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Modelling the Road Trauma Effects of Potential Vehicle Safety Improvements in the Western Australian Light Passenger Vehicle Fleet:

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Abstract

This project profiles 2006-2009 crash data and 2006-2012 registrations for West Australian passenger vehicles by fleet type: metropolitan corporate, rural corporate, government and private. It also projects crashes and occupant injuries by road user, for the 2012 registered new vehicles over 22 years as a baseline for evaluating different fleet purchasing scenarios.

The WA corporate and government fleet was found to have an over representation of aggressive vehicle market groups and to be growing in proportion of all registrations. The safety implications for both for the fleet drivers and the general public on transfer to private ownership were addressed by evaluating alternative vehicle purchasing scenarios.

The best outcome in terms of reductions in the societal cost of crashes and occupant injuries was found with the scenario which mandated 100% fitment of forward collision and autonomous emergency braking systems operating at all speeds to fleet vehicles. This scenario produced societal savings of \$117 million and prevented serious and fatal injuries to over 200 road users.

The best outcomes that came within fleet buyer break-even costs were vehicle substitution scenarios. Purchasing of large vehicles instead of medium and large SUVs in metropolitan areas and medium SUVs instead of large SUVs in rural areas, not only was estimated to save society \$17 million in crash related costs but also was estimated to be purchased for less than corporate and government fleets under current purchasing practices.

Keywords

Safety features, new cars, evaluation, fleet, accident analysis, corporate, government , Western Australia, scenarios, projections, statistical analysis, economic analysis

Disclaimer

This report is disseminated in the interest of information exchange. The views expressed here are those of the authors and not necessarily those of Curtin University or Monash University.

Preface

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Contribution Statement

| | |
|-----------------|---|
| Laurie Budd | Data preparation and analysis, study design, preparation of report manuscript |
| Stuart Newstead | Project management, study concept and design and manuscript review. |
| Jim Scully | Study design and preparation of report manuscript |

Ethics Statement:

Ethics approval was not required for this project.

Contents

| | |
|--|-----------|
| 1.0 INTRODUCTION | 1 |
| 1.1 SCOPE..... | 1 |
| 1.2 SAFETY TECHNOLOGIES AND PURCHASING POLICY SCENARIOS CONSIDERED | 2 |
| 2.0 DATA SOURCES AND MANAGEMENT | 6 |
| 2.1 REGISTRATION DATA | 6 |
| 2.1.1 Identification of fleet vehicles and vehicles entering and departing from the government or commercial fleets | 8 |
| 2.1.2 Identification of Vehicle Details..... | 8 |
| 2.1.3 Vehicle safety measures | 9 |
| 2.2 CRASH DATA | 10 |
| 3.0 PROFILE OF WA REGISTERED VEHICLES..... | 12 |
| 3.1 SIZE OF FLEET | 12 |
| 3.2 TRENDS IN MARKET GROUP DISTRIBUTION | 13 |
| 3.3 VEHICLE AGE | 16 |
| 3.4 VEHICLE CRASHWORTHINESS, AGGRESSIVITY AND TOTAL SAFETY RATING | 17 |
| 3.5 VEHICLE SCRAPPAGE AND TRANSFER | 21 |
| 3.6 PROFILE OF NEW VEHICLES REGISTERED IN 2012 | 22 |
| 4.0 WA CRASH DATA PROFILE | 24 |
| 5.0 METHODOLOGY FOR ESTIMATING BENEFITS OF SAFER VEHICLE PURCHASING SCEANRIOS..... | 27 |
| 5.1 SCENARIOS CONSIDERED..... | 28 |
| 6.0 NEW 2012-REGISTERED - VEHICLE PROJECTION RESULTS..... | 31 |
| 6.1 NUMBER OF REGISTERED VEHICLES..... | 31 |
| 6.2 NUMBER OF CRASHED VEHICLES | 32 |
| 6.3 NUMBER OF SERIOUS INJURIES | 33 |
| 7.0 BASELINE COST ESTIMATES OF FLEET AND PROJECTED INJURY AND CRASH COUNTS | 34 |
| 7.1 CRASH COSTS OF THE BASELINE SCENARIO..... | 34 |
| 8.0 CRASH SAVING DIFFERENTIALS FROM BASELINE FOR SCENARIOS | 36 |
| 9.0 BREAK-EVEN COSTS | 39 |
| 10.0 SUMMARY AND IMPLICATIONS | 41 |
| 10.1 IMPLICATIONS OF THE RESEARCH | 46 |
| 11.0 REFERENCES | 48 |

