VULNERABLE ROAD USERS
DIAGNOSIS OF DESIGN AND OPERATIONAL SAFETY
PROBLEMS AND POTENTIAL COUNTERMEASURES

Technical Committee 3.2:
Design and Operation of Safer Road Infrastructure
World Road Association
STATEMENTS

The World Road Association (PIARC) is a nonprofit organisation established in 1909 to improve international co-operation and to foster progress in the field of roads and road transport.

The study that is the subject of this report was defined in the PIARC Strategic Plan 2012 – 2015 and approved by the Council of the World Road Association, whose members are representatives of the member national governments. The members of the Technical Committee responsible for this report were nominated by the member national governments for their special competences.

Any opinions, findings, conclusions and recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of their parent organisations or agencies.

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Technical Committee 3.2.
*Design and Operation of Safer Road Infrastructure*
World Road Association
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Following the World Health Organisation, nearly half of those dying on the world’s roads are vulnerable road users (VRU) [7]. This proportion is much greater in low- and middle-income countries, because of the greater variety and intensity of traffic mix and the lack of separation from other road users, than in high-income countries.

Compared to other road users the vulnerable user group is particularly exposed to injury as they are not protected by a vehicle shell.

For years, pedestrians, cyclists, moped riders, etc. have been considered in the PIARC guidelines on road safety [2], [3], [4], [5], [6]. However, considering that worldwide the total number of vulnerable road users deaths and injuries remains unacceptably high the PIARC 2012-2015 technical committee “Design and Operation of Safer Road Infrastructure” decided to review and update its guidelines, checklists and manuals emphasizing on the safety of this group of users.

As a first step a PIARC common agreed definition of VRUs has been proposed. This definition focuses on road users who are at great risk because of insufficient physical protection or because of relative high speed difference with potential conflicting modes. Through this definition a specific attention is given to four main categories of road users; i.e. pedestrians, cyclists, riders of powered two-wheelers, light duty farm vehicles or animal drawn vehicles.

In a second stage the working group worked on listing infrastructure safety treatment solutions to mitigate risks for VRU sub-groups along urban and interurban roads. After crosschecking with the PIARC catalogue of design safety problems & potential countermeasures published in 2009 [4], it was decided to focus on updating and consolidating the chapter 6 of this catalogue (i.e. dedicated to design and operational safety problems for VRUs and potential countermeasures). The results of the work in this area are presented hereafter in chapter 3 and appendix 1. A liaison matrix introduces the relevant safety issues and provides an overview of possible design or remedial measures as regards to each type of VRUs sub-groups.

In parallel the road safety audit (RSA) and inspection (RSI) checklists [5],[6] have been amended to account for the newly adopted definition. Checklists have been made more consistent to address safety issues related to pedestrians, cyclists, powered two-wheelers and other VRU subgroups. All the questions from the different stages of RSA and RSI for all three types of roads defined have been assembled in a single matrix (MS Excel file format). By a simple filtering the checklists’ user can simply get the list of questions corresponding to the road type and audit stage or inspection that are relevant for him. The full update of the RSA/RSI checklists is provided in appendix 2 (paper format), but before using these checklists it is still recommended to carefully consult the guidelines on road safety audits (reference 2011R02) and on road safety inspections (reference 2012R27) where processes are described in full detail.
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INTRODUCTION

In many of its publications PIARC has dealt with the safety of all road users. For years, pedestrians, cyclists, moped riders, etc. have been considered in the PIARC guidelines on road safety (Road safety Manual [2], Catalogue of design safety problems and potential countermeasures [4], Road safety audit guideline for safety checks of new road projects [5], Road safety inspection guideline for safety checks of existing roads [6], Human factors guidelines for safer road infrastructure [3].

When building the PIARC 2012-2015 Strategic Plan, the technical committee “Design and Operation of Safer Road Infrastructure” (TC 3.2) decided to review and update its guidelines, checklists and manuals emphasizing on the safety of vulnerable road users. Building upon the efforts of former TC working groups (from the previous cycle) a new group dedicated to Vulnerable Road Users safety has therefore been created.

