

safety

The *Safety
Directions*
Development
Programme

directions

Working Paper 2

Acknowledgements

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SAFETY DIRECTIONS

**The *Safety Directions*
Development Programme**

Working Paper 2

June 1998

Foreword

This Working Paper is the second in a series of technical documents which form part of the LTSA's *Safety Directions* Development Programme. This Programme is creating the tools needed to underpin New Zealand's road safety funding cycle. In this way it contributes to the achievement of the LTSA's statutory objective of undertaking activities that promote safety in land transport at reasonable cost.

Working Paper 2 describes how the *Safety Directions* Development Programme supports the four procedures which comprise the funding cycle – budget setting, budget allocation, performance monitoring, and target setting – and outlines the data sources which are also components of the programme and essential to its success.

This and the other Working Papers in the series are being published to stimulate debate within the wider road safety community. We would welcome your input and comments to assist this process and to help us to further improve the quality of our safety findings.

A handwritten signature in black ink, appearing to read 'Reg Barrett', with a large, stylized flourish above the name.

Reg Barrett
Director of Land Transport Safety

CONTENTS

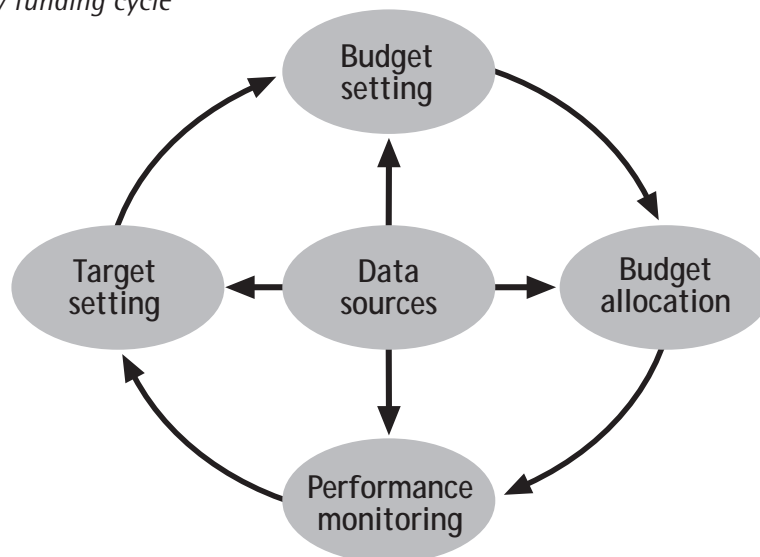
Introduction	1
Road reform	1
Progress to date	2
Setting the road safety budget	3
Budgeting to achieve a target	3
An international comparison	4
Allocating the road safety budget	5
The equimarginal principle	5
Data requirements	6
Allocation models	7
Allocation by Territorial Authority	7
Allocation by road type	7
Allocation by intervention type	8
Monitoring road safety performance	8
Control charts	8
Category analysis	9
Monitoring intermediate outcomes	9
Setting road safety targets	10
Existing targets for 2001	11
Proposed targets for 2010	11
Data sources	13
Crash Analysis System	14
Crash reporting rates	15
National Travel Survey and Willingness to Pay/Accept Survey	15
The next steps	15
References	17

Introduction

This paper describes the LTSA's *Safety Directions* Development Programme. The *Safety Directions* Development Programme will create the tools needed for the safety funding cycle (*figure 1*).

Figure 1

The safety funding cycle



The safety funding cycle embodies four procedures—budget setting, budget allocation, performance monitoring, and target setting—which are supported by data sources that are also part of the Programme. The safety funding cycle is underpinned by the LTSA's corporate mission to undertake 'activities that promote safety in land transport at reasonable cost' (*Land Transport Act 1993*), which obliges the LTSA to weigh the costs and benefits of its safety activities and those of its partners when deciding where and how to allocate resources.

Each component of the funding cycle requires its own analytical tools. This paper describes these tools, and shows how they are to be devised.

Road reform

The *Safety Directions* Development Programme is being conducted within the context of far-reaching institutional reform of New Zealand's roads. As part of the reform, the Ministry of Transport is conducting the Land Transport Pricing Study (LTPS) to develop a new framework for road funding and regulation. Already it has identified policy options to be assessed in the context of the Government's 'strategic result area' for land transport infrastructure, that is, to '[e]nsure that policies are in place to price land transport infrastructure so that there is an efficient level of investment reflecting economic and environmental costs and benefits' (MoT 1997). The *Safety Directions* Development Programme will create the tools that the LTSA and its partners need in order to satisfy this requirement (*box 1*).

Box 1

Market failure in the provision of road safety

If there were an efficient market for road safety—that is, one composed entirely of willing sellers and willing buyers—road users would in effect have to ‘purchase’ the level of social cost they wished to impose on others.

If certain road users did not wish to pay the going rate, they could choose to modify their behaviour or adopt preventive measures so as to avoid imposing a social cost on others in the first place.

Under such a system there would be no need for any of the procedures and tools described in this paper. Instead, market forces would determine the optimal level of road safety.

This does not happen because the provision of road safety is characterised by an inherent market failure. Dangerous drivers impose very large costs on other road users because there is no way of forcing them in all cases to pay for the damage they do. They cannot be consistently identified before they offend; they cannot always be found after they offend; and in any case, they rarely have the wealth to compensate their victims adequately.

