Speed management

A ROAD SAFETY MANUAL
FOR DECISION-MAKERS
AND PRACTITIONERS

good practice

World Health Organization
FIA Foundation for the Automobile and Society
Global Road Safety Partnership
The World Bank

Speed management: a road safety manual for decision-makers and practitioners

ISBN 978-2-940395-04-0

Suggested citation:
Speed management: a road safety manual for decision-makers and practitioners.
Geneva, Global Road Safety Partnership, 2008

Design by Inís Communication: www.inis.ie

Table of contents

Acronyms

ABS	Anti-lock braking system
ARRB	Australian Road Research Board
BAC	Blood alcohol concentration
BRRI	Building and Road Research Institute (Ghana)
CEA	Cost-effectiveness analysis
CBA	Cost-benefit analysis
DFID	Department for International Development (UK government)
ECMT	European Committee of Minsters of Transport
EDR	Electronic data recorder
EMS	Emergency medical services
EU	European Union
FIA	Fédération Internationale de l'Automobile
FIA-Foundation	The FIA Foundation for the automobile and society
GHA	Ghana Highway Authority
GPS	Global positioning system
GRSP	Global Road Safety Partnership
iRAP	International Road Assessment Programme
ISA	Intelligent speed adaptation
km/h	Kilometres per hour
LMIC	Low and middle-income countries
MP	Member of Parliament
NHTSA	National Highway Traffic Safety Administration (USA)
OECD	Organisation for Economic Cooperation and Development
OHS	Occupational Health and Safety
ORN	Overseas research note (published by TRL/DFID)
QALY	Quality-adjusted life year
RCT	Randomised control trial
RSL	Road speed limiters
SARTRE	Social Attitudes to Road Traffic Risk in Europe
TARC	Thailand Accident Research Centre
TRL	Transport Research Laboratory (UK)
VKT	Vehicle kilometre travelled
VRU	Vulnerable road user
VTI	Swedish transport research institute
WHO	World Health Organization

Preface

Road traffic injuries are a major public health problem and a leading cause of death and injury around the world. Each year nearly 1.2 million people die and millions more are injured or disabled as a result of road crashes, mostly in low-income and middle-income countries. As well as creating enormous social costs for individuals, families and communities, road traffic injuries place a heavy burden on health services and economies. The cost to countries, possibly already struggling with other development concerns, may well be 1%–2% of their gross national product. As motorization increases, road traffic crashes are a fast-growing problem, particularly in developing countries. If present trends continue unchecked, road traffic injuries will increase dramatically in most parts of the world over the next two decades, with the greatest impact falling on the most vulnerable citizens.

Appropriate and targeted action is urgently needed. The *World report on road traffic injury prevention,* launched jointly in 2004 by the World Health Organization (WHO) and the World Bank, identified improvements in road safety management that have dramatically decreased road traffic deaths and injuries in industrialized countries that have been active in road safety. The report showed that the use of seat-belts, helmets and child restraints has saved thousands of lives. The introduction and enforcement of appropriate speed limits, the creation of safer infrastructure, the enforcement of blood alcohol concentration limits and improvements in vehicle safety, are all interventions that have been tested and repeatedly shown to be effective.

The international community must now take the lead by encouraging good practice in road safety management and the take up of these interventions in other countries, in ways appropriate to their particular settings. To speed up such efforts, the United Nations General Assembly passed a resolution on 14 April 2004 urging greater attention and resources to be directed towards the global road safety crisis. Resolution 58/289 on "Improving global road safety" stressed the importance of international collaboration in the field of road safety. A further resolution (A58/L.60), passed in October 2005, reaffirmed the United Nations' commitment to this issue, encouraging Member States to implement the recommendations of the *World report on road traffic injury prevention*, and commending collaborative road safety initiatives so far undertaken towards implementing resolution 58/289. In particular, it encouraged Member States to focus on addressing key risk factors, and to establish lead agencies for road safety.

To contribute to the implementation of these resolutions, the Global Road Safety Partnership (GRSP), the World Health Organisation (WHO), the FIA Foundation for the Automobile and Society (FIA-F) and the World Bank, are collaborating to produce a series of 'how to do' manuals aimed at policy-makers and practitioners. This manual is one of them. Each manual aims to provide step-by-step guidance to support countries wishing to improve road safety and to implement specific road safety interventions as outlined in the *World report on road traffic injury prevention*. They propose simple, effective and cost-effective solutions that can save many lives and reduce the shocking burden of road traffic crashes around the world. We would encourage all to use these manuals.

David Silcock
Chief Executive
Global Road Safety Partnership

Etienne Krug
Director
Department of Injuries and Violence Prevention
World Health Organization

David Ward
Director General
FIA Foundation for the Automobile and Society

Anthony Bliss
Lead Road Safety Specialist
Transport Division
Energy, Transport and Water Department
World Bank

Contributors

This manual was drafted under contract to GRSP by a team of researchers from ARRB Transport Research (ARRB, Australia), the Transport Research Laboratory (TRL, UK) and Swedish National Road and Transport Research (VTI, Sweden). Parts of the manual have been taken from earlier manuals such as *Helmets: a manual for decision makers and practitioners*, the first manual in the series, and *Drinking and Driving: a road safety manual for decision-makers and practitioners,* the second in the series. Such duplication supports the wish to produce a unified series of road safety manuals.

Many people were involved in its preparation as authors, contributors, providers of case studies, peer reviewers and as technical editors. GRSP expresses sincere thanks to them all.

Advisory Committee
Anthony Bliss, Etienne Krug, David Silcock, David Ward

Editorial Committee
Rikke Rysgaard, David Silcock, Meleckidzedeck Khayesi

Principal Authors
Eric Howard, Lori Mooren, Goran Nilsson, Allan Quimby, Anna Vadeby

Peer reviewers
Amy Aeron Thomas, Paige Mitchell, Rune Elvik, Dai Dongchang, Peter Njenga, Jacques Nouvier, Radin Umar R.S., Marilena Amoni, Davey Warren, Geoffrey L Collier, Susan Kirinich, Mike Winnett.

Contributors to modules or extracts from previous manuals used here
Rebecca Ivers, Stephen Jan, Dang Viet Hung, Charlie Mock, Margie Peden, Meleckidzedeck Khayesi, Matts-Ake Belin, Tamitza Toroyan, Ray Shuey, Blair Turner, Rikke Rysgaard, David Silcock.

Technical and style editing
Angela Burton

Financial support
GRSP gratefully acknowledges the financial support received from the World Bank Global Road Safety Facility that made the production of this manual possible.

WORLD BANK GLOBAL ROAD SAFETY FACILITY

Acknowledgements

The following people kindly submitted case studies or supported our search for suitable contributions for inclusion in the manual. Their contributions (used or unused) are gratefully acknowledged – any errors they might contain are the responsibility of the authors.

Amy Aeron-Thomas, Sverker Almqvist, Terje Assum, Lárus Ágústsson, Rohit Baluja, Matts-Ake Belin, Antony Bliss, José Cardita, Fernando Pestana, Jean-Pierre Cauzard, Richard Driscoll, Goran Gustavsson, Yong He, John Hine, Seng Tim Ho, Eric Howard, Jens Huegel, Allan Jones, Dick Jonsson, Kim Jraiw, Kunnawee Kanitpong, Steve Lawson, Jerry Lebo, Stein Lundebye, Per Mathiasen, Lori Mooren, Margie Peden, Rune Peterson, Allan Quimby, Bengt-Goran Rosqvist, Alan Ross, Gregg Rowe, Rikke Rysgaard, Anchulee Siroratrangsi, John Smart, Radin Umar R. S, Robert Susanj, Chamroon Tangpaisalkit, Fergus Tate, Joel Valman, Pieter Venter, Mike Winnett, Jing Mei Wu.

Executive summary

Excessive and inappropriate speed is the most important factor contributing to the road injury problem faced by many countries. The higher the speed the greater the stopping distance required, and hence the increased risk of a crash. As more kinetic energy must be absorbed during a high-speed impact, there is a higher risk of injury should a crash occur.

Speed management is a very important tool for improving road safety. However, improving compliance with speed limits and reducing unsafe driving speeds are not easy tasks. Many drivers do not recognize the risks involved and often the perceived benefits of speeding outweigh the perceived problems that can result.

The management of speed remains one of the biggest challenges facing road safety practitioners around the world and calls for a concerted, long-term, multidisciplinary response. This manual advocates a strong and strategic approach to creating a safe road system, with speed management at its heart. Reducing motor vehicle speeds in areas where the road user mix includes a high volume of vulnerable road users such as pedestrians and cyclists is especially important.

Many low and middle-income countries have a serious, and in some cases worsening, road safety problem. A number of research projects have clearly identified inappropriate speed as being a particular problem. This manual provides advice and guidance for policy-makers and road safety practitioners in these countries and draws on the experience of a number of countries that have already initiated speed management programmes. Lessons from successful and non-successful initiatives are used to illustrate the advice provided.

The manual consists of a series of 'how to' modules. It provides evidence of why speed management is important and takes the user through the steps needed to assess the situation in their own country. It then explains the steps needed to design, plan and implement a programme, including how to obtain funding, set up a working group, develop an action plan and, if necessary, introduce appropriate legislation. It considers the potential role of measures involving engineering and enforcement, as well as using education to change speed related behaviour. Finally, the manual guides the user on how to monitor and evaluate the programme so that the results can be fed back into programme design. For each of these activities, the document outlines in a practical way the various steps that need to be taken.

In preparing the material for this manual, the writers have drawn on case studies from around the world to illustrate examples of 'good practice'. It is hoped that the modular structure of the manual means it can be read and easily adapted to suit the problems and needs of individual countries.

Introduction

Background to the series of manuals

In 2004 the World Health Organization (WHO) dedicated World Health Day – for the first time – to the topic of road safety. Events marking the day were held in over 130 countries – to raise awareness about road traffic injuries, stimulate new road safety programmes and improve existing initiatives. On the same day, the World Health Organization and the World Bank jointly launched the *World report on road traffic injury prevention*, highlighting the increasing epidemic of road traffic injuries. The report discusses in detail the fundamental concepts of road traffic injury prevention, the impact of road traffic injuries, the main causes and risk factors for road traffic crashes, and proven and effective intervention strategies. It concludes with six important recommendations that countries can take to improve their road safety record.

Recommendations of the *World report on road traffic injury prevention*

1. Identify a lead agency in government to guide the national road traffic safety effort.
2. Assess the problem, policies, institutional settings and capacity relating to road traffic injury.
3. Prepare a national road safety strategy and plan of action.
4. Allocate financial and human resources to address the problem.
5. Implement specific actions to prevent road traffic crashes, minimize injuries and their consequences, and evaluate the impact of these actions.
6. Support the development of national capacity and international cooperation.

The report emphasizes that the growing global problem of road traffic injury can be reduced through the system-wide, multi-sectoral implementation of proven road safety interventions that are culturally appropriate and locally tested. In its fifth recommendation, the report makes it clear that there are several 'good practice' interventions, already tried and tested, that can be implemented at low cost in most countries. These include strategies and measures that address some of the major risk factors for road traffic injuries through:

- setting laws requiring seat-belts and child restraints for all occupants of motor vehicles
- requiring riders of motorcycles to wear helmets
- establishing and enforcing blood alcohol concentration limits
- setting and enforcing speed limits
- managing existing physical road infrastructure to increase safety
- improving vehicle safety.

A week after World Health Day on 14 April 2004 the United Nations General Assembly adopted a resolution calling for greater attention and resources to be directed towards road safety efforts. The resolution recognized that the United Nations system should support efforts to tackle the global road safety crisis. At the same time, it commended WHO and the World Bank for their initiative in launching the *World report on road traffic injury prevention*. It also invited WHO, working in close cooperation with the United Nations Regional Commissions, to act as coordinator on road safety issues within the United Nations system.

Following the mandate conferred on it by the United Nations General Assembly, since the end of 2004 WHO has helped develop a network of United Nations and other international road safety organisations – now referred to as the 'United Nations Road Safety Collaboration'. The members of this group have agreed on common goals for their collective efforts and are focusing attention on the six recommendations of the *World report on road traffic injury prevention*.

A direct outcome of this collaboration has been the setting up of an informal consortium consisting of WHO, the World Bank, the FIA Foundation for the Automobile and Society and the Global Road Safety Partnership (GRSP). This consortium is working to produce of a series of 'good practice' manuals covering the key issues identified in the *World report on road traffic injury prevention*. The project arose out of the numerous requests to WHO and the World Bank from road safety practitioners around the world asking for guidance in implementing the report's recommendations.

The manuals are aimed at governments, non-governmental organizations and road safety practitioners. Written in an accessible way, they provide practical steps on how to implement each recommendation in line with good practice, while making clear the roles and responsibilities of all those involved. The manuals are based on a common template. Although primarily intended for low and middle-income countries, the manuals can apply to a range of countries and are adaptable to different levels of existing road safety. Each manual includes case studies from both developed and developing countries.

The World report on road traffic injury prevention advocates a systems approach to road safety – one that addresses the road, the vehicle and the user. Its starting point is the belief that to tackle road traffic injuries effectively, responsibility needs to be shared between government, industry, non-governmental organizations and international agencies. Furthermore, to be effective, road safety must have commitment and input from all the relevant sectors, including those of transport, health, education and law enforcement. These manuals reflect the views of the report; they also advocate a systems approach and – following the principle that road safety should be pursued across many disciplines – they are targeted at practitioners from a range of sectors.

Background to the speed management manual

Why was the manual developed?

Speeding (i.e. driving above the speed limit) and inappropriate speed (driving too fast for the conditions, which relates to the driver, vehicle, road and traffic mix rather than the speed limit) are almost universally recognized as major contributory factors in both the number and severity of traffic crashes. In many countries, speed limits are set at levels that are too high for the roadside conditions and the mix and volume of road users, particularly where there are many pedestrians and cyclists. Safe travel conditions cannot be achieved in these circumstances. Speed management policies and programmes will play a key role in any effort to improve a country's road safety record.

The management of drivers' speed involves a wide range of measures including setting and enforcing speed limits, engineering measures designed to reduce speeds, and public education and awareness campaigns. Many countries also require speed limiters be fitted to vehicles such as buses and lorries. There is now a vast library of information available on the subject of speed management (and traffic 'calming') so the question of 'what to do and where' can be daunting. This manual presents good practice on speed management, and offers a framework that can be adapted to local conditions.

The manual was written to inform and support policy-makers and road safety practitioners involved in developing and implementing road safety and speed management programmes in low and middle-income countries. It is one of a series of easy-to-use resources providing practical advice on the steps necessary to improve overall road safety record.

Target audience

Although aimed specifically at low and middle-income countries, this manual has something to offer all countries working to improve their safety record. It aims to help all road safety practitioners, whether working for government or non-governmental organizations. The list of users will vary according to the country, but will certainly include:

- policy-makers and decision-makers in parliaments, ministries, local authorities and road authorities
- members of the judiciary
- politicians
- police officers
- highway engineers
- road safety and public health professionals
- transport managers

- manufacturers of vehicles, motorcycles and bicycles
- employers in the public and private sectors
- insurance industry personnel
- school and college teachers
- researchers on road safety
- driving and road safety instructors.

What does this manual cover and how should it be used?

Managing vehicle speeds is complex and difficult, partly because of the number of opposing factors that need to be overcome. This manual looks at how successful speed management programmes draw on a range of different strategies to do this, including engineering works, setting speed limits, enforcement and public education. For each of these strategies the manual explains the necessary steps, and how they need to be co-ordinated. It explores how political commitment is needed if any substantial programme of change to current travel speeds is to be introduced and supported.

Any new or improved speed management programme will be influenced to a great extent by the systems and programmes already in place. This manual helps users identify which steps are relevant to their particular situation, and then provides practical advice about how to implement them. As well as focusing strongly on engineering and technical measures, the manual also describes the legislative and institutional structures that need to be in place for a programme to be sustainable and successful.

This is a road safety manual, and therefore does not address speed related pollution and energy consumption. It can be noted, however, that in broad terms, reducing vehicle speeds generally offers benefits in terms of less pollution and reduced energy consumption, as well as fewer injuries.

What is covered?

The manual addresses all aspects of speed management, from administration (e.g. legislation and setting of speed limits) to more practical ways of achieving compliance (e.g. engineering, enforcement and education). It is strongly recommended that a balanced programme encompassing all available measures is used. 'One-track' solutions are unlikely to be effective.

The technical content of this manual is divided into five modules, briefly described below.

- **Module 1** addresses the general and specific links between speed and road risk, and the need for interventions that manage speed to reduce the number and severity of traffic crashes. It introduces the *Safe-system* approach to improve road safety and discusses its reliance on achievement of safe travel speeds across road networks.

- **Module 2** guides the user through the process of assessing a country's current situation with respect to speed limits and speeding. It outlines the data needed for a good diagnosis, and how these data can be used to set realistic targets and priorities for a programme.
- **Module 3** describes the tools available for use in a successful speed management programme. It begins by explaining how to classify roads by function before determining how to set speed limits. It covers the range of engineering, enforcement and education tools and practices for speed management, providing advice on the benefits that can be expected from each. The module includes sections on what legislation is desirable, how to improve compliance, and establishing appropriate marketing and publicity strategies. Educational interventions are also discussed, as well as the role of employers in speed management.
- **Module 4** discusses how to develop and run a speed management programme. This includes setting up management and consultation arrangements, securing community and political support early on, and choosing from the range of tools described in Module 3. It shows how to decide on the most effective tools for achieving objectives, given the assessment of the problem as advised in Module 2.
- **Module 5** provides a simple framework for evaluating road safety and speed management programmes. The module shows how to use research to guide the development of the speed management programme, monitor progress and evaluate outputs, impacts and outcomes. It discusses the process of identifying the aims of the evaluation, considers different types of evaluation, how to select the most appropriate method of evaluation, and choosing the performance indicators. The module also discusses the need to disseminate evaluation results to inform other stakeholders

Case studies, in the form of boxed text, are included throughout the manual. These examples have been chosen to illustrate processes and outcomes, with experiences from a wide range of countries. Less detailed 'notes' are also included as boxed text to illustrate briefer points of interest. At the end of each module is a summary and references section.

How should the manual be used?

The manual is not intended to be prescriptive, but rather adaptable to particular needs.

The technical modules contain flowcharts and checklists to help readers determine where their country stands with regard to the problem of excessive speed, and to take the steps that will offer the greatest potential for improvement. The modular structure of the manual is intended to help this process, separating the different elements of the programme.

Although different parts of the manual will be relevant to different stakeholders and practitioners, it would be beneficial if all those involved could be aware of the contents of the whole document so they can understand how their role fits into the overall programme. All users will probably benefit from reading Module 2, enabling them to assess their situation and to choose particular actions. The choices made at this point will decide which of the remaining sections are useful. For example, a country with little enforcement could decide that this element has a high priority, but importantly recognize the role that education and publicity play in maximising the effect of police activity.

We encourage users to adapt the manual to local conditions: this means it may need to be translated and that sections of it may need to be altered to suit the local environment. We would appreciate feedback on users' experiences in this process.

What are the manual's limitations?

This manual is not meant to be comprehensive. It draws upon the experience of its contributors from around the world to identify practical and effective steps that can be taken on speed management, and thus reflects the views of those involved in its production. There may well be successful interventions followed by other countries that are not covered here. Similarly, the case studies – used to illustrate processes, good practice and practical constraints – are not exhaustive but merely illustrate points made in the main text.

The manual is not intended to be an academic document or an exhaustive 'state of the art' review. The references it contains are those that were found useful in its development, or that can provide more in-depth information, if required, for the reader.

How was the manual developed?

The manual is based on a standard template developed jointly by four partner organizations (the World Health Organization, the World Bank, the FIA Foundation for the Automobile and Society, and the Global Road Safety Partnership). The template was not meant to be rigid, but to provide a flexible structure which, where possible, would unify the planned set of manuals in their form and approach.

An advisory committee of experts from the different partner organisations oversaw the process of developing each manual and provided guidance on its content. The technical modules of the document were contracted out to organizations or individuals with particular expertise in the area. These people, in this case from Australia (ARRB), Sweden (VTI) and the United Kingdom (TRL), further developed the outline of their modules, reviewed the relevant literature and drafted the technical content, ensuring it reflected the latest scientific views on good practice. Invitations to submit case studies were sent by GRSP to many practitioners around the world. The draft document was subjected to peer review, and final review by advisory and editorial committees.

The technical content was peer reviewed by road safety practitioners, researchers and other experts from around the world. The draft document was then revised by GRSP to take account of the comments received, and passed for style editing.

Dissemination of the manual

This manual is being translated into a number of major languages, and countries are encouraged to translate it into local languages. The manual will be disseminated widely through the distribution channels of all four organizations involved in the series of manuals.

The manual is available in PDF format to be downloaded free from the websites of all partner organizations.

Visit GRSP's website at www.GRSProadsafety.org

How to get more copies

Further copies of the manual can be ordered by writing to:

Global Road Safety Partnership,
c/o International Federation of Red Cross and Red Crescent Societies,
PO Box 372,
17 Chemin des Crêts,
CH-1211, Geneva 19,
Switzerland

www.GRSProadsafety.org

Contact: grsp@ifrc.org

Partner organizations in the development of the manual

Global Road Safety Partnership (GRSP)

The Global Road Safety Partnership is a partnership between business, civil society and government dedicated to the sustainable reduction of death and injury on the roads in developing and transition countries. By creating and strengthening links between partners, GRSP aims to increase awareness of road safety as an issue affecting all sectors of society. GRSP seeks to establish sustainable partnerships and to deliver road safety interventions through increased resources, better coordination, management, greater innovation, and knowledge sharing both globally and locally.

GRSP is a hosted programme of the International Federation of Red Cross and Red Crescent Societies.

Address:
Global Road Safety Partnership,
c/o International Federation of Red Cross and Red Crescent Societies,
PO Box 372,
17 Chemin des Crêts,
CH-1211 Geneva 19,
Switzerland

www.GRSProadsafety.org

Contact person:
David Silcock, Chief Executive
Email: grsp@ifrc.org

World Health Organization (WHO)

As the United Nations specialized agency for health, the World Health Organization aims to integrate road safety into public health programmes around the world in order to reduce the unacceptably high levels of road traffic injuries. A public health approach is used, combining epidemiology, prevention and advocacy. Special emphasis is given to low and middle-income countries where most road traffic crashes occur. In recent years WHO has focused its efforts on the implementation of the recommendations contained in the *World report of road traffic injury prevention*, which it co-produced with the World Bank, and in particular on addressing the main risk factors for road traffic injuries. Following a United Nation's General Assembly resolution on road safety, adopted in 2004, WHO acts as a coordinator for road safety initiatives within the United Nations system, and to this end has facilitated the development of the United Nations Road Safety Collaboration – a group of over 40 international road safety organizations, including many United Nations agencies. This coordinating role was further endorsed by a fourth UN General Assembly resolution, adopted in 2005.

Address:
World Health Organization,
20 Avenue Appia,
CH-1211 Geneva 27,
Switzerland

www.who.int/violence_injury_prevention/en/

Contact person:
Margie Peden, Coordinator, Unintentional Injury Prevention,
Department of Injuries and Violence Prevention
Email: traffic@who.int

World Bank

The World Bank promotes the improvement of road safety outcomes in low and middle-income countries as a global development priority. It provides financial and technical support to countries, working through government agencies, non-governmental organizations, and the private sector to formulate strategies to improve road safety. The World Bank's mission is to assist countries in accelerating their implementation of the recommendations of the *World report on road traffic injury prevention,* which it developed jointly with the World Health Organization in 2004. To achieve this, it emphasizes country capacity-building, and the development of global partnerships, with a focus on the achievement of measurable road safety results.

Address:
World Bank,
1818 H Street,
NW, Washington DC 20433,
USA

www.worldbank.org/transport/roads/safety.htm

Contact person:
Anthony Bliss, Lead Road Safety Specialist, Transport Division
Energy, Transport and Water Department
Email: abliss@worldbank.org

FIA Foundation for the Automobile and Society

The FIA Foundation for the Automobile and Society is a registered UK charity with the objectives of promoting public safety and public health, the protection and preservation of human life, and the conservation, protection and improvement of the physical and natural environment. Since its establishment in 2001, the FIA Foundation has become a prominent player in promoting road safety around the world. It conducts advocacy to raise awareness about the growing epidemic of road traffic injuries, and to place road safety on the international political agenda. It promotes research and the dissemination of results to encourage best practice in road safety policy, and offers financial support to third party projects through a grants programme.

Address:
FIA Foundation,
60 Trafalgar Square,
London,
WC2N 5DS,
United Kingdom

www.fiafoundation.com

Contact person:
David Ward, Director General
Email: d.ward@fiafoundation.com

1

Why focus on speed?

Why focus on speed?

This module provides background information on why speed is a risk factor in road traffic crashes and injury, and the importance of tackling it with a range of different measures. In order to successfully promote, design and implement a speed management programme, it is important to understand the role of speed in road traffic crashes, and the relationship between speed and the severity of those crashes. Such information is important in persuading political leaders, stakeholders and the public to support a speed management programme.

The module is divided into two sections:

1.1 Road traffic crashes and injury involving speed: This section describes the nature of crashes and speed related injury. It demonstrates how unsafe motor vehicle speeds can increase both the risk of a collision and the severity of injury to crash victims. The impact of speed on vulnerable road users, particularly in developing countries, is described. Reasons why people drive at unsafe speeds are discussed.

1.2 What is speed management? This section discusses the definition of speed management – an active approach that requires (or persuades) drivers to adopt speeds that offer mobility without compromising safety. The *Safe-system* approach aims to achieve a road transport system that anticipates and allows for human error, while minimising the risk of death or serious injury. Benefits of speed management are discussed, and the impact of even small reductions in speed on safety is described.

This manual does not suggest that higher speeds cannot be beneficial. Shorter journey times can provide economic benefits and increased mobility. But policy-makers must trade these benefits against the increased costs of death and injury that might occur. This manual presents the road safety case for speed management, and offers practical advice on how to manage speeds in order to deliver road safety benefits.

This manual does not consider speed related noise or air pollution, or energy consumption. Although these issues are important, they are beyond the scope of this manual.

1.1 Road traffic crashes and injury involving speed

1.1.1 Speed, energy transfer and injury

Speed has been identified as a key risk factor in road traffic injuries, influencing both the risk of road traffic crashes and the severity of the injuries that result from them *(1, 2, 3)*. Higher speeds lead to a greater risk of a crash and a greater probability of serious injury if one occurs. This is because, as speed increases, so does the distance travelled during the driver's reaction time and the distance needed to stop. Also, at speed, the effects of drivers' errors are magnified. In a crash, the higher the speed the greater the amount of mechanical (kinetic) energy that must be absorbed by the impact. Hence, there is more likelihood of serious injury.

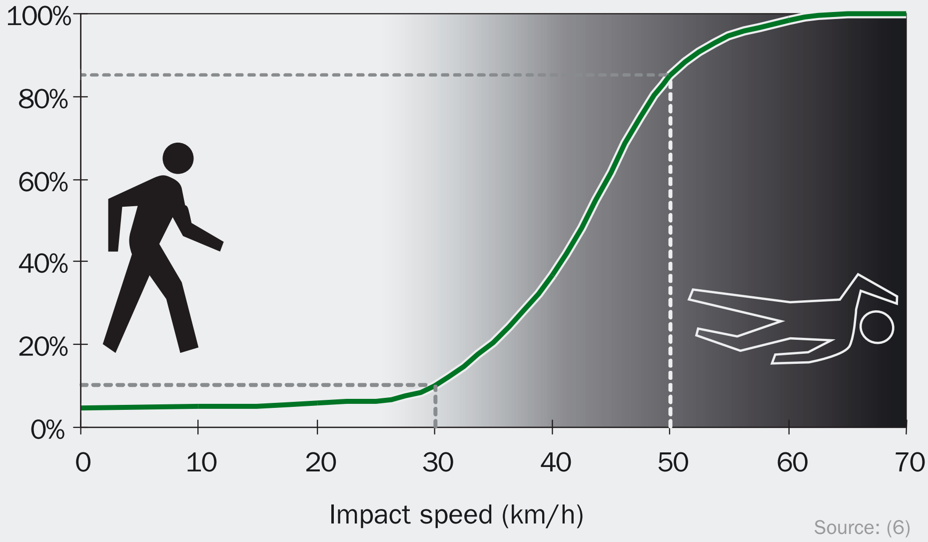
According to research *(1, 2)*, harmful injury is the result of 'energy interchange'. During a collision, injury results from the transfer of energy to the human body in amounts and at rates that damage cellular structure, tissues, blood vessels and other bodily structures. This includes kinetic energy, for example when a motor vehicle user's head strikes the windshield during a crash. Of the various forms of energy – kinetic, thermal, chemical, electrical and radiation – kinetic energy transfer is the biggest contributor to injury. It is useful for road traffic injury prevention researchers and practitioners to understand the biomechanics of kinetic energy injuries. This will help them develop measures that will limit the generation, distribution, transfer and effect of this energy during a road traffic collision *(2)*.

Regardless of whether the kinetic energy is generated by a motor vehicle crash, a gunshot or a fall, the force to which human tissue is subjected on impact is the product of the mass and velocity involved. The kinetic energy to be absorbed equals one half of mass multiplied by the square of velocity – illustrating that the effect of velocity is greatly enhanced as velocity increases. The level of damage to the body will depend on the shape and rigidity of the colliding surface or object, but velocity usually plays the most critical role *(4)*.

In a crash, it is physically impossible for any occupant to securely hold an unrestrained object, such as a child. In a collision of just 50 km/h, the child's weight will effectively increase by 20 times and a 5 kg baby will appear to weigh 100 kg within a split second. Source: *(5)*.

Vulnerable road users such as pedestrians, cyclists, moped riders and motorcyclists have a high risk of severe or fatal injury when motor vehicles collide with them. This is because they are often completely unprotected or, in the case of a motorcyclist, have very limited protection. The probability that a pedestrian will be killed if hit by a motor vehicle increases dramatically with speed. In Figure 1.1 the probability of a fatal injury for a pedestrian colliding with a vehicle is illustrated. The research indicates that while most vulnerable (unprotected) road users survive if hit by a car travelling 30 km/h, the majority are killed if hit by a car travelling at 50 km/h *(6)*.

Figure 1.1 **Probability of fatal injury for a pedestrian colliding with a vehicle**



Source: (6)

In the majority of serious and fatal crashes, injuries are caused because loads and accelerations – exceeding those that the body can tolerate – are applied by some part of the car *(7)*. The human tolerance to injury by a car will be exceeded if the vehicle is travelling at more than 30 km/h. Pedestrians, as illustrated above, incur a risk of about 80% of being killed at a collision speed of 50 km/h. For car occupants, wearing seat-belts and using well-designed cars generally can provide protection to a maximum of 70 km/h in frontal impacts, and 50 km/h in most side impacts *(8)*. Higher speeds could be tolerated if the interface between the road infrastructure and vehicle were well designed and crash protective – for example, by the provision of crash cushions on sharp ends of roadside barriers. However, most road systems allow much higher speeds without the protective barriers between vehicles and roadside objects.

The unpredictable nature of human behaviour in a complex traffic environment means it is unrealistic to expect that all crashes can be prevented. But if greater attention were given to the tolerance of the human body to injury when designing the transport system, there could be substantial benefits when crashes do occur, meaning they might not lead to serious injury or death. Most traffic systems, however, are not designed on the basis of human tolerance. Separating cars and pedestrians by providing footways is very often not done. Speed limits of 30 km/h in shared-space residential areas are often not implemented. Historically, car and bus fronts have not been designed to provide protection for pedestrians against injury at collision speeds of 30 km/h or more.

1.1.2 How does speed affect road traffic collisions and injury?

Most road safety experts agree that the single most important contributor to road fatalities around the world is poor speed selection, commonly interpreted as the use of inappropriate vehicle speeds, or 'speeding'.

NOTE

Definition of speeding

It is useful to establish a working definition of 'speeding' for the purposes of police assessment of the role of speed in a crash.

The definition for general application in this manual is drawn from OECD, ECMT (2006) which is: "Speeding encompasses *excessive* speed (driving above the speed limit) or *inappropriate* speed (driving too fast for the conditions, but within the limits)."

Source: *(6)*

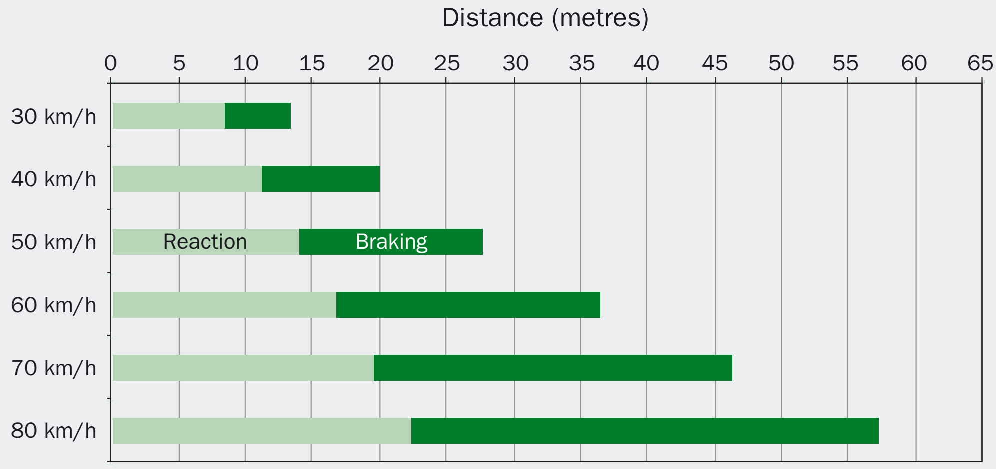
Higher speeds increase the risk of a crash for a number of reasons. It is more likely that a driver will lose control of the vehicle, fail to anticipate oncoming hazards in good time and also cause other road users to misjudge the speed of the vehicle. It is clear that the distance travelled in a given time – and so the distance travelled as a driver or rider reacts to an unsafe situation on the road ahead – is greater for travel at a higher speed. In addition the stopping distance for a vehicle, after a driver reacts and brakes, will be longer at a greater travel speed.

Studies have shown that reaction time can be a little as one second, but in one trial *(9)* it was found that most response times were between 1.5 and 4 seconds. The consequences of such factors are illustrated in Figure 1.2.

The figure shows driver reaction distances and braking distances in metres to illustrate what can happen if a child runs out into the road at a point about 13 metres in front of a car. If the car is travelling at 30 km/h it can just stop before hitting the child, but if the speed of the car is 50 km/h, the distance covered in the driver's reaction time (14 metres) is more than the distance to the child. Consequently, the child will be hit by the car travelling at 50 km/h and the chances of it surviving are small.

Excessive and inappropriate speed is the biggest road safety problem in many countries *(6)*. While identifying contributory factors in traffic crashes can be somewhat subjective, there are surveys *(10)* and studies *(11)* that suggest that as much as one-third of collisions resulting in a fatality involve an element of excess speed. Speed is an aggravating factor in all crashes.

Figure 1.2 Illustration of the stopping distance in an emergency braking



Source: (6) adapted from the Australian Transport Safety Bureau

CASE STUDY: **Speed related crashes, New Zealand**

Frith et al *(11)* attributed 31% of all fatalities and 17% of all serious injuries in New Zealand to speeding in the year 2002, based on police judgements. They further stated that these levels were likely to under-estimate the full impact of speed on crashes and crash severity, given that speed contributes to the severity of crash outcomes regardless of the cause.

They indicated that as a broad estimate, if the average speed on New Zealand's rural roads were reduced by just 4 km/h, the total number of road crash deaths would decrease by about 15% and the total number injured by about 8% – meaning that about 45 deaths and 480 reported injuries would be avoided (the difference between the fatal and serious injury proportions reflects the greater impact of any speed reduction on the most severe injuries).

NOTE

Small increases in speed result in large increases in crash risk

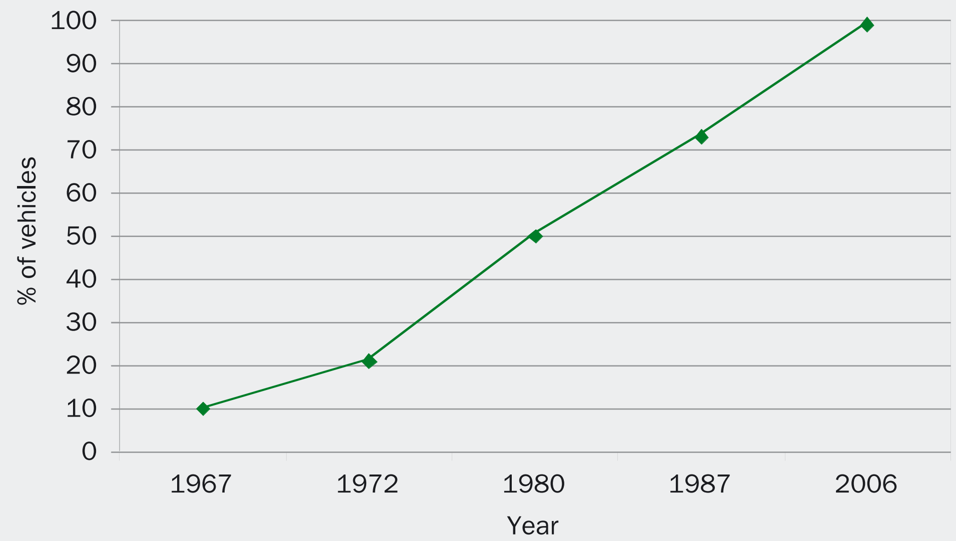
Studies provide direct evidence that speeds just 5 km/h above average in 60 km/h urban areas, and 10 km/h above average in rural areas, are sufficient to double the risk of a casualty crash – roughly equivalent to the increase in risk associated with a blood alcohol concentration of 0.05 g/100 ml (the blood alcohol limit for driving in many countries). The evidence also indicates that 'moderate speeding' (within 10 or 15 km/h of the posted limit), makes a large contribution to serious road crashes – comparable to the contribution of more extreme speeds – because it is so common.

Source: *(12, 13)*

The problem of speeding has increased over the years since the maximum speed that new cars are capable of is, in many cases, double the existing speed limit in rural areas. Many modern cars now are easily capable of speeding, which was typically not the case when speed limits were first introduced. It is therefore more of a challenge to convince drivers to drive within posted speed limits.

As Figure 1.3 demonstrates, the development of engine technologies over the past 40 years has resulted in most cars having a top speed well in excess of maximum speed limits *(6)*. This presents challenges in managing travel speeds to within limits for both high-level and low-level speeders.

Figure 1.3 Percentage of vehicles sold in France capable of travelling more than 150 km/h



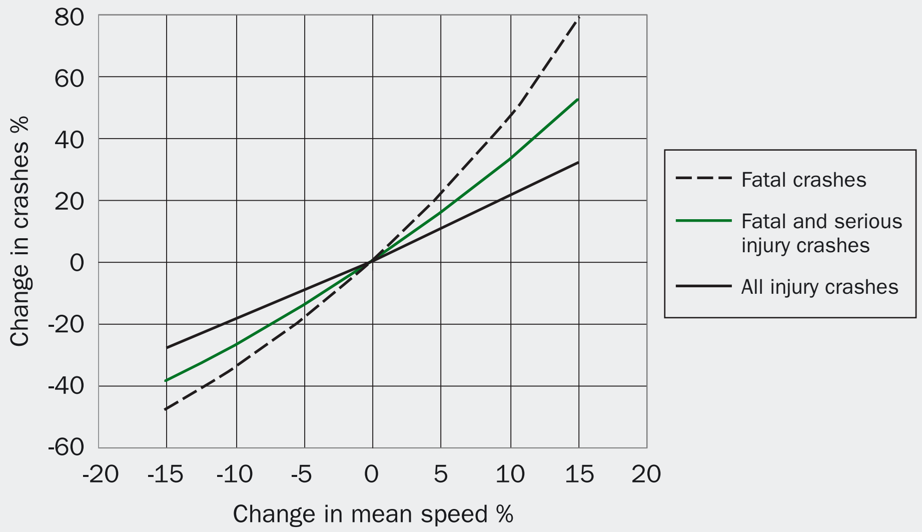
CASE STUDY: **Effect of changes in speed limits**

A review of the studies on speed limit changes from several countries (South Africa, Belgium, Finland, France, UK, Germany, USA and New Zealand) where a speed limit was reduced or a new limit was introduced found a reduction in road crashes ranging from 8% to 40% *(14)*.

