SWOV Fact sheet

Road safety hazards of public transport

Summary
Public transport is generally safer for those making use of it than for other road users. In the light of the Dutch government promoting the use of public transport, it is expedient to pay greater attention to the safety of public transport vehicles. The arrival of relatively new types of public transport, such as light rail, further reinforces this. However, as yet there is comparatively little information about the background of the involvement of large, non-standard vehicles, such as buses and trams, in crashes in urban traffic. A large part of the measures that have already been identified in the (moderately) available research, and that can especially enhance the safety of other road users, can be taken relatively easily. Further research is necessary to further improve the safety of other road users, as well as of users of public transport vehicles.

Background and content
For decades, the Dutch government has been using policy to promote the use of public transport as an alternative to car use. In general, public transport is safe for those making use of it, the occupants of buses, trams and trains. It is less well known how safe public transport is for other road users. This fact sheet focuses on this latter issue in particular. If not mentioned differently, use is made of the numbers of police registered numbers of crashes and casualties from the source file of the Dutch Ministry of Infrastructure and the Environment.

How big is the problem?
The number of casualties among users of public transport (bus, tram/light rail, metro, train) is limited: an annual average during the past ten years (2000 - 2009) is 1 fatality and 19 serious road injuries. The hazards of public transport vehicles are much bigger for other road users: an annual average of 41 fatalities and 138 serious road injuries during the same period. Among them, 116 are casualties (16 of them fatalities) of crashes with buses and 63 (25 of them fatalities) of crashes with a tram or train.

The crash rate and the casualty rate are measured by relating the number of vehicle kilometres driven by passenger cars, buses and trams to the number of crashes or casualties. Comparison of the casualty rates shows that there are 7 times more crashes with a severe outcome (fatalities and/or serious road injuries) in crashes with buses than in crashes with a passenger car, and 12 times more in crashes with a tram. These ratios are even more unfavourable for fatalities: 15 times as many in crashes with buses and 57 times as many in crashes with a tram than in crashes with a passenger car.

With respect to fatalities, the trend in the number of casualties as a result of crashes with public transport vehicles has been consistent with the trend in all fatal road accidents in the Netherlands during the last five years (*Figure 1*). However, the level of the trend for public transport vehicles is slightly lower than for all road fatalities combined. The trend for serious road injuries in crashes with public transport vehicles (*Figure 2*) is more or less consistent with the trend for serious road injuries in all crashes in the Netherlands. The trend for fatalities in crashes with trams seems more erratic because of the fewer numbers (an annual average of seven fatalities). The number of serious road injuries by trams alone has not been shown, because this data is not reliable in the current crash registration. On the other hand, we can show the trend for serious road injuries in crashes with trains/trams combined and we then see an increase since 2006. The annual number of fatalities on railway crossings has for some years been fluctuating around eighteen (VenW, 2010a). The annual average of two hundred suicides on railways has in fact been excluded here. Such fatalities are not road fatalities.

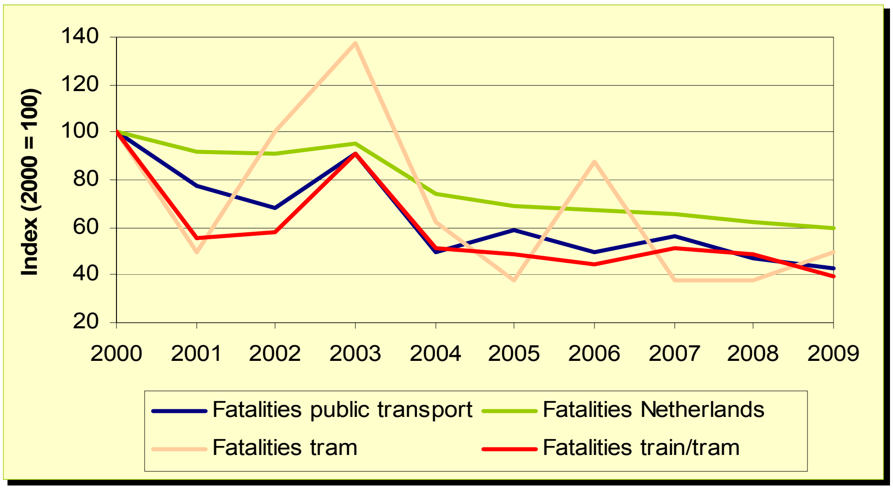

Figure 1. *Trend in the annual number of fatalities in all crashes in the Netherlands, in crashes with public transport vehicles (bus, tram/light rail and train), in crashes with train/tram and in crashes with trams (2000 = 100).*

