% but also reduces crash costs by 2% is worth more overall when congestion and crash cost reductions are totaled. Current planning generally gives little consideration to overall safety impacts, which tends to undervalue transit improvements and transit-oriented development, and overvalues roadway expansions that increase vehicle traffic and sprawl.

This issue is not just a theoretical issue. People are willing to pay significant premiums to drive safer vehicles and live in safer communities. The analysis in this report indicates that transit travel and transit-oriented development tend to provide large safety and security benefits. Our challenge is to communicate these benefits to individuals and decision-makers.

Risk Perception and Communication

Despite its overall safety and security, many people consider public transit dangerous, and so are reluctant to use it or support its expansion in their community (Ferrell, Mathur and Mendoza 2008; Kennedy 2008). Several factors may contribute to this exaggerated fear. Transit travel often requires passengers to be confined with strangers in sometimes crowded and uncomfortable vehicles and stations, and although most passengers are responsible, considerate and clean, a small portion may be anti-social, rude and dirty (Ringerud 2014). These conditions can cause feelings of powerlessness, discomfort and insecurity. Disproportionate media coverage can also stimulate transit fear. Because transit accidents and assaults are infrequent, they tend to receive significant media coverage (Martin 2011). A fatal transit crash or transit terrorist attack often produces national and international media coverage, while fatal automobile crashes are so common they are usually only reported locally.

Conventional traffic safety programs often emphasize the overall safety of automobile travel, since most crashes involve special risks such as impaired driving, young drivers and hazardous road conditions (ITE 2007). From this perspective, it is inefficient and unfair to increase safety by reducing total vehicle travel because that “punishes” all motorists for risks caused by a minority. Those safety programs seldom acknowledge the relative safety of transit travel or promote transit as a traffic safety strategy. A new traffic safety paradigm recognizes that all vehicle travel incurs risk, that high- and low-risk driving are complements (increasing total vehicle travel usually increases higher-risk driving), and that vehicle travel reduction strategies can increase safety (FHWA 2010; Litman and Fitzroy 2012). Transit agency safety and security messages, such as those illustrated in Figure 14, tend to emphasize dangers, including dramatic but unlikely threats such as terrorism, without counterbalancing messages about transit’s overall safety.

Figure 14 Most Transit Safety & Security Messages Emphasize Risks, Not Safety



Transit agency safety and security messages often emphasize unusual dangers without counterbalancing messages that emphasize the overall safety and security of public transit travel.

For this study I reviewed the safety and security messages of twenty representative transit agency websites, as summarized in Table 10. Most describe various risks and safety programs, and some offer safety advice. Although some include information about public transit economic and environmental benefits, only one (Utah) mentions the overall safety of transit travel, and none describe transit’s relatively low crime rates.

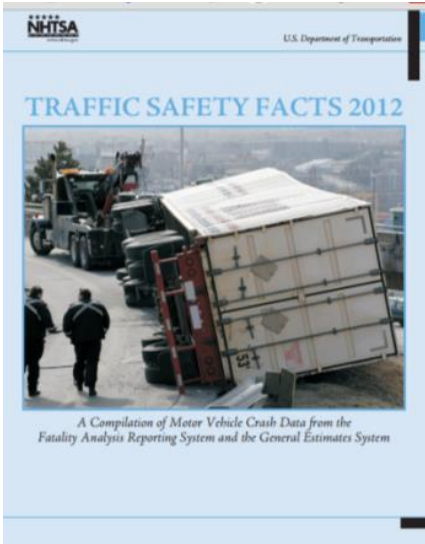
Table 10 Summary of Transit Agency Websites' Safety and Security Messages

Agency, City, Website	Safety and Security Messages
Champaign-Urbana Mass Transit District, Champaign-Urbana, IL (www.cumtd.com)	"Safety and Security" page describes what the agency is doing to maximize rider security and safety.
Chattanooga Area Regional Transportation Authority, Chattanooga, TN (www.carta-bus.org)	No mention of safety or security.
Chicago Transit Auth., (www.transitchicago.com)	Includes a "Safety and Security" page, and a "Security Tips" brochure.
Greater New Haven Transit District, New Haven, CT (www.gnhtd.org)	Emphasizes that operators receive special safety training. No other discussion of safety or security.
Intercity Transit, Olympia, WA (www.intercitytransit.com)	Lists various benefits of public transit, but not traffic safety. Has no specific safety or security messages
Long Beach Transit, CA (www.lbtransit.com)	"Safety and Security" page describes the Agency's security programs.
Maryland Transit Administration, Baltimore (www.mta.maryland.gov)	"MTA Police Force" page describes policing programs. "Safety, Quality Assurance, Risk Management" page describes some safety programs.
Massachusetts Bay Transportation Authority, Boston, MA (www.mbta.com)	"Safety" page describes ways to increase user safety (mostly personal security). "Transit Police" page describes security programs and recent crimes.
Metro Transit, Minneapolis, MN (www.metrotransit.org)	Includes "Safety and Security" page which describes safety and policing programs and offers safety tips.
METRO, Oklahoma City, OK (www.gometro.org)	"Transit Benefits" page mentions "enhances safety" as a community benefit. "Safety and Security" page provides safety and security tips.
Metropolitan Atlanta Rapid Transit Authority, Atlanta, GA (www.itsmarta.com)	"Safety on MARTA" page offers safety and security trip, and a "MARTA Police" page which describes the agency's policing services.
Metropolitan Transit Authority of Harris County, Houston, TX (www.ridemetro.org)	"Safety and Security" page describes ways to increase personal safety and security. States that "In today's world, protecting one's personal safety has never been more important."
Metropolitan Transportation Authority, New York, NY (http://new.mta.info)	"Customer Safety" page offers safety tips. "MTA Police" page describes police services. "Performance Indicators" page reports accident rates.
Miami-Dade Transit, Miami, FL (www.miamidade.gov)	"Passenger Safety" page provides safety tips. A "Transit Watch" page encourages passengers to report suspicious and illegal activity.
Pierce Transit, WA (www.piercettransit.org)	"Safety and Security" page emphasizes responsible rider behavior.
Southeastern Pennsylvania Transportation Authority, Philadelphia (www.septa.org)	"Safety and Security" page emphasizes anti-terrorism programs, describes policing activities, and offers various safety and security tips.
Suburban Mobility Authority for Regional Transportation, Detroit, MI (www.smartbus.org)	"Safety and Security" page provides basic safety advice. Emphasizes operators' safety training and the system's low accident rates.
Toronto Transit Commission, Toronto, ON (www.itsmarta.com)	"Safety and Security" page offers information and guidance on public transit safety and security.
TransLink, Vancouver, BC (www.translink.ca)	"Sustainability" page highlights environmental benefits but not safety. "Safety and Security" page describes the agency's safety and security programs.
Utah Transit Authority, Salt Lake City, UT (www.rideuta.com)	States, "You are 25 times less likely to die in a traffic accident when you ride public transit versus travel in a personal vehicle." "Safety and Security" page offers safety tips.