Research in America *(15)* examined the effect of changes in speed limits on deaths on rural interstate highways. Road crash deaths in the groups of states that raised their speed limits from 65 to 70–75 mph rose by 38% and 35% respectively, relative to fatality levels in the states that did not change their speed limits.

There is a sizeable body of research from around the world (but mainly conducted in higher income countries) that clearly demonstrates the relationship between speed and risk *(16, 17, 18)*. There is a consistent finding from the research that greater speed increases crash, injury, and fatality rates, and that decreasing speed reduces these rates. One example is the *Power model (19)* that estimates the effects of changes in average speed on traffic crash incidence and severity. It suggests that a 5% increase in average speed leads to an approximate 10% increase in crashes involving injury, and a 20% increase in those involving fatalities (Figure 1.4).

Figure 1.4 Illustration of the *Power model* and the relationship between percentage change in speed and the percentage change in crashes



This relationship results both from the laws of physics and the cognitive abilities of the driver/rider to deal with unexpected (but often predictable) circumstances. With higher speeds, the impact speed in a crash increases, as do the forces that the vehicle and occupants must absorb. Higher speeds also mean that road users have a lesser opportunity to take preventive actions.

CASE STUDY: **Raising and lowering the national speed limit, USA**

Between 1987 and 1988, 40 states in the USA raised the speed limit on interstate highways from 55 mph (88 km/h) to 65 mph (104 km/h). This resulted in an increase in average car speeds of about 3 mph (5 km/h). Over the same period there was an increase in deaths on these roads of between 20 and 25%.

Source: *(20)*

1.1.3 What factors contribute to speeding?

There are many reasons why individual drivers speed. Travelling at higher speeds offers the immediate 'reward' (as a perception, if not in practice) of a shorter journey time. This benefit is reinforced every time a driver undertakes a journey and travels above the speed limit without any adverse consequence. Importantly, while speeding is involved in a very high percentage of serious and fatal road crashes, from an individual driver's point of view, the chance of having a serious crash as a result of exceeding the speed limit is quite low, so the speed-crash threat may be less of a consideration by drivers compared with the speed-penalty threat.

The circumstances of individual trips can influence a driver's choice of speed. For example, if the vehicle is owned by an employer, the driver may be tempted to drive at higher speeds. When an individual is under pressure or feels the need to rush, unsafe speeds may be selected. Sometimes drivers and riders speed just for fun.

Drivers will frequently claim that they were unaware of the speed limit, hence the need for adequate signs, even though ignorance is no defence. Importantly, some researchers believe that people always tend to optimize the level of risk behaviour they engage in, such that they choose to drive faster on 'safer' roads, especially if they perceive little risk of enforcement activity. Others *(21)* have found that driving fast gives a sense of thrill or achievement.

Most drivers consider themselves above average in terms of skill. A number of surveys conducted in various countries around the world *(21)* demonstrate that up to 90% of drivers think they are an above average, low-risk driver. For that reason, drivers believe they can travel above the limit and not place themselves at high risk. In any event, many regard the limits as arbitrary and do not fully understand the greater risks associated with even small increases in speed.

Additionally an important factor in many countries is pressure that is applied by fleet managers and employers to be more productive (i.e. drive faster) while public transport operators and the drivers themselves come under pressure to stick to challenging timetables, and even race to pick up passengers and goods.

Increasing motorization

With greater motorization and economic development there is an increasing demand to build roads to a higher standard in order to reduce journey times and congestion. This means higher speeds – but with higher speeds the numbers and severity of accidents will increase for all types of road user unless appropriate action is taken. The *World report on road traffic injury prevention (22)* illustrates these general trends and makes estimates based on them. These show that, while fatalities in high-income countries will fall by 27% over the period 2000–2020, globally there will be an increase of 67%. In south Asia, this increase is predicted to be 144%.

CASE STUDY: **Commercial drivers pressured to speed and 'race', Ghana**

Comments from taxi/bus drivers were obtained from surveys conducted in 2007 by Ghana's TV Channel 2 and the National Road Safety Commission:

- "We drive at high speeds."
- "There is no enforcement of speeding."
- "Because of the high sales targets, we are under pressure. You can't do anything. You are always thinking of loading."
- "It may take two hours just to get to the (city) barrier so some lose their patience and start speeding."
- "The law at the (bus) station is that if two 'cars' pass you, you have to start again (i.e. lose your place in the queue), but the owner does not understand this, hence we are always under pressure."*

* At the bus/taxi stations, drivers queue up for passengers in order, departing only when full. The drivers try to keep this order en route. However, if a bus is overtaken on the road by at least two of the buses that were originally behind him, he loses his position and is pushed two places back in the queue at the next bus station. This means further delay before the bus is full and ready to set off again. This results in speeding and racing, because pay is dependent on number of trips and the number of passengers carried.

1.2 What is speed management?

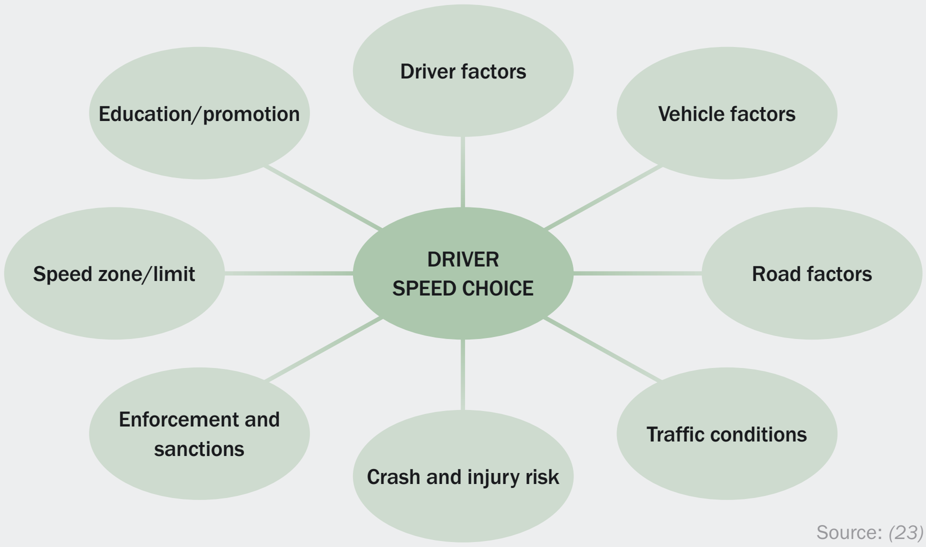
Speed management encompasses a range of measures aimed at balancing safety and efficiency of vehicle speeds on a road network *(6)*. It aims to reduce the incidence of driving too fast for the prevailing conditions, and to maximize compliance with speed limits. An appropriate speed, in the context of a *Safe system*, is a speed level that considers traffic safety as the main goal, in the context of mobility and prevailing conditions such as roadside development, the mix of users along the road, the frequency of access to the road (including intersections), the volume and mix of traffic, environmental concerns and the quality of life for residents living along the road.

1.2.1 Aims of speed management

Speed management aims to reduce the number of road traffic crashes and the serious injury and death that can result from them. Speed management needs to employ a range of measures that will include enforcement, engineering and education. The more widespread the measures, particularly enforcement, and the greater the range, severity and implementation of sanctions against speeding, the more compliance will result. To achieve wide public acceptance of enforcement, speed limits need to be appropriate – and recognized as such by the public.

In considering how to influence speed, it is of value to be aware of factors affecting drivers' choice of speed, as illustrated in Figure 1.5.

Figure 1.5 Factors affecting speed choice



Source: *(23)*

Speed limit selection is a critical indicator of the safe speed for that section of road. This imposes a substantial responsibility on the limit-setting authority. In setting appropriate speed limits it is useful to have the following information for the section of road under review:

- speed measurements
- measurements of traffic flow and mix
- traffic crash data
- information from the police on speeding offences
- the design speed and criteria used to build or rehabilitate the road
- land use and property access adjoining the road
- physical characteristics of the road and roadside
- presence of vulnerable road users.

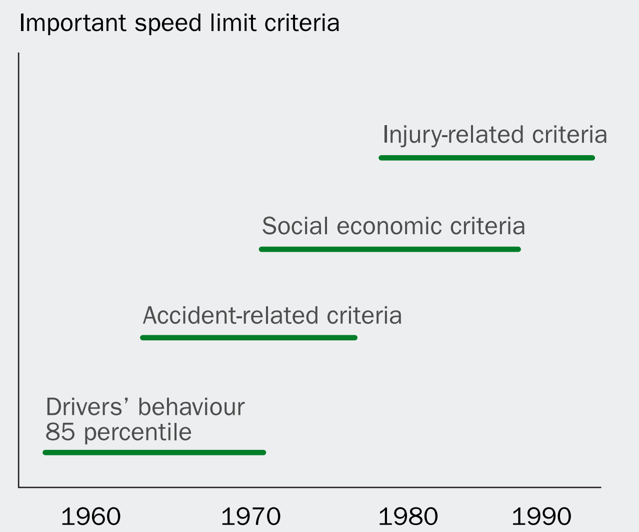
This information will be useful in comparing proposed limits with the current travel speeds (including the speed distribution) and crash rates. The purpose is to identify the scale of the change in travel speed necessary for safe operation, and to identify the measures necessary to achieve this.

Without substantial, and often expensive, traffic calming works, it is necessary to recognize that speed limits without enforcement and enforcement without suitable sanctions usually result in ineffective speed management. Consequently, speed enforcement and sanctions will generally always be needed to ensure compliance with speed limits.

1.2.2 Setting speed limits

Speed limits are widely used to define acceptable speeds. They provide a basic indicator to road users of the maximum speed allowed under the law. In this sense, they can be described as representing a society's judgement, through the legal process, of the balance between the various issues surrounding speed choice. Speed limits have evolved over time as societies have set different priorities for their road system. Figure 1.6 describes this evolution in Sweden.

Figure 1.6 Major factors determining speed limits, Sweden, 1960–1990



Source: *(24)*

In the 1960s limits were set largely to reflect drivers' behaviour and using the 85th percentile speed – in effect saying drivers were making rational choices and only those in the minority 15% would be judged as 'speeding'. As analyses of crash data revealed a growing speed related problem, limits were set that took into account road design factors (sight distance, road curvature and so on). Economic trade-off then was introduced. With cost-benefit analysis of road projects using estimates of the 'value of time' savings to justify investment, there was a natural trend towards faster roads. Finally, with the current philosophy of *Vision zero*, the Swedish parliament has said that avoiding death and injury is an absolute priority, and the speed management system as a whole must be based on this philosophy.

There are no absolute rights and wrongs in selecting limits. It is for a government to determine its priorities, which most likely will change as a society develops. It is undeniable, however, that if a government wishes to reduce the death and injury toll in a country, then the *Safe-system* approach is the way to go. Such a system cannot be achieved overnight, but by accepting the principles, and applying them as infrastructure, laws and enforcement develop, so the numbers and severity of crashes will be reduced. Section 3.1 discusses good practice regarding setting speed limits in this context.

It should be noted that speed limits on their own will have only modest effects on actual speeds. A study cited in the OECD/ECMT report *(6)* shows that, in places where speed limits are changed and no other actions such as law enforcement are taken, the change in average speed is only 25% of the change of the speed limit. Other information shows that if speed limits are changed either upwards or downwards by 10 km/h, the change in average speed is only 2–4 km/h. While these changes can improve safety records, it is important to have an effective enforcement strategy when dealing with the issue of speed *(16)*.

1.2.3 Safe systems and the role of speed

In all regions of the world, to prevent road death and disabling injury, a traffic system better adapted to the physical vulnerabilities of its users needs to be created – with the use of more crash-protective vehicles and roadsides. The *Safe-system* approach, as exemplified by *Vision zero* (Sweden), *Sustainable safety* (Netherlands) and *Safe system* (Australia) *(25, 26, 27, 28, 12)* should set the framework for the long-term management of speeds on a nation's roads. Figure 1.7 illustrates the *Safe system* in conceptual terms.

The aim of a safe system is to achieve a road system that allows for human error without leading to death or serious injury. It recognizes the limits of force that the human body can survive and focuses on systematically addressing various factors involved in specific crash types to reduce the risk of injury. Crashes are always likely to happen, even though there is a continuing focus on prevention. The *Safe-system* approach aims to minimize the severity of injury when a crash occurs and is based on the premise that road users should not die because of system failings.

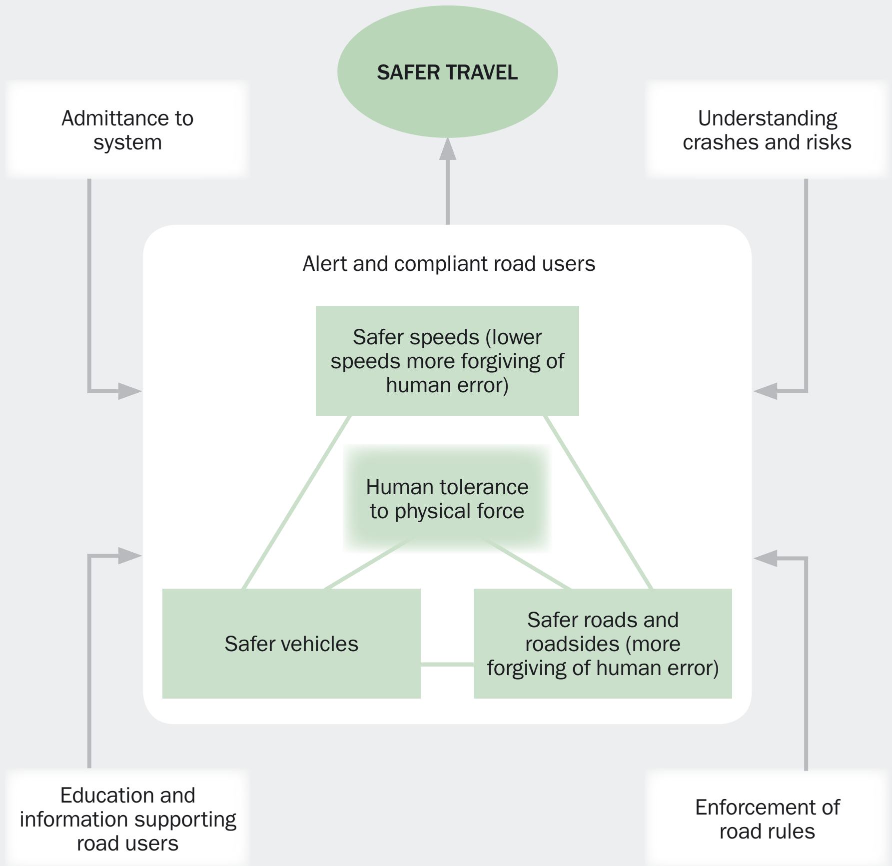
One important cornerstone in the *Safe-system* context is that the care of human life and health is considered to be more important than anything else. This is clearly expressed within *Vision zero (25, 26)* where an ethical approach to road safety is taken. The long-term goal is that no one should be killed or seriously injured in road traffic. The moral basis of *Vision zero* corresponds to the views often already adopted in connection with rail, sea or air travel.

The consequences for speed management of adopting a *Safe-system* approach result in, for example:

- a 30 km/h speed limit being used in built-up areas where there is a mix of vulnerable road users and motor vehicle traffic

- a reduction in the likelihood of fatal side-impact crashes at intersections (it is often preferable to build a roundabout instead of installing traffic lights, and it is advisable to limit approach speeds to less than 50 km/h)
- a reduction in the likelihood of fatal head-on crashes on two-way single carriageway roads (median barriers should be used with high volumes of traffic, or speed limits should be kept below 70 km/h).

Figure 1.7 A *Safe-system* model



Source: *(12)*

It should be the aim of low and middle-income countries first to stabilize any worsening situation, and second to create road safety policies rooted in 'good practice' as demonstrated by better-performing countries. *Safe-system* thinking can contribute to the immediate needs of low and middle-income countries and, as for all countries, to more rapid, long-term road safety improvement.

The *Safe-system* approach requires system managers to understand crash causes in order to assess crash risk. It is critical that the key risk factors that contribute significantly to crashes are identified and understood. To assist this aim, accurate crash and injury data collection and analysis systems need to be put in place if they do not already exist.

The key elements in the *Safe system* are:

- **To manage speed**
  Carefully targeted, wide-scale infrastructure programmes, vehicle safety improvements and enforcing appropriate speed limits will reduce the likelihood of crashes occurring and/or reduce their severity to survivable levels. For example, it is not feasible to lower speeds on rural roads to 50 km/h (the speed at which a side-impact collision would be survivable) if there are trees or poles adjacent to the roadway. The answer lies in removal of the hazards or installation of protective barriers. Other measures to reduce the likelihood of vehicle-control loss, or vehicles leaving the road, could also be considered, including provision of sealed shoulders and audible edge lining, together with vehicles being equipped with electronic stability control features. On the other hand, speed limits of 30–50 km/h in areas of higher pedestrian crash risk (from vehicles) will substantially reduce pedestrian fatality risks.

  These examples assume that road users are complying with road rules. However, the challenges inherent in deterring non-compliant behaviour are substantial, and in lower income countries improvements in training of new drivers and improved enforcement will all need to play a role.

- **Focus on the importance of vehicle safety**
  Improving a country's vehicle fleet offers major benefits, and as much as possible should be done to encourage the purchase and supply of safe vehicles. Today, most modern cars protect a seat-belted occupant up to about 70 km/h in a frontal collision *(22)* and up to about 50 km/h in side impacts. The European Transport Safety Council has estimated that if every car owner upgraded their vehicle overnight to the safest in its class, then fatalities on Europe's roads would drop by 40–50% *(29)*. It is likely that such a development in low and middle-income countries would result in far greater benefits.

  Improved pedestrian safety ratings for vehicles and improved object detection technology will also lead to lower severity of crash outcomes. The benefits of intelligent speed adaptation are now available to any country prepared to legislate for its provision in new vehicles, and to develop and maintain the necessary digital maps of speed limits. This is an important opportunity for major reductions in road trauma, but strong government leadership will be needed to bring it about.

- **Management of road and roadside/network safety**
  While ensuring that new roads provide improved levels of safety, the real challenge is how to set and enforce speed limits on the existing road network. If the speeds are too high because of the road standard (high crash-risk) and infrastructure solutions are not cost effective (because of, for example, low volumes/low crash numbers) there will be a need to lower and enforce the existing speed limits. However, the public needs to be made aware of why this is being done and how they will benefit from such changes.

1.2.4 Benefits of speed management

Promoting a successful speed management programme following a *Safe-system* approach clearly has many benefits. The most obvious one is of course the reduction in the number of deaths and injuries resulting from crashes *(6, 14)*.

The safety benefits of lowered travel speeds include:
- greater time to recognize hazards
- reduced distance travelled while reacting to hazards
- reduced stopping distance of the vehicle after braking
- increased ability of other road users to judge vehicle speed and time before collision
- greater opportunity for other road users to avoid a collision
- less likelihood that a driver will lose vehicle control.

Tables 1.1 and 1.2 show the importance of small changes in average speed in producing safety benefits. They show the estimated safety effect of a reduction of speed of 1 km/h and 2 km/h respectively, from different reference levels in percentage savings of different severities of crashes. The tables show that speed reductions have a greater effect for more severe crashes.

Table 1.1 **Application of the *Power model* for different reference speeds when the average speed is reduced by 1 km/h**

Percentage (%) reduction in crashes for 1 km/h reductions in average speeds

	Reference speed in km/h							
	50	**60**	**70**	**80**	**90**	**100**	**110**	**120**
All injury crashes	4.0	3.3	2.8	2.5	2.2	2.0	1.8	1.7
Fatal and serious crashes	5.9	4.9	4.2	3.7	3.3	3.0	2.7	2.5
Fatal crashes	7.8	6.5	5.6	4.9	4.4	3.9	3.6	3.3

Table 1.2 **Application of the *Power model* for different reference speeds when the average speed is reduced by 2 km/h**

Percentage (%) reduction in crashes for 2 km/h reductions in average speeds

	Reference speed in km/h							
	50	**60**	**70**	**80**	**90**	**100**	**110**	**120**
All injury crashes	7.8	6.6	5.6	4.9	4.4	4.0	3.6	3.0
Fatal and serious crashes	11.5	9.7	8.3	7.3	6.5	5.9	5.4	4.9
Fatal crashes	15.1	12.7	10.9	9.6	8.6	7.8	7.1	6.5

Source: *(18)*

The tables clearly show the importance of even small reductions in speed. However, achieving such changes in average speed often require great effort. One reason is that drivers' perceptions of a reasonable and acceptable speed tends to increase over time, because of faster cars and better roads. To achieve speed reductions in rural areas, public information activities and enforcement methods need to offset this development through increased effort and stronger sanctions.

CASE STUDY: **Reduced speed limit and safety outcomes, New Zealand**

During the 1973 fuel crisis, the New Zealand government reduced rural speed limits from 55 mph (88 km/h) to 50 mph (80 km/h), leading to an 8–10 km/h reduction in average rural speeds. The drop in speed led to a significant drop in injuries, as compared with urban roads which were unaffected by the speed limit change *(30)*. On main intercity roads the number of deaths dropped by 37%, serious injuries decreased by 24% and minor injuries decreased by 22%. The corresponding reductions for urban areas were 15%, 9% and 4%.

Many governments have demonstrated a reluctance to enforce limits effectively, as there is considerable public reaction to such measures. A commitment to support enforcement will be essential to achieving safe travel speeds by drivers.

CASE STUDY: **Changes in speed limits and crashes, Australia**

In Australia, the speed limit on Melbourne's rural and outer freeway network was increased from 100 km/h to 110 km/h in 1987 and then changed back to 100 km/h in 1989. Compared to a control area where the speed limit remained the same, the injury crash rate per kilometre travelled increased by 24.6% when the speed limit increased, and decreased by 19.3% when the speed limit decreased *(31)*.

Summary

- The risk of a crash and the likelihood of serious injury as a result of a crash both increase with higher vehicle speeds.
- Reducing speed limits lowers the rate of crashes, serious injuries and fatalities.
- Most unprotected road users survive if hit by a car travelling up to 30 km/h.
- Most unprotected road users are killed if hit by a car travelling 50 km/h.
- Speeding is a major road safety problem in many countries, contributing to at least one-third of all crashes, and is an aggravating factor in almost all crashes.
- Speed limits of 30km/h should be considered for road lengths where there are high pedestrian movements along and across the road, and no adequate pedestrian segregation.
- The *Power model* estimates the percentage change in risk as a result of a percentage change in average speed (the relative speed change). For example, a 5% increase in average speed leads to approximately a 10% increase of all injury accidents, and a 20% increase in fatal accidents.
- The aim of a safe road system is to achieve a road transportation system that allows for human error without it leading to death or serious injury.
- *Safe-system* thinking can contribute to the immediate needs of low and middle-income countries and, for all countries, to more rapid, long-term road safety improvement.
- Speed management is a central part of a *Safe system.* This consists of setting and enforcing appropriate speed limits, but also aims to convince drivers to choose appropriate speeds in the prevailing circumstances through education and publicity; it also advocates the selective use of engineering treatments.
- Without a strong, sustained public commitment to robust enforcement of speeds on the network by government, speed management programmes are unlikely to be effective.

References

1. Gibson JJ. The contribution of experimental psychology to the formulation of the problem of safety: a brief for basic research. *Behavioral Approaches to Accident Research,* 1961, 77–89. New York, Association for the Aid of Crippled Children.
2. Haddon W Jr. Energy damage and the ten countermeasure strategies. *The Journal of Trauma,* 1973, 13 (No.4) 321–331.
3. De Haven H. 'Mechanical analysis of survival in falls from heights of fifty to one hundred and fifty feet'. *War Medicine*, 1942, 6:586–596 (reprinted in *Injury Prevention*, 6:62–68).
4. Christoffel T, Gallagher S. *Injury Prevention and Public Health: Practical Knowledge, Skills, and Strategies*, 2nd edition, 2006.
5. Seat-belt campaign toolkit. London, FIA Foundation, 2004.
6. OECD/ECMT Transport Research Centre: *Speed Management report*, Paris 2006 (available in English and French).
7. Mackay GM. Reducing car crash injuries, folklore, science and promise. *American Association for Automotive Medicine,* 1983, No.5.
8. Tingvall C, Haworth N. *Vision zero: an ethical approach to safety and mobility.* Paper presented to the 6th Institute of Transport Engineers International Conference on Road Safety and Traffic Enforcement: Beyond 2000, Melbourne, 6–7 September 1999
9. Evans L. *Traffic Safety and the Driver*, USA, Van Nostrand Reinhold, 1991.
10. OECD/ECMT Transport Research Centre, *Country reports on safety performance,* results of a survey undertaken by the OECD/ECMT Working Group on Ambitious Road Safety Targets. (www.cemt.org/JTRC/index.htm).
11. Frith et al. Road safety impacts of excessive and inappropriate vehicle speed, *Austroads road safety handbook*, Vol. 2, 2005.
12. Australian Transport Council. *National Road Safety Action Plan 2007–2008.* (www.atcouncil.gov.au/documents/nrss_actionplan_0708.aspx)
13. Kloeden CN et al. *Travelling speed and the risk of crash involvement*. Canberra, Federal Office of Road Safety, CR172, 1997 (www.atsb.gov.au/publications/1997/pdf/Speed_Risk_1.pdf).
14. *Managing Speeds of Traffic on European Roads (MASTER) Final report European Commission.* Project of the 4th framework programme, 1998 (http://virtual.vtt.fi/master/).
15. Patterson, TL et al. The effects of increasing rural interstate speed limits in the USA. *Traffic Injury Prevention*, 2002.
16. Taylor MC et al. *The effects of drivers ' speed on the frequency of road accidents*. Crowthorne, Berkshire, UK TRL Report No. 421. Transport Research Laboratory (TRL), 2000.
17. Elvik R, Vaa T. *The handbook of road safety measures*. 2004, Amsterdam, Elsevier.
18. Aarts L, van Schagen I. Driving speed and the risk of road crashes: A review. *Accident, Analysis and Prevention*, 2006, 38:215–224.
19. Nilsson G. *Traffic safety dimensions and the power model to describe the effect of speed on safety.* Bulletin 221, Sweden, Lund Institute of Technology, Lund University, 2004.
20. Transportation Research Board *Managing speed. Review of the practice for setting and enforcing speed limits.* Special report 254, National Academic Press, 1998.
21. SARTRE 3 report, *European drivers and road risk; Report on principal results*. France, Institut de Recherche sur les Transport et leur Securite INRETS, 2004.

22. Peden M et al, eds. *World report on road traffic injury prevention*. Geneva, World Health Organization, 2004.
23. Oxley J, Corben B. *Effective speed management*. Melbourne, Monash University Accident Centre, VICROADS, 2002.
24. Belin M. *Trends in setting speed limits – Sweden as a case study*. Sweden, Swedish Road Administration, Borlänge, 2007.
25. *Vision zero – from concept to action.* Sweden, Swedish Road Administration, Borlänge, 2000 (www.vv.se).
26. *Safe traffic, Vision zero on the move*. Sweden, Swedish Road Administration, Borlänge, 2002 (www.vv.se).
27. Wegman, F, Aarts, L, eds. *Advancing sustainable safety: National road safety exploration for 2005–2006*.SWOV, 2006 (www.sustainablesafety.nl).
28. *National Road Safety Strategy 2001–2010.* Australian Transport Council. (www.dotars.gov.au/index.aspx).
29. *Reducing traffic injuries resulting from excess and inappropriate speed.* Brussels, European Transport Safety Council, 1995.
30. Frith B, Toomath JB. The New Zealand open road speed limit. *Accident Analysis and Prevention*, 1982, 14:209–218.
31. Sliogeris J. *110-kilometre per hour speed limit: Evaluation of road safety effects*, Melbourne, Report No. GR92–8, Vicroads, 1992.

2

How to assess the situation

How to assess the situation

Module 1 explained why speed management is needed to reduce the large numbers of fatalities and injuries associated with unsafe speeds. However, before designing and implementing an effective speed management programme, it is important to assess the existing situation.

The sections in this module are structured as follows:

2.1 What do you need to know? An effective speed management programme will be based on an understanding of both the extent and nature of the problem in a country, as well as any key underlying factors contributing to it. Essential information in understanding the existing situation in relation to speed will include awareness of:
- existing road hierarchies by function
- activities occurring on the roads (particularly vulnerable road-user activity)
- data on crashes
- speed levels
- speed involvement in crashes
- the existing legal position for speed limits
- speed compliance
- attitudes to speed.

2.2 How to measure the problem: This section shows how to determine the prevailing travel speeds and how to determine the extent of speed related injury risk. It also considers why many people do not comply with speed limits and discusses the need for an appreciation of community attitudes towards potential speed management initiatives.

2.3 How are current speed limits set, advised and enforced? This section provides advice on assessing whether current speed limits are too high, resulting in unacceptable crash risk for a range of road environments and functions. It also considers the important roles of signage and enforcement.

2.4 Understanding management arrangements: This section describes the information needed about a country's existing management arrangements and policies with regard to speed control. A key question is who is responsible (i.e. which lead agency is responsible) for road safety and speed management? It also considers who the road safety stakeholders within and outside government are, the details of any previous speed management programmes and experience in the country, and the potential resources (financial, human, and institutional) that may be available for future speed management programmes.

2.1 What do you need to know?

First, it is necessary to build up knowledge of the situation to be addressed through speed management. Beginning with the roads and road environment, an examination of the infrastructure and its uses, laws and their enforcement, road-user behaviour and the inherent risks associated with speed should be carried out.

2.1.1 Road functions and setting speed limits

Reducing risk through speed management requires a good understanding of individual road functions. For example, a major arterial road carrying through traffic between cities may be able safely to accommodate maximum speeds of 70 km/h; whereas, roads through shopping and residential areas with high pedestrian activity may need to have a maximum limit of 30 km/h.

A road system is usually a hierarchy of roads based on each road's primary function. Ideally speeds of motor vehicles using each road will be appropriate to the type and quality of the road, the types and mix of road users, and the surrounding environment. Before one can determine how best to manage travel speeds, it is important to examine and classify the types of roads in the road system.

While a hierarchy of roads is necessary, it is only a starting point for consideration of more detailed speed limit and speed management arrangements. The issue of road hierarchy is more fully addressed in Module 3.

Awareness of any existing hierarchy that the road authority or municipalities have adopted is important. A review of any hierarchy and individual roads within it, based on road user mix and current travel speeds, will be an important part of an assessment of the appropriateness of the designated road function and existing speed limits. It is also important to recognize that road hierarchy can change, for example unpaved roads can be surfaced, which is likely to result in more traffic and higher speeds. This may have implications for the existing hierarchy.

Activities on roads and road environment

When determining whether speed limits are at the right level, it is especially important to take into account the presence of pedestrians, cyclists and other road users who are more vulnerable to injury in the event of a crash. In residential areas where children may be playing close to the road, for example, the speed limit should be set quite low. If motorized four-wheeled vehicles cannot be separated from two-wheeled road users (or three-wheeled vehicles used extensively in countries such as India and Bangladesh), again the maximum speed should reflect the risk to the more vulnerable road user.

A study of the road and its environment, including the behaviour of the people close to the road, should be undertaken to enable a full assessment of speed related injury risks. For example, is there extensive ribbon residential or commercial development in rural areas along arterial roads? Are people walking along the side of the road?

Assess whether there are any land-use plans which could lead to a road changing in function over time, e.g. the amount of traffic, the mix of traffic, the speed and the safety risk. It is then necessary to re-evaluate the safety provisions for the pedestrians and other vulnerable road users.

This study should have a particular focus on those road users that are more likely to be injured because of a lack of protection – pedestrians are as important to plan for as drivers. Changing the traffic environment may require lower speed limits and/or additional infrastructure improvements, such as giving vulnerable road users priority at crossings or separating them from the fast-moving vehicles using barriers.

2.1.2 Speed and crash data

Good data are important in assessing the situation. This means data that are appropriate, accurate, complete and reliable. The information collected should include:

- numbers of fatal crashes where speed was a contributing factor
- number and type of road users killed as a result of speeding
- the age and sex of all involved in speed crashes
- type of road, traffic volume and speed limit of roads where speed crashes have occurred
- mean free flow travel speeds (see section 2.2.2)
- other measures of speed distribution, such as the 85th percentile speed (the speed below which 85% of vehicles travel)
- speed variance.

In order to be successful, a speed management programme needs the backing of both policy-makers and the public. Accurate data on speed related serious casualties and free flow speeds will help provide evidence about the potential scope for serious casualty reductions.

Methods for collecting data vary and the breadth of data obtained will depend on its source. Hospital data on crashes and injuries, for instance, will only take account of part of the problem because they only include cases that are brought to the hospital. Similarly, police data on crashes will only record cases the police investigate.

However, either of these two sources provides a good starting point. Ideally the information obtained by trauma rescue, medical facilities, police, press and road authority investigators will be integrated to give a fuller picture of circumstances and outcomes of speed related crashes.

Some of the desired data, such as free flow mean speeds, will not always be readily available. The lack of such data should not be used as an excuse for inaction or ignoring the problem of speed related serious casualties. Some country-level injury data, no matter how rudimentary, together with some simple measurement of free flow speeds, can be used as a starting point to develop a strategy for better managing speed.

2.1.3 Legislation and regulation

It is also important to know what laws and regulations about speed and speeding exist in the country or project area (see Box 2.1), and how these are periodically reviewed and updated. The issue of how they are implemented and enforced is also important.

Laws about speed management usually include setting limits, defining sanctions for people who break them (fines, suspension) and specifications of equipment used for enforcement by the police.

It should be clear who has the legal responsibility for setting speed limits on the road network in the country. It is usually the government road authority for the arterial routes, and municipalities for local roads and streets, either alone or with the approval of the roads authority. However, the setting of limits can be a police responsibility in some countries.

Some countries have extensive regulation and legislation regarding speed management. Compliance with these regulations depends in part on the understanding of road users about when, where and how to comply with them. While signage standards vary considerably between different countries, there is a need to examine whether speed limit signage is adequate, and whether signs are highly visible and well understood by the population.

It may be useful to begin by reviewing the current state of laws and regulations in relation to speeding as shown in the checklist in Box 2.2.

In many countries there is a lack of consistent enforcement of existing legislation – whether as a result of weak capacity or poor governance – that leads to corrupt practices. In assessing the country situation, an analysis of the existing enforcement regime should form part of the diagnosis. It would help reveal the state of the relationship between the intention of legislation/regulation and the way it is actually enforced.

BOX 2.1: **Example of speed limit legislation, South Africa**

Speed limit

59.

(1) The general speed limit in respect of –

(a) every public road or section thereof, other than a freeway, situated within an urban area;

(b) every public road or section thereof, other than a freeway, situated outside an urban area; and

(c) every freeway, shall be as prescribed,

(2) An appropriate road traffic sign may be displayed on any public road in accordance with section 57, indicating a speed limit other than the general speed limit which applies in respect of that road in terms of subsection (1): Provided that such other speed limit shall not be higher than the speed limit prescribed in terms of subsection (1)(c).

(3) The Minister may, after consultation with the MECs [Members of the Executive Council of the provincial government], in respect of any particular class of vehicle, prescribe a speed limit which is lower or higher than the general speed limit prescribed in terms of subsection (1)(b) or (c): Provided that the speed limit so prescribed shall not replace a lower speed limit indicated in terms of subsection (2) by an appropriate road traffic sign.

(4) No person shall drive a vehicle on a public road at a speed in excess of –

(a) the general speed limit which in terms of subsection (1) applies in respect of that road;

(b) the speed limit indicated in terms of subsection (2) by an appropriate road traffic sign in respect of that road; or

(c) the speed limit prescribed by the Minister under subsection (3) in respect of the class of vehicle concerned.

Certain drivers may exceed general speed limit

60.

Notwithstanding the provisions of section 59, the driver of a fire-fighting vehicle, a rescue vehicle or an ambulance who drives such vehicle in the carrying out of his or her duties, a traffic officer who drives a vehicle in the carrying out of his or her duties or any person driving a vehicle while engaged in civil protection as contemplated in an ordinance made in terms of section 3 of the Civil Protection Act, 1977 (Act No. 67 of 1977), may exceed the applicable general speed limit: Provided that –

(a) he or she shall drive the vehicle concerned with due regard to the safety of other traffic; and

(b) in the case of any such fire-fighting vehicle, rescue vehicle, ambulance of vehicle driven by a person while he or she is so engaged in civil protection, such vehicle shall be fitted with a device capable of emitting a prescribed sound and with an identification lamp, as prescribed, and such device shall be so sounded and such lamp shall be in operation while the vehicle is driven in excess of the applicable general speed limit.

Source: National Road Traffic Act (1996), available at www.transport.gov.za/library/index.html

BOX 2.2: **A proposed checklist for determining the current legal framework**

- What current laws and regulations relate to road safety generally? Is there a specific law on speed and speeding? If so, does it apply nationally or locally?
- Are there highway design standards that specify recommended speed limits?
- Are they up-to-date?
- To whom does the law apply? To all vehicle drivers, or are there specified variations – for example for learner and novice drivers, or for different vehicle types? How well understood are existing variations in speed limits for different vehicle types?
- Does the law apply to all types of road?
- Does the law specify any default speed limits for urban and rural areas?
- How are limits signed?
- What are the penalties for not complying with the law?
- Is the law enforced? Is it enforced everywhere, and among all types of vehicle-based road users?
- Which government agency is responsible for preparing/modifying laws in relation to speed?
- How is a variation on the law or a new law officially adopted by the government?

2.1.4 Speed risk profile and vulnerable road users

The crash risk varies for different classes of road user. Vulnerable road users are defined as those exposed directly to vehicle impacts (pedestrians, cyclists) as opposed to those protected within a vehicle (drivers, passengers). Pedestrians, cyclists and those using motorized two-wheeled and three-wheeled vehicles are much more vulnerable to injury than those using larger motor vehicles.

An examination of the risks of exposing vulnerable road users to heavier motorized traffic warrants particular attention. This examination should consider whether enough has been done to manage the speed of motorized vehicles so that collision and injury risks are minimized.

While the behaviour of vulnerable road users is often a contributory factor in injury crashes, it is often difficult to enforce laws governing the behaviour of these road users. It is difficult to apprehend cyclists in traffic. Even when offenders are apprehended, it is difficult to process a violation, especially when the road user is not required to carry a licence (e.g. pedestrians and cyclists).

It is essential that the risks faced by vulnerable road users on the network are well understood, and that the locations where they experience higher-than-average crash risk (based on crash data) are carefully studied in order that targeted risk reduction solutions can be developed.

In addition to understanding speed crash and injury data, it is useful to conduct further research about local behaviour patterns and cultural settings to determine which people are most at risk of having a speed related crash. Knowing more about the circumstances in which people drive or ride at dangerous speeds can inform speed management measures, for example public education, licensing policies or design of infrastructure.

2.2 How to measure the problem

Speed on roads is a major public safety and health issue, although the precise causal role of speed in road crashes is difficult to determine. Collecting and analysing data that can indicate prevalence of unsafe vehicle speeds on the road network helps to guide and measure the effectiveness of the speed management programme.

CASE STUDY: **Matatu magic, Kenya**

To celebrate the World Health Day in 2004, BBC World Service produced a radio show called *Matatu magic*. A tale of suspense and heroism, treachery and tragedy, *Matatu magic* transports you to the tarmac of the Kenyan capital, Nairobi. There, the drivers of minibus taxis – known as *matatus* – are kings of the road, and regularly play Russian roulette with the lives of their passengers. At least they did, until the government introduced strict new laws in 2004. This five-part drama series, written by Kenneth Gitari – himself a Kenyan matatu driver – explores the central role these vehicles play in the life of the city.

In 2004, road safety measures in Kenya were largely successfully imposed. All of the country's 40,000 matatu drivers were obliged to reduce the number of seats in each vehicle, to install seat belts for all passengers and a speed limiter which costs around $300. The seat belts range between $12 and $20 each. These are expensive measures, but it is generally accepted that the best way of improving road safety is to reduce the speed and volume of traffic.

The radio show created debate on the BBC website. Below some of the quotes from the web debate:

"From my observation the seat-belts have reduced overcrowding in public transport, the speed governors have installed a lot of discipline. This can be seen in Mombasa and other towns in Kenya."
—Mohamed Shariff, Kenya

"The use of seat-belts and speed governors to prevent the prevalent road carnage is like immunization against a deadly malady."
—George Kyalo Mutua, Kenya

Sources: www.bbc.co.uk/worldservice/specials/1225_deathontheroads/page4.shtml and http://news.bbc.co.uk/2/hi/africa/3593905.stm.