As a first step the working group (WG 3.2.1) decided to develop a PIARC common agreed definition of VRUs. In addition to the own expertise of its members, the WG 3.2.1 consulted some relevant references. Willing to include the safety issues faced by users in the LMICc, the WG also surveyed the ASANRA group during a joint meeting in Victoria Falls (May 2013). Discussions and results of the work in this area are presented in chapters 1 and 2.

In a second stage the working group worked on listing infrastructure safety treatment solutions to mitigate risks for VRU sub-groups along urban & interurban roads. This started with a brainstorm session aiming to list the most comment problems and possible infrastructure solutions. After crosschecking with the PIARC catalogue of design safety problems & potential countermeasures published in 2009, it was decided to focus on updating and consolidating the chapter 6 of this catalogue. The results of the work in this area are presented hereafter in chapter 3 and appendix 1.

As suggested by the Strategic Plan the working group worked in parallel on a revision and update of the RSA & RSI checklists to account for the newly adopted VRU definition. Updates suggested by the former TC (but never published) were also implemented. Results are described in the chapter 4 and appendix 2.

The WG3.2.1 actions are consolidated in this Technical report.
1. DEFINITION OF VULNERABLE ROAD USERS

Walking and cycling are transport modes where relatively unprotected road users interact with traffic of high speed and mass. This makes pedestrians and cyclists vulnerable. They suffer the most severe consequences in collisions with other road users because they cannot protect themselves against the speed and mass of the other party.

VRU often means pedestrian and cyclist in the mind of people, but some other types of road users should be considered as well.

Compared to cars, powered two-wheelers (PTWs) are less stable, less visible and of course a moped or a bike offers much less protection to the rider than other motorized vehicle. All around the world they are involved in a disproportionately high percentage of fatal and serious accidents. This makes mopeds riders and motorcyclists vulnerable, notwithstanding the fact that they can be as much a threat for pedestrians and cyclists as other motor vehicles because of their speed.

In low-income and middle-income countries the ownership and use of motorcycles and other two-wheelers are generally relatively high – for example, in India 69% of the total number of motor vehicles are motorized two-wheelers and 27% of road deaths are among users of motorized two-wheelers. This fatality figure is between 70–90% in Thailand, and about 60% in Malaysia. Injuries to the head and neck are the main cause of death, severe injury and disability among users of motorcycles and bicycles.

Source: GRSP [1]

Similarly, slow and small agriculture vehicle as well as animal drawn vehicles often experience severe consequences in collisions with motorized traffic, due to speed differences and because of their relative un-protection.

The vulnerability of road users may also be attributed to their level of task capability (limitations in performing one or more task aspects) or even to their resilience to accidents (capability to quickly recover). However, even if novice drivers (limited task capability) or elderly car drivers (also low resilience) may also be considered as vulnerable, the working group decided to concentrate on the users it felt were the most vulnerable first because of insufficient physical protection or because of relative high speed difference with potential conflicting modes.

Similarly and even if everybody agrees that road workers can be considered as VRUs (based on the criteria mentioned above) the group decided to exclude this user type in its current work. The working group stated that addressing safety issues related to road workers usually needs specific measures that were already addressed by the existing guidelines issued by the former committee (TC report 2012R29 - Improvements in safe working on roads).
Consequently the working group suggested adopting the following definition:

The “vulnerable” road users are those road users who are at great risk because of insufficient physical protection or because of relative high speed difference with potential conflicting modes.

Even if various criteria, like the level of task capability or the recovering capability, may impact the vulnerability of vehicle occupants, Pedestrians, cyclists, riders of powered two-wheelers, as well as light duty farm vehicles or animal drawn vehicles are more particularly vulnerable. The working group therefore focussed on these four main categories of road users.

Additional factors should be considered when looking at infrastructural measures to mitigate the risk faced by VRUs:

• In some specific circumstances vulnerable road users may themselves be a threat to others; e.g. heavy PTWs, mopeds or even cyclists at higher speeds may be dangerous for other VRUs;
• The fatalities amongst vulnerable road users are usually higher in low-income and middle-income countries (LMICs) - due to lack of resources to provide or maintain adequate and safe infrastructure, land use planning problems (e.g. linear settlements), sometimes combined with unsafe users behaviour;

_Pedestrians, cyclists, and riders of powered two-wheelers and their passengers (“vulnerable road users”) account for around 46% of global road traffic deaths. This proportion is much greater in low-income countries than in high-income countries: for example, in low-income countries of South East Asia over 80% of those killed are vulnerable road users, while in the high-income countries of the Americas the corresponding figure is 22%._

*Source: WHO [7]*

• LMICs also have greater variety and intensity of traffic mixing the slow-moving and vulnerable non-motorized road users, as well as motorcycles, with fast-moving motorized vehicles.

