The role public transport can play in *Safer Journeys* and, in particular, to advance the Safe System approach

December 2015

B Frith, J Burton, M Trotter, G Rive
Opus Research, Lower Hutt

NZ Transport Agency research report 581
Contracted research organisation – Opus Research

ISBN 978-0-478-44543-5 (electronic)
ISSN 1173-3764 (electronic)

NZ Transport Agency
Private Bag 6995, Wellington 6141, New Zealand
Telephone 64 4 894 5400; facsimile 64 4 894 6100
research@nzta.govt.nz
www.nzta.govt.nz

Frith, B, J Burton, M Trotter, G Rive (2015) The role public transport can play in safer journeys, and, in particular, to advance the Safe System approach. *NZ Transport Agency research report 581.* 74pp.

Opus Research was contracted by the NZ Transport Agency in 2014 to carry out this research.

Keywords: accident, bus, ferry, mode, multimodal, New Zealand, public transport (PT), risk, Safe Systems, Safer Journeys, safety, train, transport, travel

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Acknowledgements

The authors would like to acknowledge the input of the following people for their valuable contributions to this work:

- Steering Group chair Peter Kippenberger
- Steering Group members: Wayne Jones, Ministry of Transport; Rob Gould, New Zealand Transport Agency; Iain McAuley, New Zealand Transport Agency; Viviane McGuire, Ministry of Transport; Carolina Lukkien, New Zealand Transport Agency.
- External peer reviewers: Professor Brian Fildes; Iain McGlinchy
- The large number of people from New Zealand and around the world who assisted with the provision of information.

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Executive summary

The key objectives of this research were to identify the contribution that urban public transport (PT) can make to the Safe System approach, and to develop an implementation plan for the insertion of PT as a safe mode into the *Safer Journeys* framework and action plans.

In order to achieve these goals, the project:

- completed a comprehensive review of existing international and New Zealand literature and practice, identifying best practice examples of Safe System approaches with an emphasis placed on PT systems
- in the light of knowledge from the review and information from transportation studies, drew conclusions regarding the potential contribution of a modal shift to PT with present urban form, and how this contribution could be enhanced with the use of urban densification
- used the insights drawn to devise a method of integrating PT issues fully into the Safe System approach to road safety, and to make recommendations as to how this might also be integrated into *Safer Journeys.*

The review is carried out from a Safe System perspective. It is thus assumed that a Safe System approach is appropriate for all urban transport modes including ferry and rail, whether or not this Safe System approach is pursued within the umbrella of New Zealand's *Safer Journeys* road safety strategy or by some other mechanism.

PT is generally considered a safe form of transport. For example, in New Zealand, passengers in cars and vans are seven times more likely than bus passengers to be killed or injured in a crash (for the same time spent travelling), indicating that bus travel is comparatively a very safe mode of travel for passengers. Note that this does not include falls inside of buses or injuries sustained entering or exiting buses. Bus drivers are very seldom killed, with no deaths in 2012, but six drivers were seriously injured and 43 sustained minor injuries in that year.

The literature and case studies from the Auckland and Wellington main urban areas indicate that PT is indeed safer than motorised personal transport modes. However, when injuries to PT users accessing PT, exiting from PT, on PT, and journeying to and from PT, are taken into account, the difference narrows. These injuries relate to walking and cycling infrastructure, including lighting, PT interchange and bus stop design, PT vehicle design (and internal infrastructure) and the driving behaviour of PT drivers. Journeys to and from PT vehicles may use vulnerable modes. It is important for walking and cycling safety to be a high priority to encourage people to use these modes and access the health benefits they afford. Also, fewer injuries will occur if there is good urban planning to provide efficient transport and reduce unnecessary journeys.

The review looked at the Safe System approach to road safety (sometimes called Vision Zero or sustainable safety) as it has been adopted by New Zealand, the governments of other developed countries, and international organisations with an interest in road safety. It also looks at how its relationship to PT is viewed.

In New Zealand, PT strategies and *Safer Journeys* are both over-arched by the Government Policy Statement on Land Transport (GPS). *Safer Journeys* impacts on PT only through measures to reduce level crossing crashes and crashes where buses or trams hit other vehicles or pedestrians. *Safer Journeys* does not actively try to improve safety by increasing PT's modal share on the basis that it is safer. Instead it leaves PT funding, which is a major determinant of PT usage, to be determined by other urban transport considerations articulated by the government in the GPS.

A literature search and a survey of overseas government agencies revealed that a similar approach had been adopted overseas. Road safety strategies sometimes contained aspirational statements relating to increasing the share of urban trips carried by PT but this was not accompanied by actions. Where the reasons for this were articulated they related to the historical reality that PT strategies and policies had always been decided by considerations outside of road safety. Thus the best strategy for road safety was to accept this and maximise the safety of the networks as they had been built to accommodate such systems. This would mean including in *Safer Journeys* PT-related injury not at present covered in *Safer Journeys* actions. This approach was then accepted as appropriate for the New Zealand context and the means of inclusion of PT within *Safer Journeys* was considered.

In New Zealand, this step, in the case of on-road vehicles like buses and trams, is already able to be fitted within the existing *Safer Journeys* framework for motor vehicle crashes, but not for PT injuries not related to collisions with other vehicles or pedestrians. New areas of interest and actions (which would of course need funding) are all that is required to make it happen in New Zealand. Such actions would incur the costs of gathering the crash information necessary to evolve countermeasures and the cost of the countermeasures themselves.

To cover PT fully (by including urban commuter rail and ferries), *Safer Journeys* needs to move from urban road safety to urban transport safety[1]. This would require no structural change, just a restatement of the reach of the strategy and the inclusion of some new areas of interest and action plans. To achieve this:

- The whole journey rather than just the road phase needs consideration.
- Data should be gathered and analysed on injury related to all aspects of the journey.
- Safety expertise can be positioned in organisational structures to influence how PT is operated. The experience of New South Wales is a pointer to what can be achieved.
- Tools to better monitor PT safety can be made available and used (an example is the progress made by Sweden in counting pedestrian-only crashes and injuries to PT passengers).

All the above could relate to *Safer Journeys* priorities accompanied by *Safer Journeys* action plans without changing the framework. In New Zealand, improvement would involve taking actions within the present *Safer Journeys* system to better ensure the safety of PT-related travel. These actions could include better recognition of non-motor vehicle pedestrian injuries and injuries entering/exiting PT in the present system. *Safer Journeys* currently addresses injury that occurs on the road network and about which we have accessible data. There is some information on cycling where no motor vehicle is involved. However, the following injuries in relation to buses and trams are recorded in separate databases that do not feed into *Safer Journeys*:

- injuries on/within the vehicle
- injuries boarding/alighting the vehicle
- injuries walking to/from the vehicle (unless a motor vehicle is involved).

In order to include these injuries in *Safer Journeys* in such a way that Safe System countermeasures may be worked out, it is necessary to set up systems that better capture their incidence and characteristics so that their epidemiology can be better known and countermeasures evolved.

[1] This would logically also include freight but this was excluded from the current project.

At present pedestrian infrastructure receives no Transport Agency subsidy unless it is part of a joint pedestrian/cycle facility. This means the money to build and maintain it comes from scarce rate-payer funds. This may have detrimental impacts on walking routes to and from PT.

There is also an understandable aspiration to make popular walking surfaces visually pleasing. Visually pleasing surfaces can be safe and of high walkability but they have to be carefully designed, implemented and maintained if they are to play a full part in a Safe System, and may require higher levels of maintenance than some simpler surfaces. This will become even more important as the population ages, as older people are more fragile and thus more vulnerable to injury than younger people.

Also road work practices as they apply to pedestrians require examination, as footpath closures may not always be accompanied by adequately safe alternative routes. Similar requirements would apply to the safety of bus/train/ferry stops, access to stops and any safety issues involved in getting on and off vehicles.

Other important areas are the interior design of PT vehicles and the training of drivers to minimise on-vehicle injury, the design of PT interchanges, vehicle design and operation, and driver management.

On the planning front, safety input to the design of PT projects is important. This would reflect Safe System principles like:

- maximal separation of conflicting modes, particularly potentially aggressive modes and vulnerable modes, and widespread use of separate travel paths
- moving towards self-explaining 'no surprises' routes for all modes
- regular Safe System audits of PT systems, including all aspects of the PT journey.

The actions advocated above will not overtly and visibly increase PT patronage. However, these types of action can also be expected to have a knock-on effect, whereby the resulting safer environment for PT users on all parts of their journey would encourage further use.

The *Safer Journeys* strategy was produced and the action plans are overseen by the National Road Safety Committee (NRSC). The members of the NRSC are the main public sector stakeholders with an interest in road safety in New Zealand, including the Ministry of Transport, the NZ Transport Agency, the Accident Compensation Corporation and the NZ Police. Any changes to be made to the strategy and action plans would need to be agreed by the NRSC. An area such as PT would therefore have to be considered by the NRSC in conjunction with the other road safety areas set out in *Safer Journeys,* and included and prioritised accordingly. The timing and extent of any changes to the priorities and action plans in the strategy would need to be discussed.

If commuter rail was to be included a decision would need to be made as to whether commuter rail operators should be represented on the committee when rail-related topics were up for discussion, or whether the input of the Transport Agency's Director of Rail Safety would be sufficient.

The recommendations arising from this work are that:

- The uptake and provision of urban PT is encouraged by the government in parallel with road safety under the overarching GPS.
- The NRSC consider the incorporation of urban PT safety into the *Safer Journeys* strategy accompanied by an appropriate name change for the NRSC to better reflect its wider scope.
- This includes consideration of *Safer Journeys* actions in these areas:
  - The acquisition of data to allow analysis of the safety of the whole journey, including segments to and from the PT vehicle, the journey on the PT vehicle, entering and leaving the vehicle, and the

implications after this for a pedestrian or cyclist. This would include the feasibility of such acquisition, the utility of the available data, and the costs of such acquisition related to the benefits. Most of this data would be from sources outside of Police reported crashes and would thus be outside the scope of the NZ Transport Agency's Crash Analysis System

  - Analysis of the above data to provide safety benchmarks and information related to the development of Safe System countermeasures
  - Carrying out work to develop Safe System actions in the form of countermeasures to ameliorate any safety problems the analyses may uncover
  - Assess the priority of such actions relative to existing actions.
- The NRSC consider whether the *Safer Journeys* strategy should include the management systems of non-road PT providers as it does at present for on-road PT.
- The NRSC consider carrying out work to elucidate the impact on road safety funding allocation of including the above additional areas into *Safer Journeys* actions.

Abstract

The key objectives of this research were to identify the contribution that urban public transport (PT), which is generally considered safer than travel by light motor vehicles, can make to the Safe System approach, and to develop an implementation plan for the insertion of PT as a safe mode into the *Safer Journeys* framework and action plans. The work indicated that, as in New Zealand, the practice overseas was for road safety strategists not to attempt to influence modal split in the direction of safer PT modes, but rather to accept the levels of modal split resulting from government PT policies and then to ensure that the system which results is managed according to Safe System principles. This would mean including in *Safer Journeys* PT-related injuries not at present covered in *Safer Journeys* actions. This would require no structural change, just a restatement of the reach of the strategy and the inclusion of some new areas of interest and action plans. To achieve this, the whole journey rather than just the road phase needs consideration. Data on injury related to all aspects of the journey should be gathered and analysed; safety expertise can be positioned in organisational structures to influence how PT is operated, and tools to better monitor PT safety can be made available and used.

1 Introduction

The purpose of this research project was to identify systematic contributions that could be made to improve road safety outcomes in New Zealand when considering urban public transport (PT) specifically, including road-based modes, rail and ferries, and to determine how PT could best be inserted in the *Safer Journeys* framework and action plans. PT includes the entire journey of which the leg taken on the PT vehicle is part. This represents a gap in the current New Zealand approach, with the relationship between PT and *Safer Journeys* not having been considered previously. Journeys to and from PT may use vulnerable modes. It is important for walking and cycling safety to be a high priority to encourage people to use these modes and access the health benefits they afford. Also, fewer injuries will occur if there is good urban planning to provide efficient transport and reduce unnecessary journeys.

PT is generally considered a safe form of transport. For example, in New Zealand, passengers in cars and vans are seven times more likely than bus passengers to be killed or injured in a crash (for the same time spent travelling) (MoT 2015e), indicating that bus travel is comparatively a very safe mode of travel for passengers. Note that this does not include falls inside of buses or injuries sustained entering or exiting buses. Bus drivers are very seldom killed, with no deaths in 2012, but six drivers were seriously injured and 43 sustained minor injuries in that year. A good illustration of this safety increment over cars comes in a 2007 Ministry of Transport trial of scrapping older vehicles in order to increase the safety of the vehicle fleet (MoT 2008). The safety benefits to drivers of subsequently using PT by virtue of a free PT pass given as a participation incentive substantially exceeded the safety benefits from upgrading a personal vehicle.

The key objectives of this research were to identify the contribution that PT could make to the Safe System approach, and to develop an implementation plan for the insertion of PT as a safe mode into the *Safer Journeys* framework and action plans.

In order to achieve these goals, the project had the following objectives:

- Complete a comprehensive review of existing international and New Zealand literature and practice identifying best practice examples of Safe System approaches with an emphasis placed on PT systems.
- In the light of knowledge from the review and information from transportation studies, draw conclusions regarding the potential contribution of a modal shift to PT with present urban form, and how this contribution could be enhanced with the use of urban densification.
- Use insights drawn to devise a method of integrating PT issues fully into the Safe System approach to road safety, and make recommendations as to how this might also be integrated into *Safer Journeys.*
- Develop an implementation plan communicating, advising and suggesting means of incorporation of findings from the project into *Safer Journeys.*

The first part of this project involved a review of information available to date. Note that PT has been defined as urban PT, in areas where the environment is predominantly built. The review was carried out from a Safe System perspective. It was thus assumed that a Safe System approach was appropriate for all urban transport modes including ferry and rail, whether or not this Safe System approach was pursued within the umbrella of New Zealand's *Safer Journeys* road safety strategy or by some other mechanism.

2 Road safety strategy in New Zealand – its development

2.1 Road safety strategy in New Zealand prior to the *Safer Journeys* strategy

Road safety strategy in New Zealand began to develop with the first New Zealand *National road safety plan* published in 1991 by the then Land Transport Division of the Ministry of Transport (MoT 1991). The Land Transport Division was established in 1988 when the component parts of MoT were given greater autonomy. The plan came as a response to discussion at a series of road safety seminars held by MoT in July and August 1990. An issue which arose from the seminars was a need to improve coordination through a national road safety plan. The plan was prepared for an Officials Committee on Road Safety which reported to an overarching Ministerial Committee on Transport Policy. Previously, road safety actions tended to be carried out on a more ad-hoc basis. Road safety strategies tend to reflect the background of the people charged with producing them and the governments in power at the time. The 1991 strategy, written primarily by a health promotion professional, took a generally public health perspective, while acting as a precursor to the later Safe System approach by using a frame of reference including the four themes:

- safer people
- safer roads
- safer vehicles
- safer systems.

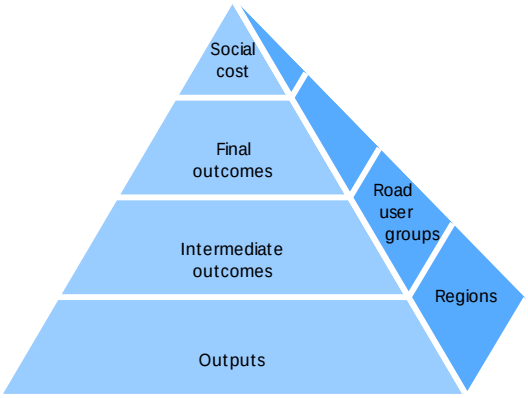
The public health perspective in the document is reflected in its quoting of the WHO Ottawa Charter for Health Promotion (1986) and its five interactive strategies for health promotion as underpinning principles of the plan. The five strategies were:

- Building healthy public policy – by putting health on the agenda of policy makers in all sectors and at all levels within society
- Creating supportive environments – creating living and working environments which promote health and are ecologically sound
- Strengthening community action – making it easier for concrete and effective community action to take place as part of the health promotion process
- Developing personal skills – providing information and education for health and enhancing life skills
- Re-orienting health services – moving the health sector in a health promotion direction, beyond its responsibility for providing clinical and curative services.

The public health perspective was further reflected in targets to progressively reduce carbon dioxide emissions by reducing vehicle travel, which would have side benefits in the road safety arena. Land use planning was also included, with a target to 'include road safety statements in territorial local authority land-use planning/resource management statutory documents by 1995'. The mention of travel reduction and land use planning meant that PT encouragement by appropriate land-use planning was on the table implicitly as a possible tool but never actually mentioned. After the Land Transport Division of the MoT was rebranded as the Land Transport Safety Authority (LTSA) in 1994, it was decided to plan a road safety strategy to 2010, with challenging but achievable targets. This time the strategy was directed by a person with an economics

background, resulting in a quantitative process involving econometric modelling. A key component of New Zealand's road safety strategy to 2010 was an outcomes management framework linking outputs with outcomes via the road safety pyramid shown in figure 2.1.

Figure 2.1 Road safety pyramid



Definitions

- Social cost is the aggregate measure of all costs that crashes inflict on the community. It includes not just material losses but also pain and suffering.
- Final outcomes consist of fatalities and serious injuries. They are what society seeks to avoid and are the main components of social cost.
- Intermediate outcomes are not desired for themselves but for what they entail – better final outcomes. They include average traffic speeds, the proportion of drunk drivers, the seatbelt-wearing rate, fitness to drive or ride, the physical condition of the road network, and the standard of the vehicle fleet. Intermediate outcomes are measured because it is both easy to do so and because they are generally reliable indicators of how well road safety interventions are working.
- Outputs represent physical deliverables, for instance the number of police patrols and infringements, and the amount of advertising delivered. Alternatively they correspond to milestones showing that a specified task has been completed.
- Social cost and final outcomes, but not all intermediate outcomes and outputs, can be broken down by road user group and local government region. This ensures that the benefits of road safety are fairly distributed.