However, a definition for use by crash investigators must identify circumstances that can be used to determine the involvement of speeding as a contributing factor in a crash (see Box 2.3).

Unsafe driving speeds increase both the likelihood and severity of road crashes. So, for example, if an investigation indicates that a driver had fallen asleep and lost control as a result, driver fatigue rather than speeding is likely to be the primary contributing factor. But these types of crashes tend to be more severe because a sleeping driver does not react to the situation. In this example fatigue was the primary (road injury) contributing factor, and speed is a secondary factor.

BOX 2.3: A definition of speeding for police use in assessing its role in a crash and crash outcome

The identification of speeding (excessive speed for the prevailing limit or conditions) as a contributing factor in road traffic crashes cannot always be determined from police reports of those crashes. Crash investigators can look for other clues or circumstances surrounding the crash that would suggest speeding was involved.

A working definition could be:

Speeding is considered to have been a contributing factor to a road traffic accident crash if that accident involved at least one 'speeding' motor vehicle.

A motor vehicle is assessed as having been speeding if it satisfies the conditions described below in (a) or (b) or both:

a) The vehicle's controller (driver or rider) was charged with a speeding offence; or the vehicle was described by police as travelling at excessive speed; or the stated speed of the vehicle was in excess of the speed limit.

b) The vehicle was performing a manoeuvre characteristic of excessive speed, that is: while on a curve the vehicle jack-knifed, skidded, slid, or the controller lost control; or the vehicle ran off the road while negotiating a bend or turning a corner and the controller was not distracted by something; or disadvantaged by drowsiness or sudden illness; was not swerving to avoid another vehicle, animal or object; and the vehicle did not suffer equipment failure.

Source: *(1)*

Other important data to enable a comprehensive analysis of speed related behaviour include information such as:

- mean free flow speeds (the average speed of all vehicles that are unaffected by slower moving vehicles)
- 85th percentile speeds
- the proportions of drivers and riders at, below or above the speed limit
- speed variance (by what amounts and in what proportions are drivers above, near to, or below the speed limit?)
- public opinion about speed compliance
- attitudes towards police enforcement activity
- public opinion about appropriateness of current speed limits and penalties.

2.2.1 How big is the speed related injury problem?

Speed is always a contributory factor in the severity of a crash. The assessment of the speed related injury problem involves a number of separate elements. In order to gauge the extent of injury that relates to inappropriate speed it is necessary to look at a number of sources of data.

Some crashes will have been identified by police as having speed as a major contributing factor, perhaps on the basis described in Box 2.3, but the police in many countries do not provide such information on crash causes *(2)*. In most crash situations, especially with mixed traffic, analysing to what extent speed contributed to the crash requires careful study.

Collecting data on road traffic crashes

Usually it is the role of police to investigate road crashes. In the case of serious crashes, specially trained investigators or accident reconstruction specialists may be able to find more clues about road environment, vehicle related and behavioural factors that might have contributed to the crash or crash severity.

CASE STUDY: **Thailand Accident Research Centre (TARC)**

The Thailand Accident Research Centre (TARC) was established in 2003 to provide a national centre for collecting data on the road crash problem in Thailand. The centre is run by the Asian Institute of Technology. TARC is focusing its efforts on on-site investigation, crash analysis and research, and has been working to develop a knowledge-base on crash investigation, analysis, technical know-how and local capacity building. Following detailed investigations at the crash scene, interviews with drivers and passengers and an inspection of all vehicles involved, possible contributory factors are determined and reported. At the crash scenes, the impact of speed is determined from the damage profile and vehicle trajectory. The radius of the yaw marks and the friction co-efficient (μ) of the road surface are important factors too, in addition to crush measurements at certain intervals along the length of direct damage of the vehicle.

Crash reports can be downloaded from the TARC website: www.tarc.ait.ac.th

While most high-income countries have teams of crash experts, many lower income countries rely on traffic police conducting such investigations – often with limited training and experience.

Using the definition in Box 2.3, investigators can determine if speed was involved in a road crash by observations, interviews of witnesses, measurement and analysis of changed road-environment characteristics including skid marks. As far as possible, an estimation of impact speed and travel speed in the moments just prior to the crash should be made. Tachometers, if they are fitted to vehicles, will record these with greater accuracy. In addition, some of the latest global positioning system (GPS) technology installed in some freight carrying vehicles can also accurately monitor travel speeds if it is linked to a recorder.

Such information can be analyzed against vehicle damage and human injury. This data should be stored and analyzed on a regular basis.

In practice, extensive information on these factors is often not available in lower income countries because data may not be complete. Issues of under-reporting in police records (for example, compared to hospital-based data) also exist, even in those countries with a good road safety record. Other sources of data might be non-governmental organizations, universities and other research organizations. Insurance companies may also have such information since police accident reports are often required as part of any claim. However, such information may not be readily available (for commercial reasons) and also may only exist in 'hard' paper files rather than being available on a computer database.

To analyze these data the following questions should be asked:

- What is the scale of the problem of speed related crashes as identified in police records in terms of the number of crashes and the number of fatalities?
- What proportion of overall road traffic crashes does this comprise?
- What does the crash data indicate about the appropriateness of speed limits?
- Who are those most likely to be involved as drivers or riders in speed related crashes?
- Where are the locations where pedestrian and other vulnerable road-user crashes form a high proportion of total crash numbers?
- What are the characteristics of drivers involved in serious or fatal pedestrian crashes?

2.2.2 How to measure speed

Assessing free flow speeds on a representative sample of arterial and local roads in urban and rural areas will be an important activity to enable an assessment of the opportunities for a speed management programme to reduce serious injuries.

Regardless of what measurement of speed is used, it is vital to take account of the different types of vehicles using the roads (lorries typically move more slowly than cars), the traffic volume (higher volumes result in lower speeds) and variables such as time of day, day of week, holidays and weather conditions.

NOTE

What are 'free speeds'?

Free flow speeds are measurements of the speed of travel of vehicles that are not affected by other vehicles. Surveys are usually carried out using a radar detector (or 'speed gun'), selecting those vehicles that have a substantial headway and are not impeded by other vehicles or other factors. It is usual to set a minimum headway between vehicles in the traffic flow of three seconds to measure free speed, but a time gap of at least four seconds is preferable.

It is important to conduct surveys under similar conditions each time, as any variation in collection procedures may result in differences in the speeds recorded. It is also important that the same location is used, as well the same recording equipment, and preferably the same equipment operator. Recording equipment such as radar should be hidden, if possible, as road users who spot the equipment may change their speed and might even brake in fear of getting a fine.

Speed surveys can be conducted with fixed speed-measuring equipment, or with observational surveys involving researchers standing by the roadside with hand-held speed measuring devices. They can also be done by observing the types of drivers who are exceeding limits (male, female, young, old). Such observational speed surveys should be sufficiently large to identify any significant differences between men and women, motorcycle riders and vehicle drivers, speeds in cities and smaller towns, urban roads and highways, and different regions of the country. New Zealand guidelines suggest that for a simple 'before/after' or 'change over time' survey, a sample of 200 vehicles is required over a minimum of two hours. This number should be used for each vehicle type or road user type. A minimum of 300 vehicles is appropriate over a one-hour period *(3)*.

The measurement of speeds should be collated and analyzed to find out the mean speed of traffic flow over a period of some hours. The 85th percentile speed should also be calculated from the free speed distributions as this speed is often used as the basis for road design and has also been used in some countries to provide guidance on appropriate limits. It should be noted that speed survey results are highly dependent on the way the survey is conducted. Box 2.4 gives useful advice.

The speed limit in these locations should be recorded and the measurements taken at a number of sample sites, if possible, over a few days and if practicable, repeated often, say every three months.

Surveying sample speeds on a regular basis will indicate trends in vehicle speeds and, importantly, provide an opportunity to monitor the impact of speed management programmes on driver behaviour (Boxes 2.5, 2.6 and 2.7).

If free flow speeds are in excess of the posted speed limit this will indicate an opportunity to reduce speeds to the speed limit by carefully targeted enforcement and public education, or to change the road layout using engineering measures. The lower speed will in turn lead to reductions in fatalities and serious injuries. If the free flow travel speeds are below the speed limit and there are still substantial crash risk problems along a length of road or at a particular site, it should be clear that travel speeds need to be reduced through lower speed limits and other measures.

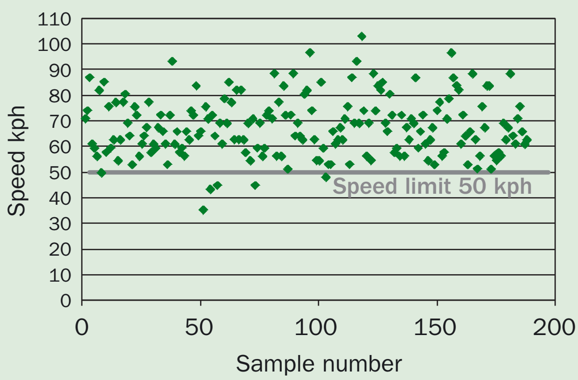
Further information about conduct of speed surveys is provided in *(3)*.

CASE STUDY: **Speed survey in Ghana**

Speed surveys were conducted in rural and urban locations using a calibrated Muni Quip K-GP Radar speed gun, operating in the K-band frequency range (24.1Ghz). The equipment operates on the Doppler principle.

The Doppler principle states that if a transmission is made into a given area, striking a moving object, the reflected signal is a different frequency and the difference between the transmitted frequency and the received frequency is proportional to the target speed. Speed can be measured both approaching the measuring site as well as after the site. If drivers observe that their speed is being measured these speeds may be very different.

The survey data shows the high levels of speeding that are found in many developing countries where the perceived risk of enforcement is often very low. It was concluded that in urban areas the potential for crash reduction (per 1 mile/h reduction in average speed) is greatest on those roads with low average speeds. These are typically busy main roads in towns with high levels of pedestrian activity, wide variations in speeds, and high crash frequencies.



BOX 2.4: **How to conduct spot-speed surveys: UK's DFID guidelines for low-income countries**

Overseas Road Note 11 (ORN11) Urban road traffic surveys (DFID/TRL 1993) gives full details on how speed surveys can be conducted in 'developing and transitional' countries.

The guidance covers:

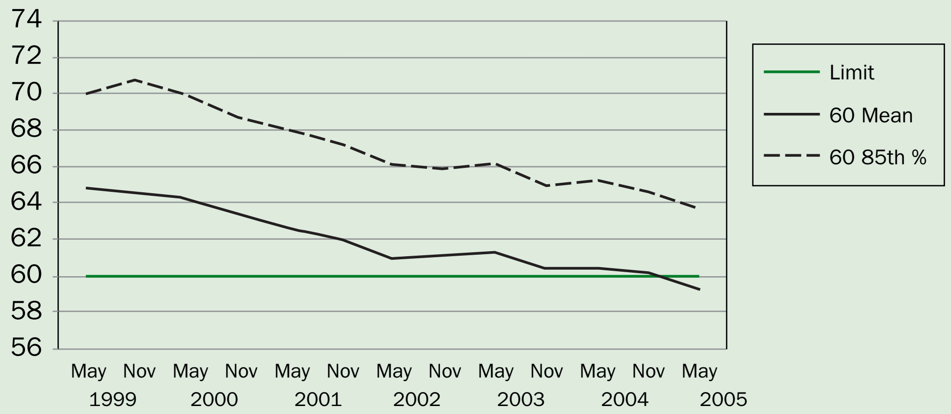
- a variety of reasons for conducting such surveys
- choice of location
- method suitable for different types of road and traffic conditions
- use of radar speed guns (spot speeds) or stop watches (average 'short-base' speeds)
- 'hiding' the observers
- which vehicles to sample
- when to carry out surveys (to obtain 'free flow' speeds)
- how to present the results.

The guidelines make reference to the 85th percentile speed as a commonly used measure, since this 'excludes extremely fast drivers (and gross measuring errors) and gives an estimate of what the majority of drivers consider a top limit'.

Available at: www.transport-links.org (search ORN11)

BOX 2.5: **Change in free speeds for a large metropolitan area (Melbourne) – 60 km/h zones**

The effects of major speed reduction as a result of publicity and enforcement campaigns in a major city over the period from 1999 to 2005 are shown. Substantial reductions in fatalities and serious injuries occurred over this time. Monitoring of free travel speeds enables any changes in speed levels to be detected, and is of considerable assistance as an intermediate and advance indicator of effectiveness in reducing road trauma resulting from speed.



Source: *(4)*

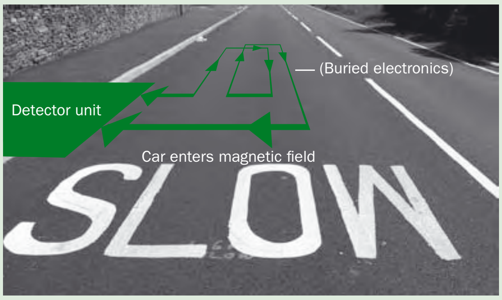
BOX 2.6: **Developing core speed-monitoring sites**

Speed management is an ongoing operation and consequently regular monitoring is essential. In order to do this, permanent measuring sites are desirable in the medium term. While there is a range of high technology equipment for monitoring traffic speed, inductive loops and pneumatic tubes still provide a durable, reliable and low-cost solution to the problem in appropriate environments. Loop and tube data loggers can be purchased for as little as US$ 500. As the equipment has its own power supply it can be set up in remote locations.

Inductive loops are cables cut into the tarmac carriageway surface, sealed in, and connected to the data logger housed in a roadside cabinet. As the measuring cables are buried they are not worn by traffic flows. Depending upon the flows and capacity of the logger, the equipment can be left unattended for weeks.

A pneumatic tube generates an air pulse when a vehicle compresses it. As the tubes are a known distance apart it is possible to calculate the time the vehicle takes between the pair of tubes and hence calculate the speed.

Although the tubes have a limited life (perhaps four weeks in continuous operation) they can be used in locations where it is not possible to install loops. Tubes can be pinned to gravel roads.

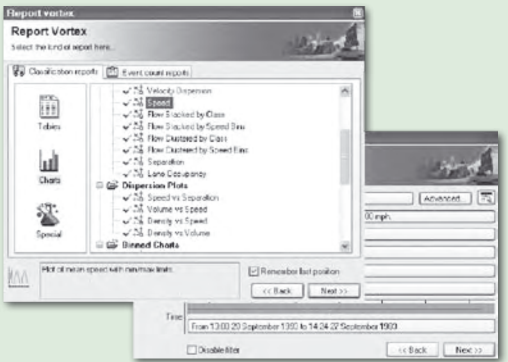


Portable traffic analyzers are a third type of equipment. A plate with a sensor fitted to the pavement determines vehicle count, speed, and type using magnetic-imaging technology. The plate is placed directly in the traffic lane. It can be installed and removed quickly and easily using a drilling machine and can be left unattended for weeks.

Tubes, loop data loggers and removable plates come with their own download software and data management packages that create a range of data presentations at the touch of a button.

Speed data loggers will also provide vehicle classification and flow-volume data. Because of this, traffic monitoring in an urban network will also identify:

- traffic flow growth
- change in vehicle usage (e.g. increase in heavy goods vehicles)
- migration of traffic onto new routes
- highway wear rates



However, the use of such equipment will not be possible in certain countries and the use of hand-held laser equipment will be preferable.

BOX 2.7: **Equipment options for speed survey data collection**

Measurements of spot speeds are generally made from a specific location on the road. Various approaches may be used to collect spot-speed data:

- methods involving timing between two points or a known distance
- microwave radar using the Doppler effect
- direct measurement using laser gun
- methods involving video
- global positioning system (GPS) equipment.

These options are described in more detail in Appendix 1.

CASE STUDY: **Testing speed measurement equipment, Malaysia**

It is important to know and maybe test which equipment to choose for the specific purpose. In Malaysia, as part of a tendering process to find a contractor to do a speed measurement programme, six prospective contractors were asked to install, test and show the usage and ability of their equipment on a 1 km test stretch of the Guthrie Expressway. Different scenarios relevant to Malaysia were tested, such as big groups of speeding motorcyclists. Some types of equipment failed to be able to measure the individual speeds. At same time the free flow speed was measured as a control to reflect the real situation and allow for evaluation of the different types of equipment in the different scenarios.

2.2.3 Speed variance

Often a distinction is made between those who drive a few km/h above the posted speed limits (low-level speeding) and those travelling at an extremely high speed (high-level speeding). Also, some countries informally accept a certain amount of low-level speeding by, for example, setting the 'tolerance' of speed enforcement (the speed resulting in prosecution) at a level above the posted limit. While such leniency goes some way towards maintaining public approval for speed enforcement, there is an impact in trauma terms which can be readily calculated, since even if the majority of drivers are driving only a *little* above the speed limit, this can result in a significant number of fatal and serious injury crashes (see Tables 1.1 and 1.2).

Driving at very high speeds in excess of the legal speed limit is dangerous. If the speed surveys find that there is a significant amount of driving well in excess of the speed limits, a range of legislative, enforcement, public education and engineering measures may be required to manage the problem. It is important to find out how often and where it is happening.

Even legal high-speed road travel such as the kind done by police and other emergency service drivers is dangerous, and can result in greater risk of injury crashes.

Awareness of the extent of these practices in a jurisdiction is useful. Such drivers should receive specialized training and be guided by specific procedures and protocols. The safety control adequacy of guidelines and protocols for emergency, e.g. high-speed police pursuits or emergency rescue driving, should be examined.

However, the majority of the injury crashes are likely to happen at lower speeds, and these should be the focus of speed management programmes, as they represent the most significant problem.

Very small increments of speed in excess of speed limits are a major factor in increasing crash risk on the network, especially if it is a behaviour that is widely practiced by the driving population. Over time, low-level speeding can become the accepted behaviour of drivers and they will expect to drive at a higher level until or unless they encounter some enforcement.

The extent of low-level speeding will be indicated in the free speed surveys. If low-level speeding is widespread and is more than 2 or 3 km/h above a posted speed limit, there may be the need to apply tougher standards to speed enforcement than those that currently exist. For example, some jurisdictions allow drivers to travel up to 15 km/h over the limit before being given an infringement notice. This results in the *de facto* speed limit becoming 15 km/h over the posted limit. The increase in crash risk as a consequence can be large.

2.2.4 Assessing community attitudes to speed management

It is necessary to know what the driving public is likely to favour and react unfavourably to when developing stronger speed management measures. Also, the balance between drivers, pedestrians and cyclists needs to be considered. Community surveys can indicate the level of public support for lower speed limits, more police enforcement, higher penalties for speeding and more engineering treatments (Box 2.8). This feedback is critical to programme design, which should also include comprehensive measures to inform the public of speed and crash risks.

However, societies have different levels of tolerance for change, and different approaches to the pace and extent of change. These constraints need to be understood and addressed in any speed management programme.

BOX 2.8: Community surveys about speed

There are a number of examples in various countries of community surveys about speed, usually conducted annually or more frequently to monitor changes in community attitudes to speed and speeding. In countries undertaking speed management programmes for the first time, the initial survey will be an important baseline record of the pre-programme attitudes.

It is important that sample sizes are adequate and the process of selection of interviewees is carefully planned to ensure the sample is representative of the population being studied.

Further details of the methodology used can be obtained from source *(5)*. Specialist assistance will be needed to ensure that surveys elicit useful and accurate information.

2.3 How are speed limits set, communicated and enforced?

Speed limit setting has traditionally reflected attempts to achieve a balance between safety and mobility. However, countries that recognize their poor safety record and are committed to reducing road deaths and injury are shifting this balance in favour of safety. Some countries are now setting speed limits with reference to the limits of human injury tolerance, that is, to a level that will not usually result in death or serious injury to road users when crashes occur. This policy position is called the *Safe-system* approach (see Module 1).

Also, many countries now recognize that lower speeds have additional benefits over and above safety, in that they contribute to economic savings (less fuel used), smooth flow of traffic, and help alleviate air pollution and noise.

2.3.1 How are speed limits set?

It is important to understand who is responsible for setting the limits, and which criteria are used to set the speed limits. Are the limits based on expert analyses, politicians' judgements, analysis of data and injury risk, or cost-benefit assessments? The implications of the different methods need to be understood in order to develop any case for changing existing methods and criteria used.

It is also necessary to determine on what basis limits have been set in a jurisdiction for both urban and rural areas, and for different classes of road and vehicles. There will usually be an agreed general speed limit for good quality rural and urban roads. These are normally referred to as the default speed limits, and are therefore not normally signposted.

Sometimes different speed limits can be applied to different standards of roads or classes of vehicles, and, in some cases, even drivers – for example new drivers.

Other questions to be asked include: has there has been a review to determine the appropriateness of speed limits, the nature of traffic/ road users, the nature of the road and roadside (including neighbouring developments and control of access to them), the standard and type of vehicles and the levels of enforcement?

2.3.2 How are speed limits communicated?

Once speed limits are set, it is important to advise drivers about these limits. This is usually done with signs and road markings. A review of the speed limit signage and information should be done to find out whether drivers understand what is required by law, and a review of the sufficiency of advice to drivers should be undertaken in preparation for any speed management programme.

Consistency is important. If it appears to a driver that the same type of road has different limits in different places for no obvious reason, then they are more likely to abuse the limit.

A fuller discussion on signage and advice to road users about legal maximum speed limits is contained in Module 3.

2.3.3 How are speed limits enforced?

In the absence of infrastructure engineering treatments that force drivers to reduce their speed (such as humps), speed limits are often not respected by the driving and riding population unless there is a level of enforcement. It is important to recognize that it is the perceived level of enforcement that critically influences speed behaviour, rather than actual levels. This means that enforcement activity needs to be publicized (i.e. used to persuade rather than to catch); but drivers are seldom fooled by extravagant claims of more extensive enforcement activity for long. It is necessary to determine as a starting point how extensive enforcement currently is in terms of geographic distribution, number of vehicles screened, distribution of enforcement over a day and over a week, and the limit that is effectively enforced.

Police may be reluctant to enforce new speed limits, as the new limits may not be well accepted by road users – resulting in criticism of or ill feeling towards the police. Police experience and attitudes to speed enforcement should be assessed.

Enforcement is discussed more fully in Module 3.

NOTE

What is the existing 'real' speed limit?

Often, police allow some tolerance for driving in excess of the legal maximum speed limit. When this occurs, road users come to believe that the limit, plus the added tolerance, is the actual speed limit. For example, many limits are only enforced when drivers are up to 10 km/h or more over that limit. Most drivers become aware of this practice and the new limit becomes the posted limit plus the enforcement tolerance. This is an example of an issue that needs to be carefully considered in designing any future programme.

2.4 Understanding management arrangements

For road safety management and speed management it is necessary to have a clear understanding of existing arrangements and responsibilities.

2.4.1 Who has responsibility for the regulation of speed on public roads?

The agency responsible for setting speed limits is likely to be a national or state/provincial one. But local authorities may also be able to set limits or establish speed zones in their cities or towns. There may be a separate agency with overall road safety responsibilities, which does not have the power to manage road regulations. It is normal for speed management roles to be shared by a range of organizations, such as road authorities, transport ministries, police, local government and others.

To implement a speed management programme it is necessary to establish what are the main government departments involved in road safety decision-making, what role each department plays and how they relate to each other. An assessment of their speed management capabilities can also be undertaken, to determine how well equipped the agencies are for carrying out necessary tasks.

2.4.2 Who are the road safety stakeholders?

A stakeholder analysis sheds light on the social and economic environment in which any new policy will be developed and implemented. Its primary function is to identify all possible partners who might have an interest in better management of speed, including those who might initially oppose efforts to reduce inappropriate speed through enforcement, lower limits or a range of engineering measures. Potential stakeholders include: government departments, non-government organizations and institutions that will be affected (positively or negatively) by the new management arrangements or standards, local communities, formal or informal groups, as well as individuals. Stakeholders will also include motoring associations whose members might be affected by new management arrangements for speed, regulators, other industry bodies and associations, vehicle manufacturers and transport operators. The media plays an important role in airing the views of the different groups and the public at national, regional and local levels, and its influence should not be underestimated.

The second important function of the analysis is to examine the roles and activities of all of the stakeholders. It is important to distinguish between stakeholders within government and those beyond it. Those within government may have a management responsibility for their role in road safety, whereas those outside government (including lobbyists) will have a keen interest either for or against speed-regulating initiatives.

Their input, advice and support for the proposed programme should be sought and valued, but the management task of providing final recommendations to government, or exercising delegated authority to act, is the role of the directly accountable road safety agencies in government (transport, roads, police, justice, health and education), with consultation occurring separately with other government ministries, such as finance. This consultation will often create potential conflict of interest related to the costs and economic development, which is why it is very important to document the benefits of a speed management and the cost savings for society.

A careful analysis should be made of the influence, importance and interests of all major stakeholders beyond the road safety agencies, within and beyond government, as this will facilitate the design of appropriate approaches for involving them. It is especially important to identify both supporters and opponents, and to appreciate the reasons for their respective positions so as to be able to develop a package that satisfies all parties. With these comments in mind, the key objectives of the analysis of the stakeholders beyond government are:

- to identify these key stakeholders, define their characteristics and examine how they will be affected by speed management policy changes (e.g. their interests, likely expectations in terms of benefits, changes and adverse outcomes)
- to assess their potential influence on the development, approval and implementation of a speed management programme
- to understand the relationship between stakeholders and the possible conflicts of interest that may arise
- to assess the capacity of different stakeholders to participate in developing a speed management programme and the likelihood of their contributing positively to the process
- to decide how they should be involved in the process to ensure the best chance of success for the programme, in particular:

- the nature of their participation (e.g. as advisers or consultants, or as collaborating partners)
- the form of their participation (e.g. as a member of the working group or as an adviser)
- the mode of their participation, (e.g. as an individual participant or as a representative of a group).

For the other government stakeholders apart from the road safety agencies, a similar but less detailed process should be undertaken to ensure they are engaged at an early stage in a positive manner. A more in-depth discussion on conducting a stakeholder analysis can be found in *(6)*.

2.4.3 What funding is there for speed management?

Without sufficient funding it will not be feasible to conduct a comprehensive speed management initiative. While the development of a case for funding will be part of the programme prepared (as described in Module 4), an understanding of current funding support is a required starting point.

What is the current budget for road safety? Are there priorities in the budget for future improvements in the field of road safety? Are there funds that might be accessed for a speed management programme? It is important to estimate the benefits of the proposed programme and to present the programme as an investment rather than a cost. It is generally the case in countries with high crash rates that the benefits to the economy from reducing death and injury on the road will far exceed the costs.

The stakeholder analysis (2.4.2) should also explore the possibility of funds being made available by stakeholders outside government.

It should also be recognized that any increase in speed enforcement activity is likely to generate funds from the penalties collected. However, in many countries that have introduced large numbers of cameras for enforcement purposes, there has often been a media response, allegedly on behalf of the public, that they are simply a way of raising revenue ('another tax on the motorist'). An examination of this problem and a proper understanding of public attitudes, or potential for this problem to arise and how to deal with it, should be made.

In a number of countries, the revenue from the penalties – for example from speed cameras – can be ring-fenced for road safety activities, rather than flowing into general government revenues. While there are many arguments about this approach, it can be used to generate wider public support on the argument that it is the speeding drivers who are paying for their 'sins', to the benefit of the community put at risk by their behaviour.

Summary

There are three main reasons for assessing the situation before starting to develop a speed management programme. First you need to identify the nature and scale of unsafe vehicle speeds. The assessment process will provide evidence for arguments as to why speed management is essential and why it should be supported. The documentation of the starting situation provides baseline indicators that can be used for monitoring and evaluating the programme. To get backing of both policy-makers and the public you need to:

- obtain an overall view of the road, its environment and use
- illustrate to what extent drivers comply with speed limits in various locations, the speed limits and the mean speeds in higher risk locations (such as where there are many pedestrians, cyclists or motorcyclists)
- understand why people speed in those locations and what proportion of serious casualty crashes have speed as a contributing factor
- measure the size of the injury risk caused by speeding, as well as the nature of the risk
- obtain accurate data on speed related serious casualties, mean free flow speeds and in comparison to current speed limits – this will help show the scope for serious casualty reductions through better speed compliance or lower limits, or both.

References

1. *Road traffic accidents in New South Wales 2000 – Statistical statement: year ended 31 December 2000*, Roads and Traffic Authority of New South Wales, 2001.
2. Frith et al. *Road safety impacts of excessive and inappropriate vehicle speed – speeding as a factor in road trauma*. Austroads Road Safety Handbook, Vol 2, 2005.
3. *Guidelines for setting speed limits, Standard Method for Conducting Manual Speed Surveys*, Appendix 4, Land Transport Safety Authority of New Zealand, 1995.
4. Speed surveys from Austroads' *Guide to Traffic Engineering Practice* (GTEP), Part 3: Traffic studies. Austroads ref AP-G11.3/04, 2004.
5. *Community attitudes to road safety,* Research and analysis report, Wave 19, 20 Australian Transport Safety Bureau, 2006 (Report CR 229) (www.atsb.gov.au/publications/2006/pdf/CR229_ Commuity_Attitudes_Survey.pdf).
6. Schopper D, Lormand JD, Waxwelier R. eds. *Developing policies to prevent injuries and violence: guidelines for policy makers and planners*. Geneva, World Health Organization, 2006.

3

What are the tools for managing speed?

What are the tools for managing speed?

There are many tools available for effective speed management. They include appropriate speed limits, engineering treatments, effective enforcement of speed limits by police and the use of extensive public information and education programmes to encourage compliance with both advisory speed signs and statutory speed limits.

In most cases a mix of tools is required to create solutions that are appropriate to the needs and capacities of the individual country. This module describes those tools available to influence speed. Six topics are covered in this module:

3.1 Speed zoning and speed limits: Speed limits that take into account the function of the road and its environment are a fundamental tool for speed management. Urban and rural settings, which have a different mix of traffic, require different approaches to achieve effective speed management. This section discusses ways to define a hierarchy of roads in accordance with their main function, and how to set appropriate speed limits for them.

3.2 Changing behaviour – regulating and enforcing speed: This section addresses the legislative and regulatory settings that provide the basis for speed compliance, and the various methods and techniques available for on-road enforcement. These include the use of fixed and mobile speed cameras, the tolerance in enforcement of speed limits by police and the importance of penalties such as fines, demerit points, licence suspensions and vehicle confiscations.

3.3 Changing behaviour – public education: The role of public education to improve compliance and support ongoing police enforcement activity is addressed in this section. The effectiveness of community-based programmes is also highlighted.

3.4 Engineering treatments: A range of measures is available to reduce speed in high-risk locations. For example, in locations of high pedestrian activity near schools, markets, shopping centres and busy urban precincts, measures such as speed humps, raised pavement sections and road narrowing are often highly cost-effective treatments.

3.5 Use of speed-limiting technology and intelligent speed adaptation: The use of speed-limiting technology – for example speed limiters and data recorders – for heavy and light vehicles is addressed in this section.

3.6 Speed management by employers: This section addresses the role of vehicle fleet operators in reinforcing speed compliance by employees.

3.1 Speed zoning and speed limits

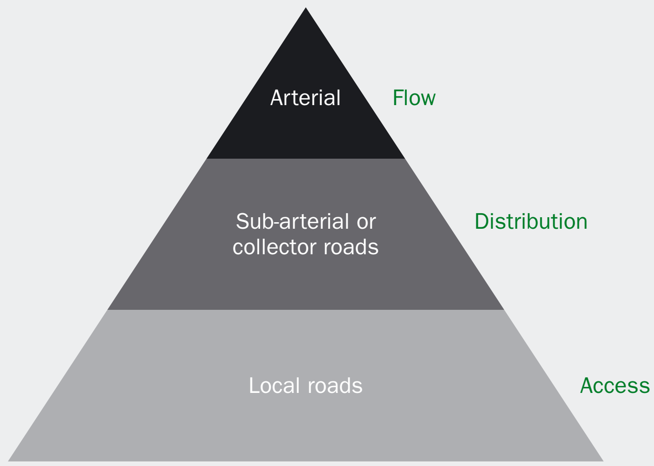
Road functions and hierarchies differ considerably between rural and urban areas. The nature of crash and injury severity risk also varies within these two broad groupings.

The classifying of each road by its particular function will reflect current use in most cases. A road's function within a hierarchy provides a basis for more consistent application of speed management across the road network, while recognizing that higher risk sections or routes will need different speed limits to respond to their relative risk. For example, areas around schools may require a lower speed limit because of the presence of child pedestrians. Classifying roads by function also enables identification of sections of the network where future engineering treatments might reduce crash risk, allowing speed limits to then be re-assessed.

3.1.1 Classifying roads by function and activity

It is valuable for long-term speed management to establish a hierarchy and function of road use for both the rural and urban network (see Figure 3.1).

Figure 3.1 A simple road hierarchy for urban areas



Considerations should include:

- population density
- road user density

- through traffic (arterial) or local traffic (access) and relative traffic flow
- road user mix – pedestrians, motorcycles, bicycles, animal-drawn vehicles, buses, trucks and cars
- ability to segregate road users
- adjacent footpaths, abutting developments
- roadside activity.

At the top of the hierarchy are roads that primarily cater for transport of people and goods over long distances through rural areas. Generally, higher speed limits are permitted on these arterial roads than are permitted on sub-arterial and local roads. At the other end of the hierarchy, local roads often accommodate a variety of functions and road user types, and are therefore usually assigned lower speed limits to ensure the safety of all road users (Box 3.1).

BOX 3.1: **Consider the uses by all road user types**

A road hierarchy needs to be based on road function and consider all road users, not just motorized traffic. It needs to be simple so that it can be understood both by those implementing it, and by road users. Typically, roads within a hierarchy will have a traffic function (primarily moving motorized vehicles over longer distances), a local function (mainly for short journeys, including those involving walking) or a mix of the two functions. Therefore, the simplest road hierarchies typically have three types of road for urban areas, and two or three for rural. Each of these road types should be linked to a specific speed limit. Roads with a traffic flow function have the highest speeds, while those with a local function have the lowest.

One simple way to rank a road within a hierarchy is by using a map. Strategic routes that mainly carry through-traffic can be marked as such. Roads with a local function can also be highlighted. The remaining roads can be marked as mixed function. Using a map, conflicts in the road network can easily be seen. For instance, a road with a mainly traffic function that passes through a local road network may suffer conflicts between road users. Long-term planning will be required for this road to bypass the local road area, and until that time, its position within the hierarchy should be downgraded to a mixed function, with a speed limit and road infrastructure (such as separation of different road user groups) appropriate to that function.

Speed limits are an essential part of defining the hierarchy as a way of informing drivers of the appropriate speed and likely activities on the road. In some high-income countries, changes in infrastructure layout and design features are also used to create a 'self-explaining road', indicating to road users what type of road within the hierarchy they are travelling on. This is achieved using standard features on different types of road within the hierarchy (such as median barriers on roads for through traffic in rural areas), and by clearly marking the transition between different types of road.

Sometimes there are few roads suitable for high speeds in a country. However, there may be a small network of good-quality *arterial* roads in rural areas that have, for example, features such as wide, paved shoulders, median barriers, adequate clear zones, few access roads, good alignment, good intersection treatments and few vulnerable road users (for example, pedestrians needing to cross it to access goods or services).

In most instances, on lower quality rural roads – often the majority of the rural network – consideration of severe crash risk potential and adoption of a *Safe-system* approach will lead to speed limits that are unlikely to exceed 60 to 70 km/h.

In urban areas, a hierarchy should also be identified so that local streets can be clearly separated from sub-arterial (distributor and collector) roads, and from arterial roads. An acceptable speed limit for each category of road should be introduced, reflecting *Safe-system* principles.

It is good practice to identify road sections where functions are in transition from through roads to roads serving local traffic functions, such as highways entering and leaving towns. In this case, short sections with speeds between highway and town limits should be defined so that there is no sudden drop or rise in speed limit. For example, a highway speed of 90 km/h dropping to an urban limit of 50 km/h may have a section between at 70 km/h to help prepare drivers for the changed speed environment.

A review of road classifications should be done periodically, taking into account population growth, urbanization, traffic mix, number of vulnerable road users and other factors that change the nature of road use.

Rural arterial and local roads

On rural arterial roads, vehicles usually travel at higher speeds and the distances travelled are often substantial. However, there may be places where large numbers of vehicles enter or leave the carriageway, or where there are numerous intersections and roadside hazards, or where there is a diverse mix of traffic, including vulnerable road users. Speed limits along these lengths of road should be lower, to reflect the increased risks resulting from the mix of functions and activities.

Local rural roads should be assigned lower speed limits that reflect their (usually) poorer quality. The presence of slow-moving vehicles such as tractors and other rural vehicles, cattle and other animals, as well as pedestrians makes it important to restrict travel speeds.

Urban arterial roads and local streets

Roads that form the 'arteries' for traffic flowing in and out of cities are described as urban arterials. If these roads are of a sufficiently high standard, and there is effective physical separation of vulnerable road users from through-vehicle traffic (with effective limitations on vehicle access to the road from abutting properties) then speed limits on these roads can be higher than on mixed-use urban local streets.

Speed limits on local urban streets should take into account the variety of functions of these streets. For example, school zones, shopping precincts and purely residential areas may have limits that ensure that young and vulnerable road users are not put at risk of serious injury. For these zones, limits as low as 20 km/h are appropriate. Merely posting lower limits will not ensure vulnerable users are not put at risk. The lower limits must be supported by the road layout and other appropriate measures.

Box 3.2 describes the impact of mixed user activity on a road hierarchy, and the need to prioritize pedestrians' and other vulnerable road users' safety above vehicle speeds.

BOX 3.2: **Function-based road hierarchy**

Roads in low-income countries can have a range of functions, including being a district distributor and transporting traffic throughout the city, to being an access road with houses and local amenities situated along it. This causes conflicts when attempting to develop Urban Safety Management techniques, and an adaptable approach may need to be sought.

Instead of an engineering-based road hierarchy, a function-based evaluation might be more appropriate in some countries, with land use being a key indicator of the road function and identifying whether this accords with the designated traffic function. This different approach would often give priority to pedestrians and those using the services situated along these roads as opposed to concentrating on vehicle needs and justifying safety measures to suit them.

In a number of countries, continuous segregated routes have been developed, linking areas of a town or city, which can also be considered part of the road hierarchy and have considerable potential for low-income countries. These include:

- **pedestrian routes:** include roadside footways, shared areas with other vehicles, footpaths or special pathways designed for shared pedestrian and cyclist use.
- **cycle routes:** include shared paths with pedestrians, separate cycle lanes on busy roads and separate cycle tracks.
- **motorcycle lanes:** purely dedicated to motorcycles in countries such as Malaysia and Indonesia which have very high usage of motorcycles.

Source: *(1)*

3.1.2 Speed zoning and speed limit reviews and guidelines

Beyond defining roads in a functional hierarchy, there are specific zones within each of the three levels of the hierarchy. For example, there are *transition zones* on arterials with a flow function as they approach a town, which may require slowing of traffic. Another example – this time with access roads in the local system – are *school zones* that require very low speed limits owing to the unpredictability of vulnerable pedestrian activities.

Establishing a consistent practice of limiting vehicle speeds on parts of road networks with similar functions and conditions assists drivers in developing good driving habits. Drivers come to understand and accept the need to limit their speed when entering certain types of area. Ideally, the areas will be *self explaining* or somehow give visual clues to the drivers about the need to drive within the prescribed speed limits.

Setting speed limits is a primary tool of speed management. This can be done in three ways. These are:

- non-signposted general, or default, limits – which set the maximum speed allowed on specific roads such as motorways, or in urban areas
- signposted limits on roads or sections of roads
- speed limits for specific vehicle or road user types – e.g. farm vehicles, heavy transport vehicles, learner drivers.

It is possible to set variable speed limits that can be changed at high-risk times, for example, when road workers are present, or when children are travelling to and from school, or during adverse weather.

A comprehensive review of existing speed limits – and especially default limits – is a key step towards reducing unacceptable crash and injury risks (Box 3.3). This should include an assessment of new road construction standards or road works in progress.

BOX 3.3: **Evaluating appropriate speeds using cost-benefit assessments**

In 2000, Norway's Public Roads Administration attempted to define appropriate speeds on various types of roads in built-up areas. Speeds were assessed on the basis of the following cost elements:

- time costs for all road users
- operating costs for motor vehicles
- crash costs
- costs related to the feeling of danger
- costs related to noise from motor traffic
- costs related to local and global pollution.

