Outcomes-Based National Road Safety Performance Measures

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Abstract

Traditionally, transport agencies tend to monitor and report on activities and outputs rather than real safety outcomes which are rarely measured apart from at the very broadest levels, for example changes in fatality counts. Recent developments in management theory, which have moved to measure performance in order to improve organisational efficiency and effectiveness, can be applied to transport safety outcomes.

This paper describes the road safety measures developed for the National Transport Commission (NTC) which sought to develop a range of outcomes-based performance measures, consistent with the most recent management concepts. The measures are formulated from a general framework for performance measurement which includes criteria for selection and content requirements.

This paper describes nine primary national and state road safety performance indicators in detail. It describes the intent and value of each measure and also relates them to rail safety performance measures for comparative purposes.

The national road safety performance measures described in this paper are comprehensive and practical for policy and operations management. The measures are important for safety focused road transport policy agencies, regulators, infrastructure owners and operators, primarily in government, but also in the private sector.

Keywords

Management, Outcomes, Measure, Performance, Indicator, Organisation

1 Introduction

Due to the diversity and levels of activity, the responsibility for outcomes from transport is shared amongst many government and private interests. National, State and Territory, and local government all have responsibilities for aspects of road and rail transport in Australia which may not be consistent. The National Transport Commission has responsibilities for some aspects of national transport performance across a range of outcomes. This paper reports the development of performance indicators for the NTC with respect to road safety.

The National Transport Commission (NTC) was formed as an independent statutory authority by agreement between the Australian, State and Territory Governments, to develop and coordinate regulatory reform for nationally consistent road and rail transport policies and laws, and for intermodal transport. NTC develops and submits reform recommendations to the Australian Transport Council (ATC) for approval and assists in co-ordinating and monitoring implementation of approved reforms. NTC proposed to develop performance indicators for its performance in five themes relevant to its objectives: transport productivity and efficiency,

safety and environmental performance, as well as regulatory efficiency and its own organisation strategies. The Council of Australian Governments (COAG 2009) challenged transport agencies to focus on outcomes of value to the community, rather than only on activities or outputs which relate to the operation of the organisation. The NTC proposed that performance measures should therefore be 'outcomes-based' as opposed to reporting 'activity' or 'outputs' and improve reporting consistency.

A review of the NTC (National Transport Commission Review Steering Committee 2009) noted: "*The next phase of transport reform will be challenging as the focus shifts from improving individual modes to lifting the performance of the national transport system as a whole. Reform development needs to holistically consider impacts on productivity, safety, pricing, network access and land-use planning and investment.*" Therefore the NTC sought to measure performance in all five of the areas identified in order to support reporting the outcomes of national transport reform.

In order to manage activities safely, problems need to considered in the context of past and current operating conditions for improvements to be made: "*a problem can be defined as a situation that requires a revision of the currently initiated program of events. The schematic mode of control can only operate satisfactorily when the current state of the world conforms to the regularities of the past. The departures from routine demanded by these situations can range from relatively minor contingencies, swiftly dealt with by pre-established corrective practices, to entirely novel circumstances, requiring new plans and strategies to be derived from first principles.*" (Reason 1990).

The recently released Draft Australian National Road Safety Strategy (Department of Infrastructure Transport Regional Development and Local Government 2010) describes: "*The cornerstone interventions must be supported by a series of management functions focused on achieving results. These are addressed in Section 11, which outlines the priorities for: Adopting a results focus for the implementation of the strategy"* and *"Monitoring and evaluating road safety progress".* This approach relies on measurement of performance.

In response to the recent government context, the need to manage its own operations effectively and report on the national transport system as a whole NTC sought to develop modern measures of performance based on contemporary management and transport philosophies.

2 Study process

The National Transport Commission engaged the Curtin- Monash Accident Research Centre (C-MARC), with subconsultants to prepare performance measures for the five areas of its primary interest. The measures were to be based on contemporary management and relate to present government requirements, transport agency needs, transport system performance and community benefits (Hughes, Hopkins et al. 2011). This paper describes the road safety performance measure outcomes of the study and the relationship with the contextual framework, but does not describe nor substantiate the whole of the study basis and outcomes. The study premise that performance measurement is a valid management tool has not been tested, although it can be inferred from the large number of studies, the amount of management effort and organisational reporting which use the technique. Further discussion on this aspect including the management theory basis and practice is described in the report.

