Safe Roads for Development

A POLICY FRAMEWORK FOR SAFE INFRASTRUCTURE ON MAJOR ROAD TRANSPORT NETWORKS

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Global Road Safety Partnership
gTKP global Transport Knowledge Partnership
iRAP International Road Assessment Programme
IRF
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WORLD BANK GLOBAL ROAD SAFETY FACILITY

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Foreword

People depend on roads in their daily life – to get to school, to work, or to the health centre. Roads underpin the businesses, agriculture and trade which provide the jobs that lift nations out of poverty.

This policy framework focuses primarily on providing a high-level overview – it is not a comprehensive and prescriptive "how to do it" guide. It is concerned mainly with those major road networks that provide the linkages between towns and cities and with the busy commuter routes in urban corridors. These major roads are generally the roads where the majority of people are killed and in their greatest concentrations.

This document focuses primarily on the safety of the users of these major roads and the conflicts between different road users resulting from the heavy use of these roads by motorised transport. Therefore, the report does not cover the roles that roads – often local roads and streets – fulfil as part of their "public domain" as a place to meet, to talk or play or search for goods and services.

President John F Kennedy made the case that networks of major roads are essential in promoting economic prosperity when he said, *Our wealth did not create our transport infrastructure; it is our transport infrastructure which created our wealth*.

However, the enormous benefits of major road networks do not come without costs. One of the most significant and distressing aspects of road transport is the enormous level of trauma that occurs with their use. Every day 3,500 people are killed and more than 100,000 people are injured in road crashes. More than 9 out of 10 of these road deaths occur in low- and middle-income countries, despite the fact that only half the world's vehicles are in these countries.

Infrastructure plays a crucial role in road safety. Well-designed roads can help people use roads safely and minimise the risk that a crash will occur. When a crash does happen, protective road infrastructure can mean the difference between life and death.

As we prepare for the UN Decade of Action for Road Safety 2011-2020, this policy framework is designed to assist policy makers in low- and middle-income countries harness the enormous benefits of safe road infrastructure. It signposts the significant social and economic benefits of ensuring new roads are safe and existing roads are retrofitted with safety treatments. Working within this framework, countries can take important steps towards addressing what is one of the most significant, yet preventable, public health crises of our time.

By working together, we have the opportunity to build a permanent memorial to those who have lost their lives on the roads – a lasting legacy of safe roads for future generations.

Tony Bliss
World Bank Global Road Safety Facility

Improving the safety of roads is the single most significant achievable factor in reducing road trauma

National Road Safety Strategy, 2000-10, Australia

The scale of road death

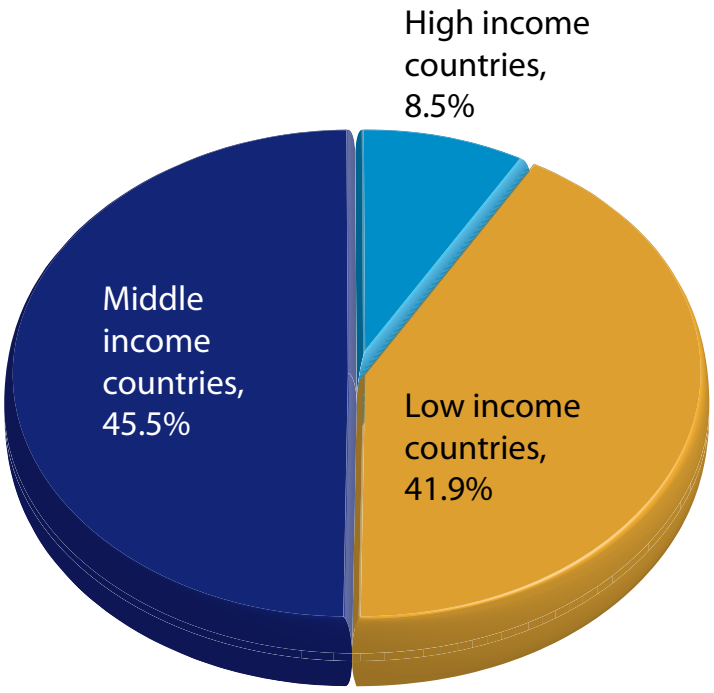
Recent figures estimate conservatively that some 1.3 million people are killed each year in road crashes and a further 50 million people are injured (World Health Organisation (WHO), 2009). These numbers are likely to almost double by 2030 unless action is taken. A prevalence of under-reporting of serious crashes, notably in low-income and middle-income countries, means that the actual number of deaths is likely to be much higher than that reported in individual countries (WHO, 2009).

Half of the world's road deaths are vulnerable road users (pedestrians, bicyclists and motorcyclists) and the majority of those killed are between the ages of 5 and 44 (WHO, 2009). In addition to the tremendous traumatic and emotional impact of road crashes, there is a vast economic consequence. It is estimated that road crashes cost the global economy US$1.4 billion every day, in terms of lost productivity, health care, emergency services. Crashes are leading cause of traffic congestion, itself a source of environmental damage.

Nationally, road crashes typically cost the equivalent of 1-3% of a country's Gross Domestic Product. Personally, road crashes can be the trigger that plunges a family into poverty.

Road death and injury is not inevitable. Road trauma is a preventable public health challenge. Road systems can be developed that reduce the likelihood of a crash occurring and minimise the severity if a crash does occur. This can be achieved with safe road users understanding the risks they impose on themselves and on other road users, safe vehicles and safe roads, together with appropriate enforcement.

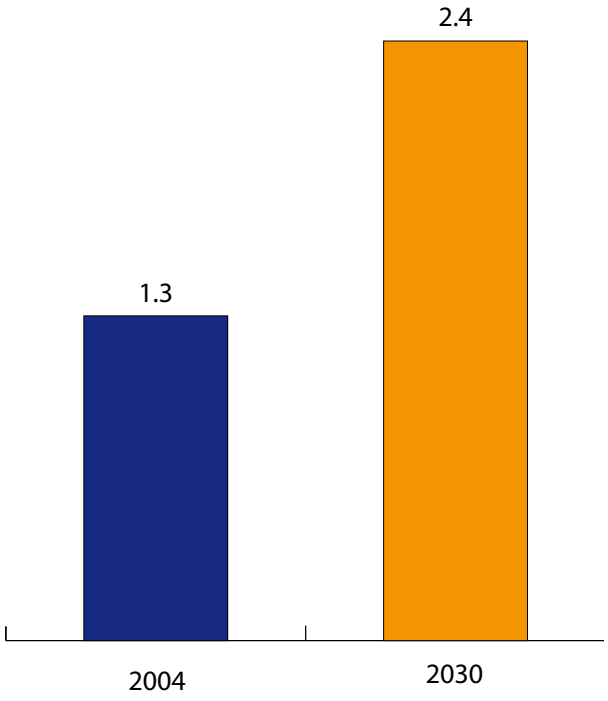
Figure 1: Road deaths by level of income (WHO, 2009)



A global consensus has grown around this 'Safe Systems' approach, and the importance of safe road infrastructure within it. The Ministerial Declaration of the First Global Ministerial Conference on Road Safety, held in Moscow in November 2009, calls for 'efforts to develop and implement policies and infrastructure solutions to protect all road users, in particular those who are most vulnerable...' A joint statement by the seven major multilateral development banks (including the World Bank) issued in November 2009 commits to "...ensure... that safety is integrated in all phases of planning, design, construction, appraisal, operation and maintenance of road infrastructure". In March 2010 the United Nations General Assembly, declaring the years 2011-2020 to be the 'Decade of Action for Road Safety', calls for "...the inclusion of activities to pay attention to the needs of all road users within the Plan of Action of the Decade, in particular the needs of pedestrians, cyclists and other vulnerable road users in low-income and middle-income countries, through support for appropriate legislation and policy, infrastructure and increasing means of sustainable transport".