On the basis of these elements the following appropriate speeds were defined:

- regional main roads: 60 km/h
- local main roads: 50 km/h
- distributor roads: 50 km/h
- access roads: 30 km/h
- roads in city centres: 30 km/h.

These figures are calculated from a scientific base. It is then up to the relevant authorities to define speed limits on the basis of these calculations.

Source: *(2)*

Some examples of speed limits applied on rural and urban roads in low-income countries are set out below. However, it is essential that limits adopted after a review in any country reflect the road safety risks applying in each part of the road network. Current general speed limits vary internationally, but most higher income countries follow a hierarchical approach and adopt speed limits within the levels indicated in Table 3.1 *(3)*. The presence of pedestrians, two or three-wheelers, cyclists, farm vehicles and animal-drawn trailers using a road or street in substantial numbers, lower standard road geometry and unsafe roadside conditions will require lower limits than indicated in the table.

Table 3.1 **Average speed limits in high-income countries**

Urban roads	30–50 km/h
Main highways or rural roads	70–100 km/h
Motorways	90–130 km/h

The maximum speed limits in low- and middle-income countries vary widely from no limits at all to limits similar to high-income countries. Table 3.2 provides a sample of lower and middle-income countries' speed limits for rural and urban areas.

Table 3.2 **Speed limits in urban and rural areas of selected lower and middle-income countries (not including motorways)**

	Rural limit	Urban limit
Argentina	80–100 km/h	40–60 km/h
Kerala, India	70 km/h	40 km/h
Uttar Pradesh, India	No limit	No limit
Ghana	90 km/h	50 km/h
Indonesia	80–100 km/h	40–60 km/h
Malaysia	90 km/h	50 km/h
Nepal	No limit	No limit
Vietnam	40–60 km/h	30–40 km/h
Uganda	100 km/h	65 km/h

NOTE

Speed management on rural unsealed roads

Unsealed roads present particular problems for regulating safe speed limits. This is because the conditions on these roads can vary significantly over time as a result of weather and other factors. Additionally, enforcement of speed limits is difficult on rural and remote roads. In this case, it may be best to influence selection of speeds by providing guidance about conditions or features that suggest that drivers need to use caution in their choice of speed. A simple way to do this is to use advisory signs that do not prescribe speed limits, because a fixed advisory speed may give a false impression about the speeds that are safe at the time of use.

Speed limit guidelines

Guidelines for setting limits can be derived from the application of *Safe-system* principles. These are important to consider when establishing an appropriate speed limit. The *Safe-system* approach advises that:

- if there are large numbers of vulnerable road users on a section of road they should not be exposed to motorized vehicles travelling at speeds exceeding 30 km/h
- car occupants should not be exposed to other motorized vehicles at intersections where right-angle, side-impact crashes are possible at speeds exceeding 50 km/h
- car occupants should not be exposed to oncoming traffic where their speed and that of the traffic travelling towards them, in each instance, exceeds 70 km/h, and there are no separating barriers between opposing flows
- if there are unshielded poles or other roadside hazards, the speed limits need to be reduced to 50 km/h or less.

Until recent years many countries have used the 'common practice' approach to speed limit setting described in Box 3.4.

BOX 3.4: **Safety risk assessment instead of common practices**

At minimum, "speed limits should reflect an appropriate balance between safety and mobility. Many countries set limits for a given section of road according to a range of criteria, including road characteristics, crash records and measured free speeds. However, there are indications that too much weight is sometimes given to measured speeds (typically 85th percentile speeds) – based on the dubious assumption that most drivers make well-balanced speed choices – and not enough weight is given to objective assessments of risk *(4)*." It should however be noted that if the gap between the speed limit and the average speed is great, the limit will lack credibility and be difficult to enforce.

Increasingly countries are modifying speed limits to make safety the criterion to limit travel speeds.

Guidelines should consider the standard of road and the roadside, vehicle standards, the line of sight and visibility, road user mix and traffic volume. Existing guidelines for setting speed limits should be reviewed to ensure consistency. This achieves system integrity, leading to greater compliance of drivers (Box 3.5).

BOX 3.5: **Factors to consider when setting speed limits**

After considering guidelines based on achieving a *Safe-system* outcome, further local factors need to be considered in setting speed limits at particular locations.

- **Traffic mix** and the different types of vulnerable road user.
- **Crash history**, severity (injury) and crash rate (per vehicle kilometre of travel (vkt)) where possible. Road alignment (both vertically and horizontally). Crash prone stretches of road should have lower limits.
- **Road shoulder width** and **pavement quality** – narrow shoulder widths (especially those with poor pavement quality) can run an increased risk of ‘loss of control’ crashes. Therefore, speed limits should be lower for these conditions.
- Road **delineation** – edge and centre-line marking, reflectors and guideposts on the edge of shoulders and advisory speed limits. Where roads have poor visual definition, the speed limits should be lower to enable time for driver judgements.
- Road and **lane widths** should be adequate (i.e. at least two lanes with a minimum lane width of 3.4 metres). Narrow lane widths offer little margin of error and therefore speed limits must not exceed that required by drivers to keep consistently within a lane.
- The intensity of **land development abutting a carriageway** – in built-up areas, there is a dual risk of poor visibility and more varied activity of people and vehicles entering the road environment, and therefore speed limits should be lower.
- The type of **intersections** and the nature of traffic control measures at intersections. While all types of intersection present increased risk to road users – and roads other than motorways should have lower limits – poorly marked intersections require even lower speeds leading up to them than other, more clearly marked intersections or roundabouts.
- Traffic **volume and traffic flow** – lower speed limits in areas of high traffic volume can be used to smooth traffic flows, making for better network efficiency and environmental benefits, as well as improved safety.
- Types and standards of **vehicles allowed to access** – roadways that vulnerable road users such as cyclists are allowed to use should have lower limits than those that only allow four-wheeled (or above) motor vehicles.
- The **free travel speed** of the road.
- The ability to **overtake safely** (within sight distance) at the posted speed.

CASE STUDY: **Setting speed limits in South Africa**

A study of speed-limit setting practices in South Africa in 2000 found that speed limits were “inconsistent, leading to the perception among drivers that they are unfair, and that the sole purpose of the limits is to prosecute drivers to generate income and not to improve safety”.

This highlighted the need for all speed limits to be established by adequately qualified practitioners, and that a certificate be issued by such a person for each speed limit introduced. The study group also proposed that provincial and national governments institute Speed Limit Review Boards to oversee the process of establishing speed limits. Source: *(5)*

While consistency of limits in similar risk settings is highly desirable, substantial variations in existing crash and injury risk along sections of the network may require different limits to be applied, unless engineering measures can be taken in the short term to lower the risk. In the long term it is important that all measures complement each other, e.g. both speed limits and engineering measures should encourage drivers to use the same speed. If road layout and signs do not complement each other, the public will not trust the system and therefore not respect the law.

BOX 3.6: **X-Limits – speed limit tools**

Most Australian jurisdictions have adopted the use of an 'expert' computer system to assist setting of speed limits. The *XLIMITS* series, considers a variety of factors in the setting of speed limits, including road and road environment factors (road function, number of lanes, horizontal and vertical alignment, presence of a median or service road), abutting development, nature and level of road user activity (pedestrians, cyclists and heavy vehicles), crash history, existing operating speeds, traffic volumes and adjacent speed limits.

Certain basic information, or 'determinant' factors produce an initial speed limit value, while other modifiers or 'advisory' factors highlight issues that require further consideration and that may alter the initial speed limit value.

The tool is based on extensive trials and input from an expert group. Versions have been provided for New South Wales, Victoria, Queensland, Western Australia, South Australia, Tasmania, New Zealand and the US, each tailored to meet local speed setting guidelines.

Further details on the XLIMITS system can be found in *(6)* and *(7)*.

Finally, care needs to be exercised when introducing speed limits for the first time on a section of road where they have not previously existed, or to increase or decrease limits on an existing section of road. Studies have shown that mean speeds will increase if new limits are in excess of previous mean speeds. This will lead to increased fatalities and serious injuries on that section of road unless extensive targeted infrastructure safety works are carried out.

CASE STUDY: **Effect on mean speeds of changed speed limits, Finland**

A Finnish study examined the introduction of speed limits on rural roads that had previously had no limit. The report includes analysis of how limits related to initial free speeds that were not subject to posted limits or enforcement.

The research showed that setting limits:

- below the pre-existing 85th percentile free speed reduced later mean speeds
- above the pre-existing 85th percentile free speed increased later mean speeds
- at the pre-existing 85th percentile free speed did not change later mean speeds.

Injury crashes were reduced if (and only if) mean speeds were reduced (and increased if speeds increased).

Source: *(8)*

3.1.3 Informing drivers of limits – signs and default limit information

There will usually be an agreed general speed limit for higher standard rural and urban roads, and these are normally referred to as the 'default' speed limits. While these are usually not signposted, they should nevertheless be clear to existing and new drivers (including visitors) entering the road network. How they may vary should be indicated by specific signs.

Locations where alternative (to default) speed limits apply are usually depicted by regulatory speed limit signposting.

These limits may include:
- linear speed limits (including transition/buffer speed limits) i.e. along lengths of roads and streets
- shared road-space speed limits for combined pedestrian and vehicle use areas, usually less than 10 km/h
- area-wide residential or commercial speed limits, with signs at entry point to the designated area
- time based speed zones
  - *school speed zone* – usually twice daily time-based lower limits for an hour or so at school starting and finishing times
  - *seasonal speed zone* – for example at beach resorts in busier summer months when vehicular and pedestrian traffic is greater
- variable speed limits (limits that change under certain conditions or times of day). These are usually electronic signs with lower limits applying for example, in wet or windy conditions
- heavy vehicle speed limits. Regulations may specify a lower limit for heavy or light vehicles on roads in open rural areas and on roads in urban areas.

Where rural roads are of a very high engineering standard, with clear and protected roadsides and limited potential for conflict with vulnerable road users or vehicles entering from the roadside, a higher limit may be appropriate. In such cases, adequate signs are needed to make it clear that the default limit does not apply. It is important that speed limit signs are provided at the end of that higher speed length where the speed limit reverts to the default limit. For sections of road where the default limit is considered too high and would provide an unsatisfactorily high road safety risk, lower limits may be called for. Regular signs are also essential at the beginning of the lower speed limit section, and at intervals along the length of that section.

As an example, repeater signs every 400 metres from the initial speed limit change could be considered a minimum standard in urban environments where the default limit does not apply. The signs should reflect international good practice, should be distinguished from other statutory and advisory signs and from other visual roadside clutter.

Signs and markings should follow the Vienna Convention (www.unece.org/trans/roadsafe/rsabout.html). This convention provides international consistency and enables drivers from other jurisdictions to more readily understand them.

Signs and road markings can be costly, but are crucial. Speed limit signs should be produced using material that is reflective, especially for sections of road that are not well lit at night. At points where speed limits change it is good practice to mark the limit with paint on all lanes of the roadway. While electronic, variable speed limit signs are more costly, they can be cost effective on high-traffic routes, or in areas where there are particularly important road safety risks to address, such as in school zones.

In rural areas, speed limit signs should be repeated at least every 5 km along the length of road where the default limit does not apply and the conditions are reasonably consistent.

It is not recommended that varying differential speed limits apply to different categories of vehicle on a section of road. This would create the opportunity for substantial turbulence within traffic and may increase the frequency of overtaking manoeuvres, which can in themselves lead to increased crash risk. If there is to be a lower limit – for example, for heavy vehicles – it is suggested that this is a consistent amount below general limits, whether default or signed, on all rural roads. Speed differential is a major cause of crash risk on higher speed roads.

Advisory speed warning signs

Advisory speed signs may be used with a warning sign where the safe speed is lower than the applicable speed limit (Box 3.7). This applies to weather, traffic and road conditions to provide for safe travel through the hazard (e.g. horizontal and vertical curves). Advisory speed signs are not generally recommended for unsealed roads, as it cannot be reasonably assumed that the advisory speed will remain the same and that the road will not be subjected to major changes in surface condition as a result of weather and wear. In these situations an appropriate hazard warning sign is more appropriate.

If these warning signs and advisory speed are to be used, it is important that they are consistent in their application and in the advice they give, particularly in relation to safe speed. Inconsistent application may well increase risk, rather than achieving an overall reduction in risk.

BOX 3.7: Unsafe but legal travel speeds

Advisory speed signs are often used on sections of road where the safe travel speed is below the applicable speed limit, such as tight curves.

Drivers of cars and heavier vehicles will usually observe this advice (or at least be alerted to the hazard) as it is often not feasible for some vehicles to negotiate the curve at a higher speed. However, for two-wheelers, it will very often be possible to travel through the bend at a higher speed than is advised or safe, but which is within the statutory limit.

It is always the responsibility of the driver to drive in accordance with the conditions. However there is always a need to consider whether limits on sections of a curving road should be lowered, rather than placing reliance on compliance with advisory signs.

3.2 Changing behaviour – regulating and enforcing speed

Establishing a clear legal framework for managing speed is a fundamental requirement for achieving compliance with speed limits. Traffic laws, enforcement strategies and resources, as well as effective and efficient mechanisms to administer penalties, are needed for this task.

3.2.1 Road rules, legislative and regulatory settings

Road rules or highway or traffic regulations that set out the framework for behaviour of road users are most often authorized by the relevant Transport or Road Safety Act. A road rule can specify that a driver must not drive over the designated speed limit on a length of road (and define the various penalties for different levels of non-compliance).

In road rules in most jurisdictions, it is the presence of signs that imposes the legal obligation for compliance.

Signs, in accordance with the road rules, should specify where the speed limit starts and finishes – for example when a speed limit sign with a different number is observed further along the road, or the road ends at a T-intersection or dead end, or a speed de-restriction sign has been installed at a point on the road. Other provisions for the establishment of, and compliance with, speed management instruments such as school speed zones, speed limited areas and speed limits in shared zones (as well as general, default speed limits applying across urban and/or rural areas in each country) should be specified in road rules. The form and appearance of speed limit signs and special signs such as area-based speed limits, shared zone speed limits or school zone speed limit signs (where applicable) should also be described and published in the road rules.

It is essential that new or amended legislation and regulation clearly require compliance with speed limits and provides for enforcement of those limits by police through a variety of means, including automated camera enforcement. In most jurisdictions, legislative power is necessary to use automated enforcement in various ways, such as mobile and fixed speed cameras, as well as police operated hand-held or car-mounted speed detection devices. Laser and radar speed measuring devices are generally accurate to within + 2 km/h and + 3 km/h respectively. In enforcement operations it will only be possible to prosecute a driver for a measured speed that exceeds the limit by more than the tolerance.

Subordinate regulations are usually required to specify the type of technology, validation procedures and the chain of evidence that is to be applied from the point of offence to the payment of the fine or subsequent court processes.

It is advisable that the level at which police will penalize a driver for exceeding the limit, known as the enforcement tolerance, is not set too high. In a number of jurisdictions, police have reduced the allowable tolerance from 10 km/h above the speed limit to a level approaching the equipment tolerance of 3 km/h above the speed limit. Evidence shows that the reduction in free speeds and in fatalities – especially vulnerable road user fatalities – as a result of this have been substantial *(2)*.

3.2.2 Speed enforcement methods

A number of police forces internationally have adopted enforcement methods based upon an *anywhere, anytime* approach to deter all speeding on the network (Box 3.8). The message is clear: speeding is illegal and unacceptable behaviour, and at odds with the interests of the community.

BOX 3.8: **Specific and general deterrence**

How speed enforcement is done determines whether its principal effect is through *specific* or *general* deterrence.

- Operating highly visible (police or fixed camera) speed enforcement in the same areas all the time is likely to result in drivers being deterred from speeding only in those **specific** areas.
- Operating a mix of highly visible and strategically directed police patrols or speed cameras increases public perception that speed enforcement can happen anywhere and at any time. The unpredictability of where and when speed enforcement operations take place will have a more **general** deterrent effect by encouraging drivers to drive within the speed limit no matter where or when they are travelling. An example is shown in Appendix 2.

Convincing the public of this can be difficult. It usually depends upon substantial resources for mobile police or mobile camera deployment, supplemented with fixed cameras at high risk locations. It will also be dependent upon extensive public advertising to increase the perception that widespread enforcement is taking place.

In routine patrols, speed checks are commonly undertaken with a police vehicle maintaining the same distance behind the offending vehicle over a distance of at least 200–300 metres, and checking the speed on the police vehicle's speedometer.

Time over distance in vehicle speed measuring devices provides an effective and indisputable speed measurement in either urban or rural areas. These instruments are set by the police officer when the speeding vehicle is first observed and followed, to just prior to the point of interception when the instrument is again triggered. This method uses both the police speedometer and the odometer to provide the average speed over the observed distance. It provides a fairer assessment of the offender's speed, eliminating excuses of 'just passing another vehicle', 'keeping up with the traffic', or 'I only speed for a short distance'.

Two parallel pneumatic tubes affixed across the roadway – see Section 2.2.2 – can be used to measure time over distance for an accurate speed calculation with a police colleague at a safe interception point a few hundred metres further on. In most jurisdictions these have been superseded by radar or laser equipment.

Speed estimates are also acceptable in some jurisdictions where a speeding vehicle may pass a marked or unmarked police vehicle (here, there is a comparative speed measurement). The driving and traffic patrol experience of the police officer may be used to substantiate an estimate of the vehicle speed, coupled with the offender's explanation for the errant behaviour. In some countries it is the police officer's opinion which is the primary evidence and the equipment is the secondary (Box 3.9).

BOX 3.9: **Evidential requirements**

In all cases, the burden of proving the actual speed and linking the speed to the offending driver rests with the police. Evidence will include:

- the identity of the driver
- evidence of the speed limit
- verifiable evidence of the speed alleged, including visual observations
- the type of equipment used
- the fact that the equipment was certified as accurate (by a secondary speed measurement device verified periodically)
- any explanation offered by the driver (not essential)
- environmental conditions e.g. traffic, weather and road conditions (relevant although not essential).

At a very basic level, using stopwatches to measure the speed between two points on a section of road which are a known, accurately measured distance apart, can be a useful form of speed enforcement. The distance can be between lines marked on the roadway or between two fixed objects in the environmental setting.

Certification of equipment accuracy may be carried out by independent laboratory testing or through police workshop technicians, reflecting the processes accepted by regulation or policy. Whatever the process, it must be able to be verified as evidence in a court of law.

Evidence of identity is not always required with speed camera technology. In some jurisdictions owner-onus legislation applies, i.e. the owner of the vehicle is liable unless s/he provides a declaration naming the offending driver at the time of the alleged offence. Some jurisdictions require a photograph of the driver; however, this does limit camera effectiveness as a deterrent.

Where camera-based operations cannot be introduced in the short term, effective compliance can be achieved (particularly in urban areas) with widespread use of hand-held radar or laser devices, coupled with normal traffic patrols and relevant interception strategies. The visibility of police operating to ensure speed compliance is often far more effective than issuing traffic infringements or tickets. Behavioural change will occur when the public perceive there is a high risk of being detected speeding, and that detection will lead to a penalty.

Equipment can later be upgraded to car-mounted, mobile radar devices and in-car video equipment which now provides the most up-to-date, high-impact police enforcement tool for traffic offenders.

CASE STUDY: **Intensifying enforcement and penalties to improve rule compliance, France**

The intensification of enforcement and penalties was achieved through introduction of automatic enforcement and penalty systems for speed violations. In November 2003, the first speed cameras were installed across the country. At the end of 2004 there were 400 speed cameras (232 fixed and 168 mobile) and by the end of 2007, there are to be 2,000 systems in operation (including fixed and mobile cameras). Around 75% of cameras are in rural areas and 25% in urban areas.

The enforcement process is now fully automated. The penalty system was modified, with minor offences having fixed fines, and more serious offences having greater fines. Overall, detection rates have increased and sanctions are more severe for repeat offenders.

The results have been very positive. Fatal and injury crashes decreased in the vicinity (6 km) of fixed cameras by 40 to 65%.

Average speed on French roads decreased by 5 km/h over three years. The rate of excessive speeding (more than 30 km/h over the limit) was reduced by a factor of five.

Between 2002 and 2005, fatalities decreased by over 30% in France – an unprecedented result. These substantial decreases are not entirely due to the implementation of automatic speed controls, but it is estimated that the decrease in speed, in which automatic speed control played the major role, accounted for roughly 75% of this decrease.

Source: *(2)*

The use of speed cameras can be a cost-effective speed management tool. It provides consistency of enforcement, reduces individual police discretion and removes point of interception collection of penalties. This reduces the potential for corrupt enforcement practices.

CASE STUDY: **Speed cameras in Santo André, Brazil**

In Santo André, the town council implemented a general road safety programme that included electronic enforcement using radar systems. Information on factors such as traffic flow, crash rates and road function were used to identify suitable camera locations. Installation of equipment was preceded by media publicity and the use of roadside banners to make the public aware of the safety benefits of speed management. Counter-campaigns were initiated by some driver and political groups in opposition to the programme. Despite such problems the campaign continued and expanded. The first year resulted in a reduction of 8.6% in crash fatalities (compared to the previous year) while the second and third years produced further reductions of 17.6 and 25.7% respectively. A similar programme conducted in Sumaré also resulted in significant crash and injury reductions.

Covert or overt use of cameras

A highly effective speed management strategy involves speed camera operations combining both fixed site and mobile (vehicle-based) camera operations. Fixed cameras, although usually readily observed or soon identified by drivers, provide a strong message that speeding will not be tolerated and visible controls are in place. As a complementary strategy, the use of covert mobile cameras, particularly in urban areas, has been proven to be highly effective in conveying the message to drivers that speeding is illegal and not permitted anywhere or anytime *(9)*. The mix is very effective in reducing average travel speeds on major sections of the network – in some cases to below the applicable speed limits.

Fixed cameras are another useful measure for addressing speed related crash risk at a particular location on the network. They tend to operate as a blackspot treatment with measureable effects upon crashes at the locations where they are placed. However, there is little evidence that they have an impact on crash reduction on the rest of the network except for a small 'halo' effect stretching a few kilometres from the camera site.

Preconditions for introduction of effective automated enforcement systems

There are a number of substantial constraints on adopting an automated speed enforcement programme (Box 3.10). Adequate administrative systems are needed in a number of critical areas before these programmes can be implemented.

BOX 3.10: **Support requirements necessary for automated camera enforcement of speed limits**

- Reliable camera technology, including accurate speed measuring equipment, clarity of image capture and effective maintenance programmes.
- A reliable postal (and property address) system for the whole jurisdiction.
- Reliable and comprehensive, computer-based driver licensing and vehicle registration systems.
- Regular and accurate data capture, verification processes and transfer by police and the court system to licensing and vehicle registration databases.
- An effective back-office processing system, including issue of infringement notice and follow up procedures for collection of unpaid fines from defaulters.
- A system for preventing the vandalising of equipment.

3.2.3 Penalties – fines, demerit points and licence suspensions

For effective deterrence it is essential that legal penalties are set at a sufficient level of severity *(10)*. The levels of fines and/or demerit points incurred towards licence suspension should escalate as the level of speeding above a speed limit increases. The introduction of effectively applied demerit point systems in many countries has been accompanied by substantial reductions in road trauma.

CASE STUDY: **Demerit point increases and effects, New South Wales, Australia**

In an effort to give more effect to its speed management programme, the New South Wales regional government conducted a trial of doubling the demerit penalties for speeding offences in 1999. Over the 45-day 'holiday period only' trial involving publicity about the penalty and enhanced enforcement, the outcomes included:

- a decrease of between 27–34% in fatal crashes
- a decrease of between 27–30% in road fatalities
- an estimated $1 million worth of additional media support
- high levels of community awareness and support
- reductions in traffic infringements.

Source: *(11)*

When appropriate regard is given to the risks associated with small increases in speeds above speed limits, it is important that the level of penalties for various levels of speeding reflect the relative risk to human life that the particular level of speeding poses. Licence suspension (and for very high speeds, licence cancellation) can be an effective deterrent against speeding, and in some countries immediate licence loss can take place when drivers are caught travelling at 25 km/h or more above the speed limit. Other penalties such as vehicle impoundment or confiscation for extreme or repetitive speeding may also be effective deterrents.

It is also critical that where licence sanctions are imposed – such as suspensions, disqualifications or cancellations – police and licensing authorities have the ability to ensure that these sanctions are rigorously enforced.

Penalties for non-compliance with speed limits

Various methods can be used to enforce the law.

- **Warning notices** can be issued in the time between any new law being passed and its full implementation. These notices inform drivers and riders that they have committed an offence under the new law, and that in the future a penalty will be imposed for breaking it.
- **Fixed penalties** can be issued with a written infringement or violation handed out on-the-spot, requiring the offending driver or rider to pay a fine to a given department (which can be separate from the police department) by a specified date (Figure 3.2).

To operate this method effectively, a computerized database should be set up to record all offences.

On-the-spot fines are levied in some countries. These are where speeding drivers or riders can be issued with an immediate infringement notice requiring the payment of a fine. Such systems should be upgraded immediately to ensure that no money transactions occur at the interception point, and a full audit of any financial transactions is maintained. This will minimize allegations of bribery, corruption and favouritism.

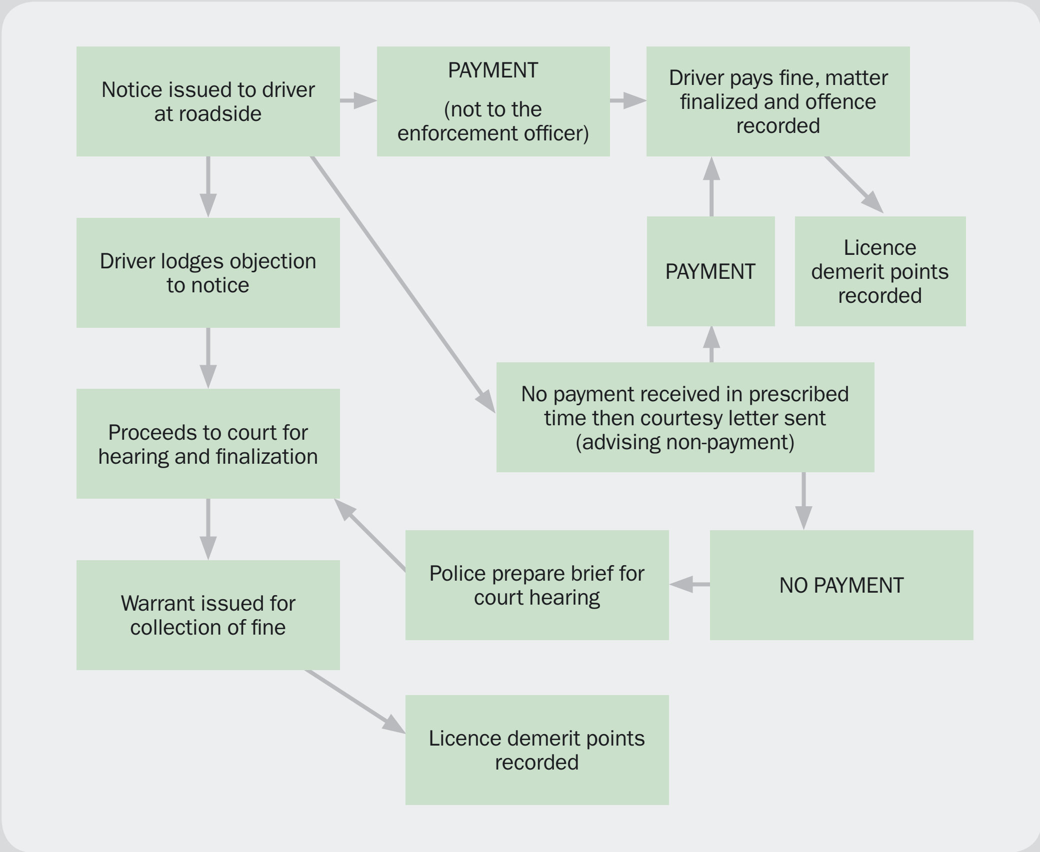
Confiscation of licences or of vehicles can be applied for serious speed offences as a blanket rule, or to repeat offenders. However, such measures are usually implemented only after other measures have been tried and found to be unsuccessful.

Demerit or black-point systems seek to deter drivers from continuing to re-offend for a range of road-law related offences. Countries without such a scheme should consider one. These schemes require the licensing authority to maintain accurate records with regard to all individuals holding licences so that each conviction for an offence reported can be recorded and attributed to the correct person. Demerit points are a form of penalty imposed when particular traffic offences are committed. When issued with a learner permit/driver licence, each driver has no demerit points.

Demerit points accumulate if a driver commits an offence that carries demerit points. A fine will often be imposed together with demerit points. Demerit points remain valid for a number of years (often three years) and the legislation specifies sanctions which are imposed when the number of 'points' reaches a particular level – e.g. cancellation of a licence with 12 or more points.

For additional examples of penalties applied to speed offences, see Appendix 3.

Figure 3.2 Process for handling fixed penalty notices and demerit point allocation



3.3 Changing behaviour – public education

Research and evaluation studies present mixed findings about links between extensive public education and the risks associated with speeding, and subsequent changes in driver speed behaviour *(12)*. The general conclusion is that mass media road safety campaigns can change knowledge and attitudes but there is limited evidence that they change behaviour in the absence of accompanying enforcement.

However, while acknowledging enforcement is essential, there are good reasons to carry out public education about the risks associated with speeding and the benefits associated with reducing mean travel speeds on any section of road or street.

3.3.1 Social marketing and public education

The objectives of speed management campaigns may sometimes be to win greater public support for measures that will have an impact on individual road user behaviour, such as legislation, stronger penalties, more enforcement or road/traffic engineering changes. In other words, the aim is to *create a demand for speed management*. This will make it easier for governments to act by reducing some of the community resistance that they might otherwise encounter.

It is important to realize that while conveying dramatically the sometimes devastating harm of a speed related road crash usually does not change individual driver behaviour, it can serve as a *call to action,* or a way to draw attention to an important injury threat in the community. Using advertising to influence people emotionally can assist in persuading them that there is an important problem to address. When the community is convinced that the issue of speeding is an important one to understand, they will then be prepared to learn more about it and support actions to reduce the problem.

In Modules 1 and 2 the link between small increments in speed and increased risk of fatal crash involvement was discussed. This information can be conveyed to the public over time using mechanisms that are in accord with local customs and supported in a variety of ways to achieve broad awareness of the message and its seriousness. The community needs to understand why speed compliance is being sought, what the benefits are and why it is necessary for them to modify their behaviour.

It may be best to start public information campaigns about speed with less controversial issues such as increased crash severity caused by excessive speed. Another less-disputed topic that the community is often interested to know about is differential stopping distances required under different speeds, weather and road surface conditions.

There is also a case for using publicity to inform the public in advance of increased levels of enforcement in order to avoid adverse reactions against the police. This is particularly the case where laws are changing – for example if a new, lower, speed limit is to be introduced.

CASE STUDY: An evaluation of the effectiveness of televised road safety messages, Ghana

The effectiveness of televised advertisements conducted by the National Road Safety Commission in Ghana was evaluated in 2005. The advertisements concerned speeding and alcohol-impaired driving and were targeted at commercial drivers. Focus group discussions were conducted with 50 commercial drivers in four cities. Discussions addressed coverage, clarity and appropriateness of messages, including suggestions for improvements.

Most contributors indicated that the messages were clear and appropriate. Television reached all participants in this urban group. However, they felt that other modes of communication, such as flyers and radio, should also be used to reach drivers who did not own televisions. A particular problem was language. The advertisements had been in English and Akan (the most common vernacular language). Participants wanted the messages diversified into more of the major Ghanaian languages.

Some participants were unclear on the behaviour that the advertisements were telling viewers to take. Participants advocated greater involvement by police in road safety. The advertisements reached and were understood by most of the target audience. Opportunities for strengthening the messages included using other media, increasing the number of languages, and stressing the change in behaviour being recommended. Overall road safety would be strengthened by increasing accompanying law enforcement activities related to speed and alcohol-impaired driving.

Source: *(13)*

Public figures as role models

In any campaign where government is seeking to change often deeply embedded behaviour (such as speeding) in a substantial proportion of the driving population, it is useful to seek to obtain the agreement of politicians, senior public officials, police and road authority staff to comply with speed limits in their driving tasks – and not only with work-related driving. Having 'opinion leaders' and celebrities to support speed campaigns can be very useful in getting public support.

It is unhelpful if public officials or politicians are known to be flouting the law. Obtaining their commitment to respect speed limits is also a very interesting way to assess underlying government support for behavioural change. It will be a barometer of their preparedness to identify with the changes being sought.

3.3.2 Increasing public perception of being detected by police

In some countries, being detected by police and charged with an offence is more likely than having a serious crash. To the individual, the risk of being caught and penalized is thus more likely to influence their choice of speed than fear of a crash. Perception of speed enforcement is a much stronger behavioural influence than messages about the injury risk of speeding.

Research indicates that combining specific public education campaigns with visible enforcement of speed can result in measurable reductions in speed related crashes *(14)*. Advertisements in the media that serve to increase the perception that drivers not complying with speed limits will be detected – and if detected, sufficiently punished – are likely to deter that behaviour.

3.3.3 Speed compliance incentives

Some countries have introduced incentives (although these tend to be small) for drivers to comply with limits (and other road laws). The potential benefit is improved public acceptance of tougher speed enforcement. One scheme in operation in Victoria, Australia, provides a 30% rebate on licence renewal for drivers with no offences (for any road laws) in the prior three years.

The benefits in terms of crash reduction are unknown and expected to be minor, but it is recognition, albeit in a small way, by government of those drivers who have not infringed and an offset – in political terms – to stringent enforcement of compliance. Such 'carrots' (rewards) can be effective in supporting the more common 'stick' (punishments) approaches.

NOTE

A word on driver training...

Post-licence, off-road driver training is usually not effective in reducing risk. Researchers believe that this is because additional training to increase driving skill tends to lead to higher risk driving because of a belief that faster speeds can be driven with enhanced driving skills.

Source: *(15)*

3.3.4 Community-based programmes

Sometimes people in local communities are motivated to take action themselves to reduce problems associated with speeding. These actions can range from community-based education initiatives, community members constructing speed humps or other traffic slowing devices in the roadway, or retribution directed at drivers who kill or injure people when driving too fast through towns.

This kind of community activity shows concern about the problem, but can create additional problems if not guided by road safety expertise. However, gaining community involvement in road safety and speed management is an effective means of influencing road users in a way that government agencies alone cannot achieve. Voluntary community work can also help to offset the costs of speed management programmes.

CASE STUDY: **Community involvement in speed enforcement, Thailand**

In Thailand, many rural communities are faced with drivers driving fast or in an impaired condition through their villages, and crashes involving villagers are frequent. The drivers/riders are often young and male.

In Khon Kaen province in the north-east of Thailand a number of community groups could no longer tolerate this behaviour and went together to the district police office to ask for help. The police were eager to help but could not see how it was possible to strengthen traffic law enforcement in these very rural and spread-out communities.

A special initiative was set up and villagers were trained to take action with (police) authority. Uniforms were provided to support this. The volunteers cannot enforce laws but have radios so they can call the 'real' police in case of trouble.

The police support the programme for two reasons. For a little investment, they get better compliance outreach, but also achieve better understanding by the public of their role in enforcing the law for the benefit of the community.

Thai villages are commonly set out in similar ways, with village gates at both ends of the village; this helps with monitoring the vehicles entering or leaving. At the gate there is often a little hut where the volunteer can sit. Where the volunteers note speeding, or believe drivers or riders may be under the influence of alcohol or other drugs, they would talk to the drivers, explaining to them the requirement to behave lawfully and responsibly.

The programme was introduced in 2005 and 35 villages participated with 350 volunteers (ten per village), of which 200 are women. The volunteers have been selected by the villages themselves and no payment is received by them. Since the introduction there has been a reported 50% reduction in both road injuries and fatalities.

3.3.5 Licensing and speed restrictions

It is extremely important when learning to drive that new drivers learn to drive at the right speed for the prevailing conditions. Even when no obvious limits or clear engineering measures are present, drivers are expected to be able to adjust speed according to the environment. For example, in Malaysia, speed management is part of the driving curriculum.

New drivers rarely have a good sense of relative speeds and some may be a little over-confident. To cover this, some jurisdictions license new drivers in stages. When drivers are starting to learn, they are sometimes required to have a licensed driver with them while driving and to drive at speed limits set lower than the limits for fully licensed drivers. Sometimes, there are one or two additional levels of provisional licence that new drivers must pass through before finally receiving a full licence, each with speed restrictions and sometimes restrictions on the number of demerit points they may receive without losing their licence.

3.4 Engineering treatments

There is a large range of engineering treatments that have been shown to be of varying use in speed management. These measures are described in significant detail in various manuals and text books, and we do not intended to repeat all this information here – recommended references are *(1, 16–22)*. However, a broad overview of available treatments is given below. A number of case studies which are known to have been effective in addressing speed are provided.

These treatments include engineering or re-engineering the road to encourage lower speeds, or make the road and its environment more forgiving or 'self-explaining'. There are also treatments that aim to separate road users, particularly vulnerable road users such as pedestrians and two-wheeled vehicles, from potential collisions that could cause injury.

3.4.1 Treatments to slow down motor vehicles

There are a range of physical features that have been developed by road safety and traffic management engineers that encourage, or force, drivers to drive more slowly. Many of these treatments have the effect of making it feel uncomfortable to drive in excess of the legal or recommended speed. Some examples are raised humps or platforms across the roadway, road narrowings or 'pinch points', roundabouts, road markings, signs and physical structures that signal to drivers that conditions are changed such that they should slow down. In addition, fixed speed cameras can sometimes be used as an alternative traffic calming or traffic slowing device.

CASE STUDY: **Raised area (trapezoidal hump) in Tamale, Ghana**

The trapezoidal hump is made in concrete, which is relatively easy to manage during construction. The height is 10 cm and the ramp on each side is 1 m long, corresponding to a gradient of 1:10. The length of the flat area is about 7 m. It should be at least 4 m, and at least 7 m, on roads with bus traffic. These properties aim at a desired vehicle speed of 30 km/h for cars and 10 km/h for buses and other heavy vehicles. The ramps can be extended to 1.7 m for a desired speed of 40 km/h (20 km/h for heavy vehicles) and 2.5 m for 50 km/h (30 km/h for heavy vehicles). However, the height is always 10 cm.

Signs and markings

Drivers are properly warned in advance to lower their speeds. This is done with painted black and yellow stripes on the ramps, and hump warning signs ahead of the humps. Street light is also considered important although this is sometimes a problem in practice in Ghana. It should also be noticed that the speed limit around the humps, ideally, should be changed to the desired speed of 30 km/h

Impact

Speeds have clearly been lowered and vulnerable road users find it easier and safer to cross at the location after the construction of the raised areas. However, a more comprehensive impact assessment is yet to be done.

The two raised areas are staggered on each side of the central island to slow vehicles down before the zebra crossings.

Illustration of the cross section of a raised area in concrete, 10 cm high and with 1 m long ramps for desired speed (30 km/h).

Speed humps and raised platforms at pedestrian crossing locations and at intersections

Single raised structures in the roadway (such as speed humps) are effective, especially in urban road environments. However, more lengthy sections of raised materials that affect drivers with audio and tactile signals when driving over them can be good options for slowing high speed traffic on the lead up to a changed traffic condition, such as an intersection that follows a lengthy stretch of a higher speed road. These are sometimes called 'rumble strips'.

CASE STUDY: Speed control using speed humps on intersection feeder roads, China

The speed hump is an effective speed reduction measure, placed across the road with a profile a little higher than the road surface. It is usually constructed of bituminous concrete, cement concrete or rubber.

Its vertical cross section can be semi-circular or parabolic. Its dimensions should be designed to ensure the safety of vehicles crossing it. At each end of the hump, near the kerb, the treatment should ensure that road drainage is not impeded. On a road section with speed humps, clear signs or markings should be placed to warn drivers, and the hump would usually be painted with reflective markings.

Speed humps force speeding drivers to slow down before intersections. When an emergency occurs, braking at lower speeds will reduce collisions with vehicles on intersecting roads. The speed hump is an effective speed reduction measure, with low project cost and high practical benefit. It has been broadly applied on national intersections with visible implementation effect.