The New Zealand Road Safety Programme (NZRSP) provides a non-market mechanism for preventing dangerous driving and mitigating its consequences. It channels funds from road users to pay for road safety interventions. The *Safety Directions* Development Programme is creating the tools to ensure that these funds are adequate to the task, properly allocated, and strictly monitored.

Progress to date

Work on the *Safety Directions* Development Programme began in 1994.

Safety Directions 1995/96 (LTSA 1994a) describes the programme, its aims, and the LTSA’s approach to achieving them; and provides information to assist the LTSA and its partners to develop and evaluate safety activities.

In early 1995, work started on developing a resource allocation model for road safety. This work is summarised in two companion documents, LTSA (1995) and LTSA (1996a). Their aim was to provide ‘key facts about road safety... a “toolbox” of concepts and terms relating to road safety... [and] a method for allocating the road safety dollar so that it has the greatest possible impact.’

In early 1996, the generalised resource allocation procedure was developed into a practical tool to be applied to police enforcement. This model is currently being used to allocate the police road safety enforcement effort between police districts (LTSA 1996b).

In 1997, work began on ‘benchmarking’ the New Zealand police enforcement environment against an overseas police force. Victoria, Australia, was chosen for this purpose, as it has an enviable track record in reducing the road toll, and may therefore have lessons for New Zealand (LTSA 1998a).

Also in 1997, work began on developing long-term road safety targets for 2010, and on determining the budget required to achieve them. Targets already exist for 2001, but they now need revision. What is needed is a more accurate way of relating road safety interventions and changes in external circumstances (demographic, economic etc.) to road safety outcomes. Only then can targets be realistic (LTSA 1998b).

Again in 1997, work began on devising ‘control charts’ for use by the Police. Control charts are a monitoring tool to help the Police distinguish between real changes in road safety risk, which should affect how the Police allocate their resources, and random fluctuations, which should be ignored (LTSA 1998c; in press).

Setting the road safety budget

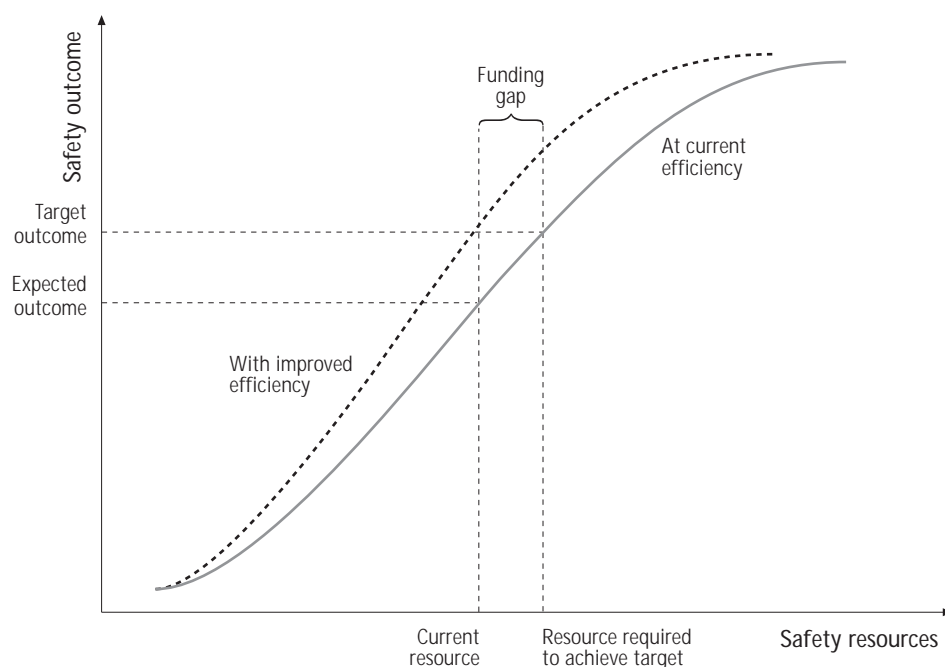
How much should New Zealand spend on road safety? This section explains how the LTSA is tackling this question, and describes the tools that it has built, or is building, to answer it.

Budgeting to achieve a target

One way to set the road safety budget is to determine the resources needed to achieve a stipulated road safety target. The LTSA is currently quantifying the relationship between scheduled resources and the achievement of road safety outcomes (*figure 2*). In this way the LTSA will be able to ensure that budgets and targets are consistent. Once a target is set, we shall know what level of resources is required to make it happen; alternatively, we shall know by how much efficiency must be improved for the target to be achievable within the budget.

Figure 2

Resources required to achieve a given target outcome



Note: Values are illustrative only.

This type of analysis may reveal a funding shortfall, or ‘funding gap’. If so, one has the option of increasing the budget, decreasing the target, boosting efficiency,