The provision of vulnerable road user facilities does not guarantee effective usage and compliance by vulnerable road users and drivers. This report aims to recommend valuable infrastructure safety treatment to mitigate risks but education and publicity programmes are needed to improve understanding and awareness while enforcement can help motivate adequate behaviour patterns.
2. VULNERABLE ROAD USER GROUPS

Amongst vulnerable road users the following groups are to be considered, based on their characteristics.

2.1. PEDESTRIANS AND ASSIMILATED

**Characteristics:**

- Persons who are walking along a road or a developed area
- Unprotected (no shell or cover)
- Various reasons for walking can be divided into categories: journeys to work or school etc., exercise or leisure

*Illustration 1 - Pedestrian subgroups (example)*
Subgroups:

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td>* Age under 14;</td>
</tr>
<tr>
<td></td>
<td>* Among them are young children and school children.</td>
</tr>
<tr>
<td></td>
<td>* They are less experienced with road traffic and do not fully understand</td>
</tr>
<tr>
<td></td>
<td>rules and regulations when using the road;</td>
</tr>
<tr>
<td></td>
<td>* They often demonstrate poor judgment - may misjudge speed and intention</td>
</tr>
<tr>
<td></td>
<td>of drivers;</td>
</tr>
<tr>
<td></td>
<td>* Their focus and concentration are easily distracted;</td>
</tr>
<tr>
<td></td>
<td>* Their physical and mental skills not fully developed;</td>
</tr>
<tr>
<td></td>
<td>* Physically fragile and small in size, sometimes hard to be seen;</td>
</tr>
<tr>
<td><strong>Elderly</strong></td>
<td>* People around the age of 70 and above;</td>
</tr>
<tr>
<td></td>
<td>* Relatively slow to react;</td>
</tr>
<tr>
<td></td>
<td>* Declining task capability and mobility;</td>
</tr>
<tr>
<td></td>
<td>* May have poor eye sight and be hard of hearing;</td>
</tr>
<tr>
<td></td>
<td>* Increased physical frailty.</td>
</tr>
<tr>
<td><strong>Person with impaired</strong></td>
<td>* Can be of any age;</td>
</tr>
<tr>
<td><strong>mobility</strong></td>
<td>* People with temporary or permanent physical, visual or hearing disability;</td>
</tr>
<tr>
<td></td>
<td>* Limit in their movement and speed - walking difficulties require more time;</td>
</tr>
<tr>
<td></td>
<td>* They may require extra care and special facilities for safe mobility;</td>
</tr>
<tr>
<td></td>
<td>* People with hearing impairments may not be aware of vehicle approaching;</td>
</tr>
<tr>
<td></td>
<td>* Blind or partially sighted people may not be able to see approaching</td>
</tr>
<tr>
<td></td>
<td>vehicles or to determine safe paths</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>* Persons not belonging to any of the above categories (or age);</td>
</tr>
<tr>
<td></td>
<td>* Rollers, skaters.</td>
</tr>
</tbody>
</table>
2.2. CYCLISTS AND ASSIMILATED

Characteristics:

• Persons riding a two-wheeled cycle (there is also three-wheeled cycle - more stable).
• A principal means of transportation in many regions especially LMIC.
• Cycling also provides a popular form of recreation usually in HIC.
• Can be used by a person of any age from children to elderly capable of riding cycle

Illustration 2 - Cyclist subgroups (example)

Subgroups (available models of cycle):

| Pedal operated                  | • Typical speed between 15 to 30 km/h.                              |
|                                | • May be designed for certain environments such as rugged terrain, racing, leisure cycling, etc. |
|                                | • Includes special bicycles!                                      |
| Electric (assisted)            | • Includes slow mopeds authorized on cycle lanes in some countries; |
|                                | • E-bike (electric powered)                                       |
|                                | • Pedelecs (pedal + electric powered)                             |
|                                | • Capable of higher speed than pedaling;                          |
|                                | • Dependent on battery technology and capacity;                   |
|                                | • The higher the bicycle speed limit and/or the delivered power are the more accident scenarios will correspond to motorcyclist ones (rather than cyclist scenarios where speed is a weak contributory factor). |
2.3. POWERED TWO WHEELERS AND ASSIMILATED