Condition of road sections where speed humps were placed

The section from Taicheng to Guanghai of the Jingguang Line Road in Guang Dong province is a typical secondary road with many small intersections. There are 63 intersections with local country roads in a 40 km stretch. Minor intersections, without clear characteristics, are often blind spots for drivers on arterial roads; in addition, local road users often lack safety consciousness and it is very common to see tractors, motorcycles and pedestrians not correctly assessing the higher speed of vehicles on the main road, resulting in numerous traffic accidents. In 2004, 14 people were killed in traffic accidents on this section of road, and minor intersection risks were identified as the main road safety problem.

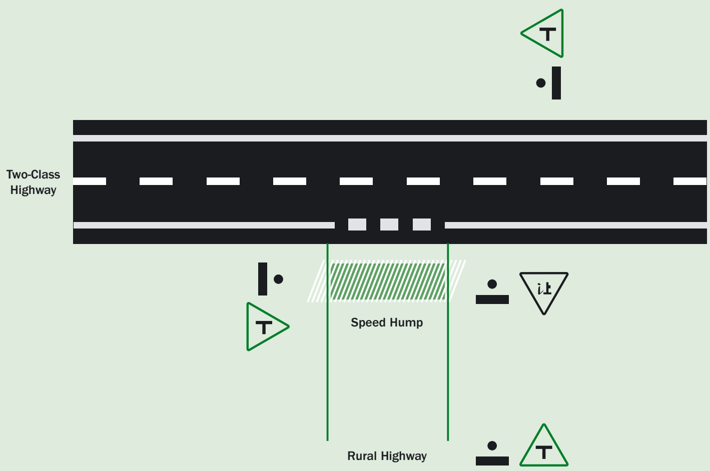
Scheme of implementation

In December 2004, intersections along this stretch were improved. Signs alerting drivers of the presence and location of intersections with minor roads were set up. Speed humps made of concrete were constructed on the branch roads (prior to intersections with main roads) to slow approaching vehicles. The speed humps are 450 cm long and 36 cm wide, and the height above the road surface is 6 cm. The vertical cross-section of the hump is trapezoidal in shape. The surface of the speed humps has been painted with yellow and dark reflective lacquer. 'Slow down' signs have been set up in advance of the humps to attract the attention of drivers.

Effect of implementation

Since installation of speed humps at small intersections along the route, crashes have reduced substantially.

Speed humps are also being used to control speed on lower classification roads in other areas and provinces, and are also proving effective. For example, in the city of Puyang in Henan province, speed humps were installed on a number of lesser roads intersecting with highways in May 2004. The number of crashes at the intersections declined, with the number of fatalities reducing by 61% compared with 2003.



Layout of speed hump installation on a feeder or branch road at the intersection with a highway

CASE STUDY: **Rumble strips at high speed junctions, Ghana**

A heavily used junction located on a main highway in Ghana used to be a notorious spot for road crashes. In 1999 engineers installed a series of rumble strips on the approaches to the junction. They were created using hot thermoplastic road marking material, and each strip was 500 mm wide, covering the full width of the road. They had a rounded profile and at the time of installation the crest was 25 mm high. Drivers were warned by means of upright signs.

A 'before and after' study undertaken by the Building and Road Research Institute found that the annual number of crashes fell by 35% after the speed management treatment. Observations of the behaviour of drivers at the site some time after the treatment revealed that a few car drivers were still speeding, perhaps because the strips had become worn down by the traffic to the extent that they no longer caused noise and discomfort when crossed at speed. It is clear that the design and maintenance of the rumble strip's profile may be critical for success.

Source: *(23)*

For additional illustrations of 'traffic calming' treatments tried in Ghana, see Appendix 4.

Gateway treatment at entrances to towns and villages

Gateways are devices used to mark a threshold – usually to a village or higher risk location on the road – where lower speeds are required from drivers.

Gateways rely on highly visible vertical treatments to capture driver/rider attention and usually include:

- large signs conveying the message that it is an entry to a location where pedestrians and other vulnerable road users are about to be encountered in greater numbers
- pavement markings to narrow the perceived width of carriageway, including painted central medians for a short distance at least
- large speed limit signs showing the lower speed limit that applies
- other pavement markings to indicate clearly that a threshold is being crossed into a different environment
- architectural and rural treatments such as picket fencing or gates, earth mounds and rock walls.

Markings can also be used to indicate an approach to a pedestrian crossing, or other changed traffic conditions where drivers should slow their vehicles in the interest of safety. A simple white jagged line as a centre line plus zig-zag lines on the edge of the lane, on both the approach and departure side of the crossing, can be used (and suitably promoted) to warn drivers that they are approaching a crossing.

CASE STUDY: Speed management on rehabilitated roads through villages, Fiji

It is frequently the case that road improvement and rehabilitation schemes carried out in low and middle-income countries result in more traffic, increased speeds and more crashes. There is a particular safety problem when such roads pass through villages and special measures may be necessary to reduce speeds and improve safety.

A method widely adopted in Fiji for villages along major roads (and also used in other countries) aims to gradually bring speeds down from the national limit to around 30–50 km/h as the traffic passes through. On the approach to a village, advance warning rumble strips on the road can be used to indicate a community ahead. A 'gateway' or threshold marker (e.g. a village sign on each side of the road) deliberately create the appearance of a road narrowing.

Similarly, a coloured section of road surface that creates a 'threshold' in combination with a small road hump can form a village 'boundary' to give clear demarcation, and informs the driver that an urban or speed-managed environment is being entered. Several road humps/raised pedestrian crossings can then be used at appropriate spacings and at steadily increasing heights to keep the traffic speeds within desired limits as the traffic passes through the village. Once the halfway point (i.e. centre of the community) is reached and the highest road hump/raised pedestrian crossing has been passed, the road humps gradually reduce until the driver reaches the gateway or threshold at the other end of the village. This provides a very effective managed speed environment through the whole length of the village.

Roundabouts

Roundabouts are effective in reducing the severity of crashes at an intersection because they require traffic to deviate from a straight path and therefore slow down to undertake the manoeuvre.

The reduced speeds of travel through an intersection that a roundabout can achieve, together with the non right-angle nature of side-impact crashes because of the geometry of the roundabout, result in reduced crash severity.

Effective roundabout installation also relies on careful design of approach islands, clearly visible signs and markings, and effective public information campaigns about how they should be negotiated by drivers.

Catering for cyclist, pedestrian and motorcycle movements at roundabouts requires care, because drivers may fail to notice them as they concentrate on the 'give way' task inherent in travelling through a busy roundabout.

CASE STUDY: **Traffic calming in Rivas, Nicaragua**

The small town of Rivas on the Pan-American Highway was burdened by severe road crashes in the mid-1990s, many of which included vulnerable road users. In 1998, a traffic calming project was carried out with support from Danida to improve the situation. The project comprized pavements, road islands, bus bays and a roundabout.

The islands stagger the road and thereby force vehicle traffic to slow down before passing them. The islands also create a safe refuge for crossing pedestrians. Bus bays ensure that buses park off the road and passengers can get on and off safely. A speed-reducing roundabout in the most important junction in the town has slowed down vehicle traffic. The police, Policía Nacional, indicate that very few severe road crashes have occurred in the town since the traffic calming project was implemented, compared to the period before.

Damage-only crashes still occur and some truck drivers complain about the narrow road design. This was, however, to be expected because the narrow design is the measure that lowers speeds and thereby increases safety. It has not been possible to retrieve old road crash data from before the project was implemented to draw conclusions about the exact impact on safety. Nevertheless, the road crash frequency is about one third of comparable road sections just outside the traffic calmed section and other towns on the Pan-American Highway through Nicaragua. It is a good example of the effect of a small reduction in speed in association with infrastructure treatments.

Pavement narrowings and engineering treatments at curves

Wider roads invite drivers to select higher travel speeds. This may be because the perceived margin for error is greater. So, narrower pavement widths tend to slow traffic speeds. Narrowing the roadway for motorized traffic will therefore assist speed reduction in an area.

CASE STUDY: **Narrowing treatment for a road in Sri Lanka**

Before treatment

After (simulated picture)

Courtesy of University of Moratuwa

Even narrowing the *perceived* lane width can achieve slower speeds. This can be done with painted markings in the road.

Specially designed road markings that create a stereoscopic illusion that the road is narrower than it is (and a resulting reduction in speed) have been trialled in number of districts in China on a variety of different types of road.

Curve warning signs are also effective in reducing crashes. Other treatments such as rumble strips across the lane of travel approaching the curve are also used in many countries.

An effective crash data system will enable higher risk curves and other hazardous locations to be readily identified.

3.4.2 Separation of vulnerable road users

Speed should be limited to ensure that vulnerable road users are not exposed to risk of serious injury (Box 3.11). If this is not possible, separating the vulnerable road users from motorized traffic is an alternative.

Pedestrian fencing is useful for improving the safety of pedestrians by directing larger flows of pedestrians away from random crossing locations (particularly in busy pedestrian crossing locations) to safer crossing points, which may be equipped with treatments such as speed humps or raised platforms in the roadway, or a set of traffic signals.

Refuge islands and medians can assist pedestrians in crossing the road by allowing a staged crossing and simplifying decision-making. Kerb extensions can also improve pedestrian safety by reducing the crossing distance, and the area and time in which the pedestrian is at risk. This is particularly helpful for older or disabled pedestrians who may have difficulty choosing a safe gap in traffic at a conventional crossing point.

In many situations in rural (and urban) areas there will not be any footpath provision for the large numbers of pedestrians walking from point to point. They will often be forced to walk on the carriageway. Provision of a walking path is a highly effective means of removing the pedestrians from a medium to high speed carriageway.

BOX 3.11: **Vulnerable road user safety measures**

Pedestrians have twice the risk of injury where they are not separated or segregated from motor vehicle traffic *(24)*. The safety of pedestrians and cyclists can be improved through area-wide road safety management *(25, 26)*.

Networks of segregated or separate pedestrian and bicycle routes connecting to a public transport system are ideal *(27)*. Such a network might consist of sections of footpath or cycle path separate from roads, plus sections running alongside roads, with particular attention paid to safe crossings at junctions.

Traffic calming measures discourage motorized traffic from travelling at speeds that put pedestrians and cyclists at high risk. They include road narrowing, roundabouts, rumble strips and speed humps.

Widespread experience of area-wide road safety management in Europe shows that it can reduce crashes and injuries by 15–80% *(28,* 29). The town of Baden, Austria, launched a management plan in 1988 that has resulted in about 75% of its road network being restricted to speeds of 30 km/h or less, and an integrated system of public transport with pedestrian and bicycle routes. The rate of road casualties has declined by 60% *(30).* Studies in Denmark *(31)* have shown that providing segregated bicycle tracks or lanes alongside urban roads reduced deaths among cyclists by 35%.

Low and middle-income countries have experimented little with area-wide road safety management, but some road safety experts believe that this should be a priority for urban areas in all countries *(32).*

Where paths are not in place and pedestrians walk on the road, educating pedestrians to walk as far off the road as possible and in the direction facing oncoming traffic is necessary.

Non-motorized two and three-wheeled vehicles carry vulnerable road users and tend to travel more slowly than motorized vehicles. Bicycles and tricycles or cyclos should be separated from motorized traffic as well, if at all possible.

3.5 Use of speed-limiting technology and intelligent speed adaptation

Collision speed and the shape and structure of vehicles involved in a crash affect personal injury or other types of damage. Lots of research goes into improving vehicle shells with safety in mind. Vehicle design is outside the scope of this manual, but there are technologies that can be adapted to the vehicles to improve drivers' speed compliance.

Road speed limiters (RSL)

This equipment is required by legislation on trucks and buses in a number of countries, including in Europe and Australia.

The European Community initially required limiters on trucks and buses over 12 tonnes and specified maximum speeds – 90 km/h for trucks and 100 km/h for buses. The requirement for these limiters has been extended to light commercial vehicles (over 3.5 tonnes) and small buses. In Australia, a 105 km/h maximum speed is permitted. RSL do not reduce speeding on roads with speed limits below the RSL settings, nor on steep downhill gradients.

Speed limiters are a measure that seeks to prevent the competitive nature of commercial freight (and bus) operations resulting in a lack of speed compliance on rural roads. Heavy vehicles (over 3.5 to 4.5 tonnes) are a higher risk to road users than other vehicles if involved in a crash.

It is recommended that speed limiters be introduced for heavy vehicles and possibly public service vehicles, in any country.

CASE STUDY: **Speed limiters, Singapore**

Vehicle engineering practices play an important role in Singapore in managing the speeds of vehicles on the roads. Heavy goods vehicles with maximum laden weight of more than 12 tonnes and buses of more than 10 tonnes must be fitted with approved speed limiters, with the set speed of 60 km/h. Light goods vehicles with 3.5 tonnes and smaller buses with more than 15 passengers must not exceed 70 km/h on the road. A heavy fine of $S1000 dollars (maximum) will be imposed for non-compliance. Illegal vehicle modifications are prohibited.

Electronic data recorders (EDR)

These devices record vehicle operating characteristics in the few seconds prior to, during and after a crash, such as speed, acceleration and airbag deployment. This data is highly useful for later detailed crash analysis and vehicle design refinements. In the

US where there is a high market penetration of EDRs (64% for 2005 model vehicles) NHTSA has indicated that their use results in fewer collisions because drivers drive more carefully *(33)*.

CASE STUDY: Application of dynamic event data recorders (SAGA system), Iceland

Iceland is using a complete information system for monitoring and reporting:

- location and usage of vehicles
- speed compared with speed limits
- driving behaviour according to predefined criteria.

SAGA is used in the vehicle fleets of 70 companies. After data is processed and analyzed, results are downloaded onto an SQL-database. Reports on the data analysis are sent out to the owner by email. Iceland Post is one of the companies using the system. Since its introduction, significant improvements in driver behaviour have been noted, including less speeding and a reduction in accidents. The system also leads to savings in operational costs of the fleet, especially in fuel consumption. Comparison of January-June 2005 statistics with those of the same period in 2004 shows the following results:

- 56% reduction in crash cost
- 43% reduction in the total number of crashes
- 51% reduction in the number of crashes where employees are responsible.

Some versions of the system can automatically send messages and fines when infringements are made (self-enforcement). However, acceptability issues for such a system are a major concern.

Source: *(34)*

Intelligent speed adaptation (ISA)

ISA refers to technology in a vehicle that enables it to 'know' the relevant speed limit from an on-board and updateable database of speed limits, and a Global Positioning Satellite (GPS) system advising where the vehicle is located. The system then provides feedback to the driver about whether current speed exceeds that limit.

There are three major types of ISA:

- informative – giving information to the driver
- voluntary supportive – driver can choose to set the maximum speed
- mandatory supportive – intervenes at all times when the vehicle exceeds the speed limit (but driver has an over-ride).

Transport companies are increasingly using GPS tracking systems to monitor their vehicle fleet, as well as driving speeds. Used in a vehicle, the device allows a driver to plot the best directions to a location, but it could also allow employers to track their movements. For example, a transport company operating in south-east Asia has in place a system of dedicated, security trained drivers, as well as container trucks equipped with GPS tracking. This provides peace of mind for customers transporting high-value goods such as electronic and computing components.

Some employers are now requiring vehicles to be fitted with speed alert and/or speed limiter devices to give drivers feedback, or to directly constrain the vehicles to pre-determined speed limits.

There are many issues surrounding reliability of speed limit data, the acceptability of mandatory supportive ISA and the substantial technical and policy decisions required of government before it can be required by regulation. However, informative ISA is likely to be supported by consumers and the infrastructure and new vehicle features needed for its introduction are under development.

It is now possible to install simple and cheap ISA systems in some types of private car which could provide a base for voluntary tracking of speed compliance.

Some insurance companies have pilot programmes with in-vehicle speed monitoring systems leading to reduced property and personal injury insurance premiums. These are reportedly showing promise *(2)*. Discussions could be undertaken with insurance companies with a view to encouraging further pilot programmes in different countries.

3.6 Speed management by employers

Often fleet managers, public service drivers and truck drivers are under pressure to meet targets, resulting in speeding and driving for many hours – both negative for road safety. Fleet-owning organizations need to understand the risk of such behaviour and that introducing road safety and speed compliance measures will reduce long-term costs. Setting clear rules in regard to permissible maximum daily distances and number of driving hours, and observing speed limits are key elements.

There are substantial opportunities for corporate fleet managers to encourage employee compliance with speed limits in corporate vehicles. Moreover, they can assist their drivers to select safe speeds on their journeys with pro-active programmes. A number of multi-national companies have extensive journey management and other fleet safety programmes. In many countries the number of vehicles belonging to government, unions or private companies counts for a substantial part of the total fleet on the roads.

Employers are able to influence employees' use of company vehicles to an extent that cannot be achieved for drivers generally. Through monitoring the number and severity of breaches of speed limits leading to a traffic infringement or more serious charge, employers can have an effect upon the behaviour of drivers who are traditionally more likely to speed than others. Employers can build in a range of incentives or sanctions to encourage compliance, and an increasing number of companies are pursuing this approach. They can also use technology (such as speed limiters or tachographs) to reduce travel speeds.

CASE STUDY: **Journey Risk Management**

With private sector support, the Institute of Road Traffic Education (IRTE) has successfully completed the 'journey risk management' (JRM) of 12,000 km of national and state highways across India. The whole section of the road was categorized into different risk areas with a colour code. The final analysis is presented in two forms:

JRM booklet including:

- risk rate maps along with the type of risks and recommendations supported, with photographs of the hazards and the potential risk areas
- maps showing the different type of facilities, their location and distances
- emergency numbers for police stations, traffic aid centres, hospitals, medical facilities, service and repair shops, and other important services and facilities.

Emergency trump card showing:

- accident blackspots, and their risks
- recommended speed limit according to the type of risks
- time taken to travel the identified section of the road
- emergency phone numbers for the identified section of the road.

3.6.1 Legislative measures

Legislation introduced by governments for the freight industry can be a strong incentive for employers to address speed management with their employees. Governments can encourage employers to take an active role in driver/rider safety, including speed management, through occupational health and safety (OHS) legislation and through provisions in transport legislation. Increasingly, governments are specifying in legislation that OHS responsibilities extend to driving as a work task and to the vehicle as a *workplace*.

In New Zealand, for example, under the Health and Safety in Employment Act 1992 and the Health and Safety in Employment Amendment Act 2002, employers are responsible for the safety of their employees at work, which includes vehicles. This includes employees who are driving as part of their work – whether they are a driver, or a passenger, whether they drive regularly or occasionally, and whether the vehicle is owned, leased or rented by the company (Box 3.12).

BOX 3.12: **'Chain of responsibility' for commercial driving**

In Australia, *chain of responsibility* principles are also being included in transport laws, attributing a share of responsibility for driver and vehicle compliance to all parties in the transport and logistics chain. These laws apply to all those organisations in the transport chain involved in the consigning, receiving or transporting of goods. For example, if there is an incident that involved a heavy vehicle driver exceeding safe speeds in order to meet a schedule, the transport company and even the goods consignor, may be found guilty of an offence if it was found that this influenced the driver's decision to drive at an unsafe speed or falsify log book records.

Specific provisions of the legislative application of these national measures in the state of Queensland include:

"If the driver or other person in control of a heavy vehicle commits an extended liability offence, an influencing person is also taken to have committed the offence unless the influencing person proves [that they] *exercised reasonable diligence and took reasonable steps to prevent the act or omission that is the offence.*

An influencing person in relation to a vehicle means any or all of the following persons –

A person, other than the owner or registered operator, who controls or directly influences the loading or operation of the vehicle."

Source*: (35)*

3.6.2 Education and feedback

Other ways that employers seek to monitor speeding and other unsafe road behaviours is through the installation of bumper stickers seeking public feedback. In this way, drivers know that if they drive at unsafe speeds or in other dangerous ways, someone may report this to their employer. In some cases, high-profile companies with vehicles featuring their name or logo will be contacted if their drivers seem to be travelling at excessive speeds or displaying other unsafe or uncourteous road behaviours.

As speeding is one of the major factors in work-related road crashes, employers can be assisted or advised to educate their employees about this risk. Governments and other agencies can help by producing basic education materials, such as those produced for the UK's Department for Transport by TRL for distributing to fleet companies (see www.dft.gov.uk/drivingforwork).

Summary

There is a range of speed management tools to assist in setting the speed environment, enforcing safe speeds, and informing drivers/riders about the speeds that are safe. It is important to consider how best to adapt these tools to the particular environment being addressed – physically, socially and politically – before using these tools.

- Identifying a hierarchy of roads that reflects road function – in both urban and rural areas – is a necessary first step, and an essential tool to manage speed in a consistent manner. Speed limits on roads at the same level in the hierarchy may vary, however, in response to major differences in risk along those roads, but consistency is desirable wherever possible.
- Appropriate speed limits are a fundamentally important tool for speed management. Speed limit guidelines need to be developed from a *Safe-system* approach. Factors such as road design, roadside (land use), traffic mix and flow, presence of vulnerable road users and vehicle quality factors will influence the limit. Clear speed limit signs need to be provided to inform drivers about applicable limits.
- Effective laws and regulations are essential. These must be supported by effective enforcement methods and practices, and an adequate range and depth of penalties for offenders.
- Public education is most likely to be an effective tool when it informs the community about the risks associated with speeding, promotes current enforcement activity and is reinforced by enforcement of speed limits.
- A range of low to medium-cost engineering treatment tools exists that provides proven safety benefits through addressing speed related risk in urban and rural settings.
- New vehicle technologies assist automatic compliance with speed. Their further development by the industry should be encouraged.
- Employers should not impose work schedules that require drivers to speed
- Employers should encourage speed compliance by employees who drive company vehicles. An increasing emphasis upon occupational health and safety by governments is placing obligations upon employers, particularly for vehicles engaged in freight movement.

References

1. Quimby A et al. *Urban safety management guidelines for developing countries,* Project Report PR/INT/254/03, Crowthorne, DFID, 2003.
2. *Speed management report.* Paris, OECD/ECMT Transport Research Centre, 2006 (available in English and French).
3. Australian Transport Council. *National Road Safety Action Plan, 2007–2008.* A R R B Transport Research Ltd, 2006 (http://www.atcouncil.gov.au/documents/nrss_actionplan_0708.pdf).
4. Australian Transport Council. *National Road Safety Action Plan, 2005–2006.* A R R B Transport Research Ltd, 2004 (http://www.atsb.gov.au/road/ nrss/nrsap05_06.cfm).
5. Slater D et al. *Setting of speed limits in South Africa.* Pretoria, South Africa, Department of Transport, 2000.
6. Fildes B et al. *Balance between harm reduction and mobility in setting speed limits: a feasibility study.* Sydney, Australia, Austroads publication AP-R272/05, 2005.
7. Jarvis J and Hoban C. *VLIMITS: An expert system for speed zone determination in Victoria.* Vermont South, Australia, ARRB Report 155, 1988.
8. Salusjärvi M. *The speed limit experiments on public roads in Finland.*. Report No.7/1981. Espoo, VTT, Technical Research Centre of Finland, 1981.
9. *Bringing down the road toll: the Speed Camera Programme.* Report of the New Zealand Controller and Auditor-General, April 2002 (http://www.oag.govt.nz/2002/speed-camera/docs/speed-camera.pdf).
10. Cameron M et al. *Scientific basis for the strategic directions of the safety camera programme in Victoria.* Melbourne, Monash University Accident Research Centre, Report No. 202, 2003.
11. Mooren L. Road safety benchmarking – speed management. European Road Safety Conference, BASt, Koln, 1998.
12. Donovan R et al. Executing effective road safety advertising: are big production budgets necessary? *Accident Analysis and Prevention,* 1999, 31(3), 243–252.
13. Jones B et al. An evaluation of the effectiveness of televised road safety messages in Ghana. *International Journal of Injury Control and Safety Promotion,* 2005, 12:23–29.
14. Elliott B. *Road safety mass media campaigns: a meta analysis.* Canberra, Australian Transport Safety Bureau, 1993 (www.atsb.gov.au/publications/1993/pdf/Edu_Media_1.pdf).
15. Christie, R. *The effectiveness of driver training as a road safety measure: A review of the literature.* Melbourne, Australia, Royal Automobile Club of Victoria (RACV), 2001.
16. *Towards safer roads: a guide for planners and engineers.* Crowthorne, UK, Transport Research Laboratories (TRL) and the Overseas Development Administration (ODA), 1991.
17. *A road safety good practice guide.* Department for Transport, UK, 2001.
18. DFID CaSE Highway Design Note 4/01, *Roadside, Village and Ribbon Development,* London, Department for International Development, 2001.
19. DFID CaSE Highway Design Note 3/01, *Vulnerable Road Users.* London, Department for International Development, 2001.
20. DFID CaSE Highway Design Note 2/01, *Horizontal Curves.* London, Department for International Development, 2001.
21. Kirk S et al. *Applying the urban safety management approach in Bangalore*, Project Report PR/INT/251/03. Crowthorne, DFID, 2005.

22. Elsenaar P, Abouraad S. *Road safety best practice: Examples and recommendations.* Geneva, Global Road Safety Partnership, 2005.

23. Afukaar FK. Speed control in developing countries: issues, challenges and opportunities in reducing road traffic injuries. *International Journal of Injury Control and Safety Promotion,* 2003, 10 (1–2):77–81.

24. Ossenbruggen PJ et al. Roadway safety in rural and small urbanized areas. *Accident Analysis and Prevention*, 2001, 33:485–498.

25. Mohan D, Tiwari G. Traffic safety in low-income countries: issues and concerns regarding technology transfer from high-income countries. In *Reflections of the transfer of traffic safety knowledge to motorising nations.* Melbourne, Global Traffic Safety Trust, 1998.

26. *Promotion of mobility and safety of vulnerable road users.* Leidschendam, Institute for Road Safety Research, 2001.

27. *Safety of vulnerable road users*. Paris, Organisation for Economic Co-operation and Development, 1998 (DSTI/ DOT/RTR/RS7(98)1/FINAL) (www.oecd. org/dataoecd/24/4/2103492.pdf).

28. *Ville plus sûr, quartiers sans accidents: realisations; evaluations [Safer city, districts without accidents: achievements; evaluations].* Lyon, Centre d'études sur les réseaux, les transports, l'urbanisme et les constructions publiques, 1994.

29. Brilon W, Blanke H. Extensive traffic calming: results of the accident analyses in six model towns. In *ITE 1993 Compendium of technical papers*. Washington, DC, Institute of Transportation Engineers, 1993:119–123.

30. Lines CJ, Machata K. Changing streets, protecting people: making roads safer for all. In: *Proceedings of the* best *in Europe conference, Brussels, 12 September 2000.* Brussels, European Transport Safety Council, 2000:37– 49.

31. Herrstedt L. Planning and safety of bicycles in urban areas. In *Proceedings of the traffic safety on two continents conference, Lisbon, 22–24 September 1997*. Linköping, Swedish National Road and Transport Research Institute, 1997:43–58.

32. Nantulya VM et al. Introduction: The global challenge of road traffic injuries: can we achieve equity in safety? *International Journal of Injury Control and Safety Promotion,* 2003, 10:3–7.

33. *Event Data Recorders: summary of findings by the NHTSA EDR working group.* Washington DC, National Highway Traffic Safety Administration, 2001.

34. Jonsson R. *Application of EDR in Iceland: SAGA system*, 2005.

35. Chain of responsibility (COR) Forum, workshop report. *A first step in preparation for the introduction for the compliance and enforcement bill.* Queensland Parliament, Port of Brisbane Authority, 2006.

4

How to design and implement a speed management system

How to design and implement a speed management system

THE PREVIOUS modules described how to assess the speed situation in a country or region and the tools that are available for managing speed. This module describes how to use this information to design and implement a targeted programme to improve speed management, and reduce the incidence of speed related fatalities and serious injuries.

The potential components of a speed management programme, using the tools set out in Module 3, are discussed in this module. These include implementing or strengthening legislation, reviewing or setting speed limits, enforcing speed limits, establishing suitable penalties and sanctions for offenders, introducing targeted public information campaigns and providing engineering treatments on the roads. It is divided into six sections:

4.1 Gaining political and community support: Before commencing a speed management programme, consulting and involving community and government stakeholders is an important step. This section discusses how to foster the support and actions needed for good speed management.

4.2 Stakeholders and roles: Achieving broad-based stakeholder support is essential for successfully implementing a speed management programme. This section provides guidance on setting up a working group of government stakeholders, a reference group of non-government stakeholders and advice on sustaining that support.

4.3 Preparing a plan of action: A discussion about setting objectives, targets and performance indicators is followed by advice on the necessary steps for developing an action plan that responds to those objectives. Guidance on issues to consider when choosing tools to deliver the plan is provided, including how to make the best use of resources.

4.4 Preparing for implementation: This section describes the range of legal, enforcement, planning, training and roll-out of engineering measures that has to be in place in order to implement a speed management programme.

4.5 Informing, influencing and involving the public: This section outlines the way to plan and carry out effective information, education and marketing campaigns in support of the speed management programme.

4.6 Planning and using pilot projects: It is often useful to test planned interventions before investing in and implementing a national or wide-scale programme. This section describes the benefits of conducting pilot projects as part of the speed management programme.

4.1 Gaining political and community support

The success of a speed management programme will depend overwhelmingly on winning the support of politicians, high-level community decision-makers and the community itself. Once evidence is produced that speed and speeding are problematic in a country or region, support from politicians (and other decision-makers) for the development or strengthening of a speed management programme must be obtained. The time that this is likely to take should be allowed for in planning.

4.1.1 Need for providing convincing evidence

Speed is a highly controversial issue, and speed reduction programmes must be carefully managed to gain and maintain vital community support for actions (Box 4.1). Even after producing evidence that speed and speeding are problematic, support from politicians and decision-makers for the development – or strengthening – of a speed management programme must not be taken for granted. While some political leaders may have a personal commitment to speed management and road safety issues, most will need convincing that the community wants them to do something (Box 4.2). As speed management necessarily restricts driving behaviour and driving choices, there is often a negative reaction by some sections of the community when speed management programmes are introduced.

Investing time and effort in involving stakeholders is worthwhile, as is communicating with the community about the intentions of the programme. Communication can include community discussion forums with representative groups and advisory councils, and stakeholder involvement can be developed through working groups. It is often best to begin with a 'pre-sell' process with government agency stakeholders or the people that will be the main programme implementation partners. In this way they can assist with the broader marketing of speed management, ultimately aiming to create a community demand for speed management that can lead to political commitment.

For communication with the broader community, print and advertising – often drawing attention to web-based material – are usually used. The community needs to be given time to adjust, particularly to new legislative and associated enforcement changes, as well as to any speed limit or infrastructure changes.

BOX 4.1 **The case for winning community support**

In a number of highly motorized countries, governments have reacted to public concern about behavioural change being sought through automated speed enforcement (such as with cameras) by discontinuing or reducing the level of automated enforcement after it has been in place for some time. The longer term road safety costs of such decisions are substantial, so great care needs to be taken to ensure that measures such as these are sustainable before they are put in place. Community feedback should be collected and relayed to the politicians to indicate how workable the programme is. Otherwise there is a considerable risk that a noisy minority – who do not want to change behaviour – will unduly influence government.

4.1.2 Securing involvement of government leaders

As a programme moves from the development phase to the implementation phase it is vital to continue to encourage the active involvement of senior government officials within key ministries. Wide-scale speed enforcement programmes, particularly automated enforcement programmes, affect large numbers of people. It is important that the implementation of initiatives is actively monitored, and that ongoing results are regularly reported to senior government leaders.

Wherever possible, senior political leaders should be given a public role in announcing speed management initiatives. This will strengthen their commitment and ensure that they are fully briefed on the details of the initiatives.

BOX 4.2 **Limits on acceptance by the public**

People do not readily change their behaviour at the behest of government, unless they are convinced by a consideration of which they were not previously aware. Their use of the roads, which is interwoven in complicated ways with the rest of their everyday lives, is a good example.

Making the use of roads safer often requires changes in road-user behaviour – either in response to changes in infrastructure or vehicles, or in response to education, training, publicity, or regulation and enforcement. Progress in implementing changes is influenced by how acceptable they are to the public. A long-standing example is the seat-belt in the UK. Seat-belts had been available for two decades and their use by drivers and front seat passengers had been gradually brought to a level of 40% before use became mandatory: once the law was introduced, the percentage usage doubled almost overnight.

It may of course be possible to win over the public to accept something to which they are at first resistant, but this often takes time, and success should not be assumed. Exercise of judgment in such cases is complicated by the role of the media in influencing and interpreting public opinion.

While elected representatives are understandably influenced by the media coverage that issues of policy and their associated actions receive (or seem likely to receive), they would be unwise to suppose that this coverage necessarily reflects the balance of views held by the public. For example, there are sometimes sharp contrasts between views reflected in the national media and those reported more locally. It is therefore important to conduct scientific surveys of public opinion to counter any potentially biased representation by the media, and that the resulting information be provided to those responsible for decision-making *(1)*.

Government ministers should receive regular briefings on the status of implementation and any issues arising. Part of the leadership role for the lead agency is to give governments the information needed to respond rapidly to community reactions to speed management initiatives. Key 'question and answer' briefings which succinctly explain why measures are being taken – and the evidence-based benefits that are being achieved – are an important way of assisting government, and increasing the likelihood of sustainability and success of the programme.

There is also benefit in engaging with opinion leaders in the community. They are vital stakeholders with the capacity to moderate debate arising in the popular media. They can be pivotal in maintaining community support as the impacts of change are felt. They should be kept fully informed as the programme is rolled out and as unexpected issues are encountered.

CASE STUDY: **India – the need for strong government support**

In order to improve road trauma outcomes in one Indian state, as part of an overall road safety project, it was agreed by the stakeholders that a pilot project to include speed management would be carried out on a section of national highway. Buses on this stretch of highway were not complying with the speed limits applicable to heavy vehicles within rural areas and towns along the highway, and were also overtaking dangerously. It was hoped that active enforcement would reduce the extent of death and serious injuries, and pave the way for a broader scale implementation.

The following tools were to be applied to achieve improved speed management (and safer compliance with road rules in general) along the pilot length:

1. A series of engineering measures:
   - Clear speed limit signage.
   - Edge, centre and barrier lines clearly marked to provide guidance for those overtaking, and to make it clear to drivers and pedestrians where the through traffic lanes were (so that pedestrians could more readily remain out of the vehicle lanes and vice versa).
   - Removal of encroachment of temporary structures on the road pavement through villages along the trial 40 km section of highway.
   - Installation of 'stop' and 'give way' line marking and signs on roads intersecting with the main highway.
   - Preparation of advice to government on introducing increased powers for the highway authority to prevent unauthorized roadside development and consequent increased access to the road.
2. Public information and education campaigns carried out through schools along the route advising of:
   - the dangers of excess speed
   - other unsafe road user behaviours
   - the need for safe pedestrian behaviours while walking along the road (as no footpaths existed in the rural areas) and when crossing the road.

   Campaigns to support police enforcement of speed limits and other road-rule compliance measures were also prepared.
3. Preparation for enforcement activity. During the 18 months of preparation for this pilot, police training was carried out and hand-held laser speed monitoring equipment was purchased so that enforcement could be readily applied over the length of the highway.

When the time for implementation was reached, the police did not consider they were in a position to enforce speeds on the highway. This is because senior police advised that if a young constable were to intercept a senior government official or politician for a speeding offence, there was a chance that the officer would be transferred to a different part of the country within a few days.

This shows the difficult underlying culture in relation to road-rule compliance, particularly speed compliance, which exists in many low and middle-income countries.

The pilot – particularly the crucial speed enforcement component – did not proceed. This shows the importance of achieving community and political support for speed management measures and major shifts in cultural attitudes before expecting police to roll out measures in low and middle-income countries.

4.2 Stakeholders and roles

There are a variety of people and organizations that have an interest in speed or speed management. Some, usually government stakeholders, will have a responsibility for speed management and their role is discussed below. Some (such as motoring and freight transport associations) will not have any formal responsibility but want to see something done to reduce speed related road injury. Others may be opposed to efforts to restrict or reduce speeds.

The extent to which the stakeholders – outside the key government road safety agencies – can be influenced to support speed management programmes will determine what and how much can be done. Table 4.1 shows examples of stakeholder organizations, their role in speed management, the relative importance of their participation and the suggested level of action at which they should be engaged.

Table 4.1 Examples of stakeholder roles in speed management

Stakeholder	Role	Importance	Action
Political/government leaders	Legislate, approve actions	High	Advise/consult
Finance authority	Approve (extra) budget	High	Advise/consult
Road authority and/or road safety department/council (national)	Road engineering, traffic laws, traffic management, advertising	High	Working group
Licensing authority	Test and authorize drivers	High	Working group
Road authority (local)	Road engineering	High	Working group
Police	Traffic law enforcement	High	Working group
Ambulance/emergency	First response	High	Working group
Education department	Education of young	Medium	Working group
Health department	Care of the victim	Medium	Working group
Community leaders	Advocacy	Medium	Consult
Media	Influence public opinion	Medium	Advise/consult
Research institutions	Research and advocacy	Medium	Consult
Employers/transport industry	Influence/control drivers	Medium	Consult
Motoring associations	Influence drivers and policy makers	Medium	Consult
Road-safety community groups	Advocacy, campaigns	Medium	Consult
Insurance sector	Finance, influence practice	Medium	Consult
Vehicle manufacturers	Produce and advertise	Medium	Consult

As the policy and operational responsibility at the national level for speed management systems is usually divided between the (road) infrastructure department and the department of justice or interior (police), these two key agencies must have a real and workable interface for the speed management programme.

This is critically important as lack of cooperative efforts can reduce effectiveness. Legislative responsibility for road safety initiatives can lie with the ministry of transport or the road authority, or, in some cases, with the ministry of justice (police).The practical work concerning the determination of limits, the placement of speed limit signs (which must be in accordance with national or local traffic regulations) and the carrying out of any minor or major works on the road network is the responsibility of the road administration, and often of local governments.

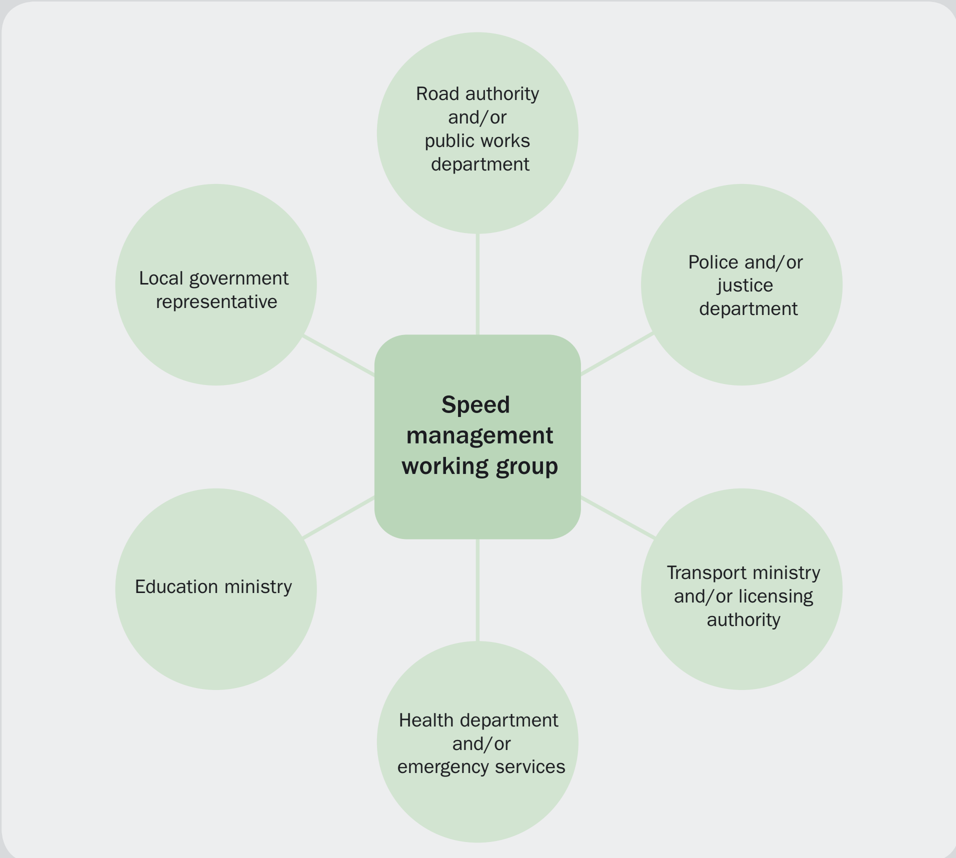
4.2.1 A Working group of government stakeholders

Establishing a working group of key government stakeholders is an essential step (Figure 4.1). The working group will need to discuss government policy issues openly and negotiate agreed views on responsibility, deciding on what resources are needed and on policy direction. For these reasons it is recommended that membership is restricted to government organizations. In recommending this step it is assumed there is sufficient commitment at senior level within the government and its road safety agencies to address the issue of speed related crashes *(2)*.

