REDUCING INJURY ON ALL LEGS OF PT JOURNEYS

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ABSTRACT

Safer Journeys is built around injury prevention on the road network using accessible data. The accessible data relates to Police reported motor vehicle crashes involving injury, accessed through the Transport Agency's Crash Analysis System (CAS). The CAS system contains limited information on cycling crashes not involving motor vehicles but non-motor vehicle walking and PT injuries are recorded in separate databases that do not feed into road safety actions or strategies. In terms of the total PT journey, these injuries are those incurred on the PT vehicle itself, while entering or alighting from PT, or while moving to or away from PT. These legs of the journey may be on foot or by cycle. In Sweden these injuries are analysed and fed into road safety planning and action. If this was done in New Zealand the whole PT journey could be brought into the Safe System approach to road safety. This would allow prioritization of these injuries for road safety countermeasure funding. This paper discusses these injuries, our present state of knowledge of them and looks at how they can be brought into the main stream of our safe system approach to road safety.

INTRODUCTION

The Safer Journeys road safety strategy is built around the prevention of injury that occurs on the road network and about which we have accessible data. The accessible data is that data collected by the Police on motor vehicle crashes involving injury and accessed through the Transport Agency's Crash Analysis System (CAS). The CAS system contains some limited information on cycling crashes not involving motor vehicles but non-motor vehicle walking and PT injuries are recorded only in separate databases that do not feed into road safety actions or strategies. In terms of the total Public Transport (PT) journey, these injuries are those incurred on the PT vehicle itself, while entering or alighting from the vehicle, or while moving to or away from the PT vehicle. These legs of the journey may be on foot or by cycle. In some countries like Sweden these injuries are analysed and fed into road safety planning and action. By doing this the whole PT journey, including the vulnerable mode legs, can be brought into the Safe System approach to road safety. This would make it possible to prioritise these injuries for countermeasures funded along with other road safety actions. In order to do this, it is necessary to set up systems that better capture the incidence and characteristics of these injuries.

PT SAFETY

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.

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.

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.

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 1 and 2[1] provide some comparative statistics on crashes involving motor vehicles from the New Zealand Household Travel Survey (MoT 2015). Figure 1 reports deaths and injuries per million hours of travel and figure 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.

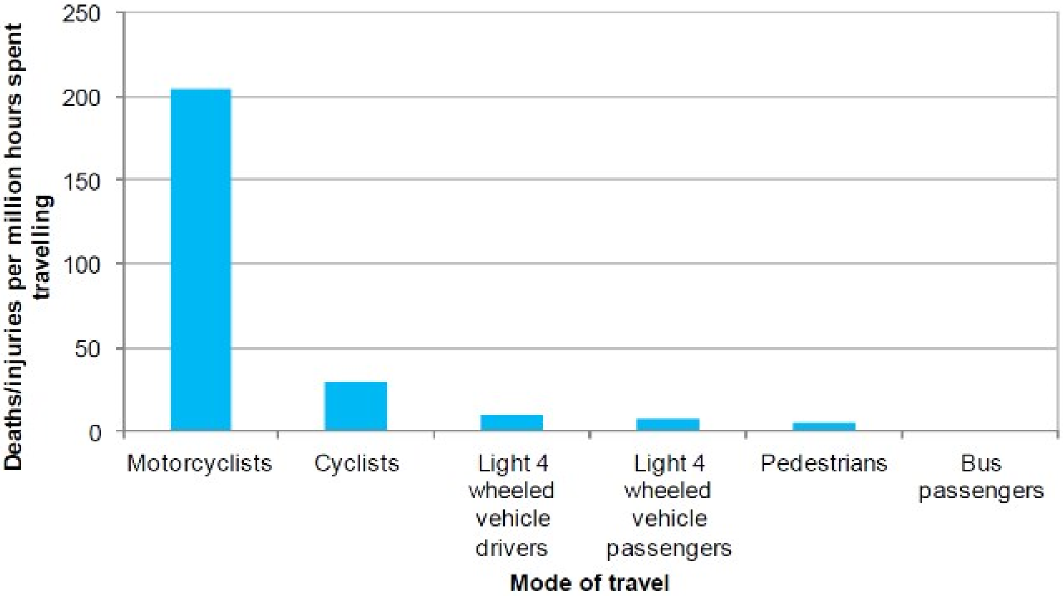

Figure 1: Deaths or injuries in motor vehicle crashes per million hours spent travelling