Many road safety solutions are proven and ready for implementation. What is needed now is the political will and leadership to apply them on a large scale.

Figure 2: Number of road deaths per year (million) without action (cited in WHO, 2009)



Improving the safety of roads is the single most significant achievable factor in reducing road trauma

National Road Safety Strategy, 2000-10, Australia

Road infrastructure

Road crashes are overwhelmingly caused by human failings, but the greatest untapped potential to prevent death and injury is through the roads themselves.

In the United States for example, road conditions are a contributing factor in more than half (53%) of all road deaths and more than a third (38%) of injuries. In terms of crash severity, road condition is the single most lethal contributing factor, ahead of speeding, alcohol or non-use of seat belts (Miller & Zaloshnja, 2009). In Sweden, road conditions are a contributing factor in at least 59% of fatal crashes (Stigson, Krafft, & Tingvall, 2008).

There has to be a clear distinction and separation between inter-urban roads for high speeds and urban roads for lower vehicle speeds and priority for vulnerable road users.

On inter-urban roads, high speeds are generally possible, depending on the local circumstances, quality of the infrastructure and the presence of appropriate alternative possibilities for slower moving (non-motorised) road users[1]. On urban roads, vehicle speeds are generally lower and priority for vulnerable road users is mandatory in most situations.

This requires strong control and management of land-use and urban development, as well the legal tools, competencies and engagement of the road administration to enforce access control along the major roads.

[1] See Department for Transport (2001) for a review of rural road hierarchies.

Figure 3: Linear developments pose particular problems (PIARC)

As many of the images in this document show, linear settlements with a mixture of through and local slow traffic and non-motorised road users can be a major road safety problem, especially in developing countries[2].

By making roads more predictable, consistent and forgiving, we can produce a long-term solution that helps save lives and reduce injuries. For example, between 1980 and 2000, in Sweden, the Netherlands and the United Kingdom, infrastructure treatments combined with speed management measures reduced the number of deaths of vulnerable road users by around a third.

The hard lessons learned in high-income countries during decades of road safety development are just as applicable in low- and middle-income countries now.

Economic benefits

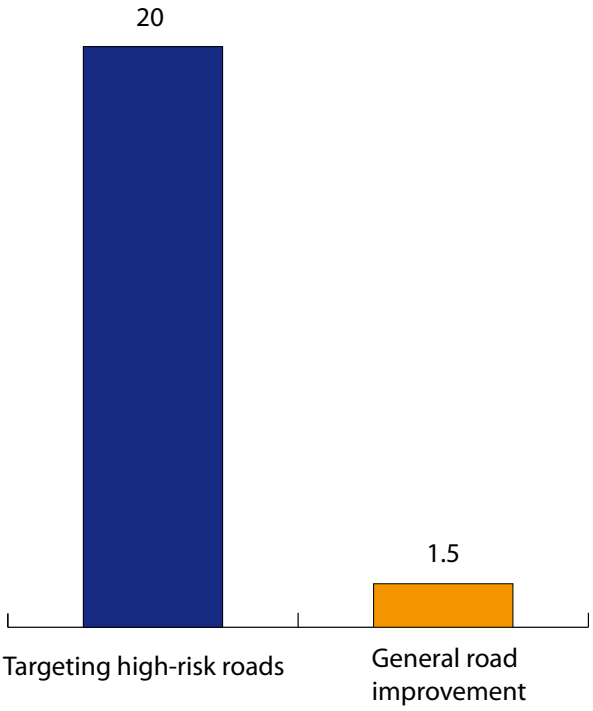
Few infrastructure investments can match the economic benefits of those generated by targeted road safety measures (see Figure 4).

Evidence from Australia, the United States, the United Kingdom, Norway, France, Canada, Netherlands, the Nordic Countries and New Zealand shows that targeted road safety projects generated crash cost savings of up to 60 times the cost of construction (OECD, 2008). That is, for each $1 invested, there was a return of up to $60 in terms of crash costs avoided. Other research has shown that low-cost improvements at specific high-risk sites have shown first year rates of return of 300% (Road Safety Foundation (2008)).

On average, with supporting maintenance, road infrastructure investment lasts around 25 years, so the safe roads built today will continue saving lives and preventing injuries long into the future.

[2] Countermeasures for linear developments on: speed management, reduction in the number and the width of lanes, in sight distances, and in provision for pedestrians, are provided by PIARC, (2009).

Figure 4: Number of lives saved for each $100m invested (Vulcan and Corben, 1998)