Characteristics:

- Two wheeled motor vehicles (mopeds, scooters, motorcycles) or similar (three wheels assimilated to motorcycles).
- Specific vehicle dynamics and tyre/pavement interactions
- Comparatively low cost and very affordable motor vehicles (therefore high ownership in LMIC);
- Motorcycles are a favored mode of transport mainly because of increasing fuel prices and urban congestion; easy to find a parking place.
- Lack of public transport also encourage its use;
- Not fully protected - only protected from head injury by helmet; just protection clothes can prevent from specific serious injuries
- Helmet wearing is compulsory in many countries, but in many low and middle income countries not enforced.

Illustration 3. Powered two wheelers subgroups (example)

Subgroups:

| Mopeds (50 ccm + Electric) | Light and low capacity version of motorcycles;  
|                           | Powered by internal combustion engine or electric motor;  
|                           | Electric mopeds are nearly silent, with zero-emission;  
|                           | Operating range and top speed is limited by engine capacity or battery technology. |
| Motorcycles               | Commonly with internal combustion engine;  
|                           | With a wide range of size and engine capacity;  
|                           | Vary considerably depending on the task they are designed for, such as long distance travel, navigating congested urban traffic, cruising, sport and racing, or off-road conditions. |
| Scooters                  | Usually 2 wheels;  
|                           | Some models with 3 wheels (2 in the front / 1 in the back). |
| Other 3-wheelers and quads| Vehicle dynamic issues similar to cars |
2.4. OTHER VRUS

Characteristics:

- Light duty farm vehicles; animal drawn vehicles;
- Speed and mass differences with regular traffic;
- Relatively unprotected riders/passengers

Illustration 4 - Other VRU subgroups (example)
Subgroups:

| Slow agriculture vehicle without protection | • Tractors, backhoes, harvesters etc.;  
|                                           | • Generally of slow speed and with various sizes (width). |
| Véhicules à traction animale et leurs passagers | • Animals used can be bulls, donkeys or horses;  
|                                           | • Except for horses drawn, others are relative slow;  
|                                           | • Commonly seen in LMIC - usually for agricultural activities in the field;  
|                                           | • Also used to transport goods or agricultural product (in LMIC);  
|                                           | • Horses drawn cart used as recreational or tourist activities in HIC. |
| Street vendors | • Also known as roadside hawkers and may be stationary or mobile;  
|               | • They are vendors of merchandise that can be easily transported;  
|               | • Usually sells items or food on special carts or makeshift tables;  
|               | • Operating on the roadside or along a section of a road during specially allocated hours. |
| Animal riders | • Usually on horses. |
3. DESIGN SAFETY PROBLEMS FOR VRUS AND POTENTIAL COUNTERMEASURES

In 2009 through its technical committee on road safety PIARC published a “Catalogue of Design Safety Problems and Countermeasures” aimed at developing and emerging countries and countries in transition. The catalogue gives brief information, including pictorial representations, of well-known design errors in a readily understood way, suggests a range of methods to overcome these and gives an indication of the comparative countermeasure costs to facilitate prioritization of the work. The catalogue can be used both as a proactive safety tool to ensure the design faults do not arise in the first place, or a reactive safety tool to assist in designing cost-effective countermeasures where problems already exist on the road network.

The sections of these guidelines are further divided into specific problem areas; one section being dedicated to vulnerable road users, more particularly safety problems as faced by pedestrians and cyclists.

In view of the definition of VRUs adopted above a review of this section of the catalogue was deemed useful and was undertaken by WG 3.2.1 during the 2012 - 2015 cycle.

All the measures considered during the review process have been listed, and their likely impact assessed for the four main categories of VRUs. This has been possible through a transversal consultation of the technical committee members and it resulted in a matrix table presented below. The matrix shows which category of vulnerable road users is likely to be impacted by a series of 38 infrastructure safety measures. Cost and implementation issues have also been addressed during the consultation process. The impact is of course country dependent, as are the associated costs. Therefore the information presented in the matrix must be considered as the more common understanding as regards to the Benefits/Effects and Costs associated to each safety measure considered.