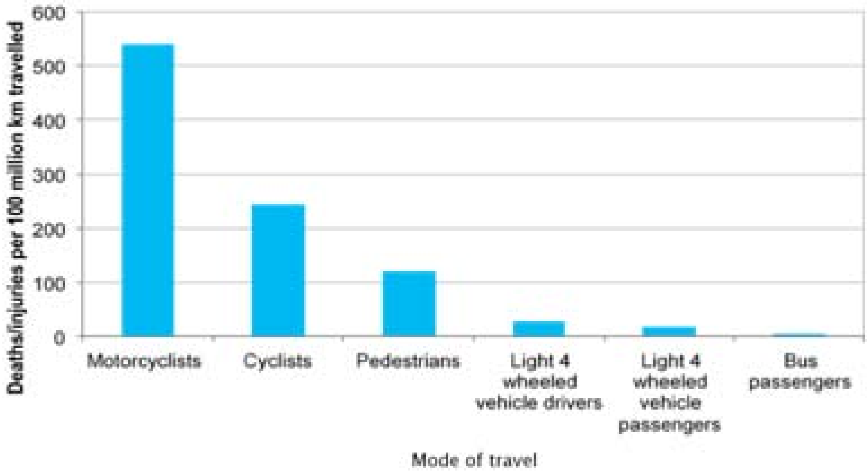

Figure 2: Deaths or injuries in motor vehicle crashes per 100 million km travelled per year

Similar statistics for New Zealand travel, but containing more modes, compiled by the Civil Aviation Authority (Campbell 2007), are depicted in figure 3.

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

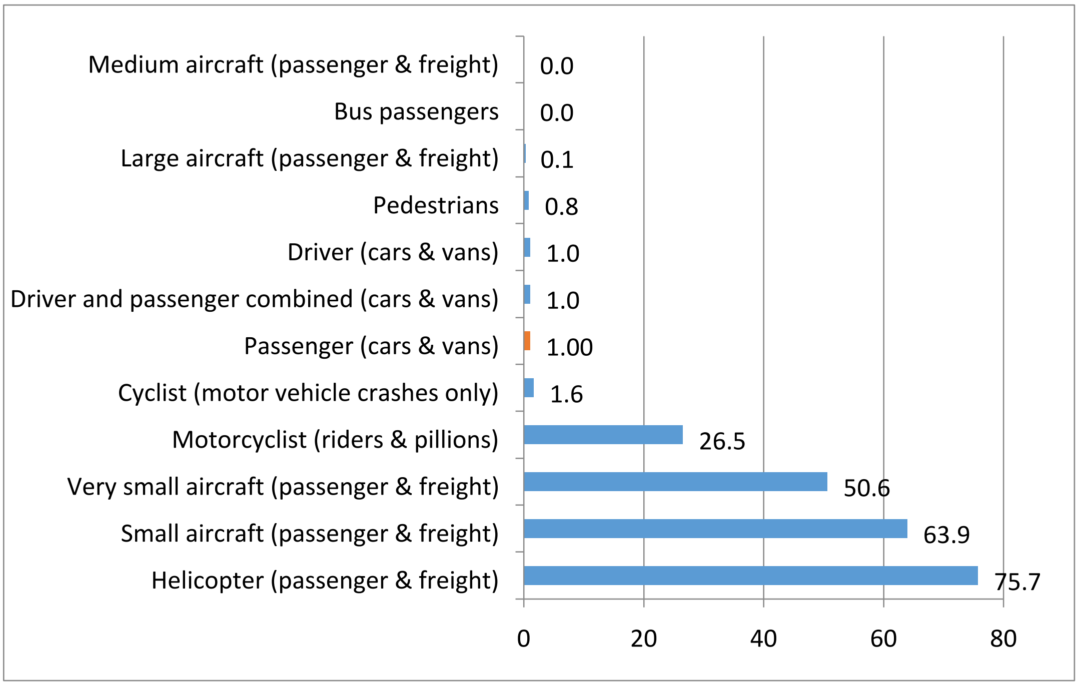

Figure 3: Relative chance of death per person per hour of travel (New Zealand Aviation 2000–2003). Drivers and passengers of cars and vans combined=1.00)

Table 1 from Berry and Harrison (2007) sets out the absolute numbers of hospitalisations in Australia for land transport on a public highway 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.

