Predicting Road Safety Strategy Performance

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ABSTRACT

This paper describes an improved approach to projecting road safety strategy performance and setting targets for these strategies. The method involved the development of a computer model that uses best available evidence on the effectiveness of a wide range of road safety initiatives. The initiatives modelled encompass the four main categories of speed, road infrastructure, vehicle safety and human performance and behaviour. Individual initiatives were modelled at a macro level, both in isolation and in combination, to generate the main output of the model which is the total number of serious casualties saved over the life of a strategy. In addition, the model predicts the percentage reduction in serious casualties in the final or other chosen milestone years of a strategy, enabling the setting of strategy targets. The model permits the performance of alternative combinations of initiatives to be assessed and optimised.

Other features of the model include its ability to incorporate the costs of both single and combinations of initiatives, allowing strategy options to be assessed with respect to cost-effectiveness and to produce other key indicators of strategy performance.

The model is compatible with the philosophy and principles of Australia's "Safe System" road safety concept and has been proven to be a valuable new tool in devising innovative road safety strategy options.

KEYWORDS

Safe System, Vision Zero, computer modelling, prediction, serious casualties, strategy performance, road safety, Victoria, VicRoads

BACKGROUND

In preparing a new road safety strategy to succeed *arrive alive!*, Victoria's road safety agencies wanted to develop robust strategy options to help advise Government. This was achieved by using an evidence-based approach to allow the relative benefits of individual initiatives to be compared and assessed. Furthermore, overall evaluations of strategy performance were required to allow Government to consider the best combination of investment options for any new road safety strategy that had the greatest impact on reducing deaths and serious injuries. The Monash University Accident Research Centre was commissioned by VicRoads to develop a model to accomplish these tasks using its cumulative expertise in road safety coupled with its capability for carrying out advanced modelling. The outcome was the METS (Macro Estimates for Target Setting) model.

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MODELLING APPROACH

Central to the overall approach to developing a new road safety strategy for Victoria has been the modelling of strategy performance using evidence-based estimates of the effectiveness of individual road safety initiatives along with alternative combinations of initiatives. The modelling approach operates at a macro level and so includes only those initiatives expected to have a sizeable impact on severe road trauma. Using evidence-based estimates of effectiveness and crash data for Victoria over recent years, the model uses mathematical methods to forecast future savings in serious casualties in each year for the life of the strategy.. The predicted savings in serious casualties can be summed over the forecast period for each individual initiative, assuming it is implemented in isolation. Savings may also be summed for combinations of initiatives implemented as part of a strategy, allowing differentiation between strategy options in terms of their potential contribution to preventing road fatalities and serious injuries. The principal measure of worth of a strategy option is the total number of serious casualties prevented over the strategy life compared with a suitable reference value. The reference value for the METS model is the level of serious casualties expected to occur in the absence of a significant road safety strategy.

Forecasting future road trauma occurrence and trends is a challenging exercise, characterised by uncertainty and the need for a variety of assumptions about the nature of the road-transport system to be used as strategy inputs. However, to plan for success, it is necessary to follow such a path, while reducing as far as practicable, the potential for error. METS takes into account two main, whole-of-system, influences.

- Future growth in serious casualties as a result of increasing exposure, reflected by vehicle kilometres travelled (VKT). Figures provided by VicRoads estimated this at 2.0% per annum over the forecast period;
- Future improvement in serious casualty rates due to the gradual effects of increasing motorisation (e.g. Jacobs, Aeron-Thomas and Astrop, 2000). This value was estimated at 1.65% per annum for Victoria, derived from the trend in serious casualties per vehicle-kilometre travelled using annual police-reported data for the period 1992-2001.

These two influences, while tending to counteract each other, resulted in a forecast general upward trend of around 0.3% per annum in serious casualties through to the forecast period due to the higher rate of traffic growth than decline in serious casualties due to motorisation. Together, the combined effect of traffic growth and serious casualty reduction due to increased motorisation was used to define a continuous point of reference against which potential savings in serious casualties due to the proposed strategy and its individual elements were estimated.

The model produces two principal outputs:

1. The estimated total number of serious casualties saved over the forecast period (relative to the forecast numbers of serious casualties in the absence of a significant strategy);
2. The percentage reduction in serious casualties in the final year of the forecast period compared with the most recent year for which full serious casualty data were available. The total number of serious casualties saved over the life of a strategy can be used to identify the most effective strategy, while the percentage reduction provides a target for achievement by the end of the strategy as well as at intermediate milestones throughout.

The model also produces a number of additional output measures for each initiative and each combination of initiatives. All investment levels are in 2006/7 values.

- The estimated cost of the initiative (as provided by responsible agencies);
- The average cost per serious casualty saved;
- The ratio of the monetary value of the serious casualties saved to implementation costs;
- The time profile of cumulative serious casualty savings over the life of the strategy;
- The predicted numbers of fatalities and serious injuries in the final year of the strategy;
- The fatality, serious injury and serious casualty rates (per capita) in the final year of the strategy. These can be compared with rates at the commencement of the strategy and with other jurisdictions of interest. Population projections were derived from data generated by the Australian Bureau of Statistics.