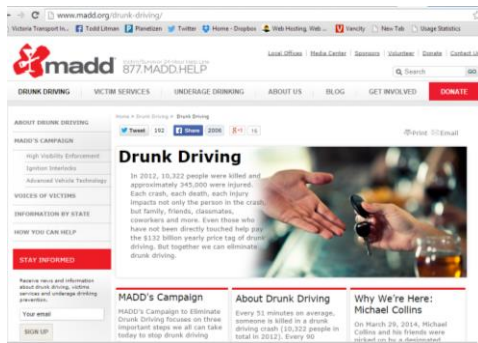
Transit agencies websites seldom provide positive information about public transit safety benefits.

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.

Program	Consideration of Transit
National Highway Traffic Safety Administration (www.nhtsa.gov)	
 <p>The cover of the NHTSA Traffic Safety Facts 2012 report features a photograph of a large white semi-truck involved in a crash, with emergency responders and other vehicles at the scene. The text on the cover includes 'NHTSA U.S. Department of Transportation', 'TRAFFIC SAFETY FACTS 2012', and 'A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System'.</p>	<p>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 <i>Traffic Safety Facts</i> 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.</p> <p>The NHTSA report, <i>Countermeasures That Work</i>, describes and evaluates various traffic safety strategies but includes no information on public transit improvements, transportation demand management (TDM), smart growth strategies.</p> <p>This emphasis on targeted programs may seem justified because the NHTSA is a <i>highway</i> 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.</p>
Toward Zero Deaths: A National Strategy on Highway Safety (www.towardzerodeaths.org)	
 <p>The screenshot shows the 'Toward Zero Deaths' website. It features a navigation bar with links to Strategy, Marketing, Partners, and Contact. Below the navigation bar is a large image of a traffic accident scene with emergency responders. To the right of the image is a text box titled 'What is TZD?' which describes the organization's mission to reduce highway deaths and injuries.</p>	<p><i>Toward Zero Deaths</i> 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.</p> <p>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.</p>
The Injury Research Foundation (www.tirf.ca)	
 <p>The logo for The Injury Research Foundation (TIRF) is an orange diamond shape with the letters 'TIRF' in white inside.</p>	<p>The <i>Traffic Injury Research Foundation</i> is a Canadian non-profit with public and private members that develops traffic safety information and programs. It has sponsored studies and programs targeting youth, seniors, impaired and distracted driving, but none that support transit, TDM or smart growth.</p> <p>It may be amenable to new approaches if presented with credible evidence of their effectiveness, and acceptance by other traffic safety organizations.</p>

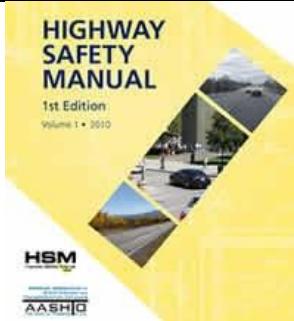
Mothers Against Drunk Driving (www.madd.org)



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).

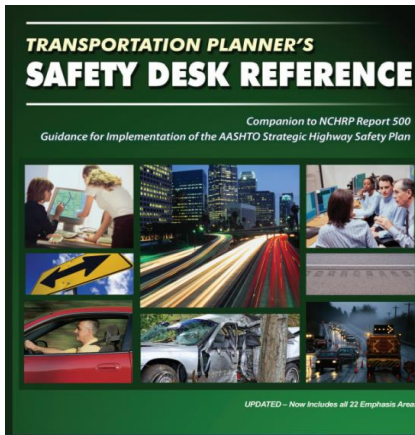
Roadway Safety Foundation (www.roadwaysafety.org)



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)

Desktop Reference for Crash Reduction Factors



Report No. FHWA-SA-07-015
U.S. Department of Transportation
Federal Highway Administration

September 2007

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.

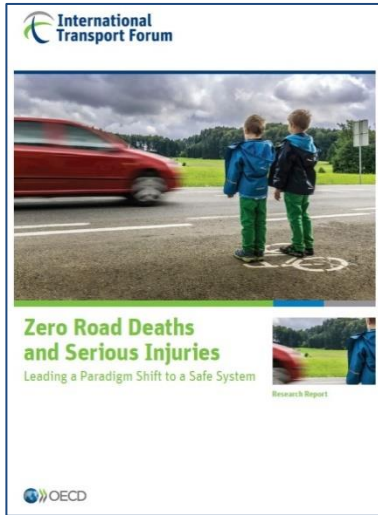
Motor Vehicle PICCS (www.cdc.gov/motorvehiclesafety/calculator)



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.

Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System



This report describes a paradigm shift in road safety policy, reflecting the Safe System principles, which assume that road crashes are both predictable and preventable, so it is possible to move towards zero road deaths and serious injuries. This, however, requires a fundamental rethink of the governance and implementation of road safety policy. Written by a group of international road safety experts, this report provides leaders in government, administrations, business and academia with emerging best practices and the starting point to chart their own journeys towards a Safe System.

This report relies primarily on targeted policies, programs and design practices, particularly traffic safety programs, safer roadway design and improved traffic law enforcement. It does state:

“Reducing the number and length of vehicle trips through city planning that brings shops and services closer to communities; and encouraging modal shift from the private car to mass transit or non-motorised travel, can reduce exposure to road traffic crashes. Yet a shift to public bus transport, bus rapid transit (BRT) or light rail is not in itself a panacea.” (p. 141)

“Travel demand management includes land-use planning, fiscal incentives and work place travel planning (teleworking, walking and cycling). The integration of environmental and road safety objectives in these measures would require selecting those deterring from the use of polluting and risky transport modes and favouring the shift towards safer and cleaner ones, such as public transport. On the other hand, walking and cycling should be favoured for environmental reasons, yet are also known to be riskier than car use. Then again, their public health benefits are generally acknowledged to outweigh their costs in terms of road trauma. Encouraging the shift towards active transport modes will be greatly aided by a Safe System environment that acknowledges individual risks for the individual and aims to minimise them, adding at the same time to positive public health outcomes.” (p. 80)

Overall, this report provides only modest support for public transit and pro-transit policies to be considered traffic safety strategies, and provide little guidance for quantifying these impacts.

A New Safety Narrative

Transportation professionals and organizations can do more to convey the overall safety and security of public transit to current transit passengers, potential passengers, local residents and businesses, and public officials. This new safety narrative can be incorporated into all types of communication, including planning documents, community engagement, performance evaluations, newsletters, websites, media contacts, advertising and employee training.

The new safety narrative provides accurate and comprehensive information on various ways that public transit can affect safety and security. It should not understate risks or blame victims by implying that they should have been more cautious; safety and security should be recognized as a serious concern that can be reduced through cooperation between transit agencies, passengers and communities. It addresses common misperceptions about public transit risks, such as exaggerated fear of crime or terrorist attacks. It answers common questions such as:

- Is public transit dangerous?
- What are the greatest risks associated with transit?
- Does expanding transit service (such as a new line or station in a neighborhood) increase local crime risk?
- How can individuals and communities minimize transit risks?
- What are accurate and objective sources of information on transit crime risks?
- How can people and businesses report transit safety and security concerns?

Transit agencies should carefully assess their safety and security messages to ensure they are overall positive and convey a sense of partnership. Although rational arguments alone may not change everybody's feelings about public transit, appropriate safety and security information should be part of marketing programs that help reposition transit as an efficient, safe, attractive, enjoyable and prestigious form of travel that can enhance people's lifestyle and community.

Below are examples of ways to apply the new transit safety narrative.

Policy and Planning Evaluation

Common transportation policy, planning and investment decisions can incorporate more comprehensive analysis of safety and security impacts. For example, when evaluating a new rail or bus line, transit encouragement program, or transit-oriented developments, crash reductions should be considered as benefits. These impacts should be described, and if possible, quantified. Models are available to help predict these impacts in a particular situation (Karim, Wahba and Sayed 2012; Lachapelle, et al. 2011). For example, a transit improvement, such as dedicated bus lanes, that shifts 5,000 daily commuters with 10-kilometer average trip distances from automobile to transit shifts 20 million total annual passenger-kilometers (5,000 commuters x 20 kms per day x 200 annual commutes = 20 million). Assuming buses average 1 death and 10 disabilities per billion passenger-kilometers, and automobiles average 11 deaths and 110 disabilities per billion passenger-kilometers, 20 million passenger-kilometers shifted from automobile to transit can be estimated to reduce 0.2 deaths and 2.0 disabilities annually, plus reductions in less severe crashes. Similarly, if transit-oriented development (TOD) residents average 5 traffic deaths and 50 disabilities annually per 100,000 residents, compared with 20 deaths and 200 disabilities per 100,000 residents elsewhere in the region, a policy that shifts 10,000 residents from auto-oriented to TOD housing can be estimated to reduce 1.0 death and 10 disabilities annually.

Public Communications

Virtually any communication involving public officials, transit passengers and the general public can incorporate information about transit safety and security. These messages should use appropriate perspectives and wording for various audiences.

- Transit passengers and potential passengers, neighborhood residents and businesses want realistic assessments of the risks they face and ways to reduce them. They want assurances that transit agencies are their partner and advocate for improving community safety, security and health. They want to know how to contact transit agencies and local officials if they have a concern or encounter a problem.
- Public officials want reliable evidence that public transit improvements and transit-oriented development can provide measurable safety, security and health benefits, or at least not exacerbate such problems.
- The general public wants accurate information on the overall safety and security of public transportation, and evidence that transportation agencies are responsive to users and residents' concerns about these issues. This is particularly important when responding to high-profile transit crashes or crimes.