Source: LTSA (2000)

In LTSA (2000), the Safe System approach, in the forms of the Swedish 'Vision Zero' and the Netherlands 'Sustainable Safety', is discussed in a fashion which implies acceptance (p58), but is never explicitly mentioned in the final strategy document (MoT 2003). This document, which is the condensed end product of a long and technically demanding gestation process, does not mention PT. However, PT was considered in the consultative discussion document which accompanied the launch of the process to develop the strategy (LTSA 2000). The document includes the following textbox (p12):

> *Public transport is generally much safer than travel by car, motorcycle or bicycle. So by encouraging people to use public transport instead, we can increase road safety. The government has recently announced a new funding system for public transport that subsidises public transport operators on the basis of their patronage. The aim is to increase the role of*

> *public transport as a safe and affordable alternative to car travel. We recognise, however, that safety is only one factor in optimising the mix of private and PT; cost, convenience and environmental impact must also be considered.*

This view underpinned the strategy's standpoint of dealing only with traffic as it appeared on the road, rather than trying to influence the uptake of public transport. This was left to the overarching transport strategies of the government of the time, which would determine public transport's level of subsidy, and thus its share of the Road Transport Fund's dollar vis-à-vis personal transport. When this strategy had run its course it gave way to the present *Safer Journeys*, which is discussed in the following section.

2.2 The strategy and its framework

New Zealand's *Safer Journeys* road safety strategy takes a Safe System approach to road safety. This approach focuses on creating safe roads, safe speeds, safe vehicles and safe road use. Under the Safe System approach to road safety, a road system is created in which serious and fatal injuries do not occur. In order for this to happen, all necessary measures must be taken to avoid crashes and, if crashes do occur, the people involved should not be subjected to the sort of trauma that would result in fatal or serious injury. The Safe System approach, as it applies to *Safer Journeys*, is illustrated in figure 2.2. *Safer Journeys* is accompanied by a series of action plans (www.saferjourneys.govt.nz/action-plans/) attacking various 'areas of concern' within the framework illustrated.

Figure 2.2 The Safe System approach as it applies to *Safer Journeys*

2.3 The context of the *Safer Journeys* strategy with respect to PT

PT strategies and *Safer Journeys* are both over-arched by the *Government policy statement on land transport 2015/2016* (GPS 2015) and are administered in parallel by the MoT and its partner agencies. Regarding PT this states:

> *We see the need for public transport to help unlock the potential of our urban areas by providing additional capacity on key corridors and a choice of ways to move around, particularly during peak commuting periods* (p8)

> *GPS 2015 provides for increased provision of public transport, if justified by demand* (p8)
>
> *Much of this investment has been ahead of patronage demand, particularly in metro rail services. A period of consolidation is needed where the focus is on securing the anticipated patronage gains* (p19)

A previous MoT publication (MoT 2011) also saw PT as a means to reduce emissions:

> *Improve modal choice in our main urban areas, so people can make greater use of PT, walking and cycling, thereby reducing their emissions.* (p32)

Regarding road safety, the GPS (2015) states:

> *Road safety is one of the Government's top transport priorities. This GPS continues support for the Safer Journeys programme and its 'Safe System' approach, which targets safer roads and roadsides, speeds, vehicles and road users.* (p1)

3 Road safety strategy overseas

The fundamental principles of the Safe System approach to road safety (sometimes called Vision Zero or Sustainable Safety) have been adopted by the governments of other countries such as Austria, the Czech Republic, Denmark, Sweden, Norway, Poland, Finland, Iceland, the Netherlands, Switzerland, Slovenia, the European Commission generally, and Australia, as well as in New Zealand (OECD 2014; OECD/ITF 2008). The International Transport Forum (ITF) organisation within the Organisation for Economic Cooperation and Development (OECD) encourages all its member nations to adopt the Safe System approach to road safety. The Safe System approach is also endorsed by the Global Road Safety Partnership (www.grsproadsafety.org/, the World Bank, the World Health Organisation (WHO), the EU and the European Transport Safety Council (ETSC)[2][3]. Those countries without a Safe System approach have, in the majority, based their strategies on the use of targets and/or statements with which to improve safety, or in some way lead in safety (see OECD 2014). More detail on the approach of four of the leading Safe System countries is provided in the next part of this section.

3.1 The Netherlands

The Netherlands has adopted a version of the Safe System approach called 'Sustainable Safety'. The genesis of this approach came from Koornstra et al (1992) which contains the following statement:

> *In a sustainably safe road traffic system, infrastructure design inherently and drastically reduces crash risk. Should a crash occur, the process that determines crash severity is conditioned in such a way that severe injury is almost excluded.*

This was based on the proposition that widespread injury should not be tolerated on the road, in a similar way to its not being tolerated in other modes. Over the years this principle has led to infrastructure improvements aimed at separating incompatible modes, an emphasis on safe vehicles, and human behavioural measures like a very low permissible blood alcohol level for drivers and copious practice requirements for novice drivers. How this statement of principle should work out in practice is summarised in five sustainable safety principles as presented in table 3.1 from Wegman et al (2006).

Table 3.1 Netherlands Sustainable Safety principles

Sustainable Safety principle	Description
Functionality of roads	Monofunctionality of roads as either through roads, distributor roads, or access roads, in a hierarchically structured road network
Homogeneity of mass and/or speed and direction	Equality in speed, direction and mass at medium and high speeds
Predictability of road course and road user behaviour by a recognisable road design	Road environment and road user behaviour that support road user expectations through consistency and continuity in road design
Forgivingness of the environment and of road users	Injury limitation through a forgiving road environment and anticipation of road user behaviour
State awareness by the road user	Ability to assess one's capability to handle the driving task

[2] The ETSC (http://etsc.eu) is a Brussels-based independent non-profit making organisation dedicated to reducing the numbers of deaths and injuries in transport in Europe.

[3] http://etsc.eu/wp-content/uploads/2014/03/ETSC_Response_to_EC_First_Milestone_Towards_an_Injury__Strategy_May_2013.pdf

Detailed proposals for what can be done in the Netherlands to 2020 based on the above principles are contained in Wegman et al (2006). The proposals in this document do not involve PT directly but urban planning measures to increase PT usage are seen as something that is serendipity for road safety.

3.2 Sweden

The Swedish Vision Zero concept is based on a similar premise to the Netherlands' Sustainable Safety, namely that 'eventually no one will be killed or seriously injured within the road transport system' (Swedish Ministry of Transport and Communications 1997). In October 1997, this vision was officially adopted in a Road Traffic Safety Bill passed by a large majority in the Swedish parliament. This has been the cornerstone of Swedish road safety policy ever since. Over the years this principle has led to infrastructure improvements aimed at separating incompatible modes, an emphasis on safe vehicles and human behavioural measures like low legal alcohol limits for driving, and extensive practice requirements for novice drivers. The measures Sweden has taken to move in the direction of Vision Zero are well summarised in an article in *The Economist* (2014). *The Economist* relates how planning has played the biggest part in reducing crashes. Safety is prioritised over speed or convenience. There are low urban speed limits, pedestrian zones and barriers that separate cars from bikes and oncoming traffic. Building 1,500km (900 miles) of '2+1' roads, where each lane of traffic takes turns to use a middle lane for overtaking, was claimed to have saved around 145 lives over the first decade of Vision Zero. Also, 12,600 safer crossings, including 'pedestrian bridges and zebra-stripes flanked by flashing lights and protected with speed-bumps' have contributed to halving the number of pedestrian deaths over the past five years. Less than 0.25% of drivers tested are over the alcohol limit. At three deaths per 100,000 population, Sweden is one of the safest countries in road safety by that measure[4]. This record is attributed primarily to the widespread adoption of the Safe System philosophy. Sweden's recent name change of Swedish Roads Administration to Swedish Transport Administration further reflects its commitment to not just road safety but transport safety in general.

3.3 Norway

Norway has a National Plan of Action for Road Traffic Safety which is published every four years, and is based on Vision Zero (Directorate of Public Roads 2015) as a fundamental principle. The Norwegian version of Vision Zero is 'A vision of no road fatalities or road accidents causing lifelong injury is set out for the long-term road safety effort' (Ministry of Transport and Communications 2000).

According to OECD (2014) 'Norway adopted Vision Zero by a decision in Parliament (Stortinget) in 2001, and strategies based on the vision were first implemented in the National Plan of Action for Traffic Safety 2002–2011. The government has since reiterated that Vision Zero will provide the basis for traffic safety activities in Norway in all subsequent national transport plans and in the latest National Plan of Action for Traffic Safety 2010–2013'. OECD (2014) also states that the Norwegian Vision Zero involves all modes of transport but provides no information outside traditional road safety areas.

The latest version of the plan identifies and describes 152 measures that will be implemented by the national government agencies, namely the Norwegian Public Roads Administration, the National Police Directorate, the Norwegian Directorate of Health, the Norwegian Directorate for Education and Training and the Norwegian Council for Road Safety.

[4] www.internationaltransportforum.org/irtadpublic/pdf/risk.pdf Accessed 7 June 2015.

3.4 Australia

Australia's approach to road safety is similar to New Zealand's. Indeed, the approaches of the two countries have developed in the background of an extensive interchange of ideas. All the states have their own variations on the theme, as will become apparent later from the state survey responses, but the principles are summarised in the National Road Safety Strategy which is coordinated by the Federal Government and put together by a National Committee on which all states and territories are represented. According to OECD (2014), 'the strategy is firmly based on Safe System principles and is framed by the guiding vision that no person should be killed or seriously injured on Australia's roads'. To progress towards this vision the strategy includes a 10-year plan to reduce the annual numbers of both deaths and serious injuries on Australian roads by at least 30% by 2020, relative to the average numbers of fatalities and serious injuries in the baseline period 2008–2010.

4 New Zealand's *Safer Journeys* and public transport

As with most other road safety strategies, *Safer Journeys* does not specifically address PT issues. It also does not contain any actions related to PT apart from the reduction of crashes involving buses, which has always been a recognised part of the road safety problem to be addressed by such documents. It does, however, in the related document *Safer Journeys for planners* (New Zealand Government 2012), provide the following as something which can be done to provide good planning for road safety:

> *Provide for safe and secure public environments that encourage walking and the use of PT* (p2)

The inclusion of PT in *Safer Journeys* at a more specific level was considered by MoT at the time of its development. On p14 of the Ministry's summary of public submissions (MoT 2009) related to *Safer Journeys*, the following statement appears:

> *One of the most commonly made criticisms of the safe system approach was its focus on cars and trucks and its lack of emphasis on public transport; sustainable forms of transport such as walking and cycling; and other modes of freight transport, in particular rail and sea. Those submitters argued that the strategy is based on the premise that road use will increase when they believed it should aim to reduce the current number of vehicle trips made.*

The document further quotes the following as an example of such submissions:

> *A further weakness of the systems approach is that it fails to consider cycling, walking, and passenger transport as being integral parts of the system. They appear as add-ons – in fact the safety of passenger transport users makes no appearance at all. A transport system includes non-vehicle modes of transport and passenger transport.*

Also in its stakeholder submission on *Safer Journeys* Auckland Transport recommended:

> *The encouragement of safer transport choices through public transport and travel plans* (MoT 2012b)

In the end, the Ministry decided that, as it relates to *Safer Journeys*, public transport would be regarded as something which is looked after in parallel to road safety as part of overarching strategies under the government's policy direction. The government has published *Connecting New Zealand*, a document which summarises its policy direction in transport (MoT 2011). With regard to public transport, *Connecting New Zealand* contains the following commitment to improving use of public transport:

> *Improve modal choice in our main urban areas, so people can make greater use of public transport, walking and cycling, thereby reducing their emissions.* (p32)

This statement, which has a similar standpoint to that prevailing in most of the world (as we will see later in this document) assumes that the safety of public transport is adequately covered in the regulations and strategies pertaining to the various modes of PT, ie buses, rail and ferry. Part of this project looked at how these modes are regulated and whether there is any likely improvement available from bringing them under the *Safer Journeys* umbrella.

Any attempt to integrate PT into *Safer Journeys* must have net positive benefits for safety, over and above those available under the present system. This means the costs of the reduction in trauma events must be greater than the continuing institutional costs of implementation, and there needs to be some evidence

that integration will reduce trauma. This in turn means there needs to be a mechanism to achieve this reduction in trauma.

The methods used must be within a Safe System framework and also be capable of implementation under the government's GPS and fiscal constraints. *Safer Journeys* in essence means movement towards the ultimate goal of a Safe System while prioritising actions to get best value for money in moving towards that goal.

The purpose of this research was to identify the contribution that PT can make to the Safe System approach, which underpins the *Safer Journeys* road safety strategy in New Zealand.

This means that all components of PT must be consciously moving in the direction of a Safe System and demonstrate that they are doing so. For instance some countries pay little, if any, attention to rail trespasser incidents. Becoming a rail trespasser is a 'mistake'[5] and Safe System approaches try to save people whether or not they are mistaken. Thus any Safe System which had no strategy to try to prevent rail trespasser incidents would be unacceptable.

In addition all PT providers would have to be moving towards Safe Systems within their businesses. This would include their provision for passenger and staff welfare and would cover such aspects as fatigue management, vehicle safety and work safety.

[5] Unless a suicide is involved.

5 How public transport is regulated

PT is in general regulated in terms of its workers along the zero harm lines of occupational health and safety requirements. Applying *Safer Journeys* principles to PT would extend this principle to PT users, giving them similar protection as in the workplace.

5.1 Passenger ferries

At present, passenger ferries are required to comply with Maritime New Zealand safety guidelines (Maritime New Zealand 2007). They are also required, in terms of their workers, to comply with the Health and Safety in Employment Act 1992 which, like *Safer Journeys*, has a zero harm focus.

5.2 Passenger rail

Passenger rail, along with other rail traffic, is regulated by the Transport Agency. According to the Transport Agency, its role is to:

> *Ensure rail operators operate in a way that secures the safety of rail passengers, rail workers and the public when in, or in the vicinity of, the rail corridor* (NZ Transport Agency 2013a)

The Transport Agency supports and undertakes regular reviews of safety performance. In 2013, the Transport Agency commissioned Australasian Transport Risk Solutions Pty Limited to complete an independent review of its rail regulator function focused on the following questions:

- Does the legislative framework represent best practice?
- Does the rail regulator's operational policy represent best practice?
- Does the rail regulator's operational activity reflect best practice?

This review concluded that New Zealand's current rail legislation represents 'good' if not 'best' practice. The legislation in its current form does not prevent or limit, in any way, the role of the Transport Agency in delivering improved safety performance, but reviewing the legislation and the Transport Agency's rail resourcing would be beneficial. The review identified the following areas where, in its opinion, performance could be enhanced (NZ Transport Agency 2014a). These were:

- Lifting the position of the rail safety regulator to a more senior level within the Transport Agency
- Promoting and reinforcing to stakeholders the role of a visible and respected safety regulator
- Improving resourcing and specialist competencies on the rail safety team
- Establishing a closer working relationship with the Australian National Rail Safety Regulator to take advantage of the sharing of information and specialist expertise
- Taking a greater role in the leadership, education and provision of information to the New Zealand rail industry.

In response to the review, the Transport Agency released an action plan in December 2013 (NZ Transport Agency 2013a) designed to address areas identified for improvement in the review. The goal was to reduce the rate of death and serious injury associated with the rail industry and achieve a decline in 'precursor events' like signals passed at danger (SPAD).This goal is very similar to that of the *Safer Journeys* Safe System approach. It is also in accordance with the fact that, as with passenger ferries and

commercial road vehicles including buses, rail is required to comply with the Health and Safety in Employment Act 1992 which, like *Safer Journeys*, has a zero harm focus.

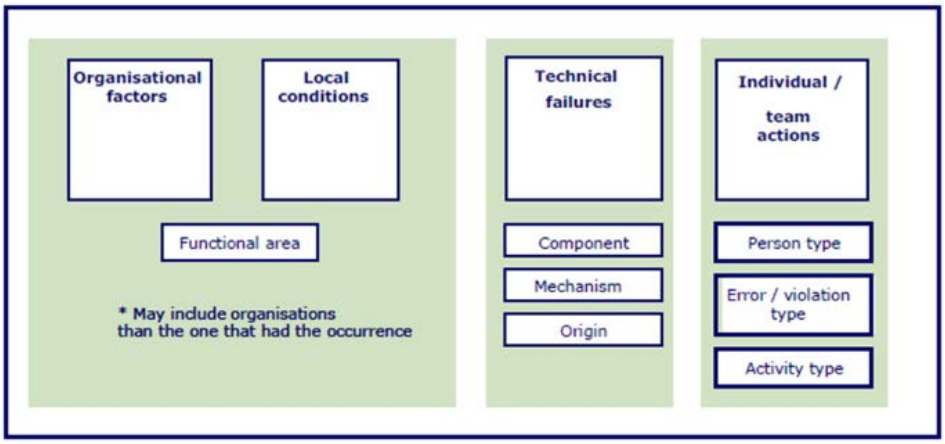
The key foci of the action plan are:

- enhanced governance, including the appointment of a Director Rail Safety in the Transport Agency (who is now in place)
- performance monitoring and transparency, including establishing a more rigorous approach to monitoring and reporting of incidents
- increased resource and capability within the Transport Agency and increased sharing of experience with Australian rail regulators
- review of the financial sustainability of rail safety regulatory services.

Safety improvement strategies are also in place for tunnels, SPADs, level crossings and unauthorised access (NZ Transport Agency 2014b).

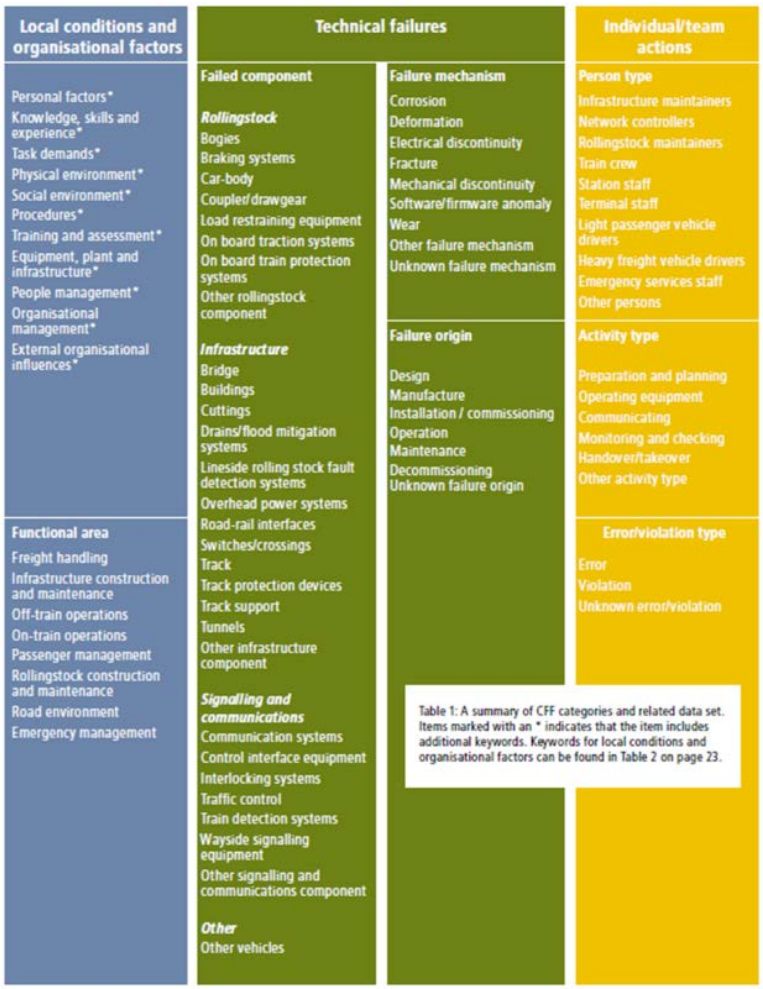
In Australia, a systems approach broadly similar to the Safe System approach of *Safer Journeys* has been adopted by the Office of the National Rail Safety Regulator (ONRSR) as a core element of its investigation process, but has only been applied in Victoria and New South Wales. The Rail Safety Regulators' Panel has developed a systems framework, the Contributory Factors Framework, with which to code and analyse all rail safety occurrences that by law have to be reported to the ONRSR (Rail Safety Regulators' Panel 2011). The framework and associated taxonomy (shown in figure 5.1 and figure 5.2) are designed specifically to address the systemic contributions to rail safety.

