Transportation Safety & Security

February 2013

To support development of the Regional Transportation Strategy, TransLink commissioned the following set of working papers on **Transportation Safety & Security**:

Part A: The Global (A) paper provides an overview of transportation safety (minimal risk of accident harm) and security (minimal risk of intentional harm) issues, based on international understanding and experience with these issues. It defines transport risks; identifies ways to evaluate these risks; analyzes the relative risks of different modes, users and conditions; investigates differences between actual and perceived risk; identifies global practices for reducing risks; and discusses implications for transport policy and planning. This analysis includes all modes of local and regional personal transport, including walking, cycling, automobile, public transport, and freight transport to the degree that it imposes risks on regional residents.

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Transportation Safety & Security

Part A: Global Context

February 2013

Summary: The Global (A) paper provides an overview of transportation safety (minimal risk of accident harm) and security (minimal risk of intentional harm) issues, based on international understanding and experience with these issues. It defines transport risks; identifies ways to evaluate these risks; analyzes the relative risks of different modes, users and conditions; investigates differences between actual and perceived risk; identifies global practices for reducing risks; and discusses implications for transport policy and planning. This analysis includes all modes of local and regional personal transport, including walking, cycling, automobile, public transport, and freight transport to the degree that it imposes risks on regional residents.

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CONTENTS

EXECUTIVE SUMMARY

This report provides an introduction to safety and security evaluation for transport planning. It outlines the issues to be considered in strategic planning and provides examples of cities and regions which have successfully adopted safety and security policies and strategies.

Safety and security are important transport planning issues. Transport-related risks impose significant costs on users and society, affect the quality of travel experience, and can influence travel activity in various ways that may support or contradict other planning objectives.

Analysis of transportation safety and security must consider various types of risks, perspectives, modes, cost categories, and risk factors, as outlined in Table 1.

Table 1 – Transport Risk Evaluation Variables

Types of Risk	Perspectives	Modes	Cost Categories	Risk Factors
Crashes	Mode user/occupant	Walking	Property damage	Mode
Falls	Other road users	Bicycling	Emergency response	Vehicle type
Crimes	All of society	Pedestrians	Medical and rehabilitation expenses	Age
Assault	Insurers	Automobile	Disability (lost productivity) costs	Location
Terrorism	Area or group (a particular community or jurisdiction)	Public transport	Casualties/deaths	Travel conditions (facility design, weather, etc.)
Overall health	Short-term	Heavy/Light vehicle	Pain and suffering	Operator condition (skill, impairment, etc.)
	Long-term		Reduced mobility by vulnerable modes	
			Prevention program costs	

A new traffic safety paradigm recognizes that all vehicle travel incurs some risk and that high-risk and low-risk driving are complements: transport and land use policies that lead to high rates of per capita vehicle travel inevitably lead to high rates of high-risk driving. For example, in an automobile-dependent community it is common for people to drive when attending social events where alcohol is consumed, for teenage boys to obtain drivers' licenses, and for seniors to continue driving despite declining ability, because alternative travel options are unavailable and stigmatized. As a result, the new safety paradigm recognizes the safety benefits of both targeted programs that reduce per-kilometre crash rates *and* from mobility management programs and smart growth development policies that reduce per capita vehicle travel and improve alternative transport options. The new paradigm represents a significant shift which not all safety experts understand or endorse.

There are also changes in the evaluation of security risks and solutions. The older paradigm focuses on active interventions such as policing and baggage inspections at transit stations. The new paradigm relies more on crime prevention through environmental design (CPTED), for example, by designing transit stations that are activity centers that attract many responsible people, and by empowering system users to report risks.

A review of transport safety and security programs around the world indicates that there are many good ideas that could be applied in this region to support regional planning objectives. Key lessons from the case studies include:

- Safety and security programs should be developed in partnership between government agencies (planning, transport, policing, public health, etc.), community groups and individuals;
- Effective safety programs use a variety of approaches (engineering, design, education, enforcement and encouragement) to address various risks (crashes, falls, crime, terrorism). They help transport system users understand the real risks they face, and empower them to increase safety, as individuals and in partnership with public agencies and community groups;
- Transit security information should be comprehensive and integrated, providing consistent messages about various risks and safety strategies through websites, signs, newsletters, brochures and other public communications. It should highlight the overall safety benefits to individuals and communities of public transit travel, in order to reduce excessive risk perception; and
- Safety should be incorporated into overall transport planning and communications programs, including efforts to encourage alternative modes, neighbourhood planning, and transport pricing policies.

1. INTRODUCTION

1.1. REGIONAL TRANSPORT STRATEGY

In order to support the development of more evidence-based plans, policies, and strategies – including an update to the Regional Transportation Strategy in 2013 – TransLink has commissioned a series of working papers. The papers are designed to help illuminate and explore key issues from a global context (A-series papers) and from the local context of Metro Vancouver (B-series papers).

This paper sets the global context for safety and security.

1.2. PURPOSE & SCOPE OF THIS REPORT

This report provides an overview of transportation *safety* (minimal risk of accident harm) and *security* (minimal risk of intentional harm) issues, based on international understanding and experience with these issues. It defines transport risks; identifies ways to evaluate these risks; analyzes the relative risks of different modes, users and conditions; investigates differences between actual and perceived risk; identifies global practices for reducing risks; and discusses implications for transport policy and planning. This analysis includes all modes of local and regional personal transport, including walking, cycling, automobile, public transport, and freight transport to the degree that it imposes risks on regional residents.

Safety and security are important planning objectives because transportation risks impose large costs on society, and risk perception can affect transport decisions, sometimes in ways that contradict other planning objectives. As a result, increased attention to safety and security can provide potential benefits, including direct benefits from reduced costs, and indirect benefits from increased use of sustainable transport options. Because these risks have many external impacts, including risk to other transport system users, they require public policy responses. To maximize efficiency and equity, these responses must be grounded in accurate understandings of risk.

1.3. METHODOLOGY

This study reviews international literature to investigate:

- How transport safety and security risks are defined and evaluated;
- Different perspectives of transport risks, including different types of risks; different definitions and measurement techniques; and how risks vary by mode, user type and travel conditions;
- How risk perception affects travel activity; and
- Exemplar approaches by transportation agencies and their partners in mitigating and communicating risks and how the issue of safety and security has been approached in strategic transportation policy.

2. BASIC CONCEPTS

2.1. DEFINING TRANSPORTATION SAFETY AND SECURITY RISKS

Below are key terms and concepts important for risk analysis. Though in practice there is inconsistency in how these terms are defined, this section aims to provide a general understanding of the individual terms.

- ***Accident*** refers to unintentional harm. Transport accidents can include vehicle crashes and collisions, pedestrian and cyclist falls, and may also include other types of injuries to vehicle occupants and system employees.
- ***Crash*** and ***collision*** are interchangeable terms referring to impact between two objects. Traffic crashes and collisions typically involve impacts involving vehicles (including bicycles). They are a sub-category of traffic accidents.
- ***Cost*** refers to damages or losses that result from a risk, which can include prevention and mitigation costs. These costs can be monetized (measured in monetary values such as dollars). The scope of monetized costs can vary; some estimates only include direct financial costs such as property damage, medical expenses and injury compensation, while others also include human pain and suffering and transport system users' willingness to pay for reduced risk.
- ***Incident*** refers to a specific event. It is the most general unit used to measure risks. For example, safety analysis is often based on the number of crash incidences, and security analysis is often based on the number of reported crime and assault incidences. It can also include events such as a passenger medical problem, an employee injury, or a disturbance.
- ***Offsetting behaviour*** refers to people's tendency to take incremental risks if they feel safer and more secure. This can affect the net safety gains of some risk reduction strategies.
- ***Risk*** refers to the probability of an undesirable event. It is often used interchangeably with danger. ***Internal risk*** refers to impacts borne directly by a mode or vehicle users, while ***external risk*** refers to danger and damage costs imposed on others, including the incremental crash risk each vehicle imposes on other road users, the additional risk larger vehicles impose on smaller vehicles and on vulnerable road users (pedestrians, cyclists and motorcyclists) and the resulting reduction in the use of these modes, and any uncompensated crash damage costs.
- ***Safety*** refers to minimal risk of accidental (unintentional) harm. Transport safety refers to minimal risk of harm by transport activities and to transport system users, including crashes and falls, and possibly other risks to transportation users, customers, and system employees.
- ***Security*** refers to minimal risk of intentional harm. Transport security refers to minimal risk of harm by transport activities and to transport system users, including vandalism, theft, threats, assault, terrorist attacks, fare evasion, and possibly other risks.

- Most statistics indicate ***reported*** crashes or incidents, but since reporting is seldom complete, some indicate ***total estimated*** crashes or incidents, based on a multiplier of those reported.[1]
- ***Vulnerable road user*** refers to pedestrians, cyclists and motorcyclists.

In practice a variety of terms are commonly used, often interchangeably, to describe transport risks. For example, the World Health Organization uses the term *road traffic injury*, while the U.S. Census Bureau uses the term *motor vehicle accidents* (MVA) and Transport Canada uses the term *motor vehicle traffic collision* (MVTC). Other commonly used terms include traffic accidents, auto accidents, road accidents, car crashes, car wrecks, motor vehicle collisions (MVC), road traffic accidents (RTA), road traffic collisions (RTC), road traffic incidents (RTI), as well as various unofficial terms such as smash-up and fender bender. Their scope may differ somewhat. For example, *traffic accident* may include all modes, while *car crash* may exclude accidents involving buses and trucks.

Accident is the broadest term since it can include harmful events that do not involve collisions, such as falls, fires and electrocutions. Some traffic safety experts prefer the term *crash*, which emphasizes that such events have specific preventable causes, as opposed to *accident* which implies a random event. On the other hand, the term *accident* recognizes that all travel activity incurs unavoidable risk, and crashes often result when a certain combination of risk factors occur together. For example, drivers often swerve outside their traffic lanes without incident, but have a crash when a pedestrian or other vehicle happens to be in that space. Crashes can therefore be considered to have one or more causes but still be random events.

2.2. RISK FACTORS AND PERSPECTIVES

Various factors can affect transport risks and should be considered in risk evaluation:

- Type of risk (collision, fall, assault, terrorist attack);
- Measurement unit (per kilometre, trip, user, capita);
- Mode (walking, cycling, bus, rail, automobile);
- Driver demographics (age, experience, gender);
- Driver condition (sober, impaired, distracted);
- Travel conditions (time of day, weather);
- Transport facilities (sidewalk, path, local street, road, highway);
- Traffic conditions (speed, density, mix);
- Traffic safety programs and resulting use of safety devices (seatbelts, helmets);
- Geography (urban, suburban, rural).

The following are examples of factors that affect accident risks:

- Young male (under 25 years of age) and senior (more than 75 years of age) drives tend to have relatively high crash rates.

[1] SWOV (2010), *Registration Rate*, Institute for Road Safety Research (www.swov.nl); at www.swov.nl/uk/research/kennisbank/inhoud/00_trend/01_monitor/registration_rate.htm.

