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The New Traffic Safety Paradigm

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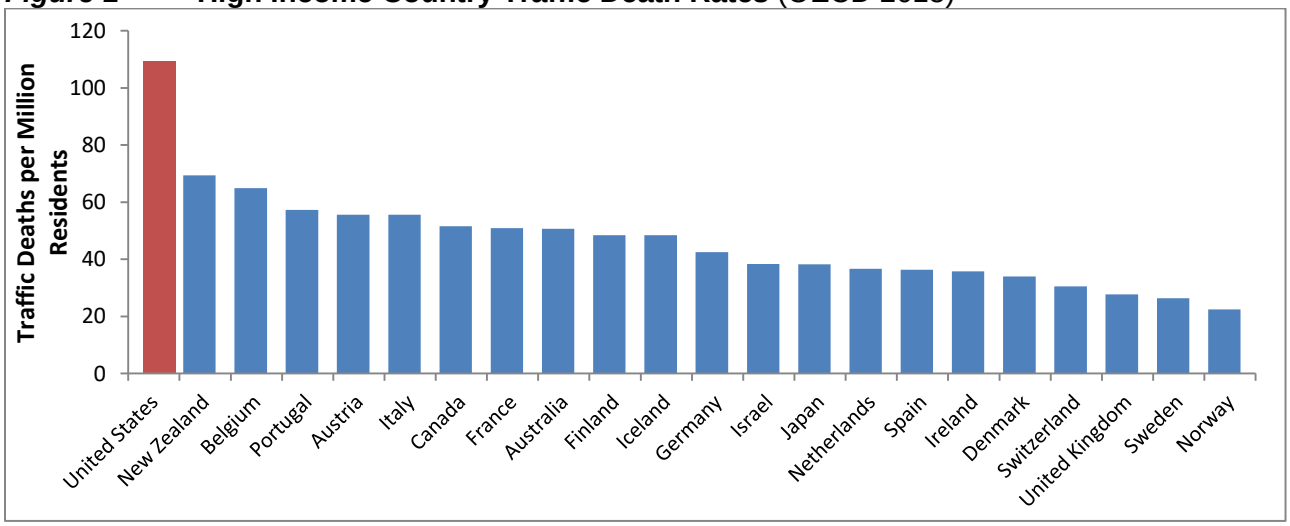
Abstract

Despite large investments in safer vehicles, roads and traffic safety programs, traffic accidents continue to impose huge costs to individuals and society. New approaches are needed to achieve ambitious traffic safety targets such as Vision Zero. A new traffic safety paradigm is changing how planning professionals measure traffic risks and evaluate potential safety strategies. It reflects recent research which improves our understanding of crash risks and potential traffic safety strategies. The old paradigm assumes that motor vehicle travel is overall very safe, and so applies targeted strategies which address specific risks. The new paradigm recognizes that all vehicle travel imposes risks, so planning decisions that increase vehicle travel tend to increase crashes, and vehicle travel reduction strategies increase traffic safety. It also recognizes that it is infeasible to reduce high-risk driving without providing viable alternatives. This expands the range of potential traffic safety strategies to include multi-modal planning, transportation demand management, and Smart Growth policies. A review of existing traffic safety programs indicates that most overlook or undervalue these new strategies.

Introduction

For decades, transportation organizations have implemented traffic safety programs. Have they been successful? Could we do better? I believe we can. For example, despite huge investments in safer vehicles, roads and programs, the U.S. has about three times traffic fatality rate as the OECD average (Figure 1), and within the U.S., traffic death rates are about four times higher in Tallahassee, Charleston and Flagstaff than in San Francisco, Boston and Seattle. Does the U.S. spend a third as much on traffic safety programs than peer countries? Are Tallahassee, Charleston and Flagstaff transportation planners less safety conscious than those in San Francisco, Boston and Seattle? Certainly not! These crash rate variations reflect differences in transportation and land use patterns that affect how residents travel and therefore their risk exposure. New research helps identify how such factors affect crash risks, information that can help develop more effective traffic safety programs and safer communities.

Figure 1 **High Income Country Traffic Death Rates** (OECD 2015)



Traffic death rates vary significantly between countries and cities, due to differences in their transport systems and land use development patterns.

This is an important issue. Traffic crashes impose huge costs, estimated to total $242-836 billion in the U.S., which is $784-2,708 per capita or 1.6-5.5% of national GDP (Blincoe, et al. 2015; Wismans, et al. 2017). This indicates that for each dollar a motorist spends on fuel their driving causes more than a dollar's worth of crash damages, including the costs vehicle occupants and other road users.

This is also a timely issue. Many governments and organizations are adopting ambitious traffic safety targets, such as Vision Zero. The United Nations Sustainable Development Goals targets plan to halve the number of global traffic deaths and injuries by 2020. Professional organizations are expending the range of impacts and options considered in transport planning, and applying more multi-modal planning, transportation demand management (TDM), Smart Growth, complete streets policies (ADB 2009; Litman 2013). These trends both support and are supported by the new traffic safety paradigm.

This report explores these issues. It describes the new traffic safety paradigm, discusses our new understanding of traffic risks, identifies additional traffic safety strategies, and discusses how these can be applied in traffic safety programs.

A New Traffic Safety Paradigm

The traffic safety discipline is experiencing a paradigm shift: a change in how problems are defined and potential solutions evaluated. The old paradigm assumed that motor vehicle travel is overall safe, so crashes result from specific higher risk people and activities, such as driving by youths and seniors, impaired or distracted driving, and failure to use seatbelts or helmets. As a result, it favors targeted safety strategies to reduce such risks. The new paradigm recognizes that all vehicle travel imposes risks, and that most drivers take small risks which can lead to crashes. This expands the scope of traffic safety strategies to including Smart Growth and Transportation Demand Management (TDM) strategies that reduce total vehicle travel.