Figure 5.1 Summary of Contributory Factors Framework categories



Source: Rail Safety Regulators' Panel (2011)

Figure 5.2 Contributing Factors Framework taxonomy



Source: Rail Safety Regulators' Panel (2011)

The Australian *National rail safety strategy* (RISSB 2010), produced by a broad coalition of government and industry, including the ONRSR, is based on risk reduction but does not consider the problem at a truly systemic level as it does not look beyond the boundary of the organisation and does not consider the interactors between the various factors. If a framework like the ONRSR's were to be developed in New Zealand, a question to be considered would be whether it should be part of the *Safer Journeys* framework, or work independently of it but with compatible philosophical objectives.

5.3 Urban buses

Bus transport is at present under the *Safer Journeys* banner, but in practical terms this relates only to the collisions buses have with other road users. A question to be considered is whether the present arrangements are adequate for ensuring the safety of bus users in non-collision situations. The Transport Agency has promulgated guidelines for the safe design of buses and the Commercial Vehicle Investigation Unit of the NZ Police enforces laws regarding the physical condition of buses.

6 Intermodal crash and injury rate comparisons

The contribution PT makes to land transport safety is a function of:

- the differences in its safety with respect to alternative modes, including the safety of the journey to and from PT, and
- the use of the mode with respect to alternative modes, which is in turn a function of land use planning, PT's integration with other modes, and the nature of the PT network vis-à-vis the road network.

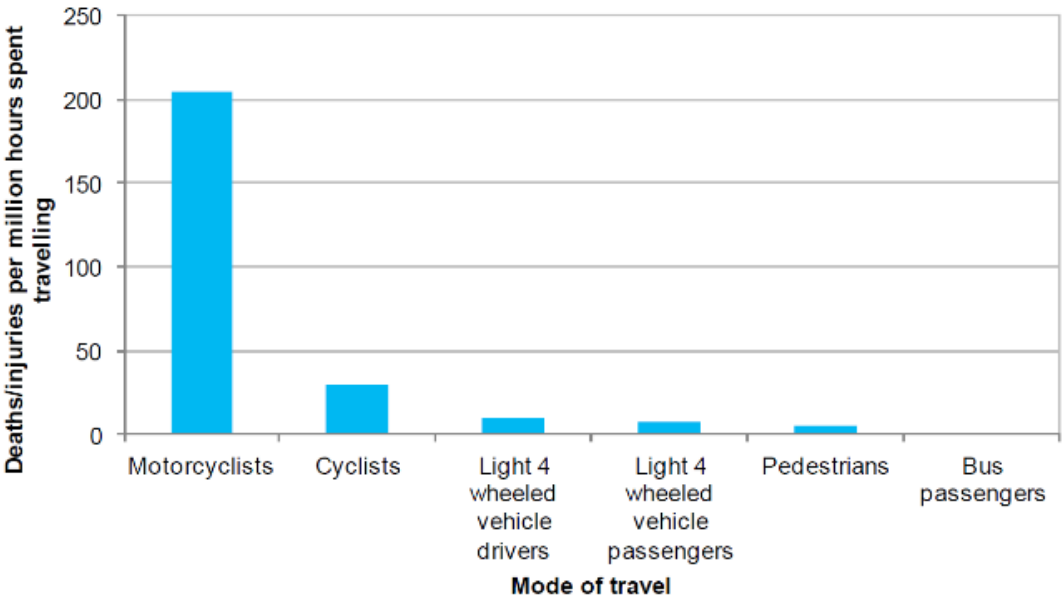
6.1 Intermodal comparisons

The safety of various modes may be considered using different rates. The most widely used of these rates are per:

- unit time of exposure
- unit distance of exposure
- licensed vehicle (for motor vehicles)
- head of population
- journey or journey segment (trip).

Figures 6.1 and 6.2[6] provide some comparative statistics on crashes involving motor vehicles from the New Zealand Household Travel Survey (MoT 2015d). Figure 6.1 reports deaths and injuries per million hours of travel and figure 6.2 reports deaths and injuries per 100 million kilometres travelled. Whether the denominator relates to time or distance, the data show that bus passengers are considerably less at risk than other road users.

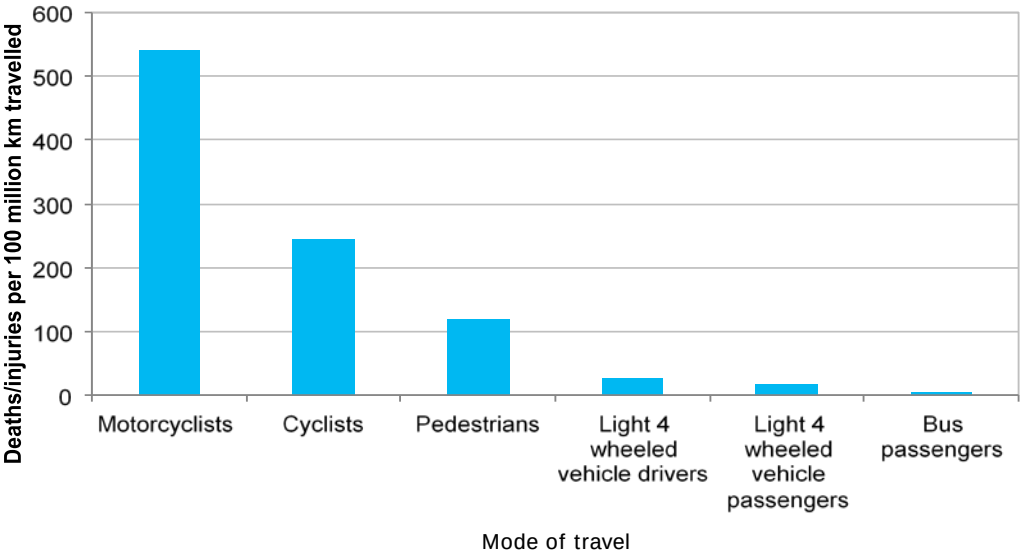
Figure 6.1 Deaths or injuries in motor vehicle crashes per million hours spent travelling



Source: New Zealand Household Travel Survey 2007–2011

Figure 6.2 Deaths or injuries in motor vehicle crashes per 100 million km travelled per year

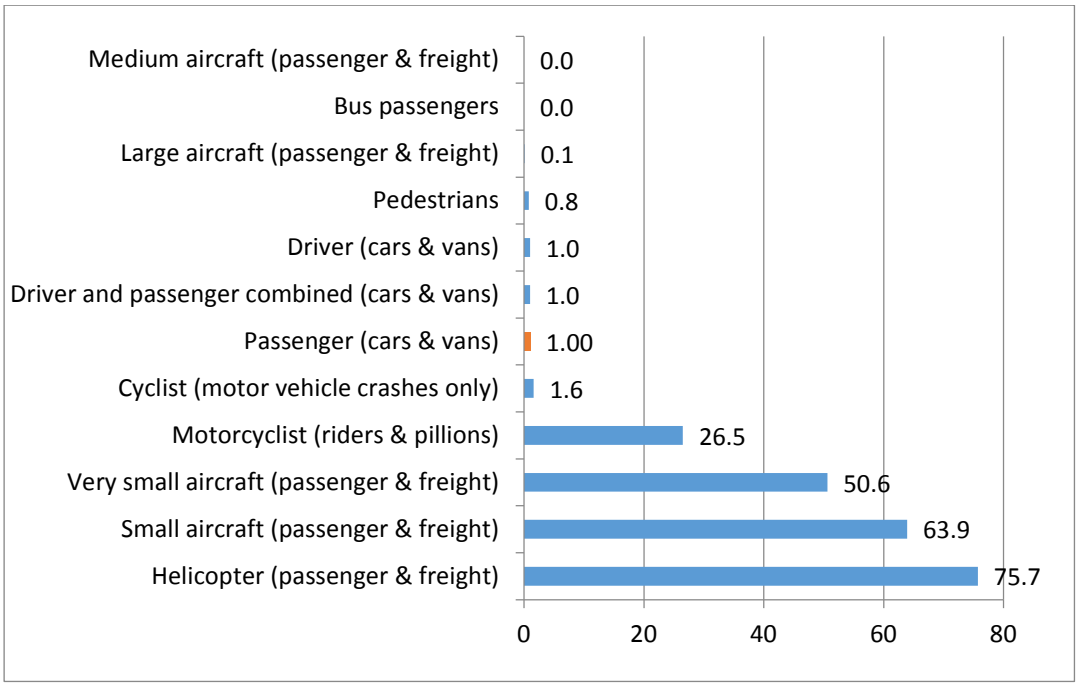
[6] Both these figures include cyclists injured in reported motor vehicle crashes only.



Source: New Zealand Household Travel Survey 2007–2011

Similar statistics for New Zealand travel, but containing more modes, compiled by the Civil Aviation Authority (Campbell 2007), are depicted in figure 6.3.

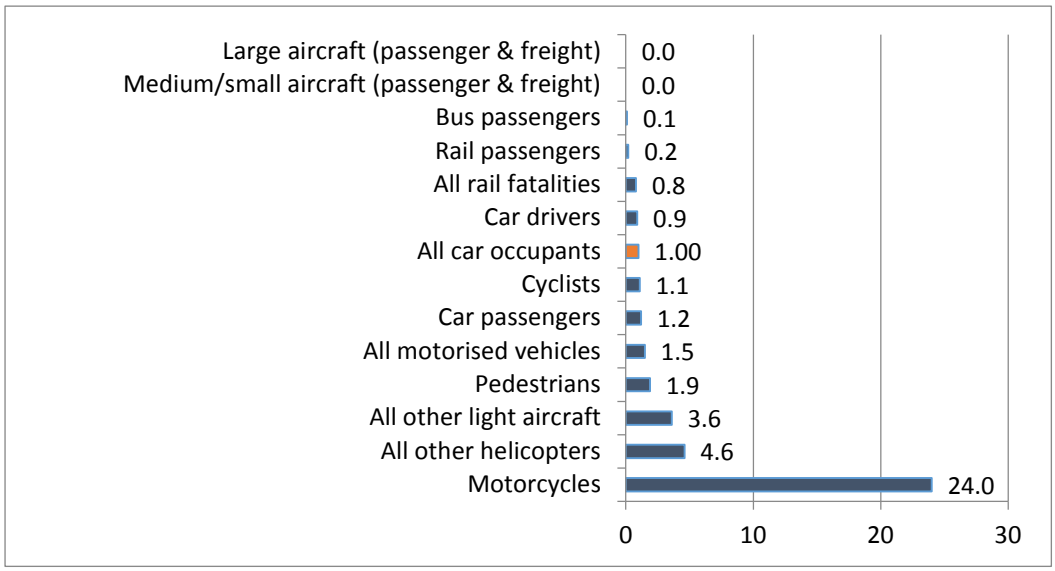
Figure 6.3 Relative chance of death per person per hour of travel (New Zealand Aviation 2000–2003, drivers and passengers of cars and vans combined= 1.00)



Source: Campbell (2007)

The same CAA document provides a similar chart for Australia, and this is shown in figure 6.4 (on the same scale as figure 6.3). The category 'all rail fatalities' in figure 6.4 is not further defined so it is not possible to ascertain whether it includes non-transport related events like suicides.

Figure 6.4 Australia comparisons: relative chance of death per person per hour of travel (1985–1986, all car occupants= 1.00)



Data sources: ATSB

Hambly and Hambly (1994) present the risks of dying in the UK per 10^8 hours from various activities. This measure is used in other areas such as disease control and is therefore a good comparator with risks in other areas. Some relative risks of death (as a rate compared to travel by car=1.00) sourced from this article are shown in table 6.1. The authors also mention that it assists one's perspective to make comparisons with the risk of death from accidents or diseases. All travel modes except bus and train carry with them higher risks than the overall risk of death by accident. The authors do not elaborate on what they mean by 'accident' or 'disease'.

Figures 6.1, 6.2 and 6.3 exhibit broadly similar relativities between the road modes for New Zealand to those depicted in table 6.1 and 6.2 for the UK and figure 6.4 for Australia, respectively. Given that the New Zealand, Australian and British information presented here was constructed from data applying to very different time periods, using different methods, there is a large degree of agreement, with PT modes comparing very well with other urban modes.

Table 6.1 Relative risks of death in the UK per 10^8 hours compared to travel by car= 1.00

Transport risks		Other risks	
Travel by car	1.00	Accident (average man in his 30s)	0.53
Travel by aeroplane	1.00	Disease (average man in his 30s)	0.20
Travel by helicopter[7]	33.33	Smoking	2.66
Travel by motor cycle	20.00		
Travel by bicycle	4.00		
Travel by foot	1.30		
Travel by train	0.33		
Travel by bus	0.06		

Source: Hambly and Hambly (1994)

[7] Scheduled North Sea operations.

Steer Davies Gleave (2005) give fairly recent death and injury rates per kilometre travelled for the UK, as shown in table 6.2. Again, urban PT modes are lower risk from the passenger's point of view. A more appropriate basis for comparing the safety of slower, more vulnerable, walking and cycling modes with motorised modes is on an hourly basis as shown for New Zealand in figure 6.1. This is because time constraints preclude walkers and cyclists from traveling comparable distances to the faster motorised modes, thus limiting their exposure to risk.

Table 6.2 Comparative death and injury rates in the UK for different transport modes (per billion PAX km travelled 2001)

Mode	Killed	Killed and injured
Motorcycle	112	5,549
Cycling	33	4,525
Walking	48	2,335
Private car	3	337
Bus or coach	0.1	196
Heavy rail	0.1	13
Light rail	0.00002	0.00007

Table 6.3 from Berry and Harrison (2007) sets out the absolute numbers of hospitalisations in Australia for traffic land transport (ie on a public highway) injury in 2003/04. The figures do not include pedestrian-only injuries which are treated as falls (and will be discussed later), but do include bicycle-only injuries. The data indicates that the number of hospitalisation injuries to bus passengers is very small in relation to those for people using other modes.

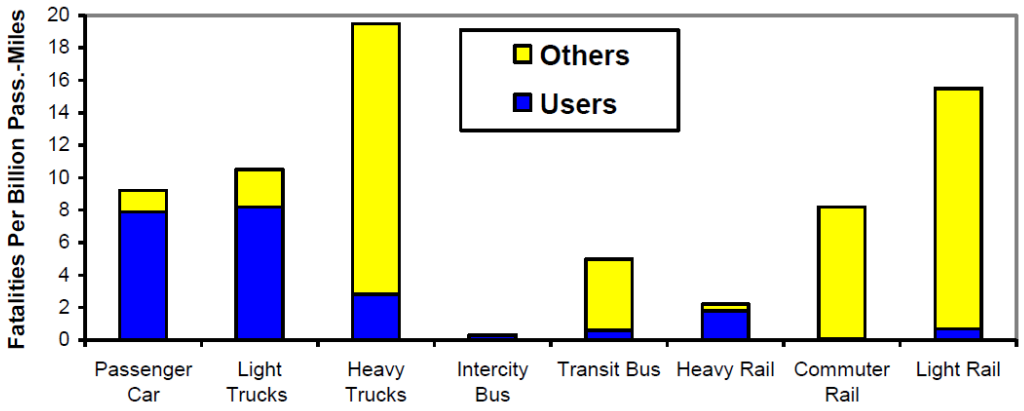
Table 6.3 Number of hospitalisations in Australia from traffic land transport injury in 2003–2004, by age and mode (no exposure)

Injured person's vehicle (pedestrians are considered 'vehicles' in this classification)	Pedestrian	Driver	Passenger	Person on outside of vehicle	Not specified	Total
Pedestrian	2,666	0	0	0	0	2,666
Pedal cycle	0	1,888	29	0	1,769	3,686
Motorcycle	0	3,532	207	0	1,692	5,431
3-wheeled motor vehicle	0	18	6	0	9	33
Car	0	9,823	4,892	63	1,128	15,906
Pick-up truck or van	0	214	97	16	28	355
Heavy transport vehicle	0	314	48	7	39	408
Bus	0	21	100	1	31	153
Other land transport	0	74	36	5	321	436
Total	0	15,884	5,415	92	5,017	29,074

Litman and Fitzroy (2014) present the chart depicted in figure 6.5 showing fatality rates per billion passenger miles for various modes, disaggregated by whether the fatality was to a user or someone else. It is based on Federal Highways Administration (FHWA) and American PT Association data.

This chart is different from the other similar charts in that it includes non-users (referred to in figure 6.5 as 'Others') as well as users. It shows that, in terms of overall fatalities including non-users, PT vehicles (although safer than private transport) have much higher rates of fatalities than the very low rates attributed to users only, which are those used in previous tables and figures.

Figure 6.5 Fatalities per billion passenger miles for various modes, disaggregated by user and non- user



6.2 Non-crash injuries on PT or while exiting/entering PT

Slips, trips and falls on PT, or while entering/exiting PT, are an important part of the total injuries to those using this transport mode. To gain information on falls occurring on PT, it is necessary to go to overseas information or the Accident Compensation Corporation (ACC). This is because these injuries are not usually reported to the Police and so do not figure in traffic crash reports in New Zealand.

