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Pedestrian non-compliance at railway level crossing gates

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Pedestrian non-compliance at level crossing gates

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Abstract:
The present project involved a literature review and observation of pedestrian behaviour at level crossing gates, in order to better understand noncompliant pedestrian crossing behaviour and to identify potential countermeasures to this issue. The literature reviewed included that relating to the pedestrian task at level crossings, factors influencing compliance with level crossing rules, countermeasures to prevent noncompliant crossing, and factors that are likely to influence pedestrians' response to safety campaigns. Observations conducted at ten Perth-area level crossings revealed that the typical noncompliant crosser is adult, male, crossing alone, and in a hurry; distraction, as well as mental and physical impairments were not common among noncompliant pedestrians. It is recommended that, because changes to crossing layout are unlikely to result in significant improvements in safety that are over and above what is already observed, potential countermeasures to the issue should focus on improved level crossing warnings and physical barriers, as well as *well-designed* education and enforcement campaigns .

Key Words:
Railway crossing
Pedestrian safety

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Preface

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Contributorship Statement

Mike Lenné secured the funding for the project and provided guidance on the direction of the research.

Brett Hughes secured project funding, workshopped the recommendations with the PTA and wrote the final part of the recommendations section.

Jessica Edquist researched and wrote the report.

Ester Elisaria performed the observations of pedestrian behaviour.

Christina Rudin-Brown reviewed the report and provided comments on study design.

Ethics Statement

Ethics approval for this project was obtained from Curtin University. The approval number is SPH – 11 – 2011.

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EXECUTIVE SUMMARY

The broad aim of the present project is to gather information about the factors associated with noncompliant pedestrian crossing behaviour at level crossing gates, in order to identify and develop countermeasures with the potential to prevent noncompliant crossings and improve safety overall. Two activities were undertaken to accomplish this goal; first, existing research literature on level crossings, pedestrian compliance, and safety campaigns was compiled and reviewed. Second, pedestrians' crossings were observed, and the characteristics associated with noncompliant behaviour recorded, at ten Perth-area level crossings.

The literature review revealed that, to comply with desired behaviour at level crossings, pedestrians must be: aware of the location and path of the crossing itself (including where to stop and look for trains or warnings), aware of and able to understand instructions and warning signals, and motivated to comply with instructions and warning signals.

Many pedestrians do not comply with warning signals, and enter the track area when warnings are activated and gates are closing (or even fully closed). There are a myriad of factors influencing compliance with rules, which may affect how likely a pedestrian is to enter the track area in defiance of activated warning signals and gates. These include individual factors such as age, gender, personality, and attitudes; social factors such as norms, enforcement and behaviour of nearby others; and situational factors such as waiting time, weather, distraction and mood. Based on the literature, a pedestrian is more likely to enter the track area against signals if they are young, male, hold positive attitudes to crossing against signals, know or have seen others who have crossed the tracks against signals, are distracted, in a hurry and have been waiting a long time to cross, or when it is raining or at night.

There are a variety of countermeasures that have been used to attempt to prevent pedestrians from accessing the track area in front of an approaching train. The most successful of these are fences and gates that close automatically when a train approaches. If problems with noncompliant crossings remain after the installation of gates, there are three general options that can be taken: improve the barriers, improve the information provided to pedestrians, or provide an alternative way to cross the tracks. Which option is chosen depends on the circumstances at an individual crossing. Improving barriers by increasing gate height or adding latches to prevent them from being opened may prevent that specific form of noncompliant behaviour, but may lead to increases in other forms of noncompliant behaviour (for example, crossing at an adjacent road crossing) which may result in increased risk to pedestrians. Extra information is only useful when information is lacking in the first place. It has been suggested that 'Red Man Standing' signs should be installed at pedestrian level crossings; however, it is not clear whether these signs would provide any benefit at crossings already equipped with auto-closing gates. 'Another Train Coming' signs have been shown to reduce incidents in which pedestrians cross after a train while warnings are sounding, not noticing a second train that is approaching the crossing; however this is a small proportion of noncompliant crossing incidents, and active 'Another Train Warning' signals are expensive. Providing an alternative route for pedestrians is unlikely to be successful if it requires pedestrians to walk a significant distance out of their way.

An alternative to the above station-specific countermeasures is the use of education and enforcement campaigns to increase pedestrians' awareness of crossing rules and their motivation to comply with them. Similar campaigns are often based on fear of a physical threat (i.e. being struck by the train and seriously injured or killed); however, this type of threat may be ineffective with young males who are more likely to cross against active warnings. Threats of social or legal repercussions for crossing in front of a train may be more effective for this group (young males) than would be physical threats. Alternatively, strategies such as humour may be used to avoid message rejection by this key demographic.

Observations at ten Perth-area rail stations confirmed that more noncompliant crossings are performed by males than by females. However, as well as school students and young adults, large numbers of middle-aged pedestrians were observed crossing against signals. Noncompliance was more common for those crossing alone than those crossing in groups; however, several groups were observed in which one or two members urged others to join them in crossing unsafely. The peak times (among those observed) for noncompliant crossings were 8-9am and 2-3pm. In the morning, the typical noncompliant pedestrian was likely to be observed hurrying to get on to a train and, in the afternoon/evening, many were observed to be hurrying through the crossing to another destination. Distraction, as well as mental and physical impairments, did not appear to be related to the likelihood of pedestrians entering or remaining in the track area while warnings were sounding. Incidents were somewhat more likely to be observed at stations with platforms on the outside of two tracks at the crossing rather than at those with tracks on the inside.

Based on the observations and the literature, the following broad recommendations are made:

- Changes to the physical layout of those stations where pedestrian behaviour was observed are unlikely to be worthwhile;
- Improvements to existing barriers and warnings are worth further investigation; and
- Education and enforcement campaigns would be likely to be effective countermeasures, as long as they are well-designed.

1. PROJECT BACKGROUND

The Public Transport Authority (PTA) of Western Australia (WA) has approached C-MARC to explore the factors associated with pedestrian non-compliance at level crossing gates. When pedestrians push through or jump over closed gates to gain access to a crossing, they run the risk of being struck by an approaching train.

Although ATSB data show that there have only been eight incidents of pedestrians being struck by trains at level crossings across WA in the past ten years (Australian Transport Safety Bureau, 2011), there have been many more ‘near misses’ and incidents with pedestrians illegally on the tracks (while the level crossing gate is closed). Examining these less severe incidents can provide insight into those factors which could be used to prevent pedestrian-train collisions, which are almost always fatal.

PTA data from July 2008 to May 2010 show a total of 158 illegal pedestrian incidents across the ten level crossings with the highest rates of such incidents in Western Australia. Of these incidents, 81% involved pedestrians who were male, and 88% involved those categorised as ‘youth’ (as opposed to ‘adult’ or ‘schoolkid’). In 63% of the incidents, the pedestrian was observed to push a closed gate open; in the remaining 37% of incidents, the pedestrian was observed to have jumped over the gate. The PTA conducted an evaluation trial of taller gates, which were equal in height to adjacent fences; however the presence of taller gates merely led to an increase in the number of incidents of pedestrians pushing the gate open (Aldcroft & Macdougall, 2004). The largest proportion of incidents occurred during the afternoon peak hours (3-6 pm), with 31% of incidents occurring during this time period; however the observed pattern of incidents varied across stations, with some being associated with more incidents during the morning or evening compared to other stations.

The broad aim of the present project is to gather more information about the factors associated with noncompliant pedestrian crossing behaviour at level crossing gates, in order to identify countermeasures with the potential to prevent noncompliant crossings and improve safety overall. Two activities were undertaken to accomplish this goal; first, existing research literature on level crossings, pedestrian compliance, and safety campaigns, was compiled and reviewed. Second, pedestrians’ crossings were observed, and the characteristics associated with noncompliant behaviour recorded, at the ten Perth-area level crossings that had previously been found to be associated with the highest number of incidents.

2. LITERATURE REVIEW

The literature review focussed on relevant studies published in the last ten years, and included both peer-reviewed (academic and industry journal articles, conference papers) and ‘grey’ literature (reports published by government bodies, etc). Transportation-related databases were searched with the keywords ‘level crossing’/’grade crossing’/’railway crossing’, ‘pedestrian’, and ‘compliance’. In addition, a database of psychological research was searched using the keywords ‘pedestrian’, ‘compliance’, ‘road safety’, ‘enforcement’ and ‘advertising’. Reports were also searched for on the websites of rail and transport authorities such as the Australian Transport Safety Bureau, state Departments of Transport and public transport safety bodies, the Federal Railroad Administration (US), American Public Transport Association, Operation Lifesaver, and the Rail Safety and Standards Board (UK).

The review concentrated on two subsets of research: research specific to pedestrian behaviour at level crossings and pedestrian-related countermeasures, and factors influencing compliance with safety rules and uptake of safety messages more generally.

2.1 The pedestrian task

Understanding the pedestrian task at a rail level crossing, including what factors influence the safety of that task, and how pedestrians typically behave while performing the task of crossing the tracks, allows responsible authorities to better target countermeasures to improve pedestrian safety.

According to Siques (2001), the safety of a pedestrian who is crossing railway tracks depends on:

- the pedestrian’s awareness of the crossing;
- the pedestrian’s path across the trackway;
- the pedestrian’s awareness of and ability to see an approaching train, and
- the pedestrian’s understanding of potential hazards at rail-road [/rail-path] crossings.

A similar model of pedestrian safety was developed using a HAZOP (hazard and operation) analysis in a report for the UK Rail Safety and Standards board (Arthur D. Little Ltd, 2009). The example given in the report is for a passive (stop sign- or give way sign-controlled) crossing. Table 1 is based on their example, with the addition of tasks and influences for active crossings. Some influences have been added from a recent review of human factors at level crossings by Edquist and colleagues (2009).

Table 1. Sequence of pedestrian task at a level crossing and influences on task performance.

Pedestrian subtask	Influences on pedestrians’ ability to perform subtask
Recognise crossing location	Visibility/conspicuity of crossing and signs Weather (e.g. rain, fog, sun glare) may impair visibility Amount of lighting at night
Stop at the crossing decision point	Is it clear where to stop? (Line markings and signs may be used to mark this point.) Is the space large enough to contain waiting pedestrians?
Read and obey the crossing instructions	Location, visibility and readability of signs Clarity of crossing procedure description
Active crossings only: Notice and obey active warnings	Location and visibility or audibility of warnings Pedestrian’s understanding of warnings

	Presence of barrier (gate) in addition to visible and audible warnings
Check for trains (look and listen)	Pedestrian's motivation to check Adequate sight lines to see approaching train Conspicuity of train Weather (e.g. rain, fog, sun glare) may impair visibility Is the train horn sounded on approach to this crossing? Is the train horn audible over ambient noise, including for a pedestrian wearing headphones?
Wait for any approaching trains	Pedestrian's motivation to cross vs. wait Pedestrian's ability to judge train speed and distance Distance visible along the train tracks Speed at which the train is travelling
Recheck for trains	Pedestrian motivation/remembering to recheck Ability to see any subsequent trains that may be approaching behind first train
Cross	Is crossing surface smooth and even, without tripping hazards? Does the pedestrian have any mobility impairments?
Exit safely	Is the exit clearly marked? If there is a gate, are there clear instructions on how to open it? Is it physically possible for the pedestrian to open the gate and proceed through the exit?

Pedestrian awareness, and recognition, of a level crossing can be enhanced by the installation of signs and tactile paving strips (Siques, 2001). The path across the track should be clearly marked, free of obstructions (including for mobility impaired pedestrians), and consistent with pedestrian flow patterns. If pedestrians are forced to walk significantly out of their way, they are likely to ignore the designated path and potentially put themselves at risk by crossing illegally (Lobb, Harre, & Suddendorf, 2001; Siques, 2001). Channelization (through the installation of fences or low barriers) may be used to prevent pedestrians from crossing away from the designated point, and to ensure that pedestrians face the direction of oncoming trains before they reach a crossing. Safe stopping points should be clearly marked, especially where there are no gates, and refuges should be provided between multiple crossing points, e.g. if pedestrians have to cross a road and subsequently a track (Siques, 2001).