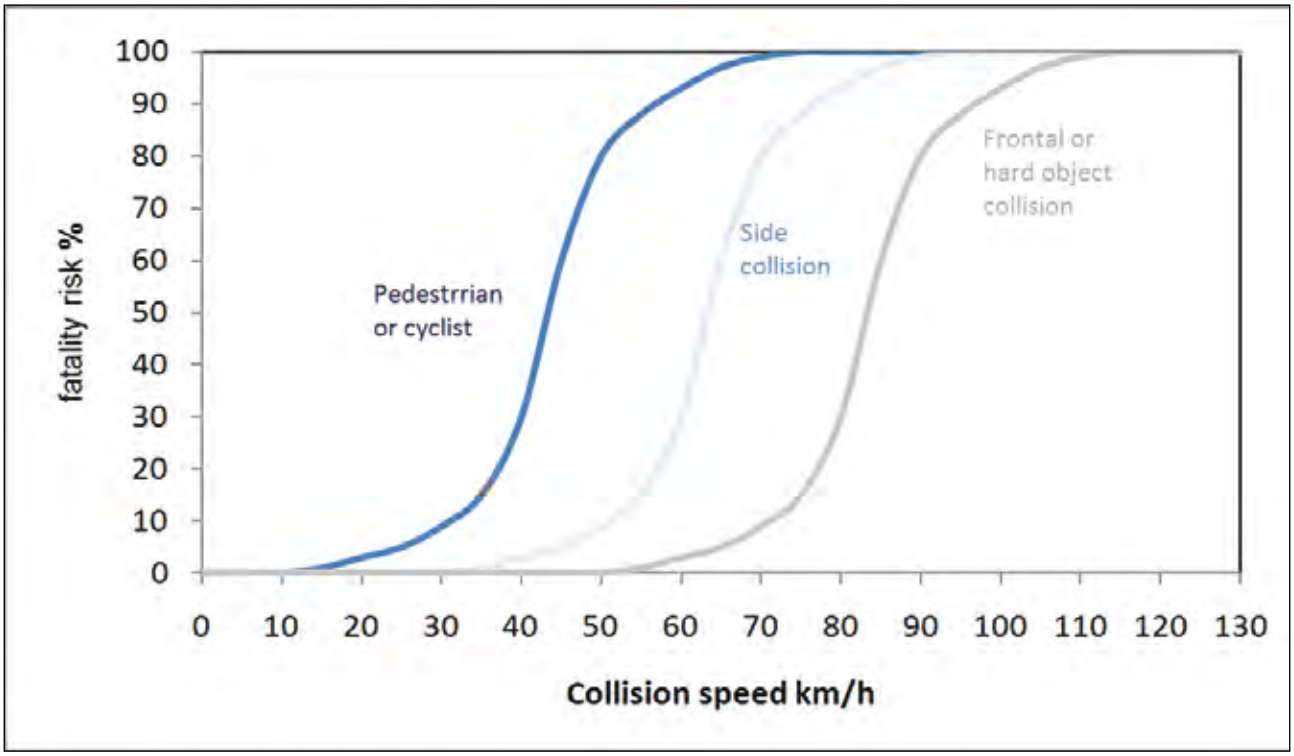
The Safe System

The 'Safe System' views the road transport system holistically by seeking to manage the interaction between road users, roads and roadsides, travel speeds and vehicles. It aims to reduce the likelihood that crashes occur, and minimise the severity of those that do happen.

Central to the Safe System approach is the recognition that humans make mistakes, and are fragile. As the chart below demonstrates, impacts at what might be considered reasonable speeds can significantly increase the risk of death and serious injury.

The Vision Zero philosophy adopted by the Swedish Government (Swedish Road Administration, 2006) illustrates many of the principles required of the Safe System. Vision Zero provides a viable policy framework for sustainable safety whose basic principles can be applied in any country, at any stage of development. Elements of this approach may appear utopian, but the approach lays the principles for the management of kinetic energy, the fundamental part of injury reduction.

Figure 5: Collision speed-fatality relationships (Wramborg, 2005)



Within this energy system, the imbalance of "kinetic mass" is such that pedestrians of 80kg travelling at 5km/h cannot harm a driver and 1500kg car travelling at 90km/h. The onus of responsibility is therefore on the driver to avoid causing injury.

Sweden has demonstrated the crucial role that infrastructure can play in creating a safe and efficient road network. By developing roads that are inherently safe, using safety barriers to mitigate the risk of head-on and run-off-road crashes, Sweden has been able to increase safely the speed limits on many of its major roads. In fact, many of Sweden's safest roads are also those where speeds are highest (Swedish Road Administration (2009)).

Recent work (Turner et al. (2009)) promotes greater use of what have been termed 'Primary' road safety treatments. These are treatments more likely to eliminate death and serious injury, than produce only mild reductions. Examples include barriers to prevent run-off-road and head-on crashes; properly designed roundabouts at junctions; raised platforms at junctions or locations where pedestrians cross. 'Supporting' treatments such as signing and line marking plus many others may reduce crashes, but not as effectively as Safe System levels require, and generally have only limited impact on severity outcomes.

Vision Zero: an operational framework for safe infrastructure

"...the speed limits within the road transport system should be determined by the technical standard of vehicles and roads so as not to exceed the level of violence that the human body can tolerate. The safer the roads and vehicles, the higher the speed that can be accepted".

In all current road transport systems, the road user is expected to assume most responsibility for safety. In most countries, there are general rules that the road user should behave in such a way that crashes are avoided. If a crash occurs, at least one road user has, by definition, broken the general rule and the legal system can therefore act.

In contrast, Vision Zero explicitly states that the responsibility is shared by the system designers and the road user according to the following principles:

1. The designers of the system are always ultimately responsible for the design, operation and use of the road transport system and thereby responsible for the level of safety within the entire system.

2. Road users are responsible for following the rules for using the road transport system set by the system designers.

3. If road users fail to obey these rules due to lack of knowledge, acceptance or ability, or if injuries occur, the system designers are required to take necessary further steps to counteract people being killed or seriously injured."

Source: Vision Zero

Target the crashes that kill on high-risk roads

As a priority, safety interventions should target the highest concentrations of death and injuries on the road network to achieve rapid and demonstrable improvements (Bliss and Breen, 2009).

Priority crash types

People are killed and seriously injured on the world's urban and rural roads in five main ways. These crashes occur on road networks of all kinds – from local residential roads to shopping streets, from city corridors to inter-urban routes. Targeting these priority crash types is central to the development of a safe road system.

Walking and cycling across the road. Vulnerable road users' risk dramatically increases when traffic speeds are greater than 30km/h. In areas where vulnerable road user flows cross other traffic, traffic calming is generally the most appropriate measure. At locations where speeds are high, this is not possible and more elaborate crossing infrastructure is needed.

Walking and cycling along the road. Pedestrians and non-motorised traffic should be provided with safe parallel paths, walkways and lanes. The higher the actual speed of the motorised traffic, the more stringent the requirements on safe parallel infrastructure: sharing the road at 30 km/h; having dedicated zones at 50 and even 70 km/h; using well-separated secured zones at speeds above that.

Head-on crashes typically kill and seriously injure vehicle occupants at speeds greater than 70km/h.

Brutal side impacts at intersections typically kill and seriously injure vehicle occupants at speeds greater than 50km/h.

Run-off road crashes into rigid fixed objects typically kill and seriously injure at speeds greater than 70km/h for frontal impacts and 30km/h for side impacts.

High-risk roads

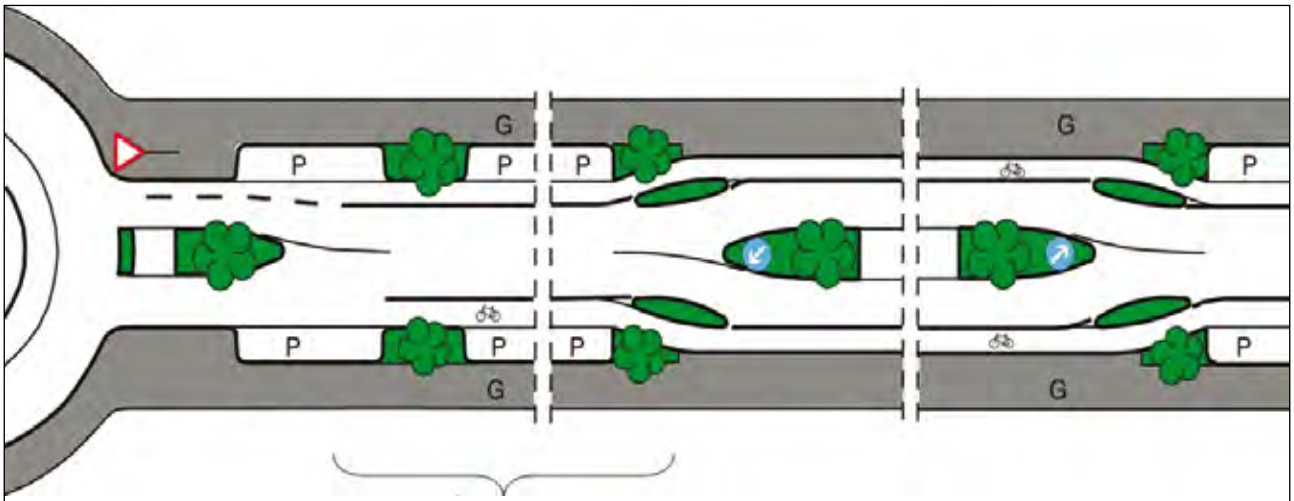
The majority of serious crashes occur on a small proportion of the world's rural and urban roads. In the United Kingdom, for example, more than half of all road deaths and one-third of all serious injuries occur on just 10% of roads (Road Safety Foundation, 2009). In Bangladesh, just 3% of arterial roads account for 40% of the road deaths (Hoque, 2009). A similar picture exists in many other low- and middle-income countries.