The working group should oversee and steer the programme, including taking decisions about overall objectives, and determining actions to be taken. These actions may use some or all of the tools described in Module 3 (road hierarchy decisions, speed limits, traffic safety and road environment improvements, legislation, enforcement, penalties and publicity campaigns) to achieve those objectives. Subgroups should be established as needed to deal with particular issues. This will require coordination of the programme with input to be obtained from all the main agencies.

The working group convener must appreciate the unique perspectives and contributions that each member brings to the programme. A set of individual responsibilities should be assigned to members – usually for action by the organization that the member represents – and the progress of their actions should be monitored by the group. Interactions between members can focus on ways that members can assist each other in carrying out these actions. For example, police may have difficulty enforcing speed limits in locations where the road authority may be able to assist with engineering treatments that make the task safer and more effective.

Figure 4.1 Representation on a speed management working group

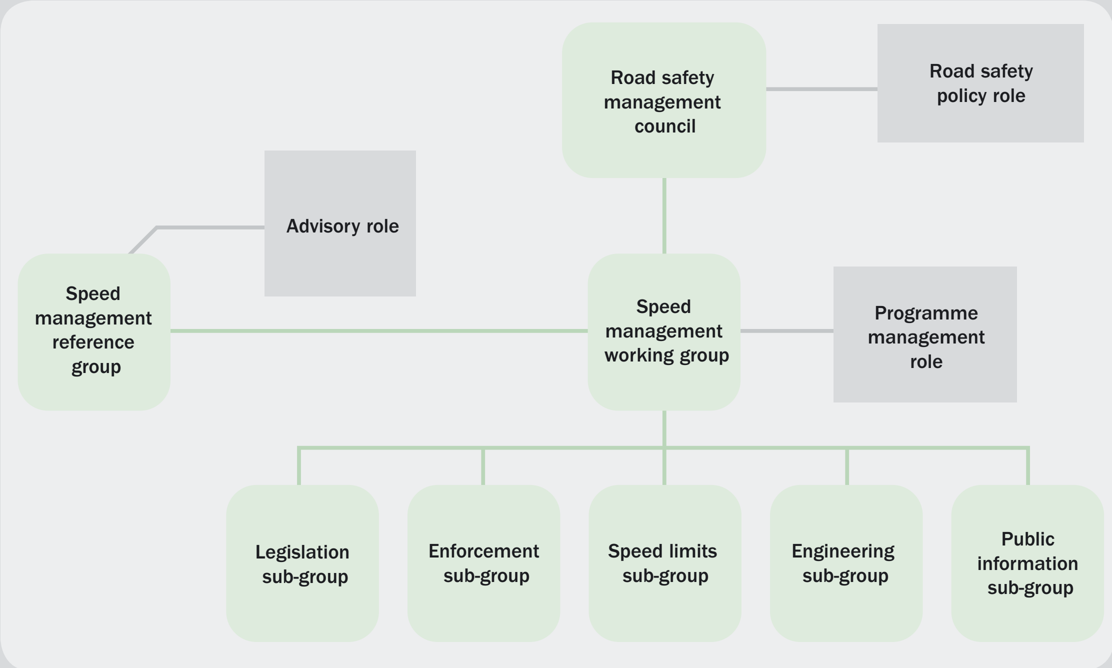


The working group should be guided by the lead government agency for road safety. The group, through its ministry or agency heads, will have the ultimate responsibility for the design of the programme and the authority to act on recommendations, including substantial proposals which will require endorsement by the agency heads or by the elected government. Working group members may also need to negotiate a specific 'memorandum of understanding' between their agencies to achieve formal recognition of their commitments to the programme, and to identify their specific roles in implementation.

The working group, usually chaired by a senior government officer with primary speed management responsibilities, develops the action programme through consultations within the group. Particular projects within the programme can then be guided by subgroups chaired by an accountable officer.

One possible arrangement for segmenting the overall task is illustrated by Figure 4.2.

Figure 4.2 Speed management programme group structure



Based upon the objectives agreed by the group, the tasks of each sub-group could involve activities contained in Table 4.2 below.

Table 4.2 Suggested sub-group tasks for the speed management working group

Sub-group	Plan/develop tasks	Delivery tasks
Legislation	• Assess legislation and propose changes	• Assess compliance with legislation, adequacy of penalties
Enforcement	• Determine enforcement methods and technology and how to support enforcement operations	• Identify needs of police, e.g. training, equipment • Strengthen enforcement of law • Coordinate enforcement campaigns
Speed limits	• Assess effectiveness of current limits in contributing to trauma reduction • Propose speed limits	• Roll-out and review
Engineering	• Identify needs • Prepare proposals	• Roll-out and review
Public information	• Assess public knowledge • Develop campaigns	• Implement campaigns
Reference/advisory group	• Consult on planning	• Consult on delivery • Involve in campaigns where appropriate

It is important that people take responsibility for managing the programme, instigating effective actions in a timely manner, acting as strong advocates and having a clear focus on results so that whatever coordinating and communication mechanisms are established, the groups do not just become 'talking committees' that do not achieve.

The meetings of the working group should be structured to enable implementation strategies to be jointly planned, and operational difficulties to be addressed. There should be well-defined working procedures and a clear work plan – extending to the eventual implementation. The coordination of activities by the different agencies is a demanding and time-consuming task; however, it is essential if the programme is to succeed. Communication – both between agencies and across the individual agencies – to ensure government and stakeholders are well informed needs to be carefully devised and actively maintained. The importance of a designated, responsible lead agency that oversees coordination of the various elements of the programme, public communications and briefings to government and stakeholders, cannot be overstated.

The government agency representatives on the working group would be expected to keep their senior manager and ministers' office fully informed. It will be of considerable assistance to the group and to the success of any speed management programme if a road safety management group composed of the heads of the key road safety agencies – effectively a road safety management council – exists and is active.

Establishment of a ministerial committee of the key ministers with road safety responsibilities – to which this group would report – would be highly beneficial for all road safety related initiatives, including speed management.

4.2.2 A reference group of other stakeholders

The working group could be assisted by a reference or advisory group which could include organizations that have an interest in, or can make meaningful contributions to, the speed management programme (Figure 4.3).

The speed management working group chair could also chair the reference group, or an independent chair can be appointed. The organizations represented on the reference group can provide valuable input and feedback to governments on proposals for speed management and would be expected to brief and advise the group they represent about the matters being discussed.

Ideally, the reference group should also include those who might be critical of a new speed management programme. Their views should be acknowledged and understood, so that the proposed programme addresses possible objections and is acceptable to the widest possible segment of society. As a number of these organizations represented are often small in scale, the working group has to assess the significance of the views held by these organizations.

Figure 4.3 Model for a speed management reference group

4.2.3 Sustaining the involvement of stakeholders

Initiatives are unlikely to succeed unless there is substantial advance communication with stakeholders and the broader community prior to any 'visible' actions taking place. A joint planning calendar for implementing initiatives can be devised to assist coordination of actions between the representatives on the working group, as well as to enable other stakeholders to contribute to the programme in a meaningful way. The calendar can be a particularly helpful tool for coordinating local and national media and enforcement campaigns.

Speed management programme information can be provided to stakeholders through regular newsletters or briefing sheets, via email, by post or through regular telephone contact from designated working group members or their support staff.

Wherever possible, senior political leaders should be given a public role in announcing speed management initiatives. This will strengthen their commitment and ensure that they are fully briefed on the details of the initiatives. It is also important to have key police officers involved in any public announcements or strategies. This provides an operational face/identity to the community as well as showing police commitment to enforcement strategies – both a subtle and direct message to ensure compliance.

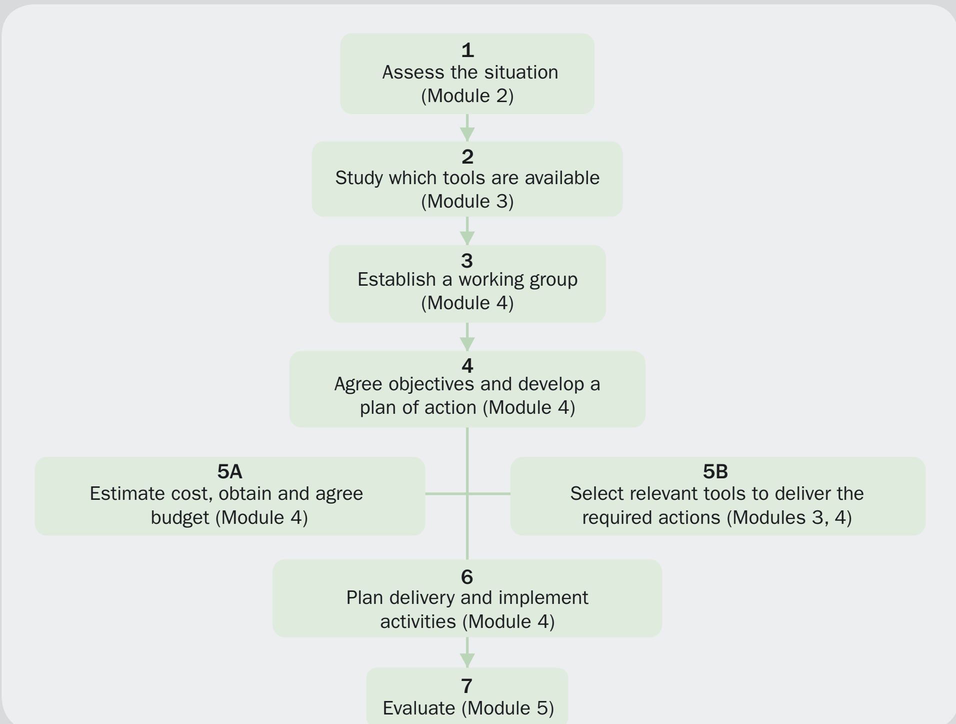
4.3 Preparing a plan of action

Before a comprehensive programme can be implemented, a plan must be set up that defines the objectives sought and lays out clear actions for how the objectives will be met. This plan must be backed by use of data, and will reflect analysis by the working group of this data and issues identified in the assessment set out in Module 2. There should also be a clear statement of problems and challenges in relation to public knowledge/awareness, legislation, speed limits, enforcement and penalties.

Based on the plan, a formal project proposal can be written. This proposal should detail the whole project cycle, describing the actions proposed to achieve the objectives in detail and their timing, the targets to be achieved, specific accountabilities for actions and funding to be sought. The working group will manage this process. Depending on the structure of government agencies and funding allocations, the proposal may split into a number of proposals as may be necessary for normal resource and policy approval processes.

Figure 4.4 shows the steps involved in developing an action plan and how these fit in with other processes described in this manual.

Figure 4.4 Steps for planning, implementing and evaluating a speed management programme



These steps may be undertaken consecutively or several activities may be carried out at the same time. For instance, the act of carrying out a situation assessment (described in Module 2) very often simultaneously raises awareness and political interest, which may be one of the objectives described in the action plan. A more in-depth discussion on developing an action plan for a national policy is provided in Schopper *(3)*.

Actions which could be expected from key government agencies and non-governmental stakeholders are summarized in Table 4.3.

4.3.1 Setting programme objectives and targets

A speed management programme has a hierarchy of objectives. A suggested hierarchy of these objectives is shown in Figure 4.5 below, together with sample performance indicators that relate to each level of the hierarchy.

The typical range of potential actions or interventions is shown at the bottom of the triangle – these form the foundation of any speed management action plan. They are implemented to achieve intermediate outcomes or objectives (some examples are shown in the middle level of the triangle) as a clear indicator of progress towards the final outcomes or objectives desired – a reduction in speed related fatal and serious injury crashes (as shown at the top of the triangle).

Figure 4.5 Hierarchy of speed management objectives and performance indicators

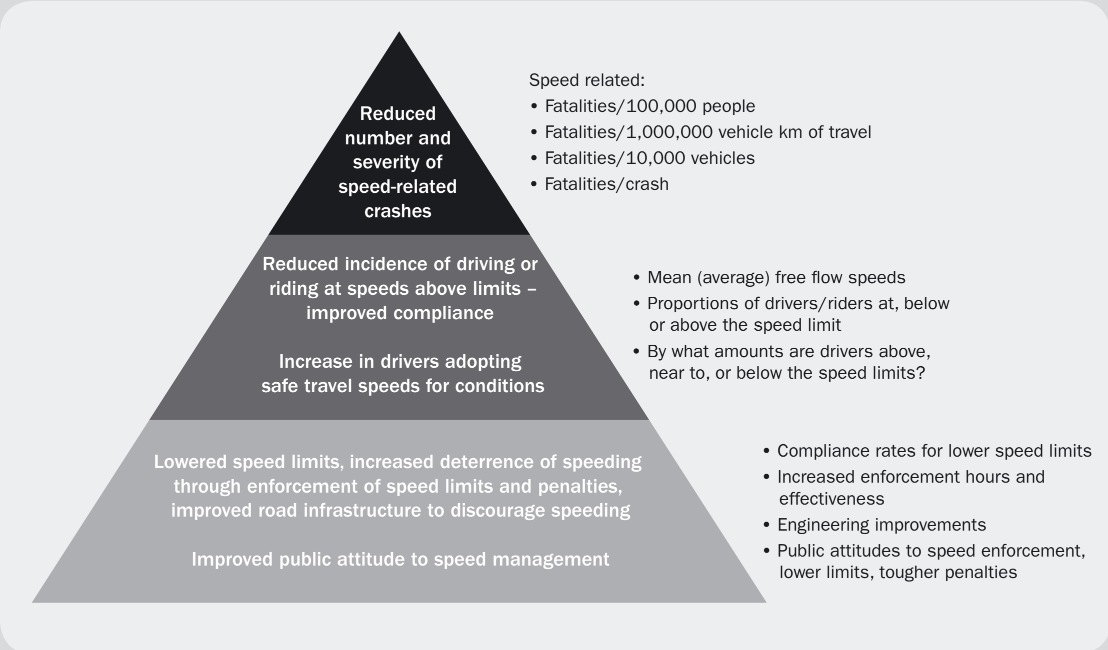


Table 4.3 Examples of typical actions by the different stakeholders involved in speed management

National and local authorities (depending on government structure)	• Decision-makers at various levels have an important role in speed management. They should be as fully informed as possible about its effects, such as the difference between private and social costs, the impact on public acceptability of different speed management strategies and tools, and the fact that popularity is not necessarily a good criterion for sustainable speed management • Transport ministers should work in close cooperation with environment and health ministers, since reducing speed has clear benefits for other sectors as well. • A common vision for a lower impact and more sustainable transport system needs to be developed by national and regional authorities responsible for transport, energy, transport planning, environment, health, justice, education and police, together with, for example, municipal governments, and other departments responsible for land use planning. • National authorities are responsible for setting general speed limits (at national level). In this respect, consideration should be given to a possible harmonisation of general speed limits between countries/regions. • As harmonisation of measures reinforces their credibility with the public, national governments should look at harmonising speed control for similar road types, both at country/state/province level and between countries/states/provinces. • Authorities should develop multi-lateral agreements for controlling the speed of foreign drivers and for the development of long-distance (international) section control for coaches and trucks, and for cars. • Authorities should adopt a pro-active role in better explaining the dangers of speeding and the reasons for speed management measures to the general public.
Local authorities	• Define the function of each road and review existing speed limits; ensure that they are consistent, credible and therefore more easily enforceable. • Develop low-speed zones integrated in the local transport plan. • Ensure there is policy support for speed management measures. As an example, a charter on speed-related issues could be a good way to involve policy makers at local level.
Police authorities/ interior ministries	• Ensure that road safety enforcement is closely aligned with speed management policies. • Enforce speed limits in the most effective ways possible, given available resources.
Vehicle industry	• Continue efforts on active and passive vehicle safety. • Propose and promote systems that assist the driver in respecting speed limits. • Forbid promoting or glamorising speed in advertising campaigns.
Technology industry	• Research and develop systems that are easy to understand and use (particularly by the elderly) and do not produce adverse consequences.
Insurance	• Become more involved in road safety and take a business approach to investments in the implementation of speed-related policies and operational improvements. • Pursue an incentives-based approach. For instance, promote intelligent speed adaptation, electronic data recorders, or other speed and safety related systems, by reducing premiums for cars equipped with these systems.
Media	• Adopt an educational role to better explain to the public the danger of speed and the benefits of traffic calming, as well as the reasons for speed management measures. • Avoid, directly or indirectly, advocating high-speed driving.
Inter-governmental agencies	• Inter-government agencies (e.g. OECD, ECMT, EU) can play a leading role via conferences, symposia and committees to foster the development and exchange of information and views. These could identify relevant trends and interactions among governments, the public and various industries, including energy, automotive, infrastructure, transport and transport-dependent industries. • Establish an international body or cooperation programme to manage and assure international enforcement of foreign drivers.
Driving instructors	• Driving instructors should be well educated on the issues of speed and its effect, and pass the message to learner drivers.
Other stakeholders	• Researchers, medical doctors, teachers, professors, parents and family in general also have an important role to play in speed moderation.
Road users	• The attitude, behaviour and culture of the road user (whether driver, pedestrian or cyclist) is the key to any successful programme. The success of a speed management programme depends on user acceptance and compliance – whether the acceptance is voluntary or the compliance enforced.

A general objective for implementation of a speed management system might, for example, be stated as decreasing the mean speed or speed variance (getting higher speeds down) by a specified amount on a certain road category, or group of roads, over a given time period.

However, general objectives such as this, whether intermediate or final in nature (as outlined above), need to be considered in a more specific and detailed context to enable the identification and delivery of effective actions. For example, speed management measures in urban areas will usually be quite different to measures implemented in rural areas.

Targets and performance indicators

Adopting targets generally results in more realistic road safety programmes, a better use of public funds and other resources, and greater credibility of those operating the programme *(4, 5)*.

Performance indicators and targets need to be established at the beginning of a programme. These can then be used to focus actions implemented and to track progress.

Developing targets will require the use of crash and injury baseline data in order to establish *measurable objectives.* For example, an activity might aim to reduce the proportion of drivers exceeding the speed limit by 10%, or to reduce the mean speed by 5 km/h at a certain road section on a certain road category over a specified time period. The experiences of other initiatives in road safety suggest that targets should be both ambitious and carried out over a long time period *(6)*.

The working group will develop the scope and nature of the actions they propose to meet their adopted objectives (which are likely to be revised on a number of occasions in the action development process), agree on the tools they plan to use and estimate the extent of implementation that will be feasible based on available funding. From this information a reasonable target calculation can be developed. This may well be an evolving process as better understanding of costs and benefits, and political acceptability of potential measures, are reached by the group and assumptions are reworked.

Once targets are set by the working group, performance indicators that will measure progress towards them need to be agreed. It is important to point out that performance must be measured before the programme starts as a baseline, so that a proper reference is available for ongoing comparison following interventions. Performance indicators are measures that indicate changes, including improvements or deterioration in areas of concern *(7)* and in baseline data such as:

- the percentage of drivers driving above existing speed limits
- mean speed distribution
- the number and rates of traffic crashes and the resultant deaths and serious injuries.

Performance measures will also be useful to establish measures of exposure, such as use of the road network by vehicles. These enable the estimation of relative risk – such as deaths per million vehicle kilometres of travel (vkm) – but data to quantify this are not always available. Three main methods to collect exposure information can be used at national or local levels and they are:

- traffic counting systems
- travel habit surveys
- amount of fuel sold.

All of these methods can be used to estimate vehicle kilometres of travel.

For each indicator there should be a specific quantifiable target, though they may in some cases be qualitative. In any case, they should be realistic (Table 4.4). Targets should be SMART i.e.:

- **Specific**: well defined and clear to anyone
- **Measurable**: be able to know when the target has been achieved
- **Agreed upon**: have the commitment of all stakeholders
- **Realistic**: can be achieved with available resources
- **Time-based**: trackable to provide an accurate assessment of when the target can be achieved.

4.3.2 Deciding on activities

Having defined overall objectives, targets and initial performance indicators, the group will be in a position to define the actions/activities that are to be pursued. Decisions about what should be done to reduce speed related injury crashes can usefully be based on four general criteria:

- Identification of speed related problems (Module 2)
- What is known about the speed risk factors and what is known to be effective in addressing these? (Modules 3 and 4)
- What are the best tools to use given the nature of the problem and situation? (Modules 3 and 4)
- What realistically can be achieved with the resources available? (Module 4)

The selection and implementation of the appropriate tools will be the basis of the action plan. It is unlikely that a single countermeasure (or tool) will have a dramatic effect on speed related crashes and injury. So an effective speed management action plan will include a number of interventions.

Table 4.4 Example of performance indicators with realistic targets

Objective	Performance indicators	Initial value of indicator*	Target value of indicator*
To decrease speed on a road section with speed limit of 70 km/h	• Mean speed • 85th percentile speed	79 km/h 90 km/h (from surveys)	70 km/h 75 km/h
To reduce the proportion of speeding drivers	• Proportion of drivers exceeding speed limit by 10 km/h • Proportion of drivers exceeding speed limit by 20 km/h	70% 30% (from surveys)	5% 0.1%
To reduce road death and injury	• Crash rate per vehicle and per population involving speed in excess of 10 km/h over the limit • Serious injury rate per vehicle and per population involving speed in excess of 10 km/h over the limit • Fatality rate per vehicle and per population involving speed in excess of 10 km/h over the limit • Fatal consequence involving speed in excess of 10 km/h over the limit	'A'	0.8 'A'
Increase in level of community concern about speeding	• Proportion of population sample survey who identify speeding as a major road safety risk and a community problem	'B'	1.5 'B'
Increase in community support for speed management initiatives	• Level of community support, measured in surveys, for increased enforcement and penalties to deter speeding behaviour	'C'	2 'C'
Increase in drivers and riders acting to change their speeding behaviour	• Number of drivers/riders agreeing not to speed in self-reported surveys	'D'	1.5 'D'
Increase in driver perception of stronger enforcement of speed limits	• Number of drivers/riders surveyed who believe speed enforcement activity is more extensive than before	'E'	3 'E'

* The value of A to E will derive from local situational studies, and the multiplying factor in the last column will be a local judgement.

BOX 4.3: **The International Road Assessment Programme and road inspections**

The International Road Assessment Programme (iRAP) is active in six continents, ranking roads for safety and promoting countermeasures. Techniques were originally developed and applied in Europe, Australia and the US, and are now used in low and middle-income countries. iRAP is built on three protocols which together highlight relationships between speed, energy, risk and injury.

The protocols involve:

- analysis and mapping of fatal and serious crash rates occurring on major roads (if available)
- performance tracking of particular road sections over time, monitoring the number of fatal and serious crashes over their length (if available)
- drive-through inspections of the safety quality of the road infrastructure in different countries to identify where crashes are likely and the extent to which roads protect road users from crashes, and from death and serious injury when crashes do occur. From these inspections a Road Protection Score (RPS) is derived.

Road inspections instead of crash data

The (RPS) was developed initially to assist understanding of why crash rates vary from one road section to another. It also has applications in those countries where crash information is poor in quality or difficult to obtain. Means of determining priorities that do not require crash data therefore become important.

Roads giving good protection across all permitted speeds therefore score highly. Roads where the crash protection is less good can score acceptably if the speed management regime is tighter. When compliance and enforcement are at low levels, simply setting a low speed limit will not decrease the injury-generating potential of inadequate infrastructure. The RPS produces a score for each route section that enables it to be compared with other sections, and proposes interventions.

See Appendix 5 for more details.

The first step in deciding on activities should be to determine a road hierarchy by road function (Module 3). The theoretical function of most roads will most likely need to be modified to reflect the actual road environment. This careful, detailed consideration of actual road function and presence of vulnerable road users will provide a basis for proposing lower limits on specific parts across the network.

The second recommended step is to focus on crash type and location. Identify the locations or areas across the network that have higher levels of crash risk and where the crashes could most readily be reduced through achievement of lower travel speeds.

As a next step it will be useful to consider what tools could be applied to achieve reductions in these crash types/severities (Table 4.5). The following table is an indicator of likely links between various crash types in urban and rural environments, and the tools that could be expected to be of use in those circumstances.

Table 4.5 Effective tools for reducing different types of crash (examples)

Urban/rural	Crash type	Indicative range of tools that could be used
Urban	Pedestrian and other vulnerable road-user fatal crashes	• Lower speed limits to meet *Safe-system* levels (30 km/h to avoid fatalities) • Enforcement of those limits • Engineering treatments – well signed and marked pedestrian crossings – humps at pedestrian crossings – gateway treatments at entrances to towns/villages – pedestrian refuges in the centre of multi-lane roads to enable safer crossing
Urban	Intersections – fatal crashes between vehicles	• Lower speed limits at approaches to intersections to meet *Safe-system* outcomes (50 km/h maximum speed) • Enforcement of those limits • Engineering treatments – platforms/humps at intersections – roundabouts – traffic signals – splitter islands – stop and give way markings and signage
Urban	Run-off-road fatal crashes	• Lower speed limits • Enforcement of those limits • Engineering treatments – locating fixed hazards well back from the edge of the carriageway wherever possible
Rural	Run-off-road crashes (often fatal because of higher travel speeds)	• Lower speed limits to reduce crash likelihood • Some enforcement of limits • Engineering treatments – sealing of shoulders – delineation of the through lanes (edge and centre-line marking) – realignment of high-risk curves – establishing clear zones free of trees, poles and other obstacles (remove, relocate or shield vehicles from obstacles) – hazard markers and advisory speed signs
Rural	Head-on crashes	• Speed limits on two-lane, two-way roads not above 70 km/h • Enforcement of those limits • Tactile centre-line marking and barrier marking • Hazard markers on curves and advisory signs approaching lower radius curves.
Rural	Intersections – fatal crashes between vehicles	• Speed limits on cross roads not above 50 km/h • Speed limits on the major through roads not above 60 km/h at the approaches to a cross intersection • Enforcement of those limits • Engineering measures – construction of offset T-intersections to replace cross roads – warning signs on all approaches – rumble strips on the minor road approaches – ensuring vegetation and other obstacles impeding vision are removed wherever possible
Rural	Pedestrian fatal crashes	• Lower limits at pedestrian crossing locations • Enforcement of those limits • Severe penalties for drivers taking inadequate care and killing or seriously injuring a pedestrian on a clearly marked pedestrian crossing • Engineering measures – basic footpaths off the side of the road – mid-road refuges for crossing pedestrians (at marked crossings)

4.3.3 Choosing and applying tools

The next step is the selection of tools most likely to address the existing problems and have the greatest road safety benefit. Table 4.5 indicates some useful starting points when considering the ways in which relevant tools could be used to greatest effect. If it is a new road, all the tools in Table 4.6 need to be considered, including appropriate road design standards and its classification.

Table 4.6 Maximising the effective use of tools

Tools (Module 3)	Defining the problem (Module 2)	Deciding what to do (Module 4)
Legislation	Reviewing the road rules, legislation and penalties already in place	Consider the ways that laws and sanctions can be strengthened
Enforcement	Assessing the effectiveness of enforcement and (human and equipment) police resources	Developing plans to improve and enhance enforcement effectiveness. This may involve considering new methods, focused strategies, enhanced training or additional equipment
Setting speed limits and speed zones	Reviewing the speed limits and determining if the limits are too high for safe travel	Planning for revisions to speed limits. Determining how best to introduce the revised limits
Signs	Reviewing the road environment to see if there can be a better communication of what the speed limits are, and why they are set at those levels	Deciding on what additional or changed signage is necessary for improvements, or changes in the speed limits or advisory speeds
Engineering changes	Assessing the road environment for opportunities to encourage reduced speeding through engineering modifications. Reviewing the engineering options available	Determining the best options for improving speed management through engineering measures, depending on level of resources available
Public information	Assessing community knowledge and attitudes, and determining what options can be used to improve knowledge and attitudes – or to complement enforcement programmes	Deciding what kinds of communication objectives should be pursued, and how
Vehicles	Assessing the vehicle fleet to determine if there could be improvements to vehicles to reduce speed related crashes	Deciding what to do about regulating or influencing a change to vehicles (design rules, inspections, vehicle safety features or otherwise influencing manufacturers) to enable improved speed management outcomes

Resources for a speed management programme will be limited. This means that the best 'value for money activities' (those that provide greatest serious casualty crash reduction per unit of expenditure) need to be identified. This is discussed further in section 4.3.8.

4.3.4 Making decisions about speed limits and signs

Establishing a hierarchy of roads by function, which reflects actual road operating activity, will provide the starting point for review and development of a speed limit framework. Decisions about speed limits should be based on *Safe-system* principles as discussed in Module 1.

NOTE

Systems that account for the vulnerability of the human body

The uncertainty of human behaviour in a complex traffic environment means that it is unrealistic to expect that all crashes can be prevented. However, if greater attention in designing the transport system were given to the tolerance of the human body to injury, there could be substantial benefits. Examples include reducing speed in urban areas, separating cars and pedestrians by providing footpaths, improving the design of car and bus fronts to protect pedestrians, and a well-designed and crash-protective interface between road infrastructure and vehicles.

Source: *(8)*

There are a range of options for the ways that speed limits can be regulated (Module 3). The most fundamental of these is prescribing a maximum speed that is permitted on each road and road section in the network – for all types of vehicle. Setting these speed limits sets broad parameters for the general speed environment. Within this context, decisions can be made about whether speed limits should also be set for specific road user types and specific place or time conditions. A matrix with considerations for a sample of these is presented below in Table 4.7.

4.3.5 Making decisions about behavioural change programmes

While it may seem ideal to raise people's awareness and encourage voluntary compliance, this is generally not enough. International road safety experience over the past few decades has shown that it is more effective to force a behaviour change through publicity-backed traffic law enforcement measures than simply to conduct campaigns urging people to choose to slow down *(9)*.

Decisions on what tools to use have political and resource implications. Table 4.8 explores the questions raised when making decisions about the approach to behaviour change that should be adopted.

Table 4.7 Considerations about selected speed-limiting options

	Type of limit	Considerations
Default limits	The legislated speed limits that apply (a) in built-up areas and (b) on open roads in rural areas – usually not specifically signed	Should reflect *Safe-system* principles. Reminder signs at prominent locations to inform the public about the underlying limit(s) are necessary
Specific limits	Signed limits on a section or sections of road	*Safe-system* principles should underpin limit selection. Clear, legible and regularly placed signs, including repeater signs, are essential if high levels of compliance are to be sought
Young/inexperienced drivers	Licence condition – i.e. learner driver, provisional driver	Young or novice drivers have a much higher crash risk than older and more experienced drivers. They may need more practice at lower speeds until they have gained more experience driving on public roads
Heavy vehicle (truck or bus)	Vehicle registration condition or lower posted speed in certain road and traffic conditions	Trucks and buses exceeding certain weight or mass dimensions can be assigned lower speed limits as a condition of their use on public roads. There may be conditions on road sections, for example with steep grades that would favour a lower travel speed in the interests of safety. Some jurisdictions also limit heavy vehicle speeds to reduce traffic noise and for asset preservation reasons
Vehicles towing other vehicles or trailers	Vehicle/trailer registration or licence condition	Vehicles towing other vehicles or objects may not have the stability required to travel at the general speed limits set for a road section. In this case, consideration can be given to setting a lower speed limit
School and other urban zones	Site-specific limit and may be applied within specific time periods	When there are many child pedestrians around, lower speed limits around schools may need to be established. These can be specific to school starting and finishing times. Similarly at marked places in an urban setting
Road work zones	Site and time specific limits can be applied when road work is being undertaken	To reduce the risk of injury to people working on roads, a work zone can be established with a lower speed limit; often complemented by additional traffic management devices

Table 4.8 Considerations about selected behavioural change programmes

Intervention	Implementation considerations
Licence restrictions (lower speeds for novice drivers or licences for certain types of vehicle use)	• Is there a sound and credible licensing system in place? • Will the police enforce the restricted speeds? Is it practical for police to enforce? • Are there practical ways to identify drivers/riders with restricted licences? • Will the restricted speeds enable safe variances in speeds that are travelled by motor vehicles in traffic? *Discussion: If the answer is, or could be, yes to these questions, licence restrictions should be pursued. If not, actions to improve the licensing system and to assist police to develop enforcement practices and preconditions are needed. If the existing traffic environment is not conducive to safe speed variances, actions to separate slower drivers through engineering means may be a better option.*
General deterrence (highly visible but unpredictable or randomized speed enforcement)	• Are there sufficient traffic police? • Are the police operations providing effective enforcement? • Can the speed enforcement operations be made visible? • Are the speed enforcement operations random enough to give a sense of *anywhere, any time?* • Can the operations be backed by positive publicity? *Discussion: If the answer is, or could be, yes to these questions, general deterrence is a highly effective speed reduction strategy and should be implemented as a matter of high priority.*
Targeted enforcement	• Do the police have the capacity and enough information about where best to target speed enforcement? • Are there road safety reasons for targeting enforcement? • Is there a determined effort to enforce speed regulations? • Will the judicial, political and cultural systems support prosecutions? • Can the interventions be evaluated? *Discussion: If the answer is, or could be, yes to these questions, a targeted enforcement programme should be put in place. Note that a combination of general and specific deterrence through issuing penalties for speeding offences is ideal. The idea is that people will be convinced by knowing that they can get caught and penalized for speeding, and that they are reminded that this can happen anywhere and at any time.*
Speed cameras (mobile and fixed)	• Are there funds for purchasing necessary equipment/resources? • Are the police willing and trained to use the equipment? • Can the infringement processing system be upgraded to process camera infringements quickly and efficiently? • Is there political and community support for speed camera enforcement? • In the case of fixed cameras, can these be supplemented with mobile patrols and other strategies to ensure compliance across the whole of the network? • Do accurate and readily accessible data systems exist for licensing and vehicle registration? • Can sufficient legislation be put in place to assure successful prosecutions? • Is there owner onus or other supporting legislation/technology so that the driver can be identified and tracked? *Discussion: If the answer to all of these questions is yes, speed cameras should be introduced. This is a very powerful tool for speed management. The right balance between fixed/stationary and mobile camera operations must be determined based on enforcement intelligence and crash analysis. The best technology might depend on which category of vehicles are the 'target' group.*
Increased penalties or sanctions	• Is the elected government willing to toughen the penalties for speeding offences? • Will the police provide rigorous enforcement for speeds with higher penalties? • Will the courts provide consistency in prosecutions? • Are there practical enforcement strategies for prosecuting unlicensed, cancelled, suspended or disqualified drivers who continue to drive? • Are the penalties equitable and sufficient to deter both poor and wealthier drivers? *Discussion: Penalties must be in place to ensure that people will be deterred from speeding, otherwise enforcement has little value. If widespread licence loss is a likely outcome of increasing penalties there may be an increase in unlicensed driving. If monetary penalties only are relied upon, there may be a tendency for the penalties to be a lesser deterrent for wealthier drivers, and may be unfair to poor drivers who may be under pressure to speed in work-related tasks.*

Continues…

Continued from previous page

Intervention	Implementation considerations
Social marketing	• Are there sufficient funds/resources to mount an effective campaign? • Is there a need to persuade people/groups to support actions? • Is there a clear message and target audience? • Does the jurisdiction have sufficient communications and creative skills to produce effective campaigns? *Discussion: Social marketing can be an effective tool in gaining the necessary community support for speed management. But this activity alone is unlikely to achieve individual behaviour change or speed crash reduction. It is useful to consider social marketing that targets particular groups, for example professional drivers – working through their employers*
Public and school-based education	• Are there specific things the public need to know in order to help them comply with safe and legal speeds? • Is the information likely to be well received by the audience? • Is school-based education complemented with parent education? • Will a greater understanding of the speed risks lead to greater support for speed management? *Discussion: Educating the public over time will assist an understanding of the speeding problem and ultimately help to deepen community resolve to reduce it. However, it will take a long time to achieve and must be complemented by other, more immediate interventions to change behaviour.*
Enforcement publicity	• If advertising messages tell people that the police are enforcing speed, will this be evident by effective police patrols, vehicle interceptions and other enforcement strategies? • Are there sufficient resources or funds to conduct a media campaign? *Discussion: The use of media advertising and other media messages have been found to boost the perception by drivers of the likelihood of being detected and booked for speeding offences. This is the most important use of media in speed management.*
Fleet safety legislation	• Are the requirements of proposed legislation fair and reasonable? • Are the requirements enforceable? • Have the interested stakeholders been consulted? *Discussion: Speeding is one of the most prevalent risks in work-related driving. Requiring employers to take some responsibility for safe driving by their employees can be an effective tool for reducing the pressure on employees to speed.*

4.3.6 Making decisions about engineering treatments

There are a number of factors to consider when deciding on which engineering treatments to consider as part of a speed management programme. Treatments can be used either at specific locations (i.e. at a site that has inappropriately high vehicle speeds), or as part of a more integrated approach to speed management across a road network.

The expected crash reduction plays a major part in decisions regarding treatment selection. There is information available on the expected reduction in crashes for a variety of road safety treatments *(10), (11)*. However, considerations such as the overall cost and cost effectiveness of treatments will also need to be considered. When deciding on the most appropriate treatment type, and the locations that should be treated first, an economic analysis should be performed to determine where the greatest gain can be made for the budget available *(12)*.

Expected speed and injury reduction, cost and cost effectiveness are typically the most important issues to consider, but effect on traffic flow, environmental and health, public and political acceptability, feasibility, available skills and current legal environment can also affect the decision.

Examples of some considerations for specific engineering-based treatments are provided in Table 4.9.

Table 4.9 Considerations about selected engineering treatments

Installation of speed humps	• Cost and expected crash reduction • Effect on traffic flow – are there alternative safe routes available for traffic; is this a bus route, or one used by emergency vehicles? • Effect on vehicle condition – humps can damage suspension if poorly designed • Are there adequate materials available to construct a high-quality facility? • Have local residents been consulted about placement of speed humps? *Discussion: The use of speed humps needs to balance their effectiveness in slowing traffic with the effects upon emergency and heavy vehicles. However the use of carefully designed humps or platforms which enable a safe speed can address many of these concerns.*
Signs to address problems at curves	• Are there defects with the road that should also be addressed at the site (e.g. improvements in poor surface-skid resistance; widening of the road shoulder)? • Is there adequate space to provide the signs in advance of the curve (i.e. is there a location where the signs will not be obscured by roadside objects; is there enough distance between the sign and the curve for drivers to respond)? • Has an assessment been made of the entire route to make signing of curves consistent? • Will the signposts pose a hazard to drivers? *Discussion: Consistency of the warnings given to drivers and riders along a route is important to avoid increasing risk.*
Roundabouts	• Cost and expected crash reduction • Is selection of a roundabout appropriate for all road users (e.g. cyclists have problems safely negotiating roundabouts with two or more lanes; small roundabouts may provide restrictions for larger vehicles, including trucks, buses and emergency vehicles)? • Is there enough road space available to construct the roundabout or will expensive or protracted land acquisition jeopardize the cost effectiveness or the delivery within an acceptable timeframe? *Discussion: Roundabouts are unlikely to reduce the number of crashes at an intersection, but they will substantially reduce the number of serious casualty crashes at the intersection.*
Pedestrian and bicycle segregation from motorized traffic	• Cost issues and volumes of pedestrian traffic will assist decisions about which options to choose • Type of road environment and existing road and roadside activities • Is there enough space for tunnel or bridge construction? • Will the types of barriers available be sufficient to reduce the potential for harmful collisions? *Discussion: Separating motorized traffic from vulnerable road users, especially in environments where motor vehicles travel at speeds that human bodies cannot withstand without serious injury, is an important principle.*

4.3.7 Ensuring an appropriate medical response

The primary prevention of death and injury caused by speeding is an overriding priority. However, if a crash occurs, many lives can also be saved through proper trauma care. This is especially the case in developing countries, where there are high fatality rates from potentially repairable injuries.

BOX 4.4: **Ensuring emergency medical services are prepared**

Setting up an EMS system may not be feasible for many countries, but alternative pre-hospital care arrangements can be developed.

Trauma care, in both pre-hospital and hospital settings, requires speedy and appropriate action by trained personnel, with proper supplies and equipment. Improving trauma systems has been shown to lower the mortality in all treated trauma patients by between 15% and 20%, and to cut the number of preventable deaths by more than 50%.