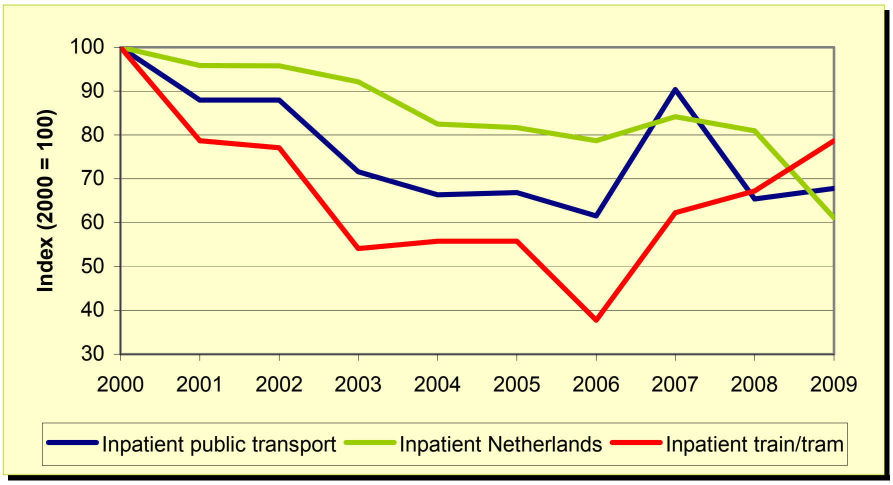

Figure 2. *Trend in the annual number of serious road injuries in all crashes in the Netherlands, in crashes with public transport vehicles (bus, tram/light rail and train), in crashes with train/tram and in crashes with trams (2000 = 100).*

What is the background of bus crashes and which measures will improve safety?
Knowledge of bus crashes is mainly based on a study by Davidse et al. (2003). This study identified the most frequent types of crash:

– crashes on bus lanes;
– crashes involving blind spots;
– buses causing rear-end collisions while braking;
– single vehicle crashes with injury for occupants;
– crashes as a consequence of bus driver distraction.

For each crash type measures are proposed to prevent such crashes. These measures relate to the bus driver, the bus itself and the road. The most important measures are:

– Training defensive driving behaviour, such as adjusting the driving speed to the actual circumstances (during driving courses and refresher courses);
– Installing mirrors with wider field of vision (side mirrors);
– Checking the design of the interior of buses and covering sharp edges of seats and other parts of the interior with a soft or flexible layer if necessary;
– Standardizing the location of the bus lanes in the infrastructure;

– Tuning the traffic control on bus lanes to the control of traffic on adjacent lanes, so that the traffic on bus lanes will behave according to the expectations of other road users. For example, it should be clear whether buses do or do not drive into the same direction as traffic on the adjacent lane;
– Standardizing the layout of pedestrian crossings on public transport lanes to those on the adjacent lanes. Public transport often has priority on a public transport lane, while a signalized pedestrian crossing is absent. The traffic lights at the adjacent pedestrian crossings often apply to the lanes for car traffic only. However, pedestrians, first crossing the lane for car traffic, followed by the public transport lane, often assume that the green light also applies to the public transport lane. The signalized crossing should also apply to the public transport lane in order to prevent hazardous situations. If this were to hamper the flow of public transport too much, a warning system should alert the pedestrian to the non-standard situation for the public transport lane.