A pedestrian's knowledge of what to do at a level crossing relies on education and awareness about level crossings, as well as signage that is present at a crossing. There is often a great deal of signage at a crossing, causing visual clutter and inappropriate complexity, which make it difficult for users to pick out the most important, relevant information. Information on these signs is often presented in text format, which can make it even more difficult for users to understand. Using symbols on signs instead of text has been shown to be more easily understood (Arthur D. Little Ltd, 2009; Dickinson, Maddock, Majernik, Atkinson, & Bickley, 2010).

A pedestrian's awareness of a train depends on their ability to look and listen, or otherwise search, for trains and their associated warning devices. At 'passive' crossings there are no specific warnings when a train approaches, so adequate sight distance must be provided for crossing users to see approaching trains. Main Roads WA guidelines for level crossings state that train drivers should sound their horn before reaching passive crossings where there is pedestrian activity, to alert crossing users that they are approaching (Main Roads

Western Australia, 2005). At higher use crossings, 'active' warnings are commonly used, which provide visual and audible indications that a train is approaching. Adequate sight distance is still important in this case. If it not possible to provide adequate sight distance to approaching trains then barriers are usually installed. There is some debate over the optimal sight distance; if crossing users cannot see down the track far enough to determine whether they can safely cross before a train arrives, the decision to cross relies entirely on the presence and reliability of warning signals. On the other hand, if crossing users believe they can see far enough down the track to judge whether it is safe to cross, they are more likely to cross even when warnings are activated, which may reduce safety (Arthur D. Little Ltd, 2009).

If barriers or gates are present that prevent pedestrians from entering the track area when a train approaches, there must be some way for pedestrians who have already started crossing to safely exit the tracks. This may be a refuge between the track and the gate (if the crossing is not typically used by large numbers of pedestrians) or an alternative gate that can only be opened from the track side. If, on the other hand, an exit gate is also able to be opened from the non-track side, it may be used by pedestrians to illegally cross when barriers are active and a train is nearby, which could inadvertently decrease safety.

2.2 Pedestrian compliance and influencing factors

2.2.1 Pedestrian compliance at railway level crossings

PTA data (see Project Background) shows that those involved in 'near miss' and 'person illegally on tracks' incidents are primarily young males. There is not a consistent pattern regarding the time of day at which errant crossings occur.

Victrack commissioned a series of reports about a similar situation of pedestrians entering the track area while the gates were closed at the Bentleigh station crossing in suburban Melbourne (Arup, 2005, 2007; Dickinson et al., 2010). Observations of pedestrian behaviour during the morning and afternoon peak periods on two days (Arup, 2005) showed that 1.5% of observed pedestrian crossings were non-compliant, i.e. the pedestrian crossed against activated warnings and barriers. Most incidents occurred during the morning peak hours, by pedestrians who entered the station. Students (primary, secondary or tertiary) were over-represented in the non-compliant crossings group compared to the overall pedestrian sample.

Knutton (2004) reports on a study in which a Finnish rail-road level crossing next to a station was observed (via video recordings around the clock) for 30 days. Over this period, the warnings and barriers at the crossing were activated 3328 times. There were 428 crossing violations by pedestrians and cyclists, corresponding to 8% of all pedestrians and cyclists crossing the track. Of concern, this number represents 72% of those who first approached the crossing after the alarm went on. This may have been due to pedestrians and cyclists using the crossing to get to the station, as well as the very long warning times (between 30 seconds and three minutes) at this crossing.

McPherson and Daff (2005) recorded pedestrian behaviour at a passive pedestrian level crossing in Melbourne's outer eastern suburbs. Most pedestrians were familiar with the crossing, and this may have led to some complacency in crossing behaviour. Video recordings over several months showed that only 52% of pedestrians aged 12-17 and 60% of those aged 18-30 looked both ways before crossing. Several cases of risky behaviour were observed, including pedestrians walking along the tracks (to reach the station platform, or houses further along the tracks), and some pedestrians who stopped walking midway through the crossing (e.g. to look through a handbag, or pick up rubbish).

Khattak and Luo (2011) examined pedestrian and bicyclist violations at a Nebraska (US) residential area rail-road crossing with an accompanying pedestrian path. The road crossing was equipped with boom barriers, flashing lights and bell to warn of train approach; however there was no separate warning or gate on the footpath. Videotaping of the crossing for three periods between 2008 and 2010 yielded a total of 336 events in which the flashing lights were activated while a pedestrian was present; of these 336 observations, 248 involved one or more crossing violations. Fifty-five percent of the violations occurred when the gates were fully lowered, and 34% while the gates were ascending. A Poisson model fitted to the data showed that there were significantly more violations when there were more users present at the crossing. Children under eight years old were more likely to cross unsafely, especially when there were no older crossing users present. Violations were also more common outside daylight hours (perhaps reflecting a fear of being seen breaking the law in daylight) and on weekends, while weather had no effect. The model did not show a significant effect of warning time, although this could have been because 80% of the observations were included in one category (warning time less than one minute). Previous research on motorists at level crossings has shown that violations are unlikely when warning time is 20-30 seconds, but more likely when warning time is greater than 30-40 seconds (Richards & Heathington, 1990), so it is possible that tabulating the data differently would have similarly revealed a significant effect of warning timing. There was no significant effect observed for event duration (although again, the majority of observations were in one category), number of trains (majority of observations were of only one train), or whether a train stopped in the crossing (24% of observations).

In 2007, Public Transport Safety Victoria commissioned research on pedestrian behaviour at Melbourne level crossings (Clancy et al., 2007). A survey was administered to 216 pedestrians at seven different crossings. There was an even gender distribution in the sample. Approximately one quarter of the sample were aged 12-17 and another quarter aged 18-25, with the remainder comprising adults aged 25-65. Respondents were asked about their crossing behaviour and reasons for crossing safely or unsafely. Males were more likely to report crossing when a train was approaching. Those aged 18-25 and 26-35 were most likely to cross before an approaching train. This behaviour was more common at passive than active crossings. Reasons pedestrians gave for crossing when a train was approaching included time factors (in a hurry, wanting to catch the train, thinking they had enough time to cross); warning factors (suspecting faulty warnings, lack of warning at passive crossings); and errors (not being aware of an approaching train/second train). Those who had been caught on the tracks with a train approaching cited similar factors, as well as mobility impairments or a congested crossing (many pedestrians) leading to a long crossing time; some respondents also cited ‘not crossing at a designated crossing point’. Those who did report safe crossing (not crossing in front of a train) cited the need to be cautious on crossings because of increased risk and danger; requiring more time to cross the railway crossing (e.g. elderly pedestrian); or the fact that they had witnessed or heard about other people getting caught or hit by trains. When asked about potential interventions, respondents listed fear, stories of injuries, fines, observing others, and social disapproval. In addition, the authors suggested that clarifying the law regarding crossings could help: 57 per cent of pedestrians believed it was illegal to cross [at a pedestrian crossing when a train is approaching]. However, 35 per cent were uncertain and eight per cent thought it was not illegal.

2.2.2 Pedestrian compliance at road intersections

A Dublin study showed that youths and males are more likely than older females to cross roads against a signal than to wait (Keegan & O'Mahony, 2003). The amount of time pedestrians were waiting also had a significant effect. When the average cycle length was around 78 seconds, 26% of pedestrians crossed against the signal; when it rose to 106 seconds, 40% crossed. Even after the installation of a display showing pedestrians how long they would have to wait before the next green signal appeared, pedestrians were more likely to cross on long signals (28%) than short (20%).

A recent study of pedestrian and driver compliance at pedestrian road crossings in Hawaii found that pedestrians who violated crossing laws were more likely to be male, and less likely to be under 12 years old than older (Kim, Made Brunner, & Yamashita, 2008). Illegal crossings were more likely in the morning peak and at lunchtime than at other times of the day, in cloudy and rainy weather than when it was sunny, and in hotel districts (with many tourists) than in other areas.

Social influences may play a part in pedestrian compliance at level crossings. A French study found that when a confederate pedestrian dressed as a high-status person (businessman) crossed against signals at a road intersection, waiting pedestrians were more than three times as likely to cross against the signals than when there was no confederate, or when the confederate was dressed in average (casual but neat) clothes (Gueguen & Pichot, 2001). Conversely, they were less likely to follow the same man across the road when he was dressed as a low status person (unshaven, greasy haired and wearing dirty clothes). Similarly, Gaker and colleagues (2010) found that presenting university students with information on the number of their peers who crossed roads illegally (28%) led to some students reporting that they were more likely to cross illegally in the next week. Interestingly, when the same fact was presented positively ('72% of people comply with traffic signals') there was no such effect on behaviour. It had been predicted that social influences would *improve* behaviour in this situation; however the authors suggest that because the peer noncompliance rate was so high, the opposite effect applied. As in other studies of compliance, females were more likely to report improved behaviour (i.e. that they would be less likely to cross against signals) after the experiment.

Social influences may be more important for women than for men. Observations of 400 pedestrians at signalised and unsignalised road intersections in France (Tom & Granié, 2011) showed that while most pedestrians looked at moving vehicles before they crossed, women were more likely than men to look at traffic signals and other pedestrians first. Men were more likely to cross when the signal was red (18% of men vs. 4.1% of women). The authors suggest that men and women appear to search for different information to work out when it is safe to cross, and act accordingly; men are more likely to cross during gaps in traffic, regardless of the signal, whereas women are generally more rule-bound and compliant with the larger group (of waiting pedestrians). It should be noted, however, that the most frequent behaviour among pedestrians of both genders was to look at moving vehicles first, but comply with the traffic signals.

2.2.3 Compliance with road rules more generally

Davey, Wallace and colleagues (2008) surveyed young drivers and rail experts about the risks of performing various behaviours at level crossings, and why the young drivers would perform the behaviours. They found that young drivers consistently underestimated the risk of behaviours such as going through an active crossing while the boom barriers are descending. Justifications for behaviour included feeling that the behaviour was low risk in terms of both physical danger and legal punishment; confidence in their own ability to judge the safety of the situation; and a community norm that the behaviour was acceptable. The authors note that these are likely to have been affected by prior learning experiences in which the driver has performed the risky behaviour, and seen others perfom the risky behaviour, multiple times without having experienced any consequences. They add that engineering measures are unlikely to completely solve the problem 'as it appears unlikely that any physical constraint will prevent a dangerous behaviour if there is a core belief that the behaviour is not dangerous.' It is likely that the same beliefs occur in pedestrians at rail level crossings, particularly young adult pedestrians comparable to those surveyed in this study.

Influences on compliance can also be investigated through review of more general road safety and psychological literature. For example, focus groups on speeding behaviour conducted with a range of driver groups revealed that role models, especially parents, played a large part in drivers' willingness to comply with, or disobey, speed limits (Fleiter, Lennon, & Watson, 2010). Most participants in that study reported feeling that speeding would damage their image as a responsible person, and so would comply with limits when passengers were in the car, and would feel embarrassed to tell others that they had received a speeding ticket. Such social influences could potentially be utilised in a level crossing safety campaign.

It should be noted that the factors influencing risky and noncompliant behaviour on roads are not necessarily the same across different behaviours and among different populations. Fernandes and colleagues (2007) studied intention to perform ten different behaviours in a sample of university students; intentions were best predicted by attitudes to each specific behaviour, rather than general attitudes, and risk factors such as gender and personality traits were only related to some behaviours. The study was repeated using a larger community sample, this time only asking about speeding and seatbelt use, and found that different risk factors correlated with intentions to speed or wear seatbelts in this sample compared to the student sample. They caution that as much behavioural research is based on university students, who are restricted in terms of age, education level, and potentially many other factors, it cannot be assumed that findings from such studies will generalise to the wider population.