Several recent publications provide technical details of on how to improve trauma care. Two, published by WHO, are strongly recommended: *Guidelines for essential trauma care (13)* and *Pre-hospital trauma care systems (14).*

Pre-hospital care

The pre-hospital stage is an important one to target in efforts to cut the number of road traffic deaths. The care given will depend on the services that exist.

Situations where no formal emergency medical service exists

A "formal" system of emergency medical services (EMS) is usually one with ambulances and trained personnel, who work in an agency with some supervision and with a network of communications. Where no formal EMS exists, governments should make alternative arrangements to provide pre-hospital care. Ways can be found to build on existing, informal systems and harness community resources, such as training members of the public in basic first aid. Setting up formal EMS systems in urban areas and along major inter-urban roadways should also be explored. Cost should be one consideration, given the high cost of these systems.

Strengthening existing EMS systems

Many EMS systems could be strengthened in a number of ways, for example, by establishing a regulatory agency to promote minimum standards for the delivery of prompt, quality and equitable pre-hospital care. They can also be strengthened by streamlining communication between sites where calls are received (such as alarm centres) and the sites of ambulance dispatch, as well as between different ambulance services; and by keeping good records on people cared for by the EMS, so as to monitor and improve the quality of care.

Essential trauma care

Improvements in trauma care need not necessarily involve high-cost, high-technology equipment. Much can be accomplished in an affordable and sustainable way through better planning and organization.

The essential trauma care services and the resources required for them can be promoted in several ways, including through needs assessments of trauma care requirements, through training in trauma care provided in appropriate educational settings, through quality improvement programmes that consider the entire trauma facility setting, and through the inspection of trauma facilities *(13).*

Rehabilitation

Many of those who survive injury go on to develop physical disabilities that limit their physical functions. Tragically, many of these consequences are avoidable and can be reduced through better rehabilitation services. Rehabilitation services are an essential element of trauma care, and can be improved by conducting in-depth needs assessments for injury-related rehabilitation and by strengthening national rehabilitation programmes. They can also be improved by incorporating the recommendations of World Health Assembly Resolution WHA58.23 and the recommendations on rehabilitation in the *Guidelines for Essential Trauma Care (13)* into a country's health policy.

4.3.8 Estimating required resources

Having worked out the activities in detail, the working group can now estimate the resource requirements and costs of each of them, and in the process draw up a budget based on quotes from suppliers or on the costs of recent, similar undertakings. The resources necessary will vary depending on the different tools. Engineering treatments, for example, are usually substantially more expensive to set up than enforcement, education or speed limit initiatives, but might be the best value for money in the longer term.

When formulating budgets for the project, the following actions are recommended:

- estimate the funds that will be required for the duration of the project
- set priorities, with activities phased if necessary to ensure that priority activities receive adequate funding
- obtain information from government departments in other countries about similar projects and their costs
- estimate the likely administrative and operational expenses for implementation
- estimate the costs of monitoring and evaluation
- estimate the costs of training
- plan for financial and performance reports to be made at regular intervals
- estimate the costs of information campaigns.

The recommended method of costing the programme is the 'marginal cost method'. This should include:

- the added costs of additional police, relevant training or new equipment and its operation, calibration and maintenance
- additional back-office costs for processing increased numbers of infringements and maintaining a high level of efficiency
- engineering treatment costs, including new signage and line marking
- publicity campaign costs.

The nature of some typical resource costs is summarized in Table 4.10.

Table 4.10 Resource needs and nature of costs involved

	Resource needed	Type of costs involved
Legislation	• Definition of legislative or administrative change • Skilled legislative writers • Political support • Law enforcement advice • Penalty setting advice and recommendation • Sound licensing system	• Staff/skills (occasional) • Staff/skills (occasional) • Staff/skills (recurrent) • Time/consultation (occasional) • Staff/skills (occasional) • Staff/system upgrades (recurrent and capital funding)
Enforcement	• Police officers • Enhanced training for professional development • Equipment	• Staff/skills (recurrent) • Funds for purchase and time • Capital funds, and recurrent calibration and maintenance
Setting speed limits and speed zones	• Skilled traffic engineers • Consultative staff	• Staff/skills (occasional) • Staff/skills (occasional)
Signs and markings	• Signs and paint	• Capital funds (initial and recurrent for maintenance)
Engineering changes	• Traffic engineers • Materials for road changes	• Staff/skills (recurrent) • Capital (long term and recurrent for maintenance)
Public information	• Behavioural scientists • Marketing specialists • Communication materials • Media	• Staff/skills (recurrent) • Staff/skills (recurrent) • Funds for purchase • Funds for purchase
Evaluation	• Social scientists, engineers and statisticians • Researchers	• Staff/skills (recurrent) • Funds for purchase (occasional)

Table 4.11 presents a summary of a number of elements that could be included in a speed management programme. They are rated on the basis of effectiveness, ease of implementation, cost, and whether there is research to demonstrate the effectiveness of the interventions. There is also reference to where more information can be found in this manual for each element.

A team of well-trained, multidisciplinary professionals is needed to implement the action plan. The team ideally will have a mix of skills, including engineering, social and behaviour science, law enforcement, political, managerial and marketing, data collection and statistical analysis skills. Professional development will need to be considered (well in advance of implementation) for all points of the delivery chain.

Table 4.11 Possible programme elements, by priority, for countries implementing a speed management programme

	Element	Description	Research	Effectiveness	Difficulty to undertake	Cost to implement	Section in this manual
High Priority	Road safety/crash data assessment	Conduct a situation analysis to define the problem, set a baseline for evaluation and determine best targeting of resources and interventions.	Yes	High	Low	Low	2
	Define road hierarchies – rural and urban	Review functions and features of the road, road environment and activities. Classify and zone the roads accordingly.	Yes	High	Medium	Low	3.1.1
	Speed limit setting	Establish maximum permissible travel speeds for motorized vehicles, a fundamental tool of speed management.	Yes	High	Medium	Low	3.1.2
	Speed limit signage and informing the public	Advise motorists of legal speed limits through signs, markings or other methods to give effect to speed limits. If this is not done effectively, compliance will be low.	Yes	High	Low	Medium	3.1.3
	Enforcement of speed limits	Enforcing speed limits is the most effective way to encourage motorists to travel at safer speeds.	Yes	High	Low	Medium	3.2.2
	Penalties, including fines and licence loss	Setting penalties high enough to deter all motorists from exceeding legal speed limits will give effect to speed limit compliance.	Yes	High	Low	Low	3.2.3
	Public education with enforcement messages	Conducting publicity campaigns to advise motorists that there will be strong levels of enforcement will assist in persuading them that if they exceed speed limits they are likely to be caught. Enforcement is needed to make this element effective.	Yes	High (if linked to enforcement)	Low	Medium	3.3.2
	Engineering treatments to slow traffic	Installing sound, physical treatments to the road to compel motorists to drive their vehicles more slowly is effective.	Yes	High	Medium	Medium to high	3.4.1
	Engineering treatments to separate vulnerable road users	Install physical barriers to prevent pedestrians and cyclists being exposed to moving motor vehicles – an effective way to prevent serious injury crashes.	Yes	High to medium	Low	Medium to high	3.4.2
	Medical trauma response systems	Ensure that emergency and medical response services are in place to reduce the long-term injury impact of serious crashes involving speed.	Yes	High	Medium	High	4.3.7
	Prepare an action plan for speed management	Plan and document interventions, expected benefits, resources needed, responsible implementing agencies and performance measurement process.	Some	High to medium	Medium	Low	4.3
	Monitoring and evaluation	Track and assess the success of interventions to ensure that the resources for speed management are put to good use.	Yes	High	Medium to low	Low	5

Continues…

Continued from previous page

Priority	Element	Description	Research	Effectiveness	Difficulty to undertake	Cost to implement	Section in this manual
Medium Priority	Speed camera enforcement	Using speed cameras to detect offenders is an effective means of speed enforcement.	Yes	High	Medium	Medium	3.2.2
Medium Priority	Graduated licensing speed restrictions	Restricting the speed that new drivers or riders can travel will reduce the likelihood and severity of crashes as a result of inexperience.	Yes	Medium	Medium (can be enforcement difficulties)	Low	3.3.5
Medium Priority	Social marketing and public education	Appealing to the public to support government speed management actions will help to secure political will to do what is necessary. Needs to be combined with enforcement to make a difference.	Some	Medium	Medium	Medium	3.3.1
Medium Priority	Legislating for employer responsibility	Encouraging employers to manage or influence employee driving practices can result in fewer speed related crashes.	Little	Medium	Low	Low	3.6
Medium Priority	Speed advisory signage	Install signs to advise motorists of recommended (lower) speeds for road and traffic conditions. This can be helpful, but usually drivers and riders will make their own judgment about speed selection unless they are *required* to do otherwise.	Some	Low	Low	Medium	3.1.3
Medium Priority	Set up a reference group for consultations	Identify stakeholder groups with a particular interest in speed management (but not responsible for outcomes) and set up a forum to gain their inputs to the programme.	Some	Medium	Medium	Low	4.2.2
Medium Priority	Promote new vehicle speed control technologies	Advise organizations with large vehicle fleets to use such technologies as speed limiters, electronic data monitors and intelligent speed adaptation devices.	Yes	Medium	Medium	Low (to promote) High (to implement)	3.5
Low Priority	Community programmes	People in local communities taking actions to promote safe travel speeds can be a useful complement to government actions.	Some	Low	Low	Low	3.3.4
Low Priority	School education	Educating young children about speed risk in appropriate ways can be helpful to creating a speed-risk conscious generation.	Some	Low	Low	Low	3.3.6
Low Priority	Incentives	Offering incentives to encourage compliance with speed limits is rarely done by governments, but sometimes employers and insurers can do this effectively.	Some	Low	Low	Low	3.3.3

4.4 Preparing for implementation

After gaining government endorsement for the proposed programme it will be necessary to review how the programme will be delivered (through legislation, enforcement, revised speed limit signage, engineering measures and public education) and the estimated funding requirements.

It may also be beneficial to look at the experience of other countries, and carry out a final check that project objectives, stakeholder commitments and funding are realistic.

4.4.1 Legislative requirements and timing

The legislative change procedures will vary from country to country but this process can take a significant amount of time. Depending on the substance of the change, it may be a simple administrative procedure for one ministry to enact. In other cases it may involve a process of discussion and debate within the legislative branch of government.

Preparing the political arm of government for legislative change, whether new rules or new penalties are proposed, requires the working group or one of its members to write a briefing document that contains:

- objectives of the proposed change(s)
- coverage or lack of coverage in other related legislation
- the reason for the proposed change(s)
- how mechanisms for enforcing and administering the legislation will be put in place
- how the community will benefit from the change(s)
- likely level of community support for the change
- the proposed timeframe for the legislation to take effect.

People with skills in drafting legislation will need to be assigned to write the change(s) in accordance with the intentions of the initiative, and the practicality of implementing the legislation. Police in particular need to be confident about the enforceability of the legislation and regulations before committing to an implementation timeframe.

4.4.2 Enforcement requirements

In order to be effective, road rules, laws and regulations require effective enforcement (Box 4.5). While simply the announcement of a new law can sometimes result in behaviour change, sustainable and meaningful change invariably depends on forcing compliance with the law through the real threat and public awareness of penalties for non-compliance. Preparation for effective enforcement should take into account police and judicial capabilities and attitudes towards the enforcement and prosecution of offenders, and the community driving culture, as well as ensuring that the resources, technology and tools needed for this process are available.

BOX 4.5 **Administration of enforcement**

Back-office processing of infringements

Planning for capacity to process increased numbers of infringements, as a result of a tougher and expanded enforcement strategy, needs to take place. Where automated enforcement is to be introduced, the processing volumes (including peaks and troughs) are likely to be substantial and thought needs to be given to the volume and rate of infringements likely to be issued.

Follow-up arrangements for unpaid fines

Planning for capacity to carry out follow-up of unpaid fines is an essential part of enforcement support. If the public believe that fines will not be pursued by the authorities, or sanctions not imposed, the deterrent effect of the speed enforcement programme will be undermined. Arrangements need to be put in place to avoid this impression being created as the enforcement effort expands.

Police culture/capacity

If speeding laws are to be effective, traffic police must be well trained, committed and have real capacity to provide effective enforcement (Box 4.6). It may be necessary to educate all police officers of the importance of speed law enforcement (not just traffic police) and to mount an 'internal campaign' to convince them that – in terms of injury risk – speeding is as critical a matter as robbery or homicide. In addition all police must set an example by their driving behaviour which will always be subject to community scrutiny.

BOX 4.6 **Training of police officers in speed enforcement**

Police officers must be trained in effective strategies and tactics to achieve maximum success. This includes:

- knowledge of the law
- understanding how speeding increases the risk of crashes occurring and the severity of crash outcome
- police officers on and off duty obeying speed limits and setting an example
- understanding how to set up speed monitoring strategies for maximum public exposure and enforcement with hand-held devices, mobile speed cameras or vehicle-mounted devices
- how to target locations with higher rates of non-compliance
- how to provide effective advice and education on speeding to drivers
- understanding the impact of crash risk on financial and human resources in the community
- publicising the savings for police, emergency services and hospitals of an effective speed programme
- understanding the best ways to measure the effectiveness of their enforcement intervention
- educational lectures, as well as individual and media warnings.

See Appendix 6 for more details about police and traffic enforcement practices.

4.4.3 Revised speed limit signs

Installing signs to clarify existing speed limits, or altered signs for locations where revised speed limits are to apply, is a major exercise if implemented consistently across the country.

For this to happen, supplies of signs with a consistent design must be purchased or produced. The timing of installation may depend on the availability of local teams to carry out the work. Care should be taken to ensure that signs are clearly visible to approaching road users and especially that they are effectively maintained and not obscured by foliage or other signs.

Information signs about default limits applying (the limit that applies when there are no speed limit signs) in urban and in rural areas are also likely to be needed. The timetable for installing these would have to be planned in accordance with the timetable for any necessary legislation.

4.4.4 Engineering measures

Implementation of engineering measures usually requires substantial lead time in order to:

- obtain resources, usually as part of the annual, government road authority budgeting cycle
- obtain necessary designs
- obtain planning and environmental approvals
- award contracts
- carry out works.

In a large number of instances, works involved – such as line marking and signs – are relatively minor and could be funded by existing annual budgets and have shorter lead times. However, timing needs to be carefully considered, and implementation should not start before the timelines are reliably estimated and agreed.

This scheduling and progress of necessary infrastructure works and treatments need to be monitored by the working group. The locations where speed compliance will bring greatest returns should be prioritized. In addition, the decision to proceed with revised speed limits and enforcement ahead of the engineering works may be taken where the problem location has a high rate of speed related casualty crashes.

Try to use all opportunities possible to inform the public that the purpose of the particular project is to support the national speed management programme. Consistent project signage themes will brand the programme and assist public awareness of its existence.

4.5 Informing, influencing and involving the public

There are three distinct objectives for public communications about speed management.

- Advising and educating drivers and other road users about speed management actions and the change in behaviour expected of them.
- Motivating compliance with speed limits and safe speeds.
- Encouraging public support for actions to address the speeding problem (Box 4.7).

BOX 4.7 **Basic steps for implementing a speed management public awareness campaign**

1. Write a background paper on the problem to be addressed, including information about the actions being implemented to deal with it.
2. Write a communications brief with clear objectives for behaviour change, including information about primary and secondary audiences for the communication, timing and duration, budget and any other relevant information.
3. Engage a creative agency or agencies (advertising, public relations and marketing specialists) and give them the briefing information.
4. Seek options for creative communications that would meet the brief (at least 3).
5. Test the creative concepts with a sample audience. Market research companies are well equipped to carry out this 'focus group' research.
6. Decide on which communication concepts and strategy to folllow.
7. Schedule the campaign communications in consultation with the working group to coordinate with other relevant actions.
8. Produce the creative materials (e.g. advertisements and other communication materials).
9. Launch the campaign – this can be a media event involving political or community leaders.
10. Implement the communications programme.

4.5.1 Working with the media

The media – including the print media, the broadcast media and the internet – serve various functions in a public education campaign. As mentioned earlier, media outlets may be interested in and cover the campaign itself – its objectives, strategies and progress. They may support it, but they may also be critical, even to the extent of running a counter-campaign.

It is therefore important that the reasons for the campaign are set out clearly and backed by evidence. It could be demonstrated, for example, that while speeding above the limit by even a small amount may save tiny amounts of time, it increases the risks of fatal or serious injuries substantially. Remember that the media like to use statistical data if it is available.

The media are also frequently keen to publicize statements from medical personalities, political leaders or the police on traffic safety issues in general. This could include the value of speed compliance, but it will require extensive briefing of the media to convey to them the facts about speed and crash risks.

A continuing part of the campaign should be to keep the media regularly informed about its progress and how it is meeting its targets. This can be done either by the government agency or by an external public relations agency.

4.5.2 Planning the campaign roll-out

The initial public education stage, before rigorous enforcement gets underway, should be no more than six months in duration, since the initial impact of a campaign that goes on any longer will begin to fade. The date set for the introduction of, for example, the new enforcement arrangements should be one that is easily remembered.

The enforcement publicity stage can have a considerable effect on behaviour, and needs to be continued until its planned outcomes are achieved. However, marketing efforts need not be continuous. Periodic marketing will reinforce a message, and is more cost-effective than continuous marketing. During this stage, it may be best to enforce the speed compliance with warnings only at first, though the campaign will become most effective when the limits are fully enforced.

4.5.3 Carrying out the campaign

Depending upon the budget, objectives and target audiences for the campaign, a range of media will usually be employed to convey its messages. Some media are more appropriate than others for a particular target group; newspapers may be better for middle-aged people, for example, cinema advertisements for younger people and radio for those in rural areas. Roadside advertisements are effective and provide economical, on-the-spot advice to a road user target audience. An experienced advertising agency will be able to advise on the best way to reach different target groups.

4.6 Planning and using pilot projects

Pilot projects are good for assessing speed management methods to see how they work best. Pilots should be substantial enough in scope to enable impacts to be measurable but should not be so large that they introduce the problems of scale associated with a full roll-out.

4.6.1 What is a pilot project?

A pilot project is a limited implementation of an initiative aimed at testing and evaluating its effectiveness on a small scale before implementing more widely.

Some pilot projects will be limited to one or two components of a proposed speed management programme while others may combine public information, engineering works, speed limit review and improved limit signage and speed enforcement – all the elements of a speed management programme.

4.6.2 What are the benefits?

Pilot projects can test a range of implementation aspects, including operational practicalities, community reaction, likely outcomes, and technical feasibility. Pilot projects can be an effective means of developing knowledge and skills for joint agency cooperation for effective delivery. Political support can often be achieved more readily if a pilot approach is to be used. Government agencies often feel less 'locked in' to a particular approach if a pilot approach is used.

Pilot projects can also assist to sell the benefits of an initiative to the community or to government. If the results of a limited trial show reductions in injury, this can provide strong evidence that full implementation will achieve substantial benefits.

Importantly, pilot trials will identify any problems with specific interventions that need to be rectified prior to full implementation.

4.6.3 How to plan and implement a pilot project

The steps to be followed are the same as those which would be used in a full-scale implementation. The geographic scope is much smaller and the number of elements may be limited. The project should be promoted as a pilot to prepare people for any unforeseen issues that may arise. It is always useful to be open with the public and tell them if a particular outcome emerges that was not anticipated, and that future programmes will be modified to reflect what has been learned.

The pilot projects should be evaluated in accordance with methods outlined in Module 5. If the pilot evaluation indicates substantial problems, it may be worthwhile to conduct a second pilot test using a different approach and evaluate this prior to full implementation.

Pilot testing can be conducted at a number of levels and for a range of interventions. At a simple level, campaign messages or speed signage can be tested with small groups of a sample target audience. But more complex programmes can be conducted on a limited basis – as pilot projects – and evaluated prior to full-scale implementation.

Usually the information collected (or test indicators) will be of the same type as used for the longer term monitoring and evaluation. The pilot testing should be designed to provide confidence that the main programme will be fully effective. It is therefore likely that both qualitative and quantitative measurements will be required, as well as obtaining feedback from those involved in conducting the programme.

Test indicators can include such things as:

- outcome data such as crash incidence and severity.
- impact data such as:
  - reductions in mean speeds
  - improved compliance with speed limits
  - increased public support for speed enforcement.
- process feedback such as:
  - stakeholder satisfaction with the intervention process.

The pilot project also offers the opportunity to clarify the inputs required, and point to possible improvements to implementation actions.

CASE STUDY: **Increased penalties for speeding**

Demerit points for speeding offences were doubled in the state of New South Wales, Australia over a holiday period. The motoring association surveyed its members, finding broad support for this initiative. Speed related injury crashes were lower than they had been in previous holiday periods and police detected fewer offences during the trial. Following these results, the legislation was extended to cover all holiday periods on a continuing basis.

Reporting and using test results

If the pre-testing indicates deficiencies in either implementation or the programme itself, stakeholders should be informed and involved in deciding on any changes required in the large-scale programme. If the pilot evaluation indicates substantial problems, these should be reported and discussed with all stakeholders before conducting further pilot testing (which may involve using a different approach) that will need to be fully pilot tested prior to full implementation.

Pilot projects can help sell the benefits of an initiative to the community or to politicians. If the results of a limited trial show reductions in injury, this can provide strong evidence that full implementation will achieve substantial benefits.

CASE STUDY: Trial of 40 km/h around school buses in New South Wales

A trial of reduced speed limits around buses during school travel times was tested in New South Wales in 1999. This involved installing flashing lights and a '40 km/h' sign on the back of buses. When this was tested with road authority officers measuring speeds on a road with a normal speed limit of 80 km/h, some unsafe sudden braking by heavy trucks was observed as the buses stopped and flashing lights (indicating that the speed limit around the bus was 40 km/h) were activated. As a result, the bus stops on higher speed roads were modified to enable more lead-up warning of bus stops ahead, and more gradual speed adjustment phases for approaching vehicles.

Summary

- Speed management is a highly contentious issue. Political support is essential for a successful programme.
- Political and community leaders must be informed and actively encouraged to support the speed management programme at the outset. Without this support substantial change is unlikely to occur.
- Stakeholders are a mix of those who hold responsibilities for speed management and those with a strong interest in speed management. Roles and mechanisms for involving stakeholders are important elements of managing programmes that address speed.
- A working group, supported by an advisory or reference group, should be established to coordinate actions for best results.
- It is important that good communication and leadership are applied to steering the speed management working group.
- An action plan should set ambitious but achievable objectives, targets and performance indicators.
- Development of activities to deliver the action plan using selected tools requires understanding of crash issues, and the acceptability of certain actions to government and the community.
- An effective action plan will include a range of activities and measures. Single actions are unlikely to have much effect.
- Before implementation it is necessary to conduct a final assessment of the steps to be followed, and confirm that the proposed delivery arrangements will maximize the likelihood of success. Resources need to be secured to implement the plan.
- Communication campaigns inform the public of speed management initiatives, enhance the effectiveness of speed management measures and foster public support.
- Conducting limited trials or pilot projects is good practice as a preliminary phase of programme implementation.

References

1. Elvik R, Vaa T. *The handbook of road safety measures.* Amsterdam, The Netherlands, Elsevier, 2004.
2. Mohan D et al. *Road traffic injury prevention training manual.* Geneva, World Health Organization, 2006.
3. Schopper D, Lormand JD, Waxweiler R, eds. *Developing policies to prevent injuries and violence: guidelines for policy makers and planners*. Geneva, World Health Organization, 2006 (http://www.who.int/violence_injury_prevention/publications/39919_oms_br_2.pdf).
4. *Speed management*. Paris, OECD/ECMT Transport Research Centre (JTRC), 2006.
5. *Targeted road safety programmes.* Paris, Organisation for Economic Co-operation and Development, 2004.
6. Elvik R. Quantified road safety targets – a useful tool for policy making? *Accident Analysis and Prevention,* 1993, 25:569–583.
7. SafetyNet. Deliverable D3.1: *State of the art Report on Road Safety Performance Indicators.* The Netherlands, SWOV, 2005.
8. Elvik R. *Quantified road safety targets: an assessment of evaluation methodology.* Oslo, Institute of Transport Economics, 2001.
9. Elliott B. *Road safety mass media campaigns: a meta analysis.* Canberra, Australian Transport Safety Bureau, 1993 (www.atsb.gov.au/publications/1993/pdf/Edu_Media_1.pdf).
10. Peden M et al. *World report on road traffic injury prevention*. Geneva, World Health Organization, 2004 (http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/index.html).
11. *Convention on Road Traffic,* Economic Commission for Europe, Inland Transport Committee, United Nations, E/CONF.56/16Rev.1/Amend.1, Vienna, November 1968 (http://www.unece.org/trans/conventn/crt1968e.pdf).
12. Ogden K. *Safe Roads: a guide to road safety engineering.* Aldershot, England, Avebury Technical, 1996.
13. Mock C N, et al. *Guidelines for essential trauma care.* Geneva, *World Health Organization,* 2004 (http://whqlibdoc.who.int/publications/2004/9241546409.pdf).
14. Sasser S et al. *Prehospital trauma care systems.* Geneva, World Health Organization, 2005 (http://www.who.int/violence_injury_prevention/publications/services/39162_oms_new.pdf).

5
How to evaluate the programme

How to evaluate the programme

Monitoring and evaluation of any programme or intervention is vital to determine whether it works, to help refine programme delivery, and to provide evidence for continuing support of the programme. Evaluation will not only provide feedback on the effectiveness of a programme but will also help to determine whether the programme is appropriate for the target population, whether there are any problems with its implementation and support, and whether there are any ongoing concerns that need to be resolved as the programme is implemented.

Once the tools of speed management are chosen, the objectives set and quantified, and the programme of actions developed, the next step is to plan the monitoring and evaluation of the programme. Performance indicators can be identified for the programmes' hierarchy of objectives, and evaluation plans devised. This module describes the step-by-step process of planning, designing and conducting the monitoring and evaluation of a speed management programme. It is divided into three key sections:

5.1 Planning the evaluation: Evaluation and monitoring need to be built into the programme from the start. An important initial stage involves collecting baseline data to assess the current situation before developing and implementing the programme. This section shows how, based on this data, the aims of the evaluation can be defined and different types of evaluation methods considered.

5.2 Choosing the evaluation methods: Once the type of evaluation has been chosen, there are different methods that can be used to carry out an evaluation. This section describes the different study types, explaining the advantages and disadvantages of each type of method. It provides guidance on calculating sample size and describes how to conduct an economic evaluation. It also outlines the types of performance indicators that can be used to measure the success of a programme, and how to set up the monitoring mechanism to follow the progress.

5.3 Dissemination and feedback: This section describes how to feed the result of an evaluation back into the planning and implementation stages, as well as ways that the results of an evaluation can be shared with different interested parties. It stresses the need to recognize and reward the inputs made by individuals and agencies because this will help to ensure sustainability of the programme – as will broadcasting and celebrating successful outcomes.

5.1 Planning the evaluation

While the ultimate aim of speed management is to reduce deaths and injuries caused by driving at unsafe speeds, it is useful to identify a hierarchy of objectives, as discussed in Module 4. The evaluation framework should be built around these objectives.

It is important that the evaluation is built into the programme from the outset, not simply 'bolted on' at the end. The process should also be developed to provide much more than a simple 'yes-no' or 'good-bad' conclusion; and it is vital to be clear about the aims and objectives of the evaluation. Therefore it is essential that the evaluation framework is developed and implemented alongside the proposed programme. Baseline data need to be collected before the intervention is put in place so that changes can be measured. Thus, this work would be carried out by the working group as they develop the action plan for the programme and conduct the programme.

While introducing safety measures that have the support of general public is preferable, it is often necessary to pursue measures that will be highly effective but, initially at least, unpopular. In these circumstances it will be useful to collect information on public (and stakeholder) attitudes about speed campaigns.

5.1.1 Aims of evaluation

The evaluation will assess the extent to which the programme objectives have been met, and may have more than one aim. There are many possible indicators that can be measured for a speed management programme, so at the outset it is essential to clarify the aim/s of the evaluation – in other words, what questions does the evaluation need to answer? The breadth of an evaluation will always be limited by the resources available, but a well-designed, simple evaluation can be as useful as a more complex and costly one.

5.1.2 Types of evaluation

Evaluation may take several forms, and one or more may be appropriate, depending on the aims of the programme to be evaluated.

Formative and process evaluation

Formative evaluation determines whether a programme is appropriate, e.g. whether it addresses risk factors, and is suitable for the target audience. For example, formative evaluation of a media campaign would ask whether the marketing material is aimed at the appropriate audience.

Instead of measuring 'outcomes' such as a reduction in crash numbers, or 'inputs' such as speeds on a particular road, a *process* evaluation examines whether the programme was carried out as initially planned, and helps identify strengths, weaknesses and ways of improving delivery in the future *(1)*. This typically involves creating a list of 'simple' indicators that can be checked or measured in order to see that the programme took place as intended, and delivered the planned outputs efficiently and to a high enough standard.

For example, a *process* evaluation of a speed enforcement intervention might ask whether:

- the police accepted their (new) role and whether they anticipated they would continue with it as expected into the future; and had the resources available
- the police had the proper equipment and training
- drivers were able to circumvent the penalty process (for example, using bribery).

This type of evaluation seeks to identify evidence of the 'productivity' of the speed management interventions. These outputs can often be measured and compared to inputs to determine implementation efficiency. For example, speed enforcement outputs can be measured in numbers of hours spent in on-road traffic policing, or in numbers of speed cameras operating compared to the investments in these resources. Other outputs would include the number and quality of engineering treatments, lower speed limits established, and quality and quantity of signs.

The evaluation, could measure, for example, whether:

- speed limits are appropriate and clearly signposted, and whether a review programme is in place
- offenders issued with a speeding penalty paid their fine
- publicity and education campaigns informed the public about the reasons for, and benefits of, speed management.

Impact assessment

An important 'impact' performance indicator for speed management projects will be the reduction or increase in the speed of vehicles on the road. The level of compliance with speed limits is an indicator of speed-related risk, and is therefore a fundamental indicator to monitor. However, measurement of any change in average speeds, and speed variance, are important to assessing the impacts of speed management interventions (methods for speed measurement and speed data analysis are discussed in Section 2.2.2). Ideally, speed surveys should take place at six-monthly intervals and at a sufficiently large number and range of sites to give a good assessment of changes that could be attributed to the speed management interventions implemented. Importantly, the cost of these surveys should be built into the overall cost of the speed management programme.

Changes in road-user knowledge and perceptions about speed and speed management are also impact measurements. Indicators such as population or target-group knowledge of the risks associated with excessive speeds, attitudes towards speed limits and perceptions such as the likelihood of being detected by police for exceeding speed limits are indicators of the impact of public education and enforcement interventions.

Depending on programme objectives, impacts of engineering treatments could include, for example:

- whether pedestrian traffic is effectively kept separate from motor vehicle traffic
- the positive or adverse effects of speed humps or other traffic calming devices
- road user understanding of speed regulatory or advisory signs.

Outcome evaluation

This type of evaluation involves measuring actual outcomes to see if the programme was successful. For example, speed management programme outcomes might be evaluated in terms of reduction in the numbers of recorded crashes involving speed as a contributing factor, a change in the ratio of fatal crashes to serious, slight injury and non-injury crashes, or a reduction in the involvement of speeding as a contributing factor to serious injury crashes compared to other contributing factors.

Using more than one outcome indicator will help to explain more about what is being achieved. For example, one consequence of a general reduction in driving speed may be that while the numbers of deaths and serious injuries may be reduced, the number of slight injury or damage-only crashes may not decrease to the same extent, or may even increase. Understanding why overall crash rates are not improving – or may even worsen – requires an analysis of crash contributing factors as it may mean that speed management is not reducing crash incidence rates.

Moreover, it is useful to segment and analyze the speed crash and injury data by road user categories, such as pedestrians, cyclists, motorcycle riders/passengers, car and truck drivers, car and truck occupants and so on. Demographic information will also assist in understanding programme outcomes with respect to gender, age, nationality, and other factors.

5.2 Choosing the evaluation methods

The methods used for each type of evaluation will vary. Both qualitative and quantitative methods can be used within the design of an evaluation (Table 5.1). Qualitative methods may be employed for formative and process evaluations, e.g. focus groups, short-answer or open-ended questionnaires. Quantitative methods such as surveys may also be employed for process evaluations.

Impact and outcome evaluations may be carried out using a variety of quantitative methods. Using an experimental or quasi-experimental design to demonstrate a change (or not) is the most powerful programme evaluation for detecting changes in outcome. The methods used will depend on the aim and the budget for the evaluation.

There is an extensive and well-defined hierarchy of experimental designs for examining the effectiveness of interventions. These range from fully randomized control trials (which can provide high level evidence for the effectiveness of an intervention) to, for example, uncontrolled 'before–after' studies which can only ever provide weak indicative evidence of effectiveness.

Table 5.1 Study types and their advantages and disadvantages*

	Formative and process evaluation	Impact and outcome evaluation	Pros and cons
QUALITATIVE			
Focus groups/ in-depth interviews	✓ – formative – process	✓ – outcome	– Can provide information on why intervention may or may not have worked – Cheap – Sample (participants) are not random sample – Results are not generalisable
QUANTITATIVE			
Randomised controlled trials		✓ – impact ✓ – outcome	– Most rigorous evidence – Expensive – Randomisation not always feasible
Controlled before–after study		✓ – impact ✓ – outcome	– Most practical design – Must have comparable control group
Interrupted time series design		✓ – impact ✓ – outcome	– Practical design if sufficient numbers of events and accurate surveillance systems in place
Before–after study (no control group)		✓ – impact ✓ – outcome	– Cheap – Low level of evidence

* Further detail about study types is available in references *7* and *11*. There is also a useful online glossary of epidemiological terms at: www.cochrane.org/resources/glossary.htm

5.2.1 Study types for formative and process evaluation

Qualitative research is in-depth research used to understand why things happen. Such studies collect data about personal observations, perceptions and beliefs, which can be used to broaden understanding of the underlying processes. Specific techniques include using focus groups, in-depth interviews, or questionnaires with short answers or open-ended questions *(2,3)*. However, an evaluation may use both qualitative and quantitative methods. For example, a process evaluation of a speed enforcement campaign might seek to identify whether 'the public' were aware of the campaign and whether it was likely to influence their behaviour and, perhaps most importantly, if not, why not?

While answers to the first two questions could be collected by simple quantitative methods such as surveys (either at the roadside, by phone or by post) the latter question (why not?) would best be answered by employing a series of focus groups – perhaps containing different types of driver. Such feedback aims to improve any future developments of the programme.

5.2.2 Study types for impact and outcome evaluations

The following methods are described for the use of road safety/speed management operational staff. The recommended study methods fall into two categories: experimental and quasi-experimental study designs.

Experimental – randomized control trial

The accepted 'gold standard' of evaluation is the randomized control trial (RCT) which can be used to provide the highest quality of evidence that an intervention or programme was or was not successful.

In a RCT, the study population is randomly allocated to either receive, or not receive the programme or intervention. If the randomisation process is adequate, other factors that may influence the outcome – measured and unmeasured – are more likely to be balanced between the intervention and non-intervention group. This means that it is possible to compare the outcomes of interest across the groups without fear of bias, and a robust estimation of the effectiveness of the intervention may be made. RCTs may be conducted at the individual level, whereby the unit of randomisation is a single unit (e.g. a person, road or intersection), or in clusters, where the unit of randomisation is a group of units, such as a town, or school (cluster RCT).

For speed management interventions the study group could be different roads, regions or cities. For example, to evaluate the effectiveness of speed detection devices in reducing speed, black-spot intersections in a city could be randomly allocated to receiving a device or not. Speeds at the intersections would be compared across all intersections before and after the implementation of the devices.

However, although RCT designs should always be considered when evaluating effectiveness of an intervention, they do require significant resources and may be difficult to conduct with a limited budget. There can also be ethical considerations in randomising a potentially beneficial intervention (that is, denying an effective intervention to participants in the non-intervention group).

Quasi-experimental study designs

If properly conducted, these study designs (while not as rigorous as fully randomized trials) can be used to establish the effectiveness of an intervention. They typically involve collecting 'trend' information by monitoring key indicators over time. Quasi-experimental evaluation methods include: controlled before-after studies, before-after studies with no control group, and interrupted time series studies. These are described below.

Controlled before-after study

This is often the most practical design for evaluating programmes. This design involves observing the outcome of interest (e.g. vehicle speeds, crash rates, violation numbers) before and after the intervention for both the sample experimental group undergoing the programme, and an equivalent control group (Box 5.1). The control group should be as similar as possible to the experimental group and any important differences between the groups need to be taken into account. A control group allows trends that may have been occurring in the population separately from those happening as a result of the programme to be taken into account.

It is necessary to plan this approach well in advance because often interventions are introduced over a lengthy period of time in different places.

Before–after study (no control group)

The before–after study without a control group is often used to evaluate the impact of a programme, but provides the weakest evidence for the effectiveness of a programme. This design involves measuring the outcome of interest before and after the programme has been run. This study design is simple, and may be conducted relatively cheaply because all that is needed is a sampling frame and people and/ or equipment to conduct observations at various sites. However, without a control group, the scientific merit of these study types is relatively limited, because it is often difficult to attribute with any certainty the change in outcome solely to the introduction of the programme.

BOX 5.1: **Speed calming, Denmark**

A ten-year before-after study in Denmark showed that after speed calming was introduced on main roads through a number of rural villages (using engineering techniques such as road narrowing, medians, raised areas, bicycle lanes etc) the number of injuries decreased by 50%. In the control group, the total number of people injured fell by 29%. This illustrates the significant impact of general improvements to road safety, although the difference of 21% demonstrates the impact of the measures.

Source: *(4)*

Interrupted time series design

It is also possible to assess the effect of a programme by using multiple measures of the outcome of interest before and after the programme. There are a number of different variations on this design, some involving control groups (Box 5.2). Studies that have used these designs generally use routinely collected measures such as fatality rates, injury rates or crash rates, as multiple measures are required for appropriate analysis. The validity of this study design can be distorted by events outside the control of those monitoring the programme (such as a petrol shortage, or a massive increase in fuel costs), which may or may not have contributed to any observed effect. However, statistical analysis of such data can take account of such factors so as to establish whether the intervention was responsible for the change.

BOX 5.2: **Speed cameras, Barcelona, Spain**

In Barcelona, researchers used a time series study to assess the effectiveness of speed cameras in reducing the numbers of road collisions and injuries (and the number of vehicles involved in collisions) on the city's beltway. The 'intervention group' was the beltway, and the control group comprised arterial roads on which no fixed speed cameras had been installed. The data was fitted to Poisson regression models that were adjusted according to trends and seasonality. The relative risk (RR) of a road collision occurring on the beltway after (compared to before) installation of speed cameras was 0.73 (95% confidence interval [CI]=0.63, 0.85). This protective effect was greater during weekend periods. No differences were observed for arterial roads (RR=0.99; 95% CI=0.90, 1.10). Attributable fraction estimates for the two years of the study intervention showed 364 collisions prevented, 507 fewer people injured, and 789 fewer vehicles involved in collisions.

Source: *(5)*

Determining sample size

For all quantitative evaluations it is important to have sufficiently large numbers in the study sample to be sure that, if an effect exists, it is detectable. The rarer the event, the greater the sample size needs to be in order to detect a difference. Crash fatalities can be relatively rare events and a study using serious injury or death as an outcome would involve a larger monitoring period, while measuring individual vehicle speeds along a particular stretch of road would require a smaller period to obtain a suitable number of participants.

Factors that must be taken into consideration in determining the sample size are the expected size of any effect to be detected, the inherent variability of any measure, and the frequency at which measurable events occur *(6)*.

Sample size calculators are freely available on the internet, but it is wise to consult a statistician regarding such estimates, particularly where cluster randomized trials or random and/or stratified samples are necessary. Links to online sample size calculators may be found in the statistical package Epi Info™ which may be downloaded at www.cdc.gov/epiinfo/

A sample size calculator for cluster randomiszed trials can be found at www.abdn.ac.uk/hsru/epp/cluster.

Statistical significance testing

Quantitative study design data requires statistical analysis. For further guidance, see *(7, 8 and 11),* or visit the relevant lectures in the basic methods and injury sections at www.pitt.edu/~super1.

5.2.3 Conducting an economic evaluation of a programme

In recent years it has become increasingly important to conduct economic evaluations of safety initiatives to demonstrate 'value for money', and to help determine the best way to spend limited budgets *(9)*.This type of evaluation is especially important in low-income countries where there are very limited manpower and funding resources, and where planned expenditure needs to be justified and shown to be worthwhile (for example, by freeing up hospital beds used by accident victims and allowing more resources for other health problems).

