

## **Priorities for future vehicle safety improvements in the Western Australian light vehicle fleet**

Budd<sup>a</sup>, L. & Newstead<sup>a</sup>, S.

<sup>a</sup> Monash University Accident Research Centre & Curtin-Monash Accident Research Centre, Curtin University

### **Abstract**

This project aimed to model the potential road trauma reductions that could be achieved in Western Australia through safer vehicle choices, particularly for Government and Corporate fleets. A specific aim was to identify safety technologies or vehicle purchasing strategies that could lead to the greatest and most cost-effective road trauma reductions.

Police reported crash data in W.A. from 2006-2009 and snapshots of the W.A. registered vehicle fleet from 2006-2012 were analysed by fleet type (corporate, government and private). Analysis estimated the cross sectional profile of the WA vehicle fleet in terms of vehicle type, safety performance and crash involvement types. Changes to the cross section over time were projected forward as a basis on which to estimate the safety effects of various fleet change scenarios.

Universal fitment of forward collision warning and autonomous emergency braking systems operating at all speeds was the scenario estimated to provide the greatest reductions in injuries and associated societal costs. Purchasing the safest vehicle within intended market group through use of resources such as ANCAP was estimated to provide the next greatest benefit. The aggressive nature of the W.A. vehicle fleet meant purchasing less aggressive vehicles was estimated to have the next greatest benefit: cars instead of SUVs in metropolitan areas and reduced size SUVs in rural areas.

### **Keywords**

vehicle safety, vehicle fleet, injury outcomes, statistical modelling,

### **Background**

In March 2009, the Western Australian Cabinet and Parliament demonstrated their commitment to reducing the number of deaths and serious injuries resulting from road crashes by endorsing *Towards Zero: Road Safety Strategy with the Potential to Prevent 11,000 Deaths and Serious Injuries on WA Roads 2008-2020*. *Towards Zero* aims to reduce the number of deaths and serious injuries resulting from road crashes by 40 per cent over its 12 year life. The key initiatives within *Towards Zero's Safe Vehicles* cornerstone include:

- encouraging corporate fleets to take up safer vehicles and vehicle safety features;
- strongly encouraging making safer vehicles and specific safety features such as electronic stability control and side and curtain airbags compulsory for government vehicles; and
- promoting the community take-up of safer vehicles and vehicle safety features.

The potential benefits accrued by the wider community if Western Australian government and commercial fleet buyers were encouraged to buy safer vehicles, are potentially significant given that 60% of new vehicles are purchased for business purposes (Road Safety Council, 2001).

This project aimed to quantify the safety benefits to the owners of commercial and government fleets as well as the wider community (once fleet vehicles pass into private ownership), attainable through the adoption of alternative vehicle purchasing practices in Western Australia. Safety benefits were estimated from a model which projected crashes and occupant injuries by road user type for the 2012 registered cohort of new light passenger and light commercial vehicles over their 22 year projected average useful life based on trends observed over the years 2006 to 2009. This construct was used as the baseline from which various different fleet purchasing scenarios were evaluated. The baseline scenario was constructed by examining the size of the vehicle fleet, its distribution between fleet sub-types (commercial, government and private), crash rates by fleet type and vehicle market group, rate of scrapping vehicles from the fleet and the rates of death and serious injuries to both vehicle occupants and other road users in the crash taken from the Australasian Used Car Safety Ratings (Newstead et al, 2012). The methodology for constructing the model is described in Newstead et al (2007). The safer purchasing scenarios considered were chosen to best target prominent crash types and trends identified through the analysis of the registered and crashed vehicle fleets by 4 broad fleet types: metropolitan corporate, rural corporate, government and private.