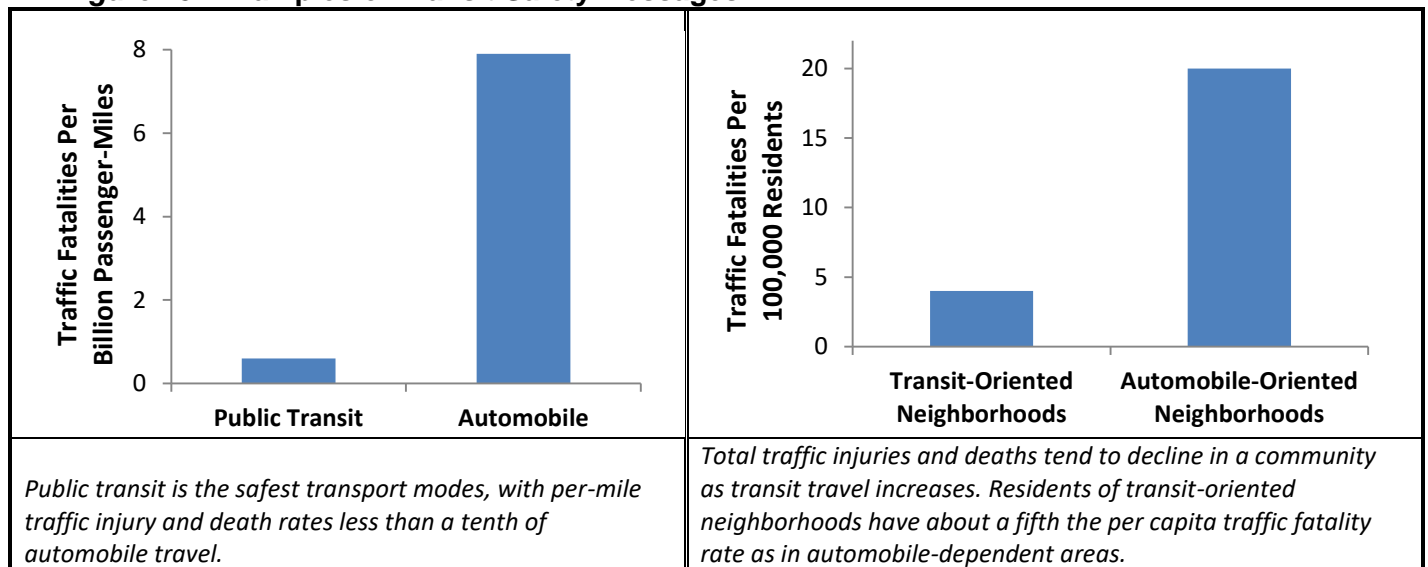
The following text box summarizes key messages which can be communicated frequently and illustrated with graphs and charts. This general information can be augmented with specific data from a particular agency or area. For example, transportation agencies can compare automobile and transit crash and crime rates and report trends in these impacts.

Ways That High Quality Public Transit Tends to Increase Safety, Security and Health

- *Shifts travel from automobile to transit.* Transit passengers have about a tenth the crash injury or death rate as automobile occupants.
- *Leverages reduced automobile travel.* High quality public transit and transit-oriented development tend to leverage overall reductions in per capita vehicle ownership and travel by creating communities where residents own fewer automobiles, travel shorter distances, and rely more on walking, bicycling and transit.
- *Increased economic opportunity.* Transit service improvements can reduce the causes of crime by improving disadvantaged people's education and employment opportunities.
- *More passive surveillance.* As more non-criminals use public transit, and live, work and walk in transit-oriented neighborhoods, there is more chance that crime threats will be prevented and reported.
- *More community cohesion.* Transit oriented development and more walkable streets tend to increase positive interactions between neighbors, providing safety and security.
- *More safety programs.* High quality transit includes active safety and security programs (crime prevention through environmental design, police patrols, and security cameras) can reduce safety and security risks.
- *Increases public fitness and health.* Since most transit trips include walking and cycling links, transit tends to increase exercise.

The new narrative presents easy to understand information. Transit agencies can present information on the relative safety of transit travel and transit-oriented development. If possible, this information should be tailored to specific communities and audiences, using local or regional data. Figure 15 illustrates examples.

Figure 15 Examples of Transit Safety Messages



Integrated Safety, Security and Marketing Programs

Many transit agencies have separated safety, security and marketing programs; the new safety narrative integrates these programs by highlighting safety and security benefits and incorporating safety and security messages into general marketing materials (schedules, maps, websites, etc.). For example, safety signs, brochures and webpages should begin with positive messages about the overall safety of transit travel before providing specific guidance on possible ways to reduce risks.

Transit agencies should develop crime prevention partnerships with users and local communities. They can provide practical guidance on how system users can prevent and respond to anti-social behaviors such as rude language (Loukaitou-Sideris, Liggett and Iseki 2010). Because mobile telephones can increase transit safety and security, as well as providing convenient transit schedule and navigation information, transit agencies can investigate ways to support mobile phone ownership by their passengers, for example, by bundling monthly transit passes with discounted telephone service.

Incident Response

Transit agencies should be prepared to respond publically to crash or crime incidents, if needed. They should acknowledge the tragedy and provide support to victims and the community, but put the incident into perspective relative to the overall safety and security of public transportation.

Transit Safety and Security Program Valuation

To the degree that transit safety and security programs increase transit travel by discretionary users (people who would otherwise drive), it can be considered a transportation demand management strategy that helps achieve strategic objectives such as reduced traffic and parking congestion, consumer savings and affordability, and pollution emission reductions. Targeted security improvements and information programs can be implemented in conjunction with other transit service improvements and incentives.

Conclusions

Public transit is, overall, a relatively safe (low crash rate) and secure (low crime rate) travel mode. Transit travel has about a tenth the crash casualty (death or injury) rate as automobile travel, and transit-oriented development residents have about a fifth the per capita traffic casualty rate as in automobile-oriented areas. Transit crimes tend to be less frequent and costly than motor vehicle crimes, and crime risk declines as more responsible (non-criminal) people use transit and live in transit-oriented communities. There is much that individuals and communities can do to increase transit safety and security.

Many people have exaggerated transit risk fears due to the combination of excessive news coverage of transit crashes and crimes, safety and security messages that highlight risks without putting them into perspective, and the nature of transit travel, which requires passengers to share sometimes crowded and uncomfortable spaces with strangers. Table 11 evaluates these factors and how to apply a new transit safety narrative.