This liaison matrix introduces the safety measures the WG has been working on (update of the chapter 6 of the catalogue) and provides an overview of possible design or remedial measures as regards to each type of VRUs considered in chapter 2. It has been drafted to help designers and safety experts willing to proactively identify countermeasures to road infrastructure design errors and/or unsafe situations.

The full update of the chapter 6 of the Catalogue of Design Safety Problems and Countermeasures is provided in of appendix 1. It is still highly recommended to consult the original catalogue [4] for all the other topics (1.Function; 2.Cross Section; 3.Alignment; 4.Intersections; 5.Public and Private Services; 7.Traffic Signing and marking; 8.Roadside Features) as well as to clearly understand how to use the catalogue as part of any road safety management procedures.
<table>
<thead>
<tr>
<th>PROBLEM OR CATEGORY (Also refer to appendix 1 for detailed description)</th>
<th>BENEFITS/EFFECTS</th>
<th>COST</th>
<th>IMPLEMENTATION ISSUES &amp; COMMENTS (Also refer to appendix 1 for detailed description)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6.01 VRUs along road sections</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Visual segregation by edge markings</td>
<td>Medium impact</td>
<td>Medium impact</td>
<td>Low impact</td>
</tr>
<tr>
<td>T2 Wider and paved shoulder</td>
<td>Medium impact</td>
<td>Medium impact</td>
<td>Low impact</td>
</tr>
<tr>
<td>T3 Appropriate traffic lane width</td>
<td>Low impact</td>
<td>Low impact</td>
<td>Medium impact</td>
</tr>
<tr>
<td>T4 Segregated footpath</td>
<td>High impact</td>
<td>Low impact</td>
<td>No impact</td>
</tr>
<tr>
<td>T5 Segregated lane for cyclists or mopeds</td>
<td>Low impact</td>
<td>High impact</td>
<td>High impact</td>
</tr>
<tr>
<td>T6 Proper crossing facilities</td>
<td>High impact</td>
<td>Medium impact</td>
<td>Medium impact</td>
</tr>
<tr>
<td>T7 Relocated bus stop</td>
<td>Medium impact</td>
<td>Low impact</td>
<td>No impact</td>
</tr>
<tr>
<td>T8 Kerbs and barriers</td>
<td>Medium impact</td>
<td>Low impact</td>
<td>Low impact</td>
</tr>
<tr>
<td>T9 Traffic calming</td>
<td>Medium impact</td>
<td>Medium impact</td>
<td>Medium impact</td>
</tr>
</tbody>
</table>
### 6.02 PEDESTRIANS & CYCLISTS CROSSING MULTIPLE LANE ROAD SECTION

| T1: 50 km/h speed limit, dedicated marking/signs or rumble strips | Medium impact | Low impact | Low impact | Low impact | $ | Better if combined with traffic calming measures, particularly where drivers often exceed the speed limit. |
| T2: Middle island by reducing the lane width & protecting by a barrier | Medium impact | Medium impact | Low impact | Low impact | $$$ | Better if combined with traffic calming measures. |
| T3: Traffic signals for pedestrians and/or cyclists | High impact | High impact | Low impact | Low impact | $$$ | Better if combined with traffic calming measures. Acceptance to waiting for the green light highly depends on the traffic volume |

### 6.03 VRUs AT HIGH TRAFFIC VOLUME INTERSECTIONS

| T1: A sign-posted alternative cycle route away from the junction | No impact | Medium impact | No impact | No impact | $ | Cyclists as pedestrians will always be tempted to shortcut even if not safe. |
| T2: Modify the layout of the intersection to cater for the cyclists | No impact | High impact | No impact | No impact | $$ $$ $$ | Access to the pre start area should be eased. Marking need appropriate maintenance. |
| T3: Marking, signing and signals at the intersection | Low impact | Medium impact | Low impact | Low impact | $$ | |
| T4: Pre-start in time / space for cyclists | No impact | Medium impact | No impact | No impact | $ | May cause dangerous manoeuvres from motorcyclists willing to reach the pre start area. |
| T5: Pre-start in time / space for motorcyclists | No impact | No impact | Medium impact | No impact | $ | |