Table 1 compares the old and new paradigm.

Table 1 **Comparing the Old and New Traffic Safety Paradigm**

Factor	Old	New
Goal	Make driving safer.	Make communities safer.
How risks are measured	Distance-based crash rates (e.g., deaths per 100 million vehicle-miles or billion vehicle-kilometers)	Per capita crash rates (e.g., deaths per 100,000 residents).
Modes considered	Focuses on motor vehicle travel. Considers pedestrians, cyclists and transit passengers high risk groups to be minimized.	Considers all modes and road users. Recognizes that shifts from automobile to alternative modes helps increase overall safety.
Solutions considered	Favors targeted programs that reduce special risks. Generally ignores multi-modal planning, TDM and Smart Growth.	Recognizes that transport and land use planning decisions affect crash rates, and the potential safety benefits of multi-modal planning, TDM and Smart Growth.
Consideration of other impacts	Uses reductionist analysis which considers traffic safety impacts in isolation.	Uses comprehensive analysis which recognizes indirect impacts and non-safety benefits.

A new traffic safety paradigm is more comprehensive and integrated.

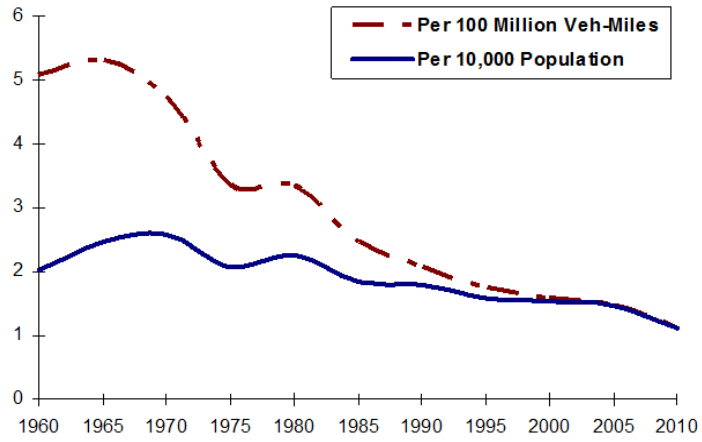
New Understanding of Traffic Risk

New research improves our understanding of traffic risk, and how transportation and land use planning decisions affect crash rates (Duduta, Adriazola-Steil and Hidalgo 2013; Ewing and Dumbaugh 2009; Ewing and Hamidi 2014; Garrick and Marshall 2011; Litman and Fitzroy 2016; Sivak and Schoettle 2010; Welle, et al. 2015). This section discusses key issues.

Measurement Units

Transportation risk analysis can be challenging because there are various ways to measure risks. For example, when measured using *distance-based units*, such as deaths per 100 million vehicle-miles, traffic fatality rates declined more than two thirds during the last half century (red line in Figure 2) which suggests that traffic safety programs were effective and should be continued. However, during this period per capita vehicle travel increased significantly which offset much of the decline in per-mile casualty rates. When measured *per capita*, as with other health risks, (blue line in Figure 2), there was little improvement despite major investments in safer roads and vehicles, and traffic safety programs. Considering these factors, much larger safety gains could be expected. For example, seat belt use increased from about 0% in 1960 to 75% in 2010, which alone should have reduced traffic fatalities about 33% (seat belt use reduces crash fatality risk about 45%), yet, per capita deaths declined just 25%.

Figure 2 **U.S. Traffic Fatalities** (*Traffic Safety Facts*, NHTSA 2014)



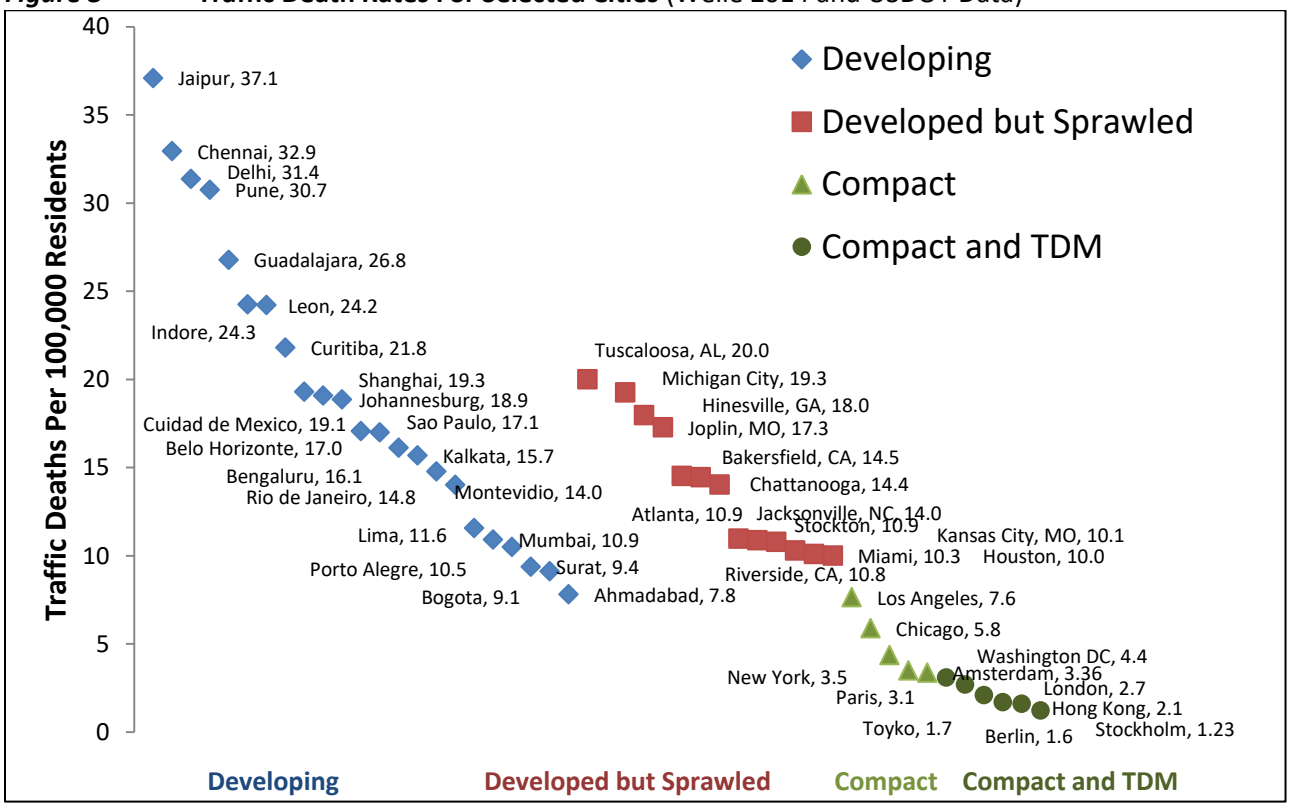
During the last half-century per mile traffic fatality rates declined substantially, but growth in per capita vehicle mileage during that period resulted in little reduction in per capita traffic fatality rates.