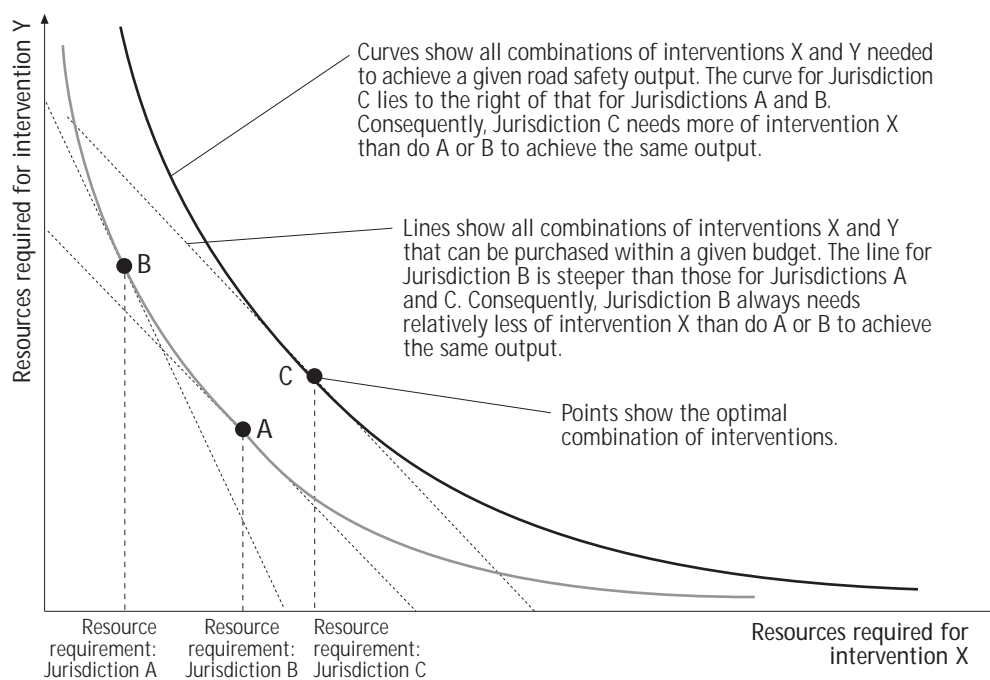
or some combination. While the analysis will not indicate which course of action is best, it will ensure that budgets and targets are consistent (these issues are discussed further under *Setting road safety targets*).

An international comparison

Another way to set the road safety budget is to examine what other jurisdictions are doing, and to emulate the good performers. But such comparisons are rarely simple. Differences in the circumstances of each jurisdiction can render the comparison invalid; and even if the comparison is valid, it must be demonstrated to be so. For instance, differences in the amount and concentration of traffic on the network can greatly affect the efficacy of road safety interventions, as can differences in network design, terrain, weather, resource costs and road users. As a result, jurisdictions may differ in the amount and optimal mix of road safety resources required to achieve a given road safety output (*figure 3*).

Figure 3

Resources required to achieve a given output in various hypothetical jurisdictions



Note: Values are illustrative only.

The LTSA is currently developing the capacity to validly compare New Zealand's road safety regime with those of other countries. Initially we have looked at only one type of intervention, road safety enforcement, as it accounts for a large part of road safety expenditure and is easier to analyse than other types of intervention (LTSA 1998a). But in the future, the LTSA intends to analyse engineering, education and encouragement, as well.

The Australian State of Victoria has reduced its road toll substantially over the last decade. For this reason, and because Victoria is physically close and culturally similar to New Zealand, the LTSA is currently studying the Victorian approach to road safety enforcement. The aim of the work is to estimate the size of the enforcement budget that New Zealand would require in order to achieve

the same impact as Victoria, while allowing for differences in the physical characteristics of the road networks in both places. Due to differences in traffic concentration, one jurisdiction may be inherently harder to enforce than another, even after controlling for differences in traffic volume, network length, and work practices. If so, the two jurisdictions will need different levels of resource inputs in order to achieve the same road safety effect; and unless this is taken into account, any comparison between the two jurisdictions could be misleading (LTSA 1998a).

Allocating the road safety budget

How should New Zealand allocate its road safety budget? This section shows how the LTSA proposes to allocate the budget as between geographical regions, intervention types, and road types.

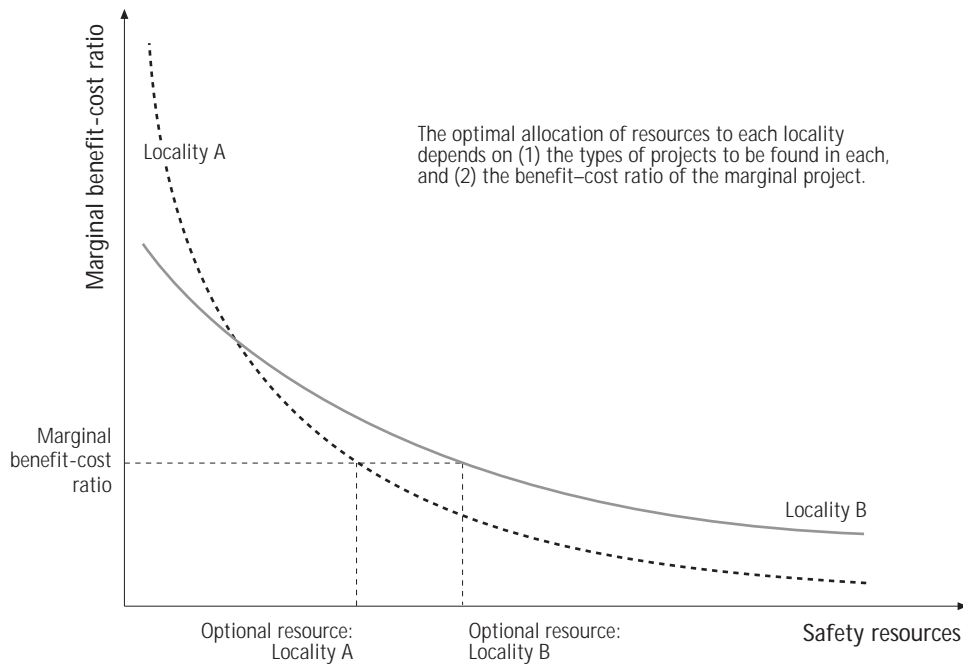
The equimarginal principle

National resources should be employed in such a way that they maximise their benefit to society. This requires that every resource be employed in the place and manner in which it is most productive. In other words, if a road safety resource can be more productive in another place or another type of intervention, it should be transferred. The equimarginal principle (LTSA 1995, 1996b) requires that road safety expenditure be expanded until the benefit of the last, or 'marginal', dollar (that is, the marginal benefit–cost ratio) is the same as that of the marginal dollar in all localities and interventions which are competing for the same resources (*figure 4*).