Table 11 Actual Versus Perceived Transit Risks

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 tend to 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 it for planning analysis.
Transit passenger crime risk	Crime rates are low on transit properties, lower than for automobile travel.	Transit crimes often receive heavy media coverage leading to exaggerated fear of this risk.	Communicate the relative security of transit, and practical ways to reduce this risk.
Crime risk while accessing transit	Variable. Usually low due to passive surveillance, but may be significant in isolated areas.	Perceived as very dangerous.	Communicate the relative security of transit, and practical ways to reduce risks.
Impacts on overall community crime rates	Transit crime is less frequent and costly than motor vehicle crimes, and declines with more transit use.	Many people have excessive fear of large, dense cities based on outdated information.	Communicate the relative security of transit-oriented communities, and practical ways to further reduce risks.
Terrorism risk	Low. Even during periods of high terrorist activity, total casualties are relatively low.	Transit agencies devote considerable attention to this risk.	Emphasize that this risk is small, and identify practical ways to reduce it.

Comprehensive analysis considers a variety of risk factors.

Transportation risk analysis is complicated. Although statistics show positive correlations between transit travel, city size and crime, these largely reflect confounding factors such as poverty; they do not mean that transit travel is risky or increased transit travel increases crime. On the contrary, overall traffic casualty and crime rates tend to decline with improved transit service and more transit-oriented development. Although these safety and security benefits can be large and valuable, they are often ignored in transport planning and policy analysis. More comprehensive safety and security analysis can help encourage transit ridership and increase public support for transit, and therefore help achieve strategic planning objectives such as traffic and parking congestion reductions, improved mobility for non-drivers, energy conservation, emission reductions, and improved public health.

This has important implications. Fear of crime, both real and exaggerated, is often a deterrent to the use of resource-efficient modes (walking, cycling and public transit) and more accessible home locations. This fear contributes to a self-reinforcing cycle of automobile dependency, sprawl, concentrated poverty and increased urban crime. As a result, reducing crime and the perception of excess crime risk is an important way to support more efficient transportation and land use development. As Ferrell, Mathur and Appleyard (2015) explain,

“Improved crime intervention strategies that can reduce the safety concerns of residents living in high-crime neighborhoods hold promise for more immediate benefits and should be considered as part of a larger package of both short-term and long-term measures to reduce auto dependency. These findings are particularly important for encouraging non-auto access modes for transit riders. Transit agencies should consider working in close collaboration with police departments in the jurisdictions surrounding their transit stations and stops in order to reduce crimes, increase non-auto access to their transit systems, and potentially increase transit ridership overall.”

The following are general recommendations for better communicating transit risks:

- Provide information that highlights the overall safety benefits of public transit to individuals and communities, and practical ways to increase safety. Communicate these messages in various ways, reflecting the diverse perspectives and concerns of different audiences.
- Collect and distribute accurate, timely and positive information on public transit risks and safety programs, including crash and crime data, and safety and security plans. Provide context when reporting risk data, for example, by comparing transit and automobile crash and crime rates, and comparing different transit services and communities.
- Provide practical guidance to transit passengers and communities on ways to increase safety and security.
- Develop better models for predicting how a policy or project will affect transit safety, security and health.
- Create multi-dimensional safety and security programs that integrate local planning, infrastructure design, neighborhood policing and user information. Apply crime prevention through environmental design (CPTED), and build partnerships with local communities and police to implement these strategies.
- Integrate the new safety narrative into transportation demand management and smart growth development programs. Reducing exaggerated fear of transit can help achieve strategic planning objectives.

- Incorporate these benefits into economic evaluation of transit improvement and encouragement programs, and transit-oriented developments.
- Integrate safety information into overall marketing activities that identify and overcome common barriers to transit travel, and reposition public transit as a prestigious and enjoyable mode.

This is not to deny that transit users may occasionally face risks, and so may choose to avoid waiting in isolated areas, just as motorists avoid parking in isolated areas or dog owners avoid walking their pets in isolated areas.

This subject deserves more research. It would be useful to perform more detailed statistical analysis of the relationships between transportation and land use conditions, and crash and crime rates, accounting for demographic factors such as age and income in order to identify how planning decisions, such as local walkability, transit service quality, street design, development density and mix, and building design affect these risks. It would be useful to explore in more detail the factors that contribute to transit dread and ways to overcome this excessive fear. It would also be useful to identify ways that individuals and communities can further increase public transit's safety and security benefits.

References

- 1000 Friends (1999), "The Debate Over Density: Do Four-Plexes Cause Cannibalism" *Landmark*, 1000 Friends of Oregon (www.friends.org); at www.vtpi.org/1k_density.pdf.
- AAA (2009), *Aggressive Driving: Research Update*, American Automobile Association Foundation for Traffic Safety (www.aaafoundation.org); at <https://bit.ly/2ZbwuKk>.
- Heather Allen (2013), *Bus Reform in Seoul, Republic of Korea*, Global Report on Human Settlements (www.unhabitat.org/grhs/2013); at <https://bit.ly/31QCcTr>.
- Michael L. Anderson and Maximilian Auffhammer (2014), "Pounds That Kill: The External Costs of Vehicle Weight," *Review Of Economic Studies*, Vol. 81, No. 2, pp. 535-571 (doi: 10.1093/restud/rdt035).
- James M. Anderson, John M. Macdonald, Ricky Bluthenthal and J. Scott Ashwood (2013), "Reducing Crime by Shaping the Built Environment with Zoning: An Empirical Study of Los Angeles," *University of Pennsylvania Law Review*, Vol. 161, pp. 699-756; at <https://bit.ly/2P4m67n>.
- G.B. Arrington and Kimi Iboshi Sloop (2010), "New Transit Cooperative Research Program Research Confirms Transit-Oriented Developments Produce Fewer Auto Trips," *ITE Journal* (www.ite.org), Vol. 79, No. 6, June, pp. 26-29; at <http://tinyurl.com/q2usu3r>.
- Peter Ayton, Samantha Murray and James Hampton (2009), *Terrorism, Dread Risk, and Bicycle Accidents*, presented at the Society for Judgment and Decision Making Annual Meeting, November 2009, Boston, MA; www.sjdm.org/programs/2009-posters.pdf; describes in "Casualty Toll Of The Dread Risk Effect," *Medical News Today*, 3 Sept 2009; at <https://bit.ly/2TMTXAt>.
- 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.
- Stephen B. Billings, Suzanne Leland, and David Swindell (2011), "The Effects of the Announcement and Opening of Light Rail Transit Stations on Neighborhood Crime," *Journal Of Urban Affairs*, Volume 33, Issue 5, Pages 549–566, December 2011; summary at <https://bit.ly/2NMChQY>.
- 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.
- Alex Blum (2012), "New MAX Line Might Not be the 'Crime Express'", *Portland Tribune* (www.portlandtribune.com), 1 August 2012; at <https://bit.ly/2OPk8t>.
- E. Blumenberg and P. Ong (2001), *Cars, Buses, and Jobs: Welfare Program Participants and Employment Access in Los Angeles*, TRB Paper 01-3068; at www.uctc.net/papers/544.pdf.