The ACC 45 claim form contains a free text box where claimants may describe the circumstances of their injury. As the ACC scheme is a no-fault scheme these descriptions are not compulsory. In some cases they may be empty. In order to get an idea of the size of the problem related to non-crash injuries associated with PT, the ACC was requested to carry out a search of the free text portion of claims by the terms 'bus', 'train', 'ferry', 'tram' and 'carriage'. They were also able to select out those claims which had a prior activity of 'getting on/off' or 'getting in or out of'.

Table 6.4 Number of new claims by transport type text term: 2009–2014

	2009	2010	2011	2012	2013	2014	Total
Bus	1,114	1,080	1,059	1,123	1,238	1,395	7,009
Train	98	129	120	138	129	148	762
Ferry	37	35	43	41	56	44	256
Tram	7	9	6	8	9	12	51
Carriage	7	6	9	7	7	11	47
Total by year	1,263	1,259	1,237	1,317	1,439	1,610	8,125

Table 6.5 Transport type by text search for activity prior to getting on/off or in/out of: 2009–2014

	2009	2010	2011	2012	2013	2014	Total
Bus	719	751	757	817	922	1,007	4,973
Train	66	90	78	95	97	96	522
Ferry	21	25	26	25	35	33	165
Tram	5	5	5	7	8	11	41
Carriage	3	2	1	5	2	4	17
Grand total	814	873	867	949	1,064	1,151	5,718

Table 6.4 relates to all the claims mentioning the five transport mode-related search terms and table 6.5 those which also are coded 'getting on/off" or 'getting in or out of". Table 6.4 indicates that in 2014 there were 1,610 claims where the mode-related search terms were mentioned. There appears to be a possible upward tendency in these claims since 2011 but it is not clear if this will be sustained. Of these claims 1,151 were associated with a prior activity related to entry or exit. Taking all the years together, most claims related to buses (86%) or rail (10%), and the rest to ferry and tram. Over all the years the percentage related to ingress and egress was 70%, with bus 71% and rail (train plus carriage) 66%. This indicates that there may be a higher level of safety entering and exiting trains than buses. This is not surprising given the more controlled environment existing at train stations than at bus stops. In the case of buses and trams, these claims will include those related to injury crashes involving other motor vehicles. It could also be argued that bus passengers, once on the vehicle, may be safer than rail passengers as the percentage of bus claims which are not related to ingress/egress is smaller than the percentage of the rail claims not related to ingress/ egress. These arguments are of course subject to some uncertainty, as the percentages of injuries for ingress/egress and actually happening on the vehicle are not independent, as their sum must add up to 100%. It could also be argued that the same data might indicate that bus passengers may be safer than rail passengers. Overseas information tends to indicate that rail passengers may be safer, with Fildes et al (2012) suggesting that Victorian bus and tram passengers may be more subject to injury than train passengers and Litman and Fitzroy (2014) (see figure 6.5) suggesting a similar result for North American passengers.

Fildes et al (2012) analyse injuries to Victorian PT users. Their analysis used surveillance data collected at a number of trauma hospitals for patients brought to the hospital with non-fatal injuries between 2006 and 2010 inclusive. Table 6.6 from the study depicts the 'injury causing event' by age of user.

Table 6.6 PT use by age of user Melbourne, Victoria- 2006–2010 inclusive

Injury Causing Event	<30yrs	30-59yrs	60plus yrs	Total (event)
Getting on/off and on the unit	672 (61%)	590 (59%)	768 (73%)	**2030** (64%)
Pedestrian hit by Public transport	104 (9%)	81 (8%)	32 (3%)	**217** (7%)
Running to catch public transport or at the stop	255 (23%)	263 (26%)	206 (20%)	**725** (23%)
Pedestrian hit on the tracks	67 (6%)	67 (7%)	41 (4%)	**175** (6%)
Other unspecified	-	2 (33%)	3 (67%)	**5** (-)
Total (proportion of age-group)	**1099** (35%)	**1003** (32%)	**1050** (33%)	**3152** (100%)

Compared with other age-groups, the 60-plus group was particularly susceptible to injury getting on and off PT or when travelling on PT. Table 6.7 looks at the 'injury causing event' by mode.

Table 6.7 Injury causing event by mode Melbourne, Victoria- 2006- 2010 inclusive

Injury Causing Event	Train	Tram	Bus	Total (event)
Getting on/off and on the unit	303 (15%)	752 (37%)	975 (48%)	**2030** (64%)
Pedestrian hit by Public transport	40 (18%)	119 (55%)	58 (27%)	**217** (7%)
Running to catch public transport or at the stop	465 (64%)	126 (17%)	134 (18%)	**725** (23%)
Pedestrian hit on the tracks	76 (43%)	99 (57%)	-	**175** (6%)
Other unspecified	-	2 (33%)	4 (67%)	**6** (-)
Total (proportion of transport)	**884** (28%)	**1098** (35%)	**1170** (37%)	**3152** (100%)

It can be seen that entering and leaving PT and being on PT accounted for two-thirds of all 'injury causing events'. Running to catch a PT vehicle or being injured at the PT stop accounted for a quarter of the events.

A state government agency, Transport Safety Victoria regulates bus, rail and maritime safety in Victoria. Transport Safety Victoria (2014) contains the chart depicted in figure 6.6 which looks at injuries incurred when boarding buses, alighting from buses, and on buses.

Figure 6.6 Bus injuries not involving motor vehicles in Victoria by year

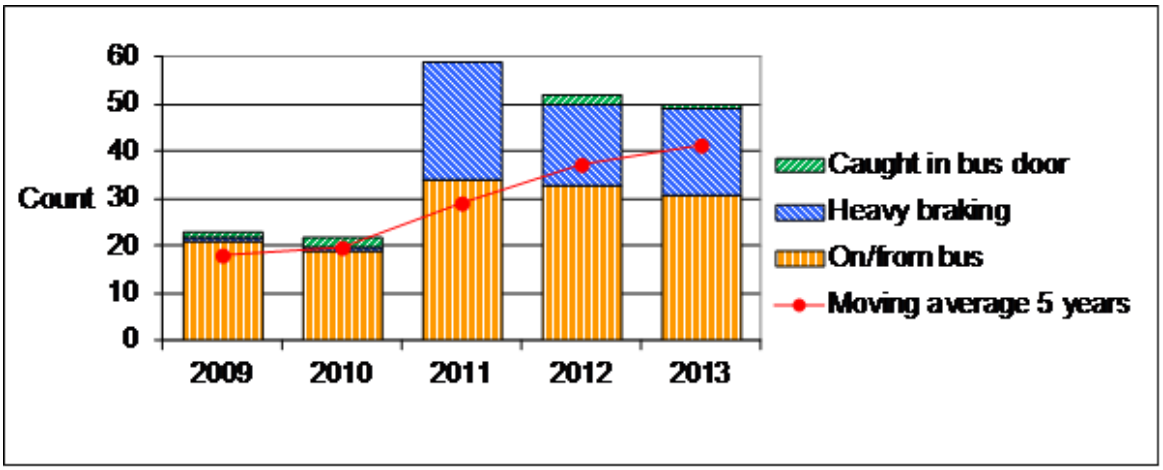
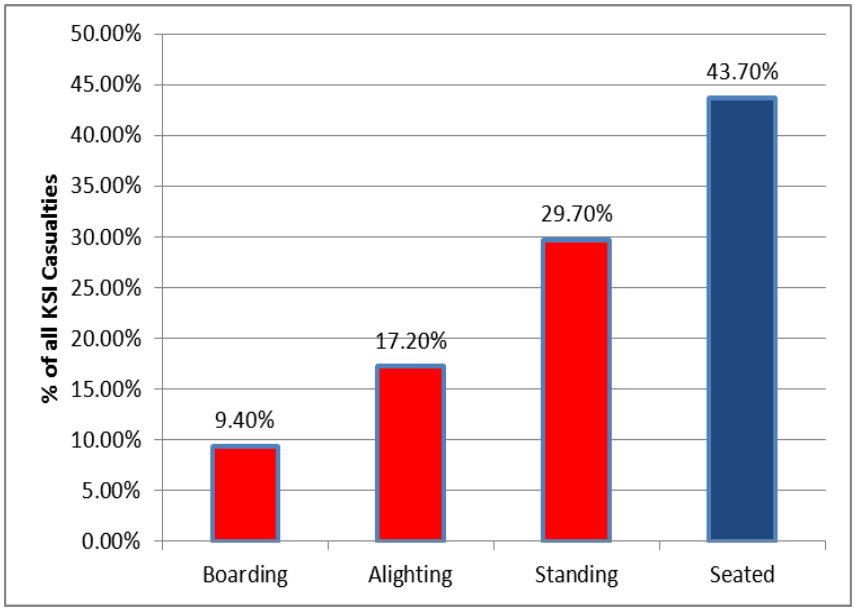


Figure 6.6 indicates that most such injuries are from heavy braking or during entrance to or egress from the bus. Comparison with figures from Fildes et al (2012) would indicate possible under reporting issues regarding the Transport Safety Victoria data.

Frith et al (2012) reported that Britain is one of the few countries to require drivers of road PT vehicles to report all injury-producing incidents to the Police. These injuries can then generate a crash report and be included in official road crash data. They quote from Kirk et al (2003) the finding that, out of all killed or seriously injured passengers on buses or coaches in Great Britain from 1999 to 2001 inclusive, 64.3% were injured in non-collision incidents. Of these casualties, 74.2% were female and a large proportion (58.0%) were 60 years or older. At the time of the study, 1.4% of overall injuries were related to buses or coaches, meaning that approximately 1% of those killed or seriously injured on British roads at the time were injured in non-collision incidents on PT.

Figure 6.7 from Kirk et al (2003) depicts in what situation travellers were injured, showing that 56.4% were not seated when injured, with 9.4% boarding and 17.2% alighting at the time of injury.

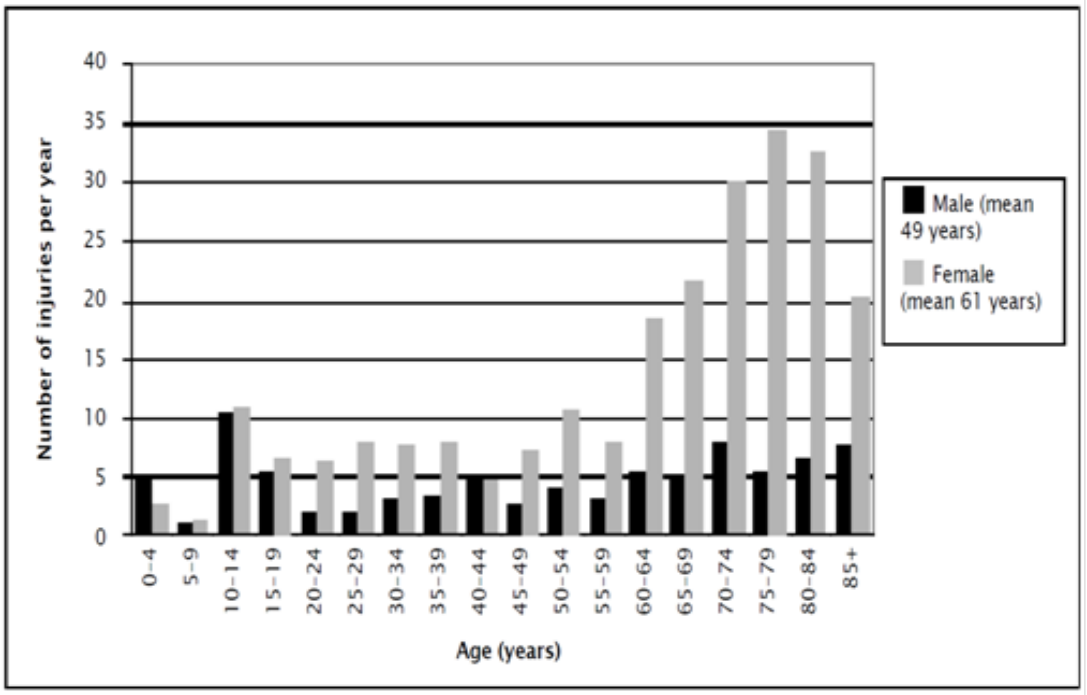
Figure 6.7 Situation of casualties killed or seriously injured related to buses and coaches



Source: Kirk et al (2003)

As shown in figure 6.8 and mentioned above, the injuries tend to be biased towards older people and women.

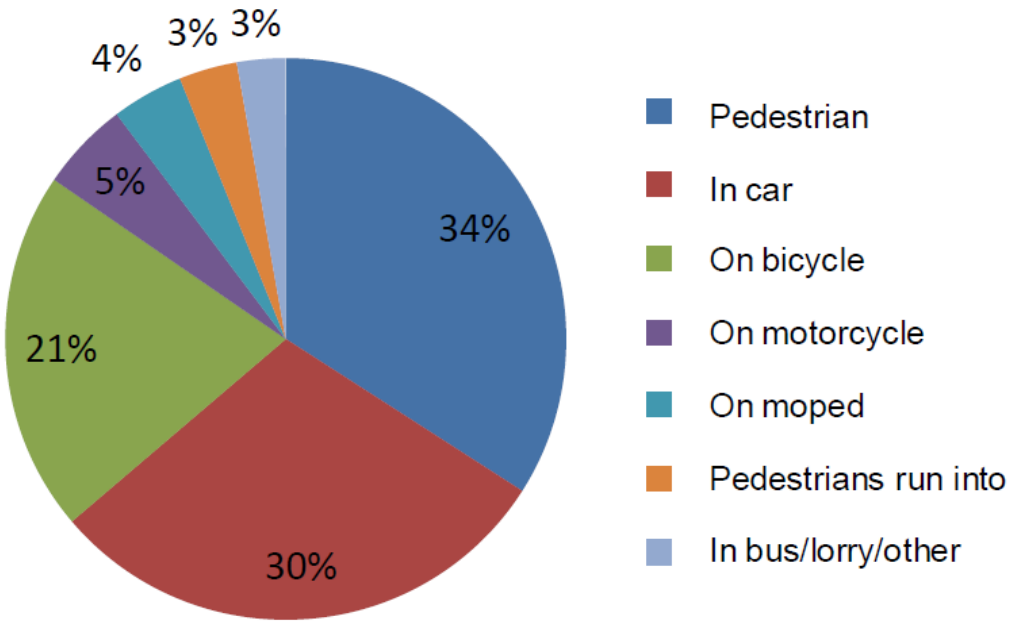
Figure 6.8 Age/gender in non- collision bus injuries in Britain from 1994 to 1998



Source: Kirk et al (2003)

Björnstig et al (2005) reported a hospital study of 284 cases of bus or coach passenger injury suffered over 10 years in a geographically well-defined area of Sweden. It was found that 54.0% of injuries occurred in non-crash incidents, with these incidents consuming 57.0% of all in-patient days. Two-thirds of these injuries were incurred while alighting from or boarding vehicles, with the rest being caused by falling or sustaining some other type of injury while the vehicle was moving. Locally there have been problems in Wellington with bus rear doors malfunctioning as passengers exit causing injury.[8]

Figure 6.9 Swedish 'very serious' injuries to road users by situation of injury



Source: STA (2012)

Therefore, injuries while on PT not related to collisions have the potential to be very serious. These need to be taken into account if integrating PT into the *Safer Journeys* view of road safety.

Outside of New Zealand various mechanisms are used to report rail injuries. All countries have mechanisms for reporting rail injuries, and an international database of incidents including injury incidents is kept by the International Union of Railways (UIC)[9]. Rail operators may have their own reporting rules. There are also reporting requirements under workplace safety rules. To give some examples, in the USA the Federal Railroad Administration has a complex set of criteria (FRA nd) for reporting events involving injury, which overarches workplace safety requirements. In Victoria the Transport Accident Commission (TAC nd) fills a similar role to New Zealand's ACC regarding no fault compensation for road and rail crash victims, so all rail injuries requiring compensation are reported to them. In Victoria, passenger rail incidents must by statute be reported to the regulator, Transport Safety, passenger vehicle incidents[10].

[8] www.police.govt.nz/news/release/bus-company-sentenced-safety-failings. Accessed 27 October 2015.

[9] www.uic.org/ Accessed 7 September 2015.

[10] An 'incident' may or may not involve injury.

6.3 Pedestrian and PT accidents

6.3.1 Discussion

Incidents involving pedestrians and PT vehicles are also important to consider when evaluating the role PT may play in the *Safer Systems* approach. In New Zealand, there were 8,271 buses registered in 2013 (MoT 2014a), representing 0.2% of the total New Zealand vehicle fleet. In 2012, 57 pedestrians were injured or killed being struck by buses/trucks (MoT 2013). To put this in context, the number of fatalities on New Zealand roads over the same period was 308, with 12,122 non-fatal injuries (MoT 2013).

Rail incidents involving injury with pedestrians (and cyclists) appear to be less common, with six collisions and 21 near collisions occurring in 2014 (MoT 2014b). Table 6.8 provides the data for rail casualty incidents over time, split by casualty type. This shows that rates of injury and fatality from rail incidents have fluctuated over the last five years in New Zealand, with increases in the rate of injury to rail employees over time being responsible for the majority of this. The data shows that, where a pedestrian is involved in an incident with a train, this is more likely to result in a fatality than an injury. Therefore, while these incidents are relatively uncommon, when they do occur they are likely to be very severe.

Table 6.8 Deaths and reported injuries for grouped rail accident types in the New Zealand rail occurrence database

		Year				
		2009	2010	2011	2012	2013
Motor vehicle level crossing casualties	Deaths	4	0	2	2	2
	Injuries	8	9	13	7	14
Pedestrian level crossing casualties	Deaths	0	1	0	4	3
	Injuries	0	0	0	0	1
Pedal cyclist level crossing casualties	Deaths	0	0	0	0	0
	Injuries	0	1	0	2	0
Person on track casualties	Deaths	7	9	11	16	6
	Injuries	3	1	5	6	2
Other casualties – members of the public	Deaths	1	0	0	1	1
	Injuries	13	24	27	16	15
Other casualties – rail employees	Deaths	0	0	0	0	0
	Injuries	10	13	42	106	94
All rail accident death and injuries	Deaths	12	10	13	23	11
	Injuries	34	48	87	138	126

Source: MoT (2014b)

In railway terms, pedestrians and cyclists involved in railway incidents are 'trespassers' unless they are legally on the tracks at designated crossing points. Patterson (2004) looked at patterns of trespasser-related incidents in New Zealand. The report included details of a Tranz Metro observational study of trespassing on Wellington suburban train lines. The study found that trespassing was worst at peak times between 7am and 9am in the morning, and 3pm and 6pm in the evening, with people moving to and from work and school. Convenience, time and suicidal intention were major reasons for trespassing. This finding is relevant to suburban commuter rail operators. In addition Patterson found, from an analysis of coroners' reports from 1999 to 2003 (see table 6.9), that alcohol and suicide were the main contributing factors to trespassers being killed by trains.