Injured person's vehicle (pedestrians are considered 'vehicles' in this)	Pedestrian	Driver	Passenger	Person on outside of vehicle	Not specified	Total	%
Pedestrian	2,666	0	0	0	0	2,666	9.2
Pedal cycle	0	1,888	29	0	1,769	3,686	12.7
Motorcycle	0	3,532	207	0	1,692	5,431	18.7
3- wheeled motor vehicle	0	18	6	0	9	33	0.1
Car	0	9,823	4,892	63	1,128	15,906	54.7
Pick- up truck or van	0	214	97	16	28	355	1.2
Heavy transport vehicle	0	314	48	7	39	408	1.4
Bus	0	21	100	1	31	153	0.5
Other land transport	0	74	36	5	321	436	1.5
Total	0	15,884	5,415	92	5,017	29,074	100

Table 1: Number of hospitalisations in Australia from highway injury in 2003–2004, by age and mode

Litman and Fitzroy (2014) present the chart depicted in Figure 4 showing fatality rates per billion passenger miles for various modes, disaggregated by whether the fatality was 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 4 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.

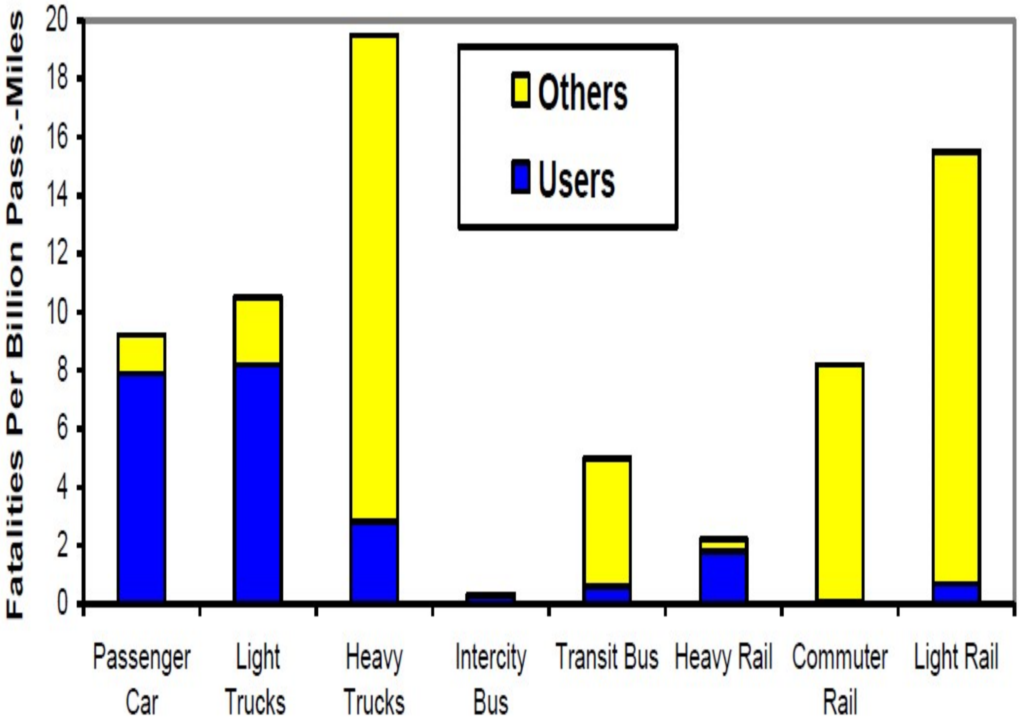

Figure 4: Fatalities per billion passenger miles for various modes, by user and non- user

NEW ZEALAND INFORMATION ON PT RELATED INJURY

Non- crash injuries on PT, 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 these injuries it is necessary to go to overseas information or the ACC. This is because in New Zealand these injuries are not usually reported to the Police and so do not figure in traffic crash reports. 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 separate out those claims which had a prior activity of 'getting on/off' or 'getting in or out'.