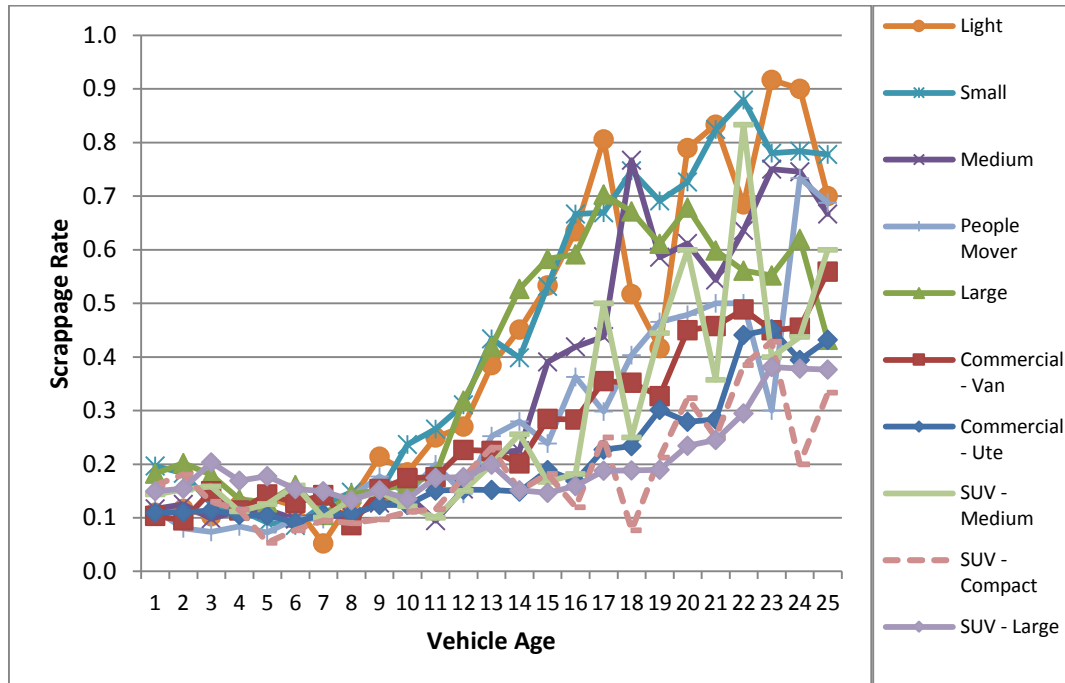
## **Model Inputs**

### ***General characteristics of the current registered vehicle fleet in W.A.***

Government and corporate fleet vehicles in WA are becoming an increasing influence on the total make-up of WA registered passenger vehicles. Growth in registrations was not only observed for all vehicles, but this growth was disproportionately greater for corporate and government fleet vehicles. From December 2008 to March 2012 the proportion of metropolitan corporate vehicles in the W.A. fleet grew from 7 to 12%, the proportion of rural corporate vehicles increased by 1% and the proportion that were government fleet vehicles more than doubled. Most corporate fleet vehicles had passed into private ownership by the time they were twelve years old. Most government fleet vehicles had passed into private ownership by five years of age.

Market group mix was also a key input to the model as was the crashworthiness (occupant injury protection performance) and aggressivity (collision partner injury protection performance) of the vehicles within each market group assigned from the Used Car Safety Ratings. Government and corporate fleet vehicles in WA currently consist of greater proportions of vehicles from market groups with higher than average aggressivity (risk of killing or seriously injuring other road users in a crash) compared to the private vehicle fleet. In March 2012, SUVs and light commercial vehicles, both of which have higher than average aggressivity, made up 61% of metropolitan corporate fleet vehicles and 76% of rural corporate fleet vehicles. In contrast, these market groups made up 52% of government passenger vehicle registrations and only 34% of private registrations.

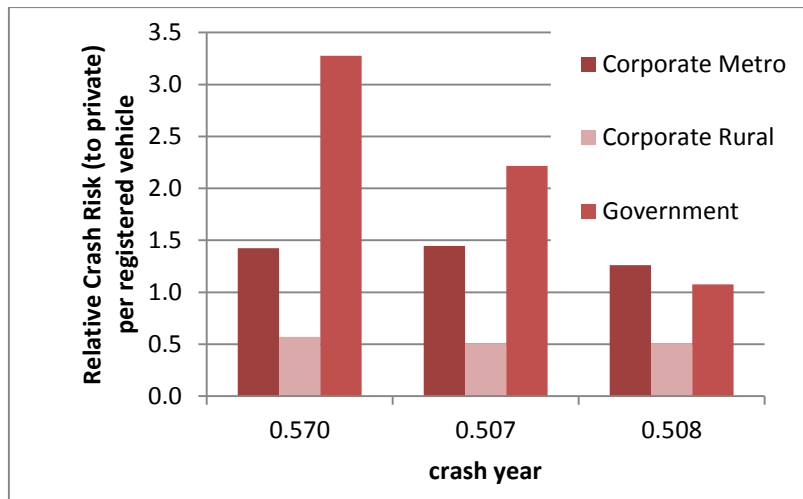
An important consideration in constructing the fleet projection model on which to estimate the effects of safer vehicle purchases was the profile of vehicles being scrapped from the fleet. Figure 1 gives the annual rate of vehicles being scrapped by market group. It shows that in generally smaller vehicles are scrapped from the fleet at a faster rate. Since smaller vehicles are generally less crashworthy, this has a positive effect on the overall safety of the fleet over time.