What is the background of tram and light rail crashes and which measures will improve safety?
During the nineties the number of tram crashes increased, resulting in a number of studies that will be briefly discussed here. ARCADIS (1998) studied the hazards of express tram crossings by comparing the four existing intercity (express) tramlines (Amstelveen, Nieuwegein, Delft and Rotterdam-Ommoord/ Zevenkamp). There are clear differences in potential and actual conflicts between these tramlines on crossings, in the location of the tram lane with respect to the road, the existence and design of warning lights, traffic signal control and in the streaming area for cyclists and pedestrians. The differences in crash frequency between these tramlines can be reduced to these differences. ARCADIS (1998) therefore recommends following the Sustainable Safety principle of homogeneity in new situations: separating in space or time. Fairly detailed recommendations have been drawn up for existing situations concerning traffic light regulations, design and marking.

The crash study of (formerly) the Transport Safety Board, RvTV (2000) showed that in many crashes road users did not give priority to trams, even though this was necessary. Non-tram drivers should actually always give priority to tram drivers if priority is not signposted. This atypical priority rule seems to have a negative effect on safety. RvTV (2000) recommended investigating the legislation and regulations for trams, highlighting the specific priority rules for trams.

Another RvTV crash study (2003) furthermore investigated the hazards of trams on (separate) lanes in urban areas, on crossings with road traffic and with pedestrians. In many cases, these crossings are not signalized and the traffic crossing should give priority to trams. The tram often passes these crossings with a speed that is similar to the speed on this separate lane. If a road user who wants to cross appears suddenly and does not give priority to the tram (deliberately or not), the relatively long braking distance of the tram makes a fatal crash practically inevitable. The tram's speed is important for the severity of the outcome. The issue, therefore, is not speed being the cause of a crash as Stoop (2008) indicates. The situation described here is clearly inconsistent with the homogeneity principle of Sustainable Safety: encounters between vehicles with large differences in mass and driving characteristics must be prevented or only take place with small speed differences.

The actual braking distance of a tram at 30 km/h is more than 25 m (RvTV, 2003). The Netherlands has no general regulations for the braking distance of this type of vehicle. Germany uses regulations (BMJ, 1987) stipulating that the braking distance at 30 km/h should not exceed 30 m. This braking distance is considerably longer than that of a passenger car or bus, which at 30 km/h need circa 20 m to come to a halt (CROW, 1996: p.193); see also *Figure 3*. For a tram to achieve a braking distance similar to that of a car, it should drive more slowly in relevant situations (i.e. where the tram mixes with other road users). This could be enforced through technical means.

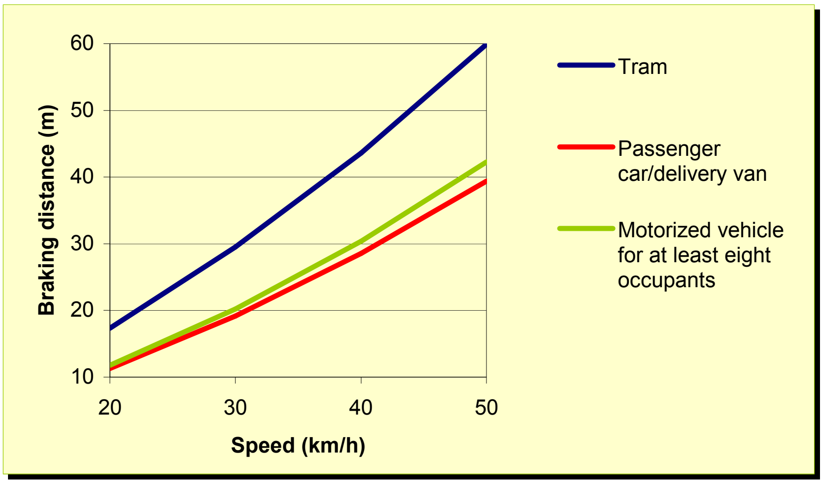

Figure 3. *Braking distance of trams, passenger cars/vans, and motor vehicles for eight or more occupants, related to the driving speed.*