Table 2 relates to all the claims mentioning the five transport mode- related search terms and table 3 those which also are coded 'getting on/off" or 'getting in or out of". Table 2 indicates that in 2014 there were 1,610 claims where the mode- related search terms were mentioned.

	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 2: Number of new claims by transport type text term: 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 3: Transport type by text search for activity prior to getting on/off or in/out: 2009–2014

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. Table 3 indicates that 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.

Incidents involving pedestrians, cyclists and PT vehicles

Incidents involving pedestrians, cyclist and PT vehicles are also important to consider. 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) putting the 57 aforementioned pedestrians at 0.5% of all those killed or injured.

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 4 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 between 2009 and 2013 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 fatality than injury. Therefore, while relatively uncommon these incidents tend to be severe.

		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

Table 4: Yearly deaths and reported injuries for grouped rail crash types in the NZ rail occurrence database 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 that alcohol and suicide were the main contributing factors to trespassers being killed by trains.

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)

Moving on to the operation of buses, after number of incidents between buses and pedestrians occurring in the Wellington CBD Opus Research carried out a behavioural assessment. This assessment explored '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[2]. 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% 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.

INFORMATION FROM THE REST OF THE WORLD

Overseas information tends to indicate that rail passengers may be safer than other PT users, 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 5) suggesting a similar result for North American passengers.

Fildes et al (2012) analysed 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 5 from the study depicts the 'injury causing event' by age of user.

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%)

Table 5: Injury causing event by age of user Melbourne, Victoria- 2006–2010 inclusive

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 looks at the 'injury causing event' by mode.

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

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%)

Table 6: Injury causing event by mode Melbourne, Victoria- 2006–2010 inclusive

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. Frith and Thomas (2010) 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 5 from Kirk et al (2003) depicts in what situation travelers were injured, showing that 56.4% were not seated when injured, with 9.4% boarding and 17.2% alighting at the time of injury.

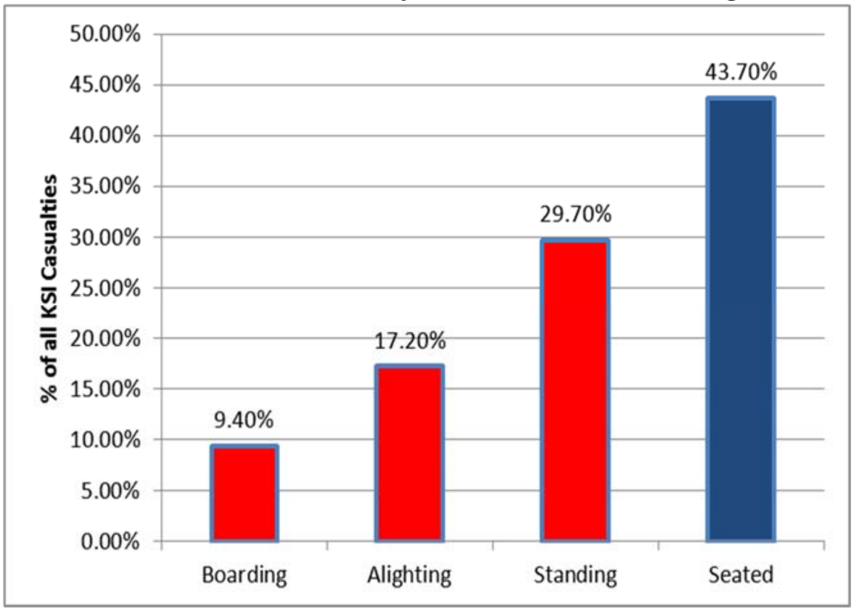

Figure 5: Situation of casualties killed or seriously injured related to buses and coaches

Figure 6, (same source) illustrates the injury bias towards older people and women.