**Figure 1. Estimated annual scrappage rates by age of passenger vehicles and market group**

### **Crash rates**

Crash rates per registered vehicle were estimated for each vehicle market group as an input to the model. As shown in Figure 2, corporate and government fleet vehicles experienced a substantially higher crash risk per registered vehicle than private vehicles in W.A. over the 2006-2009 period, despite most corporate and government fleet drivers being over 25 years of age and despite most corporate vehicles being newer and thus more likely to be fitted with newer crash avoidance technology such as electronic stability control. The observed higher crash risk per registered vehicle is most likely due to greater travel exposure by corporate and government fleet vehicles compared with private vehicles in W.A.



**Figure 2. Relative Crash Risk per Registered Vehicle by fleet and crash year, 2007-2009**

### **Crash type mix and injury outcomes**

The final input to the model was the mix of specific crash types and injury outcomes associated with each vehicle type in each fleet group. Driver injuries in rural corporate fleet crashes were more likely to be serious than for metropolitan corporate or private fleet crashes. Crashes involving rural corporate and government fleets also had a higher severity of injury compared to metropolitan corporate or private fleets. Rural corporate SUV vehicles were also over-represented in head-on crashes and rural corporate vans and utilities were over represented in head on fatal and serious crashes. In comparison to the private SUV fleet metropolitan corporate SUVs were also over-represented in roll-over crashes, *hit object* crash types and crashes with heavy vehicles. The baseline model of fleet safety constructed accommodated the representation of various vehicle types and fleets in each crash type as well as the relative number of serious injuries and fatalities occurring in these crashes.

### **Projected Baseline Model**

A baseline model was constructed for 2012 registered vehicles projected over a 22 year life. Modelled crash numbers are a function of:

- i) the market groups of the 2012-registered vehicle cohort;
- ii) the current fleet status of the 2012-registered vehicle cohort;
- iii) the future fleet status of the 2012-registered vehicle cohort;
- iv) future rate of vehicles being scrapped
- v) expected crashes in future years
- vi) the type of crash (whether it involves a risk of injury to the occupants of the 2012-registered vehicle only, other road users only, or both other road users and occupants of the 2012-registered vehicle) and the expected injury outcomes in these crashes.

As an illustration of typical model data, Figure 3 shows the number of vehicles in each fleet type expected in future years based on past trends.

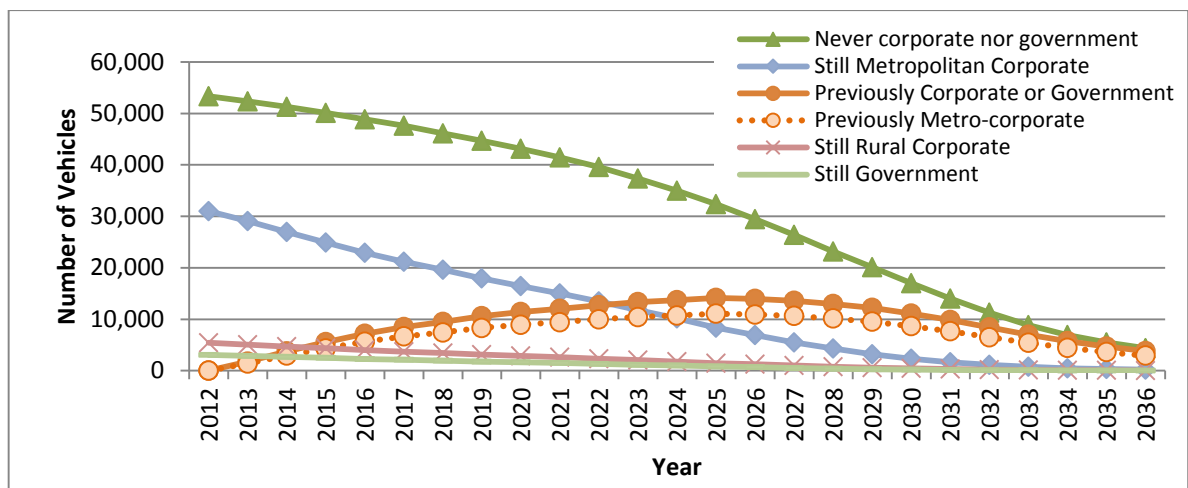


Figure 3 Number of 2012-registered vehicles at the beginning of each calendar year by fleet status

In addition to estimating the number of crashes, the model also allowed the estimation of the number of seriously injured road users that were injured in different types of crashes.