Geographic Factors

Although many factors related to drivers, vehicles, and road conditions affect crash rates, for a given individual or group, a change in their annual mileage tends to provide a proportionate change in their crash risk. For example, if a fuel price increase causes average vehicle travel to decline from 12,500 to 11,500 annual vehicle-miles those drivers are unlikely to become less skilled or more risky, so crashes are likely to decline proportionally, or even greater since about 70% of crashes involve multiple vehicles, so each vehicle removed from traffic reduces both its chances of causing a crash *and* of being damaged by a crash caused by another vehicle (Edlin and Karaca-Mandic 2006). Even a perfect driver who never violates traffic rules increases safety by driving less, because this reduces their chance of being injured by another road user's mistake.

Figure 3 illustrates per capita traffic fatality rates in cities around the world. The highest rates tend to occur in developing countries, many of which have more than 20 traffic deaths per 100,000 residents. These rates usually decline as a region develops economically, but public policies determine how much they decline. Sprawled developed country urban regions typically have 10-20 deaths per 100,000 residents; compact regions have 5-10 deaths per 100,000 residents; and regions that are compact and have transportation demand management (TDM) policies to minimize vehicle travel often have fewer than 5 deaths per 100,000.

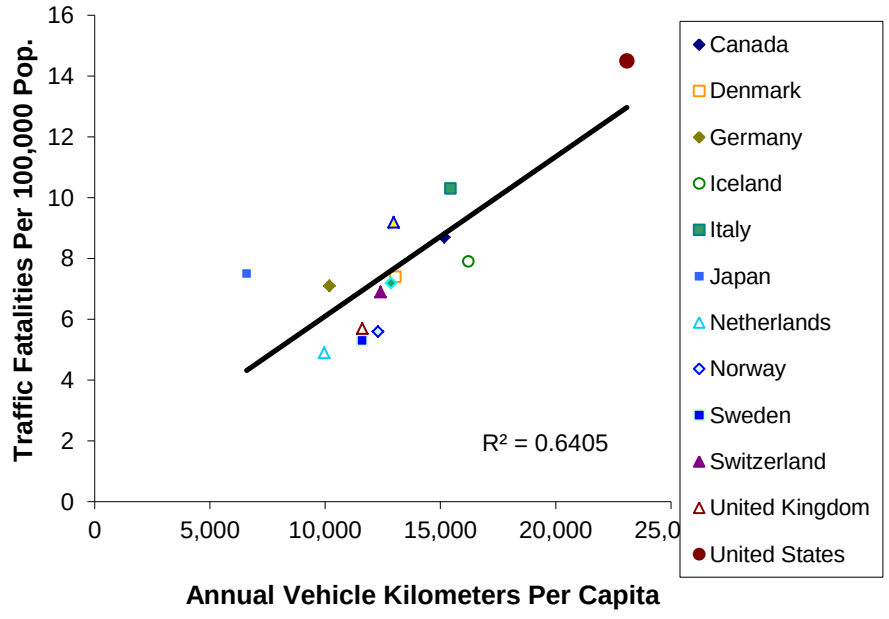
Figure 3 **Traffic Death Rates For Selected Cities** (Welle 2014 and USDOT Data)



Low-income countries tend to have high traffic death rates, which decline as they develop economically. How much they decline depends on transportation and land use conditions. Developed but sprawled urban regions tend to have much higher traffic fatality rates than more compact regions, and the lowest fatality rates occur in compact cities with TDM strategies to reduce vehicle travel, which often have a quarter of the traffic fatality rate as developed but sprawled urban regions.

Among high-income countries, per capita crash rates tend to increase with per capita vehicle travel, as illustrated in Figure 4. The U.S. has the highest traffic death rate among peer countries because it also has the highest per capita annual mileage.