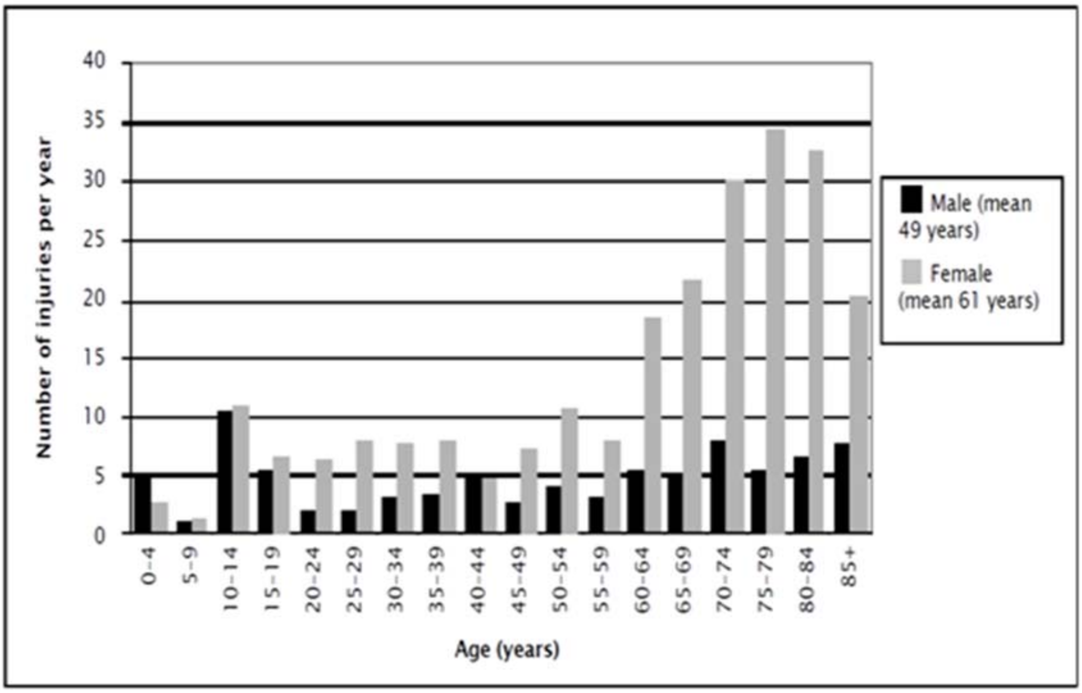

Figure 6: Age/gender in non- collision bus injuries in Britain from 1994 to 1998

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[3] .

Figure 7 from STA (2012) portrays Swedish "very serious injuries" to road users by situation of injury. It is apparent that non-motor vehicle related injuries and injuries "in bus" are included.

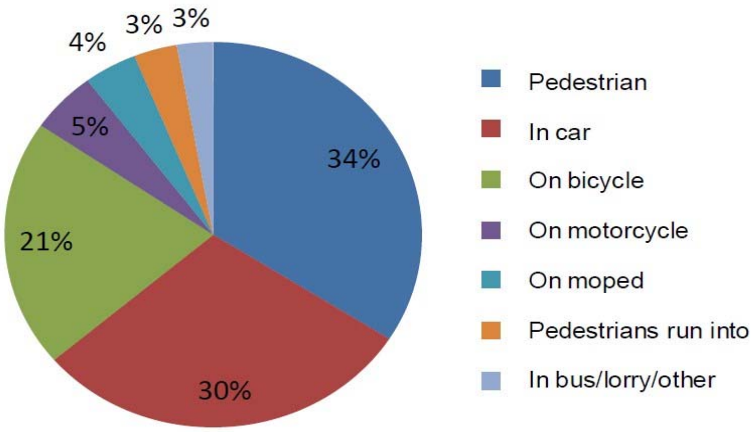

Figure 7: Swedish "very serious" road injuries

Therefore, injuries while on PT not related to collisions have the potential to be very serious. These need to be taken into account in road safety strategy and action.