The equimarginal principle governs the allocation of the road safety budget to spatial units such as Territorial Authorities or police districts. It can also be used to allocate the road safety budget in other ways, for instance by intervention or road type. By allocating resources in this way we take some of the subjectivity out of expenditure decisions.

Figure 4

Optimal resource allocation to two hypothetical localities



Note: Values are illustrative only. Although the chart relates to localities, an analogous approach can be applied to other resource classifications, for instance classification by intervention type.

Data requirements

For its application, the equimarginal principle requires us to quantify the relationships between road crashes and the factors that cause them. Normally, these relationships are gauged from historical data; and it is these data that determine the way in which the equimarginal principle can be applied. If, for instance, we classify crashes by Territorial Authority, we are only able to allocate resources optimally to each Territorial Authority and not to smaller units. But if, say, we classify crashes by the individual road segment on which they took place, we can allocate resources optimally to spatial units smaller than the Territorial Authority, perhaps even to the road segment itself. This is almost certainly more accurate. In general, the precision of the resource allocation procedure is limited by the data on which it is based: the more detailed the data, the greater the precision.

Resource allocation modelling demands data on crashes, network characteristics, and resource inputs. Currently, these data are only available *as a group* on an area basis. This is why our existing resource allocation model (see below) uses the Territorial Authority as its unit of analysis, even though a more detailed analysis, say by road segment and intervention type, would have been desirable. However, we expect this to change; it may in future be possible to classify the required data both by road segment and by intervention type. These improvements will make it possible to build a new generation of resource allocation tools of greater precision.

Allocation models

Allocation by Territorial Authority

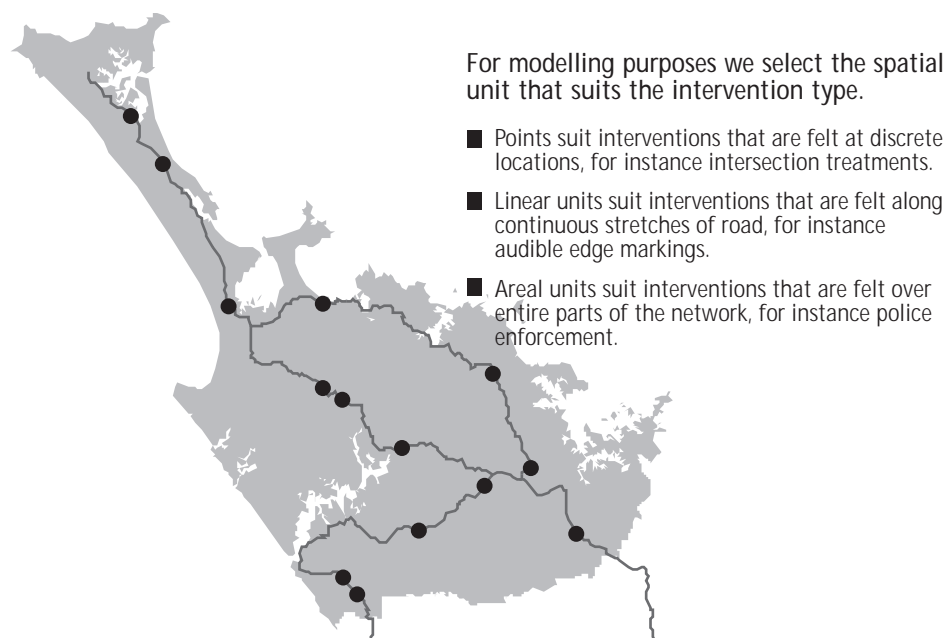
The equimarginal principle is currently being used to guide the allocation of enforcement resources to Territorial Authorities (LTSA 1996b). To develop the model now in use, we first showed how the level of enforcement in a Territorial Authority affected its social cost of crashes, after adjusting for differences in traffic volume and density. This relationship we quantified and expressed in mathematical terms. Next, we inferred the marginal reduction in social cost occasioned by a marginal increase in enforcement resource, using the relationship already established. Lastly, we calculated the enforcement resource that would be required by each Territorial Authority provided the marginal benefit–cost ratio were the same everywhere and the total resource budget were used up.

Allocation by road type

The LTSA intends to build resource allocation models that optimise road safety resources by road type characterised by, say, functional class or level of traffic flow. This will provide more precision, and hence will extract more from the safety dollar, than the existing area-based model. But it requires us to assign crashes to individual road links, which will only become feasible when the LTSA's enhanced crash database is fully operational (see later section on *Data sources*). This database will allow us to match crashes and interventions to the appropriate spatial unit (*figure 5*).