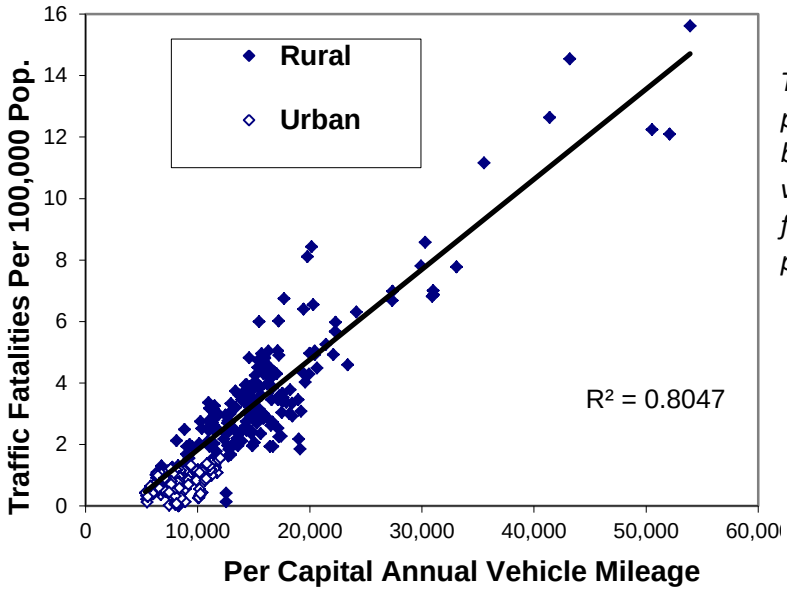
Figure 4 **Vehicle Mileage and Traffic Fatality Rates In OECD Countries** (OECD Data)



Among economically similar countries there is a strong positive relationship between per capita vehicle travel and traffic deaths. This can explain why the U.S. has the highest per capita traffic fatality rate among its peers despite decades of traffic safety policies and programs.

Similar patterns occur within countries. Figure 5 shows that per capita traffic fatality rates tend to increase with per capita vehicle travel among U.S. states.

Figure 5 **Vehicle Mileage Versus Traffic Fatalities In U.S. States** (FHWA 1993-2002 data)



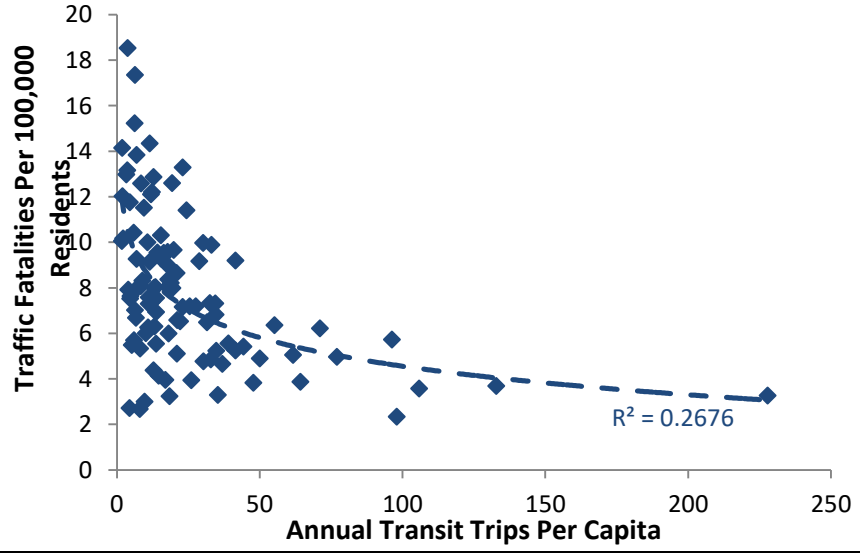
This graph indicates a strong positive relationship between per capita annual vehicle mileage and traffic fatalities in U.S. states, particularly in rural areas.

Similar patterns occur within urban regions. Ewing and Hamidi (2014) found that more compact U.S. urban areas had slightly higher *total* crash rates but much lower *fatal* crash rates than sprawled areas: each 10% increase in their compact community index is associated with a 0.4% increase in total crashes, and a 13.8% reduction in traffic fatalities. Various studies indicate that per capita traffic crash rates tend to decline with more compact and mixed development, smaller block sizes, increased street connections, narrower streets, better pedestrian and cycling facilities, better crosswalks and refuge islands, roundabouts and more traffic calming (Ewing and Dumbaugh 2009; Karim, Wahba and Sayed 2012; Welle, et al. 2015). Comparing California urban areas, Garrick and Marshall (2011) found that the safest cities have higher intersection densities (averaging 106/sq mile compared with 63/sq mile state average) and more walking, cycling and transit (16% mode share compared with 4% state average). This research suggests that many common urban planning and roadway design practices, such as the geographic separation of activities, and hierarchal road systems with wider arterials and dead-end residential streets, increase crash rates by increasing total vehicle travel and traffic speeds.

Quality of Transport Options

Another factor that significantly affects transportation crash rates is the quality of non-automobile travel modes available in a community (Santos, et al. 2011). Figure 6 illustrates the relationship between transit trips and traffic fatality rates for U.S. cities. 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). This represents a small increase in transit mode share, from about 1.5% up to about 4%, but is associated with large reductions in traffic fatality rates. This suggest that many of the factors that encourage transit travel, such as more compact development, improved walking conditions, and reduced parking supply, also tend to reduce traffic fatality rates.