The built environment can influence behaviour and compliance with rules. For example, the concepts of Crime Prevention Through Environmental Design and the UK Police Force's Secure by Design program promote the design of environments that reduce opportunities for crime. However there is little evidence regarding the effectiveness of environmental changes to convince people not to take physical risks (such as crossing in front of a train).

In summary, there are a myriad of factors that influence pedestrians' tendency to comply with rules, which may affect how likely a pedestrian is to enter the track area in defiance of activated warning signals and gates. These include individual factors such as age, gender, personality, and attitudes; social factors such as norms, enforcement, and behaviour of nearby others; and situational factors such as waiting time, weather, distraction and mood.

2.3 Potential countermeasures to pedestrian noncompliance

Level crossings that are located within metropolitan areas generally have sufficient numbers of trains and crossing users that hazard reduction guidelines require them to be equipped with active warnings, fences and pedestrian gates (Main Roads Western Australia, 2005). The ten crossings where PTA data indicate higher levels of errant pedestrian crossings are all located within metropolitan areas, and are thus already equipped with these features. Fences and pedestrian gates / barriers that are installed around level crossings have been found to be effective countermeasures to reduce the number of pedestrians crossing in front of a train (Lobb et al., 2001; Siques, 2002; van der Horst & Bakker, 2002). However, video observations by the PTA show that some pedestrians may still enter the track area when the gates are closed, either by jumping the fences, pushing the gate open, or using an emergency exit gate (Aldcroft & Macdougall, 2004). The following section examines potential countermeasures to this safety risk.

2.3.1 Changes to station layout

Although platform layout was identified in one study as related to pedestrian behaviour particularly in the context of multiple train arrivals (Arthur D. Little Ltd, 2009), no studies were located examining changes to platform location.

Pedestrian underpass

The above Victorian study (Arup, 2005) compared the frequency of non-compliant pedestrian crossings at Bentleigh station to the frequency of non-compliant crossings at two nearby stations. The first comparison station had a pedestrian underpass as well as a pedestrian level crossing; across both crossing types at this station, 1.4% of all pedestrians crossing were non-compliant. The second comparison station had a level crossing on the non-station side of the road, with a pedestrian underpass as the only pedestrian provision on the station side of the road (however pedestrians could walk onto the road and cross the tracks there). At this station, 1.0% of the pedestrian crossings involved pedestrians crossing via the road when the boom gates were down; however a further 16.7% of pedestrian crossings occurred via the road when the boom gates were up. Although pedestrians are not at risk from a train in this latter situation, they may have been at risk from vehicles using the road. The study concluded that providing a pedestrian underpass was unlikely to significantly improve pedestrian safety at level crossings.

Changes to sight distance

When sight distance is inadequate to see an approaching train in time to decide whether it is safe to cross, crossing users must rely entirely on warnings to make their decision. Pedestrians sometimes suspect that warnings are faulty and cross despite activated warnings, leading to near misses with approaching trains (Clancy et al., 2007). Thus increasing sight distance so that pedestrians can see further down the tracks might prevent risky crossings. However, long sight distances are also associated with risky behaviour in that pedestrians may see the approaching train but misjudge its speed and distance, and decide to cross despite warnings. A UK report therefore examined planned obscuration of sight distance as a potential countermeasure (Arthur D. Little Ltd, 2009). The report concluded that reduced sight distance would not be useful; while this would increase user's perceptions of risk (thus potentially leading to safer behaviour), it would also potentially increase actual risk, as well as posing an accessibility problem.

2.3.2 Improved barriers

Gate latches

A mechanical gate latch was installed on the emergency exit (bypass) gate at the Bentleigh station crossing discussed above, in addition to new warning signs discussed below (thus any effects of the gate latch, Red Man Standing Signal, and Another Train Coming warning cannot be separated from each other). There were 30 noncompliant crossings of a total of 3061 crossings before the changes were made (0.98% noncompliant), and 34 out of 3912 (0.87% noncompliant) afterwards (Arup, 2007). The majority of the 'after' noncompliant crossings were committed via the bypass gates, showing that the mechanical gate latch could not eliminate this method of obtaining entry to the crossing.

An electronic emergency exit gate latch (EEEGL) was installed on the bypass gate at Yarraville crossing in Melbourne's west (Dickinson et al., 2010). CCTV footage showed that after installing the latch only one pedestrian entered the tracks using the bypass gate (compared to 30 before). However, there was an increase in the more common problem of pedestrians crossing illegally using the adjacent road crossing. From the perspective of overall safety (not only safety at level crossings), this is even more risky as pedestrians using a rail-road crossing are potentially endangered by road vehicles as well as by trains.

2.3.3 Improved Warnings

'Red Man Standing' Signal (RMSS)

As an alternative to providing a pedestrian underpass, Victrack trialled improvements to the active warnings provided at the Bentleigh crossing. One countermeasure trialled was a 'Red Man Standing' sign, which is similar to those used at pedestrian road crossings; this sign consisted of an icon of a standing pedestrian that lit up in red when a train was approaching, and was not lit (i.e. did not display a green walking man) the rest of the time. Lloyd's Rail Register performed a fault tree analysis (Dickinson et al., 2010), involving the development of a model of the 'faults' or potential 'things that could go wrong' resulting in a collision, and the allocation of probabilities to each event. Their analysis indicated that RMSS would impact the probabilities of users being impatient, willing to take risks, and believing that it is safe to cross. Unfortunately, no justifications are given by the authors for these conclusions. Based on this fault tree analysis, the authors also conducted a cost-benefit analysis, and concluded that the costs of implementing RMSS would be greater than any safety benefits achieved at active crossings.

A UK report on potential risk reduction solutions for pedestrian crossings (Arthur D. Little Ltd, 2009) examined the use of red/yellow/green traffic-light style signals at crossings. The report concluded that traffic-light signals were more likely to *introduce* risk rather than reduce it, due to the potential for pedestrians to transfer across their mental model for road intersections (i.e. that the signals are a guide only, and that it is safe to cross in gaps) to rail crossings. It is possible that this would also apply to RMSS.

'Another train coming' (ATC) warnings

Another countermeasure trialled at Bentleigh was an 'Another train coming' sign. This countermeasure is designed to address the problem of one train blocking the visibility of a subsequent approaching train, when pedestrians may assume active warnings refer to the first train and try to cross without seeing the second train. These incidents are thought to account for over half of pedestrian fatalities at railway level crossings (Daff, Hogan, Barry, Irving, & Coller, 2007). ATC warnings were expected to affect the same probabilities as the Red Man Standing sign (see above). Unlike the RMSS, however, the ATC warning was to be activated only if another train approached while the crossing warnings were already activated. Therefore the fault tree and cost-benefit analysis again concluded that the potential safety benefits to be achieved by this sign would be less than the costs of implementing it at many crossings (Dickinson et al., 2010). However the report notes that such signs may be especially useful at crossings where subsequent approaching trains are common, particularly near stations, or where near misses with subsequent trains are known to have occurred.

A flashing graphical sign that is activated only when two trains approach a crossing was installed at a crossing on the LA Metro light rail network (Farradyne & Sabra Wang and Associates, 2002; Khawani, 2001). The sign alternates between a pedestrian looking at a train coming from the left and a pedestrian looking at a train coming from the right. The proportion of pedestrians crossing six seconds or less before train arrival was 4.0% before sign installation and 2.7% after, a reduction of 32% (Farradyne & Sabra Wang and Associates, 2002). Three years after the sign was installed, 556 pedestrians at the station were surveyed; 77% were aware of the sign and 93% thought the sign improved safety. Although only 4% recognised the precise meaning of 'more than one train coming', another 88% interpreted it in a safety relevant way (as meaning 'train coming', 'don't cross', 'wait', 'danger', 'look both ways' or 'slow down').

The above report (Farradyne & Sabra Wang and Associates, 2002) also describes a similar sign at a rail-road intersection, cycling between the screens 'Warning' – '2nd train coming' –

animation of two trains moving across the screen. The sign was aimed predominantly at motorists, rather than pedestrians, and was successful in reducing motorist risky behaviour. Pedestrian signals were also installed at the adjacent footpath crossing, and pedestrian behaviour was also recorded. However, the number of observed pedestrian violations was low and no exposure data (i.e. numbers of pedestrians crossing/waiting) is provided; therefore it is difficult to establish whether there was any effect of the sign on pedestrian behaviour.

Researchers in Adelaide, South Australia, have also trialled active signs that provide the visual warning ‘Caution More than one train’ and which are accompanied by an audible warning (Daff et al., 2007). This sign has been installed at two crossings and there are plans to install more at another 17 crossings. Unfortunately, the results of this trial are not yet available at the time of writing this report.

A simpler system to those decribed above was trialled at a rail-road crossing at a busy footpath in Ville Saint-Laurent, Quebec, Canada (Stewart, Brownlee, & Stewart, 2004). This system consisted of a static sign reading ‘Attention! 2 trains when flashing’, plus beacons that flashed when a second train approached. Of the 1870 pedestrians (or cyclists) present during second-train events before the sign was installed, 83% violated the crossing; after installing the sign, the proportion of violations dropped significantly to 31% (of 509 observations). The benefit-cost ratio (BCR) for rolling out the warning system to more crossings was calculated as between 0.52 and 0.79. Although the calculated BCR was less than 1, it should be noted that the BCR is highly sensitive to the value given for a human life. In addition, the risk of second train fatalities varies widely, and the BCR would be higher if warnings were installed only at crossings with a high risk of second-train-related pedestrian violations.

The simplest and cheapest system to warn crossing users of second trains is a static warning sign that does not change. Girard and colleagues (2003) report the development and piloting of a static warning sign to notify pedestrians that, concealed behind one train, another train could approach. The symbolic design shows a pedestrian crossing the track in front of one train, while another train approaches on the second track, with a red arrow showing its movement. The graphic is displayed on a yellow diamond (the standard shape and colour for cautionary warning signs), with a supplementary textual sign beneath reading ‘Attention!’. The signs were mounted at two pilot crossings and, after one week, users of the crossing were surveyed during morning and afternoon peak periods over several days. A total of 506 interviews were conducted; only 34% of those interviewed reported having seen the sign before; however 71% understood the desired meaning of ‘take care when crossing, another train may be coming’, with a further 18% thinking it meant crossing the tracks was prohibited (when trains are approaching).

A study conducted for the Rail Safety and Standards Board (UK) looked at different types of ‘second/another train coming’ (ATC) warnings around the world, as well as options for improving current UK warnings, and public comprehension of warnings (Arthur D. Little Ltd, 2008). The current UK ATC warnings consist of a static sign, with certain types of (active warning) crossings having an additional light and/or a change in the frequency of an audible warning tone when a second train is detected. Over 600 people (at schools, a shopping centre, an airport and other public settings around the UK) were asked to watch a video clip of a crossing with a particular warning becoming active, and then answer questions about their likely behaviour when crossing the tracks at this site. The survey revealed that providing an active sign saying ‘Wait! Another train coming!’ and/or an audible warning saying ‘Do not cross! Another train coming!’ could reduce crossing errors by 20-80%, with the combined visual and audible warning providing more benefit (i.e. viewers of this warning were more likely than viewers of other warning types to report that they would obey the warnings). A static warning sign was also tested, but did not improve understanding. A cost-benefit analysis suggested that it would only be worth implementing active ATC warnings at level crossings currently fitted with ‘miniature warning lights’, and not those crossings equipped with barriers, as the risk of second train incidents is only about 6% of the total risk at barrier-equipped crossings.