Figure 5

Spatial units used in resource allocation modelling



Allocation by intervention type

The LTSA plans to use the equimarginal principle to allocate resources by intervention type as well as by road type. The results will show which interventions should be undertaken, to what degree, and where. They will indicate the optimal mix of enforcement types (general patrol, traffic cameras, breath-testing etc.) and will show where road engineering best satisfies a road safety need, and where enforcement is more appropriate.

Monitoring road safety performance

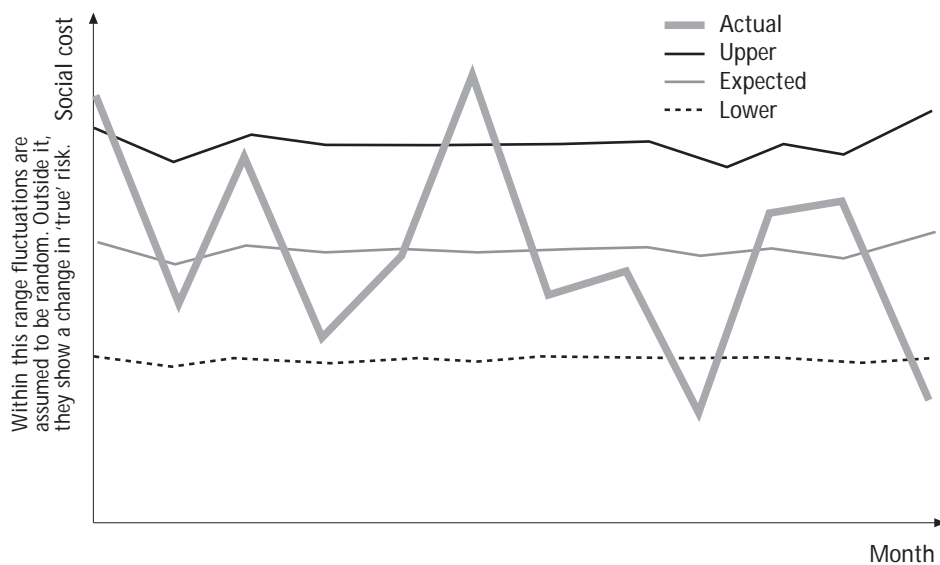
How can the LTSA and its road safety partners check that the road safety budget is being well spent? This section describes three forms of monitoring that the LTSA and its partners intend to undertake.

Control charts

Because road crashes are random events, the number of crashes over a given period depends on a combination of 'true' road safety risk and mere chance. Control charts (*figure 6*) help us distinguish between the two. Control charts show the upper and lower boundaries within which the observed risk is expected to vary if the 'true' risk is unchanged. If the observed risk goes outside these boundaries for long, we can be confident that the true risk has changed. If it stays within the boundaries, or only exceeds them temporarily, we can reasonably assume that true risk has not changed and that any fluctuation is due to random chance. Control charts, therefore, help the road safety agency to avoid false alarms and to direct efforts to where they are needed.

Figure 6

Example of control chart



Note: Values are illustrative only.

Control charts can be tailored to suit different purposes. They may apply to the number or social cost of crashes; to any sufficiently long period; to any sufficiently large area, such as an individual police station, police district, or the entire country; and to any specific programme, such as drink-driving or speeding.

Of all road safety interventions, enforcement and publicity have the most immediate impact on outcomes. An enforcement blitz can for instance be reflected in the road toll within days. Consequently control charts are readily applied in the area of police enforcement. The LTSA is currently devising a system of control charts for the Police, which will use them to reveal which programmes are working and which are not (LTSA 1998c).

In much the same way that the Police will use control charts to fine-tune their enforcement efforts, the Road Controlling Authorities may use them to fine-tune their asset base. Control charts will for instance reveal which parts of the network need work. Currently, Road Controlling Authorities monitor crashes by mapping them and looking for clusters in the same location. Control charts can do the same sort of thing, but with more statistical rigour. Moreover, unlike mapping, control charts can be devised to detect patterns that are not spatial. For instance, they might show which functional classes of roads merit attention, even when the individual roads in question are spatially scattered.

Category analysis

The LTSA intends to develop another analytical tool—category analysis—to complement its system of control charts. By matching crash data to individual road segments, automatically, cheaply, and on a national scale, we shall seek to develop risk standards for every category of road. Categories will be defined in terms of factors that have a bearing on road safety and for which data are available: engineering standard, enforcement level, traffic flow, and—depending on data availability—driver and vehicle characteristics. Enhancements to the LTSA's Crash Analysis System (see later) allow us to do this by linking crash data with comprehensive data on road characteristics throughout the network from any spatial data source. With risk standards established for each road category, the Police and Road Controlling Authorities will be in a position to rate the performance of the roads under their control.