- Seniors tend to have high fall rates (for example, tripping on a sidewalk), and their injuries tend to be more severe than younger people.
- Walking and cycling tend to have relatively high casualty rates per kilometre of travel, but because pedestrians and cyclists impose minimal risk on other road users and drivers tend to become more cautious if they see more pedestrians and cyclists on their roadways, per capita traffic casualty rates tend to decline as walking and cycling activity increase in a community.
- Public transport tends to have low casualty rates per passenger-kilometre, but most transit trips include walking links so transit travel risk varies depending on whether analysis considers just the transit link or an entire journey.
- Urban roads tend to have relatively high crash rates per vehicle-kilometre, but most urban collisions occur at relatively low speeds and so have low severity. Rural roads tend to have lower crash rates per vehicle kilometre, but those crashes tend to be more severe, and rural residents drive more annual miles than urban residents, resulting in high per capita traffic casualty rates in rural areas.
- Security risks vary depending on conditions. Under most circumstances, walking and public transit are relatively secure modes, but in some situations, particularly where there are few other users, the risk (both perceived and real) can increase. As a result, strategies that increase walking, cycling and public transit travel can increase security if they increase the presence of responsible users.
- Many transport planning decisions involve trade-offs between different types of risks. For example, shifting from a smaller to a larger automobile tends to reduce internal (user) crash risk, but tends to increase external risks (imposed on other vehicle users). Similarly, shifting from an urban to a rural location tends to reduce crash frequency but increases crash severity and therefore disabilities and deaths.
- The units used to measure risk can also affect analysis. For example, urban areas tend to have relatively high rates of crashes per vehicle-kilometre, and therefore high insurance premiums, but rural residents tend to drive more annual kilometres, and rural crashes tend to have high severity and therefore casualty (injury and death) rates. As a result, urban driving is considered dangerous when measured as crashes or insurance costs per vehicle-kilometre, but rural driving is considered dangerous when measured as fatalities per capita.

These examples are not comprehensive and are intended simply to illustrate the diversity of factors that can affect risk, and how they can be affected by the perspective and units used in analysis. A particular transport activity or policy may appear to increase risk when evaluated in one way but to increase safety when evaluated in another. For example, while it may be accurate to say that for an individual taking a particular trip, driving is often safer than walking, it may be equally accurate to say that total per capita crash rates are likely to decline in a community as total walking activity increases. This highlights the importance of understanding the different perspectives and measurement units when undertaking transportation risk analysis.

Traffic safety analysis is also complicated by the tendency of risks to maintain equilibrium. If a risk is considered excessive, individuals and society respond until it is reduced to a more acceptable level, (called *offsetting behaviour*). This can involve more caution by individual travelers, and safety programs that target specific geographic areas, groups or modes considered high risk. Conversely, travelers often take small additional risks when they feel relatively safe, such as driving faster, or talking on a telephone

while driving. As a result, strategies that reduce perceived risk may provide less net safety benefits than expected.

3. RISK EVALUATION

3.1. INTERNATIONAL AND CANADIAN TRANSPORT SAFETY DATA

The majority of transport safety data and analysis is focused on road safety. This can be explained by a number of historical reasons, including the wealth of data in this area. Fatality data is often used for such analysis because it is generally the most comprehensive and accurate data available, particularly for comparisons between different jurisdictions. For crashes and collisions many accidents are unreported, so various methods are used to estimate total crashes, injuries and crash costs.[2] Research by the World Health Organization indicates that each traffic fatality represents about 15 severe injuries requiring hospital treatment, 70 minor injuries, and about 150 property damage only (PDO) traffic crashes (WHO 2004).

Since 2003, Transport Canada has published annual *Canadian Motor Vehicle Traffic Collision Statistics* reports which summarize reported collisions, injuries and fatalities by mode, demographics (age and gender), location (urban or rural and province); traffic injury and fatality rates; and various other factors[3].

Figure 1 compares per capita traffic fatality rates for Canada and its peers. Canada's per capita traffic fatality rate is higher than most peer countries but lower than the U.S. This can be explained, in part, by differences in per capita vehicle travel, as indicated in Figure 2. Though other factors can also affect per capita traffic fatality rates, numerous studies indicate that, holding other factors constant (that is, for otherwise similar jurisdictions or demographic groups), per capita vehicle travel is an important factor.

[2] SWOV (2010), *Registration Rate*, Institute for Road Safety Research (www.swov.nl); at www.swov.nl/uk/research/kennisbank/inhoud/00_trend/01_monitor/registration_rate.htm.
[3] *Statistics and Data +Website* (www.tc.gc.ca/eng/roadsafety/resources-researchstats-menu-847.htm).

Figure 1 –Traffic Fatality Rates in OECD Countries

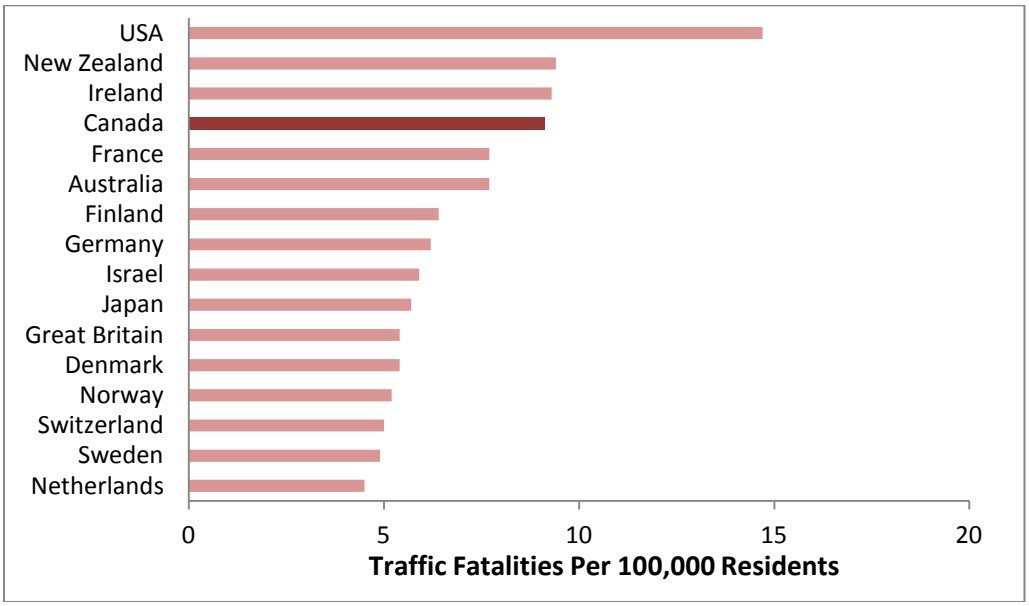
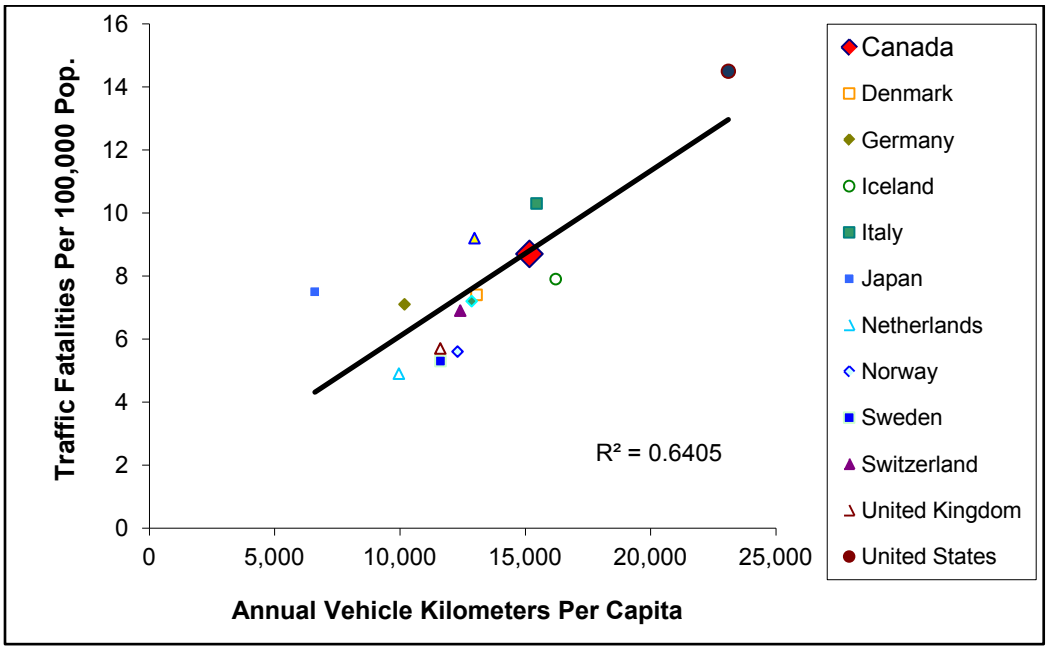


Figure 2 – Vehicle Mileage and Traffic Fatality Rates in OECD Countries



3.1.1. Crash Rates by Mode and Vehicle Type

Various data sets compare traffic crash rates for different modes, though the information available on pedestrian and cyclist falls is less comprehensive[4]. Table 1 is an example of this data, indicating total and per billion vehicle-mile fatality rates for vehicle occupants and other road users, for various transport modes in the United States. These statistics only reflect collisions. .

[4] CDC (2010), *Falls Among Older Adults*, U.S. Center for Disease Control (www.cdc.gov); at www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html.

Table 2 – U.S. Transportation Fatalities by mode, 2001[5]

	Fatalities			Veh. Travel	Occupancy	Pass. Travel	Fatality Rate	
	User	Others	Totals	Billion Miles		Billion Miles	User	Others
Passenger Car	20,320	3,279	23,599	1,628	1.59	2,589	7.9	1.3
Motorcycle	3,197	19	3,216	9.6	1.1	10.6	303	1.8
Trucks – Light	11,723	3,368	15,091	943	1.52	1,433	8.2	2.3
Trucks – Heavy	708	4,189	4,897	209	1.2	251	2.8	16.7
Intercity Bus	45		45	7.1	20	142	0.3	-
Commercial Air						-	0.3	
Transit Bus	11	85	96	1.8	10.8	19	0.6	4.4
Heavy Rail	25	6	31	0.591	24	14	1.8	0.4
Commuter Rail	1	77	78	0.253	37.7	9.5	0.1	8.1
Light Rail	1	21	22	0.053	26.8	1.4	0.7	14.8
Pedestrians	4,901	0	4,901	24.7	1	25	198	-
Cyclists	732	0	732	8.9	1	8.9	82.2	-

Figure 3 and Figure 4 illustrate these fatality rates andnd demonstrate that public transit travel tends to have significantly lower fatality rates than automobile travel. In particular, U.S. and Canadian transit passengers have approximately one-tenth the traffic fatality rate as automobile occupants.

[5] Based on BTS, *National Transportation Statistics* (www.bts.dot.gov), 2003, Tables 1-32, 2-1 and 2-4; APTA, *Safety Summary By Mode* (www.apta.com), 2003. Pedestrian and cycling mileage is based on FHWA, *National Bicycling and Walking Study Ten Year Status Report*, (www.fhwa.dot.gov), 2004, assuming 0.7 mile average walking trip and 2.3 mile average cycling trip length. Light truck "Others" deaths are calculated based on a portion of pedestrian deaths, plus 1,282 additional automobile passenger deaths over what would occur if car/truck collisions had the same car occupant fatality rate as car/car collisions, based on Gayer (2001). This is conservative because it does not account for the higher per mile collision involvement rates of light trucks compared with passenger cars.