Christopher R. Browning, et al. (2010), "Commercial Density, Residential Concentration, and Crime: Land Use Patterns and Violence in Neighborhood Context," *Journal of Research in Crime and Delinquency*, Vol. 47, No. 3, pp. 329-357; at <http://jrc.sagepub.com/content/47/3/329.short>.

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](http://repository.asu.edu/attachments/135054/content/Broyles_asu_0010N_13784.pdf)); at http://repository.asu.edu/attachments/135054/content/Broyles_asu_0010N_13784.pdf.

BTS (annual reports), *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.

Sarah Burd-Sharps and Kathryn Bistline (2022), *Reports of Road Rage Shootings are on the Rise*, Everytown for Gun Safety (<https://everytownresearch.org>); at <https://bit.ly/3vO0mi4>.

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.

Robert Cervero and G. B. Arrington (2008), "Vehicle Trip Reduction Impacts of Transit-Oriented Housing," *Journal of Public Transportation*, Vol. 11/3, pp. 1-17; at www.nctr.usf.edu/jpt/pdf/JPT11-3.pdf.

Brian Christens and Paul W. Speer (2005), "Predicting Violent Crime Using Urban and Suburban Densities," *Behavior and Social Issues*, Vol. 14, pp. 113-127; at <https://bit.ly/2mrYTe9>.

CTS (2006), *About Accessibility: Access to Destinations Study*, Center for Transportation Studies, University of Minnesota (www.cts.umn.edu); at www.cts.umn.edu/access-study/about/index.html.

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

DfT (2010), *Crime and Public Transport*, UK Department For Transport (www.dft.gov.uk); at www.dft.gov.uk/pgr/crime.

Nicolae Duduta, et al. (2012), "Understanding Road Safety Impact of High-Performance Bus Rapid Transit and Busway Design Features," *Transportation Research Record*, 2317, Transportation Research Board (www.trb.org), pp. 8–14 (DOI: 10.3141/2317-02); at <https://bit.ly/2ZhrjbA>.

Nicolae Duduta, Claudia Adriaola-Steil and Dario Hidalgo (2013), *Saving Lives with Sustainable Transportation*, EMBARQ (www.embarq.org); at <https://bit.ly/38moTCW>.

Nicolae Duduta, et al. (2014), *Traffic Safety on Bus Priority Systems: Recommendations for Integrating Safety Into the Planning, Design, and Operations of Major Bus Routes*, EMBARQ (www.embarq.org); at <https://bit.ly/1B1ggON>.

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.

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*, Metropolitan Research Center at the University of Utah for the National Cancer Institute, the Brookings Institution and Smart Growth America (www.smartgrowthamerica.org); at www.arch.utah.edu/cgi-bin/wordpress-metroresearch.

FBI (2012), *Crime in the United States 2012*, Uniform Crime Statistics, Federal Bureau of Investigation (www.fbi.gov); at www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2012. Tables 12-19 contain vehicle theft data.

Christopher Ferrell, Shishir Mathur and Emilia Mendoza (2008), *Neighborhood Crime and Travel Behavior: An Investigation of the Influence of Neighborhood Crime Rates on Mode Choice*, Report 07-02, Mineta Transportation Institute (www.transweb.sjsu.edu); at <http://works.bepress.com/shishirmathur/12>.

Christopher Ferrell, Shishir Mathur and Bruce Appleyard (2015), *Neighborhood Crime and Transit Station Access Mode Choice - Phase III of Neighborhood Crime and Travel Behavior*, Report 12-47, Mineta Transportation Institute (www.transweb.sjsu.edu); at <https://bit.ly/2lsbOj9>.

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

Claude Fischer (1980), "The Spread of Violent Crime from City to Countryside, 1955-1976," *Rural Sociology*, Vol. 45, No. 3, pp. 416-434; at <https://bit.ly/2kelxbu>.

James C. Fraser, Deirdre Oakley and Diane K. Levy (2013), "Mixed Messages on Mixed Income," *Citiescape*, Vol. 15, No. 2, pp. 1-14; at www.huduser.org/portal/publications/Citiescape_Jul2013.pdf.

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.

Richard A. Gardiner (1978), *Design for Safe Neighborhoods: The Environmental Security Planning and Design Process*, National Institute of Law Enforcement and Criminal Justice of the United States Department of Justice and from the United States Department of Housing and Urban Development; at <https://www.ncjrs.gov/pdffiles1/Digitization/50335NCJRS.pdf>.