Countdown timers

A study of pedestrians who crossed against signals at road intersections showed that most overestimated the amount of time that they had been waiting (or would have to wait) at the signal (Keegan & O'Mahony, 2003). As a countermeasure to this behaviour, a ‘countdown timer’ was installed, showing how many seconds remained until the green man would be displayed. Three hundred and twenty-one pedestrians were interviewed before installation, and 312 after, approximately equally split between those who crossed against the signals and those who waited. After installation of the countdown timer, both those who crossed and those who waited overestimated their waiting time less, and felt that the wait duration was more reasonable. Video recordings of 750 cyclists and 26,947 pedestrians before timer installation, and 563 cycles and 24,060 pedestrians after installation, showed that the timer significantly reduced the number of pedestrians crossing during the red man phase, from 35% to 24%. It is possible that this system would also reduce the number of impatient pedestrians crossing at railway level crossings, although the factors influencing compliance are somewhat different; many pedestrians are not just waiting to pass through the crossing, but wanting to enter a train. Therefore displaying the amount of time until the train leaves the station may increase their motivation to cross against the signals (in order to catch the train), rather than increasing their motivation to wait.

A recent review of the use of countdown timers at road intersections (Levasseur & McTiernan, 2010) found that, due to the variability inherent in adaptive traffic control systems, the most commonly used countdowns show the time remaining to the end of the ‘walk’ phase. These countdowns have had mixed results, and their use at level crossings would not be possible using current level crossing signalling technology.

Future countermeasures

Future level crossing safety countermeasures may become available with the arrival of relevant Intelligent Transportation Systems (ITS) in vehicles. For example, Desai and colleagues (Desai, Singh, & Spicer, 2010) describe a project to develop a system in which trains can communicate with crossing infrastructure and road vehicles using Global Positioning System (GPS) data and Dedicated Short Range Communication (DSRC). This would enable trains to broadcast their position, direction and speed to road vehicles approaching a level crossing; devices in the vehicles would then be able to display a warning to the driver, suggest an alternative route, or provide other advice. This information might also be made available to pedestrians, for example via smartphone applications; however it would not be possible to rely on this mode of communication as not all pedestrians are likely to own and use such devices. Warnings given by infrastructure at the crossing itself are still needed. DSRC has the potential to provide more accurate and consistent warning times than those based on track sections (as is currently the case).

A recent literature review from the CRC for Rail Innovation (Larue, Soole, & Rakotonirainy, 2010) notes that in addition to in-vehicle warnings, Intelligent Transport Systems at railway crossings may also include dynamic advanced warnings (on approach to the crossing, so that road users can choose an alternative route), second train warnings, automated wayside horns, radio break-in messages, and obstacle detection (where information on pedestrians or vehicles within the level crossing boundaries is relayed back to the train driver, who can then brake). All of these systems may be relevant to pedestrian safety at level crossings.

2.3.4 *Education campaigns*

A UK study noted that teenagers are more likely than others to be involved in second-train pedestrian incidents, and suggested that education campaigns at schools near level crossings might be a more effective countermeasure than installing expensive warning equipment at the crossings (Arthur D. Little Ltd, 2008).

An education campaign was trialled at Bentleigh crossing, as students were over-represented among pedestrians who crossed against signals, particularly in the morning; only 14% of pedestrians were students, however 46% of noncompliant crossings were made by students (Arup, 2005). After the new warning signs were installed, an education campaign was conducted in local schools. In the 'after' morning peak pedestrian counts, 23.5% of pedestrians were students, and students made 33% of noncompliant crossings; students were still over-represented among those who crossed against signals, but less so than in the previous survey (Arup, 2007). However there was no investigation of students' awareness of the education campaign, so it is not possible to determine whether the difference was due to the campaign or to other factors.

Lobb and colleagues (2003) examined the effects of a high school level crossing education campaign on the behaviour of students using a nearby train station. This station is not reported as having warnings or barriers of any sort. The safe crossing area is reportedly at one end of the platforms where viewing distance down the line is maximal, however due to gaps in fences it is possible to cross elsewhere. Students were observed at the train station and surveyed about their attitudes before and after the intervention campaign; observations were also conducted during the campaign to observe the effect of different phases of the campaign. The first phase involved general communications: a billboard near the station, as well as posters and leaflets at school that advertised safe crossing. Observations showed that these interventions alone had little effect on crossing behaviour (which was highly variable over the five or six days of observations in each condition). Two months after the communications phase started, rail and council personnel gave talks to students and there was an announcement about rail safety in the school assembly. This resulted in a significant drop in unsafe crossings, from around 40% to around 30%. The third phase involved the teacher on duty issuing detentions to students who were observed crossing unsafely, as well as occasional rewards (pens and chocolate bars) given by council personnel to students observed crossing safely. This intervention resulted in a very significant drop in unsafe behaviour, to around 10% of crossings, as well as reducing the variability in crossing behaviour on different days. After two weeks, detentions were only given out for unsafe crossings during one period per week (students did not know which period this would be), and the occasional rewards were continued. This increased the variability in the proportion of students crossing unsafely, however the average remained low (approximately 15% of crossings per day were unsafe). Survey results showed an increase in the number of students who knew it was illegal to cross outside the designated crossing, an increase in the perceived safety of crossing at the designated crossing, and no significant difference in the perceived safety of crossing elsewhere (either with or without a train nearby). The authors concluded that awareness-raising activities were likely to be ineffective with the demographic of adolescent male crossing users, and that enforcement was a highly effective countermeasure.

A study conducted over 16 months in Arlington Heights, Illinois, USA, examined the effect of combined education and enforcement campaigns (Sposato, Bien-Aime, & Chaudhary, 2006). The campaign included safety inserts with utility bills, radio and television public service announcements, poster campaigns, train station public address announcements, increased frequency of presentations from the existing Operation Lifesaver ongoing education campaign, and enforcement blitzes in which police were present at crossings and gave fines for noncompliant behaviour. Data on violations at three rail-road crossings (all equipped with motorist and pedestrian boom barriers) were collected for 2 months before the campaign, throughout the year-long campaign, and for two months afterwards. There were significantly fewer pedestrian violations of all types (type I after warning activation but before barrier activation; type II while barrier was descending; type III when barrier was fully closed) during the campaign period than before it; this reduction was maintained in the post-campaign period. Reductions in the most dangerous type III violations were greatest at the crossing adjacent to a station (with the highest level of pedestrian activity); at this crossing there was a 76% decrease in pedestrians entering the crossing past a closed barrier after the campaign.

2.4 Safety education campaigns and messages

2.4.1 Background theoretical perspectives

Delaney and colleagues (2004) reviewed mass media campaigns on road safety, and noted that those that were developed using a theoretical basis were more likely to be successful than those that were not. These theoretical models include the Theory of Reasoned Action, later developed into the Theory of Planned Behaviour (Ajzen, 1991), which holds that behaviour is determined via a considered, rational process, taking into account attitudes towards a behaviour, social norms surrounding that behaviour, and the actor's perceived control over the behaviour. An alternative set of theories are those related to the Health Belief Model (Rosenstock, 1966; Rosenstock, Strecher, & Becker, 1988), which posits that health behaviours are determined by the person's perceived susceptibility to, and perceived severity of, a health threat, along with their evaluations of costs and benefits of various behaviours related to the threat, and cues to action.

Campaigns based on these two models will try to change people's attitudes surrounding a given behaviour (such as crossing in front of a train) by informing them of highly negative consequences (i.e., severe health threat) that could happen to them (i.e., high susceptibility if they perform the undesired behaviour). Messages typically end by informing people of actions they can take to avert the threat (i.e. obeying warnings, not crossing in front of trains). This form of messaging is known as a 'fear appeal' or 'threat appeal' because it raises a threat and attempts to create fear of the threat in order to change behaviour.

The importance of social factors is emphasised in Aker's (1979) Social Learning theory. This theory posits that deviant (i.e. noncompliant) behaviour can be explained by imitation of others' behaviour, differential reinforcement (i.e. different rewards and punishments for alternative behaviours), and social definitions of behaviour as good or bad (similar to attitudes and norms in the Theory of Planned Behaviour), all occurring within social groups (such as peer groups, families, and broader groups such as schools, churches, etc). These are all potential points of leverage for safety campaigns.

2.4.2 Evaluations of previous campaigns

While campaigns based on fear or threat and that contain highly emotive themes achieve high levels of recall among observers, as well as high levels of self-reported future behaviour change / intent to behave in the desired manner (e.g. Harrison & Senserrick, 2000), their effect on actual behaviour is less clear. Very few evaluations of level crossing or rail safety education campaigns are available to determine whether this approach is successful in the rail safety area. The two education campaigns (Lobb et al., 2003; Sposato et al., 2006) discussed above represents the only published evaluation of a pedestrian-focussed rail safety campaign located during the present review.

There are potential negative effects of campaigns that evoke fear as their primary mechanism for behavioural change. Theorists (Leventhal, Singer, & Jones, 1965; Witte,

1992) have noted that fear not only motivates people to control the danger they face (by changing behaviour in the desired manner), it may also motivate people to control the fear they experience. This may involve ignoring the message containing information about danger, or even increasing the undesired behaviour (in cases where the undesired behaviour is a coping response to anxiety, such as smoking). In a recent review, Hastings and colleagues (2004) noted that among the most vulnerable groups, fear appeals may actually lower the probability of changing behaviour. If a person does not believe they are capable of performing the desired behaviour, they may assume that the message applies to others, or reject the message as false, or potentially reject any further messages from the same source. These effects can be particularly pronounced when the fear/threat used is that of death (Henley & Donovan, 1999).

Alternative campaign strategies may use more positive themes, such as hope, empathy, or humour. These may work particularly well for young people who have grown up in an environment of 'post-modern' advertising (Hastings et al., 2004). An example of such a humour-based campaign in a transport safety context is the current Yarra Trams campaign 'Beware the rhino', comparing a light rail vehicle with a rhinoceros on rollerskates (Yarra Trams, 2011).

Gender is related to degree of message acceptance for 'negative' appeals. Lewis and colleagues (2008) showed one of four road safety messages based on fear, agitation, pride, and humour to 551 participants in an online survey. They found that gender had a larger effect on message acceptance for the negative appeals (fear and agitation) than it did for the pride- and humour-based appeals.

It should be noted that threats used in campaigns do not have to be physical. Legal or social sanctions may also be applied. These may be more effective than physical threats in some demographic groups. For example young males may be unlikely to respond to a message that implies a physical threat, but they show more concern for a social threat such as losing their driver's licence (Rotfeld, 1999, cited in Lewis et al 2007). Lewis and colleagues (2007) examined responses to two road safety advertisements concentrating on physical threats. The found that males were more likely to see such messages as having more influence on others than on themselves, while females thought they would be more affected than others.

The NSW RTA's anti-speeding 'Little Pinky' campaign is an example of a campaign focussing on social consequences of the undesired behaviour. The campaign encourages those observing speeding to waggle their pinky finger to let the driver know they don't approve; the tag line is 'Speeding – no one thinks big of you'. Audience testing prior to the campaign on eight groups of 17-25 year old and 30-50 year old male and female drivers received positive feedback about the avoidance of fear and shock tactics, and the encouragement to those who observe speeding to demonstrate their disapproval (Roads and Traffic Authority (NSW), undated). An evaluation of the campaign showed that a majority of the 200+ respondents, including the targeted group of young male drivers, understood the message believed the campaign would change driving behaviour (their own, and in general).

Of the two non-physical threats (e.g., legal, social), Zimmerman (2008) notes that social sanctions may be more powerful than legal sanctions; however, legal sanctions may function as signifiers of social norms. Zimmerman (2008) surveyed 430 college students and found that instances of drink-driving and stealing that had not been legally punished were associated with lower feelings of guilt and social disapproval about the offences; observing a friend offend without being punished had a similar effect.

Scott-Parker and colleagues (2009) surveyed 165 young people (aged 17-24 years) and found that social variables such as imitation (of others' driving behaviour), anticipated punishments and rewards (from parents, peers and police), differential association (with people who engaged in risky driving), and personal attitudes accounted for two-fifths of the variation in risky driving behaviour, on top of the one-fifth explained by demographic variables. Changing social norms and responses to peer behaviour entails long-term commitment and resources across many stakeholders. This sort of behaviour change model may lend itself to broader based programs. Senserrick and colleagues (Senserrick et al., 2009) found that a school-based program concentrating on 'resilience building' or safe behaviour generally (including drug and alcohol use and looking after friends, as well as driving) was more effective than a school-based program focussing only on driving. The PTA could possibly partner with other authorities to deliver a similar program delivered in secondary schools; however this would not reach the majority of current noncompliant crossers who are adults.