Figure 3 – US Fatality Rate by Mode (BTS, Tables 2-1 and 2-4; APTA 2003)

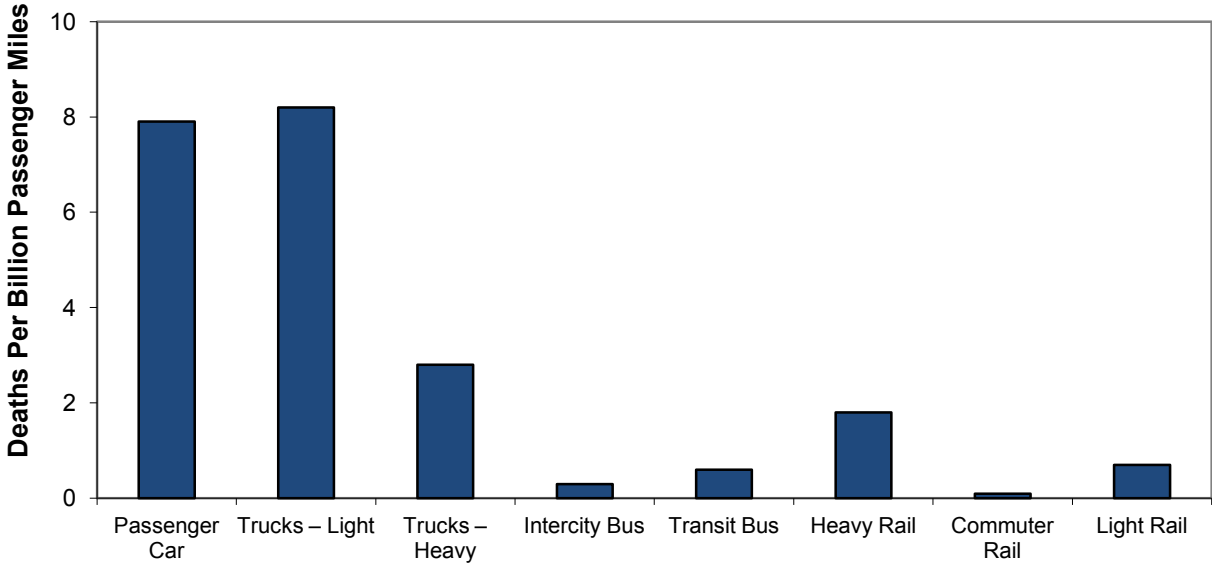
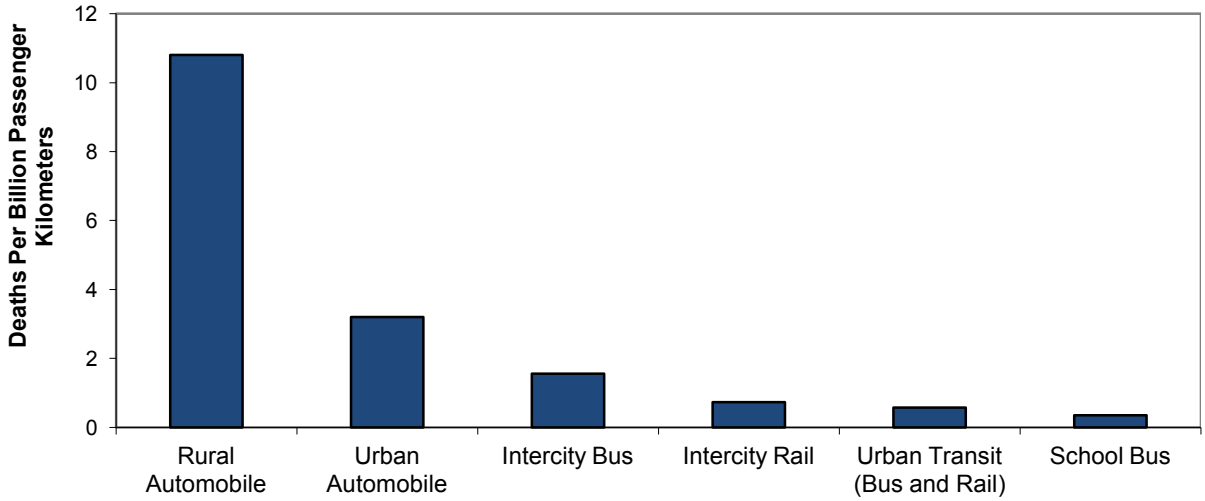
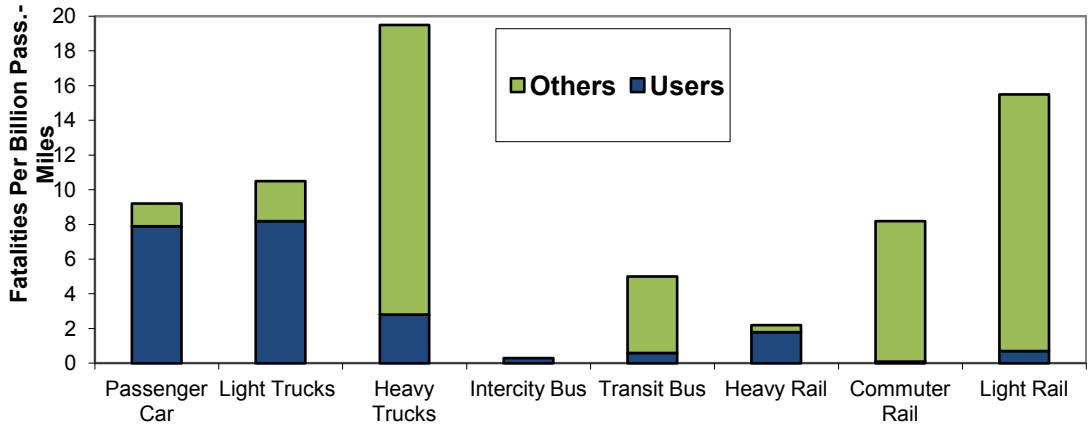


Figure 4 – Canadian Fatality Rate by Mode (CUTA 2000)



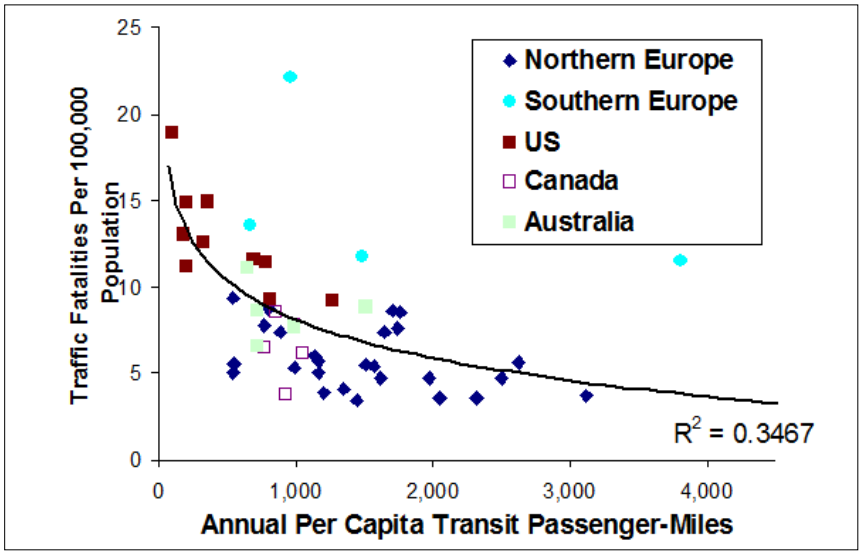
Both Figure 3 and Figure 4 present only the risk per kilometre/mile for the occupant of the vehicle/train. Figure 5 illustrates the magnitude of fatalities for both vehicle occupants and other users of the road or transportation network.

Figure 5 – U.S. Transport Fatalities (FHWA and APTA Data 2002)



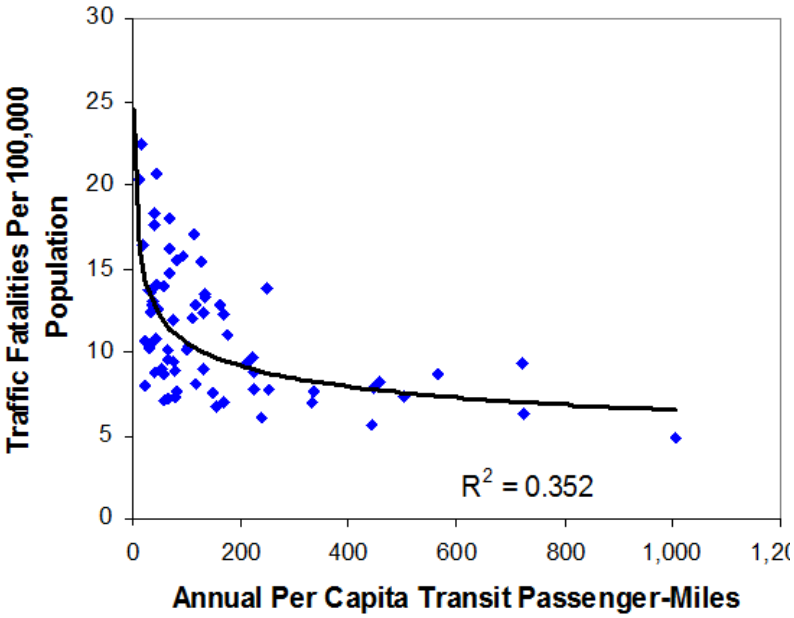
Both international and U.S. data show that per capita traffic fatality rates tend to decline as per capita public transit ridership increases in a city, as illustrated in Figure 6 and Figure 7.

Figure 6 – Traffic Fatalities Versus Public Transit Travel In Various Cities[6]



[6] 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).

Figure 7 – Traffic Fatalities Versus Public Transit Travel In U.S. Cities[7]



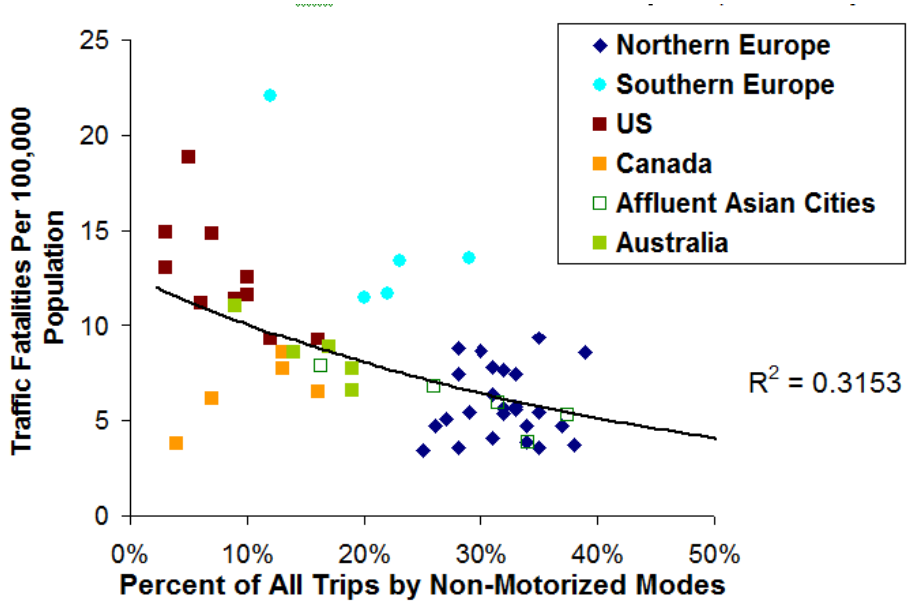
Similar patterns occur with non-motorized travel, as illustrated in Figure 8. The data indicates that per capita traffic fatality rates tend to decline as automobile mode share declines and travel by walking, cycling and public transport increases. However, mode share is just one factor that affects per capita traffic risk and the lower per capita traffic fatality rates associated with increased walking, cycling and public transport may partly reflect other confounding factors associated with urbanization, such as slower traffic speeds and faster emergency response Newer crash prediction models provide better guidance on how specific transport and land use policies affect travel activity and crash risk in an area[8, 9].