Table 6.9 Contributing factors associated with trespasser fatalities, from New Zealand coroners' reports 1999–2003[(a)]

Cause	Number
Alcohol	20
Suicide	17
Lying/sitting on track	7
Walking on track	6
Crossing track	3
Jumped in front of train	3
Hearing impaired	3
Cannabis	3
Working near track	2
Fall from platform	2
Inattentive	1
Playing chicken	1

[(a)] A fatal incident can have more than one contributing factor.

Patterson (2004) concluded that:

> *The most effective measure for reducing these behaviours is to completely restrict access to the railway tracks throughout New Zealand. This is a very expensive option for New Zealand, which has over 4,716 km of railroads, and may be subject to vandalism. Thus other measures are needed such as an education campaign backed up by enforcement in problem areas. This is unlikely to reduce suicide incidences but may help reduce incidences of intoxicated pedestrians walking home via the railway tracks and people crossing the track for convenience.* (p14)

Table 6.10 shows the temporal pattern of trespasser serious injury and death between 1994 and 2003.This shows that around 60% of trespasser deaths and serious injuries are within the times of day when one would expect most commuter trains to be running, with a substantial proportion also occurring late at night.

Fildes et al (2012) report that two-thirds of all PT deaths reported in Victoria were judged by the coroner to be intentional to cause self-harm by the user. Given that 90% of Victorian PT deaths are related to trains, this implies significant death by self-harm (suicide) in the Victorian train-related deaths.

Table 6.10 Time of day and day of week when Wellington Tranz Metro trespassers were killed or seriously injured, 1994–2003

Day of week	Day (6am–5.59pm)	Evening (6pm–9.59pm)	Night (10pm–5.59am)
Monday	11	2	5
Tuesday	11	3	9
Wednesday	19	4	8
Thursday	22	3	17
Friday	13	4	19
Saturday	7	2	6
Sunday	8	0	2
Total	91	18	66

Moving on to the operation of buses, due to a number of incidents between buses and pedestrians occurring in the Wellington CBD (eg Fuatai 2014; NZ Police 2011; Newswire 2010), Opus Research carried out a human factors behavioural assessment to explore the correlates of 'near misses' (or potential conflicts) and the rate at which these were occurring at several key sites (Thomas et al 2011). This work therefore provides insights into the rate at which these incidents occur in a city with a bus network.

The main part of this study consisted of extensive observations (through recorded footage) at four fixed locations across the 'Golden Mile' in the Wellington CBD[11]. These observations showed that situations in which pedestrians are at heightened risk of an accident with a bus make up only a very small proportion of pedestrian crossings. In total, 3.8% (N=53) of the 1,386 total crossings observed were defined as 'potential conflicts', with a vehicle occupying the same space as a pedestrian within two to three seconds. In total 23 (43.4%) of these crossings were in potential conflict with a bus, indicating that crossings where small gaps in front of buses are accepted make up a substantial proportion of overall potential conflicts with vehicles in this city (Thomas et al 2011). However, as detailed below, vehicle type (bus versus car) did not relate to likelihood for potential conflict.

When any crossing that included conflict avoidance behaviours (such as vehicle swerving/braking, pedestrian false starting, partially running or partially crossing), were included in the definition of near-miss the 3.8% rate increased to 6.6% (N=92) (Thomas et al 2011). Both of these rates of potential conflict are substantially lower than those found in other cities, such as Sydney at 10% (Hatfield and Murphy 2007).

This exploratory study included a number of factors that were hypothesised as likely to relate to crossing behaviours and outcomes (Thomas et al 2011). These factors included those relating to:

- Pedestrians: including demographic measures (age, gender, body type), clothing measures (clothing type, footwear type, headwear including use of headphones), and activity during crossing (audio activity, visual activity, physical activities)
- The site: including engineering factors (road width, lane separation, kerb height, colour contrast, street furniture, and sight distance) and road and roadside environment alterations (any recent alterations that could alter behaviour, such as speed zone changes, use of colour, change from two-way to one-way).

It was found that a number of factors were related to the occurrence of potential conflicts (Thomas et al 2011), including:

- Looking behaviour: those crossing at locations without pedestrian signals where pedestrians only partially looked (eg only looked in one direction before stepping on to the road) were more likely to be in potential conflict with a vehicle
- Waiting behaviour: those who waited on the road rather than the footpath were more likely to accept smaller gaps with vehicles
- Speed during crossing: pedestrians who increased their speed part way through crossing were more likely to have potential conflicts, revealing that these incidents may arise when pedestrians misjudge the speed or distance of the approaching vehicle (or simply do not notice them prior to beginning to cross)

[11] The 'Golden Mile' is a bus route in the Wellington CBD consisting of Lambton Quay, Willis Street, Manners Street and Courtenay Place.

- Non-compliant crossing behaviour at signalised pedestrian crossings: potential conflicts only arose at signalised crossings when the pedestrians crossed during the red phase (eg were temporally non-compliant).

Factors found not to relate to the occurrence of potential conflicts included:

- individual differences such as age, gender and body type
- footwear type (including sport shoe versus high heel) or clothing type
- perceptual impairment due to audio-visual activities or physical impairment due to physical load
- time of day (eg peak, where people may be in a hurry versus non-peak)
- crossing group size
- spatial deviation at signalised crossings
- vehicle type (with potential conflicts being equally likely with buses and cars).

6.3.2 Conclusions

Overall, the evidence available to date shows that crashes between pedestrians and buses and trains are relatively infrequent in New Zealand. However, they have the potential to be very serious when they do occur. Findings from the previous work by Thomas et al (2011) reveal ways in which the existing risk can be reduced further by targeting factors found to relate to the occurrence of potential conflicts. For example, social marketing campaigns could be implemented emphasising the relationship between positive pedestrian behaviours and safety outcomes, and improved crossings could be installed as appropriate to encourage compliance (such as PUFFIN crossings that reduce wait times for pedestrians). For more detailed results and a full list of recommendations see Thomas et al (2011).

6.4 Catastrophic risk

Signals passed at danger (SPAD) incidents are a potential source of catastrophic rail crashes. SPADs have been identified as a key factor in a number of major rail catastrophes, including the Ladbroke Grove rail crash in the UK and the Hinton train crash in Canada (Lawton and Ward 2005). All things being equal the chances of SPADs occurring can only increase if rail traffic in the form of commuter rail is to increase. Of late, the number of SPAD incidents occurring in New Zealand has been increasing despite attempts by the rail Industry to mitigate SPAD risk (KiwiRail 2013). The continued increase in SPAD incidents indicates that current safety programmes have not been completely effective in moderating the factors that contribute to these incidents. However, recent action in this area on the commuter rail network in Auckland brings promise of better future outcomes (NZ Transport Agency 2013b). The upgrade of the Auckland commuter network incorporates new signalling equipped with European Train Control System (ETCS) level-1 automatic train protection functionality and the new trains have the on-board equipment to allow the ETCS to function. This will ensure that trains are stopped within the space of the safe overlap at signals. Electronic train protection, a train stop system working electronically to activate the air brakes, has also been installed to the existing diesel locomotives. Electronic train protection is a variant of the mechanical train stop system used in Wellington. Neither of these systems prevents SPADs *per se* but they both reduce the risk of collisions between trains markedly.

In the Australasian context, Naweed (2013) conducted an extensive investigation of factors contributing to SPAD incidents, and the countermeasures employed to mitigate and manage SPAD risk, looking not only at behavioural strategies but also organisational and systems strategies. Naweed employed a combination of

operational observations, focus group interviews and workshops to elicit knowledge from employees of eight rail organisations in Australia and New Zealand. It was found that the majority of SPAD events were the result of driver distraction and were influenced by four factors: time pressure, controller interaction, sighting restriction and station dwell. These are influential in that they cause disruption to the parameters of the service dynamic and disconnection/dislocation in the driver's signal dynamic.

Another area of potential catastrophe in both rail and road passenger transport are crashes or fires in tunnels. There is a large body of literature dealing with the issues involved in tunnel safety both road and rail with international organisations taking a coordination role in setting standards[12][13].

Other catastrophic risks to road passenger transport are road surface collapse and the travel of passenger vehicles beneath overhead obstacles that are lower than the height of the vehicle. These situations do occur occasionally but are very rare particularly on scheduled services with well-defined routes. They can be mitigated by rigorous auditing of routes and measures to prevent vehicles deviating from their routes. This is all part of having rigorous safety management systems within a Safe System framework. The risk of catastrophes like the Cradle Mountain minibus tragedy[14] where two vehicles were attempting to pass each other on a mountain road and one of them, a minibus on a tourist excursion, fell down a steep slope, can be mitigated by proactively employing good road safety engineering principles. Again such incidents are very rare particularly on the scheduled services which are the subject of this report.

To summarise, catastrophic risk is something which needs to be mitigated by proper safety management under a Safe System approach to safety.

[12] www.unece.org/trans/main/ac9/ac9rep.html

[13] http://tunnels.piarc.org/en/safety/

[14] www.courtlists.tas.gov.au/magistrate/decisions/coroners/cradlemt/info_5.htm Accessed 10 September 2015

7 Traveller safety when travelling to and from public transport

This section deals with those aspects of traveller safety when moving to and from PT not already dealt with in *Safer Journeys*. These aspects would also need integration if PT was to be included in any future version of *Safer Journeys*. They relate to non-motor vehicle injury to people walking and cycling. At present cycling is a very small mode when combined in a trip chain with PT. However, this may change to some extent if the reach of PT is to increase. Although this section is about journeys to and from PT some of the subject matter could also be applied to journeys with other purposes.

7.1 Walking infrastructure

Pedestrian safety relates to slips, trips and falls on roads and roadsides going to and from PT, and pedestrian collisions with motor vehicles. Work carried out by Frith and Thomas (2010) indicated the following infrastructural issues which can impact on pedestrian safety:

- Kerbs (vertical changes) are a major contributory factor in pedestrian trips, falls and injuries, particularly when stepping up (as opposed to down).
- Maintenance is more of an issue than initial design and construction.
- Site visits suggested that places where accidents occur tend to be rated unfavourably by experts vis-à-vis the part of the infrastructure associated with the accident. They also tend to have one or more faults that violate design standards in the relevant Transport Agency guide.
- Environments that are not forgiving to pedestrians, who may be fatigued, visually impaired or distracted, are more likely to cause accidents.
- Uneven construction is the most commonly reported hazard type in roadside pedestrian accidents.
- Environments ought to be predictable to the pedestrian ('no surprises').

Improving walking safety requires attention to these issues. This means attending to materials used in walking infrastructure (eg not using slippery materials), installation (eg avoiding unevenly laid pavers) and maintenance (eg fixing cracks, potholes) as well as using good design principles. These issues all need attention in the case of routes to and from PT, as they do in other situations.

7.2 Lighting for pedestrians

Many journeys to and from PT occur after dark. In their study, Frith and Thomas (2010) found that people who suffered an accident after dark, rated the walking environment of well-lit areas significantly better in terms of the design compared with that of poorly-lit areas. People were less likely to see hazards in poorly-lit environments, particularly surface hazards such as cracks, utility covers or grates.

Lester (2010) in a review of public lighting for pedestrians states that:

> *Throughout a pedestrian lighting scheme, the illuminance[15] needs to be reviewed from the perspective of likely pedestrian activity types and locations, and potentially matched to desired pedestrian activity types and locations.*

[15] For instance, the light coming from the lighting sources or luminaires.

Thus, on a pedestrian route to and from PT, the lighting needs to be suited to purposive walking and, at the stopping point of the transport; it needs to be suited to alighting, boarding and waiting.

Under these conditions navigation is important. Lester (2010) suggests that pedestrians should be able to distinguish 'through routes' from 'access routes' offered by the pedestrian network, with cues through the relative differences in the lighting levels provided for each. Targeting lighting so that it highlights particular features can contribute to a sense of orientation and thereby assist people to easily find their way. Lighting well-known buildings, monuments and other significant structures can allow their use as orientation landmarks for night-time users. She quotes from van der Hoeven et al (Eds) (2008) the statement that:

> *Important routes can be accentuated and objects that may aid orientation and navigation can be illuminated.*

Lester (2010) concludes that in a broad, open space, a clear thoroughfare can be encouraged and directed by providing a concentrated light passage. Physical items such as coloured paving can also be used to reinforce the passageway effect without compromising the daytime flexibility of the space.

Such measures would seem well suited to improving the safety of well-trafficked routes to and from PT. Also, with the advent of LED lighting, which is very energy efficient, the capacity to light at reasonable cost has increased, making pedestrian route lighting more affordable (Patterson and Gillespie 2011).

It is also important for after-dark pedestrians who are walking in areas where vehicles travel to wear suitable clothing, including reflectorisation, and to carry torches (CDC 2014).

7.3 Non-motor vehicle pedestrian and bicyclist crashes

In New Zealand, Frith and Thomas (2010) found that around 700 pedestrians were admitted to hospital per year due to slips, trips and stumbles on the road and roadside. This is similar in number to the 738 pedestrians admitted for motor vehicle injuries in 2008.

Thomas and Frith (2010) also reported that in Australia in 2003/04 there were 4,587 hospitalisations due to 'falls' classified as 'on street or highway'. This is 72% higher than the 2,666 pedestrian hospitalisations associated with motor vehicles.

In 2009, Methorst et al (2010) estimated the number and severity of pedestrian and bicycle accidents, including both those related to and those unrelated to, motor vehicle crashes. It was revealed that most pedestrian and cyclist casualties arose from accidents not involving another vehicle, and that around one-third of pedestrian fatalities and 80% of pedestrian injuries were due to falls. These results are tabulated in table 7.1 from Feypell et al (nd).

Table 7.1 Number of pedestrian and bicycle injuries in the Netherlands, 2003–2007

Average number of victims per year (2003–2007)[a]				
	Deceased	**Hospitalised (excl. deceased)**	**Urgent medical assistance (excl. hospitalised)**	**Total**
Pedestrians	150	5,200	49,700	55,000
Of which single accidents[b]	45	4,000	45,900	50,000
Of which traffic accidents	105	1,200	3,800	5,000
Cyclists	220	7,600	60,200	68,000
Of which single accidents	50	6,000	47,500	53,500
Of which multiple vehicle	170	1,600	12,700	14,500

[a] Numbers rounded and corrected for doubles.

[b] A 'single accident' for a pedestrian is one involving the pedestrian alone – no other person or vehicle involved. For instance a trip, fall or collision with an obstacle.

Swedish studies (eg Öberg 2010; Larsson 2009) quoted in Feypell et al (nd) showed similar results, with 75% of injured pedestrians being related to pedestrian-only events (table 7.2).

Table 7.2 Pedestrian injuries in Sweden, 1998–2007

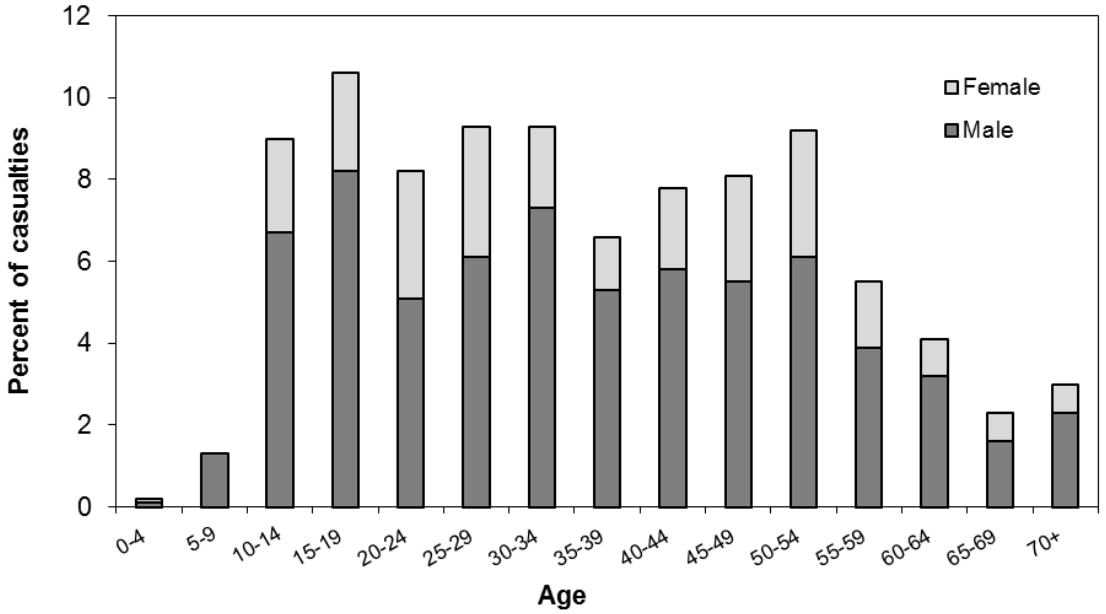
		Traffic accident	**Non- traffic accident**	**Total**
Sweden (1998–2007)	Injured pedestrians (number)	6,433	19,656	26,089
	Injured pedestrians (%)	25%	75%	100%

Source: Larsson (2009)

The US Department of Transportation (1999) analysed the circumstances of 1,345 cases of pedestrian injury. It showed that 64% of pedestrian injuries did not involve a motor vehicle. The Spanish National Health Survey (Ministerio de Sanidad y Consumo 2006) indicated that in Spain, there were as many people injured falling in the street as in traffic crashes.

Figure 7.1 depicts non-motor vehicle-related cyclist hospitalisations in New Zealand in 2012. These include off-road cases (eg trail-biking) as well as on-road cases. A small number of these may be related to trip chains involving PT.

Figure 7.1 Non- motor vehicle- related cycling injuries by age and gender



Source: MoT (2015f)

To provide perspective, figures 6.1 and 6.2 show motor vehicle-related injuries to cyclists per unit time and per unit distance.-

7.4 Safe interchange facilities

If PT is to increase its share of urban journeys, it is axiomatic that it must cater to as many personal transport choices as possible. In order to achieve this, a network approach is required with multiple nodes where PT passengers may change as seamlessly as possible between routes and between modes (Mees et al 2010). These interchange facilities cover a wide range of situations from simple bus stops, to facilities like the New Lynn interchange in Auckland, to the complex facilities one sees in major cities like Tokyo. In all cases the interchange (and intersections) need to be safe. This is not only for the protection of people transferring between modes, but for the good of the service as a whole. The very existence of a need to transfer between modes or vehicles is seen as a penalty by passengers and, if the interchange is lengthy and/or unsafe or perceived as unsafe, travellers may not use it and patronage will suffer. This has a safety decrement attached to it if the alternative is a less safe mode. Thus design of interchanges is important (Monigl et al 2010).