Figures

| | |
|---|----|
| FIGURE 1 PROPORTION OF TOTAL PASSENGER VEHICLE REGISTRATION REPRESENTED BY CORPORATE VEHICLE TYPE | 12 |
| FIGURE 2A LIGHT COMMERCIAL VEHICLES AS A PROPORTION OF THE PRIVATE, GOVERNMENT AND CORPORATE PASSENGER VEHICLE REGISTRATIONS | 13 |
| FIGURE 2B LIGHT, SMALL, MEDIUM AND LARGE VEHICLES AS A PROPORTION OF THE PRIVATE, GOVERNMENT AND CORPORATE PASSENGER VEHICLE REGISTRATIONS (EXCL. LCV)..... | 14 |
| FIGURE 2C COMPACT, MEDIUM AND LARGE SPORS UTILITY VEHICLES AS A PROPORTION OF THE PRIVATE, GOVERNMENT AND CORPORATE PASSENGER VEHICLE REGISTRATIONS (EXCL. LCV)..... | 15 |
| FIGURE 2D PEOPLE MOVERS AS A PROPORTION OF THE PRIVATE, GOVERNMENT AND CORPORATE REGISTRATIONS (EXCL. LCV) | 15 |
| FIGURE 3 AGE PROFILES OF NON-COMMERCIAL, GOVERNMENT AND COMMERCIAL FLEET..... | 17 |
| FIGURE 4 AVERAGE CRASHWORTHINESS BY PRIVATE, GOVERNMENT AND CORPORATE FLEET..... | 18 |
| FIGURE 5 AVERAGE AGGRESSIVITY BY PRIVATE, GOVERNMENT AND CORPORATE FLEET FOR VEHICLES WITH >1982 YEAR OF MANUFACTURE | 19 |
| FIGURE 6 AVERAGE TOTAL SAFETY RATING BY PRIVATE, GOVERNMENT AND CORPORATE FLEET FOR VEHICLES WITH >1982 YEAR OF MANUFACTURE | 20 |
| FIGURE 7 SCRAPPAGE RATES BY AGE OF REGISTERED PASSENGER VEHICLE, AND FLEET TYPE FOR THE 12/2008 SNAPSHOT, INCLUDING VANS AND UTILITIES. | 21 |
| FIGURE 8 ESTIMATEDTRANSFER RATES OF CORPORATE AND GOVERNMENT VEHICLES TO THE PRIVATE FLEET, FOR 2007 AND 2008 VEHICLE REGISTRATIONS | 22 |
| FIGURE 9 CRASH RISK PER REGISTERED VEHICLE BY FLEET TYPE AND CRASH YEAR, 2007-2009 | 24 |
| FIGURE 10 DISTRIBUTION OF DRIVER INJURY RISK BY FLEET TYPE, 2006-2009 | 25 |
| FIGURE 11 DISTRIBUTION OF SERIOUS INJURY RISK BY FLEET TYPE, 2006-2009 | 25 |
| FIGURE 12 NUMBER OF 2012-REGISTERED VEHICLES AT THE BEGINNING OF EACH CALENDAR YEAR BY FLEET STATUS..... | 31 |
| FIGURE 13 NUMBER OF 2012-REGISTERED VEHICLES INVOLVED IN CRASHES IN EACH YEAR IN THE PERIOD 2012-2034 BY FLEET STATUS | 32 |
| FIGURE 14 ESTIMATION OF THE NUMBER OF SERIOUSLY OR FATALLY INJURED ROAD USERS FROM CRASHES INVOLVING 2012-REGISTERED VEHICLES BY THE FLEET STATUS OF THE 2012-REGISTERED VEHICLE . | 33 |
| FIGURE 15 PROPORTION OF TOTAL COST (\$645M) DUE TO CRASHES OCCURRING DURING THE PERIOD 2012-2034 THAT INVOLVED 2012-REGISTERED VEHICLES BY FLEET STATUS AND CRASH/INJURY SEVERITY | 34 |
| FIGURE 16 PROPORTION OF TOTAL COST (\$645M) DUE TO CRASHES OCCURRING DURING THE PERIOD 2012-2034 THAT INVOLVED 2012-REGISTERED VEHICLES BY FLEET STATUS AND WHETHER THE INJURED OCCUPANT WAS AN OCCUPANT OF THE 2012-REGISTERED VEHICLE | 35 |