Figure 6 **Transit Travel Versus Traffic Deaths in the U.S.** (Litman 2016)



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

As active travel (walking and cycling) increases in a community, both total per capita traffic casualty rates and per-mile pedestrian and cyclist crash rates tend to decline (ABW 2010), an effect sometimes called *safety in numbers* (Jacobsen 2003). Economically developed countries with active travel high rates, such as Germany and the Netherlands, have pedestrian fatality rates per billion kilometers walked a tenth as high, and cyclist fatalities rates only a quarter as high, as in North America (Fietsberaad 2008).

Transportation Pricing

Recent studies investigate how transportation prices affect crash risks (Litman 2014). In a comprehensive study of 14 industrialized countries, Ahangari, et al. (2014) found a significant inverse relationship between gas prices and road fatality rates: a 10% gasoline price decline caused a 2.19% increase in road fatalities. Burke and Nishitateno (2015) estimate the fuel price increases that would result if countries stopped subsidizing vehicle fuel, and using standard price elasticity values, estimated the reductions in vehicle travel and traffic fatalities that would result. They find that a 10% fuel price increase reduces traffic deaths by 3-6%, so removing global fuel subsidies would reduce approximately 35,000 annual road deaths worldwide.

In the U.S., Sivak (2008) found that a 2.7% vehicle travel decline caused by high fuel prices and a weak economy during 2007-2008 reduced traffic deaths by a much larger 17.9% to 22.1%, probably due to large vehicle travel reductions by lower income drivers (who tend to be young or old, and therefore higher than average risk) and speed reductions to save fuel. Grabowski and Morrisey (2004) estimate that in the U.S., each 10% fuel price increase reduces total traffic deaths 2.3%, with a 6% decline for drivers aged 15 to 17 and a 3.2% decline for ages 18 to 21 according to analysis. In follow-up research, Grabowski and Morrisey (2006) estimate that a one-cent state gasoline tax increase reduces per capita traffic fatalities 0.25%, and traffic fatalities per vehicle-mile by 0.26%. Leigh and Geraghty (2008) estimate that a sustained 20% gasoline price increase would reduce approximately 2,000 traffic crash deaths (about 5% of the total), plus about 600 air pollution deaths.

Studies by Chi, et al. (2010a, 2010b, 2011 and 2013) quantify fuel price impacts on traffic crashes in various U.S. regions. Fuel price increases reduce both total traffic crashes and distance-based crash rates (e.g., per million *vehicle miles traveled*), with impacts that vary by geographic and demographic factors, and increase over time. All these studies show that fuel price increases reduce per-mile crash rate, so a 1% reduction in total VMT provides more than a 1% reduction in total crashes. For example, in Mississippi, controlling for other risk factors (total vehicle travel, seatbelt use, state unemployment and alcohol consumption), they find that each 1% inflation-adjusted gasoline price increase reduces total (all types of drivers) crashes per million vehicle-miles traveled 0.25% in the short-run (less than one year) and 0.47% in the medium-run (more than one year) (2010a). In Minnesota, Chi et al estimate that a $1.00 per gallon gasoline price increase would reduce total rural crashes 28.15%, rural injury crashes 3.9%, total urban crashes 18.40%, and urban fatal crashes 18.4%. They find that fuel price increases cause larger short-term crash reductions by younger drivers, and larger intermediate-term reductions by older and male drivers (2010a; 2011), and large drunk driving crash reductions (2010b).

Distance-based pricing (also called *Pay-As-You-Drive* or *per-mile pricing*) changes vehicle insurance premiums and registration fees into variable fees, which gives motorists additional savings for reducing annual mileage (Ferreira and Minike 2010). With fully-prorated vehicle insurance (total premiums are divided by average annual mileage, so a $600 premium becomes 5¢ per vehicle-mile, a $1,200 premium becomes 10¢ per vehicle-mile, and $1,800 premium becomes 15¢ per vehicle-mile) the average motorist would pay about 8¢ per vehicle-mile, which is predicted to reduce their vehicle travel 8-12%, and more if other fixed vehicle charges, such as registration fees, are also made distance-based.

This should provide proportionately larger crash reductions, for two reasons. First, higher-risk motorists pay more per vehicle-mile and so have a greater incentive to reduce mileage. For example, a low-risk driver who currently pays $360 annual premiums would pay 3¢ per mile and so would be expected to reduce mileage only about 5%, but a higher-risk driver who pays $1,800 in premiums would pay 15¢ per vehicle-mile and so would be expected to reduce mileage more than 20%. Some distance-based

insurance pricing systems base premiums on when, where and how a vehicle is driven, which can provide additional safety benefits by discouraging risky driving activity. Second, since about two-thirds of traffic crashes involve multiple vehicles, widely-applied distance-based pricing can provide external safety benefits, that is, reduced risk to other road users regardless of whether or not drivers reduce their mileage (Edlin and Karaca-Mandic 2006). As a result, if fully implemented in an area, distance-based pricing can reduce traffic crashes by 12-15%, and possibly even more, depending on price structures and other factors such as the quality of transport options. Using a comprehensive data base of vehicle insurance claim and mileage data, Ferreira and Minike (2010) found a strong positive relationship between crash rates and a vehicle's annual mileage.

TDM Programs

There are also various TDM programs which reduce certain types of automobile travel, including commute trip reduction, freight transport management, parking management, special event traffic management, and TDM marketing programs (VTPI 2016). Although their impacts vary significantly depending on conditions, such programs have proven successful at reducing motor vehicle travel. For example, commute trip reduction programs can typically reduce affected vehicle travel by 2-6% if they include support and encouragement strategies such as carpool matching and bicycle parking, and a 10-30% reduction if they include financial incentives such as parking pricing or cash out (Kuzmyak, Evans, and Pratt 2010). Although most of these programs only affect a small portion of total travel, their cumulative impacts can be significant (Cotton 2012).