By targeting priority crash types on high-risk roads, affordable measures can dramatically improve safety. For example, through sweeping installation of pedestrian bridges, walkways, raised crossings and speed humps to roads in residential areas, at schools and public transport interchanges, the city of Tshwane in South Africa was able to cut pedestrian deaths by half and reduce injuries by a quarter (International Road Federation, 2008a).

Not all high-risk roads are old roads. While new roads bring new opportunities for development, for many, they increase death. New roads are almost always built to expect greater volumes of traffic and higher speeds because this supports national macro economic goals. This does not need to increase the likelihood of serious injury although it almost always will if these roads are not restricted to through-traffic, if linear settlements are not avoided and there is not first class provision for pedestrians, cyclists and other vulnerable road users.

Access to new roads by pedestrian, cyclists and motorcyclists is often not provided in a way that offers protection or priority to these road users and the risk of serious crashes increases dramatically. It is of paramount importance that roads built to help eradicate poverty are built to protect life.

Figure 6: Countermeasures on a linear development (PIARC, 2009)



We need simple, affordable safety features. These interventions are as effective as vaccines.

Carla Gonzalez, former Minister for Transport, Costa Rica

Vaccines for roads

Safer roads have the capacity to address key crash types, but also play an important role in addressing behavioural issues (such as providing visual cues to slow driver speeds) and make travel safer for all road users. Road infrastructure often holds greater potential to protect road users than programmes that aim only to improve behaviour or vehicle safety.

For example, traffic calming as part of urban safety management can provide self-enforcing speed reduction; similarly, measures that separate pedestrians or cyclists direct these road users away from conflict. Both rely on infrastructure design but influence behaviour. Other situations demand a more protective approach, often when the risk is less well understood by the road user or the consequences of a crash would be needlessly severe. Provision of median barriers to reduce head-on crashes or the introduction of frangible and "breakaway" poles may be examples.

Where pedestrian or other vulnerable road user activity is likely, these road users should be at the forefront of road design and layout considerations. Road designers should be aware that nearly everywhere, activity of non-motorised road users can be, and should be, expected. Restricting access to certain user categories is only acceptable when appropriate, comfortable and safe alternatives are readily available. The need to cross a road at multiple and not-too-distant locations should also be respected and facilitated, in order not to make a road a barrier for the local citizen.

Figure 7 summarises some elements of the measures taken to counter five priority crash types referred to elsewhere in this document.

The focus on the measures shown here is on prevention of severe injuries and there is an important distinction to be made here between this injury prevention and crash reduction. Indeed, the adoption of the Safe System approach concerns the shift from the former to the latter. This document cannot provide a comprehensive list of the crash countermeasure techniques available, but it seeks to provide a flavour for what may be achieved. Further information is available at www.irap.org/toolkit/. Benefits quoted are indicative. Countermeasures influence crashes and injuries, and the severity of both, to different extents.

Figure 7: Examples of "vaccines for roads" for common crash types

Pedestrian facilities

- footpaths
- crossings (see right)
- overpasses
- additional lane for walking
- 30km/h zones
- pedestrianisation of streets or areas

Example – pedestrian crossings give priority to pedestrians when crossing the road. When signalised, they halt vehicle traffic. They can be used at midblock locations (that is, between intersections) or incorporated into existing signals at intersections. Signalised crossings can reduce injuries by up to 30 per cent.

Bicyclists

- bicycle paths and lanes (see right)
- crossings
- overpasses

Example – segregated bicycle paths remove the potential for conflict with motorised vehicles when riding along the road. Lanes alongside traffic give more limited protection. Crossings and overpasses protect when going across roads. Junction design can also help cyclists be seen and separate them from other vehicles.

Median separation

- Flexible posts
- Central hatching
- Safety barriers (see right)
- Wide medians

Example – median safety barriers physically separate opposing lanes of traffic. This helps stop vehicles travelling into opposing traffic lanes. The barriers can also be used to limit turning options for vehicles, and shift these movements to safer locations. Median barriers can reduce injuries by 50 per cent but their use must be considered carefully because they may increase speeds and reduce space for other road users.

Roadside hazard reduction

- Hazard removal or relocation
- Safety barriers (see right)

Example – where space permits, roadside safety barriers can be used to stop 'out of control' vehicles from leaving the road and hitting roadside hazards or rolling down slopes. They are designed to absorb the impact of a crash and minimise injuries. Safety barriers can reduce injuries by 40 per cent.

Intersection upgrades

- Turning lanes
- Signalisation
- Roundabouts (see right)

Example – a roundabout is a one-way road around a circular central island at an intersection. Roundabouts cause little delay to traffic. They need less maintenance than signalised intersections, typically reduce severe injuries overall but may actually increase low severity and property-damage crashes. Special consideration for cyclists must be incorporated in their design.

Road definition

- Signage
- Road markings (see right)
- Channelisation and layout improvements

Example – road markings help all road users with information about positioning and priorities on the road and about conditions ahead. Markings are particularly helpful where visibility can become poor (for example, because of rain, fog or darkness) and on sharp bends. Markings can reduce injuries by 30 per cent.

Using visual cues within infrastructure to reduce speeds and match posted speed limits

- Width reduction
- Portals
- Choice of materials
- "Readable" roads
- Speed limits

Example – trying to impose a maximum speed by traffic signs in a situation where the driver perceives that the road "allows" much faster speeds generally results in non-compliance. Drivers should be provided with visual cues about what is a reasonable speed from the infrastructure. Speed limit signs should support this.

Accessibility planning – major roads and the community interface

The public spaces alongside major roads need strong and courageous policies to influence land-use and activity. When large budgets are spent on roads and other infrastructure, it is crucial to include this public space in the upgrading.

Lessons from history

The second half of the 20th century had a clear focus on increasing mobility (the "quantity of movement"), especially in high income countries. While this initially has had a positive effect on general prosperity, many of these countries now suffer from reduced accessibility (the "quality and possibility of access").

Major roads frequently pass through places where accessibility is a priority and there are lessons to be learned from history.

In urban areas, accessibility has declined both for motorised and non-motorised road users as a result of congested roads, reduction or inhibition of public transport (due to both traffic congestion and competition for the scarce public space), and because walking and cycling has been discouraged (by the danger and health hazard imposed by heavy motorised traffic). Away from urban areas, many "improvements" in rural situations have had unwanted consequences on accessibility. When traffic increases on small country roads and mixed-use inter-urban roads, they may become unsuitable for pedestrians and cyclists.