Tables

| | |
|---|----|
| TABLE 1 : REGISTRATION FLEET DATABASE VARIABLES | 7 |
| TABLE 2 : MARKET GROUPS WITH POSSIBLE BODY TYPE..... | 9 |
| TABLE 3 : REGISTERED PASSENGER FLEET AT CENSUS DATES -BY PERCENTAGE OF OWNERSHIP | 12 |
| TABLE 4 : TOTAL 2012 NEW PASSENGER VEHICLE REGISTRATIONS BY MARKET GROUP | 23 |
| TABLE 5 : SUMMARY OF THE SAVINGS ASSOCIATED WITH EACH OF THE ALTERNATIVE FLEET PURCHASING SCENARIOS THAT WERE ESTIMATED OVER THE USEFUL LIVES OF THE 2012-PURCHASED METROPOLITAN CORPORATE FLEET VEHICLES | 36 |
| TABLE 6 : SUMMARY OF THE SAVINGS ASSOCIATED WITH EACH OF THE ALTERNATIVE FLEET PURCHASING SCENARIOS THAT WERE ESTIMATED OVER THE USEFUL LIVES OF THE 2012-PURCHASED RURAL CORPORATE FLEET VEHICLES..... | 37 |
| TABLE 7 : SUMMARY OF THE SAVINGS ASSOCIATED WITH EACH OF THE ALTERNATIVE FLEET PURCHASING SCENARIOS THAT WERE ESTIMATED OVER THE USEFUL LIVES OF THE 2012-PURCHASED GOVERNMENT FLEET VEHICLES | 37 |
| TABLE 8 : GROSS AVERAGE PER VEHICLE SAVINGS IN SOCIETAL CRASH COSTS AS A WHOLE FROM ALTERNATIVE FLEET PURCHASING POLICIES WHEN COMPARED TO THE BASELINE SCENARIO | 39 |
| TABLE 9 : ESTIMATED SAVINGS IN COMMUNITY SOCIAL COSTS ASSOCIATED WITH EACH ALTERNATIVE FLEET PURCHASING SCENARIO OVER THE USEFUL LIVES OF THE 2012-PURCHASED FLEET VEHICLES..... | 44 |
| TABLE 10 : PER VEHICLE SAVINGS IN SOCIETAL CRASH COSTS AS A WHOLE FROM ALTERNATIVE FLEET PURCHASING POLICIES WHEN COMPARED TO THE BASELINE SCENARIO | 45 |

EXECUTIVE SUMMARY

The aim of this study was to profile registered vehicles and crash data from 2006-2012 for West Australian passenger vehicles by fleet type: metropolitan corporate, rural corporate, government and private. It also aimed to construct a model to project crashes and occupant injuries by road user for the 2012 registered cohort of new light passenger and commercial vehicles over 22 years as a baseline upon which to evaluate different fleet purchasing scenarios.

Stage 1 of the study profiled WA passenger vehicle registrations from 2006 to 2012 and WA passenger vehicle crashes from 2006 to 2009. 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 has been disproportionately greater for corporate and government fleet vehicles. From December 2008 to March 2012 the proportion of metropolitan corporate fleet vehicles grew from 7 to 12%, the proportion of rural corporate vehicles increased by 1% unit and the proportion that were government fleet vehicles more than doubled.

With greater proportions of new government and corporate vehicles becoming registered, the average age of these vehicles was observed to decrease, so, newer and generally safer vehicles are trending to make up a larger proportion of the corporate and government fleets. However, a trend for increasing average age in rural corporate SUVs was observed, indicating that proportionally fewer new vehicles are entering this market group sector. In general, more aggressive market groups were held onto by the corporate fleet for longer periods. These trends result in potentially less safe light commercials and SUVs in corporate fleets; particularly in the rural corporate fleet.

Government and corporate fleet vehicles in WA currently consist of greater proportions of vehicles from aggressive market groups compared to the private vehicle fleet. In March 2012, these SUVs and light commercial vehicles 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. In 2012, new vehicles from aggressive market groups continued to be purchased in large proportions for the corporate and government fleets. The flow on effect of the more aggressive corporate and government fleet is that greater proportions of vehicles from aggressive market groups are entering the private fleet when they are transferred from corporate or government ownership. Thus the large proportions of aggressive market groups in the corporate and government fleets are not only a concern for fleet buyers, but also for society in general as these vehicles transfer to private ownership. When involved in crashes, higher aggressivity vehicles put the occupants of the other vehicle and unprotected road users at higher risks of serious injury. Thus, the large increasing proportions of more aggressive market groups in the corporate and government fleets is of concern because of the injury and cost of injury burden it places on society.