Monitoring intermediate outcomes

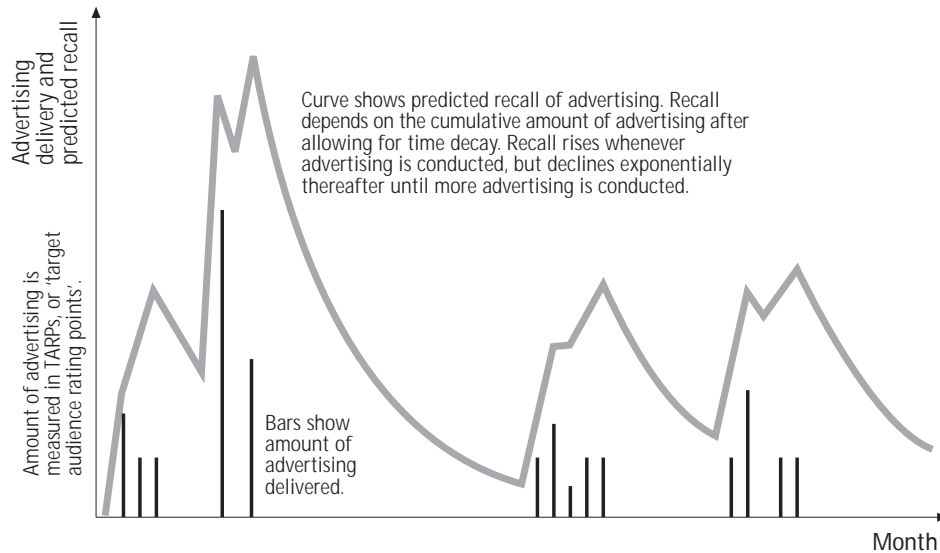
Intermediate outcomes are not desired for themselves but because they contribute to the desired final outcome—reductions in social cost. Intermediate outcomes can be misleading as a change is not necessarily reflected in social cost. But they offer advantages. Unlike social cost, which is difficult to interpret because it depends on many factors simultaneously, intermediate outcomes can be chosen so as to be unambiguous. A well selected intermediate outcome is affected by only one probable cause—the intervention that we wish to monitor. It therefore reflects the effectiveness of that intervention.

The LTSA regularly monitors traffic speeds, the prevalence of drink driving, and restraint wearing rates. The LTSA also monitors public attitudes towards these behaviours and towards road safety interventions aimed at improving them. The results will be available at sufficient accuracy to permit valid comparisons to be made from year to year for the same police district, and, for the same year, between districts. These surveys are essential for monitoring the impact of the relevant road safety interventions. They will be reviewed, and possibly refined and extended, as part of the *Safety Directions* Development Programme.

Intermediate measures can be incorporated into analytical tools. An example is the 'adstock' model that is used to guide the placement of road safety advertising (figure 7).

Figure 7

Example of monitoring of an intermediate measure



Note: Values are illustrative only.

Setting road safety targets

Ambitious but achievable road safety targets are valuable because they focus the efforts of all concerned with road safety. Until now the LTSA and its partners have lacked robust tools to link targets with the resource inputs needed to achieve them. Consequently, some targets may not have been achievable, and others may have provided insufficient challenge. Comprehensive tools are needed to quantify the relationship between resource inputs and outcomes, while allowing for changes in population and road use.

Existing targets for 2001

National road safety outcome targets and performance measures for the year 2001 are monitored every quarter. Most are consistent with targets used overseas, though some are unique to New Zealand. Targets include

- safety outcomes
 - road crash deaths
 - fatal crashes
 - reported serious injuries
 - hospital admissions;
- behaviours
 - driving speeds
 - the wearing of seat belts
 - the wearing of cycle helmets; and
- combinations of outcome and behaviour
 - drivers killed with excess alcohol
 - fatal crashes with speed as a contributor.

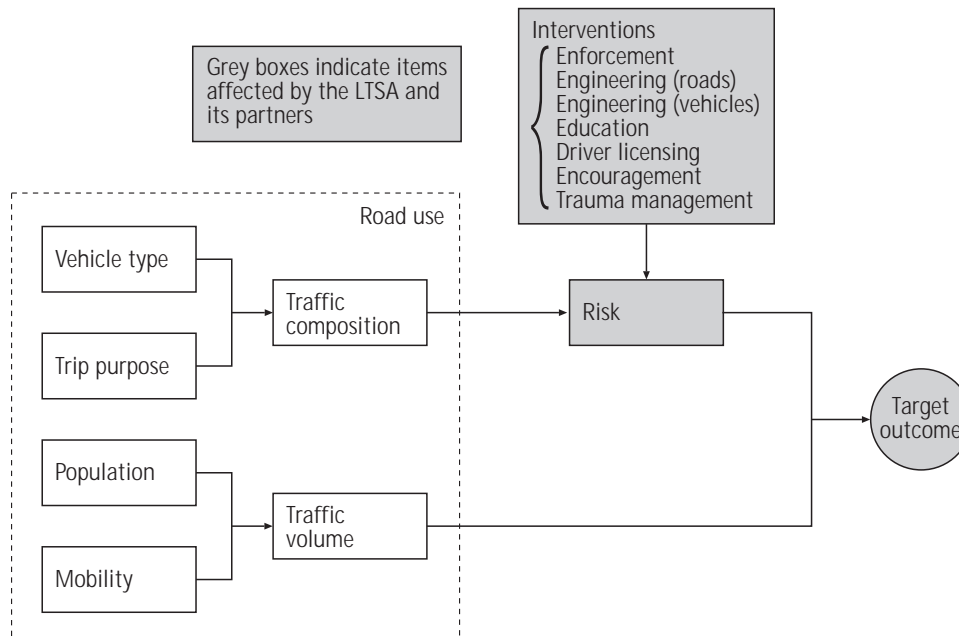
Targets may be measured in absolute units, for instance the number of road fatalities; as proportions, for instance the percentage of travellers wearing seat belts; or as rates, for instance the number of fatalities per 10 000 vehicles.

Proposed targets for 2010

As part of the *Safety Directions* Development Programme, the LTSA will build a model for setting new targets for 2010 (LTSA 1998b). Many factors affect road safety outcomes; the target-setting model successively calculates the effect of each on the current road toll, and so arrives at a target for a future year (*figure 8*). The purpose is to set out clearly and unambiguously the assumptions and other data on which the target is based. This will assist the LTSA and its partners to determine whether or not targets are being met, and to assign accountability for any shortfalls.