Sharpe Research (2003) reviewed several recent mass media campaigns in the UK to draw out lessons for the Rail Safety and Standards Board to consider when constructing a new campaign about railway safety. The five campaigns were targeted at diverse areas, from childhood literacy support, anti-smoking, child pedestrian safety, anti-child abuse, and television licence evasion. All were state wide campaigns that aimed to change behaviour. The lessons included the following findings:

- telling people what to do is more effective than telling people what not to do;
- it is worthwhile to profile the target group, examine their beliefs and motivations, tailor-make advertisements and then check their appeal with that group;
- people respond well to an approach that treats their noncompliant behaviour sympathetically;
- raising legal obligations as well as attempting to persuade can be effective; and finally,
- changing social norms towards a particular behaviour requires a long term approach.

The authors note that many successful campaigns have used 'allies' to add to the campaign impact; these need not necessarily be 'stakeholders', but any organisation with a potential interest in reducing rail crossing accidents, including commercial partners such as retailers and sports clubs, as well as the media. They suggest undertaking 'target market research' to determine what distinguishes noncompliant and compliant pedestrians. The responses of noncompliant pedestrians towards information about railway safety, and towards existing road safety/other safety publicity, could provide valuable information about the content and tone of rail safety campaign messages. Messages should be tested on the target group before launch. The campaign should have an evaluation strategy built in, which may include a pre/post survey of awareness and attitudes, as well as recording data on behaviours and safety incidents in the longer term. Finally, they note the danger of 'wear-out': when an audience feels they have seen a message many times before and it no longer tells them anything new, they will cease to pay attention to the message, so new messages are required. This may particularly be a problem at railway crossings where many users pass through the same crossing every day and are highly familiar with the existing warnings.

2.4.3 Ergonomic considerations for safety messages on signs at stations

Evaluations in both the UK (Arthur D. Little Ltd, 2009) and Melbourne, Australia (Dickinson et al., 2010) have noted that railway level crossings are cluttered with large amounts of visual information, particularly text information. Therefore it is important that safety messages follow good ergonomic practice. Castro and Horberry's (2004) recent book on the human factors of transport signs note that signs are more likely to be noticed and read when they are:

- Placed where viewers expect to find useful information
- Not surrounded by other similar looking signs
- High in contrast to the background (e.g. by addition of colour or a coloured border)
- Comprised of *simple* symbols, with or without words

- Simple and clear

For example, a sign could be placed at eye level on an extended pole in the middle of a crossing gate (away from other signs), reading 'Stop – crossing tracks while alarm is on is illegal'. The sign might include a simple pictogram and a coloured background or border. Rudin-Brown and colleagues (2002) note that orange and red are colours most often noticed as they are associated with hazards. They also found that sans-serif fonts are easiest to read.

2.4.4 Summary of literature on behaviour change and safety campaigns

A consistent thread running through the literature is the challenge of developing safety campaigns that are able to reach young men. Threats of social or legal repercussions for crossing in front of a train may be more effective for this group than would be raising physical threats. Alternatively, strategies such as humour may be used to avoid message rejection by this key demographic. At the same time, it is important that any safety messages do not appear to be targeted solely at one particular demographic. If, for example, it is perceived that PTA safety messages are only targeting young men, it is possible that older and female pedestrians will assume the message does not apply to them and that they can continue to use their own judgement about when it is safe to cross rather than relying on warnings. It is also important that signs bearing safety messages follow good ergonomics practice in terms of location, high contrast, colour, font, simplicity of message and use of symbols where appropriate.

3. OBSERVATION OF PEDESTRIAN BEHAVIOUR

3.1 Method

Based on the above literature, a guide was developed to observe and record pedestrians' behaviour at level crossings in a non-intrusive manner (so that the likelihood that their behaviour was affected by the presence of observers was minimised). Passive observations were considered the best method of examining behaviour, given resource constraints and the sensitivity of investigating illegal behaviour. While interviews would provide more insight into the risk perceptions and decision-making process of non-compliant crossers, it was considered unlikely that pedestrians approached immediately after crossing illegally would agree to an interview, while conducting interviews with pedestrians regardless of their crossing behaviour would take hundreds of hours to obtain enough data about those who crossed illegally. Instead, the observer simply stood on the platform and surreptitiously noted pedestrian behaviour and characteristics of those who performed the behaviours of interest.

Observations were carried out at rail stations with the highest number of incidents of crossing violations by pedestrians recorded by the PTA. . Details of the observation hours at each crossing are presented in Table 2. Observations were completed over a three-week period in June 2011 (during the school term).

Table 2. Details of observations at crossings

Crossing	Location	Line	AM Observations	PM Observations
City West Station	East of station	Fremantle	7-9am	2-6pm
City West Station	West of station	Fremantle	7-9am	2-7pm
Oats St Station	South side of station, adjacent to road crossing	Armadale	7-9am	2-7pm
Burswood Station	South side of station	Armadale	7-9am	2-7pm
Queen's Park Station	South side of station	Armadale	7-9am	2-7pm
Carlisle, Mint St	Adjacent to Mint St road crossing, ~150m north of station	Armadale	NA	2-7pm
Gosnells, Dorothy St	Adjacent to Dorothy St road crossing ~150m south of station	Armadale	NA	2-7pm
Maddington Station	South side of station	Armadale	NA	2-7pm
Loch St Station	South side of station	Fremantle	NA	2-7pm
Sherwood Station	South side of station	Armadale	NA	2-7pm
Cottesloe, Jarrad St	Adjacent to Jarrad St road crossing, ~100m south of station	Fremantle	NA	2-7pm

'Near miss' and 'person illegally on tracks' data from the PTA were used to identify the Perth-area rail stations with high incident rates, and the time of day at which these occurred, to maximise the amount of non-compliant behaviour observed. Crossings at Oats Street, Burswood, Queens Park, and City West (F35 and F37) stations were visited during the morning (7-9am) and afternoon (2-7pm) peak incident times, as these were the crossings with the highest number of incidents across both morning and afternoon peaks. Crossings at Carlisle, Maddington, Gosnells, Shearwood, Cottesloe and Loch Street stations were visited only in the afternoon peak period, as PTA data showed that they had few incidents in the morning. In total, 71 hours of observations were recorded.

The PTA has recorded 158 'near miss' and 'person illegally on tracks' incidents at these sites in the 23 months between July 2008 and May 2010, an average of 0.7 incidents per site per month. Therefore it was anticipated that, during the limited observation time available at each site, the likelihood of observing someone jumping over or pushing open a gate to gain entry to the tracks was quite small. As a consequence, it was decided to record any incidents of pedestrians/cyclists crossing the tracks while the alarms were sounding. This behaviour is more common, but still potentially risky. Unfortunately the total number of risky incidents observed was still too low for statistical analysis, however it is possible to explore some basic trends. The observation guide with factors recorded may be found in Appendix A.

It was not possible for the observer to simultaneously note the details of noncompliant crossing occurrences as well as the number of other pedestrians who crossed compliantly. The observations thus do not take exposure into account, and it is not possible to calculate the risk of an incident (the probability of a noncompliant crossing, given the opportunity or number of pedestrians crossing). The aim of this part of the research was to collect qualitative data on the characteristics of individuals who were observed to engage in non-compliant behaviour, rather than to quantify the overall prevalence of noncompliant behaviour. This should be borne in mind when comparing station layouts or pedestrian demographics. However the results provide some exploratory data suggestive of factors that may be worth further investigation.

3.2 Results

The observer noted 52 incidents during which pedestrians and cyclists crossed before a train while the alarm was sounding. Descriptive statistics about the station, the pedestrian or cyclist and the situation for these incidents are given below. Seven incidents in which pedestrians opened the gates to cross after the train while the alarm was still sounding are described separately. The data collected for each incident is presented in Appendix B.

3.2.1 Station layout

Twenty-nine incidents (0.94 incidents per hour observed) occurred at the four stations in which the platforms are outside and pedestrians are forced to cross both tracks in one crossing; 22 of these 29 incidents involved pedestrians who subsequently entered a train. Transit police were present during observations at two of these stations, which may have reduced the amount of noncompliant behaviour observed. There were 15 incidents (0.79 per hour observed) at the three stations where the platform is on the inside of the tracks and each track has a separate crossing (see Figure 1). There were eight incidents (0.40 per hour observed) at the three crossings with two tracks together but no platform access.

Figure 1. Maddington station crossing showing pedestrian refuge between two tracks

Twenty-four incidents occurred at the six sites with sight distances of approximately 30 seconds (or less) to and from the city, and twenty-eight incidents occurred at the five sites with sight distances of between 30 and 60 seconds in both directions. It is notable that none of the sites identified as high-incident sites based on PTA data have longer sight distances than 60 seconds. If this in not typical for sight distances on the rest of the network, sight distance may be regarded as a potential contributing factor to noncompliant crossing behaviour. However it is not possible to ascertain this from the present restricted data set (of the crossings with the highest level of noncompliant behaviour) alone.

It should be noted that twelve of the incidents (23%) occurred at one crossing, City West F37 (see Figure 2). This is presumably a busier crossing than the others observed. Unfortunately it was not possible for the observer to record baseline numbers of pedestrians crossing at each site, which would have provided the necessary exposure data. City West F37 has platforms on the outside of the two tracks, and sight distances of around 30 seconds to and from the city.

Figure 2. City West F37 crossing, facing north. Note both sets of tracks must be crossed in one crossing.

3.2.2 Pedestrian characteristics

It should be noted that it was not possible for the observer to gather comparison exposure data on pedestrians who crossed in a compliant manner. Therefore it is not possible to determine whether the characteristics of noncompliant pedestrians simply reflect the characteristics of all pedestrians using the crossings, or whether certain features are more common in noncompliant pedestrians.

Seven (13%) of the incidents involved high school students. Five of these incidents involved groups of students encouraging each other to cross before the train, including one group of three boys who jumped the gate and one large group of girls in which one held the gate open for two others to cross. The remaining incidents involved adults, with the majority of pedestrians (31, or 60%) appearing to be over 30 years old; two of these appeared to be over 60 years old. A large proportion of the incidents (44%) involved pedestrians dressed in business attire.

PTA data indicate that males are far more likely to be involved in ‘near miss’ and ‘person illegally on tracks’ incidents. The present data support this conclusion somewhat; in total, 30 females and 44 males (59%) crossed before the train while the alarm was sounding. There were 14 instances (27%) in which more than one person crossed together; four groups comprised females only, five were all male, and five mixed. Those pedestrians who crossed alone were more likely to be male (23 males *vs.* 14 females).

The majority of the incidents involved pedestrians on foot, while seven (13%) involved cyclists. One group of pedestrians included a pram. No wheelchair or motorised scooter users were observed crossing unsafely.

Although it was not possible to determine pedestrians’ familiarity with the station and timetable in the present study, it should be noted that regular users may know the timetable well, and this may influence their behaviour when they know a train is coming soon, or the delay to the next train.

3.2.3 Situational characteristics

Fifteen of the 52 incidents (29%) occurred in the morning observation period (1.5 incidents per hour observed), while 23 (44%) occurred between 2pm and 4.30pm (0.8 incidents per hour observed) and 14 occurred between 4.30pm and 7pm (0.5 incidents per hour observed). Figure 3 shows the incident rate by time of day. Note that morning observations were only carried out at the four stations with the highest incident rate (one of which included two crossing sites), while the afternoon/evening observations were carried out at ten stations (the top four, and the six with the next highest incident rate).