[7] Based on U.S. Federal Highway Administration and Federal Transit Administration data.

[8] Gordon Lovegrove and Terek Sayed (2006), "Macro-level Collision Prediction Model For Evaluating Neighborhood Level Traffic Safety," *Canadian Journal of Civil Engineering*, Vol. 33, No. 5 (http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_tocs_e?cjce_cjce5-06_33), May, pp. 609-621.

[9] Lawrence Frank, Andrew Devlin, Shana Johnstone and Josh van Loon (2010b), *Neighbourhood Design, Travel, and Health in Metro Vancouver: Using a Walkability Index*, Active Transportation Collaboratory (www.act-trans.ubc.ca); at http://health-design.spph.ubc.ca/files/2011/06/WalkReport_ExecSum_Oct2010_HighRes.pdf.

Figure 8 – Traffic Deaths Versus Public Transit Travel In Various Cities[10]



3.2. INTERNATIONAL AND CANADIAN TRANSPORT SECURITY DATA

Due to the variety in the types of transportation security risks, applicable data is collected by various agencies and organisations, including the police, the judicial system, health providers, and transport operators.

3.2.1. Crime

Transportation crimes can include; assault/thft; fare evasion; vandalism; and road rage.
Crime risk analysis is complicated by various confounding geographic and demographic factors. For example, transit service and ridership tend to increase with urbanization, and urban areas have specific socio-economic characteristics with regard to age profiles, levels of inequality and cultural diversity compared to non-urban settlements. Transportation crime profiles therefore tend to reflect the risk profiles of these areas and groups. As a result, some statistics may indicate that certain crimes increase with transit supply or ridership, but that does not necessarily mean that transit causes such crimes.

The relationship between transit and security is a complex one because increased transit supply can significantly change the characteristics of an area, in particular a rail station. For example, the number of criminal incidents could increase but the crime rate (measured per capita) could decline due to the growth in the number of people in the area. Likewise, public transit can improve accessibility to education and work opportunities and provide lower income residents with more opportunities, which can improve overall security.

3.2.2. Terrorist Risks

[10] Jeffrey Kenworthy and Felix Laube (2000).

In Canada terrorism, including transit terrorism, is a small risk compared with other more common safety and security dangers[11]. Even including events such as the 11 September 2001 terrorist attacks which killed nearly three thousand people, the 11th March 2004 Madrid rail bombing which killed nearly two hundred people, and the 7 July 2005 London subway attack which killed about fifty people, traffic crashes kill hundreds of times as many people on average as terrorism. In 29 OECD countries for which suitable data were available, the annual road injury deaths were approximately 390 times that from international terrorism[12].

3.3. RISK SUMMARY

Table 3 summarizes how the different types of transportation risks for various modes typically change compared to the risk profile of an average car. This is general and does not apply in every situation, but helps illustrate various factors and perspectives to consider when evaluating risks and safety. For example, some strategies that reduce user crash risk, such as shifting to a larger vehicle, may increase risks to other road users or other risks.

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[11] 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); at http://transit-safety.fta.dot.gov/security/SecurityInitiatives/DesignConsiderations/CD/front.htm.

[12] N. Wilson and G. Thomson (2005), "Deaths From International Terrorism Compared With Road Crash Deaths In OECD Countries," *Injury Prevention* (http://ip.bmjjournals.com) Vol. 11, pp. 332-333.

Table 3 – Typical Changes in Risks from Vehicle and Mode Shifts

Mode	**Internal Crash Risk** (change in level of risk compared to a standard hatchback car)	**External Crash Risk** (change in level of risk compared to a standard hatchback car)	**Security** (change in level of risk compared to a standard hatchback car)
Motorcycle	Very high	Reduced risk to other road users, high medical and disability external costs	Comparable risk
Rail Transit	Large reduction	Medium to large reduction	Increased personal assault risk. Reductions in other risks.
Bus Transit	Large reduction	Medium to large reduction	Increased personal assault risk. Reductions in other risks.
Walking	Increased per-kilometre	Large reduction	Increased personal assault risk. Reductions in other risks.
Compact Car	Increased in multi-vehicle collisions.	Reduced in multi-vehicle collisions.	Comparable risk
Electric Car	Higher risk if hit by larger vehicles	Increased risk to pedestrians due to quiet	Comparable risk
Large Vehicle (Van, Light Truck, SUV)	Reduced risk in multi-vehicle crashes. Higher rollover risk.	Increased in multi-vehicle collisions	Comparable risk

4. RISK PERCEPTION

The perception of risk can impact how people make transportation choices which may or may not accurately reflect their true risks. Perceived risk can increase user stress, affect travel decisions, and suppress mobility. Therefore perceived risk can be considered a user cost, similar to fares, fuel and travel time. Women, older people, people with disabilities, and members of minority ethnic groups tend to be particularly concerned about security risks when walking and using public transport[13].

4.1. HOW RISK PERCEPTION AFFECTS TRAVEL DECISIONS

Risk perception can affect travel decisions. Customers are often willing to pay extra for increased safety, for example, to purchase a vehicle that has optional safety features (such as airbags) or ratings, or choosing a travel mode that they consider safe. Conversely, a perception that a particular travel activity or mode is unsafe or insecure is likely to reduce its use. These fears can affect both short-term travel decisions (such as whether to commute by automobile or public transit) and long-term planning decisions (such as whether to support development of a local bike path or rail transit station).

There is evidence that people are reluctant to use sustainable modes (walking, cycling and public transit) because they are considered less safe than automobile travel. A study of seven San Francisco Bay Area cities found that that neighbourhood crime rates influence people's propensity to choose non-automotive modes[14]. Areas with high vice and vagrancy crime rates were associated with a lowered probability of walking and public travel. The perceived risk of walking and public transit travel may be partly justified, particularly from an individual's perspective. As one researcher explains[15],

> "Criminologist agree that public transit tends to frame opportunities for crime, as it moves large proportions of high-risk populations around the city, along a limited number of paths and destination points. Transit stations are truly public places that mix a wide range of consistently interchanging users together. Offenders can linger anonymously at bus stops and train stations while waiting for potential victims. Some passengers represent easy targets: being tired, preoccupied, carrying packages or other stealable objects, or being accompanied by young kids that gather their attention. In large transit systems transit stations are often called "crime attractors" because they have the potential of generating crime and disorder by producing crowds. In small systems, characterized by low volumes and low density stations, opportunities for crime may arise because of desolation and lack of surveillance."

[13] DfT (2011), p. 5.
[14] 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.
[15] 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.

However, transit stations are generally as safe as other public spaces, and are often safer overall due to passive (bystanders and shops) and active (cameras, transit security staff and police) surveillance.

4.2. How Risk Perception Can Different From Actual Risk

There is considerable evidence that many people have an inaccurate understanding of true transportation risks, including an underestimate of the risks of driving and exaggerated sense of public transit risks. This can be explained from a combination of the following factors:

- Many people have a biased sense of transport risks, due to the disproportionate media coverage of unusual events, such as transit vehicle crashes, transit passenger assaults, and terrorist attacks. Public transit crashes, assaults and terrorist attacks tend to be sensational (by nature of being infrequent) and receive considerable media attention, while automobile crashes, crimes and attacks are so common that they often receive little media attention;
- Many people are proud of their driving skill and believe that crash risk is primarily associated with certain high-risk behaviours and groups. By considering themselves as "safer than the average driver" (sometimes called the *Lake Wobegon Effect*), they are offended at the suggestion that their driving imposes significant risks[16]. This may lead to underestimates of the true risk of driving and the safety benefits that result from policies, programs, lifestyles and location choices that reduce driving;
- People tend to feel more secure in situations in which they feel a sense of control (such as driving a car), and experience special dread in situations in which they consider themselves out of control. Similarly, intentional risks (such as assaults and terrorist attacks) tend to generate more dread than accidents (such as traffic crashes);
- Public transit stations and vehicles are confined public spaces and many people have personally experienced fear while using public transit travel; and
- In recent years, there have been a few, high profile terrorist attacks on transit vehicles and stations (although none in Canada), and public transit agencies have sponsored campaigns to alert riders of terrorist threats. These may stimulate excessive fear of this risk.
- Transportation, in particular transit stations, can act as a geographical identifier and incidents become linked to the transportation network even if they are not directly associated with it. This is particularly relevant to issues of security. For example, an assault could be described as happening 'near the SkyTrain station' even though the incident had no connection to the transit system.

Much of the transport safety messaging over the last few decades has emphasized that automobile travel can be safe if drivers follow certain rules.and public transit passengers must be extra cautious to prevent exposure to personal assaults and terrorist attacks. Responses by public transit agencies, with messages that highlight crime and terrorist risk, may exacerbate this problem. There is currently little public education which emphasizes the overall safety of public transit travel and what the level of risk is compared to other transport modes.

[16] John Townsend (2011), *Lake Wobegon Effect and the Cell Phone Ban*, Huffington Post (www.huffingtonpost.com/john-b-townsend-ii/the-lake-wobegon-effect-a_b_1163246.html).

5. TRANSPORTATION SAFETY AND SECURITY PLANNING

There is extensive literature on transport safety and security planning. It generally describes facility design features that reduce crash rates per vehicle-kilometre,[17] and special programs that target high-risk travel behaviour[18, 19]. Transport Canada has safety programs for air, marine, rail and road; the road safety strategy focuses on four risk factors (box below).

Figure 9 – Canada's Road Safety Strategy[20]

Four Key Risks Targeted In Canada's Road Safety Strategy

Impaired Driving: Includes all forms of impairment, such as impairment resulting from the ingestion of a substance (alcohol, drugs (prescription, over-the-counter or illicit)), as well as due to actions that result in driver impairment from natural causes (fatigue or distracted behaviours).

Speed & Aggressive Driving: Includes driving at speeds beyond posted legal limits on all road types in urban and rural settings, and driver behaviours deemed outside of socially acceptable norms that put other road users at risk of injury or contribute to crashes and casualties. It also includes driving too fast for road conditions.