Higginson and Glover (1998) analysed the characteristics of good interchanges and identified opportunities for practical improvements. Signing, lighting and walkways, safer pedestrian crossings and on-street stop-point grouping to minimise walking distances, were found to often make interchange easier, quicker and more pleasant, at a minimal cost.

NSW Ministry of Transport (2008) advises that separation between the key modes of pedestrians, cyclists, buses, taxis and cars improves safety and efficiency. Segregating different vehicle types within an interchange can also help to reduce potential conflicts. Designated entrances and exits to the station and road network, particularly for buses, are desirable. Design models that segregate pedestrian and vehicle movements, and feature clearly marked crossing points that give pedestrians priority, are recommended

to minimise conflict. Separating flows of arriving and departing passengers will maximise the efficiency of pedestrian spaces. Effective management of significant pedestrian flows can be achieved with signalised crossing of roads or grade separation where appropriate.

The Auckland Transport Interchange Design Guidelines (Auckland Transport 2013) have little specific detail on safety, which is predominantly considered in association with personal security.

Olszewski (2012) proposed a method for quantitative assessment of PT interchanges. This method takes safety into account only in places where pedestrians conflict with traffic. The degree of safety is assigned to each road crossing depending on its type as follows:

- underground or overhead crossing = 100%
- signalised crossing, no conflicts with turning vehicles = 70%
- signalised crossing, conflicts with turning vehicles = 50%
- unsignalised zebra crossing = 30%
- unmarked pedestrian crossing = 0%.

7.5 Urban planning to influence modal split

If PT is to be integrated into the Safe System approach to road safety, Safe System principles must be incorporated into planning practices. Land use is much more than the location and density of residential development, along with the permitted mix of uses (residential, retail, services, employment, health, leisure, etc). It also includes:

- the distance to shopping, health care, leisure and other services
- the detailed local road layout which, alongside residential density, helps to determine the feasibility of efficient, usable PT
- the network of paths or footpaths for pedestrians, powered wheelchairs, scooters and bicycles, including safe road crossings to encourage use of these transport modes where applicable.

In current land-use planning practices, especially for new developments, marketing concerns often outweigh considerations of functionality for future generations. Compact communities with locally available facilities are of general benefit to society, and support environmental sustainability policies. Howard and Szwed (2005) have provided a comprehensive list of safe land transport system planning practices. These include:

- providing employment, education and recreational opportunities within the new development
- clustering land uses into activity nodes (including schools and shops) to maximise PT, walking and cycling options
- integrating planning, from the start of the planning process, for all transport modes (not only cars, motorcycles and trucks but also PT, cycling and walking)
- planning for direct and convenient bus routes within walking distance of all new residential allotments
- introducing PT services early in new growth areas
- locating activity centres near railway stations or other PT interchanges so that PT is convenient
- providing safe and convenient access to transport interchanges for people of all abilities and ages, and by all modes of transport, particularly walking and cycling

- scheduling PT infrastructure development (stations and PT interchanges) to suit residential development needs
- encouraging bus operators to extend routes into new residential estates at the earliest possible stage so that reliance on cars can be minimised
- planning activity centres to be free of vehicular traffic if possible; otherwise, speeds should be engineered to be as low as possible
- scheduling main bus routes to provide direct connections with major activity centres
- developing pedestrian and cycle paths to provide direct, continuous access
- as far as possible, separating pedestrian and cycle paths from major traffic routes, while maintaining personal security (ie being open and visible)
- ensuring paths are continuous and convenient, and connect with adjacent networks, and have a consistent standard and are well signed.

In addition Safe System principles dictate that path users, such as pedestrians, cyclists and wheel chairs, should not conflict with each other.

They also urge that successful land-use planning – in keeping with Safe System principles – will need to involve a broad range of people:

- the developers: town planners, urban designers and traffic engineers
- local government: councillors, planners and traffic engineers
- regional government: infrastructure planning, land use planning and education
- the community: consumers, workers, local residents etc.

If these sorts of principles were to be applied, the use of less safe modes would decline, with an attendant move towards PT. Useful guiding documents in this area are the NZ Transport Agency (2009) *Pedestrian planning and design guide* and the New Zealand Standard, *NZS4404:2010 Land development and subdivision infrastructure*.

8 How public transport can fit into a Safe System framework – lessons from overseas

The data analyses available regarding risk of injury while travelling via PT indicate that PT is a very safe mode relative to other modes, and therefore a modal shift to PT would improve road safety. However, this is an explicit aim of few road safety strategies in developed countries. It is more often dealt with as part of the less-than-explicit background statements which link road safety strategies to sister strategies and overarching strategies in the world of strategic transport planning. Where it is mentioned in road safety strategies, it is as an aspirational statement with no associated targets or actions.

The following information is gleaned from public sources augmented by an email survey. The survey was conducted to gather further information than is available publicly regarding international inclusion of PT in road safety strategies, which in the main use a Safer System framework. The following key questions were asked of those contacted, including:

- Is modal shift to urban PT part of [insert country]'s road safety strategy?
  - If yes, please explain how this is achieved and the reason why it is included, and if you feel doing so has a positive influence on road safety.
  - If no, please explain how urban PT strategy is decided in your country and whether you see any road safety advantages in linking it to the road safety strategy or incorporating it into the road safety strategy.

Respondents were also asked to provide related documentation or references where available. The information provided below varies with the amount of information available from the sources contacted.

8.1 The European Commission

The European Commission Urban Mobility Package, in the context of enhancing sustainable urban mobility, considers road safety in a traditional Safe System fashion with no integration of thinking between road safety and the possibility of increasing it with assistance from modal shifts to PT.

8.2 The World Bank

The World Bank (2002) also tackled road safety separately from PT safety. This may be related to the fact that the World Bank deals largely with developing nations, where PT is not always a safer option.

8.3 The World Health Organisation

The WHO has taken an active part in promoting road safety with its decade of action for road safety 2011–2020 and its accompanying road safety status reports, the latest being WHO (2013). In WHO (2013), safe PT is promoted as a way to improve mobility, while increasing safety and reducing congestion, with the following statement (page 33):

> *Governments must ensure that PT systems are safe, accessible and affordable. In this way reductions in congestion and improvements in mobility can be achieved concurrently with improvements in safety.*

Concern is expressed about the lack of safety in PT in parts of the developing world. However, no opinion is offered on what institutional or strategic arrangements should be brought into play to achieve safer PT in the developing world.

8.4 The European Transport Safety Council

The ETSC promotes the links between safety, modal shift and PT. ETSC (2008, p33) includes the statement 'The EU should encourage the Member States in the short term (2010–2012) to promote the extension, quality and use of PT'. This is later backed up by the following recommendation to the European Commission in ETSC (2011, p12) that it should 'Recognise the benefit that the core PT modes (bus and rail) are the safest modes of transport'. Earlier it is made clear that the term 'PT' includes the journeys to and from PT, by foot and cycle. Car journeys to and from PT are not mentioned as part of a PT journey, which is arguable.

8.5 The United Nations

The United Nations (2013) has an overarching transport goal of 'Creating universal access to safe, clean and affordable transport'. This is conceptualised via its 'Avoid-Shift-Improve' approach which revolves around the following points:

1 Avoid the need for unnecessary motorised trips through smarter land-use and logistics planning

2 Shift the transport of goods and persons to more efficient modes

3 Improve the efficiency and environmental performance of transport systems by improved vehicles, fuel and network operations and management technologies.

To implement this sort of concept would involve overarching actions above *Safer Journeys*. Again, the strategy seems to involve shaping the road transport sector through overarching sustainability policies and then using normal road safety measures to deal with the safety of the traffic flows which exist after the sustainability policies have been implemented.

8.6 Sweden

In Sweden a traditional Safe System approach to road safety is in place. There is a small difference, however, in that the strategy in place has an ambition to take slips, trips and falls related to PT into account. This includes such incidents while boarding and exiting PT vehicles, as well as on pedestrian and bicycle journey legs (including those accessing and leaving PT vehicles) (STA 2012). Modal shift is not used as a specific instrument to improve safety in Sweden. Swedish authorities accepted in the 1990s that road safety considerations were never likely to be deciders of PT policy or strategy. There is, however, a focus on 'whole journey' safety, with pedestrian injuries not related to motor vehicles being counted, including significant numbers reported to take place in transit while inside PT vehicles. Bicycle crashes not related to motor vehicles are also recorded. Planning of safety for urban PT is typically done by the relevant local government, with the Swedish Transport Administration also having a role to play (eg being involved in designing bus stops, setting speed limits and so on, that influence the safety of PT).

8.7 Norway

The Norwegian National Transport Plan 2014–2023 (Ministry of Transport and Communications nd) has the objective that 'the growth in passenger transport in urban areas must be absorbed by PT, cycling and

walking'. Absorption by PT would be safer than more private road traffic, but again there is no objective to achieve greater safety through a shift from cars to PT.

8.8 France

In France there is a strategy to favour PT over private vehicles (Ministry of Ecology and Sustainable Planning and Development, nd-a), which overarches the road safety strategy (Ministry of Ecology and Sustainable Planning and Development, nd-b).

8.9 United Kingdom

The UK Department for Transport (DfT) has a Strategic Framework for Road Safety (UK Department for Transport 2011a). This framework, which does not refer to a Safe System approach, gives a blueprint for improving road safety in the UK. It, like other documents, does not take into account modal shift between private transport and PT. PT is taken care of under sustainable travel. It does, however, delegate much of the decision making to the local and regional levels where this may have been taken into account already, and recommends making links to 'other local agendas', such as sustainable travel (p9).The overarching 2011 UK White Paper on 'making sustainable transport happen' (UK Department for Transport 2011b) recommends measures to achieve shifts from private transport to PT, including encouraging walking and cycling where possible.

DfT has launched a 'Door to Door Strategy' (DfT 2013) for improving sustainable transport integration. This looks in depth at non-motor-vehicle journeys and how they connect and can be fostered on a door-to-door basis. This, by its nature, includes PT and journeys to and from PT. It gives considerable space to safety issues. This is from the same department as the UK's Road Safety Strategy, and thus under the same overarching government policy umbrella, but the two work in separate parallel streams. The 'Door to Door' strategy speaks more about air quality and congestion but improved road safety would be an additional benefit. From a road safety point of view there is the idea that moving people out of their cars and onto PT could make them more vulnerable as pedestrians and cyclists. This is one of the few documents around which, in a practical situation – commuting to work – views the safety of all modes in a dispassionate fashion. Among actions the strategy sought to promote were better funding for walking and cycling safety, improving sustainable access to PT and better interchange facilities.

8.10 Australia

8.10.1 The Federal Government

The concept of modal shift to urban PT is not discussed specifically as part of the road safety strategy (eg there are no targets or action items relating to modal shift in the road safety strategy), with the strategy being more focused on other solutions. One sentence from the strategy publication does hint at the concept, however:

> *Safe alternative transport options are to be encouraged, including the use of PT.* (Australian Transport Council 2011, p37)

Further, it appears that no state or territory has concrete objectives or strategies in place to pursue increased PT use for safety outcomes. Therefore, while the potential road safety benefits of increased PT are acknowledged amongst road safety agencies, this is not a specific target sought after, with other

reasons for pursuing increased PT use (like lower emissions and sustainability) prevailing, and therefore other agencies working towards this goal.

8.10.2 States and territories of Australia

8.10.2.1 Australian Capital Territory (ACT)

In ACT, the PT strategy is set out in the ACT Government's Transport for Canberra Policy[16] which links its objectives to sustainability, public health (eg reducing obesity) and the environment. The Transport for Canberra Policy notes the two main opportunities are to change the balance of travel towards walking and cycling, and PT. It identifies safety as a barrier to people participating in cycling and walking, and references the ACT road safety strategy as the policy response.

Therefore, increasing PT patronage is a specific goal in the region. However, this aim has not been included in a Safe System framework.

8.10.2.2 South Australia

Towards zero together: South Australia's road safety strategy (Government of South Australia 2011) is based on a Safe System approach and recognises the need to increase safety priorities in land use and transport planning decisions by building connections with the planning process. This strategy is supported by action plans and the current Road Safety Action Plan (2013–2016)[17], containing 66 actions to be undertaken over the next three years falling under six key focus areas:

1 Investing in safer roads

2 Creating safer communities and neighbourhoods

3 Encouraging safer behaviours

4 Continuously improving the licensing system

5 Using new technologies

6 Creating better informed communities.

One of the priorities under 'creating safer communities and neighbourhoods' is to provide grants and partnership programmes to deliver projects that influence changes in road use behaviour towards safer, greener and more active travel. This includes encouraging a reduction in car use in favour of PT use. Urban PT strategy is also a key component in the Integrated Transport and Land Use Plan[18], and the 30-Year plan for Greater Adelaide[19].

8.10.2.3 Victoria

In Victoria, given population growth, congestion, constrained space and budgets for new infrastructure and its maintenance, there is a move towards consideration of implementing mode shift policies. However, the implications for road safety have not been quantified. From the Safe System perspective such a shift, if implemented, while seeming to improve road safety, needs to be cognisant of more walking and cycling and the inherent fatality/serious injury risks of these activities, if the land-use planning and road-use environment are not modified accordingly.

[16] www.transport.act.gov.au/policy_and_projects/transport_for_canberra_policy

[17] www.dpti.sa.gov.au/towardszerotogether/road_safety_strategies/sa_road_safety_action_plan

[18] www.transportplan.sa.gov.au/

[19] www.dpti.sa.gov.au/planning/30_year_plan/30_year_plan_2010

In Victoria the regulation of bus, rail and maritime safety is handled by a state government agency, Transport Safety Victoria[20] operating under its own Act of the Victorian Parliament following the principles espoused by the Office of the National Rail Safety Regulator (ONRSR). This agency uses a safety management framework broadly similar to the Safe System approach and, according to its website:

- licences, registers and accredits operators and other industry participants
- monitors the transport industry's and participants' systems for managing safety risks
- monitors compliance with transport safety legislation
- takes enforcement action as appropriate to promote safety outcomes in Victoria
- investigates and reports on transport safety matters
- provides advice and recommendations to the Minister for Ports and the Minister for PT on transport safety issues
- promotes awareness, and informs and educates on transport safety issues, including through practical guidance and training
- collects, analyses and reports on safety data and safety science
- develops policy relating to the administration of transport safety legislation
- represents Victoria in national reform issues, including the Council of Australian Government's national rail safety and maritime safety regulation agendas
- maintains constructive relationships with stakeholders in government, industry and the wider community on transport safety issues.

8.10.2.4 New South Wales

Road safety is now part of the overarching structure of Transport for NSW to ensure integrated transport planning. The NSW road safety strategy[21] fits under the NSW Long Term Transport Masterplan[22] which contains the strategic direction across all modes. Working within the same agency under the same transport masterplan means the road safety people are fully involved in investment in PT. Road safety audits are undertaken at every step of development. Thus, improving road safety is linked to improving PT by virtue of an integrated approach to planning. However, this is not without issues including possible risks to PT users and vulnerable road users from new PT infrastructure, and from increased PT movement on the road and on the rail corridors.

Overall, New South Wales has found the positives of their approach overwhelmingly outweigh any negatives for road safety. By working within one agency (and one transport cluster across the state) road safety professionals are directly involved and can work within PT project teams to identify, manage and mitigate any potential road safety risks. The fact that structurally they sit together means there is far more interaction and collaboration.

[20] www.transportsafety.vic.gov.au/

[21] http://roadsafety.transport.nsw.gov.au/aboutthecentre/strategies/nswroadsafetystrategy/index.html

[22] www.transport.nsw.gov.au/content/nsw-long-term-transport-master-plan

8.10.2.5 Queensland

Modal shift to PT has not been considered specifically in the most recent Queensland road safety action plans nor in Queensland's road safety strategy[23]. PT is mentioned only as an interested party. The link with PT may be considered in the future but shifts to active transport may have higher priority.

8.10.2.6 Western Australia

Western Australia's (WA) road safety strategy[24] includes 'Increased use of PT' as one of its five Safe System-based guiding principles (p23). These are:

- the limits of human performance
- the limits of human tolerance to violent forces
- shared responsibility
- a forgiving road system
- increased use of PT.

The fifth PT guiding principle is backed up by the statement:

> *Buses and trains are safer modes of travel than cars and motorcycles. The fewer people driving cars and riding motorbikes and scooters on our roads, the fewer deaths and serious injury crashes will occur. Increasing the use of alternative modes of transport also reduces congestion and vehicle emissions and supports sustainability.*

This inclusion signals that WA fundamentally recognises that getting people out of cars and off motorbikes and on to PT will contribute to reducing the number of people killed or seriously injured. However, the size of modal shift in transport required to significantly reduce serious crashes is not expected to be achieved quickly. Nevertheless, encouraging people to use PT will help realise safety benefits and contribute to WA achieving its towards zero target of 40% fewer people killed or seriously injured by 2020.

The WA Department of Transport is the key transport agency, along with its partners the PT Authority and Main Roads WA in consultation with the WA Department of Planning, which continue to plan for population growth in the Perth area. Currently, there is no overarching strategic plan for transport in WA. A transport policy framework provides a useful framework for describing the other key policy inputs that need to be considered as part of integrated transport planning.

Moving people and freight growth are the key priorities and are described in the Moving People Network Plan which sets a strategic approach to moving Perth's and Peel's rapidly growing population. It focuses on moving people, not vehicles, to manage congestion. There are now a number of short and longer-term plans in place that aim to manage transport needs into the future.

PT for Perth in 2031 – mapping out the future for Perth's PT network. Draft for public consultation document (WA DoT nd) describes Perth's future PT needs and specifically references safety outcomes.

8.11 Austria

The Austrian Road Safety Programme has modal shift as one of its strategic guiding principles (Austrian Ministry for Transport, Innovation and Technology 2011). However, the motives for this appear to be more

[23] http://tmr.qld.gov.au/Safety/Road-safety/Strategy-and-action-plans.aspx

[24] http://ors.wa.gov.au/Towards-Zero.aspx

likely related to sustainability and cultural differences as opposed to a Safer Systems approach. It appears modal shift has been successful in Austria, with 73% of all trips being conducted on a mode other than car (eg on PT, bicycle or walking) in 2012 in Vienna. In Innsbruck this figure was 67% and in Graz, 55%.