MODEL STRUCTURE

1.1 Description

The METS model was developed over a period of 16 months from early 2006. This section is based on the current version, v5.89 (19 June 2007).

METS is an Excel workbook of 25 linked worksheets. The underlying model uses seven of these, with the remainder providing support and output in both graphical and tabular formats. The model is a numerical implementation of concepts developed in the late 1990s by MUARC researchers Peter Vulcan and Bruce Corben (e.g. Vulcan & Corben, 1998). It starts with a base number of annual serious casualties (killed and hospitalised) derived from police-reported data. The effectiveness of individual countermeasures in reducing the proportion of total serious casualties is used to predict serious casualty numbers from the effects of the countermeasure in isolation for each year for the duration of the strategy. Underlying trends are also taken into account as detailed above. Individual countermeasures are then combined into strategy 'packages', either additively or multiplicatively, the latter avoiding double-counting of savings when different initiatives act upon the same 'pool' of serious casualties.

A unique feature of METS is its ability to allow different levels and combinations of initiatives to be relatively easily compared.

1.2 Key Assumptions

METS uses a worksheet with around 70 input variables, both user-defined and calculated. Variables are separated into general parameters as well as parameters relating to each of the Safe System components, namely infrastructure (safe roads and roadsides), speed, vehicles and behaviour (safe road use). Input variables were derived from reliable agency-supplied statistical data or the results of sound research. For a number of minor variables, however, neither of these sources was able to provide the specific data required. Where this was the case, conservative consensus estimates were used, based on the best evidence currently available.

1.3 Outputs

METS is primarily designed to give an understanding of the likely scale in serious casualty reductions in a manner that aids understanding by senior policy and decision makers.. Care must be taken to avoid implying greater accuracy than the model is able to provide. The following sections describe the main outputs, as well as some of the additional information available where relevant inputs allow.

The two principal outputs of the model are (a) cumulative numbers of serious casualties saved over the life of the strategy and; (b) performance of the strategy in its final year, as well as selected milestone points. Strategy performance is measured as the percentage reduction in the number of serious casualties in the selected year compared with a chosen baseline year, usually the average of the previous three years where full serious casualty data is available. The number of cumulative serious casualties saved is a relative figure calculated by projecting the future state of baseline serious casualties in the absence of a specific strategy. Although it is a somewhat arbitrary baseline, it allows different strategy options to be compared with one another. Moreover, cumulative savings are important to consider, as strategy performance in a single year may give little indication of overall strategy performance.

Where the costs of implementing initiatives have been provided, the model also provides approximate indications of (a) total strategy cost; (b) cost per serious casualty saved; (c) the monetary savings to society resulting from the serious casualty savings and; (d) the ratio of monetary savings to strategy cost. Costs are all expressed in present-day values, with future cost increases not taken into account.

1.4 Factors Affecting Forecasting

METS is intended to provide macro estimates of serious casualty savings over the life of a road safety strategy. In order to accomplish such a complex task, it was necessary to make a number of simplifications. In general, these were aimed at ensuring conservatism of estimates, with the key factors being described below.

- Serious casualties were assumed to rise in direct proportion to increased vehicle kilometres travelled and in inverse proportion to the natural reduction factors described earlier;
- The background level of road safety improvement was calculated from the numbers of serious casualties and vehicle kilometres travelled for the period 1992-2001. During this period, relatively few specific road safety initiatives were in place. The model has also taken into account the projected effects of existing infrastructure investment, contributing to some serious casualty savings between 2006 and the start of the strategy.
- The possibility of diminishing returns from infrastructure investment as higher risk sites are addressed have not been accounted for, but it is expected that the estimated serious casualty savings from infrastructure investment were set conservatively and should be achievable with well-targeted programs.
- Long-term commitment to major infrastructure investment is expected to lead to substantially lower unit costs of major treatment types, such as roadside barriers. This likely gain has been ignored by the model.
- With regard to vehicle safety countermeasures, no allowances were made for any changes in fleet mix, with the assumption being that the relative proportions of each crash type remain similar to current values. Furthermore, the distribution of serious casualties by speed zone was assumed to remain constant throughout the life of the strategy;
- Due to the complexity in appropriately identifying and modelling individual behaviour change initiatives, an approximate cumulative effectiveness of 8% over 10 years was assumed.

CONCLUSION

The METS model is a macro-level mathematical implementation of the work of a number of road safety researchers going back 20 years or more. It allows the estimated serious casualty benefits of individual road safety initiatives, within each of the elements of the Safe System, to be easily compared and combined as 'packages' allowing objective evaluation of the relative benefits of each. METS is an ongoing project, currently being applied in other Australian jurisdictions and subject to continual development in consultation with a number of road safety experts to help validate and improve its accuracy into the future.

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