Occupant Protection: Includes issues pertaining to proper restraint use among all road users, vehicle technology enhancements (crashworthiness and crash-avoidance) and safer roads (e.g.: dangerous roadside obstacles, lighting, signage, etc.).

Environmental Factors: Includes issues/factors that may affect the likelihood of crash occurrence (e.g.: roadway configuration, roadway construction, road surface condition, road and roadside design, weather conditions, urban and rural infrastructure, etc.).

Similarly, most transport security programs are designed to focus on specific threats in specific areas, such as vandalism and assaults in transit vehicles and stations. Although these may be appropriate and beneficial, they do not necessarily consider all potential risk factors and risk reduction options.

For example, research described in Section 3 indicates that per capita traffic casualties tend to decline with increased use of alternative mode, yet mobility management programs and smart growth policies are seldom considered as transport safety strategies. Transit security programs that focus on transit vehicles and stations often fail to consider other journey links, particularly walking to and from stations and stops. This tends to reflect data and analysis that focuses on specific risks and areas (such as crash rates on a specific road, or assault rates at transit stations) rather than more comprehensive analysis of entire systems.

[17] Rune Elvik (2010), *Assessment and applicability of road safety management evaluation tools: Current practice and state-of-the-art in Europe*, Norwegian Institute of Transport Economics, (www.toi.no); at www.toi.no/getfile.php/Publikasjoner/T%D8I%20rapporter/2010/1113-2010/1113-2010-elektronisk.pdf.

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

[19] 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.

[20] *Canada's Road Safety Strategy* (www.ccmta.ca/crss-2015/strategy.php).

Some experts emphasize the value of transport policy reforms to achieve safety and health objectives, but that literature is primarily published in the health field[21]. There is also research concerning the incremental risks to people who shift to non-motorized travel[22], and the crash reduction benefits that can result from traffic calming and complete streets roadway design[23]. But there is little information published in the transport planning and engineering academic fields concerning how to evaluate the overall traffic safety and security impacts of transport and land use policies. There are a few exceptions, including:

- An article by Reid Ewing and Eric Dumbaugh, *The Built Environment and Traffic Safety: A Review of Empirical Evidence*, indicates that denser urban areas appear to be safer than the suburbs. The research states that dense urban areas include less forgiving design treatments—such as narrow lanes, traffic-calming measures, and street trees close to the roadway— which can appear to enhance a roadway's safety performance compared to more conventional roadway designs[24];
- A report, *Preventing Road Traffic Injury: A Public Health Perspective For Europe*, by the World Health Organization emphasizes the value of incorporating traffic safety objectives in all transport planning, and recognizes the traffic safety benefits of various mobility management strategies (such as road pricing and telework encouragement), as indicated in Figure 10[25];

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[21] J. Ball, M. Ward, L. Thornley, and R. Quigley (2009), *Applying Health Impact Assessment To Land Transport Planning*, Research Report 375, New Zealand Transport Agency (www.landtransport.govt.nz); at www.landtransport.govt.nz/research/reports/375.pdf.

[22] Jeroen Johan de Hartog, Hanna Boogaard, Hans Nijland and Gerard Hoek (2010), "Do The Health Benefits Of Cycling Outweigh The Risks?," *Environmental Health Perspectives*, doi:10.1289/ehp.0901747; at http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.0901747.

[23] Eric Dumbaugh (2005), "Safe Streets, Livable Streets," *Journal of the American Planning Association* (www.planning.org), Vol. 71, No. 3, pp. 283-300; at www.naturewithin.info/Roadside/TransSafety_JAPA.pdf.

[24] 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 2009, pp. 347-367; at http://jpl.sagepub.com/cgi/content/abstract/23/4/347.

[25] Francesca Racioppi, Lars Eriksson, Claes Tingvall and Andres Villaveces (2004), *Preventing Road Traffic Injury: A Public Health Perspective For Europe*, World Health Organization, Regional Office for Europe (www.euro.who.int/document/E82659.pdf).

Figure 10 – The Health & Safety Impacts of Various Transport Policies

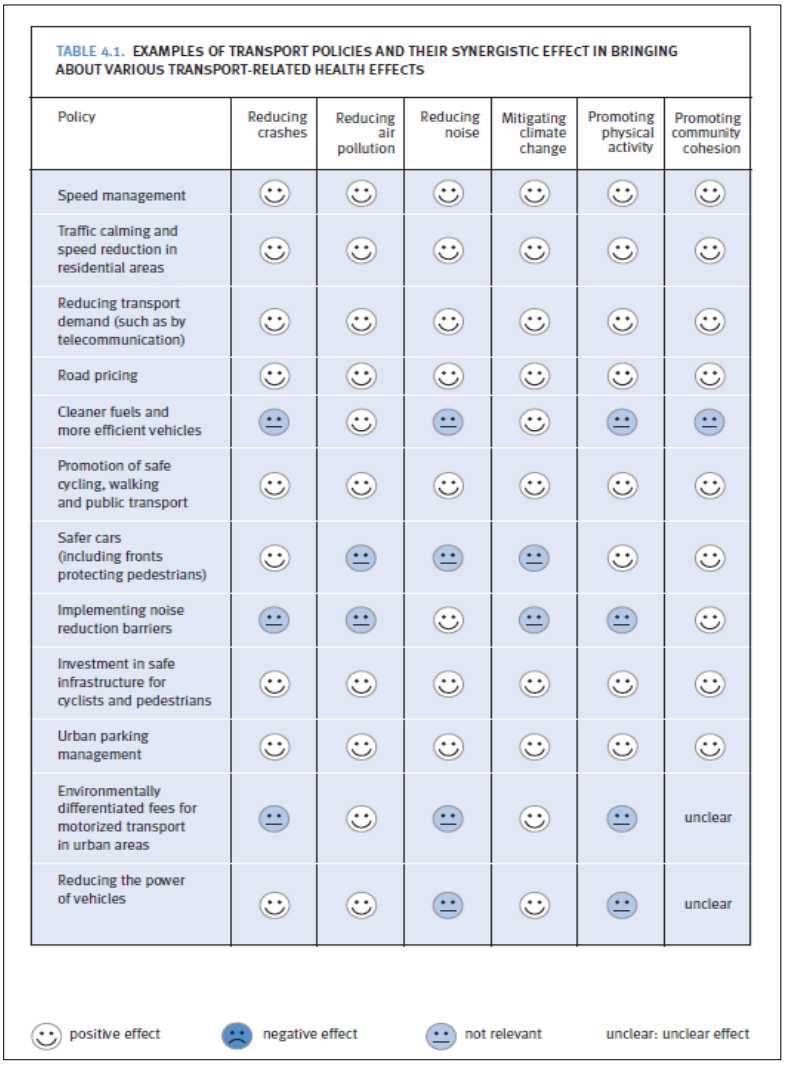


TABLE 4.1. EXAMPLES OF TRANSPORT POLICIES AND THEIR SYNERGISTIC EFFECT IN BRINGING ABOUT VARIOUS TRANSPORT-RELATED HEALTH EFFECTS

Policy	Reducing crashes	Reducing air pollution	Reducing noise	Mitigating climate change	Promoting physical activity	Promoting community cohesion
Speed management	☺	☺	☺	☺	☺	☺
Traffic calming and speed reduction in residential areas	☺	☺	☺	☺	☺	☺
Reducing transport demand (such as by telecommunication)	☺	☺	☺	☺	☺	☺
Road pricing	☺	☺	☺	☺	☺	☺
Cleaner fuels and more efficient vehicles	😐	☺	😐	☺	😐	😐
Promotion of safe cycling, walking and public transport	☺	☺	☺	☺	☺	☺
Safer cars (including fronts protecting pedestrians)	☺	😐	😐	😐	☺	☺
Implementing noise reduction barriers	😐	😐	☺	😐	😐	☺
Investment in safe infrastructure for cyclists and pedestrians	☺	☺	☺	☺	☺	☺
Urban parking management	☺	☺	☺	☺	☺	☺
Environmentally differentiated fees for motorized transport in urban areas	😐	☺	😐	☺	😐	unclear
Reducing the power of vehicles	☺	☺	😐	☺	😐	unclear

☺ positive effect ☹ negative effect 😐 not relevant unclear: unclear effect

- Research by William Lucy highlights the overall reduction in violent deaths (murder and traffic crashes) associated with urban rather than suburban locations[26]; and
- Research by Murray May, Paul J. Tranter and James R. Warn argues for fundamental change in transport policy development to create more sustainable communities, justified in part by the significant traffic safety benefits that can result[27].

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

[27] Murray May, Paul J. Tranter and James R. Warn (2011), "Progressing Road Safety Through Deep Change And Transformational Leadership," *Journal of Transport Geography*, Vol. 19 (www.elsevier.com/locate/jtrangeo), pp.

6. INTERNATIONAL CASE STUDIES

This section outlines strategies and initiatives that are particularly appropriate as exemplars for the Greater Vancouver region for the development of safety and security strategies. The case studies cover the following safety and security themes:

- Public consultation on road safety problems and solutions (Seattle);
- How a transit agency can develop policy to improve security (Calgary);
- The education of road users to adopt safer travel behaviours (New York City) and of transit customers to be aware of safety and security (Toronto and Singapore); and
- The link between transportation demand management and improvements to overall transportation safety (Seoul).

6.1. SEATTLE ROAD SAFETY SUMMIT

In 2011 the Seattle Mayor and Council members assembled a 'Summit Workgroup' to bring together a cross section of people involved in road safety in Seattle. This included elected officials, roadway users, major employers, business leaders, bicycle and pedestrian advocates, and the Chiefs of the Fire and Police Departments. The Workgroup undertook detailed consultation with the general public to understand the key issues in road safety. This included three public forums, an online survey, and in-person outreach, which resulted in over 3,000 comments from 600 respondents. The Workgroup was tasked with reviewing the public comments and using their knowledge of health and safety to outline the next steps for the City.

The Workgroup identified the following issues from the public responses:

- Education and enforcement is widely supported;
- People want to see behaviour change;
- People don't know all the rules;
- People also know many of the rules but don't follow them;
- We should focus on what will add to what's already being done;
- Let's look at other campaigns (tobacco, recycling, seatbelts) for best practices; and
- A long-term, sustained campaign will be necessary to create lasting change.

As a result of this the Workgroup has recognized that there is no single solution to achieve improvements in road safety, and that it will take a mixture of short and long term actions to change behaviour. To guide future road safety strategies the Workgroup aims to use the guiding principles outlined in Figure 11.

1423-1430; at https://blogs.otago.ac.nz/amc/files/2011/08/May-Tranter-Warn-JTG-road-safety.pdf; more detailed report at http://203.30.79.89/c/rtt?a=sendfile&ft=p&fid=1280717558&sid.

Figure 11 – The Five "E's" Guiding Seattle Road Safety

Education: People know what "Click It Or Ticket" means, and you've seen "Drive Hammered, Get Nailed" on signs and billboards. Together we will launch a similar long-term, sustained campaign to help people share the road safely.

Enforcement: We will review what we heard from the public about enforcement and examine our current enforcement efforts. By increasing awareness about our enforcement efforts, we can help change behavior.