### 6.04 PEDESTRIANS AT INTERSECTIONS

| T1: Zebra crossing, with or without a central refuge | Medium impact | Low impact | No impact | Low impact | $ | Better if combined with traffic calming measures. Crossing type depends on the traffic volume and to what user (vehicles/pedestrian) the priority is given. |
| T2: The installation of pedestrian fences and central refuges | Medium impact | No impact | No impact | No impact | $$ | Better if combined with traffic calming measures. Be careful pedestrians would likely try to find a shorter way which might lead to unsafe situations. |
| T3: A minor road central refuge at an unmarked crossing place | Medium impact | No impact | No impact | No impact | $ | |
| T4: Traffic signals to control the movements at the intersection | Medium impact | Low impact | Low impact | Medium impact | $$ | Much use in urban area and suburban area, frequent jaywalking in low traffic volume in rural area, should not increase accident risk. |
| T5: Pavement Markings to restrict parking | Medium impact | Low impact | Low impact | Low impact | $ | May be combined with use of flexible bollards. |
| T6: Install kerb extensions | Medium impact | Low impact | Low impact | Low impact | $ | |
| T7: Signs and equipment | Low impact | Low impact | Low impact | Low impact | $ | |
### 6.05 Pedestrian Crosswalks – Signing

| T1: Dedicated signs and marking | Medium impact | Low impact | No impact | Low impact | $ |
| T2: Traffic-calming measures | High impact | Medium impact | Low impact | Medium impact | $$ |

### 6.06 Pedestrian Crosswalks – Signals and Lighting

| T1: Use a pedestrian phase at the signals with symbols | Medium impact | No impact | No impact | Low impact | $$ |
| T2: Use a pedestrian phase at the signals with a numerical-countdown display | Medium impact | No impact | No impact | Low impact | $$ |
| T3: Acoustic signals / tactile knobs at crossings | Medium impact | Low impact | No impact | Low impact | $$ |
| T4: Appropriate lighting | High impact | Low impact | Low impact | Low impact | $$ |

**Appropriate signal phase needed to mitigate risk of jaywalking.**

**Can be confusing when crossings with acoustic signals are close to each other.**

### 6.07 Medians and Refuge Islands

| T1: Medians painted on the road surface | Low impact | Low impact | Low impact | Low impact | $ |
| T2: Raised medians and refuge islands | Medium impact | Low impact | Low impact | Low impact | $$ |
| T3: Multifunctional medians | Medium impact | Low impact | Low impact | Low impact | $$$ |

**Risk of crash with traffic island in case of lack of visibility.**

**Important to provide good sight conditions.**

### 6.08 Sidewalk Accessibility - Obstructions Free

| T1: Give a clear path to pedestrians | Medium impact | No impact | No impact | Low impact | $ |

**Obstructions along cycle paths are even more dangerous.**

### 6.09 Sidewalk Accessibility - Kerb Ramps

| T1: Use kerb ramp at intersection | Medium impact | Medium impact | Low impact | Low impact | $ |
| T2: Add tactile strips across the width of the sidewalk leading to the crosswalk | Medium impact | No impact | No impact | No impact | $ |

**Ramps are useful also on cycle paths.**

**May be more difficult to implement in historic city areas.**

### 6.10 Sidewalk Accessibility - Work Zones

| T1: Adequate protective barriers | Medium impact | Low impact | Low impact | Low impact | $$ |
| T2: Longitudinal barricades | Medium impact | Low impact | No impact | Low impact | $$ |
| T3: Provide safe pavement surface conditions | Medium impact | Medium impact | Medium impact | Low impact | $$ |

**Benefits/Effects:** Likely impact rated from 0 to 3 (No, Low, Medium, High) - **Cost:** relative value: rated from $ to 4$
4. RSA/RSI CHECKLISTS ADDRESSING VRUS PROBLEMS AND NEEDS

4.1. BACKGROUND

Road safety auditors and inspectors carry out audits and inspections (respectively) on the basis of their personal experience and knowledge of road safety. They target elements known to be risk factors for accident occurrence or injury severity.