Generally fleet buyers were found not to purchase the most crashworthy vehicles available within the market groups chosen. In metropolitan corporate fleets the most crashworthy model in 2012 amounted to 7% of utility, 6% of van 16% of large vehicle, 0.05% of medium vehicle, 0.1% of small vehicle, 11% of light vehicle, 73% of people mover, 3% of compact SUV, 1% of medium SUV and 9% of large SUV purchases. With the exception of

people movers, there was significant room for improvement in the safety of fleet vehicles purchased.

Corporate and government fleet vehicles experienced a substantially higher crash risk per registered vehicle than private vehicles in WA 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 safety technology. The observed higher crash risk per registered vehicle is most likely due to greater travel exposure by corporate and government fleet vehicles compared to private vehicles in W.A.

Metropolitan corporate utilities and vans pose a more serious crash risk to other road users than do privately owned utilities and vans, relative to the rest of their respective fleets. Metropolitan corporate, relative to private, vehicle crash risk was highest for utilities and vans. At 1.8, it was higher than the 1.5 times relative crash risk obtained for SUVs and other passenger vehicles. When comparing metropolitan corporate vehicle crashes to private vehicle crashes by crash type and broad market group, metropolitan corporate utilities and vans were found to be more likely to be in a rear-end crash, more likely to be in a crash with a heavy vehicle, more likely to be in a fatal and serious injury crash and more likely to be in a fatal and serious injury head on crash. Driver injuries in rural corporate crashes are more likely to be serious than for metropolitan corporate or private injury crashes. Because of the more aggressive composition of corporate and government fleets, they do not pose a higher risk of any driver injury compared to the private fleet. However, once a driver injury is reported, the risk of the driver injury serious or fatal tended to be greater in the rural corporate fleet than in the metropolitan corporate or private fleets. Rural corporate SUVs, vans and utilities had a higher percentage of roll-over crashes than their private counter parts. 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 some crash types. They had a higher than expected percentage of roll-over crashes, proportionally more *hit object* crash types and were over-represented in crashes with heavy vehicles.

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 WA 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 new technologies that specifically targeted the most frequent crash types in WA. Forward collision warning systems with autonomous braking intervention were proposed 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.

Before proposed scenarios were evaluated, a baseline model was presented 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) the future year of the crash; and
- v) 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);

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.

This 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.

This model demonstrated that approximately half of the serious and fatal injuries, from crashes involving these vehicles over the 22 year period, could be attributed to occupants of the 2012 registered vehicle, the remainder being sustained by the collision partner. Approximately 70% of the proposed crashes were *property damage-only* crashes regardless of the vehicle's original or current fleet type. The baseline model of the 2012 new vehicle fleet estimated a lifetime total of 5,635 crashes and 2,320 injured occupants from crashes involving vehicles that were originally metropolitan corporate fleet vehicles, 571 crashes and 235 injured occupants involving vehicles that were originally rural corporate fleet vehicles and 359 crashes and 147 injured occupants from crashes involving vehicles that were originally government fleet vehicles. These figures indicate the relative size of each fleet and hence the relative importance to overall road trauma.

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. Approximately 14% of crash costs were attributable to *property damage-only* crashes and 16% of crash costs were attributable to the vehicle damage and general costs associated with injury crashes. The remaining 70% of costs were associated directly with the human costs of injuries to occupants and other road users involved in the crashes: 67% serious and fatal injury costs and 3% minor injury costs. Total crash costs amassed over the 22 years to \$247 million dollars for vehicles that were originally metropolitan corporate and to \$24 million for originally rural corporate vehicles and \$15 million from vehicles that were originally registered to government. 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 human cost of minor injuries.

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 SUVs with large vehicles and rural large SUVs with medium SUVs
 - A. Using a fleet average vehicle for the market group
 - B. Using the least aggressive model in the market group
3. Fitment of active forward collision detection and intervention operational at speeds of 80 km/h and greater
4. Fitment of active forward collision detection and intervention 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

Table E1 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. It also gives the expected number of savings in deaths and serious injuries for the cohort over its lifetime and the community social costs specifically related to deaths and serious injuries.

Table E1: Estimated savings in community social costs associated with each alternative fleet purchasing scenario over the useful lives of the 2012-purchased fleet vehicles

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

Results in Table E1 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 most effective 4 scenarios considered.