G. Gigerenzer (2004), "Dread Risk, September 11, and Fatal Traffic Accidents," *Psychological Science*, Vol. 15, pp. 286 –287; at <https://bit.ly/2kqPNRI>.

John I. Gilderbloom, William W. Riggs and Wesley L. Meares (2015), "Does Walkability Matter? An Examination of Walkability's Impact on Housing Values, Foreclosures and Crime," *Cities*, Vol. 42, pp. 13–24 (doi:10.1016/j.cities.2014.08.001); at <http://bit.ly/1swuVXD>.

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.

Bill Hillier and Ozlem Sahbaz (2006), *High Resolution Analysis of Crime Patterns in Urban Street Networks: An Initial Statistical Sketch From an Ongoing Study of a London Borough*, University College London; at www.spacesyntax.tudelft.nl/media/Long%20papers%20I/hilliersahbaz.pdf.

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.

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.

C. Kirabo Jackson and Emily Greene Owens (2010), “One for the Road: Public Transportation, Alcohol Consumption, and Intoxicated Driving,” *Journal of Public Economics*; at <https://bit.ly/2Qaf0cZ>.

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

Peter L. Jacobsen (2003), “Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling,” *Injury Prevention* (<http://ip.bmjournals.com>), Vol. 9, pp. 205–209; at <http://injuryprevention.bmj.com/cgi/content/full/9/3/205>.

Alvaro José and Moreno García (2005), *Impacto De Transmilenio En El Crimen De La Avenida Caracas Y Sus Vecindades (Estimating Transmilenio's Crime Impact on The Avenida Caracas and its Neighboring Areas)*, Universidad de los Andes (<http://economia.uniandes.edu.co>); at <http://bit.ly/2viymlr>.

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).

Matthew E. Kahn, Edward Glaeser and Jordan Rappaport (2008), “Why Do the Poor Live in Cities? The Role of Public Transportation,” *Journal of Urban Economics*, Vol. 63, No. 1. Pp. 1–24; at <http://dash.harvard.edu/handle/1/2958224>.

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://amonline.trb.org/1slsr0/1slsr0/1>.

D.M. Kennedy (2008), *Personal Security in Public Transport Travel in New Zealand: Problems, Issues & Solutions*, Report 344, Land Transport New Zealand (www.nzta.govt.nz); at www.nzta.govt.nz/resources/research/reports/344.

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. 8/1, pp. S72-S82; at <https://bit.ly/2kpAY1A>.

Matt Lerner (2014), *Crime Grade for Homes and Apartments*, Walkscore Blog (<http://blog.walkscore.com>); at <https://bit.ly/30he5Ns>.

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.

Jianling Li and Jack Rainwater (2000), *The Real Picture of Land-Use Density and Crime: A GIS Application*, presented at the ESRI International User Conference in San Diego, June 26-30; at <http://proceedings.esri.com/library/userconf/proc00/professional/papers/pap508/p508.htm>.

Shirlee Lichtman-Sadot (2019), "Can Public Transportation Reduce Accidents? Evidence from the Introduction of Late-Night Buses in Israeli Cities," *Regional Science and Urban Economics*, Vol. 74, pp. 99-117 (<https://doi.org/10.1016/j.regsciurbeco.2018.11.009>); at <https://bit.ly/31TzTiF>.

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

Todd Litman (2005), "Terrorism, Transit and Public Safety: Evaluating the Risks," *Journal of Public Transit*, Vol. 8/4 (www.nctr.usf.edu/jpt/journal.htm), pp. 33-46; at www.vtpi.org/transitrisk.pdf.

Todd Litman (2009), "Transportation Policy and Injury Control," *Injury Prevention*, Vol. 15, Issue 6 (<http://injuryprevention.bmj.com/content/15/6/362.full>); at www.vtpi.org/tpic.pdf.

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*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/tranben.pdf.

Todd Litman (2014), "A New Transit Safety Narrative," *Journal of Public Transportation* (www.nctr.usf.edu/category/jpt), Vol. 17, No. 4, pp. 114-135; at www.nctr.usf.edu/wp-content/uploads/2014/12/JPT17.4_Litman.pdf.

Todd Litman (2016), *The Hidden Traffic Safety Solution: Public Transportation*, American Public Transportation Association (www.apta.com); at <https://bit.ly/34ho5x7>.

Todd Litman (2018), *A New Traffic Safety Paradigm*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/ntsp.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.

Anastasia Loukaitou-Sideris (2009), *How to Ease Women's Fear of Transportation Environments: Case Studies and Best Practices*, Mineta Transportation Institute (<http://transweb.sjsu.edu>); at <http://transweb.sjsu.edu/project/2611.html>.

Anastasia Loukaitou-Sideris, Robin Liggett, and Hiroyuki Iseki (2010), *The Geography of Transit Crime: Documentation and Evaluation of Crime Incidence on and Around the Green Line Stations in Los Angeles*, University of California Transportation Center (www.uctc.net); at www.uctc.net/papers/550.pdf.

Juha Luoma and Michael Sivak (2012), *Why Is Road Safety in the U.S. Not on Par With Sweden, the U.K., and the Netherlands? Lessons to be Learned*, Transportation Research Institute, University of Michigan (www.umtri.umich.edu); at <https://bit.ly/2Jlzk8>.

John Martin (2011), *The Incidence and Fear of Transit Crime: A Review of the Literature*, Centre for Public Safety, University of the Fraser Valley (www.ufv.ca); at <http://cjr.ufv.ca/the-incidence-and-fear-of-transit-crime-a-review-of-the-literature>.

Wesley E. Marshall and Norman W. Garrick (2011), "Evidence on Why Bike-Friendly Cities Are Safer for All Road Users," *Environmental Practice*, Vol 13/1, March; at <https://bit.ly/2Li14in>.