Even at a local level, accessibility is often drastically decreased. When the main street of the village is turned into a through-road without comprehensive calming considerations, this road turns into a barrier between the different parts of the village. The important public space, around which much of the local activity was originally built, is not conducive to important elements of community life.

Encouraging walking and cycling

Learning from the mistakes made in the past, well-informed communities all over the world are promoting accessibility as the main policy and planning objective. In some places, comprehensive re-shaping of city centres has taken place. With their "sustainable streets" program, New York converted important areas in Manhattan to plazas and closed off a road as iconic as Broadway to motorised traffic. Some cities like London and Stockholm introduced congestion taxes, resulting in more sustainable transport use and more "liveable" centres. Quality and ease of access between people and between people and goods has been implicitly recognised as an important key indicator of prosperity.

Experience shows that communities flourish when sustainability increases, both locally and at a national level, and when there is a considerable portion of walkers, cyclists and users of public transport. However the quality of the walkers' and cyclists' experience can vary greatly over time and in different places. This in turn is known to have an impact on decisions on whether or not to walk or cycle. Planning with only mobility in mind can reduce the possibility of walkers and cyclists to reach certain destinations and lower public transport patronage.

Figure 8: Pedestrianisation of Broadway (johnanna.be)

Priority policies

Given the dramatic population growth to be expected in many cities worldwide, it is essential to plan cities and communities for a growing number of people who do not own a car. They need comfortable and safe infrastructure for walking and cycling, and for access and stopping points to rest or to wait for public transport.

On the interface with the major roads with which this document is concerned, there should be good provision for vulnerable road users, focusing on: land-use control; widening and repair of narrow and damaged footways; enforcement of laws prohibiting parked cars on footways; removal of unnecessary barriers or street furniture; rehabilitation and review of pedestrian crossings.

The public spaces alongside major roads need strong and courageous policies to influence land-use and activity. When large budgets are spent on roads and other infrastructure, it is crucial to include this public space in the upgrading. The human activity that takes place there often happens because the road is there and it can be the stage for the essential "liveability" of the area – commercial, social, functional and recreational activity. (See the NGO Brussels Declaration (2009) for more details.)

Figure 9: Parallel routes where necessary

Figure 10: Pedestrians need protection when crossing and walking alongside roads

Investing in proven programmes and maintaining safe roads

Programmes that save lives

Among the programmes that have been proven to significantly reduce road deaths and serious injuries are:

- Mass-action programmes or network safety upgrading, which comprehensively assess and improve routes and entire networks.
- High-risk site analyses (often called "black spot" programmes in the past) that improve specific locations with a history of crashes.
- Road Safety Audits which can be undertaken in the design, construction and post-construction phases of a project and do not rely on crash data.

These programmes can be reactive or proactive – working to reduce known problems of persistent crash types at particular locations (high-risk sites) or seeking to raise the overall safety standard of the road network where crashes are likely and foreseeable (audits and network safety upgrading). See, for example, PIARC (2008), International Road Federation (2008b) and iRAP (2008).

Infrastructure design affects both injury likelihood and crash risk because it provides guidance for road users, through signs, traffic controls and road design, on what they should be doing. Good design makes it clear to the road-user where they are supposed to be and what they are expected to do. It ensures that people are neither misled nor surprised by the road layout and that they are not overwhelmed by information or find that it is contradictory.

Strategic investment

Financial resources dedicated to road safety are often scarce and limited in developing and emerging economies. However, financing deserves special attention, since, without stable and sustainable funding, even outstanding road safety initiatives might not succeed.

Techniques developed over the last 10 years enable entire networks to be assessed ("star rated") for safety risk, injury savings estimated, potential countermeasure locations pinpointed and budgets proposed for implementation. The map and tabulation below show such a plan for urban corridors in Nairobi (iRAP, 2009). Subsequent more detailed assessment helps direct spend.

While external donor contributions can be used as a catalyst to implement road safety initiatives, secure and sustainable financing should be generated domestically.

Figure 11: Star Rating roads for safety (iRAP, 2009)

Figure 12: Nairobi road safety investment programme (iRAP, 2009)

Countermeasure type	Sites / length	Estimated cost (20 years)	Killed and serious injuries saved (20 years)	Value of safety benefit (20 years)	Cost per KSI saved
Pedestrian Facilities	127 sites	$3.5m	10,300	$246m	$748
Shoulder widening	68km	$1.9m	4,200	$100m	$456
Roadside Safety - Barriers	26km	$2.0m	1,400	$34m	$1384
Additional lane	6km	$1.3m	900	$22m	$1376
Delineation	44km	$0.6m	500	$12m	$397
Road Surface Upgrade	11km	$0.3m	300	$8m	$539
Regulate roadside commercial activity	6km	$0.1m	300	$7m	$233
Parking improvements	6km	$0.1m	300	$7m	$278
Intersection - roundabout	6 sites	$0.2m	200	$4m	$1084
Duplication	1km	$0.3m	100	$4m	$1284

KSI = killed and serious injuries.

Governments play an important role in identifying innovative ways of securing stable flow of financing such as road user fees and private sector funding. A significant budget for financing road safety engineering measures should be ring-fenced from the funding source used for road construction, upgrading and maintenance.

The Commission for Global Road Safety (2008) has supported a World Bank-inspired proposal that all internationally funded road infrastructure projects in middle and low-income countries should include a minimum 10 per cent road safety component, to ensure road safety is properly integrated into project design and implementation, and to enable safe management of new and rehabilitated roads.

Smart investment in roads delivers economic benefits throughout a society. Better roads help businesses through faster transit times and lower transportation costs. They help students get to school and parents get to work. Investments that improve safety of roads are investment in a healthy future. There are other cross-sectoral benefits, mainly, but not exclusively seen in good design of local roads – public space and the benefits that good design and investment can have on this and the road network's ability to stimulate pedestrians and provide health benefits though limiting obesity through non-activity.

The World Bank launched the Global Road Safety Facility in 2005 as a dedicated funding mechanism to support initiatives aimed at reducing deaths and injuries in low- and middle-income countries. The facility is supported by FIA Foundation, the Government of the Netherlands, the Government of Sweden, and the World Bank's Development Grant Facility. The World Bank is providing $35 million in financing for its first project, strictly dedicated to road safety in Vietnam.

In 2006 the Commission for Global Road Safety in its report called for a ten year $300 million action plan to invest in capacity building in road injury prevention in low- and middle-income countries. The Commission suggested that governments could contribute $200 million with other sources contributing the remaining $100 million. In 2009 Bloomberg Philanthropies became the first major donor to global road safety with a five year, $125 million investment in a 'Road Safety in 10 countries' project. Some of this investment is directed to safe road infrastructure assessment.