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

WALKING AND CYCLING SAFETY WHEN TRAVELLING TO AND FROM PT

This section deals with those aspects of traveler safety when moving to and from PT. 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.

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. Frith and Thomas (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 from Feypell et al (nd).

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.

Table 7: Number of pedestrian and bicycle injuries in the Netherlands, 2003–2007

Swedish studies (e.g. 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 8).

		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)

Table 8: Pedestrian injuries in Sweden, 1998–2007

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 8 depicts non- motor vehicle- related cyclist hospitalisations in New Zealand in 2012. These include off- road cases (e.g. trail- biking) as well as on- road cases. Some of these may be related to trip chains involving PT.

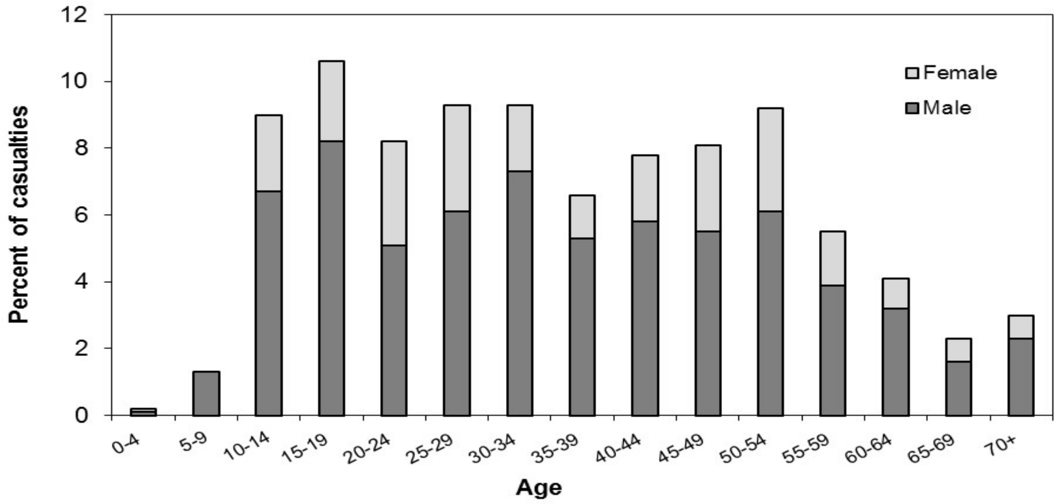

Figure 8: Non- motor vehicle- related cycling injuries by age and gender Source: MoT (2015a)

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.
- Accident sites tend to be rated unfavourably by experts regarding 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 (e.g. not using slippery materials), installation (e.g. avoiding unevenly laid pavers) and maintenance (e.g. 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.

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[4] needs to be reviewed from the perspective of likely pedestrian activity types and locations, and potentially matched to desired pedestrian activity types and locations.*

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. 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. 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).

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 interchanges 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

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

passengers and, if the interchange is lengthy and/or unsafe or perceived as unsafe, travelers 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).

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 urban planning to influence modal split

Planning Principles

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.

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

SWEDEN AS A ROLE MODEL

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 most developed countries land (OECD 2014; OECD/ITF 2008). However, out of all these countries only Sweden has made a really concerted effort to include the injuries sustained on the total PT journey into their consideration of road safety policy.

Sweden has a Safe System approach to road safety is in place which seeks 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). In Sweden, these injuries are analysed and fed into road safety planning and action. By doing this the whole PT journey including the vulnerable mode legs can be brought into the Safe System approach to road safety.

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.

Sweden has targets for reducing non motor- vehicle, cycle and pedestrian crashes and also crashes involving people on and entering/exiting from PT. 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 (e.g. being involved in designing bus stops, setting speed limits and so on, that influence the safety of PT).

CONCLUSIONS

To cover PT related injury fully (by including urban commuter rail and ferries); focus would need to move from urban road safety to urban transport safety.[5] This would require some new areas of interest and action as has already happened in Sweden. To achieve this:

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.
- Tools to better monitor PT safety can be used (an example is the progress made by Sweden in counting pedestrian- only crashes (ie trips, fall) and injuries to PT passengers).

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[5] This would logically also include freight but this was excluded from this discussion

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