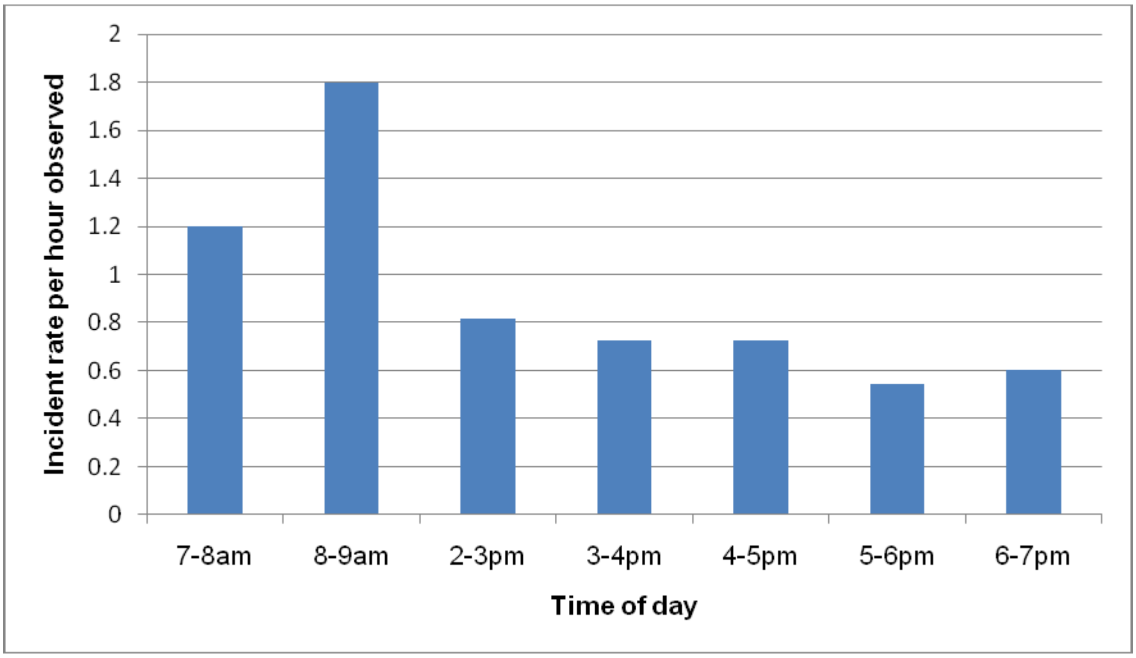

Figure 3. Rate of observed incidents by time of day.

Thirty incidents (58%) involved pedestrians entering the train, and 22 (42%) involved pedestrians passing through the crossing. Destination varied by time of day, as shown in Figure 4. During the morning and early afternoon, about two-thirds of incidents involved pedestrians entering the train. Between 3-4pm and after 5pm, more incidents involved pedestrians passing through the crossing.

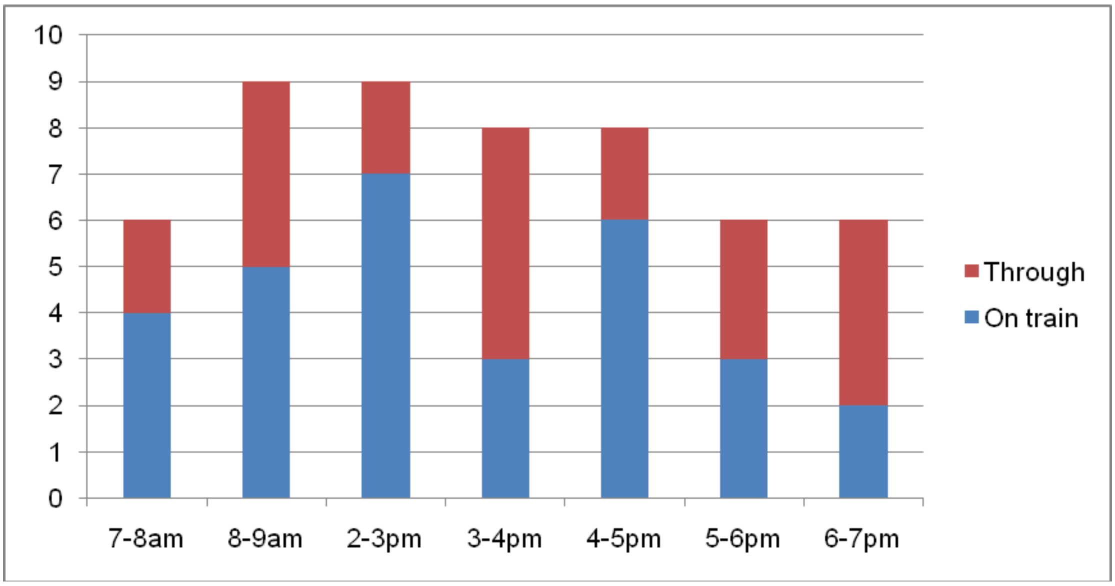

Figure 4. Number of incidents by time of day and destination of pedestrian

The majority of incidents occurred before the gates had closed off access to the tracks. However there were two incidents when pedestrians jumped the gates, four incidents when pedestrians or cyclists pushed the gates open and two incidents where a pedestrian held the gate open (while it was closing) for another person (or dog) to go through. A further seven incidents involved pedestrians pushing the second gate to exit the tracks, while in 15 incidents pedestrians were required to use the bypass gate to exit. There were 26 incidents in which pedestrians ran across the tracks to exit before the gates closed.

There were few incidents of noncompliant crossing that involved pedestrian distraction. Only six incidents (12%) were observed as being potentially related to distraction; in two cases the pedestrian was distracted by other people and, in four cases, by a mobile phone. Even when pedestrians were not distracted, they often failed to search for approaching trains before crossing. In 40 of the incidents (77%), the pedestrian(s) did not look for trains in either direction before crossing. Pedestrians looked both ways in only three of the incidents (6%).

Most instances of noncompliant behaviour involved close proximity to an oncoming train. In 48 incidents (92%), the pedestrian cleared the tracks less than ten seconds before the train arrived. This is unexpected, as in most of these incidents the gates were not fully closed, although gates are designed to be closed at least 13 seconds before the train arrives (Aldcroft & Macdougall, 2004). This figure is based on a minimum warning distance equating to 21 seconds at the maximum train speed; gates are designed to start closing six seconds after lights and bells begin, and to take two seconds to close, leaving 13 seconds until train arrival or longer if the train is travelling at less than the maximum speed. The appropriateness of the current timing for gate warning and barrier activation at these 10 level crossing sites should be verified.

3.2.4 Noncompliant crossing after a train had passed

Seven incidents were observed in which pedestrians did not wait for the gate to open after the train had passed through before crossing the tracks. In the observed incidents there were no situations involving a second train; however crossing before gates open is still risky behaviour. Six incidents involved pedestrians pushing the crossing gate open, and one involved a boy pushing his hand through the bypass gate to unlatch it from the inside.

Three of the incidents involving pedestrians crossing illegally after a train had passed occurred at City West F37 station (platforms outside, sight distance 25-35 seconds). The others were observed at Loch St station (platforms outside, sight distance 25 seconds each way), Burswood station (platforms inside, sight distance 25 seconds each way), Maddington station (platforms inside, sight distance 30-35 seconds), and Queens Park station (platforms inside, sight distance 60 seconds each way).

Two of the seven incidents of pedestrians crossing after the train involved single males (one secondary school student, one adult). Three comprised groups of males: one involved two primary school boys, a second involved three secondary school boys, and a third involved two adult males. One was an all-female group (six secondary school girls) and one was a large mixed group of secondary school students.

One incident involved pedestrians passing through the crossing; the other six involved pedestrians entering a waiting train. There was no distraction observed among any of the pedestrians who crossed illegally after a train had passed. One pedestrian had a bicycle, the rest were on foot with no mobility impairments. Pedestrians looked both ways for trains in only one incident (the two men crossing together), and one way only in a further two incidents; the rest of the incidents did not involve pedestrians looking at all. In all of the cases, pedestrians were on the tracks less than ten seconds after the train had cleared the crossing.

3.2.5 Summary of noncompliant crossings

From the observations conducted during this study, it appears that the typical noncompliant pedestrian is an adult, is somewhat more likely to be male, and is crossing alone; however several groups were observed in which one or two members urged others to join them in crossing unsafely. In the morning they are likely to be hurrying to get on to the train, and in the afternoon/evening they are hurrying through the crossing to get to another destination.

Distraction, as well as mental and physical impairments, does not appear to be involved in many incidents of pedestrians entering or remaining in the track area while warnings are sounding. Incidents are somewhat more likely to occur at stations with platforms on the outside of two tracks at the crossing. No pattern of results could be identified with regards to sight distance.

3.2.6 A note about station context

Stations do not exist in isolation, but are linked to their surroundings in terms of operation. Furthermore stations are equally linked to the surrounding community in terms of social factors. For instance, while not included in this study, Subiaco Station has large numbers of football fans, and Fremantle Station has many tourists. West Perth Station may have larger numbers of higher paid workers due to the proximity to West Perth, while other stations may have larger proportions of people from lower socio economic situations or cultural backgrounds.

These social contexts are not generally considered in any detail. Indeed a description of social factors is not evident in either the transport or safety literature. However, there is the potential for social factors, status and issues to be considered in the design of countermeasures by reflecting interests, behaviours, cultural sensitivity, literacy, income or other factors.

The approach in this study is to recognise that individuals are the key to understanding motivations and targeting improved behaviour. In this sense individuals are a product of their socio-economic context. Having said that, it is equally valid to recognise the socio-economic and physical context of stations, which may influence behaviour, activity or opportunities. This context has not been assessed but offers potential for additional valuable information.

4. RECOMMENDATIONS

The present project has reviewed the literature on pedestrian behaviour and compliance at rail-road level crossings, including previous infrastructure countermeasures and safety campaigns. The project also gathered qualitative data about who is crossing against activated warning signals at 10 Perth-area level crossings, and the situations in which they cross. Based on the literature review and the observations of pedestrians, recommendations were developed. Potential directions to guide the development and design of countermeasures were workshopped by the researchers and subsequently with representatives of the PTA. This ensured a quality mix of concepts based on academic evidence, practice and experience.

4.1 Changes to station layout

The best-proven, most effective, countermeasures to reduce noncompliant, risky pedestrian crossing behaviour (fences/mazes and auto-closing gates) have already been installed at the crossings identified by the PTA data as having the highest frequency of illegal crossings. <u>Further changes to station layout are unlikely to be worthwhile.</u>

There is little evidence that pedestrians in a hurry will use an underpass or overbridge to access platforms rather than pushing through the gate or using the road crossing, as using an underpass or bridge requires walking further and takes longer. These options also raise accessibility issues and are very expensive. Likewise, while incidents are more common at stations with platforms on the outside than on the inside of the tracks, it would be very expensive to move platform locations and would not eliminate risks. Changing the sight distance could also be expensive with little evidence that this would prevent noncompliant crossings. Therefore none of these options are recommended.

4.2 Improvements to existing barriers and warning signs – worth further investigation

4.2.1 Gate latches

<u>Gate latches</u> to prevent the gates being pushed open <u>may be worth trialling</u> at the locations with the largest number of noncompliant crossings. However, prior experience suggests that this should <u>only</u> be undertaken <u>when there are no alternative routes</u> to cross the tracks that are more dangerous for pedestrians (e.g. nearby road crossings).

4.2.2 Additional active warnings

Additional active warnings such as the ‘Red Man Standing’ sign and the ‘Another Train Coming’ sign may be worth trialling. While the Red Man is included in the Australian Standard for level crossings as an option for pedestrian crossings, it is not clear what effect it would have on noncompliant crossing behaviour when lights, bells and gates are already present. There is <u>insufficient evidence to recommend for or against installing a ‘Red Man Standing’ sign</u>; more research is required.