The Commission for Global Road Safety has also recommended that major bilateral and multilateral donors commit at least 10 percent of the cost of their road investment projects in those countries to safety rating, assessment and design. There has been some progress in reaching this goal, as interna-

tional organisations such as the Multilateral Development Banks and UN regional commissions are now giving greater attention to road infrastructure safety issues. Indeed, the 2009 joint statement by the World Bank and six leading multilateral development banks: A Shared Approach to Managing Road Safety accepts that road safety must be a higher priority for the banks' multi-billion dollar roads portfolios and a process is now underway to harmonise procedures and improve road safety outcomes. According to the Commission these donor resources are needed as a catalyst to implement road safety programmes that will become self-sustaining over the long period.

Maintenance of safe road infrastructure

Roads are a significant asset of all governments. They are also subject to significant use and deterioration over time and require adequate funding devoted to maintenance. Poor maintenance can create new hazards that can influence crash occurrence or severity. Good maintenance is a life-saving measure in its own right.

Maintenance must focus on keeping the road safe and serviceable and ensure that the intended purpose and design of the road is maintained. Maintenance programs can also enable incremental improvements in safety levels through simple low-cost attention to pavement condition, barriers, signs and line-marking, sight-distance and visibility constraints and road debris.

Road safety engineers should not miss the opportunities that maintenance programmes may provide. In some places maintenance programmes have budgets tenfold that of safety. Fine-tuning maintenance programmes to take greater account of safety, or to act in synergy with safety, can deliver far greater safety benefits than would ever be generated from safety budgets alone. This can cover a variety of targeted crash types. A good example is the inclusion of an adequate road shoulder – sometimes done to preserve the road asset by reducing "edge-break"; repairing the edge of carriageway in this way can also reduce casualty crashes by 30%.

Building a strong safety culture and institutions

Road safety maturity reflects how much politicians see road deaths as a priority, how well the professions are trained and supported, and how much the population is engaged with these issues and will support and comply with what is required of them

Setting and managing targets

Strong institutional frameworks for road safety are required to achieve sustained reductions in road death and injuries. The road safety management system implemented must include a results focus and cover issues related to coordination of stakeholders, legislation, funding and resource allocation, promotion, monitoring and evaluation, research and knowledge transfer (Bliss and Breen, 2009) – see figure below.

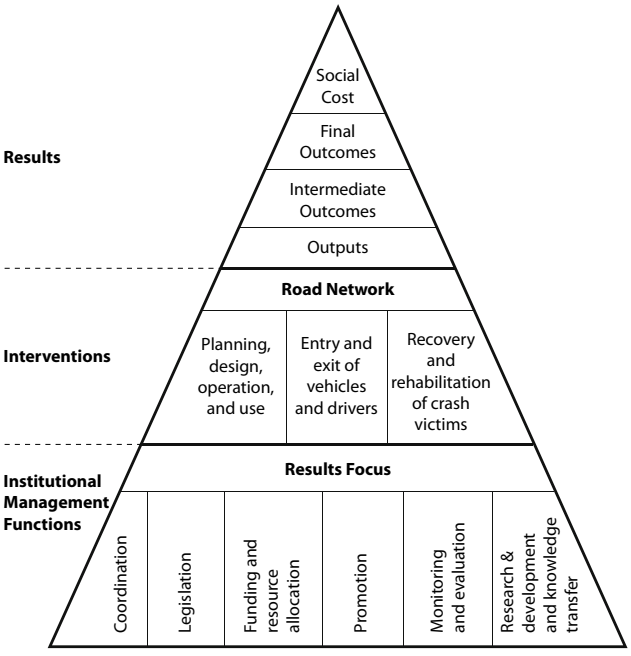
The Safe System covers the "planning, design, operation and use" of the road network. This is achieved by:

- safety design standards and rules for the different road categories and functions, including separate consideration of urban and interurban roads
- the means to assure compliance with these rules
- methods to measure and rate the overall level of safety being achieved.

and, related specifically to detailed assessment:

- PIARC recommends that Road Safety Audits should be undertaken in the design phases of a project to eliminate safety deficiencies before they are built (see Appendix).
- Road Safety Inspections should be undertaken on existing roads in the post-construction phase and regularly to detect the existing safety deficiencies. They do not necessarily rely on crash

Figure 13: The road safety management system



data but will also be the tool for analysing hazardous road sections.

Safe System implementation

How the Safe System is implemented will vary enormously from country to country, dependent upon the "road safety maturity" of a country and the resources in this pyramid that it is able to apply. This maturity is loosely the extent to which politicians see road deaths as a priority, how well the professions are trained and geared up, and how much the population is engaged with these issues and will support and comply with what is required of them.

Targets

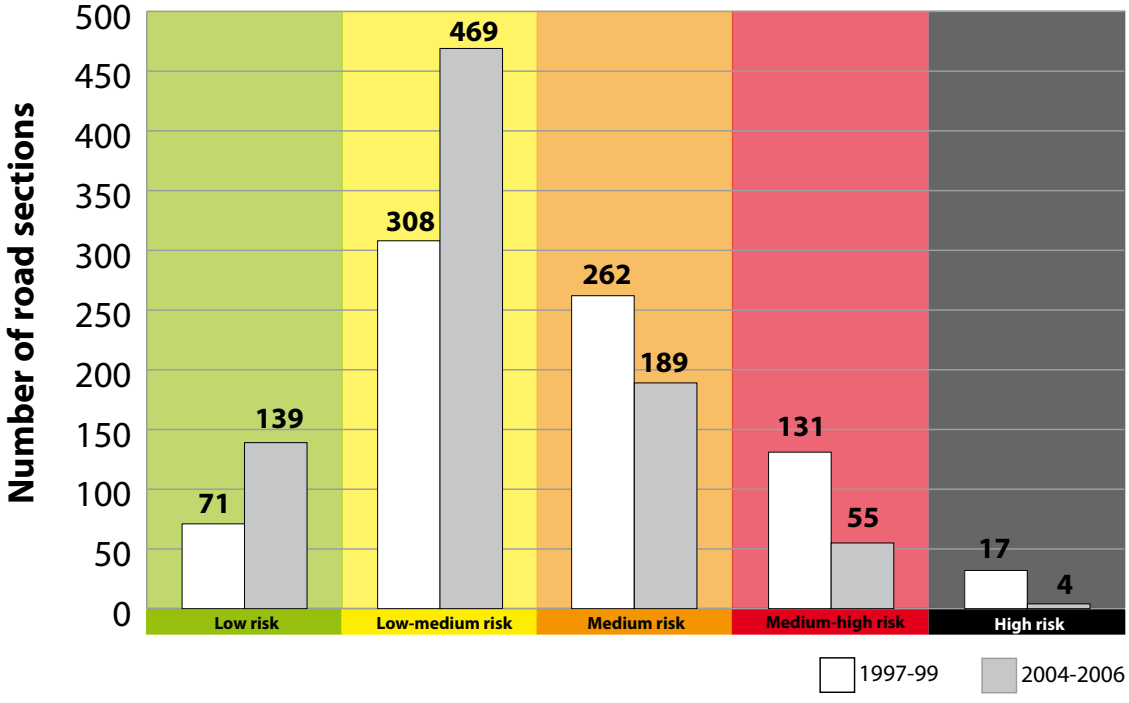
Many countries have set targets for death reduction, often over a period of up to 10 years. In Europe, the target has been a reduction of fatalities by half. The OECD (2008) has published recommendations for achieving government commitment at the highest levels in order to achieve these targets. The stated global objective or vision of the UN Decade of Action for Road Safety 2011-2020 is to stabilise and then reduce global road deaths, and the UN encourages national governments to establish targets to support this international aspiration. Those countries that have set quantified road safety targets have much greater success in delivering safety outcomes (OECD, 2002).