8.12 Finland

Modal shift is not included in the 2011–2014 Road Safety Plan in Finland. Modal shift is included in a list of long-term policies with intentions to develop mobility behaviour and mode choice by promoting walking, cycling and PT, and improving their conditions and guidance.

Contrasting with this minor focus on PT within the safety strategy in Finland, PT is reported to be strongly included in the government's transport policy and environment strategy for transport. The 2011–2014 Road Safety Plan is currently under evaluation and the next policy being developed, with a possible increased focus on factors such as: modal shift, urban planning, education and campaigns, traffic control and ITS.

8.13 Germany

Modal shift to urban PT is not part of Germany's national road safety strategy (FMTBUD 2011), with PT being part of regional responsibilities. The federal structure in Germany means national authorities are only able to provide recommendations. However, previous initiatives introduced in Germany have shown safety benefits, such as the introduction of 'disco buses' (weekend PT services for people aged 18–24 years) in the 1990s having a cost–benefit ratio reaching more than four (in terms of reduced road crashes) (see ROSEBUD Consortium 2006).

8.14 Hungary

Modal shift to urban PT is part of the road safety strategy in Hungary. Sustainability and environmental protection benefits are cited in addition to road safety benefits with regard to this goal. Measures used in Hungary to reduce car usage and improve modal split values for PT include:

- separate bus lanes
- signal priority for PT
- strong subsidisation of fares
- car parking toll system (planned) to redistribute demand in high-use zones
- reliable real-time PT information provision.

8.15 Netherlands

In the Netherlands, road safety and PT work in parallel, but without an overlap in policy. Therefore, PT has not featured to date in the Netherlands road safety strategy.

8.16 Summary

The international organisations are all in favour of reducing the use of personal motorised transport by shifts to PT, but so far this has only been reflected in recommendations, which are of course these

organisations' stock in trade. Table 8.1 provides a summary of the information reviewed above regarding practices in individual countries.

Table 8.1 Summary of practices by country

Country/or Australian state/territory	PT included in road safety strategy?	Is this planned for future?	Increased PT use existing goal in other strategies?	Additional notes
Australian Federal Government	✓	✓	✓	Road safety strategy does hint at the concept of modal shift (one sentence)
Australian Capital Territory	×	×	✓	
Queensland	×	×	✓	
South Australia	×	×	✓	Modal shift is a priority under one of the 6 key focus areas in the current road safety plan
Victoria	×	×	✓	
Western Australia	✓	✓	✓	Increased use of PT is one of five 'guiding principles' of the state's Safe System approach to road safety.
Austria	×	×	✓	Has had large successes in promoting PT use
Finland	✓	✓	✓	Modal shift included as a long-term policy
France	×	Not known	✓	
Germany	×	×	✓	PT is a regional responsibility. The federal structure means national authorities may only give recommendations. Evidence of a safety benefit of mode shift is available, however
Hungary	Not clear	×	✓	Measures employed to improve modal split include: separate bus lanes, signal priority, strong subsidisation of fares, car park tolling and reliable real-time information provision
Netherlands	×	×	✓	
Norway	×	Not known	✓	
Sweden	×	×	✓	Focus is on 'whole journey' safety – pedestrian and bicycle single crashes are counted

9 Summary of insights gleaned

- Overall, PT has been considered sporadically in the road safety strategies among developed countries and international organisations. Overwhelmingly road safety strategies revolve around road vehicle use driven by data on Police-reported crashes.
- The integration of PT into Safe System approaches or other types of road safety strategy has generally not been considered or undertaken widely. Most countries prefer to run their PT strategies, including those related to modal shift, in parallel with their road safety strategies, under overarching Government priorities. This group includes New Zealand.
- There are a few notable exceptions, but these consist of aspirational statements rather than commitments to hard actions or targets.
- This appears to be related to an appreciation that in PT strategy and policy, road safety policy makers are at best 'token players', with strategic decisions on PT being based more on other criteria like sustainability, emissions control and the need to provide PT services which meet the needs of communities.
- The impact on system safety of a policy of encouragement of PT under separate overarching priorities would, of course, be contingent on the industrial groups running the PT operations and their government regulators having a Safe System approach to their own operations, with definite policies to improve safety. This is the case with New Zealand's institutional arrangements.
- There exists, in New Zealand, an unintended, and data-availability driven under-emphasis, on the safety of people involved in injury events on the transport network not related to motor vehicle crashes. These include injuries to PT passengers on PT, passengers boarding and alighting from PT, walkers injured in non-motor vehicle incidents and cycle-only crashes. These types of injury are an important part of total land transport system trauma, and need greater awareness which requires better data availability, so that the required safety analyses can be undertaken. In Sweden these types of injury are now included in the road safety strategy.
- In addition to injury reduction benefits from a proportionately greater use of PT which could be achieved by other strategies, there are possible injury reduction benefits over and above those available under the current system from the integration of PT into *Safer Journeys*. These benefits would flow from the analysis of injury events not at present taken into account, leading to specific countermeasures to reduce the incidence of these events.

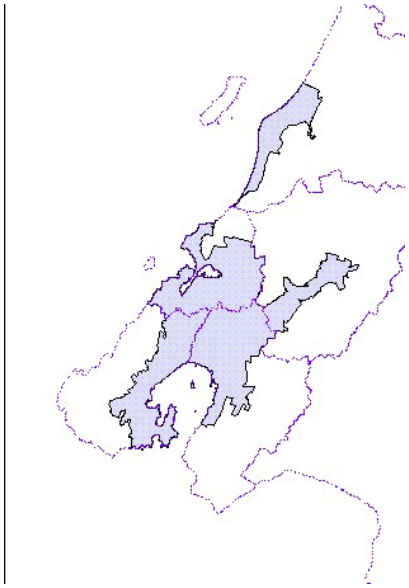
10 The potential impact of increased PT use on injuries in the main urban areas

All things being equal, an increase in PT usage should decrease travel by other modes by an amount equal to the increase in PT usage. All things being equal means, in this context, that the increased PT is not accompanied by changes in other modes to 'take up the slack'. Also changes to demography, including such factors as immigration-related cultural change and an aging population, are not taken into account. Fortunately, in New Zealand we have travel survey data from the (2015a) national travel survey, which enables us to compare the mode shares of various types of travel and also look at the consequences of mode changes on safety, by matching the travel data related to the change to injuries in Police-reported crashes involving motor vehicles and which may also involve non-motorised vehicles and pedestrian crash data.

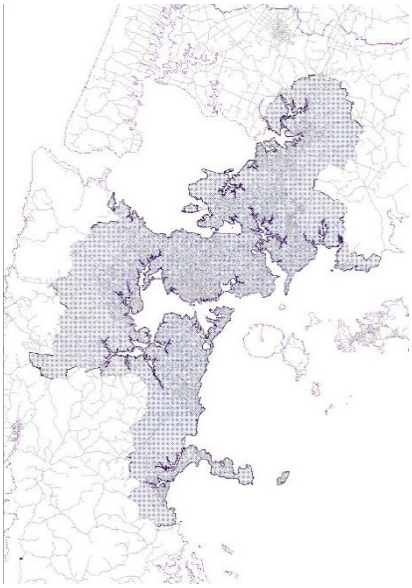
This section looks at the potential changes in injuries related to a hypothetical doubling of PT usage in the Wellington and Auckland main urban areas (MUAs) on an 'all things being equal' basis. The MUAs of Auckland and Wellington are defined by Statistics New Zealand as the areas shown in the maps in figure 10.1.

Figure 10.1 The main urban areas of Wellington and Auckland

Wellington MUA



Auckland MUA



Images courtesy MoT

As PT usage is typically concentrated between 7am and 9am, and 3pm and 7pm (MoT 2015b) most of the injuries saved by a move to PT would be expected around those times on weekdays. Figure 10.2 shows the weekday injury crashes by hour of day in the Auckland and Wellington MUAs.

Figure 10.2 Annual average number of Police- reported weekday injury crashes by time of day in the Auckland and Wellington MUAs during the years 2009–2014 inclusive

10.1 An example of travel changes associated with doubling PT in two measures of travel

New Zealand Travel Survey data supplied by the MoT was used to estimate travel by various modes in those areas during the period 2009–2012. The annual average travel by motorised personal transport (MPT) was matched to annual average crash data for MPT modes from the Transport Agency's Crash Analysis System (CAS) for 2009–2014. MPT was defined for this purpose as travel by car, van or motorcycle/moped. The travel survey measures of travel which were used related to person time spent travelling and person distance covered while travelling. The relevant travel tables are shown in tables 10.1 and 10.2. It is assumed that all increases in PT are from MPT, with no transfers from walking or cycling.

The next stage is to estimate the impact of a doubling of PT travel on MPT travel, and by implication MPT injury. It can be expected that, if PT increases, there will be commensurate decreases in MPT injury related to the consequent reduction in MPT travel. The changes considered are a doubling of:

- person time spent on PT
- person distance travelled on PT.

These changes are related to, but not exactly similar to, Auckland Transport PT targets. The Auckland Transport targets are over an extended time frame while this study looks at a hypothetical immediate step change.

This study explores two scenarios:

- person time spent on PT related to Police-reported PT injuries
- person distance travelled on PT related to Police-reported PT injuries.

It is not known which of these measures of travel relates best to injury while travelling, but looking at both scenarios provides an example of the range of potential injury reductions from shifting from MPT to PT with doubling PT. Table 10.1 depicts person hours of travel (in units of millions) by mode in the Auckland and Wellington MUAs.

Table 10.1 Million person hours of travel by mode in Auckland and Wellington MUAs (annual average- 2009–2012)

	Pedestrian	Car/van driver	Car/van passenger	Motorcycle rider or pillion	Cyclist	Local PT (bus/train/ ferry)	Other household travel
Auckland	49.3	277.7	77.1	1.6	4.5	21.9	7.5
Wellington	29.3	86.1	28.7	0.9	2.8	11.8	3.9
Total	78.5	363.8	105.7	2.5	7.3	33.6	11.4

Table 10.2 depicts person kilometres of travel (in units of millions) by mode in Auckland and Wellington MUAs.

Table 10.2 Million person kilometres by mode in Auckland and Wellington MUAs (annual average- 2009–2012)

	Pedestrian	Car/van driver	Car/van passenger	Motorcycle rider or pillion	Cyclist	Local PT (bus/train/ ferry)	Other household travel
Auckland	206.26	8,587.98	2,673.27	47.51	63.72	380.22	45.72
Wellington	117.79	3,108.52	1,124.28	41.38	34.6	239.47	18.15
Total	324.05	11,696.5	3,797.55	88.89	98.32	619.69	63.87

The information in tables 10.1 and 10.2 can now be combined with Police-reported injury data to compute the changes in Police-reported injury associated with doubling PT according to our two measures of travel.

The reader should note that these calculations have assumed that, in shifting from car to PT, there are no additional injuries experienced from non-reported incidences in getting on or off the PT unit, or injuries incurred from falls, slips, and trips while on PT. Obviously, these will tend to offset any benefits from the modal shift. It can be argued, though, that there are also likely to be non-reported injuries to car occupants in using their vehicles, so these should also be taken into account. It is reasonable to ignore these likely modifiers for the purpose of the example as they are little known effects to adjust by. This is an area that warrants further research.

10.2 MPT injury decreases associated with doubling of bus PT according to two measures of travel

In tables 10.1 and 10.2 MPT travel may be calculated by the summation of car/van driver, car/van passenger and motorcycle rider or pillion travel.

It is now possible to calculate the MPT injuries saved through an instantaneous doubling of PT according to our two measures in each MUA. This is done by first assuming that the person distance or time added to PT is deducted from MPT travel. We can then calculate the injury reduction by taking the total MPT injuries for each MUA and discounting them by the percentage reduction in MPT person hours or person kilometres travelled. These injury reductions will now be calculated for the Auckland and Wellington MUAs.

10.2.1.1 Auckland MUA

Doubling time spent on PT

In the case of Auckland, the total person hours for car/van occupants and motorised two-wheelers are 356.4 person hours annually and 21.9 person hours for PT users annually. If PT was to double to 43.8 person hours annually, this would decrease by 21.9 the MPT person hours annually, or by 6.1%. Between 2009 and 2014 there were on average 3,293 injuries to car/van occupants and motorised two-wheelers per year in the Auckland MUA. If these were to decrease by 6.1% there would be approximately 201 fewer injuries exclusive of any increase related to the extra PT trips.

Doubling person kilometres on PT

If similar calculations are made on the basis of person distance travelled annually, we find that annual motorised personal transport person kilometres would decrease by 380.22 million, from 11,308.76 million to 10,928.54, or by 3.4%. Again, if car/van occupants and motorised two-wheeler injuries were to decrease by this percentage there would be approximately 112 fewer injuries.

10.2.1.2 Wellington MUA

If the same calculations are carried out for Wellington the result is that the estimate of the percentage of injuries saved using the time rate is 10.2% and that using the distance rate is 5.6%. Given a baseline of an annual average of 793 injuries to car/van occupants this means 81 injuries are saved using the time rate and 44 using the distance rate.

10.2.1.3 Total for Auckland and Wellington MUAs

Adding these totals gives a grand total of 282 injuries saved using the time rate and 156 injuries using the distance rate for the combined Wellington and Auckland MUAs. This assumes of course that the modal shift is instantaneous. This is illustrated in table 10.3.

Table 10.3 Injuries saved in the Auckland and Wellington MUAs by doubling time spent by passengers on PT and distance covered by passengers on PT

MUA	Injuries saved by doubling passenger time spent on PT	Injuries saved by doubling passenger distance covered on PT
Auckland	201	112
Wellington	81	44
Total	282	156

10.3 Increases in bus-related injury associated with doubling bus PT according to two measures of travel

This section deals only with buses. This is because it is too hard to separate out commuter rail crashes from all rail crashes, and ferry-related injuries are hard to access. There were on average of 65 Police reported bus-related road injuries in the Auckland MUA per year over the relevant time period: two fatal, eight serious and 55 minor. Similarly for the Wellington MUA there were on average one fatal, five serious and 17 minor bus-related injuries per year. It is assumed that bus-related injuries would be double these numbers irrespective of whether the measure doubled is person time spent on buses or person distance travelled on buses. Thus, when the narrative reaches the stage of comparison these figures will be compared with the figures for our two measures of MPT.

10.3.1 Social costs

The MoT publishes social costs of crashes and crash injuries each year. These are disaggregated for urban and rural areas. The relevant urban figures for 2014 are (MoT 2015c):

- fatal injury: $3,982,000
- serious injury: $730,000
- minor injury: $71,000.

Summing the social costs of all the Police reported bus-related injuries yields an annual social cost of $17.7 million for bus-related injuries in the Auckland MUA, comprising two fatal, eight serious and 55 minor. Similarly there is an annual social cost of $8.84 million in the Wellington MUA, comprising one fatal, five serious and 17 minor injuries on average per year. These social costs can then be compared to the social costs saved by reducing MPT by an analogous amount of person hours or person kilometres. These are shown in tables 10.4 and 10.5 along with the associated indicative benefit–cost ratios (BCR).

10.3.1.1 Person time spent on buses

In this case, for the Auckland MUA, we reduce annual injuries on MPT by 201 through doubling person time on buses. If these follow the average annual pattern in the Auckland MUA, they will decrease by two fatal, 21 serious and 178 minor injuries. These in accordance with MoT figures would have a total social cost saving of $45 million. Thus, taking just these injuries into account, the change would have a BCR of around 2. The actual figure would be lower due to not counting 'on bus', 'entering bus' and 'leaving bus' injuries, and vulnerable mode injuries on connecting journeys to and from the bus. Similarly, for Wellington the indicative BCR comes out at 2. This is shown in table 10.4.

Table 10.4 Social benefits and indicative BCR associated with saved MPT injuries through doubling PT passenger hours travelled

MPT injuries saved by doubling PT passenger hours travelled						
	Fatal	Serious	Minor	Social benefit from less MPT injury	Social cost from greater bus injury	BCR (ignoring injury costs not associated with bus crashes involving other road users)
Auckland MUA	2	21	178	$35.9 million	$17.7 million	2.0
Wellington MUA	1	12	68	$17.6 million	$8.8 million	2.0
Total	3	33	246	$53.5 million	$26.5million	2.0

10.3.1.2 Person distance on buses

Similarly, if the MPT injury reductions are based on distance travelled, the social cost saved from MPT journeys would be based on saving one fatal injury, 12 serious injuries and 102 minor injuries. For Auckland, this results in social cost savings of $19.98 million. This is very close to the increase of social cost associated with the increase in PT, yielding an indicative BCR of 1.1. Using the same method yields an indicative BCR in Wellington of 1.1.

Table 10.5 Social benefits and indicative BCR associated with saved MPT injuries through doubling PT passenger kilometres travelled (based on travel 2009–2012 and injuries 2009–2014)

MPT injuries saved by doubling PT passenger kilometres						
	Fatal	Serious	Minor	Social benefit from less MPT	Social cost from greater bus injury	BCR (ignoring injury costs not associated with bus crashes involving other road users)
Auckland MUA	1.00	12	99	$19.8 million	$17.7 million	1.1
Wellington MUA	0.5	6.5	37	$9.4 million	$8.8 million	1.1
Total	1.5	18.5	136	$29.2 million	$26.5 million	1.1

Although they differ with the travel measure used, in all cases the indicative safety BCRs from shifting people from MPT to PT are positive, bearing in mind the assumptions that buses are the only PT mode taken into account and the only injuries taken into account are those reported by the Police. This excludes those injuries journeying to and from PT, entering and leaving PT, and injuries sustained during a PT journey which are not reported by the Police. Taking these into account would reduce the above BCRs by a presently unknown amount. Further study would be required to include these injuries (which are discussed in chapter 6) and to look at what is the most appropriate measure of travel to use in this sort of comparison. It is to be emphasised that these are only the safety benefits, and other non-safety benefits may accrue from a shift towards PT in urban areas. The BCRs are strikingly similar irrespective of whether it is the Auckland or Wellington MUA being considered.

11 Should modal shift to public transport be viewed as a road safety measure by road safety strategists?

11.1 Discussion

The actions looked at in earlier sections may have a positive but relatively small impact on modal split. To substantially tip modal split in the direction of greater PT usage, vis-à-vis other motorised modes, requires concerted action on the part of government, both central and local. It is arguable whether putting this under the umbrella of *Safer Journeys*, ie viewing it primarily as a safety measure rather than a sustainability measure or an emission control measure as in the GPS, would improve safety by moving the modal split more than if it was not placed under safety.