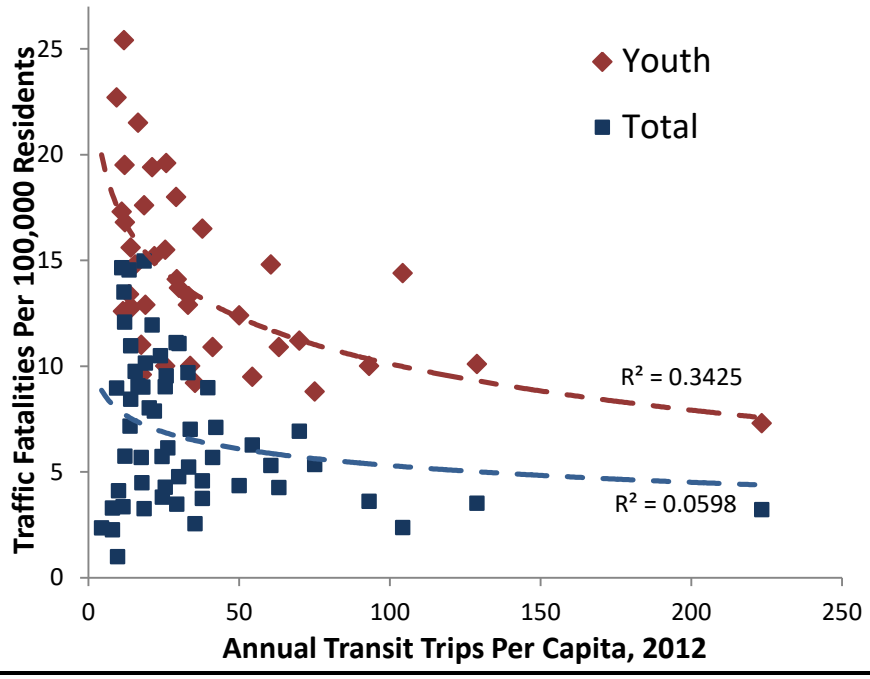
Factors Affecting Higher-Risk Driving

The conventional traffic safety paradigm assumes that driving is usually safe, since most accidents are associated with specific risk factors such as youth, senior, impaired or distracted drivers, or unusual road conditions such as snow or fog. It therefore uses targeted programs intended to reduce higher-risk driving, such as graduated licenses that reduce driving by youths, special senior driving testing, and various laws and education campaigns intended to discourage impaired and distracted driving. Traffic safety therefore depends on the factors that affect higher-risk driving, and therefore the effectiveness of strategies to reduce such driving.

Available research suggests that high-risk driving reduction strategies are most effective if the targeted travellers have suitable travel options. For example, comparing U.S. urban regions, both total and youth (age 15-25) fatality rates tend to decline with increased transit ridership; the relationship is statistically much stronger for youths than the overall population, as illustrated in Figure 7. This suggests that many young people are willing to reduce their driving and associated risks but can only do so if they have suitable mobility options.

Similarly, a key factor affect drunk driving is how patrons get to restaurants and bars: if they drive there they are likely to drive home. Improving walking, cycling and public transit, and compact development which reduces the distances between homes and drinking establishments, increases the feasibility of using a safer mode after drinking (Greenwood and Wattal 2015).

Figure 7 **Youth and Total Traffic Fatality Rates Compared to Transit Travel**



Youths (15-25 years old) have about twice the traffic fatality rates as the total population average, and both youth and total fatality rates tend to decline with increased transit ridership. This relationship is statistically much stronger for youths than the overall population, which suggests that many young people want to reduce their driving and associated crash risks, but can only do so if they have adequate travel options.

This suggests that lower- and higher-risk driving are complements: factors that tend to increase lower-risk driving, such as automobile-oriented transport planning, low fuel and parking prices, and sprawled land use development generally increase high-risk driving, and the effectiveness of traffic safety programs intended to reduce higher risk driving, such as graduated licenses, senior driver testing, and anti-impaired and -distracted driving campaigns depends on those travellers having viable alternatives.

Summary

This research identifies a wide range of factors that affect traffic crash rates, and therefore potential traffic safety programs. Table 2 indicates conventional and new traffic safety strategies.

Table 2 **Conventional and New Traffic Safety Strategies**

Conventional	New
Roadway design improvement	Higher fuel, road and parking prices (including road tolls), and distance-based insurance and registration fees
Traffic calming and traffic speed reduction	Smart Growth policies that result in more compact, mixed and connected development
Graduated licenses and senior driver testing	More connected roadways and pedestrian networks
Anti-impaired and distracted driving campaigns and laws	Reduced parking supply and more efficient management
Seatbelt and helmet encouragement and laws	Walking, cycling and public transit improvements
Vehicle crash protection and road worthiness standards	Complete Streets roadway design practices
Improved driver education and traffic law enforcement	Transportation demand management programs
Better emergency response and medical treatment	

Recent research identifies a new set of strategies that increase safety by reducing total vehicle travel and improving mobility options for higher risk travellers.

Traffic Safety Programs Evaluation

Many current traffic safety programs continue to reflect the old traffic safety paradigm. For example, much of the basic data available for evaluating traffic risks uses distance-based exposure units, which ignores the additional crashes caused by increases in total vehicle travel, and therefore the safety benefits of vehicle travel reduction strategies.