Sub-targets may be related specifically to infrastructure and other measures (eg Wegman and Aarts (2006), iRAP (2008)) as performance indicators. These could target a percentage of the high volume roads in a country that meet a high safety rating, or are adequately protected by appropriate barriers. In urban areas it could be the percentage of local access roads with a 30 km/h speed limit.

Capacity-building and knowledge transfer

The creation and sharing of knowledge on how to manage, design, build and maintain safe road systems must be a high priority. This must be under-

Figure 14: Celebrating success by showing risk reduction across the network from one 3-year period to the next (Road Safety Foundation, 2008)



taken at a global, regional and country level. The solutions for safe road infrastructure and safe road systems are ready to implement; they just need to be resourced and provided with the capacity to deliver the programmes developed locally within each country. Initiatives such as the Good Practice Guides for Speed Management, Drinking and Driving, Helmets, Seat-Belts and Child Restraints and this Policy Framework Guide for Safe Road Infrastructure provides a starting point for this important component of global action to reduce road death and injury. These documents and many other resources are available via the global Transport Knowledge Partnership (gTKP), which is currently the most comprehensive (and free) online knowledge library where information, knowledge, best practice as well as relevant links can be found (www.gtkp.com).

Measure progress and celebrate success

The collection of data to measure progress against targets and to evaluate the effectiveness of treatments and interventions is essential. This research and reporting will provide a measure of performance over time and allow relevant stakeholders to focus on high-return initiatives and modify underperforming strategies.

In the United Kingdom for example, EuroRAP used Risk Maps to demonstrate that the government had achieved a significant reduction in high-risk primary route roads between 1997 and 2006 (see Figure 11 below).

Where good crash data are not available, other measures of injury risk may be used as proxies. New initiatives in road safety can be tested and implemented where appropriate. Success can be shared and used to help support further investment to reduce death and injury.

Conclusions

Roads are a crucial contributor to many of life's essential activities and to social and economic development. In many countries, lack of a road means that large parts of the population do not have access to the outside world.

Many existing roads and many built as new are unsafe. Road deaths and injuries are unaffordable and in places where the support for those at the margins of society is often limited, they have particularly devastating consequences. There are ways of improving infrastructure safety in a systematic and durable way.

A key part of improving infrastructure will be to use a holistic approach, whereby the needs and the risks for all road users are closely examined and taken into account. Depending on the local situation, this could include strong development control discouraging linear settlements, good access control when development control has failed, separating fast moving traffic from vulnerable road users wherever appropriate, or reducing speed of the motorised traffic. For the major roads considered in this report, this includes providing for the primary function of the road as part of a network and considering the interface with life alongside the road – where people live, shop, play, meet and talk.

Making road infrastructure durably safe is cost-effective and yields extraordinarily good rates of return. Several studies have shown that the benefits of infrastructure investment are likely to be as good as or better than other approaches to crash reduction.

There are proven models that demonstrate the benefits of crash reduction work – first year rates of return on investment in excess of 300 per cent can be achieved with the implementation of dependable low-cost measures.

High-performing countries such as Sweden provide examples of what can be achieved through adopting a structured Safe System approach to safety based upon the tolerance of the human body.

There are proven methods to be used in identifying, assessing and treating road networks. They show how to prioritise action across road networks and how to engage with those who are responsible. Managing kinetic energy in road design is the fundamental issue. Five main crash types account for the majority of deaths and serious injuries.

Human factors interact with the road and vehicle and determine the likelihood of crashes. Road design should not surprise or overwhelm the driver; road hierarchies should be reinforced so that through problems of through-traffic mixing with local traffic are minimised. Where there is likely to be pedestrian and other vulnerable road-use activity, the needs of these road users should be respected and provided for with appropriate speed limits and facilities.

Road injury interventions may be carried out in a reactive or proactive manner. They can be assessed and implemented at a variety of levels, from single-sites to entire road networks. Examples are apparent throughout the world.

Funding and resource allocation is the best possible indicator of a country's aspiration to achieve a reduction of road deaths. The recommendation is that a minimum of 10 per cent of road spending is devoted to road safety.

Appreciation of the role of institutional management functions in improving road safety is as important as knowing which potential road safety interventions exist and how to implement them.

Setting death-reduction targets, and engaging with those who will adopt them, is a fundamental part of this exercise.

Recording dependable information about crash injuries is crucial to forward planning although there are ways of estimating casualties and casualty savings where this information is not complete or available.

The United Nations has proclaimed a 'Decade of Action for Road Safety 2011-2020', with the stated objective of stabilising and then beginning to reduce global road deaths. Safe road infrastructure has a vital role to play in helping to achieve this ambitious and essential vision.

References

A Shared Approach to Managing Road Safety: Joint Statement by 7 Multilateral Development Banks http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22386249~pagePK:64257043~piPK:437376~theSitePK:4607,00.html

Bliss, T. and Breen, J. (2009). Implementing the Recommendations of the World Report on Road Traffic Injury Prevention. Country Guidelines for the Conduct of Road Safety Management Capacity Reviews and the Specification of Lead Agency Reforms, Investment Strategies and Safe System Projects, World Bank Global Road Safety Facility, Washington DC.

Commission for Global Road Safety (2009). Make Roads Safety: A Decade of Action for Road Safety, London. http://www.makeroadssafe.org/publications/Documents/decade_of_action_report_lr.pdf

Department for Transport (2001). Development of a rural road hierarchy for speed management. http://www.dft.gov.uk/pgr/roadsafety/speedmanagement/developmentofaruralroadhiera4798

Hoque, M. S. (2009). Unplanned Development and Transportation Problems of Dhaka City, International Symposium on Vulnerability in Cities, University of Tokyo, 25-27 March.

International Road Federation (2003). Safe mobility: an IRF discussion paper on road infrastructure safety. Geneva. http://www.irfnet.org/files-upload/pdf-files/Safe%20Mobility.pdf

International Road Federation (2008a). "City of Tshwane", 2007 Road Safety Awards, February 2008. Geneva.

International Road Federation (2008b). Cost effective means of optimising road safety. Geneva. http://www.irfnet.org/files-upload/pdf-files/PTCRS%20Publication%20order%20form.doc

iRAP (2008). Vaccines for roads. July, Basingstoke. http://www.irap.org/media/1515/iRAPVaccinesforRoads.pdf

iRAP (2009). Kenya Report iRAP502.10, November, Basingstoke.