Economic evaluation essentially addresses the question of whether an intervention represents a worthwhile use of resources. The usual way to address this question is a comparison of two or more intervention options one of these is usually either a 'do nothing' or 'status quo' alternative.

Economic evaluation is based on the comparison of alternatives in terms of their costs and consequences *(9)*. The term 'consequences' is used here to represent an outcome of value. There are various forms of economic evaluation that can be conducted – each differing in terms of scope, i.e. the range of variables included in the analysis. Importantly, each form of economic evaluation typically entails a set of starting assumptions; recognition of these is necessary for the policy-maker to make appropriate use of the evidence from such studies.

A common element across all forms of economic evaluation is that they involve measuring costs. Costs usually comprise, at least in part, the direct programme costs for the resources that are used to run the programme (e.g. equipment, staff, consumables). However, in principle, other costs may also be relevant such as those incurred by patients, carers and the wider community. Furthermore, there are 'downstream' costs and savings that may be considered. e.g. a programme may result in reduced hospitalisations and these savings in resources may be deemed relevant. The type of costs selected generally depends on the perspective taken in the evaluation and the nature of the resource allocation problem being addressed *(6, 9, 10)*.

Methods used in economic evaluation

The most common form of economic evaluation is cost-effectiveness analysis (CEA). This entails the total cost of programmes measured alongside a defined outcome to produce a 'cost-effectiveness ratio' (e.g. cost per life saved, cost per life-year saved or cost per case prevented).

Because there is a comparison made between two alternatives, say A and B, the results are typically presented as an *incremental* cost-effectiveness ratio – measured as the additional costs of A vs B as a ratio over the additional outcomes achieved of A vs B. For instance if A costs $2 million and saves 100 lives and B (which might be current practice) costs $1 million and saves 20 lives, the incremental cost-effectiveness ratio of A vs B is $12,500 per life saved ($1 million/80 = 12,500). Whether this represents 'value for money' and thus should be funded is ultimately a judgement for the decision-maker, and might depend on factors such as the cost effectiveness of other alternatives and budgetary constraints.

The assumption in CEA is that the objectives of interventions being compared are adequately captured in the measure of outcome used. However, a single dimensional measure such as lives saved may not be sensitive to quality-of-life changes. One modification to conventional cost-effectiveness analysis is cost-utility analysis which is based on an outcome measure, Quality Adjusted Life Year (QALY) incorporates change in survival and quality of life and thereby enables a wider set of interventions to be legitimately compared than would be possible with CEA.

Another form of economic evaluation, often used to evaluate transport sector investment, is cost-benefit analysis (CBA), which seeks to evaluate interventions in terms of total costs and total benefits – both dimensions being valued in monetary terms (e.g. dollars). Therefore if benefits are greater than costs, the decision would be to fund the programme. Note here that a cost-benefit analysis does not require a direct comparison with a programme alternative because the 'decision rule' (i.e. the criterion on which investment decision is made) is based solely on the comparison of costs and benefits from a single programme measured in commensurate (monetary) units. Valuation of health benefits in this way can be challenging, but one approach would be to elicit from beneficiaries of programmes their maximum willingness to pay for these benefits (i.e. if they had to pay for it in a hypothetical market place). The idea behind this approach is to derive a valuation for an intervention akin to the way in which consumers value goods and services in markets. Another means of valuing benefits in monetary terms is in terms of productivity gains, e.g. reduced disability will result in greater productivity, which in turn could be measured by wage rates.

Choosing the appropriate type of economic analysis for the needs of the particular programme will depend on resources available (both economic and human), and the aims of the evaluation (Box 5.3). Taking quality of life into account is a powerful measure for evaluations of road crashes where lifelong disability resulting from serious injury may be an outcome.

BOX 5.3: **Speed calming, Ghana**

In 2007, the Ghana Highway Authority (GHA) and the Building and Road Research Institute (BRRI) carried out an evaluation of eight speed calming schemes on crash-prone stretches of highway passing through settlement areas. These schemes included measures such as road narrowing, delineators and road studs. The results proved that the schemes had been an extremely good investment for local people. The 'break even' analysis showed that the eight schemes had 'earned back' their costs in terms of benefits to the society in just 1.6 years – in savings on material damage, medical treatment and lost working capacity. At one site, the first year rate of return (FYRR) was 232%. It was an extremely cost-effective investment for Ghanaian communities.

5.2.4 Choosing the performance indicators

Performance indicators (or outcome measures) are a measure of how successful a programme has been. They should relate directly to the objectives of the programme. Choice of performance indicators will be determined by the aims of the evaluation, the study type used, the resources available and, to a certain extent, the requirements of the funding agency. For instance, government funding agencies may require certain information to ensure support for increased enforcement or for further roll-out of a programme.

To succeed in implementing a successful speed management intervention it is necessary to carefully monitor the programme's progress. The performance indicators could be changes in observed speeds, in the number of crashes, or reactions from the public and stakeholders. Monitoring is needed in order to rectify problems as quickly as possible, as well as ensuring government and key stakeholders are kept fully informed of progress, challenges, difficulties and solutions. The performance can also be measured in terms of economic efficiency. Ideally, outcome and other programme performance measurements are carried out by a qualified and independent evaluation specialist.

The quality of the evaluation depends on the accuracy of data collection. If there is a uniform capture, coding and reporting system already set up by the police or transport authorities (or even in hospitals and/or health departments) there may be aggregated data available on crash severity, types of crash and even contributory factors, such as excessive speed. As quality may vary, completeness and accuracy of these data sources should be carefully checked before use. Additional data collection methods – or improvements to the existing methods – may be required.

In some instances the evaluation may set out to assess the effectiveness of capacity building measures – e.g. training and equipping police to conduct speed enforcement. Such an evaluation might assess whether the police have been provided with suitable equipment (e.g. speed radar), and been given proper training in its use, and sufficient knowledge of the programme's purpose in order to improve road safety and reduce casualties through enforcement.

NOTE

The need for monitoring and evaluation

A simple but effective monitoring and evaluation system is required to track progress of road safety activities and to estimate the safety impact. For action plans in developing countries, initial focus is often on institutional strengthening and capacity building rather than on reducing the number of casualties. Monitoring and evaluation systems established as part of implementing action plans and safety initiatives must therefore, where appropriate, be able to indicate progress towards achievement of institutional impact and developmental objectives.

Source: World Bank. Washington DC *www.worldbank.org/transport/roads/safety.htm*

Setting up a monitoring and evaluation mechanism follows the processes of carrying out a situational assessment (Module 2) and developing and implementing an action plan (Module 4). A monitoring programme for speed management would ideally analyze relevant data for measuring road crash injury outcomes and speed indicators. Table 5.2 gives examples of such measures.

Monitoring the programme involves keeping a close check on all indicators, to ensure the programme is on track towards the goals set out. Monitoring can be:

- *continuous*, with the lead agency of the working group overseeing the overall programme, or
- *periodic*, with activities measured at the end of each stage of the implementation.

Table 5.2 is not a comprehensive list of indicators or monitoring actions, but it gives an example of the types of monitoring that may be helpful in measuring the effectiveness of a speed management programme. It is important to allocate responsibility for the monitoring and evaluation and define resources for this task – both human as well as financial resources. A feedback mechanism should also be put in place to allow the regular revision of a programme and to report back to the programme owner. This could result in adjustments to improve the programme.

There are a number of sources to assist with guiding the preparation of an evaluation plan. For example, a United States government agency has produced a comprehensive guide to evaluating road safety projects *(11)*. It provides an overview of the steps required, from designing the evaluation to reporting the findings. The methods used for each type of evaluation will vary.

Table 5.2 Potential performance indicators for monitoring and evaluation (limited sample only)

	Objective	Potential indicators for monitoring	Monitoring mechanism/ data sources
Outcomes	Reduce incidence of speed as a factor in crashes	• Speed-related crashes compared with all crashes • Rates of speed crashes per 100,000 people • Rates of speed crashes per 10,000 vehicles • Rates of speed crashes per vehicle kilometre travelled	• Crash reports/police or crash investigators • Population census data • Vehicles registered for use on public roads • Highway/road administration data related to traffic volume and road design
	Reduce severity of road crashes	• Injury level per crash or numbers of fatalities per crash • Number or rates of speed-related fatalities or serious injuries over time	• Police, hospital and emergency services data on crash cause and injury severity • Monitor speed-related fatalities every month and record and track trends over time
	Reduce pedestrian fatalities	• Number of pedestrian deaths where speed is a factor	• Police, hospital and emergency services data
Impacts	Increase compliance with speed limits	• Percentage of drivers measured at or below speed limits	• Speed survey data
	Reduce mean free speeds and high speeds	• Reductions of driver travel speeds	• Speed survey data tracked over time
	Increasing public acceptance of speed management	• Percentage of people who are in favour of government actions to reduce speeding	• Interviews or written questionnaire data on community attitudes (e.g. to speed enforcement, engineering treatments, speed limits, etc.)
Outputs/process	Increasing capacity of police to enforce	• Extent of area covered by enforcement • Ratio of traffic police working with speed enforcement to total police	• Increase size of traffic police force • Change enforcement practices and locations • Improve system of issuing penalties and collecting fines
	Increased value for campaign expenditure	• Number and frequency of publicity spots in the media • Amount and nature of feedback from the target audience	• Monitor media coverage and compare costs of additional advertising that would have been needed • Target audience reach as determined through market surveys
	Increased improvements in separating vulnerable road users from motorized traffic	• Numbers of sites successfully treated • Numbers of vulnerable road users not protected	• Site changes documented and counted • Vulnerable road-user compliance observed

5.3 Dissemination and feedback

Once an evaluation is complete it is important to provide feedback to the stakeholders involved in the programme as well as the public, even if results were not very good. Dissemination of the results in this way will help to garner further support for the programme if it is successful, and help others gain support for the introduction of similar programmes. Publicity from dissemination activities may also increase the impact of the programme.

Checklist

- ☐ Start evaluation process at the beginning of programme implementation.
- ☐ Determine aim of evaluation and develop evaluation framework.
- ☐ Clearly define target population, place, time and performance indicators.
- ☐ Develop and test procedures for data collection, ensuring consistency in measurement.
- ☐ Collect and analyze data – before implementation and at predetermined intervals after implementation.
- ☐ Write and disseminate evaluation report, feeding back to various aspects of programme.
- ☐ Use evaluation results to feed back into new planning cycle and to promote programme sustainability.

Communicating results

While a programme may have succeeded in achieving its objectives, it is helpful to examine and discuss with the working group (see Section 4.2.1) what elements worked well and why.

If the programme has not been successful it is important to share this with others so that weaknesses or relevant issues are considered in similar interventions, including whether or not to introduce such interventions in the first place. The working group should discuss implications of the evaluation findings and consider whether they demonstrate any tangible benefits, problems to be rectified, or elements to be abandoned. Moreover the evaluation could discover unexpected side effects of the programme – both positive and negative. These should inform the further development of the programme.

Apart from discussing the evaluation results with the working group and the reference group (see Section 4.2.2), dissemination may involve presenting the results at public meetings, using the media to publicize the outcomes of the programme, or publishing reports and papers in scientific literature. The results of the evaluation should be fed back into the planning cycle and the appropriate modifications to the programme made before it is further expanded.

Giving recognition to individuals and agencies, and celebrating success

When successful outcomes have been identified, it is recommended that both formal and informal activities be arranged with staff from participating agencies to celebrate success. In road safety projects the major benefit that staff receive from participation in a successful project is personal satisfaction. However, positive endorsement by senior management of the value of their work is a critical component for maintaining staff morale and showing all participants that their work is acknowledged and acclaimed. Equally, one agency showing its appreciation of the good inputs by another can go a long way towards building strong, long-lasting partnerships.

Sharing lessons to ensure sustainability of the programme

Sharing lessons about programme success factors with key stakeholders will help to ensure that any benefits obtained at the beginning of the programme are maintained. Longer term funding requirements and adequate speed management resources are more likely to be secured if programme performance is measured and reported.

Summary

- Monitoring and evaluation should be seen as an integral component of all speed management programmes.
- The strategy or framework adopted for monitoring and evaluation needs to be determined at the beginning of a programme, and any necessary data collection for the purpose of evaluation should be built into project implementation.
- As well as providing information on the effectiveness of a programme, monitoring and evaluation will help to identify any problems in implementing the programme, meaning that necessary changes can be implemented at an early stage.
- Determining the aims of the evaluation will help to decide how best to carry out the evaluation. There are a number of different methods that can be used to evaluate the various elements of a speed management programme. Each method has advantages and disadvantages, and the choice of which to use will depend on the main objectives of the programme, the evaluation questions, and the resources available.
- It is important that the results of any pilot testing, monitoring and evaluation are shared with the appropriate stakeholders, and that this information is used in planning and improving both current and future programmes.

References

1. Rossi PH et al. *Evaluation: a systematic approach*. California, Sage Publications, 2004.
2. Britten N. Qualitative research: qualitative interviews in medical research. *British Medical Journal*, 1995, 311:251–253.
3. Kitzinger J. Qualitative research: introducing focus groups. *British Medical Journal*, 1995, 311:299–302.
4. *Danish experiences with speed management*, paper presented by Lárus Ágústsson, MSc., Civ. Eng. (Project Manager, Danish Road Directorate, Danish Ministry of Transport) at Transportation Research Board 84th Annual Meeting, January 2005.
5. Pérez K et al. Reducing road traffic injuries: effectiveness of speed cameras in an urban setting, *American Journal of Public Health* 2007, 97:1632–1637.
6. Kerry SM, Bland JM. Statistics notes: Sample size in cluster randomisation. *British Medical Journal*, 1998, 316:549.
7. Woodward M. *Epidemiology: study design and data analysis*. 2nd edition. Boca Raton, Florida, Chapman and Hall CRC, 2005.
8. Rothman, KJ, Greenland S. Modern Epidemiology. 2nd edition. Hagerstown, Maryland, Lippincott-Raven, 1998.
9. Drummond MF et al. *Methods for the economic evaluation of health care programmes*, Oxford, Oxford University Press, 1997.
10. DETR, *A road safety good practice guide for highway authorities*. London, Department for Transport, Local Government and the Regions, 2001.
11. *The art of appropriate evaluation: a guide for highway safety program managers.* Washington DC, Department for Transportation Report HS 808894, May 1999 (www.nhtsa.dot.gov/people/injury/research/ArtofAppEvWeb/index.htm).

Appendices

Appendix 1: Methods of speed data collection

Methods involving timing

The increasing availability of electronic time and data recorders has meant that manual timing of vehicles using a stopwatch is now used only as a last resort. The passage time of a vehicle between two detectors, a measured distance apart, can easily be recorded. Detectors can include pairs of pneumatic tubes, tribo- and piezo-electric cables, switch tapes, inductive loops and photo-electric or electro-magnetic beams.

Microwave radar gun

A microwave beam is sent to the target vehicle, which reflects back a signal to the receiver in the radar gun. The moving vehicle affects the frequency of the returned signal. By measuring the amount of frequency shift and the duration of the time interval, the speed of the targeted vehicle can be determined. A microwave radar gun has a wide cone of detection, which is about 70 m at a range of 300 m.

Direct measurement using laser guns

The laser infrared gun has a small detection cone of about 1 m in diameter at a distance of 300 m between the laser gun and the targeted vehicle. The equipment relies on the measurement of the round-trip time of the infrared light beam to reach a vehicle and be reflected back.

Methods involving video

Video can be used to determine vehicle speeds and is becoming increasingly cheaper to use and operate. The general method involves recording the distance moved by a vehicle in a short period (perhaps a couple of frames), then computing the speed.

Manual data extraction from a video recording is time consuming, tedious and expensive, making the technique not particularly useful for routine surveys. However, the continuing development of automatic data extraction procedures should make vehicle speed data collection from video a cost-effective alternative.

Global positioning system

Vehicles can be fitted with receiver units that pick up signals from the Global Positioning System (GPS) satellite network.

The accuracy of code-based differential GPS (DGPS) accuracy is about 2–3 m with a baseline distance (i.e. range of coverage) of 100–200 km.

Appendix 2: Speed enforcement – Victoria, Australia

In 2002, a Ministerial road safety forum identified the need for radical actions to be implemented and launched the *arrive alive! 2002–2007* strategy, with a strong focus on behavioural change programmes, such as speed enforcement. Key initiatives for the speed enforcement component of *arrive alive!* included:

- increased attention to 'lower level speeding' by reducing the threshold speed (i.e. the trigger speed at which the cameras are set or the enforcement level applied by on-road policing)
- intensifying enforcement efforts – more hours for the mobile camera programme and more fixed cameras
- making enforcement more unpredictable – including implementing 'flashless' mobile cameras and a mix of marked and unmarked police vehicles. Reviewing the sanctions for speeding.

The Victoria Auditor-General's 2006 review of the state's speed enforcement programme considered (among other things) whether the speed enforcement programme had been effective in reducing speed and road trauma.

The review concluded the programme had been very effective. In 2005, for the first time, average travel speeds in metropolitan Melbourne's 60, 70 and 80 km/h speed zones were below legal speed limits. However, in 100 and 110 km/h speed zones across the state, compliance with speed limits had not improved. In each of these zones, around 15% of drivers still travelled at speeds above the speed limit.

arrive alive! sets ambitious targets, aiming for a 20% reduction in deaths and serious injuries by 2007. During the first four years of the strategy (2002–2005), there was a reduction of around 16% in fatalities. In August 2006, Victoria reached its lowest fatality level over a 12 month rolling period.

Road crashes occur as a result of many causes; it is therefore difficult to conclude that the reduction in road trauma is solely because of improved compliance with speed limits. However, the greatest reductions in trauma have been in the lower speed zones, which are the most intensively enforced. There have also been significant reductions in pedestrian trauma and severity of serious injuries – two measures sensitive to changes in travel speeds. These factors suggest that improved compliance with speed limits has been a major contributor to trauma reductions.

Source: Australian Transport Council. *National Road Safety Action Plan, 2007–2008.*

Appendix 3:
Examples of suspension or withdrawal of driving licence and other non-monetary penalties applied to speed offences

Country	Amount of speeding, km/h or other criteria (specified)	Duration of suspension or withdrawal	Other penalty
Australia (Victoria)	25–34 35–44 45 +	1 month 6 months 12 months	
Canada	**Demerit points** 10–15 (6 during new-driver probationary period)	First suspension: 1–3 months Subsequent suspensions: 2–6 months	
Denmark	% above speed limit	**First offence:** Conditional suspension of licence for 3–5 years. You still have the right to drive **Subsequent offences:** Withdrawal of licence for 6 months to 10 years, or permanently **First offence within 3 years of obtaining first driving licence:** A general prohibition of driving will replace suspension of the driving licence	**First and subsequent offences:** Supervised driving test is required before reinstatement of licence **First offence within 3 years of obtaining first driving licence:** Special driver training and supervised driving test
For cars and light trucks without a trailer:	> 60%		
For HGV, buses, vehicles with a trailer etc:	> 40% (> 60% in 30 km/h zones)		
France	> 50	Withdrawal of licence for 3 years	**50 km/h with recidivism within 3 years:** Up to 3 months imprisonment
Greece	> 40 or exceeding a speed of 140 km on motorways, 130 km on highways, 120 km on other roads	Withdrawal of licence for 1 month	
Korea	**Demerit Points** > 40 > 120 > 200 > 270	 Suspension for 1 year Withdrawal for 1 year Withdrawal for 2 years Withdrawal for 3 years	
Poland	**Demerit points** 20 or 24	Not specified	**Upon withdrawal of licence:** 1. Drivers licensed for less than 1 year, with more than 20 demerit points: training and written and driving test for new driving licence 2. Drivers licensed for at least 1 year, with more than 24 points: written and driving test WITHOUT training
Portugal	> 30 ≤ 60 > 60	1 month to 1 year 2 months to 2 years	Compulsory training; cooperation on road safety campaigns

Source: 2008, Australian Transport Council. *National Road Safety Action Plan, 2007*

Appendix 4: Traffic calming in Ghana – rumble strips and speed ramps

Traffic calming is the term given to self-enforcing engineering measures designed to reduce vehicle speeds – and sometimes vehicle flow – in the interests of safety. Engineers in the UK, Holland and Denmark have pioneered work on this. They used *rumble strips* to alert drivers to the need to slow down, and vertical and horizontal deflections to force them to slow down. These vertical deflections are better known as *speed ramps* – or *road humps.*

Rumble strips and humps were first introduced in Ghana about five years ago, and they have since become very widespread. They are often installed on newly built roads in response to complaints or concerns about high speeds. Sadly, however, almost no attempt has been made to check whether they do reduce speeds and road crashes, and by how much. Engineers are trying different designs, but they are doing this without evidence on what works and what doesn't. It cannot be assumed that the results of studies done in Europe will be valid for Ghana.

In order to evaluate these measures properly we need 'before and after' studies. In the absence of these all we can do is make an 'after assessment' based on speed surveys (for some measures) and observation.

Assessment

Rumble strips

They are about 15–25 mm high and made of thermoplastic or concrete. They are usually laid in a pattern – typically 3 groups of 4 or 5 strips. Sometimes the width of the strip and the spacing (within the group and between groups) is varied in order to make the 'rumble' more noticeable if the driver does not slow down – but there is no evidence that this has any effect. The first rumble strips were installed at Suhum on the Accra – Kumasi road. A 'before and after' evaluation undertaken by BRRI concluded that accidents had reduced. They have been very widely used since. Cost: 650,000 Ghanaian Cedis per metre (2005).

Although rumble strips are designed only to alert drivers, the hope is that they will also slow them down. Observation shows that a minority of drivers do slow down – but most drivers quickly realize that the faster they cross them the less 'rumble' and discomfort they experience. The strips wear down gradually, so need to be reshaped every year or so.

Conclusion: not very useful on their own, but helpful as a warning of speed ramps or other severe hazards.

Mini-humps in asphalt

They are typically about 35 mm high and 500 mm wide. They are made of asphalt, which is roughly formed into a round-topped hump. A white line marking is added to make them more visible. One of the first sites where they were tried was at Ejisu on the Accra – Kumasi road, and they were later used on the new Tema – Akosombo road. Observation suggests that they are perhaps too severe in the way they reduce speeds, because of the severe discomfort caused if drivers try to travel over them at anything greater than about 10 km/h. Long vehicles and articulated vehicles are particularly affected, and their suspension may suffer. On busy roads this type of speed ramp may cause traffic to queue back a long way. Cost: 1,200,000 Ghanaian Cedis per metre (2005).

Conclusion: excessively tough on drivers (and their vehicles) – better alternatives exist.

Pre-fabricated mini-humps

These round-topped mini-humps made from recycled tyres are about 40 mm high and 900 mm wide. They are nailed to the road. They have been used in Cape Coast and a few places in Accra. Observation shows that they are quite effective in reducing speeds. A survey at a site on a dual carriageway arterial road recorded the mean speed of vehicles crossing the mini-hump as 33 km/h (85th percentile: 42 km/h). Discomfort and vehicle wear does not seem to be excessive. Cost: 2,000,000 Ghanaian Cedis per metre (2005).

It is reported that sections of the mini-hump sometimes come loose, and cannot easily be re-fastened.

Conclusion: perform well but maintenance problems may preclude wider use.

Standard 3.7 m speed ramp

The standard ramp is round-topped, 100 mm high and 3.7m wide. This Ghanaian version, incorporating concrete block paving set in mass concrete haunches, works well and has been very widely used. Observation shows that it reduces vehicle speeds to about 15–20 km/h, and, when spaced at about 100 m intervals, it can control mean speeds to about 30 km/h. Cost: 1,450,000 Ghanaian Cedis per metre (2005).

The concrete haunches should be painted to make the ramp more visible.

Conclusion: this is the best choice of speed-reducing measure for local roads, especially where there are large numbers of pedestrians using the road. However, it is too severe for use on arterial roads.

Flat-topped speed ramp

In some countries flat-topped humps are used at zebra crossings – and are effective in slowing down vehicles sufficiently to enable pedestrians to use the crossing safely. The flat-topped platform should normally be 75–100 mm high and at least 6 m wide; the ramps should have a maximum slope of 1:13. The ramp can be constructed of reinforced concrete or asphalt. The ramp illustrated is at Kotoka International Airport, but the design is too severe for general use.

Conclusion: worth trying at zebra crossings on local roads where the volume of traffic is such that pedestrians have to wait too long before they can cross.

9.5 m speed ramp

This is a Danish design – it is a round-topped hump, 100 mm high and 9.5 m wide. It is made of asphalt. It has been used on the approach to villages and other potential hazards areas on the Takoradi – Agona road (see illustration). Rumble strips provide a warning. Observation shows that the ramps are effective in reducing speeds. A survey at one ramp recorded the mean speed of vehicles crossing the ramp as 45 km/h (85th percentile: 55 km/h). Discomfort and risk of vehicle wear seem to be minor.

Constructing these ramps may not be easy – some of those on the Agona road show deformations, possibly because of inadequate compaction.

Conclusion: good choice of traffic calming measure for villages on trunk roads; possible potential for speed reduction on urban arterials.

Appendix 5: The International Road Assessment Programme and network safety upgrading

The International Road Assessment Programme (iRAP) is active in six continents, scoring roads for safety and promoting countermeasures. Techniques were originally developed and applied in Europe, and since 2001 more than 20 countries have worked within the European Road Assessment Programme (EuroRAP). Sister programmes in Australia and the US have extended these applications and they are now being used in low and middle-income countries. There are pilot studies in Chile, Costa Rica, Malaysia and South Africa, and iRAP will extend to 20 more countries over next five years.

At the heart of Road Assessment Programme lie three protocols which highlight the relationship between speed, energy, risk and injury. The protocols involve:

- analysis and mapping of fatal and serious accident rates occurring on major roads
- performance tracking of particular road sections over time, monitoring the number of fatal and serious accidents over their length
- drive-through inspections of the safety quality of the road infrastructure in different countries to identify where crashes are likely, and the extent to which roads protect road-users from accidents, and from death and serious injury when accidents do occur. From these inspections a Road Protection Score (RPS) is derived.

Risk mapping and performance tracking

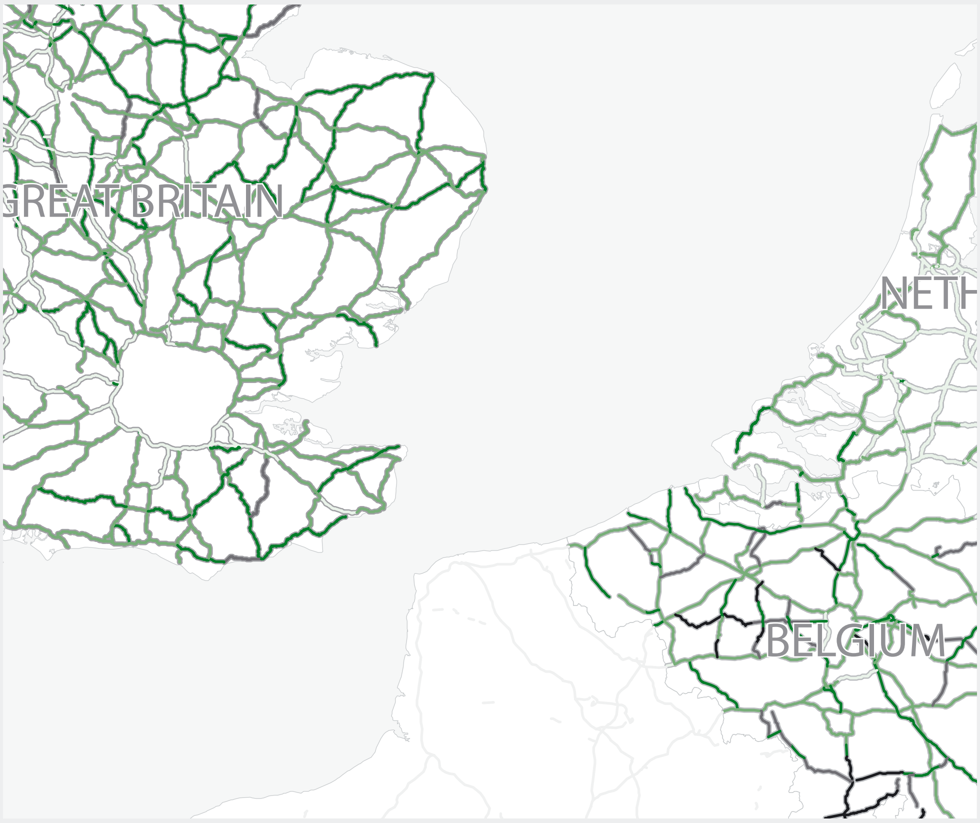
The Risk Rate Map presents crash rates based on fatal and serious injuries per vehicle-kilometre, portraying risk and showing how risk changes as an individual moves from one road section to the next.

The Road Assessment Programme has focused on the roads where most deaths occur. In Europe the majority of deaths occur outside built-up areas, with usually about 30–40% concentrated on a network of major rural roads. In low and middle-income countries, pedestrian deaths are more common – often in and around urban areas.

In the UK and in Spain the there has been detailed performance tracking of road sections through time. The focus provided by EuroRAP has helped to reduce the number of high and medium-high risk road sections. It has fallen by around 30% in these countries over recent three-year comparison periods. EuroRAP has monitored the measures associated with the biggest falls in crashes and injuries. Typically, the most improved sections show crash reductions of 50–70% from one three-year period to the next as a result of very low-cost packages, including improved signing and lining, re-surfacing, speed reduction measures and removal of the opportunity for collisions. Crash protection measures also feature.

In 2006 a pan-European map was produced, showing how risk varies across large parts of Europe *(1)*. Figure 1 shows detail from this map, with risk shown in fatal and serious crashes per vehicle kilometre in black (highest risk), grey, green, light green, and lighter green (lowest).

Figure 1 **EuroRAP pan-European risk rate map (detail)**



Road inspections instead of crash data

The Road Protection Score (RPS) was developed initially to assist understanding of why crash rates vary from one road section to another. It also has applications in countries where crash information is poor quality or difficult to obtain. This is often the case in low and middle-income countries where there are high levels of under-reporting and, even where there is reporting of a crash, the recording of locational information is of variable quality. Means of determining priorities that do not require crash data therefore become important.

The RPS produces a score for each route section that enables it to be compared with other sections. It focuses on the road design and the standard of road-based safety features, and describes protection from accidents (elements of primary safety) and protection from injury when collisions do occur (secondary safety). The RPS is therefore related to:

- the design elements known to affect the likelihood of an accident occurring
- the safety features known to mitigate injury severity
- the observed speed limit (because the risk of injury increases with speed)

Roads giving good protection across all permitted speeds therefore score high. Roads where the crash protection is less good can score acceptably if the speed management regime is tighter, but simply reducing speed limits over long road sections is unworkable. When compliance and enforcement are low, simply setting a low speed limit will not decrease the injury-generating potential of inadequate infrastructure.

Road inspection results in Germany have shown the potential for infrastructure improvements on German roads and the injury reduction benefits that would result *(2)*. The EuroRAP star rating system was compared with crash data for 1,200 kilometres of motorway in Bavaria and Rhineland-Palatinate. Motorways rated as 4-star produced 50% less severe run-off accidents than 3-star motorways. Run-offs account for about 40% of all severe accidents on motorways – 70% of the motorways scored 4-star, the remaining 30% were 3-star. Because they provide relatively few safety elements, 60% of other major rural roads achieved only 2-star rating.

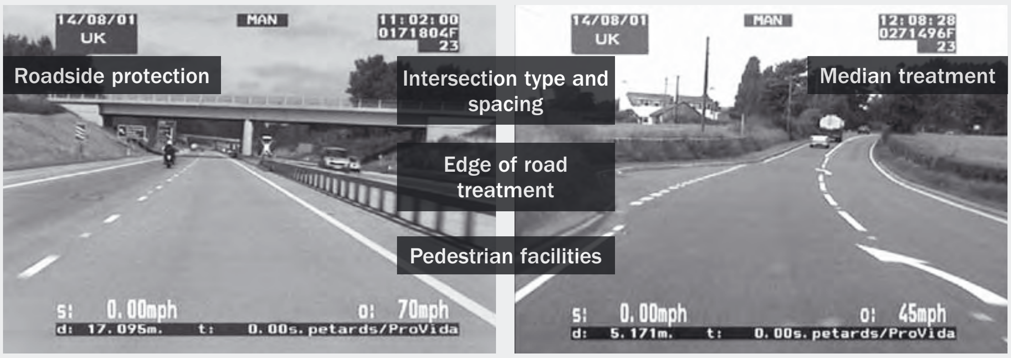
In Sweden, the RPS has been used in a speed management context by turning its application 'on its head' and asking: how high can the permitted speed be on a section with these particular geometry and infrastructure characteristics? Speed limits have therefore been set from first principles and according to the extent that the road protects from severe injury.

Table 1 summarizes the extent to which roads are currently built to reduce the risk of serious injury in the four collision types addressed within the Road Assessment Programme across the world. It shows too how roads are designed, by segregation of road users, to avoid collisions. It also provides recent data reflecting their safety record. Motorways, for example, have median barriers to reduce head-on collisions, protected side areas to avoid severe run-off collisions, and merging junctions (where brutal side-impacts are minimized because collisions usually involve glancing blows as vehicles merge at acute angles). Motorways also prohibit vulnerable road users. Figure 2 illustrates the extent to which elements of this protection also exist on single and dual carriageways.

Table 1 **Summary of protection from the four main types of collision (by road type)**

Collision	Motorway	Dual carriageway, grade-separated junctions	Dual carriageway, at-grade junctions	Mixed dual and single carriageway	Single carriageway
Head-to-head	High	High	High	Medium	Low
Junctions	High	High	Low	Low	Low
Run-off	High	High	High	Medium	Low
Vulnerable Road users	High	Medium	Medium	Low	Low
Risk of death and serious injury/billion vehicle kilometre travelled (UK)	18	28	43	53	80

Figure 2 **Similar high-level design elements can be assessed on roads of differing standard**



These are high-level indications showing which significant road features (e.g. the presence or absence of median protection) make a major difference to fatal and serious crash rates, indicating where major systematic potential exists to save lives. This work has the potential to generate powerful messages that will explain to the general public and decision-makers alike where priorities lie, and whether countries can afford to save lives.

Network safety upgrading

Review of national casualty-reduction strategies shows that in high-performing countries, road infrastructure improvements, combined with appropriate speed limits, are expected to deliver the greatest savings compared to improvements to vehicles and driver and road-user behaviour (Table 2). It is likely that in low and middle-income countries the balance between measures may vary considerably, and differ from those shown here. However, even brief surveys of infrastructure in low and middle-income countries show roads with enormous potential for improvement.

Table 2 Sources of casualty reduction *(3)*

Measure	Netherlands %	Sweden %	UK %
Road infrastructure	50	59	44
Vehicles	26	20	35
Behaviour	24	15	16
Other	–	6	5
Total	**100**	**100**	**100**

Lynam and Lawson (2005) have made estimates of the benefits of improving infrastructure, and of reducing the crash risk associated with different scenarios, by infrastructure upgrading and speed management. In a country where driving standards are generally high compared to others, and where the vehicle fleet is for the most part safe, particularly good returns are to be found in reducing risk at junctions (Table 3) but there are also good returns from reducing run-off injuries.

Table 3 Investment justified in different elements of road design *(4)*

Measure	Annual benefit: €1,000 per km	Assumed life-years	Net present value* €1 million per 10 km
Convert grade-separated dual carriageway (DC) to motorway	30	20	4.6
Halve risk from run-off on motorway	20	10	1.8
High-quality merge junctions on DC	64	20	9.4
Halve junction risk on DC	44	10	3.7
Halve risk from run-off on DC	20	10	1.8
Halve junction risk on single carriageway (SC)	29	10	2.4
Median in low-flow SC	25	10	2.1
Median in high-flow SC	25	10	2.1
Halve risk from run-off on SC	10	10	0.9

*Net present value illustrates the rate at which a scheme pays for itself over time.

References

1. Hill J (ed). *Getting organised to make roads safe – second pan-European progress report*, EuroRAP, Basingstoke, UK, 2006 (available at www.eurorap.org).
2. Research from the Institute of Road Traffic (Institut fur Strassenwesen) of the University of Karlsruhe, working with ADAC (available at http://217.174.251.13/news_item?search=y&ID=9).
3. Koornstra M et al. *Sunflower: a comparative study of the development of road safety in Sweden, the United Kingdom and the Netherlands, table 8.9, p115.* Leidschendam, Institute for Road Safety Research, 2002.
4. Derived from Table 4 in Lynam D, Lawson D. *Traffic Engineering & Control*, 2005, 46, No.10, 358–361.

Appendix 6: Effective use of police resources

Scarce police resources must be used effectively and efficiently to maximize the value of law enforcement operations targeting speeding. Strategic law enforcement integrates fundamental principles of policing as one part of a larger, multi-organisational intervention, but in general enforcement practices must work towards:

a) increased visibility of enforcement

This includes highly visible, publicly observable and strategically located speed monitoring activities. Hand-held speed detection devices operated by police standing on the roadside together with vehicle-mounted moving radar devices (operating in particular on rural highways) will be a visible and continuous reminder to the public about the dangers of speeding and the risks of detection, serving to deter speeding behaviour. There should be at least two police officers in the roadside working teams and effective recording arrangements for data that can be verified separately at the end of each speed management session by independent police supervisors at the local police station. As noted in Module 3, there is an important benefit in covert automated enforcement arrangements being used, in addition to visible police patrol presence.

b) repetition of enforcement publicity campaign messages

This indicates to drivers that the risks of being caught are high – anywhere, anytime.

c) strict, fair and consistent enforcement

After an initial public warning period, police enforcement should be strict, non-discriminatory, fair and consistent. This will (eventually) lead to a permanent change in driver and rider habits (not just short-term), on highways, or where police enforcement can be anticipated. If there is no enforcement there will be limited or no compliance.

d) well-publicized enforcement

To achieve maximum effectiveness, compliance-driven enforcement must be combined with coordinated education and publicity campaigns involving the continuous engagement of national government, local government, the mass media and other agencies. This means conducting publicity campaigns before, during and after policing activities with safety messages that reinforce the enforcement. Safety brochures on speed compliance may be handed out with a warning as an alternative to issuing a fine in the early stages of implementing a sustainable speed enforcement and management programme.

e) training and safety

Target operations should be well planned with all traffic officers being appropriately trained and briefed. Safety should be paramount, with adequate consideration for the safety of the interception officers and the driving public, the safe use of equipment and the selection of speed-checking sites. These requirements apply equally to mobile camera operation.

f) locations

The guidelines for location of mobile camera or hand-held detection device sites need to be carefully devised and based upon crash history, or complaints from the public to police about serious non-compliance with speed at specific locations. However, a substantial number of locations for mobile camera operation from time to time should also be chosen to achieve unpredictability of location and times of enforcement, strengthening the message that speed enforcement occurs anywhere and at anytime. These matters need to be captured in an operational guideline for police use.

Fixed cameras are usually placed at locations where there are high crash numbers or high crash risks. As mentioned in Module 3, these cameras tend to serve as a crash blackspot or higher crash-risk location treatment. They are a useful part of a complete speed enforcement solution.

g) recognizing the value of enforcement

It is important that police commanders and all ranks appreciate the cost of enforcement compared with the cost of emergency operations following crashes, medical treatment and rehabilitation of the injured. Strategic enforcement can achieve results by reducing the percentage of drivers and riders who exceed speed limits. The aim is to create the perception that the risk of being caught and fined is greater than the cost of the inconvenience of changing behaviour to actively comply with the relevant speed limits. These messages should form part of internal police briefings and be a focus of multi-disciplinary road safety workshops involving police.

Road safety good practice manuals

Version 1 – February 2008

Speed management – a road safety manual for decision-makers and practitioners prepared under the leadership of the Global Road Safety Partnership (GRSP) is the third in a series of 'good practice' manuals being produced by the informal consortium of WHO, the World Bank, the FIA Foundation and GRSP as part of the United Nations Road Safety Collaboration. In addition to this latest volume in the series, we have taken this opportunity to provide electronic versions of the two earlier manuals *Helmets* and *Drinking and Driving,* in the original English, plus all other currently published translations. With the future publication of manuals on additional subjects and new translations we plan to release updated versions of this CD periodically. We hope that you will find this CD a useful tool.