The study included the following stages:

- Reviews of:
  - transport and management literature to understand contemporary concepts,
  - government requirements from agencies with respect to reporting,
  - current practice in transport performance measurement to understand current practice and to relate to contemporary concepts and requirements; and
- Preparation of descriptions of:
  - selection criteria for performance measures,
  - specifications for performance measures,
  - proposed performance measures.

Each of the activities involved close collaboration between the study team itself to ensure a common basis as well as consistency of style and content. The team also collaborated closely with staff of the NTC to ensure requirements were met. The study did not require, and time limitations did not allow, any consultation with stakeholders.

3 Foundations for performance reporting

3.1 Management of safety performance

There are numerous methods and principles which can be applied to managing performance generally and safety in particular, and the reporting of results is an essential part.

A process to develop a management system to manage performance has been defined (Diamond 2005) with the following steps: defining performance measures, overcoming technical issues and ensuring the measures relate to the allocation of resources for the organisation's activities to occur.

The COAG Inter-Governmental Agreement (IGA) (COAG 2009) requires performance to be reported and notes that data quality is crucial. Therefore data should be: meaningful, understandable, timely, comparable, administratively simple and cost effective, accurate and, hierarchical. (Diamond 2005) proposes 5 desirable (or SMART) characteristics for performance targets: specific, measurable, achievable, relevant; and timed.

The Commonwealth Government of Australia accrual-based outcomes and outputs budgeting and reporting framework (Chan, Nizette et al. 2002) seeks to focus public-sector decision-making and accountability on three core issues: outcomes (the intended influence of the government on the community), outputs and administered items (the achievement of the government of the influence); and performance indicators (the means by which the government and the community describe the achievement of the influence in an efficient and effective way) (Chan, Nizette et al. 2002). The GOSPA model facilitates the definition of a specific evaluation structure via the following structural descriptions: Goal, Objectives, Strategies, Plans/Programs and Actions (Newstead and Diamantopoulou 2010).

In transport the PIARC framework for reporting performance in road agencies (PIARC 2004) describes four categories of reporting: road planning or operational indicators (both outputs form activities and social outcomes), indicators for physical structures (assets), functional indicators, and community indicators (relating to community impacts).

Agencies and other organisations measure performance, but doing so is only beneficial if it informs decisions to produce better results (outcomes), represent value to the beneficiaries, is useful in practice and relates to the management of the organisations activities. In other words the performance measures must be relevant and valid, and represent value, both for the community and governments, and operationally for transport agencies.

A question remains as to the value of performance reporting. There is no doubt that it is accepted in many fields of endeavour, including general industry, government, transport and road safety. However an assessment or evidence of the value of performance reporting, in itself in improving outcomes was not required in this study.

3.2 Transport safety performance measures

There are several important issues and details which should be applied when measuring safety performance generally (Reason 1990) which apply equally to road safety:

- there is a recognised problem (although it may be presumed rather than explicit) which may range from minor to catastrophic;
- there is a current situation, controls and a program of events;
- existing controls are relevant to previous practice and circumstances;
- fundamental change may be required to deal with the problems.

The components of a robust safety culture includes having good data through a safety information system (Reason 1997). Measuring safety performance is as fundamental to managing the transport system as a whole, as it is to the agencies, organisations and individuals which are an integral part of it. Making useful and effective improvements is difficult and unlikely without understanding of the existing situation and problems. This requires understanding of the system conceptually and analytically, including measures of performance.

There are many possible measures for road safety used in the academic literature, by government agencies and by others. These commonly focus on the number of people killed and injured, and rates compared with travel and population as well as quantifiable social costs of crashes expressed in financial terms. However, these high level indicators are generally too broad for use in policy development and strategic planning, so more disaggregated measures are often sought and used. This results in a multitude of inconsistent measures notwithstanding the possible rationale for their validity individually. Indeed one measure may be very appropriate for one circumstance and irrelevant for another.