Miller, T. & Zaloshnja, E. (2009). On a crash course: The dangers and health costs of deficient roadways. Pacific Institute for Research & Evaluation. http://www.pire.org/detail.asp?core=39633

NGO Brussels Declaration (2009): http://www.who.int/roadsafety/ministerial_conference/ngo_declaration_full.pdf

OECD 2002, Safety on roads: what's the vision? OECD, Paris. Order form at: http://www.oecdbookshop.org/oecd/display.asp?K=5LMQCR2KC0LT&LANG=EN

OECD (2008) Towards Zero – Ambitious road safety targets and the safe systems approach, OECD, Paris. Order form at http://www.oecdbookshop.org/oecd/display.asp?k=5KZG1MV9LGVC&lang=en

PIARC Road Safety Manual (2003) Order form at: http://publications.piarc.org/en/technical-reports/road-safety-manual.htm (New electronic edition in preparation)

PIARC Guidelines on Accident Investigations, Road Safety Audits and Inspections, Human Factors in Road design and operation and a catalogue of design safety deficiencies and countermeasures. http:// www.piarc.org

PIARC (2009) Catalogue of Design Safety Problems
and Potential Countermeasures
http://www.nc-piarc.si/dokumenti%5CTC_reports%5C2009R07-NewRelease-E.pdf

Road Safety Foundation (2008). Getting ahead: Returning Britain to European leadership in road casualty reduction. Basingstoke. http://www.eurorap.org/library/pdfs/20081001_CSRD_GettingAhead_bookletWEBv3.pdf

Road Safety Foundation (2009). Measuring and mapping the safety of Britain's motorways and A roads. Basingstoke. http://www.eurorap.org/library/pdfs/20090624_RSF_report_LOW_RES%20for%20Web.pdf

Stigson, H. Krafft, M. & Tingvall, C. (2008) Use of fatal real-life crashes to analyse a Safe Road Transport System model, including the road-user, the vehicle and the road. Traffic Injury Prevention Volume 9, Issue 5 , October 2008 , pages 463 – 471 Available at: http://www.informaworld.com/smpp/content~db=all~content=a903343145

Swedish Road Administration (2000) Which roads will be effected by the new speed limits? http://www.vv.se/Andra-sprak/English-engelska/Road-safety/New-speed-limits/Which-roads-will-be-affected-by-the-new-speed-limits/

Swedish Road Administration (2006). European Union issue 11 Transport. A new Vision. Paper by Johansson, J hosted at http://www.vv.se/PageFiles/12660/eu11_roger_johansson_atl%5B1%5D.pdf?epslanguage=sv

Turner, B., Tziotis, M., Cairney, P., Jurewicz, C. (2009). Safe system infrastructure: national roundtable report.
http://www.arrb.com.au/documents/ejournal/Free%20Downloadable%20PDF%20AAR%27s/ARR%20370%20Safe%20System%204Jun_Eversion.pdf

UN Collaboration- coordinated Good Practice Guides available
http://www.who.int/roadsafety/projects/manuals/en/index.html

United Nations General Assembly Resolution A/64/L.44 Global Road Safety Crisis
http://www.fiafoundation.org/Documents/Road%20Safety/UN-Decade-of-Action-Resolution.pdf

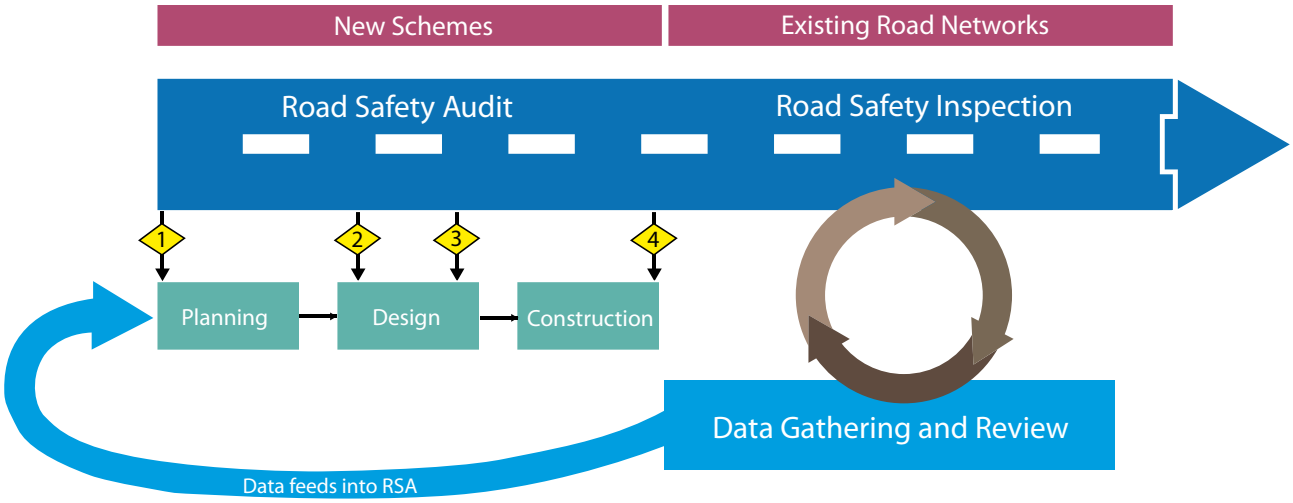
Vulcan, P. and Corben, B. (1998) Prediction of Australian Road Fatalities for the Year 2010, Monash University Accident Research Centre (MUARC), Melbourne. www.ors.wa.gov.au/_layouts/getAsset.aspx?URI=2468012&REV=1

Wegman, F. and Aarts, L. (2006) Advancing Sustainable Safety, National Road Safety Outlook for 2005-2020, SWOV ISBN-10: 90-807958-7-9, ISBN-13: 978-90-807958-7-7 http://www.swov.nl/rapport/DMDV/Advancing_Sustainable_Safety.pdf

World Health Organisation (WHO), 2009. Global status report on road safety: time for action. Geneva, World Health Organisation, 2009. http://whqlibdoc.who.int/publications/2009/9789241563840_eng.pdf

Wramborg, P. (2005). "A New approach to a safe and sustainable road structure and street design for urban areas". Paper presented at Road Safety on Four Continents Conference, Warsaw, Poland.

Appendix – the process of Road Safety Audit and Road Safety Inspection (PIARC)*



*For context on Road Safety Audit and Road Safety Inspection see page 10 – "Investing in proven programmes and maintaining safe roads" and page 12 "Building a strong safety culture and institutions".

Acknowledgements

This document has been produced by members of the United Nations Road Safety Collaboration "Working Group 4 – Infrastructure" that was created on the initiative of Michael Bernhard (International Road Federation), former chair of that group.

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Working Group 4 is grateful to the many contributors who helped in the preparation of this document and to colleagues within these organisations listed above. The responsibility for the content is that of the authors and the views do not necessarily reflect those of the United Nations Road Safety Collaboration.

More information

FIA Foundation for the Automobile and Society

http://www.fiafoundation.org

GLOBAL ROAD SAFETY PARTNERSHIP

http://www.grsproadsafety.org/

gTKP global Transport Knowledge Partnership

http://www.gtkp.com

iRAP INTERNATIONAL ROAD ASSESSMENT PROGRAMME

http://www.irap.net

IRF

http://www.irfnet.org/

WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE

http://www.piarc.org

WORLD BANK GLOBAL ROAD SAFETY FACILITY

http://www.worldbank.org/grsf

For more information about the UN Decade of Action for Road Safety:

ROAD SAFETY IS NO ACCIDENT

http://www.who.int/roadsafety/en/

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