Figure 8

Components of target outcome



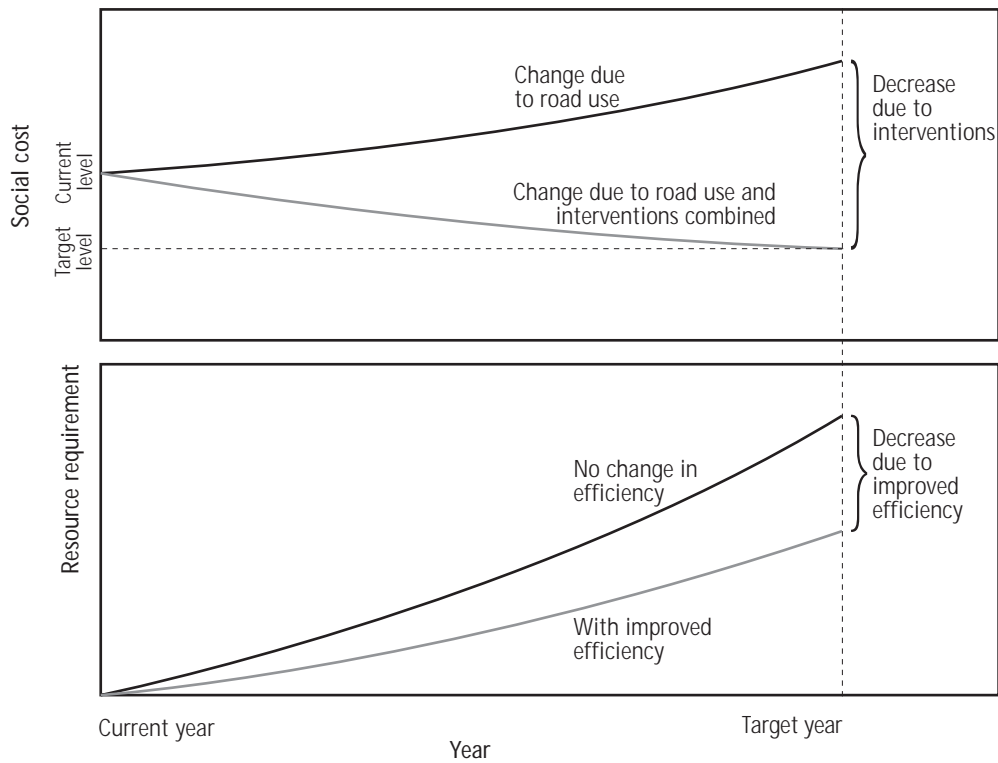
Note: Interventions are classified as in the *National Road Safety Plan 1995* (LTSA 1994). 'Enforcement' includes the advertising associated with enforcement efforts. 'Encouragement' comprises other community programmes that are motivational and persuasional in nature. 'Driver licensing' and 'Trauma management' have been added.

The model will generate year-by-year projections that can be used to ensure that the road safety budget is consistent with the targets that are being demanded (figure 9). It first considers factors not under the control of the LTSA and its partners, mainly traffic mix and volume, and the characteristics of the vehicle fleet. Because traffic is growing, social cost tends to increase unless the LTSA and its partners intervene to prevent it. Hence the model also considers factors which are under the control of the LTSA and its partners: education, encouragement, enforcement, road engineering, vehicle engineering, driver licensing and trauma management. Finally the model predicts the outcome that follows from all factors acting together. The result is the target. In order to provide additional motivation, targets may be 'stretched' by adding a further margin to account for extra effort and improved efficiency.

Because of the way in which the targets are derived, they will be demonstrably achievable. But sometimes the model's prediction of what is achievable may require funding in excess of what has been approved. If so, either the road safety budget must be raised or new ways found to boost outcomes. Alternatively it may be possible to achieve the target with the existing budget by increasing efficiency. While the model will not answer these questions, it will highlight them and discipline any discussion.

Figure 9

Projected social cost and estimated budget requirement



Note: Values are illustrative only.

Data sources

All of the analytical tools used in the funding cycle require data on crashes, network characteristics, and resource inputs. Currently, these data are only available *as a group* on an area basis (table 1). This will change. The enhanced Crash Analysis System now makes it possible to classify crashes by road segment automatically and efficiently. It may also in future be possible to classify resource inputs both by road segment and by intervention type. These improvements will make it possible to build a new generation of analytical tools of far greater precision than those the LTSA currently possesses.

Table 1
Availability of data for analytical tools

Data	Disaggregated by...		
	Area	Road segment	Intervention type
Crash data			
Social cost of crashes	Available from existing CAS	Available in future from enhanced CAS	Not classifiable by intervention type
Network characteristics			
Traffic volume and composition	Available from road controlling authorities	Available from road controlling authorities	Not classifiable by intervention type
Road characteristics	Available from road controlling authorities	Available from road controlling authorities	Not classifiable by intervention type
Resource inputs			
Enforcement	Available from NZ Police	May be available in future	Available from NZ Police
Engineering	Available from road controlling authorities	Available from road controlling authorities	Available from road controlling authorities

Crash Analysis System

The Crash Analysis System (CAS) is the LTSA's central database of crashes. It records every injury crash that is reported to the Police, and contains data about the people and vehicles involved, and the road conditions where the crash took place.