In the case of the NTC, one criteria considered valuable was consistent measures to compare road and rail transport, since the NTC has responsibilities for both and because the modes compete for demand and government intervention. It is also highly desirable to have measures which can be aggregated and disaggregated by State, for different types of use, or by types of vehicle. This is partly because it reflects how the data is often originally collected and how it can be used for practical purposes.

The survey of agencies reported in this study demonstrated that agencies can and do measure activities, (which translate inputs into outputs), outputs (the means produced by agencies which achieve outcomes) and outcomes (results which have value to others). In transport, intermediate consequences exist, such as the amount of travel, asset value, mode share or

financial values of consequences (benefits and costs). However, there is a predominance of activity, output and intermediate measurement compared with outcomes.

The purpose of rail safety reporting (ATSB 2010) could equally be applied to road safety: *"to assist rail safety professionals and researchers in understanding and mitigating risk. In addition, it can be used for international comparative research, while informing the public about emerging issues in rail safety."* Indeed in this study, road and rail safety were considered together.

The crucial initial question regarding safety surrounds the definition of what it is, so that it can be measured for a variety of purposes. BITRE (Bureau of Infrastructure Transport and Regional Economics 2009) concludes: *"The definition of a road crash is essential to costing the economic impact of road crashes and comparing changes over time. Not all accidents on a road are considered by authorities to be road crashes, and not all crashes occur on public roads."* and *"Equally important is that this definition of road crash excludes suicides and homicides; events indirectly related to a road crash; off-road crashes…and collisions involving only non-road vehicles."*

The European situation is similar to Australia where the following issues in reporting road safety between countries are critically important (SafetyNet 2004):

- the only comparable measure of reporting is fatalities;
- for non-fatal crashes there are widely different definitions of severity; and
- there is significant underreporting of non-fatal crashes.

The reasons for measuring safety performance have been summarised (European Transport Safety Council (ETSC) 2001) as:

- reporting on (real) underlying performance when short-term fluctuations occur;
- to report accurately;
- to understand what leads to crashes;
- to inform the development of effective countermeasures;
- to highlight problems as they develop before substantial consequences occur;
- to demonstrate the effectiveness of countermeasures and programs; and
- to monitor progress and improve performance.

Targets for road safety are an essential part of vision-based contemporary road safety strategies. Therefore, being able to measure the outcomes is essential if targets are to have any meaning in reality and utility for management to make improvements (Wegman, Lynam et al. undated). For the Swedish 'Vision Zero' Road safety strategy initially only six key indicators were chosen; speed, seat belt, car safety, rural roads, urban roads, drink-driving and bicycle helmets (Berg, Strandroth et al. 2009). Subsequently these were expanded to 13 indicators: speed (state roads), speed (municipal roads), drink-driving, seat belt, bicycle helmets, car safety, safe heavy vehicles, rural roads, urban roads (crossings for pedestrians and cyclists), urban roads (crossings for cars), urban roads (sum), rapid and qualitative emergency care, non-fatigue, valuing of road safety. Other parameters were described for each of these including exact measurement, objective, starting point and effect on fatalities.

National road safety indicators typically include road accident fatalities, fatalities per 100,000 population, fatalities per 100,000 motor vehicles (Elvik 2008), (IRTAD 2009). Less

commonly reported are the number of people seriously injured or injured, crashes, and the total cost of road crashes.

There are many difficulties in reporting these figures. Countries and Australian States use different definitions, even for death, depending for instance on the elapsed time or other circumstances (e.g. suicide). Data can be difficult to collect accurately, particularly for non-motorised vehicles and pedestrians. Countries have different criteria as to whether crashes are reported (Elvik, Hoye et al. 2009), which is also true for Australian States.

The primary target outcomes may be the total social cost of road crashes (OECD 2009) or the numbers of people impacted. The social cost is a poor measure for comparison between countries, since the value of human life and quantifiable financial costs are much lower in developing countries than developed countries. It is important to not have too many indicators. Focus on a few key indicators which have a major effect on road safety is more effective (Elvik 2008).

Recently there has been more recognition of 'exposure' as an important parameter for relative comparison since it is a most objective measure of exposure to risk, so fatality rate (fatalities per billion vehicle kilometres travelled) has often been reported (IRTAD 2009). Population has been used as another comparator for normalising the outcomes, which relates to public health measures.