It is possible to think of two mechanisms by which targeting modal split as a road safety measure might possibly be effective:

1 If coming under the Safer Journeys umbrella meant that the funding balance between PT and motorised modes was tipped in PT's favour

This seems unlikely as both streams of funding are already under the New Zealand Land Transport Programme's funding umbrella (NZ Transport Agency 2012) and the funding decisions are taken in a holistic rather than uncoordinated fashion. There is already a strong push by the government towards PT as a congestion control and environmental measure and this is resulting in increased funding support. In 2011, the government expected to invest $4 billion in PT subsidies, and $2.3 billion for the Auckland and Wellington commuter rail networks for new equipment over the following 10 years (MoT 2011).

2 If coming under the Safer Journeys umbrella meant that the safety cultures of other modes would be improved

This again seems unlikely. The other modes are already under the tutelage of government bodies which have safety as high priority areas of their operation. There would need to be new safety-related actions which would require new funding, and these actions would need evidence bases to indicate they were worth doing as safety measures.

Also, leaving aside emissions and sustainability, the raison d'être of PT is the transport needs of the urban areas served by PT, where the people of these areas pay a large proportion of PT costs through rates and the fare box.

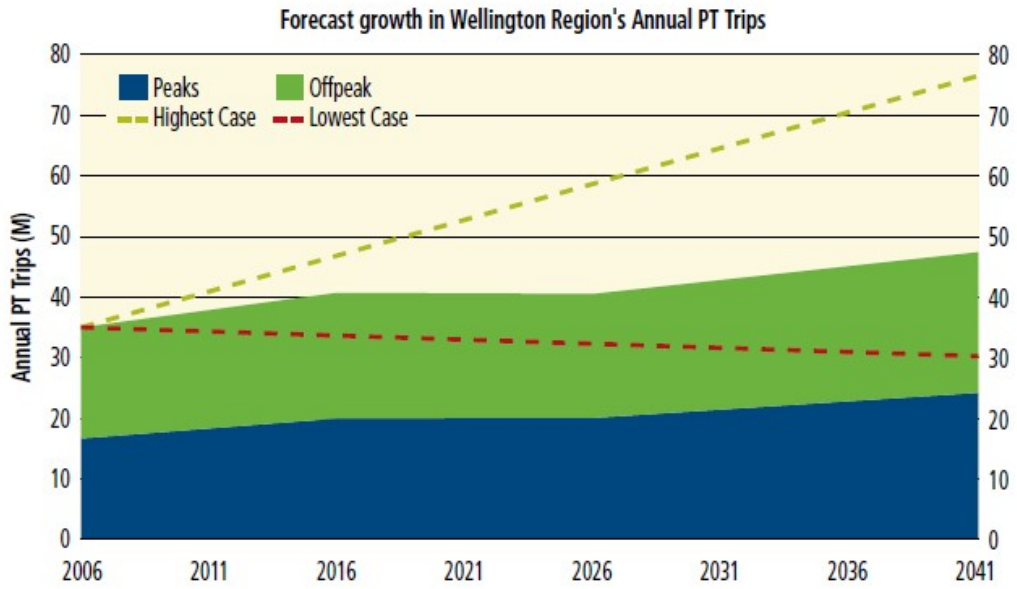
At present regional councils and the Auckland Council are putting considerable effort into moving modal split towards PT. Auckland Council has the following feasible but challenging targets (Auckland Council 2015):

- Doubling PT trips from 70 million to 140 million by 2022
- Increasing non-car (walking, cycling, and PT) mode share in the morning peak from 23% to 45% of all trips by 2040
- Increasing the proportion of trips made by PT into the city centre during the morning peak from 47 percent of all vehicular trips in 2011 to 70% by 2040
- Increasing the number of PT trips per person per year from 44 to 100 by 2040

- Increasing the proportion of people living within walking distance of frequent PT stops from 14% to 32% by 2040.

In discussion the council observed that achieving these targets would require continued investment in frequent PT networks that support the intensification of centres, corridors and future urban areas. Thus it can be taken that these targets reflect the potential impact of such planned changes in urban transport networks and in the form of the urban built environment. Road safety is a side issue with little impact if at all. Wellington has taken a different approach using scenario planning and endeavouring to forward plan the PT system to cater for possible future scenarios (GWRC 2010). Figure 11.1 summarises these scenarios.

Figure 11.1 Projected regional vehicle kilometres travelled per annum



Source: Wellington Transport Strategic Model

GWRC (2009, p2) claims 'integration' with PT planning in the following statement:

> *Many of the region's transport plans contribute to achieving a safe transport system. The regional plans for walking, cycling, and public transport sit alongside and integrate with this plan. These other plans focus on the provision of good quality infrastructure and services to ensure they are easy, safe and attractive to use. Public transport is the safest mode of travel and mode shift from less safe modes will positively contribute to safer outcomes. The corridor plans also include specified road and public transport improvements which often have safety benefits.*

This statement confirms the view that PT has safety benefits but they are incidental to the other benefits for which it is provided.

The Auckland Road Safety Plan (ARTA 2009) does not address relationships with other regional plans, but PT is mentioned constantly throughout the document in a descriptive manner as a safer mode to be encouraged and ways to encourage it are described. Whether this mention of PT in the road safety plan has changed any outcomes in terms of PT is impossible to know. Auckland will, of course, have done broadly similar planning to that done in Wellington, but has chosen to give more prominence to targets.

Discussions with Auckland Transport officials indicate that currently the road safety and PT teams work together on an ad hoc project-by-project basis. This is generally done by putting working groups together when required. There is active road safety input into PT projects ranging from the design of large scale public projects like bus lanes and interchanges to the design of bus stops and access to those bus stops. This, in many cases, is in the form of post auditing, which means retrofitting if road safety problems are detected. Auckland Transport is aware of this problem and is endeavouring to move towards a more proactive approach resembling that of New South Wales.

Regarding the safety of PT in Auckland there appears to be an emerging trend of injuries to people moving between PT infrastructures, eg people being hit by light vehicles while walking across the road between two bus shelters. Over the last five years there have been seven serious injuries and two fatalities related to this type of crash.

Auckland Transport is aware more needs to be done in relation to the Safe Systems approach. To this end they run half-day versions of the two-day course that used to be run nationally and would like to incorporate more PT into this than occurs at present.

They are also concerned to avoid mismatches with the street design aspirations of road safety engineers where, for instance traffic calming objectives may conflict with desires by PT operators to minimise impediments to vehicle movement.

In both Auckland and Wellington planning documents show a thorough approach to fostering PT within the structure and rules set down by the Transport Agency through the National Land Transport Programme which in turn operationalises policies laid out in the GPS.

11.2 Summary

In summary, there is little to dispute the notion that movement to PT would increase safety overall. Thus moves to tip the modal split towards PT will improve safety whatever their impetus. It is also true that too little attention is given to injuries not involving other motor vehicles on the journey to and from PT, on PT, and entering and alighting from PT. Some mechanism for giving these more prominence in the minds of decision makers is required, along with practical actions to better identify the size of the problem. This problem already has some emphasis within the land transport system and thus comes within the ambit of *Safer Journeys*. What is needed are actions under *Safer Journeys*, of which at present there are none. There may also be advantages in placing the management of safety within PT providers and regulators under the *Safer Journeys* umbrella.

Also, the surveys of overseas jurisdictions showed no practical impact of road safety strategies on PT provision policies or strategies. There were supportive words in some road safety strategies but nothing in the way of concrete actions. Indeed, in Sweden and Australia there was an acceptance that other factors like sustainability, emissions and urban form will continue to drive PT development and that road safety strategists would continue as supportive spectators giving encouragement from the side-lines.

The situation is similar in New Zealand with factors other than road safety driving PT policy in the GPS. There would thus appear to be a strong case for concluding that it is not worthwhile for road safety strategists to attempt to influence modal split away from MPT to urban PT. There is, however, a need to better understand injuries to PT users so that measures can be taken to make PT even safer, which will reinforce any government moves to increase its use. Governments will continue to promote and implement road safety and PT separately but with overarching direction provided at present by the GPS. This will be the view henceforth taken in this report. However, as previously mentioned there is a case for some aspects of PT to be under *Safer Journeys*. Discussion of this will follow.

12 Implementation

The *Safer Journeys* strategy was produced and implemented under the auspices of the National Road Safety Committee (NRSC). The members of the NRSC are the main public sector stakeholders with an interest in road safety in New Zealand. These include:

- MoT
- NZ Transport Agency
- ACC
- NZ Police.

The NRSC also has a number of associate members including Local Government New Zealand, The Energy Efficiency and Conservation Authority, the Ministries of Justice, Health and Education, and the Ministry of Business, Innovation and Employment.

The NRSC is serviced by the MoT. Therefore any implementation of changes to *Safer Journeys* related to PT would be the responsibility of the NRSC and, by implication, its servicing agency the MoT.

As discussed earlier, the changes envisaged do not involve any profound amendments to the structure of *Safer Journeys*. Taking cognisance of injuries on the total journeys involving road-based urban PT only involves changes in areas of interest and associated actions. When this is extended to rail and urban ferries, only an acknowledgement that the whole of journeys using urban passenger rail and ferries are of interest to *Safer Journeys*, and may be the subject of actions, would seem to be required.

Any of these changes could be made by a decision of the NRSC, following an appropriate briefing from the MoT, and the agreement of the Minister of Transport, who would naturally also be briefed appropriately by the MoT.

Once these changes have been made these areas would be considered along with other road safety areas in *Safer Journeys* and included and prioritised accordingly. The timing and extent of any changes to the priorities and action plans in the strategy would need to be discussed.

If commuter rail was to be included a decision would need to be made as to whether commuter rail operators should be represented on the committee when rail-related topics are up for discussion or whether the input of the Transport Agency's Director of Rail Safety would be sufficient. It would also be appropriate for the NRSC to consider a name change. The 'National Land Transport Safety Committee' could be a possible alternative.

Safer Journeys is an NRSC strategy so any recommendations related to this work are addressed to the NRSC. Any work arising from the recommendations would come about through agreement by the NRSC partners as to the appropriate agencies to carry out the work.

13 Conclusions

An incremental approach towards inclusion within the present system is required.

Some overseas jurisdictions are already part of the way towards inclusion of PT injury not involving other motor vehicles in a Safe System approach. An example is Sweden, which has targets for reducing non-motor-vehicle, cycle and pedestrian crashes and also crashes involving people on and entering/exiting from PT.

In New Zealand, this step, in the case of on-road vehicles like buses and trams, is already able to be fitted within the existing *Safer Journeys* framework. New areas of interest and actions (which would of course need funding) are all that is required to make it happen in New Zealand. Such actions would incur the costs of gathering the crash information necessary to evolve countermeasures and the cost of the countermeasures themselves.

To cover PT fully (by including urban commuter rail and ferries), *Safer Journeys* would need to move from urban road safety to urban transport safety.[25] This would require no structural change, just a restatement of the reach of the strategy and the inclusion of some new areas of interest and action plans, as has already happened in Sweden.

To achieve this:

- The whole journey rather than just the road phase would need consideration.
- Data should be gathered and analysed on injury related to all aspects of the journey.
- Safety expertise could be positioned in organisational structures to influence how PT is operated. The experience of New South Wales is a pointer to what can be achieved.
- Tools to better monitor PT safety can be made available and used (an example is the progress made by Sweden in counting pedestrian-only crashes (ie trips, fall) and injuries to PT passengers).

All the above could relate to *Safer Journeys* priorities, accompanied by *Safer Journeys* action plans, without changing the framework. In New Zealand, improvement would involve taking actions within the present *Safer Journeys* system to better ensure the safety of PT-related travel. These actions could include the following:

1 **Better recognition of non- motor vehicle pedestrian injuries and injuries while entering, exiting and on PT in the present system.**

Safer Journeys addresses injury that occurs on the road network and about which we have accessible data. There is some information on cycling where no motor vehicle is involved. However, the following injuries in relation to buses and trams are recorded in separate databases that do not feed into *Safer Journeys*.

- injuries on/within the vehicle
- injuries boarding/alighting from the vehicle
- injuries walking to/from the vehicle (unless a motor vehicle is involved).

In order to include such injuries in *Safer Journeys* in such a way that Safe System countermeasures may be worked out it is necessary to set up systems that better capture their incidence and characteristics, so that their epidemiology can be better known and countermeasures evolved. The CAS system at present deals, in practical terms, only with crashes involving motor vehicles that are reported to the Police. There is a

[25] This would logically also include freight but this was excluded from the current project.

CAS movement code for crashes 'in vehicle' but, in the case of the vehicle being a bus, this code is hardly ever used. Most of the above injuries are either outside the purview of the Police or unlikely to be reported by them. Thus there appears little point in considering any extension of CAS to include their analysis. However, there are other sources of data available. Other sources of data which could be used, and should be investigated include:

- ACC injury claims
- reports from the Police of vehicle faults on buses
- workplace injury and incident reports related to PT vehicle operation
- reports from rail operators, collated by the Transport Agency, of incidents and injuries related to rail PT. Similar reporting procedures are in action between the Maritime Safety Authority and passenger ferry operators
- Transport Agency assessments of the efficacy of urban passenger rail operator management systems and Maritime Safety Authority assessments of the efficacy of passenger ferry operator management systems.

2 Revisit the funding of pedestrian infrastructure including pavements and lighting

At present pedestrian infrastructure receives no Transport Agency subsidy except at the construction stage or if it is part of a joint pedestrian/cycle facility. This means the money to maintain it comes from scarce rate-payer funds. This may potentially have detrimental impacts on walking routes to and from PT.

3 Put together procedures to make sure that safety and walkability are prime considerations in pedestrian infrastructure irrespective of aesthetic requirements.

There is an understandable aspiration to make popular walking surfaces visually pleasing. Visually pleasing surfaces can be safe and of high walkability but they have to be carefully designed, implemented and maintained if they are to play a full part in a safe system, and may require higher maintenance than some simpler surfaces.

4 Look at road works system practices as they apply to pedestrians.

Footpath closures may not always be accompanied by adequately safe alternative routes.

5 Improve the safety auditing of bus/train/ferry stops, access to stops and any safety issues involved in getting on and off vehicles

6 Look at the interior design of vehicles and the training of drivers to minimise on- vehicle injury

7 Use a Safe System approach in the design of PT interchanges

The literature on interchanges, including the 'grey literature', does not mention safety explicitly very often. Much more emphasis is placed on security, which is itself very important. There is no reason to believe that safety has not been dealt with well. However, if a Safe System approach had been used, safety might arguably have been dealt with better. With an aging population these areas will be used in the future by more people of greater fragility and lower physical capability who may have shifted from personal transport for this very reason. This needs to be taken into account in their design.

8 Use a Safe System approach to vehicle design and operation and driver management (NZ Transport Agency 2014c)

At present urban bus design is governed by the NZ Transport Agency (2011) *Requirements for urban buses in New Zealand* (RUB). This is a set of rules which are to be complied with rather than a performance-based specification. These rules appear to be sound and it is arguable whether a Safe System approach like that espoused by *Safer Journeys* would have improved them. In fact this sort of approach may have been an unstated input. A Safe System approach would predicate a high priority for passenger safety in future revisions of RUB.

Again the requirements for drivers come under 'zero harm' health and safety guidelines which are backed up by penalties for the company if not adhered to. It is again arguable whether being under the Safe System approach of *Safer Journeys* would have made a difference.

9 Ensure design safety input to PT projects.

This would reflect Safe System principles like:

- maximal separation of conflicting modes, particularly potentially aggressive modes and vulnerable modes
- moving towards self-explaining 'no surprises' routes for all modes
- regular Safe System audits of PT systems, including all aspects of the PT journey.

Some of the actions described above may already be happening quietly in the background, but monitoring of them needs to be done so that progress can be gauged.

The above discussion is mainly applicable to buses. Similar remarks could be made about ferries and trains. The sorts of actions advocated above will not overtly and visibly increase PT patronage. However, these sorts of actions can also be expected to have a knock-on effect whereby the resulting safer environment for PT users on all parts of their journey would encourage further use.

To a large extent, the infrastructure safety of those parts of the journey not actually associated directly with the vehicle could be covered in an expansion of the scope of the Transport Agency's (2014c) *Guidelines for public transport infrastructure and facilities guidelines*, at present at the stage of an interim consultation draft.

14 Recommendations

The recommendations arising from this work are that:

- The uptake and provision of urban PT is encouraged by the government in parallel with road safety under the overarching GPS.
- The NRSC consider the incorporation of urban PT safety into the *Safer Journeys* strategy accompanied by an appropriate name change for the NRSC to better reflect its wider scope.
- This includes consideration of *Safer Journeys* actions in these areas:
  - The acquisition of data to allow analysis of the safety of the whole journey, including segments to and from the PT vehicle, the journey on the PT vehicle, entering and leaving the vehicle, and what happens thereafter possibly as a pedestrian or cyclist. This would include the feasibility of such acquisition, the utility of the data able to be acquired, and the costs of such acquisition related to the benefits. Most of this data would be from sources outside of Police reported crashes and would thus be outside the scope of CAS.
  - Analysis of the above data to provide safety benchmarks and information related to the development of Safe System countermeasures
  - Carrying out work to develop Safe System actions in the form of countermeasures to ameliorate any safety problems the analyses may uncover
  - Assess the priority of such actions relative to existing actions.
- The NRSC consider whether the *Safer Journeys* strategy should include the management systems of non-road PT providers as it at present does for on-road PT.
- The NRSC consider carrying out work to elucidate the impact on road safety funding allocation of including the above additional areas into *Safer Journeys* actions.

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Appendix A: Glossary

ACC	Accident Compensation Corporation
ATSB	Australian Transport Safety Bureau
BCR	benefit–cost ratio
CAS	Crash Analysis System
Dft	Department for Transport (UK)
DoT	Department of Transport (Perth, Australia)
ETCS	European Train Control System
ETSC	European Transport Safety Council
EU	European Union
FHWA	Federal Highways Administration
GPS	Government Policy Statement on land transport
GRSP	Global Road Safety Partnership
ITF	International Transport Forum
LTSA	Land Transport Safety Authority
MoT	Ministry of Transport
MPT	motorised personal transport
MUA	main urban areas
nd	no date (or date unknown)
NRSC	National Road Safety Committee
NSW	New South Wales
OECD	Organisation for Economic Cooperation and Development
ONRSR	Office of the National Rail Safety Regulator (Australia)
PT	public transport
RUB	*Requirements for urban bus in New Zealand* (Transport Agency 2011)
SPAD	signals passed at danger (rail)
STA	Swedish Transport Administration
TAC	Transport Accident Commission (Australia)
The Transport Agency	New Zealand Transport Agency
UK	United Kingdom
WA	Western Australia
WHO	World Health Organisation