Environment: We will apply the best practices to our streets, separating modes of travel where it makes sense to do so, and continue to use our Complete Streets plans to make the streets safer for everyone. We will also take a holistic look at corridors. The recent Aurora Traffic Safety Project is a good example of how engineering can combine with education and enforcement to make a measurable improvement in the safety of our roads.

Evaluation: Evaluating our efforts over time ensures that we're improving on what we do and targeting the right things. The education, enforcement, and environmental efforts that we undertake as part of the Road Safety Summit will be evaluated as we go along so that we can be sure we're using resources in the most effective way possible.

Empathy: Our campaign will emphasize the shared responsibility we have to eliminate fatalities and injuries and improve safety on our roads. We need to look out for each other and help everyone get where they're going safely.

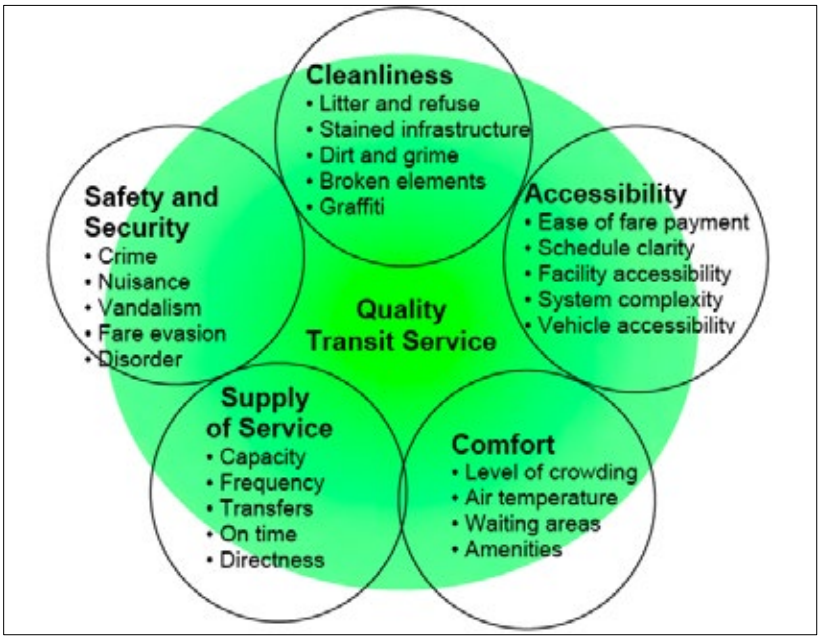
The key lessons of this case study include:

- Extensive public involvement was used as a starting point to understand the key road safety issues. The Summit Workgroup reacted to this information, rather than outlining what they thought first;
- The Workgroup contained broad representation from government, business, and citizen groups to reflect how road safety cuts across a wide range of city issues; and
- In the public survey, driver behaviour (distracted driving, speeding etc) was highlighted as the greatest road safety problem. Road conditions (potholes, road surface) were identified as the second most significant problem; and
- When suggesting solutions, the pubic survey ranked bicycle and pedestrian design (separated facilities, complete streets etc) as the solution that could improve road safety the most. An education campaign for all modes was the second most often quoted solution.

6.2. CALGARY TRANSIT SERVICE QUALITY IMPROVEMENT PLAN

In response to general customer concerns and a specific high-profile incident, Calgary Transit developed a comprehensive transit improvement strategy for delivering safety, cleanliness, accessibility, comfort and service supply[28]. This recognized that issues of safety and security were a key dimension of the overall customer experience, as demonstrated in Figure 12.

Figure 12 – Elements Determining the Quality of Transit Service



The strategy aims to improve public perception of safety and security on the transit system and address cleanliness and maintenance issues. The efforts to specifically increase perceived safety and security focus on four areas:

- *Presence.* Demonstrate to customers that Calgary Transit is there to protect them by improving the security presence;
- *Infrastructure.* Address infrastructure issues to improve the environment for customers from a security perspective;
- *Information.* Ensure that staff and customers have the information they need to protect themselves; and
- *Organizational resilience.* Improve Calgary Transit's ability to respond.

[28] Calgary Transit (2009), *Delivering Quality Transit Service: A Strategy For Delivering Safety, Security and Cleanliness*, (www.calgarytransit.com/pdf/Delivering_Quality_Transit_Service.pdf)

Figure 13 - How Calgary Transit is Improving Service by Focusing on Safety & Security

Focus Area	Presence	Infrastructure	Information	Organizational Resilience
	Demonstrate to customers that Calgary Transit is there to protect them	Improve the environment for customers from a safety perspective	Ensure customers and staff have the information they need to protect themselves	Improve Calgary Transit's ability to respond
Initiatives	Increase the Peace Officer forces on the system	Implement Calgary Transit secure lighting program	Develop an extensive educational marketing campaign geared towards customers	Heighten Calgary Transit employee security consciousness and ability to respond (Transit Watch)
	Enhance operational partnerships with Calgary Police Service and Bylaw Services	DriveCam program	Implement Transit Watch program	Build organizational strength
	Enhance private security presence	New LRV infrastructure security provisions	Train and station announcements	Coordinate and share information with other experts
	Creation of Centre Street Joint Deployment Centre	Enhance security system checks		Strengthen Calgary Transit's Peace Officer development program
	Enhance PS100 Support Program	Camera system enhancement		Strategic Peace Officer deployment program
	Operations Supervisor customer engagement program	Link to cleanliness goal		

The key lessons from this case study include:

- One high-profile crime can have a major impact on people's perceptions of the security of a transit system. Transportation agencies must therefore be proactive in setting safety and security strategies and not wait until an incident forces them into acting. Safety and security has been shown to be a key factor in how customers rate the quality of their experience; and
- Successful safety and security strategies are multi-dimensional and incorporate infrastructure design, the communication of information, risk procedures, and overcoming the perception of crime.

6.3. UK DEPARTMENT OF TRANSPORT – SECURITY

The UK Department of Transport's *Transport Analysis Guidance*, "Security Sub-Objective" document provides specific recommendations for evaluating the security impacts of specific transport projects, including road, railroad and public transit[29]. The table below shows the indicators it recommends for evaluating public transport security, which it suggests can be reinterpreted for other uses such as roadways and freight terminals. The document includes worksheets for evaluating specific projects.

Table 4 – Security Indicators for Public Transport Passengers[30]

Security	Indicator	Poor	Moderate
Site perimeters, entrances and exits	Unmarked or poorly marked site perimeters, exits etc. Use of solid walls or similar.	Attention to boundary and exit marking, but otherwise unfavourable use of materials.	Clearly marked site perimeters/exits. Use of open fencing rather than solid walls.
Formal surveillance	No CCTV system in place. Design discourages staff surveillance and isolates passengers.	CCTV system exists but inadequate number or location. Poor design discourages staff surveillance.	Effective CCTV system in place. Design to encourage staff surveillance and group passengers.
Informal surveillance	Poor use of materials (fencing etc) and design. Poor visibility from site surrounds. Isolated from other human activity.	Unfavourable use of materials but reasonable proximity of retailers or other activity.	Positive use of materials and design to maximize visibility from site surrounds. Proximity to retailers or other activity.
Landscaping	Landscaping features (design, plants etc) inhibits visibility and encourages intruders.	Some positive use of landscaping, but more measures needed.	Positive use of landscaping features to contribute to visibility and deter intruders.
Lighting and visibility	Poor design including recesses, pillars, and other obstructions that hinder camera/monitor view. Inadequate lighting in passenger areas at night. No or poor lighting on signs, information and help points.	Design includes some recesses but does not severely limit camera/monitor view. Moderate lighting in passenger areas. Lighting not to daylight standard. Attention to lighting on signs, information and help points.	Good design to avoid recesses and facilitate camera/monitor view. Lighting to daylight standard in passenger areas when facility open. Attention to lighting on signing, information and help points.
Emergency call	No or very poor provision of emergency phones, help points and public telephones. Little provision or information on emergency help procedures.	Basic provision of emergency phones, help points and public telephones. Improvements to these and on emergency help procedures needed.	Good provision of emergency phones, help points, public telephones and information on emergency help procedure.

Key lessons from this case study include:

- Various design strategies and special programs can increase transport security.
- Informal surveillance from other system users, nearby employees (such as a shop located in or near a transit station), and by-passers contributes to security.

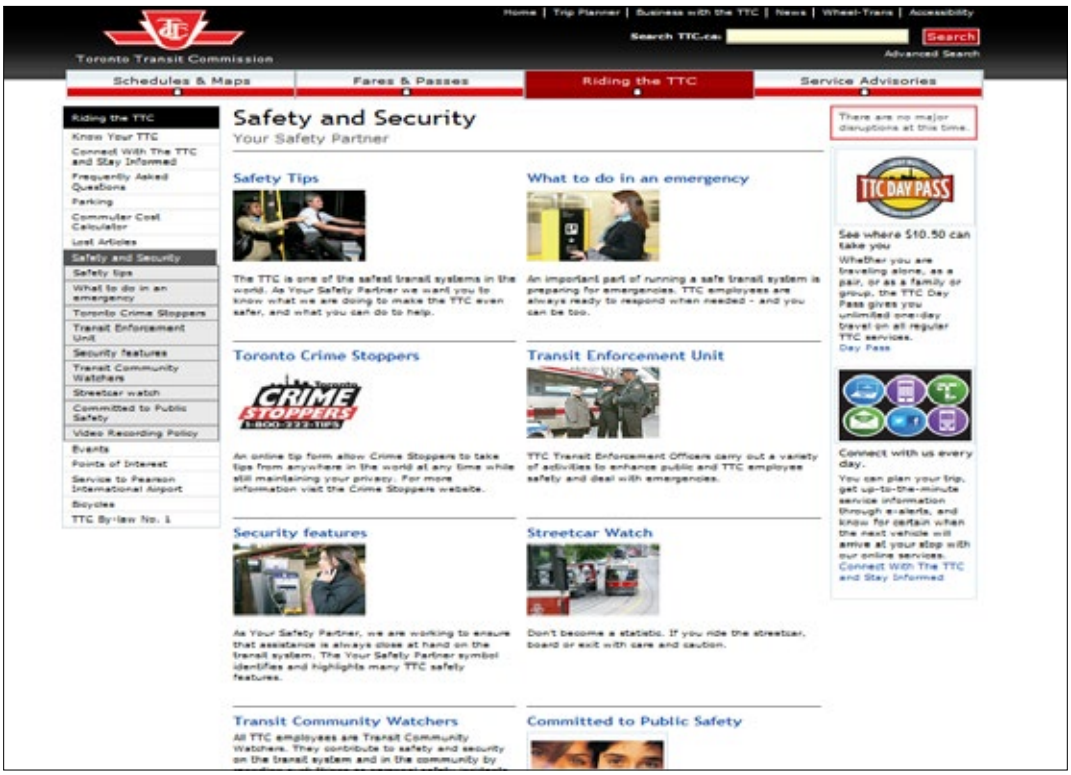
[29] DfT (2011), "Security Sub-Objective," *Transport Analysis Guidance*, Unit 3.4.2, Department for Transport (www.dft.gov.uk/webtag); at www.dft.gov.uk/webtag/documents/expert/pdf/unit3.4.2.pdf.
[30] DfT (2011), Table 1.