RSA and RSI should be conducted taking into consideration the point of view of every kind of road user, e.g. motorists, lorry drivers, public transport users, but also the vulnerable road users such as pedestrians and cyclists, moped riders, etc. Taking into account the point of view of every kind of road user means that each route (for cyclists, pedestrians, etc.) has to be logical and continuous. It is also important to look at how interactions happen between different types of road users or transport modes.

Obviously RSA and RSI are complex experience-based procedures and checklists can be used to assist in the process to ensure that safety aspects have not been overlooked during the analysis. Former road safety technical committees of PIARC have produced Guidelines on Road Safety Audits (reference 2011R02) and on Road Safety Inspections (reference 2012R27). These guidelines have a unique structure in respect of the road characteristics to be checked and analysed. The guidelines propose detailed checklists to support both the RSA and RSI procedures.

4.2. CHECKLISTS ADDRESSING VRUS PROBLEMS AND NEEDS

Existing checklists (i.e. developed by former road safety technical committees of PIARC) already address safety issues faced by vulnerable road users. However these documents mainly address safety problems faced by pedestrians and cyclists, where the definition of VRUs adopted in the present report (chapter 1) covers a wider group of road users; i.e. pedestrians, cyclists, powered two-wheelers, light duty farm vehicles, animal drawn vehicles, etc. (chapter 2). This new definition logically called for a revision the existing checklists. Accordingly the working group (WG3.2.1) set up during the 2012-2015 work cycle started the review and update process. It is however recommended to continuously upgrade these checklists (i.e. by next coming PIARC working groups) to progressively implement new knowledge gained from good practices around the World.

The review conducted by WG3.2.1 mainly consisted in the following actions:

As far as possible checklists have been amended to address safety issues related to pedestrians, cyclists, powered two-wheelers and other VRU subgroups (chapter 2);
• The vocabulary has been made more consistent (e.g. cyclist, sight distance, obstacle free zone, …);
• All questions where phrased in such a way as to make the preferred answer a “yes”;
• All the questions about planning and general land use or that were giving too detailed advise where deleted from this checklist;
• Links to national specifications/guidelines have been avoided to ensure compliance with the guidelines from every country (e.g.: “outside of the safety zone” instead of “at more than 20 meters”);
• RSI has been separated from RSA stage 4/5 because additional questions have been considered from earlier stages of RSA.
Finally all the questions from the different stages of RSA and RSI for all three types of roads defined have been assembled in a single matrix (MS Excel file format). By a simple filtering the checklists’ user can simply get the list of questions corresponding to the road type and audit stage or inspection that are relevant for him.

The full update of the RSA/RSI checklists is provided in *appendix 2* (paper format). Before using these checklists it is strongly recommended to carefully consult the guidelines on road safety audits (reference 2011R02) and on road safety inspections (reference 2012R27) where processes are described, typical safety deficiencies are presented, role and responsibilities are made clear and finally some interesting examples provided.
5. CONCLUSIONS

In crash situation injuries are the result of a combination of the released kinetic energy, the biomechanical properties of the human body and the physical protection that vehicle offers its occupants. Unfortunately pedestrians, cyclists, riders of powered two-wheelers, as well as occupants of light duty farm vehicles or animal drawn vehicles are lacking physical protection and are particularly vulnerable in case of conflict with cars and heavy vehicles.

All these sub-groups have been considered in this report and along the revision process of two important PIARC guides; i.e. the Catalogue of design safety problems and countermeasures, published in 2009 and the road safety audit (RSA) and inspection (RSI) checklists published in 2011 and 2012.

The 6th chapter of the catalogue addressing vulnerable road user’s safety has been upgraded during the 2012-2015 work cycle and assists the designers to identify potential deficiencies and develop suitable strategies to prevent these. It presents the most common types of design failures in a graphical and readily understood way, and also provides a range of potential solutions to these design failings.

The catalogue can be used both as a proactive safety tool to ensure the design faults do not arise in the first place, or a reactive safety tool to assist in designing cost-effective countermeasures where problems already exist on the road network. This guide is fully complementary to the RSA and inspection RSI checklists that are build following the same chapters structure in the way they assist road safety auditors and road safety inspectors doing their job.
6. BIBLIOGRAPHY / REFERENCES


Also consulted:


7. GLOSSARY

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