Estimating benefit costs ratios for each scenario considered was difficult due to the difficulties establishing a precise cost for the fitment of new technologies to vehicles. Fitment costs will inevitably vary between vehicles and will reduce over time as the technology becomes more prevalent. Table 10 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.

Table E2 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 | |
|-----------------|------------------------------------|----------------------------------|------------------------------------|----------------------------------|------------------------------------|----------------------------------|
| Scenario | Number of affected vehicles | Gross savings per vehicle | Number of affected vehicles | Gross savings per vehicle | Number of affected vehicles | Gross savings per vehicle |
| 1 | 29,095 | \$1,638 | 4,935 | \$792 | 2,880 | \$1,072 |
| 2a | 6,077 | \$778 | 738 | \$1,125 | 456 | \$1,016 |
| 2b | 6,077 | \$2,341 | 738 | \$2,020 | 456 | \$2,627 |
| 3 | 31,000 | \$503 | 5,417 | \$285 | 3,099 | \$307 |
| 4 | 31,000 | \$3,248 | 5,417 | \$1,840 | 3,099 | \$1,952 |
| 5 | 31,000 | \$83 | 5,417 | \$47 | 3,099 | \$54 |
| 6 | 31,000 | \$188 | 5,417 | \$106 | 3,099 | \$117 |
| 7 | 31,000 | \$261 | 5,417 | \$147 | 3,099 | \$159 |
| 8 | 11,597 | \$223 | 2,381 | \$133 | 922 | \$153 |
| 9 | 5,455 | \$160 | 1,215 | \$109 | 376 | \$82 |

Table E2 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 a 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.

1.0 INTRODUCTION

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 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. It builds on the 2008 level of road safety activity and investment with a range of additional road safety initiatives spread across the strategy's four cornerstones of Safe Road Use, Safe Roads and Roadsides, Safe Speeds and Safe Vehicles.

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.
- Promoting the community take-up of safer vehicles and vehicle safety features.

In a report for Austroads, Newstead, Scully, Becker & Delaney (2007) quantified the economic and safety benefits that may be obtained through the adoption of safe vehicle purchasing policies for light passenger vehicles and light commercial vehicles by fleet managers. Analysis was based on injury outcomes in real world crashes related to vehicle design and specification derived under the Monash University Accident Research Centre's (MUARCs) Used Car Safety Ratings program. The Austroads study identified several realistic safer fleet purchasing policies that were estimated to result in significant road trauma savings to both fleet owners and the wider community. The report demonstrated that if government and commercial fleet buyers were encouraged to buy safer vehicles, they would directly reap the benefits as well as the benefits flowing on to the wider community when those vehicles were passed on second hand. The potential benefits accrued by the wider community in Western Australia are significant given that 60% of new vehicles are purchased for business purposes (Road Safety Council, 2001).

The purpose of this project was to quantify safety benefits that may be obtained through the adoption of alternative vehicle purchasing practices in Western Australia. In particular the project has considered the extent to which the adoption of alternative vehicle purchasing practices by fleet managers in Western Australia will benefit the owners of commercial and government fleets as well as the wider community once fleet vehicles pass into private ownership.

1.1 SCOPE

There are several reasons why it is of particular interest to look at the benefits for Western Australia in isolation to other Australian states. Firstly, the passenger vehicle fleet in Western Australia is different to that of other States. For example, a greater proportion of the Western Australian passenger vehicle fleet is made up of Four Wheel Drive vehicles than for other states. Interrogation of the Australian Bureau of Statistics' (2008) Sales of New Motor Vehicle data reveals that in the period 2003-2007, Four Wheel Drive vehicles accounted for 19.4% of vehicles sold in Western Australia, compared with 17.9% when all Australian states are considered. Furthermore, Scully & Newstead (2007) estimated that 11.5% of vehicles purchased since 1997 in Western Australia that were involved in crashes in which the driver was injured were Four Wheel Drive vehicles, compared with 8.2% of

vehicles for all Australian states. Secondly, the potential for the Western Australian fleet to change over the coming years given a shift in vehicle purchasing practices is greater than that of most other states. The Australian Bureau of Statistics' (2008) Motor Vehicle Census reported that the average annual growth of the registered fleet in Western Australia in the period 2003 to 2008 was 4%, compared with a 3% average for Australia. Furthermore, the way commercial and government fleet vehicles are driven in Western Australia differ to the way they are driven in other states, which means the requirements of fleet buyers in Western Australia differ to those of other states. This is also true of the way all vehicles including private vehicles are driven: differences in traffic density and road environment means that there are differences in the distribution of crashes that vehicles driven in Western Australia are involved in when compared to vehicles driven in other States. Interrogation of the Australian Transport Safety Bureau's (2009) Fatal Road Crash database revealed that 55.5% of fatalities in Western Australia were due to single vehicle crashes, compared with 48.5% when fatalities in all Australian jurisdictions were considered.