‘Another Train Coming’ signs have been shown to reduce noncompliant crossings in the context of a second train approaching soon after the first (when crossing during activated warnings is particularly dangerous). However these signs are not activated during single train events and thus can only affect a small proportion of noncompliant crossing behaviour. <u>‘Another Train Coming’ signs will be most beneficial at crossings where there is frequently more than one train approaching the crossing within a short time, and crossings where pedestrians frequently attempt to cross between trains.</u>

4.2.3 Providing information on train departure times (countdown timers)

No published investigations of pedestrian countdown timers in the context of railway level crossings were identified. A second-by-second countdown is probably not viable in a railway environment due to uncertainties in passenger loading times. However modern technology makes it possible to provide information at the crossing on when the next trains are expected (note this will not necessarily be when they are scheduled). During the present study, some incidents were observed in which pedestrians ran across a closing crossing, presumably thinking their train was arriving, when the crossing warning had actually been activated by a train on the other track. Such incidents might be prevented by providing accurate information on train arrivals at crossings near stations. It is also possible that providing information about which train is approaching would encourage pedestrians to cross the tracks who otherwise would wait. If countdown timers were to be implemented, it would be necessary to observe pedestrian behaviour closely to determine whether or not the timers were associated with overall improvements in crossing behaviour.

There is no evidence whether countdown timers would be beneficial or not in the railway context. However given the benefits in some circumstances in other contexts, they may be worth trialling. Such a trial would require careful monitoring of pedestrian behaviour due to the potential for adverse safety outcomes.

4.2.4 Passive warning signs

Passive warning signs (e.g. ‘Do not cross tracks while lights are flashing or alarm sounding’ and ‘Danger – look out for trains on two tracks’ signs) are covered under Australian standards and the operating railway’s internal standards. It is unlikely that any further warning signs would be useful. However there is the potential for the display of current warning signs to be improved in accordance with ergonomic principles at some stations. These include:

- Locating signs centrally in pedestrians’ cone of vision (preferably at eye height) as they walk towards the crossing and decide whether to cross
- Moving distracting signage away from the decision point (such as the ‘to report crossing faults’ sign, advertising signs)
- Pictograms and colours are already used to non-verbally indicate danger
- Some signs have inconsistent wording across different crossings; these could be standardised to the simplest wording.

4.3 Behaviour Change: Education and enforcement campaigns – effective when well-designed

Behaviour change messages encompass a large variety of types of messages, which may target pedestrians’ knowledge, attitudes, social norms, perceptions of costs and benefits of particular actions, etc (see p12). Although education campaigns are often the first solution proposed to resolve safety problems, they are not often evaluated to determine how well they have achieved their goals. There is evidence that carefully designed campaigns can change attitudes towards certain behaviours. There is also evidence that changes in specific attitudes can result in changes to specific behaviour. However, many mass media campaign evaluations have used future behavioural intentions as proxies for behaviour, which may lead to inflated estimates of a campaign’s effectiveness. In the railway crossing context, the evidence suggests that education combined with enforcement is more effective than an education campaign alone.

The following suggestions regarding message content and delivery/presentation are necessarily very general. More detailed behavioural market research should be undertaken to develop an optimised campaign. Such a campaign could comprise different messages for the different risk groups, which could then be rotated around different stations over time to reduce 'staleness' and ensure each risk group is reached. Alternatively messages could be targeted differently at different stations depending on the profiles of crossing users (for example, more businesspeople and fewer students at City West station might dictate a more sophisticated message here; messages involving sportspeople as role models may be more effective at stations used by those going to major sporting events; etc). Likewise it may be considered optimal to have different messages during the week vs. on the weekend, or at different times of the year e.g. school holidays. There is currently insufficient evidence to decide these details.

4.3.1 Message content

There are a number of different target audiences, and no one message will be effective for all of those audiences. Messages need to be appropriately tailored to the target audience, but ideally not so tailored that those pedestrians outside the targeted demographic reject the message. Examples of target audiences (based on PTA 'person illegally on tracks' data and the observations from the current study) and messages they might respond to (based on the literature review on pages 12-15) are given in Table 3.

Table 3. Potential messages for different target audiences

Risk group	What are they thinking?	What messages will they respond to?
Young males	Invincible - I won't be hit by the train	• Fear/physical threats ineffective • Positive campaigns, e.g. humour
Groups, especially high school students	• Distracted talking • Peer pressure to cross	• Change social norm towards safe crossing. • Role model/celebrity spokesperson • Peer to peer (e.g. 'Little Pinky', p14)
Adults going to work	In a hurry - must catch/beat train	• Time saving – legal sanctions • Physical threats may be effective for this group, especially women

Credible messages about social consequences are likely to be effective for all groups. In general, messages are more likely to be accepted and acted upon if they come from a trusted source. Hence the use of a trustworthy spokesperson can be effective. Messages concerning legality and enforcement should be supported with an increased enforcement presence; otherwise there is the danger of reinforcing a perception that crossing behaviour is not important and offences will not be punished.

4.3.2 Message delivery/presentation

It is important that any posters at stations presenting safety messages maximise the probability that they will be noticed: they should be located somewhere that pedestrians are likely to see as they make the decision on whether to cross, and should not be surrounded by visual clutter. Beyond this, presentation will again need to be tailored to the target audience. Alternative media for message presentation may include electronic (variable) signs, or audible messages instead of or in addition to visual messages. The style, tone, and delivery of messages requires further concept consideration and development.

4.3.3 Enforcement

Additional powers for Transit Officers are unlikely to be necessary. It is not certain whether heavier sanctions would be useful without an increase in the number of offences being punished. Increased visibility of officers and increased frequency of receiving a warning or fine for noncompliant crossing have been shown to reduce noncompliant crossing.

The effectiveness of videocamera enforcement is not known in the context of pedestrians at level crossings. The use of security cameras for enforcement purposes may also raise privacy concerns. The potential use of video cameras in enforcing compliant crossing behaviour requires further research.

Positive reinforcements (for example, staff handing out pens and chocolate to those who crossed compliantly in Lobb et al's 2003 study, discussed p11-12) can also be effective. Positive reinforcements for compliant crossing may be worth investigating further.

4.4 Novel countermeasures

Although no evaluations in the railway level crossing context were located, it is possible that novel countermeasures that make waiting more pleasant would decrease the number of people who cross against the signals instead of waiting for the crossing to open. These might include provision of entertainment such as radio, music, videos, news, games or puzzles, real-time competitions, etc. These could be delivered by a variety of media.
The concept of waiting inducements would require further investigation and development to determine what enticements could be used, and how effective they would be for the various target groups. Potential inducements could be gathered by looking at other contexts in which people have to wait, and how these are made more pleasant. Market research would need to be conducted to determine whether an inducement would be effective for each target group.

4.5 Countermeasure evaluation

Whatever countermeasure or combination of countermeasures is chosen, it is important that a well-designed evaluation of pedestrian behaviour and safety is conducted to determine whether the campaign is actually having an effect. This will allow the PTA and any other involved bodies to target their limited funds to the countermeasures that have the greatest effect. Making the results of evaluations publicly available assists safety bodies around Australia to learn from each other, as well as ensuring that results are not lost over time. Therefore it is recommended that the PTA ensure that countermeasures are evaluated and the results are published.

4.6 Countermeasure Opportunities for the Perth context

The process of developing and selecting countermeasures is based on identification of risk groups, cognitive motivations and consequently potential concepts which people might respond to. The possible countermeasures are myriad, and informed by the literature and experience of researchers and PTA staff. The types of countermeasures are summarised in Figure 5.

The development of countermeasures best follows a two tiered approach:
1. Meeting the minimum requirements for safety management and recognised standards
2. Measures must be deployed flexibly and be appropriate for the specific context ,so should be applied thoughtfully.

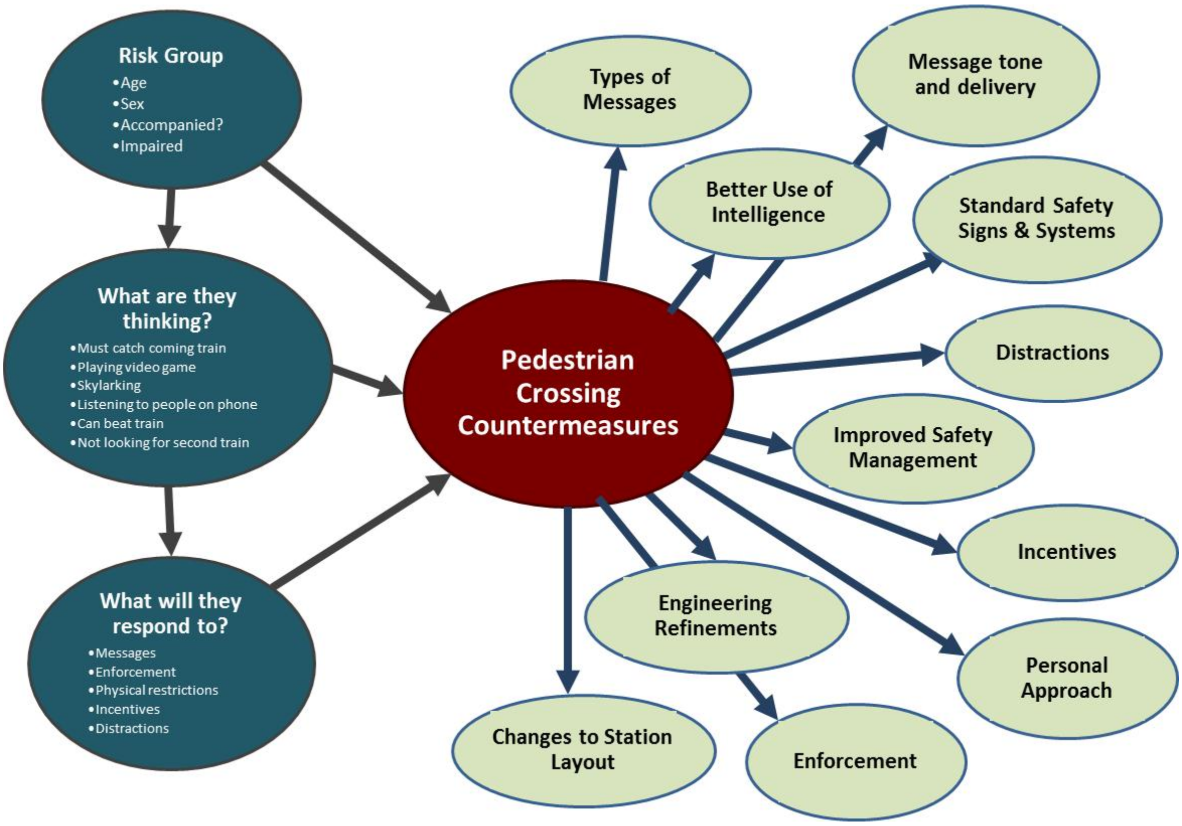

Figure 5. Summary of targets and countermeasures

The conceptual styles of countermeasure are described in more detail in Table 4. These are not necessarily fully developed, evaluated and evidence- based countermeasures, but include ideas discussed in workshops between the researchers and with PTA staff. It is important that any countermeasures implemented are appropriately targeted to the local context, and thus the ideas of experienced, local PTA staff were gathered.