The model was created using estimates of present fleet purchasing patterns and forecasts of scrapping rates and transfer rates to private ownership based on what has occurred in previous years. The model represents a baseline scenario of what role we would expect vehicles originally registered as fleet vehicles in 2012 to play in crash outcomes over their useful lives (the following 22 years). It was used to evaluate various alternatives in the composition and specification of the 2012 new vehicle cohort to see what effect they have on injury outcomes when compared to the status quo represented by the baseline scenario. The effect of modifying various model parameters according to the scenarios proposed to reflect various changes in vehicle fleet purchasing and management policies was investigated. Expected number of crashes and casualties at each severity level resulting from changes in these model inputs were then compared with the baseline scenario to calculate the relative benefits of various fleet purchasing and management policies. The present value total costs of these crashes to society were determined using a 4% discount rate and 2006 crash and injury costs from BITRE (2009) adjusted with the CPI to 2012 values. The efficacy of each scenario considered at reducing the present value of crash costs was directly related to its ability to reduce serious and fatal injuries since 67% of crash costs were attributable to the human cost of serious and fatal injuries and only 3% of crash costs were attributable to the cost of minor injuries.

### Fleet purchasing Scenarios

Scenarios were considered to increase the proportion of more crashworthy vehicles or decrease the aggressivity of vehicles in government and corporate fleets. It was hypothesised that if W.A. corporate and government fleets consisted of proportionally fewer aggressive and/or more crashworthy vehicles, injury outcomes in crashes would improve. Scenarios were also proposed to evaluate crash reductions associated with increased uptake of Electronic Stability Control in light commercial vehicles and Side Curtain Airbag technology in all cars. Additional scenarios were evaluated considering increased uptake of emerging crash avoidance technologies that specifically targeted the most frequent crash types in W.A. Forward collision warning systems with autonomous braking intervention were considered to address rear-end collision types. Lane departure

and fatigue warning systems were proposed to address out of control crashes such as single vehicle roll-overs and *hit object* crashes. Lane change/blind spot warning systems were proposed to address crashes from intentional lane changes such as side-swipes.

In total, nine scenarios for changing the profile of the newly registered 2012 vehicle cohort in WA were considered:

1. Only purchasing the most crashworthy vehicle in each market group
2. Replacing the purchases of large and medium metropolitan fleet SUVs with large vehicles and rural large SUVs with medium SUVs (aggressivity reducing scenarios)
  - A. Using a fleet average vehicle in terms of aggressivity for the market group
  - B. Using the least aggressive model in the market group
3. Fitment of active forward collision detection and autonomous braking operational at speeds of 80 km/h and greater
4. Fitment of active forward collision detection and autonomous braking operational at all speeds
5. Fitment of fatigue warning systems
6. Fitment of lane departure warning systems
7. Fitment of lane change/blind spot warning systems
8. Fitment of Side Curtain Airbags (SCA) to models without SCA as standard
9. Fitment of ESC to utilities and vans without ESC as standard

### **Estimated Benefits**

Table 1 summarises the results of the scenario modelling by fleet type. It gives both the present value of the total lifetime savings in community social costs associated with the 2012 vehicle fleet including savings in minor and non-injury crashes and the expected number of savings in deaths and serious injuries for the cohort over its lifetime. It also gives the community social costs specifically related to deaths and serious injuries.

Results in Table 1 identify the priorities for improving the safety of the WA vehicle fleet by quantifying the relative impacts of each scenario on serious and fatal injury and costs to the community.