The reports mentioned conclude that relatively many crashes involve road traffic (especially pedestrians and cyclists) and trams. The reports point towards a kind of blind spot for this problem in road safety policy. The large absolute number of crashes may not be high, but it seems that there is a definite safety problem between trams and road traffic. This problem may intensify due to an increase in so-called light rail traffic (trams driving on a separate lane outside urban areas). If tram-like trains and train-like trams mix with road traffic, additional problems may be expected (as they have larger masses, longer vehicles and higher speeds). The drivers partly drive in situations with separate lanes that are signal controlled and partly in situations mixing with road traffic and pedestrians. It requires training to switch between these different situations. Split-level crossing are preferable, but may not be possible or feasible in all cases (Hummel, 2002). In general, a pedestrian-friendly tram front may already reduce the severity of the outcome of a crash.

While planning the light rail line in the Dutch city of Leyden, it was investigated whether tramlines meet the principles of Sustainable Safety. It was systematically studied if the way of including the tram route adheres to the principles of Sustainable Safety (VIA, 2006). Furthermore, CROW (2007) has drawn up recommendations for enhancing safety when including existing and new tramlines in an urban area. This report also expressly refers to the principles of Sustainable Safety.

What is the background of crashes on railway crossings and which measures will improve safety?

Van der Ham (1972) has shown that attention has been paid to crashes on railway crossings for decades. During the nineties, an annual number of circa forty fatalities occurred on railway crossings. Since then, the number has decreased to slightly less than twenty, partly due to crossings being closed. The Dutch government framework documents for rail safety (Ministry of Transport, Public Works and Water Management, VenW, 2004; 2010b) also include other measures for further reducing the number of crashes on railway crossings. For example: no construction of new level railway crossings, no extension of the number of traffic lanes on railway crossings and only allowing changes to the railway or the road crossing it if, after study, additional safety measures have been taken. Risk analyses are conducted for existing railway crossings that in most cases lead to carrying out these measures.

Which role can be played by the concession provider?

For meeting their own targets of road safety, those granting concessions for public transport (provinces or regions that enter into a contract with a public transport company) will benefit from a public transport company that also considers road safety of prime importance. For this purpose, those granting concessions can include quality requirements for safe transport in their concession specifications.

Conclusions
Presently, an annual total of circa two hundred casualties (fatalities of serious road injuries) occur in crashes with buses, trams, metros and trains. Of this total, 10% are occupants of the public transport vehicle involved and 90% are other road users. The hazards of public transport vehicles are therefore much bigger for other road users than for the passengers of public transport. Moreover, the consequences of crashes with public transport vehicles are often far more severe than of other road crashes. There is comparatively little information about the backgrounds of the involvement of large, non-standard vehicles, such as buses and trams, in crashes in urban traffic.

Recommendations
Based on the limited information, various measures can nonetheless be identified that contribute to the safety of public transport, not only preventing crashes but also reducing injury. Concerning the former, preventing crashes, it is to be recommended that bus drivers and tram drivers are continually trained in driving in conjunction with (crossing) road traffic and pedestrians (so that they start showing defensive driving behaviour). It is also to be recommended that the traffic control of bus and tram lanes should match the control on the adjacent lanes for other traffic better. It follows that the non-standard regulations for trams should be further studied. Furthermore, split-level crossings are preferable for light rail lines, but this may not be possible or feasible in all cases. Concerning the latter, reducing the severity of occupant injuries, sharp edges in the interior of buses and trams can be covered more fully. A (pedestrian-) friendly tram front could reduce the severity of a crash for other road users. For the tram to have a braking distance comparable to that of passenger cars, the driving speed should be lower. This is especially important on crossings and in other situations in which the tram mixes with road traffic and this can be enforced by technical means. With respect to regulations, general (not locally drawn up) technical specifications are then necessary for the minimum braking deceleration of trams. Finally, the parties granting concessions, that is to say the provinces or regions that enter into a contract with a public transport company, could include specific safety requirements in their concession regulations.

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(Dutch SWOV reports have an English summary)

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