Table 4. Potential countermeasures for different target audiences

Countermeasure Theme	Possible concepts
Types of Message	• ***Your favourite celebrity says…*** • ***Humour*** • Fear • Save yourself/save your family • Another train is coming soon • Other messaging
Message Tone and Delivery	• ***Relevant to the target audience*** • ***Personal PTA staff approach (CSA's, TO's, etc.)*** • ***Target school or community groups at risk, or with relevant messages*** • ***Visual / audible*** • ***Sport*** • ***Music*** • ***Constantly 'fresh' - variable / random or many messages***

	• Quirky • Artistic • Graphic • Blog sites • Social media and viral campaigns (Twitter, Facebook, etc.)
Use of Intelligence	• ***Continue to collect evidence for countermeasure design and implementation*** • ***Collect qualitative and quantitative information on target groups*** *(including schools, communities)* • ***Collect qualitative information on locations, times*** • ***Collect qualitative information on behaviours*** • ***Use many means to collect data -*** video surveillance (CMR), TO's, CSA's, targeted observations and surveys • ***Ask schools, colleges, community groups for ideas, issues, relevant messages*** • ***Engage with families***
Standard Safety Signs and Systems	• ***Signs meeting Australian Standards*** • ***Signs exceeding Australian Standards*** • ***Simplify, consolidate, standardise, rationalise*** • ***Audit and review signage at all crossings***
Distractions	• ***Music*** , ***radio*** (or video) ***while you wait*** • ***A 'game' or puzzle*** (audible or visual, possibly with a prize) • Advertising/newspaper/ information
Improved Safety Management	• ***Safety activities written into staff duties*** • ***Deployment of available resources specifically for safety purposes, (CSA's, TO's, DP, etc.),*** • ***Innovation development and deployment*** • ***Complementary activities***, not single event, single policy • ***Integrate best practice and improvements in future planning***
Continuous Improvement	• ***Monitor, review & refine information and practice*** • ***Collect information on socio-economic context*** • ***Undertake detailed design of new initiatives*** • ***Evaluate new initiatives***
Incentives and Rewards	• ***Music*** • Multirider cards for good behaviour, reward or competition prize • A 'real-time' competition • Video/ TV
Engineering Refinements	• ***Paint gates prominent colour***, not drab 'invisible' grey • ***Physical restrictions (e.g. locked gates)*** • ***Countdown displays or timers or "Time to next train***

	is…" • ***Active signs, flashing signals, alarms*** (noise)***, voice message*** (Danger - Danger) • Underpasses and overpasses if practical and effective
Changes to Station Layout	• ***Remove distracting signage*** • ***Clearly delineated paths - obstructed alternative paths*** • ***Paths with logos, icons or messages*** • Improvements to barriers • Improvements to warnings
Enforcement and Deterrent	• ***Increased visibility of transit officers*** • ***PA announcement to shame poor behavers*** (through CMR) • Increased transit officer numbers • Increased videocamera presence / utility • Fines, penalties and sanctions
Personal Approach	• ***Hero, icon or champion - personal appearance, signs, videos*** • ***Transit Officers, Customer Service Assistants, Delta Patrol***

The feasibility, advantages and disadvantages of these opportunities has not been assessed. However, it was considered by PTA and research staff that the measures shown in bold italics offer the greatest likelihood of being worthwhile. These opportunities overlap, so that any particular proposal requires the appropriate content, style and delivery.

4.6.1 Further Development

The next stage for these opportunities is to develop the concepts in more detail to assess advantages, disadvantages, and feasibility. Some opportunities, such as countdown timers, will require good research to develop a useful initial design to trial.

Implementation including detailed design and planning the timing, costs and location need to be prepared.

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6. APPENDIX A. OBSERVATION GUIDE

Date____________________ Time (24hrs) __________to ____________
Crossing name____

Crossing characteristics:
Platform location: inside/outside tracks (circle)
Number of crossings:_________________
Number of tracks to be crossed: ____________________________________
Average visible approach time (time between train first being visible and train arriving at crossing)
TO CITY: ____________min_____________sec
FROM CITY: ____________min_____________sec

Errant crossings: see next page
Any other incidents observed: (eg 'skylarking' – mucking around on tracks, putting coins down, playing chicken; vandalism, theft etc).
____
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<u>Crosser characteristics & behaviour:</u> Separate page for each person who crosses tracks *(ONLY WHILE GATES ARE CLOSED)* or performs other behaviour of interest
Age*(approx)* 1= Preschool 2 = Primary school 3 = Secondary school
4 = 18-30 5 = 30-60 6 = >60

Gender M / F / ?

Dress 1 = Looking smart 2 = Casual wear 3 = Looking rough/dirty

4 = other ***(describe if possible)*** ____

Mobility (if >1 code all) 0 = No apparent mobility or other impairment 1 = Wheelchair
2 = Pram/stroller 3 = Suitcase/baggage/luggage 4 = Mobility scooter 5 = Slow walker
6 = Other ***(describe)*** ____

Mood 0 = Alert & unhurried 1= Hurrying 2 = Distracted by person *(talking, helping watching),*
3 = Distracted by object ***(mobile phone / iPod/ MP3 / electronic game)***
4 = Sad / dreamy / cognitively distracted 5 = Drunk, drug or mental impairment
6 = Other (***describe)***____
NB: if >1 conditions code all – i.e. if on mobile phone, walking fast code 1, 2

In group? 1 = Y 2 = N 3 = Not sure

Situation (if >1 code both) 1 = Jump 2 = Push 3 = Hand on gate 4 = Running
5= look over gate 6= Other (describe)_________________7= used bypass gate

Looked for trains? 0 = Not at all 1 = One way only 2 = Both ways

On/Off/ Through? 1 = Getting on train 2 = Getting off train
3 = Passing through crossing **(*without entering station)***

Clear Time *(cross before train)* 1= < 10 sec 2= 11-20 sec 3 = 20-30 sec
(if didn't cross against gates code N) 4 = 30 -60 sec 5 **= >** 1 min

Clear time *(cross after train)* 1 = after train, < 10 sec 2 = after train, 10-20 sec
3 = after train, >20 sec ***(only use 'after train' codes if there were no subsequent within 1 min)***
(if didn't cross against gates code N)

Situation descriptions: More details of each subject crossing situation – what happened as he/she approached, decided to cross, actions they took, after crossing
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7. APPENDIX B. OBSERVATION DATA

Highlighted rows are the most safety-critical incidents.

Platform	Sight distance to city	SD from city	Station	Notes	Event Time	Age	Gender	Dress	Mobility	Mood	Group	Situation	Looked	On/ Off/ Thru	Time before train	Time after train
out	25	35	City West F37	n	18.30	5	M	2	0	1	2	1	0	1	1	.
out	35	40	Oats pilot	transit police	14.55	3	3M	2	0	1	1	1	0	1	1	.
in	25	25	Burswood	rain	7.32	5	M+F	1	0	1	1	2	2	1	1	.
in	25	25	Burswood	rain	7.58	4	M	2	0	1	2	2	0	1	1	.
none	30	30	Carlisle	rain	18.02	5	M	2	0	1	2	2	0	3	1	.
none	30	30	Carlisle	rain	18.12	5	M	2	0	6	2	2	0	3	1	.
out	25	35	City West F37	n	15.55	5	M	1	0	1	2	2	0	1	1	.
out	25	35	City West F35	rain?	16.28	5	2 F	2	2	2	1	2	0	1	1	.
in	30	35	Maddington	n	15.55	3	3F	1	0	1	1	2	0	3	1	.
out	35	40	Oats	transit police	8.25	4	M	1	0	1	2	2	2	1	1	.
in	60	60	Queens Park	n	17.13	5	F	2	0	2	1	2	1	3	2	.
in	25	25	Burswood	rain	7.30	5	M+F	1	0	1	1	4	1	3	1	.
out	30	30	Shearwood	n	16.50	6	F	2	0	1	2	4	0	1	1	.
out	30	30	Shearwood	n	17.00	5	M+F	2	0	2	1	4	0	3	1	.

none	30	30	Carlisle	rain	18.24	3	2 M	2	0	1	1	4	0	3	1	.
out	25	35	City West F37	transit police	7.37	4	F	1	0	3	2	4	0	3	1	.
out	25	35	City West F35	rain?	14.12	5	F	1	0	1	2	4	1	3	1	.
out	25	35	City West F37	n	14.30	5	2 F	1	0	2	1	4	0	1	1	.
out	25	35	City West F37	n	16.08	5	M	1	0	1	2	4	0	1	1	.
out	25	35	City West F37	n	16.15	5	F	1	0	1	2	4	0	1	1	.
out	25	35	City West F37	n	18.14	4	4 F	1	0	1	1	4	0	1	1	.
in	30	35	Maddington	n	17.40	5	M	1	0	1	2	4	0	1	1	.
none	30	40	Cottesloe	far from station	16.15	5	F	2	0	1	2	4	0	3	1	.
out	35	40	Oats	transit police	7.30	5	F	1	0	1	2	4	0	1	2	.
out	35	40	Oats	transit police	8.13	5	F	2	0	6	2	4	2	3	2	.
out	35	40	Oats	transit police	8.55	4	F	2	0	1	2	4	1	1	1	.
out	35	40	Oats pilot	transit police	14.00	4	M	2	0	1	2	4	0	1	1	.
out	35	40	Oats pilot	transit police	14.30	4	M	2	0	1	2	4	0	1	1	.
out	35	40	Oats	transit police	14.32	5	M	1	0	1	2	4	0	1	1	.

out	35	40	Oats pilot	transit police	14.38	3	3M	2	0	1	1	4	0	1	1	.
out	35	40	Oats	transit police	16.00	5	M	2	0	1	2	4	0	1	1	.
none	35	60	Gosnells	n	14.23	5	2M	2	0	1	1	4	0	1	1	.
none	35	60	Gosnells	n	15.44	3	M	2	6	1	2	4	0	3	2	.
in	60	60	Queens Park	n	8.45	4	F	2	0	3	2	4	0	1	1	.
in	60	60	Queens Park	n	15.50	5	M	2	0	1	2	4	0	3	1	.
in	25	25	Burswood	rain	8.07	4	M	1	0	1	2	7	1	1	1	.
out	25	35	City West F37	transit police	8.15	5	3 M	1	0	1	3	7	0	3	1	.
out	25	35	City West F37	transit police	8.21	5	M+F	1	0	1	2	7	0	3	1	.
out	25	35	City West F37	transit police	8.21	5	F	2	0	6	2	7	0	3	1	.
out	25	35	City West F37	n	16.15	6	M	1	0	1	2	7	1	1	1	.
out	25	35	City West F35	rain?	17.19	5	M	1	0	1	2	7	0	1	1	.
out	25	35	City West F37	n	17.38	4	F	1	0	1	2	7	1	1	1	.
in	30	35	Maddington	n	15.35	4	F	1	0	1	2	7	0	1	1	.
in	30	35	Maddington	n	15.38	3	2M	2	0	1	1	7	0	3	1	.
out	35	40	Oats	transit police	8.00	5	M	1	0	1	2	7	0	1	1	.
out	35	40	Oats	transit police	8.10	4	M	2	0	1	2	7	1	1	1	.

none	35	60	Gosnells	n	15.28	5	F	1	0	1	2	7	1	3	1	.
in	60	60	Queens Park	n	14.25	3	M	2	0	6	2	7	0	3	1	.
in	60	60	Queens Park	n	18.20	4	M	2	0	1	2	7	0	3	1	.
in	30	35	Maddington	n	16.08	4	M	3	0	6	2	2+4	0	1	1	.
in	60	60	Queens Park	n	17.31	5	2M 1F	2	0	1	1	2+4	0	3	1	.
none	35	60	Gosnells	n	17.55	5	M	1	0	1	2	4+7	0	3	1	.
in	25	25	Burswood	rain	15:15	4	M	2	0	1	2	2	2	1	.	1
in	60	60	Queens Park	n	15:10	2	M	0	0	6	1	2	1	3	.	1
in	30	35	Maddington	n	17:04	3	M	2	0	1	2	2	1	1	.	1
out	25	35	City West F37	n	14:55	3	3 M	1	0	1	1	2	0	1	.	1
out	25	35	City West F37	n	15:22	3	6 F	1	0	1	1	2	0	1	.	1
out	25	25	Loch	rain, wind	14:45	4	M	2	0	1	2	2	0	1	.	1
out	25	35	City West F37	n	14:39	3	M +F	1	0	1	1	7	0	1	.	1
in	60	60	Queens Park	n	14:37	5	M	2	0	1	2	2+3	0	3	.	1
none	35	60	Gosnells	n	15:10	4	2M 3F	2	0	2	1	2+3	2	3	.	1