For example, the National Highway Traffic Safety Administration (NHTSA), *Traffic Safety Facts Report,* includes a graph showing crashes per 100 million vehicle-miles (Figure 7) but no comparable graph of per capita crash rates. Similarly, a table titled, "Motor Vehicle Traffic Fatalities and Fatality Rates, 1899-2012" (page 232), reports distance-based traffic death rates but no comparable per capita death data. There is also no data for comparing crash rates by mode, and therefore the potential safety impacts of mode shifting. As a result, this report provides little guidance on the safety benefits of transportation demand management strategies and Smart Growth.

Similarly, the U.S. Department of Transportation's traffic safety targets are all distance-based (IRTAD 2014, p. 518): the 2014 targets are fewer than 1.02 deaths per 100 million vehicle miles travelled, fewer than 0.16 non-occupant deaths per 100 million vehicle miles, fewer than 0.82 passenger vehicle fatalities per 100 million vehicle miles, and fewer than 0.114 fatalities per 100 million large truck and bus vehicle miles travelled. These distance-based targets fail to reflect the risks of increases in per capita vehicle travel and the potential safety benefits of vehicle travel reduction strategies.

Table 3 **Evaluating Traffic Safety Programs** (Litman 2016)

Program	Evaluation
Desktop Reference for Crash Reduction Factors, Institute of Transportation Engineers (www.ite.org)	This report estimates the crash reductions provided by various countermeasures implemented in specific situations. The strategies considered are all roadway physical design (including signs and marking) strategies, plus increased traffic law enforcement. It provides no support for multi-modal planning, TDM or Smart Growth.
Developing Safety Plans: A Manual for Local Rural Road Owners	This US Federal Highway Administration report describes how to develop Local Road Safety Plans. It defines key emphasis areas and local strategies for improving rural road safety. It provides no support for multi-modal planning, TDM or Smart Growth.
Global Road Safety Partnership (www.grsproadsafety.org)	This coalition of industry, government agencies and research organizations works to improve road safety in developing countries. Some of its documents, such as the *World Report on Road Traffic Injury Prevention* recommend demand management safety strategies. *Drinking And Driving: A Road Safety Manual For Decision-Makers And Practitioners* recommends that, "public transport must be easily accessible and available to deter people from driving after drinking" (p. 58).
Global Status Report on Road Safety (http://bit.ly/1GsQ3DJ)	This World Health Organization report summarizes traffic risk information from 180 countries, and evaluates their progress toward the 2030 Agenda for Sustainable Development goal of halving global traffic deaths and injuries by 2020. It recognizes (p. 50) the importance of improving walking, cycling and public transit. "Policies to encourage investment in public transport" is an indicator of countries' efforts to increase safety and mobility.
Governors Highway Safety Association (www.ghsa.org)	This organization provides information on state traffic safety programs. Its *Highway Safety Program Guidelines* recommends targeted safety strategies. It provides no support for multi-modal planning, TDM or Smart Growth.
Highway Safety Manual (http://bit.ly/2oF4Xix)	This AASHTO manual provides information and tools to incorporate safety into roadway planning, design, operations, and maintenance decisions. It is primarily concerned with highway design and operations. It provides no support for multi-modal planning, TDM or Smart Growth.
Mothers Against Drunk Driving (www.madd.org)	This organization advocates policies to stop drunk driving including public education, increased law enforcement and ignition interlock devices. It promotes "Safe Ride Programs" which encourages drinkers to use alternatives to driving, but provides no support for alternative modes.

Motor Vehicle PICCS (www.cdc.gov/motorvehiclesafety/calculator)	This US Center for Disease Control calculator identifies a dozen potential state-level traffic safety strategies and their potential safety benefits. It includes a fact sheet for each intervention, a final report and user guide. It provides no support for multi-modal planning, TDM or Smart Growth.
National Highway Traffic Safety Administration (www.nhtsa.gov)	This is the leading U.S. traffic safety agency. Its report, *Countermeasures That Work*, describes various traffic safety strategies but includes no support for multi-modal planning, TDM or Smart Growth.
Road Safety Foundation (www.roadwaysafety.org)	This automobile industry organization supports highway safety. Its *Roadway Safety Guide: A Primer for Community Leaders* describes various roadway engineering strategies and traffic safety programs, but provides no support for multi-modal planning, TDM or Smart Growth.
The Injury Research Foundation (www.tirf.ca)	This Canadian coalition sponsors traffic safety programs targeting youths, seniors, impaired and distracted driving, but includes no support for multi-modal planning, TDM or Smart Growth.
Toward Zero Deaths (www.towardzerodeaths.org)	This coalition of traffic safety advocacy organizations supports strategies to increase safety for drivers, passengers, vulnerable users, vehicles, infrastructure, plus improved emergency response but includes no support for multi-modal planning, TDM or Smart Growth.
Transportation Planner's Safety Desk Reference (http://bit.ly/2oFbz0j)	This US DOT report includes 22 emphasis areas, each with an overview, descriptions of appropriate safety strategies, crash modification factors that can be used to predict crash reductions and best practices. It recommends 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."
Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System (http://bit.ly/2nQZJmP)	This OECD report provides guidance for road safety planning. It primarily recommends conventional safety strategies, but 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 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)

Of fourteen traffic safety programs reviewed only four mention multi-modal planning, TDM or Smart Growth strategies, and even these provide little practical guidance for their implementation.

Of these fourteen traffic safety programs and documents only four (Global Road Safety Partnership, Global Status Report on Road Safety, Transportation Planner's Safety Desk Reference and Zero Road Deaths) consider more multi-modal planning, TDM or Smart Growth strategies, their support often consists of vague statements such as "improving public transit." They provide little practical guidance on how to predict the traffic safety impacts, how to evaluate their overall benefits and costs, or how to incorporate them into integrated traffic safety programs, and how to implement them.