The consequences of road 'unsafety' are twofold:

- direct personal effects (death, injury, pain and suffering, lost quality of life, etc.); and
- financial effects (including property damage to vehicles, infrastructure and product, lost production, etc.).

Measures of these two primary effects could be used for reporting performance. However, many of these consequences can be measured diversely. Absolute numbers, years of life lost and, dollar costs are but a few and all of the alternatives, all of which can be normalised with relative rates, as noted above. Despite many measures being possible, suggested or used, clearly the highest level indicator is the number of people killed and injured (or seriously injured).

A survey of Australian road and transport government agencies and industry annual reports, corporate plans and performance reports identified nearly 30 individual measures of performance in addition to activities and outputs. Twelve documents reported measurable safety indicators, but six documents had no measurable safety performance indicators. Public transport safety performance reporting may include road and/or rail transport, so the road safety performance may combined and not be clearly distinguished.

A useful property of performance measurement data is scalability to vehicle types, regions, types of roads. Such disaggregation is necessary to identify specific issues worthy of being addressed specifically. However, stratified data results in too many indictors and too much detail for strategic purposes and detailed data is not always available.

3.3 Performance measure selection and specification

As a result of the review of management literature, Australian government requirements and transport agency practice, the following criteria were set to choose the relevant measures to report transport performance:

- policy relevance;
- accessibility;
- representativeness and validity;
- reliability;
- simplicity; and
- outcomes-focussed.

Based on the selection criteria, each of the proposed measures need to be described in order to be used. The descriptions included the following components:

- title - name of the indicator;
- purpose - why it is being measured;
- object - what is being measured;
- metric and direction - definition of the indicator (e.g. dimensions) and in which direction is progress measured;
- data requirements - what the input data is;
- data collection methods - how the data is collected;
- timing - whether a short or long-term indicator, any delay in reporting and any timing issues;
- ownership - the source of the data and the agency which reports it;
- reliability - consistent across states, modes, internationally, etc.;
- relationships - links between the performance indicators and other proposed indicators;
- future developments - such as improving accuracy, reduced cost, improving consistency, etc.; and
- other information - any other issues, comments, problems, opportunities, other information, etc.

4 Proposed national road safety performance measures

The proposed performance measures are detailed in Tables 1a, 1b and 1c. Two other specifications included are not shown here; ownership and other information. Ownership describes the agency responsible for collecting and maintaining the data. Other information includes some additional specific detail with respect to the measure which should be noted.

The performance measures proposed are largely consistent with other jurisdictions (Breen 2004), (IRTAD 2009), with a few particular differences. Performance measures can also be interpreted from strategy target measures. However, there will be some differences between reporting, despite intentions to standardise.

There are numerous other measures which could be devised although in practice this normally occurs with stratification into sub-categories. Road user grouping is perhaps one area of reporting which is perhaps more useful for further measures. In particular, vulnerable road users (especially indigenous users, young users, older users, pedestrians, cyclists and motor cyclists) are overrepresented in safety statistics and are sensitive for the community.

It is desirable for the performance measures to relate to agency philosophies and operations. In the Safe Systems approach to road safety, vehicles, roads and speeds are physical elements which are relatively easy to measure, assess and monitor. The pillar which is most subjective and variable is the road user who responds biologically, emotionally and intellectually in ways which are not only difficult to determine, but also difficult to measure and manage.

Therefore performance indicators for road users are possible but are often difficult to measure, are subject to variability and may only apply to certain sub-groups rather than the population as a whole.

A great range of additional or alternative performance measures may be justifiable or even preferable. Some indicators, such as "The traffic weighted percentage of State road length which meets AusRAP standards" may not be as robust as other measures, due to difficulties in measurement. The safe speed measure assumes that speed zones are set consistent with Safe Systems principles. This is unlikely to be the case given the relatively recent development of Safe Systems, its gradual introduction in practice, and the extended length of time for speed zones to be reviewed. An alternative indicator may be the proportion of roads with speed zones which comply with safe systems principles.