- The most beneficial scenario for reducing overall community costs and serious injuries was fitment to all fleet vehicles of forward collision warning and autonomous emergency braking systems that operate at all speeds. Systems that only operate at high speeds were also highly beneficial being ranked third in priority, a much higher priority than those systems only operating at low speeds which are currently more commonly available.
- Maximising the crashworthiness of new vehicles entering the fleet in each market group (to be equivalent to the best crashworthiness available in the market group) showed the second highest potential benefit.
- Reflecting the high proportion of large SUVs in corporate fleets in WA, the third most effective vehicle safety scenario for reducing road trauma in WA is to

encourage downsizing of large SUVs to medium SUVs or large cars with the lowest possible aggressivity

- Each of the other scenarios considered also offered road trauma reduction benefits although the magnitude of the potential savings were considerably lower than the 4 most effective scenarios identified.

**Table 1. Estimated savings in community social costs associated with each alternative fleet purchasing scenario over the useful lives of the 2012-purchased fleet vehicles**

Fleet	Corporate Metro			Corporate Rural			Government		
	Total Savings	Serious Casualty Savings		Total Savings	Serious Casualty Savings		Total Savings	Serious Casualty Savings	
Scenario	\$M	N	\$M	\$M	N	\$M	\$M	N	\$M
<b>1</b>	47.6	144	48.8	3.9	13	4.1	3.1	10	3.1
<b>2a</b>	4.7	17	5.3	0.8	3	0.8	0.5	2	0.5
<b>2b</b>	14.2	42	13.5	1.5	5	1.5	1.2	4	1.1
<b>3</b>	15.6	32	11.0	1.5	3	1.1	1.0	2	0.7
<b>4</b>	100.6	197	66.4	10.0	21	6.7	6.0	13	4.0
<b>5</b>	2.5	6	2.1	0.2	1	0.2	0.2	0	0.1
<b>6</b>	5.8	12	4.1	0.5	1	0.4	0.4	1	0.3
<b>7</b>	8.0	13	4.2	0.8	1	0.4	0.5	1	0.3
<b>8</b>	2.5	8	2.6	0.3	1	0.3	0.1	0	0.1
<b>9</b>	0.8	2	0.6	0.1	0	0.1	0.03	0	0.02

Estimating benefit costs ratios for each scenario considered was difficult due the difficulties establishing a precise cost for the fitment of new technologies to vehicles or the cost of alternative vehicle selections. Technology fitment costs will inevitably vary between vehicles and will reduce over time as the technology becomes more prevalent. Table 2 presents estimates of the maximum additional expenditure per vehicle that can be made to achieve a cost benefit ratio of 1 for fitting the technology to the eligible vehicle fleet or making an alternative vehicle choice.

**Table 2: Per vehicle savings in societal crash costs as a whole from alternative fleet purchasing policies when compared to the baseline scenario**

Fleet	Corporate Metropolitan		Corporate Rural		Government	
	Number of affected vehicles	Gross savings per vehicle	Number of affected vehicles	Gross savings per vehicle	Number of affected vehicles	Gross savings per vehicle
<b>1</b>	29,095	\$1,638	4,935	\$792	2,880	\$1,072
<b>2a</b>	6,077	\$778	738	\$1,125	456	\$1,016
<b>2b</b>	6,077	\$2,341	738	\$2,020	456	\$2,627
<b>3</b>	31,000	\$503	5,417	\$285	3,099	\$307
<b>4</b>	31,000	\$3,248	5,417	\$1,840	3,099	\$1,952
<b>5</b>	31,000	\$83	5,417	\$47	3,099	\$54
<b>6</b>	31,000	\$188	5,417	\$106	3,099	\$117
<b>7</b>	31,000	\$261	5,417	\$147	3,099	\$159
<b>8</b>	11,597	\$223	2,381	\$133	922	\$153
<b>9</b>	5,455	\$160	1,215	\$109	376	\$82

Table 2 shows that;

- Significant amounts can be invested in forward collision detection and mitigation technologies provided they operate at all travel speeds.
- Lower but still significant amounts can also be invested in improving vehicle crashworthiness and lowering the aggressivity of the corporate SUV fleet. Although these scenarios can often be achieved at no or little extra cost, the analysis provides the basis for a potential direct or indirect incentive to be considered to help achieve the potential benefits estimated.
- Expenditure on other technologies can be very small before the point of diminishing returns is reached so clever strategies need to be considered to get these technologies into vehicles at minimal cost. These might include encouraging competition between manufacturers through consumer programs to ensure the technologies are included as standard.

### **General Implications of the Research**

This research has established a data system and analysis framework to which vehicle safety policy and strategy options in W.A. can be applied in the future to establish their likely effectiveness and relative worth.