6.4. TRANSPORT SAFETY AND SECURITY WEBSITES

Many public transport agencies have pages devoted to safety and security issues on their websites. Since transport system users are concerned about safety and security, a webpage that offers comprehensive and relevant information on safety and security issues could receive considerable traffic and help communicate key messages. Some examples of transit security websites are evaluated below.

The Toronto Transit Commission's *Safety and Security: Your Safety Partner* web page, illustrated below, is comprehensive and targeted, and conveys positive messages: that TTC is a safe form of transport, that TTC is concerned about and proactive concerning safety and security, and that there are specific things that individuals can do to increase their own and others safety and security.

Figure 14 - Toronto Transit Commission's Safety and Security Website



The Singapore Public Transport Security Committee's *SafeJourney* website is intended to educate students, particularly upper primary and lower secondary school students, about public transport security issues, particularly terrorism threats. It is designed to engage visitors with attractive and interactive features including games, contests and videos which contain practical information for the general public. The website provides information on how passengers can help identify and responds to threats and emergencies. Although good for user engagement it is not comprehensive and only considers transit travel and terrorist threats.

Figure 15 – Singapore's *Safejourney* website

Key lessons from this case study include:

- Transit security information should be comprehensive and integrated, providing consistent messages through websites, signs, newsletters, brochures and other public communications. It should consider multiple modes and risks, for example, a transit user website should include information on safety for walking, cycling and automobile parking covering crash, crime and terrorism risks;
- Information should be positive, highlighting the overall safety benefits to individuals and communities of public transit travel, in order to reduce excessive risk perception. It should also describe specific actions that individuals can do to increase their own and other system users' safety and security;
- Websites, and other information sources, should describe what community organizations (public transport agencies, planning agencies, police, volunteer organizations, etc.) are doing to improve traveler safety and security; and
- Provide accurate and timely information on safety and security risks, including crash and crime data, recent incidents and events, new policies and plans, and even debates.

6.5. NEW YORK CITY PEDESTRIAN AND BICYCLE SAFETY PROGRAMS

New York City has successfully implemented a variety of pedestrian and bicycle safety programs focused around public education. The New York City Department of Transportation has performed extensive analysis of pedestrian[31] and bicycle[32] risks and developed education and marketing campaigns to address these risks.

The *LOOK* bicycle safety campaign, supported by a coalition of city agencies, cycling advocates and the automobile association, aims to prevent collisions between motorists and cyclists by educating the public about bicycle safety and encouraging cars and bikes to share the road. The *LOOK* campaign advertisements were run in print media, aired on radio, and posted on bus stop shelters, bus tails, phone kiosks, taxi tops, at gas stations and on postcards placed in restaurants around the city.

Figure 16 – New York City's Department of Transportation *LOOK* Campaign

The *LOOK* campaign was developed for the NYC Bicycle Safety Coalition following the 2006 release of the City's first comprehensive analysis of bicyclist fatalities and serious injuries, which indicated that nearly all fatal crashes resulted of poor driving or bicycle riding behavior. In addition to improving motorist and cyclist awareness, the City, last year, committed to doubling the number of on-street bicycle lanes and paths in three years, improving data collection, analysis and reporting of bicycle injuries, and increasing enforcement to keep cars from parking in bicycle lanes.

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[31] NYCDOT (2010), *New York City Pedestrian Safety Study & Action Plan*, New York City Department of Transportation (www.nyc.gov/html/dot/html/about/pedsafetyreport.shtml).

[32] *Bicycle Statistics and Reports* (http://home2.nyc.gov/html/dot/html/bicyclists/bikestats.shtml); Safety Programs (http://home2.nyc.gov/html/dot/html/safety/safety.shtml); .

Figure 17 – New York City's Department of Transportation LOOK Campaign

In addition to targeting drivers, the Department of Transport has developed the '*Don't Be A Jerk'* bike safety ad campaign which features celebrities on bikes humorously highlighting essential do's and don'ts. The ads combine satire and humor to convey the need for bicyclists to follow the rules of the road. *Don't Be a Jerk* is part of DOT's larger Bike Smart initiative, which includes the Bike Smart Pledge (an online campaign for bicyclists to register their commitment to safe cycling on their Facebook and Twitter pages).

The key lessons from this case study include:

- Non-motorized safety is important, particularly in urban areas and for public transport users;
- Targeted safety education and encouragement programs can be useful;
- Programs should reflect different perspectives, including safety actions by pedestrians, cyclists and drivers; and

- Safety program development should include transport agencies, public health organizations, pedestrian and cycling groups, and motorists organizations.

6.6. SAFETY IMPACTS OF TRAVEL DEMAND MANAGEMENT

Travel Demand Management (TDM) refers to various policies and programs that encourage travelers to use more efficient transport options, including changing from peak to off-peak, to more resource-efficient modes, closer destinations, and mobility substitutes such as telecommunications and delivery services when possible[33]. TDM is increasingly being implemented[34], but generally as a way to reduce traffic and parking congestion, or as an energy conservation and emission reduction strategy. Yet, there is evidence that TDM strategies can provide significant traffic safety benefits[35, 36], but this is often overlooked or undervalued when these strategies are evaluated or when traffic safety experts consider possible risk reduction options.

This section examines the safety impacts of two recent mobility management programs.

6.6.1. London Congestion Pricing[37]

Since February 2003 the city of London has charged a fee for driving private automobiles in its central area during weekdays as a way to reduce traffic congestion and raise revenues to fund transport improvements. This has reduced automobile trips in the charging zone by 15-20%, increased vehicle traffic speeds, and increased public transit ridership. This program was introduced primarily as a way to reduce traffic congestion; safety benefits are seldom mentioned as a justification. However, this scheme appears to provide significant safety benefits. The *Fifth Annual Monitoring Report* (TfL 2007) states that, although traffic accidents have been declining throughout the London region since 2003, within the charging zone crash reductions were greater than would be otherwise expected, providing 40 to 70 additional annual accident reductions within the charging zone. There was no evidence of disproportionate or detrimental changes to the number of reported accidents involving two-wheeled vehicles in or around the charging zone, or to accident trends on roads surrounding the charging zone.

6.6.2. San Francisco Mobility Management Programs

[33] Noxon Associates (2011), *Transportation Demand Management for Canadian Communities: A Guide to Understanding, Planning and Delivering TDM Programs*, Noxon Associates (www.noxonassociates.com/guide.html) for Transport Canada (www.tc.gc.ca); at www.tc.gc.ca/media/documents/programs/tdme.pdf.
[34] GTZ (2003-2011), *Sustainable Transportation: A Sourcebook for Policy-Makers in Developing Countries*, (www.sutp.org), by the Sustainable Urban Transport Project – Asia (www.sutp-asia.org) and Deutsche Gesellschaft fur Technische Zusammenarbeit (www.gtz.de).
[35] Todd Litman and Steven Fitzroy (2005), *Safe Travels: Evaluating Mobility Management Traffic Safety Impacts*, VTPI (www.vtpi.org); at www.vtpi.org/safetrav.pdf.
[36] Gordon Lovegrove and Terek Sayed (2006), "Macro-level Collision Prediction Model For Evaluating Neighborhood Level Traffic Safety," *Canadian Journal of Civil Engineering*, Vol. 33, No. 5 (http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_tocs_e?cjce_cjce5-06_33), May, pp. 609-621.
[37] TfL (2008), *Central London Congestion Charging Impacts Monitoring Sixth Annual Report*, Transport For London (www.tfl.gov.uk/tfl/cclondon/pdfs/ThirdAnnualReportFinal.pdf).

The City of San Francisco has various mobility management policies and programs, including substantial investments in walking, cycling and public transport, relatively low parking supply and high parking prices, and compact, mixed land use development, and since 1995 a "transit first" policy which states that, "Decisions regarding the use of limited public street and sidewalk space shall encourage the use of public rights of way by pedestrians, bicyclists, and public transit, and shall strive to reduce traffic and improve public health and safety"[38]. The San Francisco Department of Public Health developed a *Vehicle-Pedestrian Injury Collision Model* which indicates that in the City, pedestrian injuries and deaths increase with motor vehicle traffic volume and speeds, and with various roadway design factors.[39] This information is being used to develop safety programs supported by both transport planning[40] and public health agencies.[41] San Francisco averages 6.24 annual traffic deaths per 100,000 residents, about half the average for U.S. urban areas.

6.6.3. Seoul Urban Transport Management Program[42]

During the last decade, Seoul, South Korea has implemented an integrated urban transport management strategy that includes significant public transit service improvements (including both subways and BRT networks), transportation demand management measures, roadway reduction, non-motorized transport improvements and integrated transport and land use development. Although this strategy was implemented primarily for its local and global environmental benefits (the city center is now considered much more liveable, and climate change emissions are reduced), this program also provides significant safety benefits. In the year after major public transit improvements were implemented in 2005, transit ridership increased by 10-20% (depending on line), total traffic accidents declined from 7,966 to 5,971 (-25%) and traffic deaths declined from 60 to 41 (-32%)[43].

Key lessons from this case study include:

- Mobility management strategies and smart growth policies that reduce total vehicle travel and encourage shifts to alternative modes can provide safety benefits; and
- These benefits are often overlooked in conventional transport planning, which tends to consider mobility management primarily as a congestion and emission reduction strategy.

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7. CONCLUSION

Safety and security are key transport planning policy themes. Both issues have a significant impact on: the quality of the customer experience; the mode choice for a particular trip or journey; and the overall costs associated with the transportation system. This report has provided an introduction to safety and security in the context of transportation planning, outlined the issues to be considered in strategic planning, and provided examples of cities and regions which have successfully adopted safety and security policies and strategies.

For a transportation agency to address safety and security in a meaningful and efficient manner, the following broad points must be considered:

- The discipline of safety and, to a lesser extent, security includes multiple ways of assessing risk. Therefore it is vital that consistent definitions are used across agencies and partners in order for risk to be clearly understood and measured. For example, the terms accident, crash, and collision are often used interchangeably but can refer to different types of accidents;
- Risk is multi-dimensional and a number of factors must be considered (age, geography, mode, weather, gender) before themes are generalized, as outlined in Table 5 – Transport Risk Evaluation Variables;

Table 5 – Transport Risk Evaluation Variables

Types of Risk	Perspectives	Modes	Cost Categories	Risk Factors
Crashes	Mode user/occupant	Walking	Property damage	Mode
Falls	Other road users	Bicycling	Emergency response	Vehicle type
Crimes	All of society	Pedestrians	Medical and rehabilitation expenses	Age
Assault	Insurers	Automobile	Disability (lost productivity) costs	Location
Terrorism	Area or group (a particular community or jurisdiction)	Public transport	Casualties/deaths	Travel conditions (facility design, weather, etc.)
Overall health	Short-term	Heavy/Light vehicle	Pain and suffering	Operator condition (skill, impairment, etc.)
	Long-term		Reduced mobility by vulnerable modes	
			Prevention program costs	

- How risk is measured can have a significant bearing on the trend identified. For example, there is a difference between assessing transport accidents by total fatalities and assessing accidents by fatality rates per billion miles travelled. It is also important that accident statistics are put into context to allow comparison between transport modes. The way transport risks are currently described tends to understate the incremental risks of automobile travel and exaggerate the risks of alternative modes;
- Transport security risks such as theft, assault, carjacking, and terrorism are overall relatively small, but there appears to be an exaggerated fear of security threats. This “dread” (excessive fear) discourages some people from using walking, cycling and public transit, and so is a barrier to regional transport planning objectives.