Table 1a. Road Safety Performance Indicators (1-3)

Component	Details	Details	Details
Indicator Title	1. Fatalities and Serious Injuries 1.1 Road	2. Safe Vehicles	3. Safe Roads
Purpose	To measure human impacts on individuals in society	To indicate the improvements in passenger vehicle safety which are occurring	To indicate the improvements to road infrastructure to improve safety which are occurring
Object	The number of people killed and seriously injured	The level of vehicle safety quality of new passenger cars	The level of safety quality of roads
Metric and Direction	The number of people killed according to current definitions *(lower is better)* The number of people seriously injured according to a definition yet to be agreed *(lower is better)*	The percentage of new passenger car sales which are 5 star ANCAP rated *(higher is better)*	The traffic weighted percentage of State road length which meets AusRAP standards *(higher is better)*
Data Requirements	Data on fatalities from current records Data on seriously injured people from police and hospital matched records	ANCAP crash ratings by passenger car type New passenger car sales numbers	AusRAP road assessments for State roads AADT traffic counts or for State roads
Timing	Fatality data is available at reasonably short notice Collection of data on serious injuries will take time to implement when agreed Collection of data on serious injuries will have a delay in reporting as data is cleaned and matched	Short-term indicator of policy outcomes Long-term indicator of safety outcomes Reasonably short delay in reporting	Long-term indicator of network safety Reasonably short delay in reporting
Reliability	Fatalities are generally consistent across Australia and internationally Serious injuries require agreement of definition	Quite reliable, but may need interpretation or estimation for some vehicle types	Reliability is dependent on the quality of data which may be quite variable.
Relationships	This data is required for other safety indicators which follow relating to exposure	Contributes in the long-term to other road safety indicators	Contributes in the long-term to other road safety indicators
Future Developments	Serious injuries are a development of existing reporting This data can be usefully disaggregated into many categories including State and Territory, owner group (government, corporate, private), mode (car, truck, rail, motorcycle, cyclist, pedestrian), region, road type, etc.	Could be extended to commercial vehicles and trucks Could possibly be used for international comparisons, although inconsistencies in crash analysis exist.	Could be extended to local roads, perhaps by sample

Note: Indicators 1.2, 4.3, 6.2, 7.2, 8.2 and 9.1 refer to related rail safety performance measures for railway operations, but are not included in the description above.

Table 1b. Road Safety Performance Indicators (4-6)

Component	Details	Details	Details
Indicator Title	4. Safe Drivers 4.1 Seatbelt use 4.2 Alcohol and drugs (road drivers)	5. Safe Speeds	6. Fatality and Serious Injury Rates for Passenger Travel 6.1 Road passenger safety
Purpose	To indicate the level of driver safety	To indicate the level of safe road use	To understand relative levels of passenger safety between modes and related to travel
Object	Driver safety	Safe speed of road use	The number of people killed and seriously injured in passenger vehicles compared with the amount of passenger travel
Metric and Direction	Percentage of vehicle occupants using seatbelts *(higher is better)* Percentage of drivers not exceeding drug and alcohol thresholds as assessed by test *(higher is better)*	Percentage of vehicles not exceeding the speed limit *(higher is better)*	The number of people killed and seriously injured divided by the passenger kilometres of travel *(lower is better)*
Data Requirements	Number of occupants and number properly restrained Number of drug and alcohol tests and number of people who pass the test	Speed and traffic volume data	Fatality and serious injury numbers (as above) Passenger travel by road
Timing	Long-term indicator of driver safety Reasonably short delay in reporting	Short-term indicator of driver safety Medium delay in reporting, data will take time to collate	Travel data will take time to collect and collate The indicators using serious injuries are not yet possible
Reliability	Reliability is dependent on the quality of data which may be quite variable.	An accurate indicator when reported properly	Fatality and injury data as above. Travel data reliability is varied, but likely to be sufficiently accurate and has been used previously
Relationships	Contributes in the long-term to other road safety indicators	Contributes in the long-term to other road safety indicators	These indicators provide additional information to the first safety indicators and rely on these for data
Future Developments	Methodology for restraint surveys needs development	None identified	Definitions of people included (in passenger travel) need to be agreed Data on passenger travel needs to be verified for accuracy

Table 1c. Road Safety Performance Indicators (7-9)