Forward collision detection and mitigation technologies that operate at all speeds is the technology of those considered that offers the highest potential for reducing serious trauma and community costs in W.A.. Promoting the uptake of this technology through consumer information programs and potentially the use of incentives should be a priority. Many of the forward collision detection and mitigation systems currently available only operate at low speeds. Manufacturers should be encouraged to prioritise development of systems that work at all speeds. On-going evaluation of the real world effectiveness of forward collision detection and mitigation systems is also



recommended since current evidence of real world performance of these systems is limited.

Low cost mechanisms to increase fitment of other vehicle safety technologies should be investigated. This could include the enhanced use of consumer programs such as ANCAP to encourage manufacturer competition to fit vehicle safety technologies as standard.

A general recommendation from this study is that fleet buyers choose the most crashworthy model in their price range and choose large vehicles over large and medium SUVs where possible. Further analysis found, with the exception of some market groups, the most crashworthy model in a market group was actually less expensive than the present market group averages and that the least aggressive large and medium SUV vehicles were also less expensive than the market group average medium and large SUVs. The most crashworthy vehicle will also give savings directly to fleet buyers in the form of reduced injury costs to occupants of the 2012-registered vehicle. Support may be provided through more vigorous promotion of vehicle safety consumer information including: ANCAP and the Used Car Safety Ratings (including the aggressivity metric) and the ANCAP pedestrian protection test, amongst fleet and private vehicle purchasers. The use of incentives either directly or through varied injury insurance premiums to encourage the purchase of more crashworthy vehicle could be considered.

It is recognised that light commercial vehicles and to some degree SUVs in W.A. are purchased for a particular purpose so could not be substituted for less aggressive market groups. However, the impact of these vehicles and vehicles from other market groups, on other road users may be improved beyond that achieved through substitution with the most crashworthy model. If models with ESC, SCA, or forward collision warning, fatigue management, lane change or lane departure warning systems were available within an additional present value cost equal to or less than the fleet buyer break-even cost, then it is recommended that fleet buyers purchase these technologies because additional savings to society would be possible without additional expense to fleet buyers.

Finally, in making less aggressive and safer vehicle purchase choices, fleet buyers create a safer and less aggressive fleet, which when transferred to the private sector, gives private buyers of second hand vehicles a wider range of more crashworthy and less aggressive choices, further contributing to the reduction of crash costs to society.

## References

- Bureau of Infrastructure, Transport and Regional Economics [BITRE], (2009), *Road crash costs in Australia 2006*, Report 118, Canberra, November.
- Budd,L., Newstead,S. & Scully,J. (2013) *Modelling the Road Trauma Effects of Potential Vehicle Safety Improvements in the Western Australian Light Passenger Vehicle Fleet*. C-MARC Report, School of Public Health, Curtin University
- Newstead, S., Scully, J., Becker, L. & Delaney, A. (2007) *Safer vehicle purchases: developing cost/benefit estimates for fleet managers and others – Project Summary Report*. Austroads Research Report AP-R323-08.

- Newstead, S., Scully, J., Becker, L. & Delaney, A. (2007) *Safer vehicle purchases: developing cost/benefit estimates for fleet managers and others – Part A- Crash Profiles and Risk Estimates*. Austroads Research Report AP-R324-08.
- Newstead, S., Scully, J., Becker, L. & Delaney, A. (2007) *Safer vehicle purchases: developing cost/benefit estimates for fleet managers and others – Part B- Injury Levels in Crashes*. Austroads Research Report AP-R325-08.
- Newstead, S., Scully, J., Becker, L. & Delaney, A. (2007) *Safer vehicle purchases: developing cost/benefit estimates for fleet managers and others – Part C- Cost of Injuries and Property Damage in Crashes*. Austroads Research Report AP-R326-08.
- Newstead, S., Scully, J., Becker, L. & Delaney, A. (2007) *Safer vehicle purchases: developing cost/benefit estimates for fleet managers and others – Part D- Injury reductions With Various Fleet Purchasing Policies*. Austroads Research Report AP-R327-08.
- Newstead, S., Watson, L. & Cameron, M. (2012) *Vehicle safety ratings estimated from police reported crash data: 2012 update*. Australian and New Zealand crashes during 1987-2010, Monash University Accident Research Centre, Report No. 313
- Road Safety Council (2001). *Road safety in the workplace: A road safety manual for all employers*. Available at:  
<http://www.officeofroadsafety.wa.gov.au/documents/workplace%20manual.swf>.