- Many regional policies intended to achieve other planning objectives, such as efforts to reduce driving, shift travel to alternative modes, and create more accessible, multi-modal communities, also tend to increase transport safety and security. Conversely, effort to further increase system safety and security, such as pedestrian and cycling facility improvements, and public transit security improvements, can help achieve efforts to reduce traffic congestion, road and parking facility costs, consumer costs, energy consumption and pollution emissions.

Key lessons from the case studies presented in this report include:

- Safety and security programs should be developed in partnership between government agencies (planning, transport, policing, public health, etc.), community groups and individuals.
- Successful safety and security programs are multi-dimensional, incorporating infrastructure design, user information, risk procedures, and inaccurate perception of crime.
- Accident statistics should be put into context to allow comparisons between transport modes. The way transport risks are currently described tends to understate the incremental risks of automobile travel and exaggerate the risks of alternative modes.
- Transit security information should be comprehensive and integrated, providing consistent messages through websites, signs, newsletters, brochures and other public communications. It should considering multiple modes and risks, for example, a transit user website should include information on safety for walking, cycling and automobile parking covering crash, crime and terrorism risks.
- Public information must provide a positive message that highlights the overall safety benefits to individuals and communities of public transit travel, in order to reduce excessive risk perception.
- Programs should reflect different perspectives, including safety actions by pedestrians, cyclists and drivers.
- Safety should be incorporated into overall transport planning and communications programs, including efforts to encourage alternative modes, neighborhood planning, and transport pricing policies.
- TDM strategies and smart growth policies that reduce total vehicle travel and encourage shifts to alternative modes can provide safety benefits.

APPENDIX

Information Resources

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International Transport Risk Data Sources

Several national and international organizations have programs to improve transportation-related data collection, including some that focus primarily on crash or security risk data. However, there is (as far as I can determine) currently no effort to standardize the collection and analysis of transport safety and security data, and neither Canada nor British Columbia have comprehensive data collection programs suitable for safety evaluation. Below are some sources of transportation-related data.

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

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Centre for Data and Analysis in Transportation (www.cdat.ecn.ulaval.ca) is dedicated to improving knowledge about energy use in the Canadian transportation sector in order to better understand the factors affecting energy efficiency and consumption in this sector, and the economic and environmental impacts of transportation policies.

DfT (2010), *Crime and Public Transport*, UK Department For Transport (www.dft.gov.uk); at www.dft.gov.uk/pgr/crime. This website has various resources for improving travelers' security, with special attention to walking, cycling and public transport.

European Road Safety Observatory (ERSO) website (www.erso.eu) provides information on European road crash statistics and safety strategies.

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Global Transport Intelligence Initiative (www.slocat.net/key-slocat-prog/466) is a programs by international program organizations involved in the collection, analysis and dissemination of data on transport in the developing countries.

iRAP International Transport Statistics Database (www.iraptranstats.net), by the Transport Statistics Programme, funding by the FIA Foundation for the Automobile and Society, provides a wide selection of transport statistics.
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TrafficLinq (www.trafficlinq.com) is an extensive directory of links covering issues regarding road traffic and transportation. It covers about 1,000 web sites world wide, and has an option to scan all transportation sites with one query.

Traffic Safety Center (www.tsc.berkeley.edu) is a multi-disciplinary research center involving transportation and public health professionals that promotes traffic safety.

TrafficSTATS (www.aaafoundation.org/trafficSTATS) provides an interactive tool for providing information on traffic risk (by vehicle-mile, vehicle-trip and minute of travel) for different transport modes, travel conditions, demographic groups and various other parameters. This project is a joint venture between Carnegie Mellon University and the AAA Foundation for Traffic Safety.

Transport Canada (annual reports), *Canadian Motor Vehicle Traffic Collision Statistics*, *Statistics and Data Website* (www.tc.gc.ca/eng/roadsafety/resources-researchstats-menu-847.htm). These reports which summarizes reported collisions, injuries and fatalities by mode, demographics (age and gender), location (urban or rural), and province; traffic injury and fatality rates per capita, vehicle, licensed driver and billion kilometres; and various other factors.

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

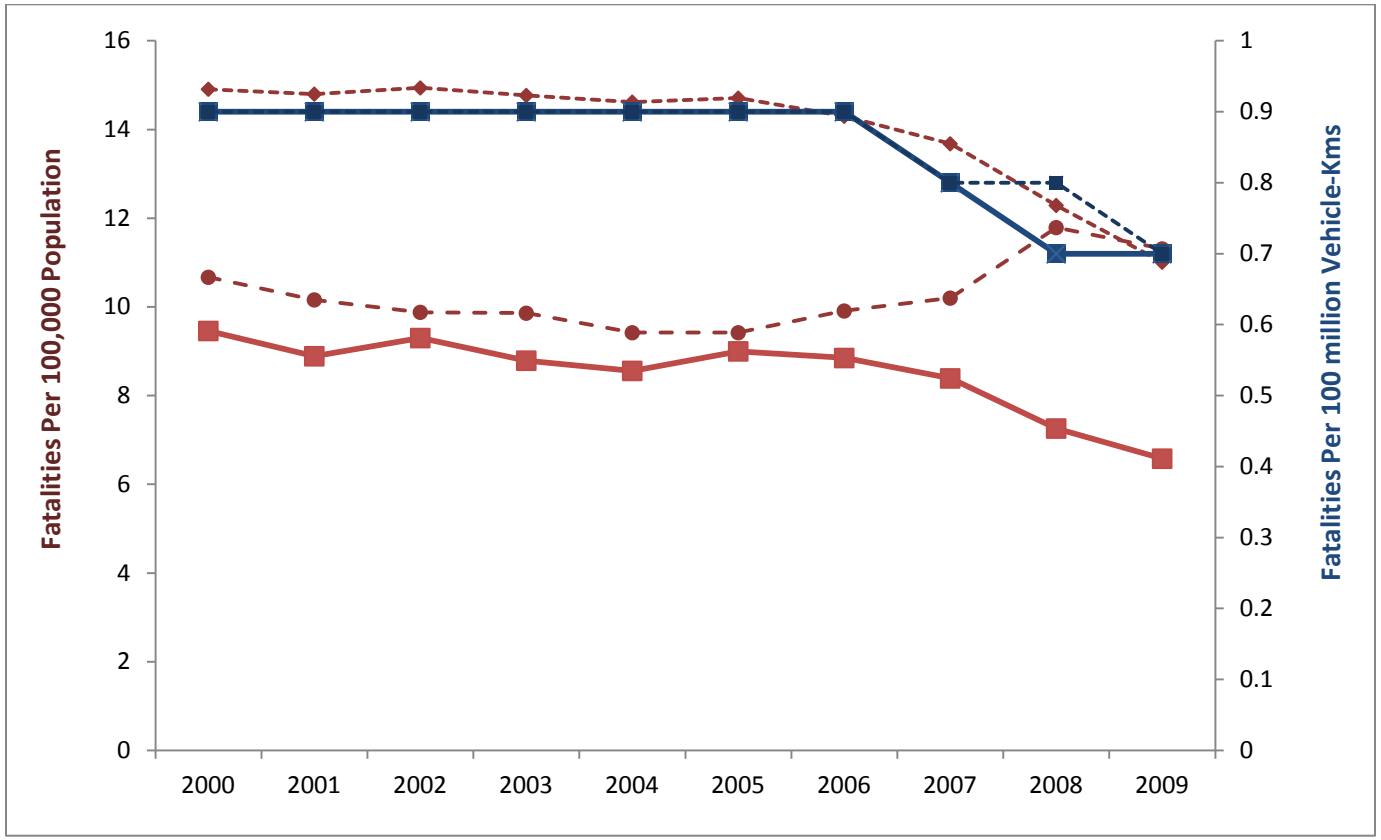
The *North American Transportation Statistics Database* provides various data for Canada, Mexico and the U.S., including crash rate data, as summarized in Table A-1 and Figure A1. This indicates that Canada has comparable *per-kilometre* crash rates as in the U.S., but much lower *per capita* crash rates than both Mexico and the U.S., and that these crash rates started to decline significantly after 2005.

Table A-1 North American Roadway Traffic Fatality Rate Data ("Transportation Safety, NATSDB 2010,

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Canada										
Population (millions)	31	31	31	32	32	32	33	33	33	34
Road motor vehicle fatalities, total	2,903	2,756	2,921	2,779	2,731	2,898	2,884	2,761	2,419	2,217
Road vehicle-kilometres, total (billions)	307	310	315	313	312	317	326	332	325	333
Road motor vehicles, total (millions)	17.4	17.7	18.3	18.6	18.8	19.2	19.7	20.3	20.8	21.2
Fatality rates per 100 million vehicle-km	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.80	0.70	0.70
Fatality rates per 10,000 road motor vehicles	1.70	1.60	1.60	1.50	1.50	1.50	1.50	1.40	1.20	1.00
Fatality rates per 100,000 population	9.46	8.89	9.30	8.79	8.56	9.00	8.85	8.39	7.26	6.58
Mexico										
Population (millions)	98	100	101	102	103	104	106	107	109	111
Road motor vehicle fatalities, total	10,487	10,124	9,954	10,052	9,690	9,783	10,450	10,934	12,834	12,505
Road vehicle-kilometres, total (billions)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Road motor vehicles, total (millions)	15.6	17.3	18.8	19.8	20.9	22.1	24.9	26.7	29.3	30.9
Fatality rates per 100 million vehicle-km	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fatality rates per 10,000 road motor vehicles	6.70	5.90	5.30	5.10	4.60	4.40	4.20	4.10	4.40	4.10
Fatality rates per 100,000 population	10.67	10.16	9.88	9.86	9.42	9.42	9.91	10.20	11.79	11.31
United States										
Population (millions)	281	285	288	290	293	296	299	302	304	307
Road motor vehicle fatalities, total	41,945	42,196	43,005	42,884	42,836	43,510	42,708	41,259	37,423	33,808
Road vehicle-kilometres, total (billions)	4,420	4,499	4,595	4,651	4,771	4,811	4,851	4,878	4,790	4,753
Road motor vehicles, total (millions)	225.8	235.3	236.8r	234.6r	243.0	247.4	250.8	254.4	255.9	254.2
Fatality rates per 100 million vehicle-km	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.80	0.80	0.70
Fatality rates per 10,000 road motor vehicles	1.90	1.80	1.80	1.80	1.80	1.80	1.70	1.60	1.50	1.30
Fatality rates per 100,000 population	14.91	14.80	14.94	14.77	14.62	14.71	14.30	13.68	12.29	11.01

This table summarizes transport fatality data from the North American Transportation Statistics Database (http://nats.sct.gob.mx/nats/sys/tables.jsp?i=3&id=13)

Figure A-1 **North American Crash Rate Data**



Canada and the U.S. have similar traffic fatality rates per vehicle-kilometre but Canada has much lower per capita fatality rates due to lower per capita annual vehicle travel, particularly in Cities.