Is Demand Management Within Traffic Safety Programs' Scope?

Skeptics could argue that, even if multi-modal planning, TDM and Smart Growth can reduce crashes, their benefits are unpredictable, costly and beyond traffic safety programs' scope. These strategies are sometimes portrayed as "social engineering" which harms residents by depriving them of preferred travel and housing options, and reduces economic productivity. These arguments are generally false.

Previously described research provides information for predicting the potential crash reductions of new safety strategies. There is no reason to believe that such models are inherently less accurate than those currently used to predict traffic engineering or safety programs impacts. More research is certainly justified, but even now we have sufficient information to make reasonable predictions.

Some of these strategies, such as major public transit service improvements, may seem costly if evaluated based on their traffic safety benefits alone, but provide other important benefits including traffic and parking congestion reductions, infrastructure savings, user savings and affordability, improved mobility for non-drivers which helps achieve social justice objectives, improved public fitness and health, energy conservation and pollution emission reductions, to name a few. When all impacts are considered, multi-modal planning, TDM and Smart Growth are often very cost effective.

It is also inaccurate to assume that TDM and Smart Growth harm residents and reduce economic productivity. They respond to growing demand for non-automobile travel options and housing in compact, multi-modal neighborhoods; serving these demands benefits users directly, and by creating more resource-efficient mobility and housing, they tend to increase economic productivity.

For individuals, the new safety paradigm means that households should be aware that multi-modal urban neighborhoods are generally much safer overall than living in sprawled, automobile-dependent areas (Myers, et al. 2013). For planning agencies and professionals, it means their analysis should recognize that policies and projects which increase total vehicle travel, such as increased parking supply and roadway expansions, are likely to increase per capita traffic casualty rates, while those that reduce vehicle travel increase safety. For example, a recent study (Decker, et al. 2017) estimated that infill housing reduces household vehicle travel by 32% compared with conventional urban fringe development. The study highlighted potential economic and environmental benefits, but overlooked the substantial crash casualty reductions that are likely to occur. Recognizing traffic safety benefits increases the justification for more multi-modal planning, TDM and Smart Growth policies.

In the past, transportation planning was reductionist; each problem was assigned to a specific agency with narrowly defined responsibilities. A new planning paradigm supports more comprehensive analysis and more integrated solutions, such as multi-modal planning, TDM and Smart Growth (ADB 2009; Litman 2013). As a result, many transport agencies and professional organizations are changing their practices. For example, until recently, advocates often claimed that roadway expansions would reduce pollution emissions, but this is less common due to greater understanding of the increased emissions caused by induced travel (Barth and Boriboonsomin 2009; UKERC 2009). Similarly, the new safety paradigm recognizes that roadway expansions that induce more travel or increase traffic speeds tend to increase traffic crashes, and so justifies alternative solutions that reduce vehicle travel.

This new paradigm allows traffic safety programs to incorporate the new strategies identified in this report. In fact, it demands that they be applied if needed to achieve traffic safety targets, or if they are overall more cost effective and beneficial than conventional strategies.

Conclusions

Despite huge investments in safer vehicles, roads and traffic safety programs, traffic accidents continue to impose large costs to individuals and society. New research improves our understanding of traffic risks and potential traffic safety strategies. It indicates that traffic casualty rates tend to increase with per capita vehicle travel and traffic speeds, which helps explain why residents in more sprawled, automobile dependent areas have many times higher traffic casualty rates than in more compact, multi-modal communities. This suggests that more multi-modal planning, TDM and Smart Growth can significantly reduce traffic crashes and provide other benefits. However, conventional traffic safety planning tends to ignore or undervalue these strategies; of 14 safety programs reviewed only four even mention them, and those that do provide little practical support for their implementation.

A paradigm shift is needed to implement these strategies to the degree justified. The old paradigm favors targeted safety programs intended to reduce specific risks. The new paradigm recognizes that all vehicle travel incurs risks, so policies that stimulate more driving tend to increase per capita crashes, and vehicle travel reduction strategies can increase safety. It also recognizes that it is infeasible to reduce high-risk driving without providing viable alternatives. The new paradigm is more comprehensive and integrated. It considers a wider range of impacts and options, and considers co-benefits, in addition to crash reductions, provided by these new safety strategies.

This is not to deny the value of conventional traffic safety strategies; they can reduce distance-based crash rates. However, they are insufficient to achieve ambitious traffic safety targets. New strategies are needed to reduce total crashes. The old and new traffic safety strategies are often complements. For example, many conventional strategies such as graduated licenses, senior driver testing, and anti-impaired and distracted driving campaigns try to reduce higher-risk driving; their effectiveness depends on those travellers having viable alternatives. As a result, traffic safety programs should support development of suitable alternatives, such as improved walking, cycling, transit and taxi services, plus Smart Growth policies which reduce the distances people must travel to access activities.

These new strategies do not eliminate automobile travel and require everybody to live in high-rise apartments; many people may rationally choose to live in automobile-dependent areas and bear the additional traffic risk. However, current demographic and economic trends are increasing demand for alternative modes and for living in more compact, multi-modal communities, so policies that improve travel options and support more compact development can increase safety and provide other benefits.

Transportation agencies and organization increasingly support multi-modal planning, TDM and Smart Growth. These trends both support and are supported by the new traffic safety paradigm which recognizes the large safety benefits they can provide.

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