Component	Details	Details	Details
Indicator Title	7. Fatality and Serious Injury Rates for Freight Travel 7.1 Road freight safety	8. Social Costs of Transport Crashes 8.1 Road	9. Signal Violations 9.2 Traffic Control Signal violations 9.3 Railway Level Crossing Signal violations
Purpose	To understand relative levels of freight transport safety between modes and related to travel	Economic costs are an important measure for governments and for comparisons with other sectors	To measure the compliance of drivers to control signals and therefore the level of risk which occurs
Object	The number of people killed and seriously injured in crashes involving freight vehicles compared with the amount of freight travel	The total cost of crashes to the community	The proportion of red control signals which are passed by drivers
Metric and Direction	The number of people killed and seriously injured in crashes involving freight vehicles divided by the freight tonne kilometres of travel *(lower is better)*	Annual dollar costs *(lower is better)*	The proportion of signals passed by train and road drivers *(lower is better)*
Data Requirements	Fatality and serious injury numbers Freight travel by road Freight travel by rail	Methodology for road crashes has recently been reported by BITRE Data is available if updated annually, but should be reviewed regularly (e.g. 5 yearly) Data for rail crashes is out of date and needs to be recalculated	Number of SPADs and number of signals passed provided by railways through the Rail Safety Regulators(s) Number of Traffic Control Signal and Railway Level Crossing Signal violations and traffic volume
Timing	Travel data will take time to collect and collate The indicators using serious injuries are not yet possible	It is unlikely that all data can be recalculated annually, however, regular updates (say 5 yearly) supplemented by annual incremental changes should be adequate	Rail SPAD data is routinely available and should be available within months of the end of the reporting period Road signal data will take time to collect and report
Reliability	Fatality and injury data as above. Travel data reliability is varied, but likely to be sufficiently accurate and has been used previously	If a common national assessment is undertaken the reliability is dependent on the data described above	Data should be reasonably consistent across sources
Relationships	These indicators provide additional information to the first safety indicators and rely on these for data	These indicators provide additional information to the first safety indicators and rely on these for data	This indicator should be a leading indicator of fatalities and serious injuries for serious crashes
Future Developments	Definitions of people included (in freight travel) need to be agreed Data on passenger travel needs to be verified for	The current methodology is likely to change from 'Human Capital' approach to a 'Willingness to Pay to Avoid Risk' approach	Data details should be verified with providers

accuracy

As a result of these considerations, it may worthwhile to undertake further investigations to assess a much wider range of measures for inclusion, However, all of the proposed measures meet the objective criteria suggested by the investigation of management and practice.

5 Conclusion

Implementing the proposed performance measures will be challenging due to inaccuracies in reporting and inconsistencies between agencies. Some indicators can be reported currently while others will require considerable negotiation and agreement prior to use. Collecting information on performance will always involve a cost, and while many measures are currently available within existing cost structures, others will involve some additional cost. However, none of these issues are insurmountable for any of the indicators. The greatest impediments may be to move towards outcomes based measurement or an unwillingness to change.

Difficulties in providing suitable data abound in performance measurement. Data which is desirable may be unavailable, costly, delayed, inconsistent, inaccurate and/or sensitive (politically, personally or to an agency). Notwithstanding these limitations, the performance measures proposed are comprehensive and practical for policy and operations management, and can be used by any safety focused road transport policy agencies, regulators, infrastructure owners and operators. While these will primarily be in government, the measures are also valid, useful and necessary for use within but also in the private sector.

In this study, a consideration was data which was relevant across indicators and to both road and rail safety, despite differences of approach in the different transport modes. For instance, the number of people killed and seriously injured is relevant to both modes, but seatbelt use is only relevant to road vehicles. Signals passed at danger (SPAD's) are a widely used measure in the rail industry, partly due to the very low number of actual incidents which result in harm. Such 'near miss' measures would represent a massive number for road safety and probably impossible to collect in practice, even by sample. However, measuring violations at traffic signals is analogous to SPAD's and very relevant at railway level crossings.

The proposed measures are contemporary, reflecting current management concepts, government requirements and modern transport and road safety practice. Despite many measures being possible, suggested or used, clearly the highest level indicator is the number of people killed and injured (or seriously injured). The study met the requirements of the NTC in developing performance measures consistent with contemporary practice to be: meaningful, understandable, timely, comparable, administratively simple and cost effective, accurate and hierarchical.

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