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.ncbi.nlm.nih.gov/pmc/articles/PMC3993997.

Neighborhood Scout (2013), "25 Most Dangerous Neighborhoods" and "100 Most Dangerous Cities in the U.S." (www.neighborhoodscout.com).

NHTSA (annual reports), *Fatality Analysis Reporting System*, National Highway Traffic Safety Administration (www.fars.nhtsa.dot.gov/Main).

OECD (2012), *International Road Traffic and Accident Database*, Organization for Economic Cooperation and Development (www.oecd.org); at www.itf-oecd.org/irtad-road-safety-database.

OECD (2016), *Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System*, Organization for Economic Cooperation and Development (www.oecd.org); at <https://bit.ly/34iWD22>.

Rabkin, et al. (2005), "Appendix A, Chronology of Terrorist Attacks Against Public Transit," *Transit Security Design Considerations*, FTA Safety And Security Website (<http://transit-safety.fta.dot.gov>).

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://bit.ly/2dStdSI>.

Jessica Wolpaw Reyes (2014), *Lead Exposure and Behavior: Effects on Antisocial and Risky Behavior Among Children and Adolescents*, Working Paper 20366, National Bureau Of Economic Research

(www.nber.org); at www.nber.org/papers/w20366.

Tanner Ringerud (2014), *26 Things You'll See on Public Transportation*, BuzzFeed (www.buzzfeed.com); at www.buzzfeed.com/awesomer/things-youll-see-on-public-transportation.

Aki Roberts and Steven Block (2013), "Explaining Temporary and Permanent Motor Vehicle Theft Rates in the United States A Crime-Specific Approach," *Journal of Research in Crime and Delinquency*, Vol. 50, No. 3, pp. 445-471; at <http://jrc.sagepub.com/content/50/3/445.abstract>.

David Rojas-Rueda, et al. (2011), "The Health Risks and Benefits of Cycling in Urban Environments Compared with Car Use," *BMJ*, 343:d4521 (www.bmj.com); at <https://bit.ly/2VvvtvJ>.

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.

Erin K. Sauber-Schatz, et al. (2016), Vital Signs: Motor Vehicle Injury Prevention — United States and 19 Comparison Countries," *Morbidity and Mortality Weekly Report*, Vol. 65, No. 26 (DOI: <http://dx.doi.org/10.15585/mmwr.mm6526e1>).

Ian Savage (2013). "Comparing the Fatality Risks in the United States Transportation Across Modes and Over Time," *Research in Transportation Economics*, Vol. 43/1, pp. 9-22; at <https://bit.ly/3vJki3>.

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.

Angie Schmitt (2016), *America Has a Terrible Traffic Safety Record Because We Drive Too Much*, Street Blog (<http://usa.streetsblog.org>); at <https://bit.ly/2gPBsKT>.

Michael Sivak and Michael J. Flannagan (2004), "Consequences for Road Traffic Fatalities of the Reduction in Flying Following September 11, 2001," *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 7/4-5, Pages 301-305 (<https://doi.org/10.1016/j.trf.2004.09.007>).

Sarah Stillman (2014), "Get Out of Jail, Inc." *New Yorker Magazine*, 23 June 2014; at www.newyorker.com/magazine/2014/06/23/get-out-of-jail-inc.

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 <https://bit.ly/2YVj6Lm>.

Thomas D. Stucky and John R. Ottensmann (2009), "Land Use and Violent Crime," *Criminology*, Vol. 47, Is. 4, pp. 1009-1368 (<https://hdl.handle.net/1805/6030>).

Emily Talen and Julia Koschinsky (2013), *Equality of Opportunity Project* (EOP), Arizona State University; at www.equality-of-opportunity.org.

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>.

Lisa Tompson (2012), *Public Transport Victimisation*, Jill Dando Institute of Security and Crime Science, University College London (<http://www.ucl.ac.uk>); at <https://bit.ly/2JNS5kl>.

Long T. Truong and Graham Currie (2019), “Macroscopic Road Safety Impacts of Public Transport: A Case Study of Melbourne, Australia,” *Accident Analysis and Prevention*, Vol. 132 (<https://doi.org/10.1016/j.aap.2019.105270>).

Uber and MADD (2015), *More Options. Shifting Mindsets. Driving Better Choices*, Uber (www.uber.com) and Mothers Against Drunk Driving (www.madd.org); at <https://bit.ly/1XzYwIW>.

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

UITP (2020), *Promoting Safe and Sustainable Cities with Public Transportation*, International Association of Public Transport (www.uitp.org); at <https://bit.ly/3IIDvtg>.

Mishca Wanek-Libman (2022), “2021 Transit Safety & Security Report,” *Mass Transit* (www.masstransitmag.com); at <https://bit.ly/3L93zzQ>.

Ben Welle, et al. (2018), *Sustainable & Safe: A Vision and Guidance for Zero Road Deaths*, World Resources Institute (www.wri.org) and Global Road Safety Facility (www.worldbank.org/grsf); at www.wri.org/publication/safe-system.

N. Wilson and G. Thomson (2005), “Deaths From International Terrorism Compared With Road Crash Deaths In OECD Countries,” *Injury Prevention* (<http://ip.bmjournals.com>) Vol. 11, pp. 332-333; at <http://injuryprevention.bmj.com/content/11/6/332.full.pdf+html>.

WSJ (2013), “Murder in America Database,” *Wall Street Journal* (www.wsj.com); at <http://projects.wsj.com/murderdata>.

C.Y. David Yang (2004), *Understanding Transit Accidents Using the National Transit Database and the Role of Transit Intelligent Vehicle Initiative Technology in Reducing Accidents*, Report FTA-TRI-11-04.1, FTA (www.fta.gov); at <http://ntl.bts.gov/lib/jpodocs/reports/13994.htm>.

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.

www.vtpi.org/safer.pdf