The CAS has been greatly enhanced. The new CAS incorporates powerful analytical and presentation tools. Also, it is a fully spatial database, that is, one in which crashes are recorded in a way that allows them to be electronically mapped. This means that results can be conveniently displayed and readily linked to other spatial data, such as the national census and roading databases kept by the road controlling authorities. The enhanced CAS embodies, or can be linked to, the following types of data.

- **Crash data.** Crash data for the CAS will come from the Police. It is mandatory to report to the Police all crashes involving injury. When a crash occurs, the Police record details of where, when, how and why the crash happened, along with a written account, a diagram, and the location of the crash. These are then entered into the CAS.
- **Traffic volume and composition.** Traffic data for the CAS will come from the National Traffic Data Base (NTDB), which contains data on every section of road in New Zealand, including its length, estimated traffic volume, vehicle composition, road classification and speed limit. The NTDB was created from the Road Controlling Authorities' roading databases, and is to be updated periodically.
- **Road characteristics.** Roding data for the CAS will come from the Road Asset Maintenance and Management (RAMM) database maintained by the road controlling authorities.

Crash reporting rates

We know that many crashes are not reported. Ambulances attend more crashes than are reported by the Police, and more people are admitted to hospital following road crashes than appear as seriously injured in police reports. Hence it is important to have estimates of crash reporting rates so that the results of the CAS can be appropriately adjusted for under-reporting, if necessary on a spatially differentiated basis. The LTSA already adjusts for under-reporting on the basis of its own and others' surveys; this work will be refined and extended.

National Travel Survey and Willingness to Pay/Accept Survey

The National Travel Survey (NTS) is a survey of personal travel patterns being undertaken by the LTSA. This information is of benefit to all agencies involved in road transport, including the LTSA, and is needed for the evaluation tools developed under the *Safety Directions* Development Programme. The last NTS was carried out in 1989, and is now out of date. The LTSA is therefore currently undertaking a new NTS. The LTSA will use the latest NTS data to estimate risk exposure by population groups according to their social and demographic characteristics. As part of the NTS, the LTSA is updating previous research (Guria 1991) into people's willingness to pay for, and (in the latest research) to accept payment for, changes in risk on the road. This work will assist in the LTSA's valuation of statistical life and life quality, and in its understanding of current levels of risk exposure by road users.

The next steps

This working paper marks the beginning of a new phase in the *Safety Directions* Development Programme. Over the next two years (1998-99 and 1999-2000) the LTSA will complete development of the analytical tools to enable it conduct all tasks in the funding cycle (*table 2*). The first step is to decide what general form the procedures and tools will take, and what data they will require; the next is to continue building prototypes; the last is to refine the prototypes into fully working form.

Table 2

Safety Directions Development Programme: Work schedule

Component	Description	Deliverables	
		Completed	Remaining
Setting the road safety budget			
	Procedures to identify the optimal level of expenditure subject to constraints	Benchmarking of enforcement Analysis of funding gap	Benchmarking of other interventions
Allocating the road safety budget			
	Procedures to direct resources to areas and interventions of greatest net benefit	Resource allocation model for enforcement	Refinement of resource allocation model to accommodate more enforcement categories, spatial detail, and other interventions
Monitoring the road safety budget			
Control charts	A device to show the effect of interventions on crash rates and social cost	National control charts	Control charts for police districts and Road Controlling Authorities
Category analysis	Estimates of risk categorised by road, traffic and user characteristics		Analysis of risk by category
Measures of intermediate output	Periodic surveys of traffic speed, drink driving, and restraint usage	Intermediate outcome surveys now in operation	Refinement of intermediate outcome surveys
	Devices to show the effect of interventions on intermediate output measures	Adstock model	
Setting road safety targets			
	A procedure to generate challenging but achievable targets against which performance may be measured	Framework and logic developed	Model building and application
Data sources			
Crash Analysis System (CAS)	Enhancements to the LTSA's crash database	Enhanced CAS now in operation	Linkages with roading data
National Travel Survey	A nationwide survey of travel patterns and attitudes	Survey in progress	Analysis of findings
Willingness to Pay/Accept Survey	A nationwide survey of the monetary value that people place on safety	Survey in progress	Analysis of findings

References

- LTSA (1994a). *Safety Directions 1995/96*. Land Transport Safety Authority, Wellington.
- LTSA (1994b). *National Road Safety Plan 1995*, Land Transport Safety Authority, Wellington.
- LTSA (1995). *Safety Directions second edition*. Land Transport Safety Authority, Wellington.
- LTSA (1996a). *Road Safety Atlas*. Land Transport Safety Authority, Wellington.
- LTSA (1996b). *A Road Safety Resource Allocation Model: Working Paper 1*. Land Transport Safety Authority, Wellington.
- LTSA (1998a). *An International Comparison of Road Safety Enforcement: Working Paper 3*. Land Transport Safety Authority, Wellington.
- LTSA (1998b). *Setting Road Safety Targets: Working Paper 4*. Land Transport Safety Authority, Wellington.
- LTSA (1998c). *Control Charts for Monitoring Road Safety Enforcement: Working Paper 5*. Land Transport Safety Authority, Wellington (in press).
- Miller, T. & Guria, J. (1991). *The Value of Statistical Life in New Zealand*. Land Transport Division, Wellington.
- MOT (1997). *Options for the Future. Land Transport Pricing Study: Discussion Document*. Ministry of Transport, Wellington.