These factors affect what types of fleet purchasing strategies can be realistically applied in Western Australia as well as the level of benefit that can be expected from each strategy. The benefits of each strategy were measured against a baseline status quo situation where the fleet purchasing policies were presumed to remain unchanged from what has historically occurred in Western Australia. The benefits of each scenario were measured in terms of the number of serious injuries prevented and road trauma savings due to reductions in crash and injury costs to both owners of fleet vehicles specifically as well as the wider community.

1.2 SAFETY TECHNOLOGIES AND PURCHASING POLICY SCENARIOS CONSIDERED

This study estimated the expected road trauma savings under various scenarios where specific safety technologies or overall safety performance are mandated in fleet purchases of light passenger vehicles or light commercial vehicles. There are two ways in which safety features can reduce the burden of injury associated with vehicles. Firstly, primary safety features reduce the risk of a vehicle becoming involved in a crash. Examples of primary safety features include Electronic Stability Control, Anti-lock braking systems and Intelligent Speed Adaptation. The other way that safety features can reduce the burden of injury is by preventing injuries or reducing the severity of injuries when a crash occurs. These safety features are called secondary safety features and airbags, safety belt pretensioners and child car restraints are common examples. Primary safety features reduce crash risk, while secondary safety features reduce the severity of injuries, or reduce the risk of injury, when a crash occurs. Different primary and secondary safety features will be effective in different types of crashes. For example, side airbags will not provide any additional protection to occupants in head-on impacts, but they will provide decreased risk of serious injury in side impacts or rollover crashes.

It was possible, using the model developed in this study, to evaluate the effect of any primary safety feature and secondary safety feature pair provided that: for the primary feature, there are available data on the likely crash risk reductions associated with the primary safety feature and the crash types to which the estimated reduction applies; and for the secondary safety feature, the types of crashes in which the safety feature will provide some protection to the occupant and the magnitude of this protection in terms of reduction in (serious) injury risk. To compare the difference between a fleet purchasing policy in

which each safety feature is always chosen when it is available in the particular model range to the status quo in terms of fleet purchasing practices, fitment rates and availability rates for each safety feature are also required. For many safety features these data are not readily available so different scenarios of fitment rate need to be considered. The following lists the primary and secondary safety features where there is good scientific evidence of the effectiveness of the feature hence warranting the feature being considered in scenarios within this study.

- Established technologies
 - Electronic Stability Control (ESC) for light commercial vehicles (ESC is already mandated for regular passenger cars and SUVs)
 - Side Curtain Airbags
- Emerging technologies
 - Forward Collision Warning
 - Forward Collision Warning and Avoidance (Autonomous Emergency Braking)
 - Emergency Brake Assist
 - Blind spot / lane change warning
 - Lane departure warning
 - Fatigue warning

Anderson(2010) evaluates the likely relative benefits of the emerging vehicle safety technologies included in the above list using New South Wales (NSW) police reported crash data from 1999-2008. The report also describes the technology and cites other evaluations of their effectiveness. The technologies chosen in the list were considered to have the most potential for crash and injury reduction and because they were found to be relevant to the reduction of crash types predominant in Western Australian. A full description of the technologies is given in the full technical report on this study.

Literature on fleet purchasing policies is limited. Furthermore, evaluations of the effectiveness of different policies are scarce. The review of fleet safety in Australia by Murray, Newman, Watson, Davey & Shonfeld (2002) revealed that the fleet safety literature and examples of fleet policies in the literature are very much focused on improving the safety culture of a workplace and encouraging safe driving practices among workers. When describing the fleet policy of companies that are good performers in terms of fleet safety, there was very little mention of company policy towards the purchasing of safer vehicles. This could be partly because many of the companies participating in the study by Murray, Newman et al. (2002) were concerned with the safety of their heavy vehicle fleet and that the crashworthiness of vehicles in their fleet was perceived to be of less relevance to their fleet safety problems than eliminating unsafe driving practices through driver training and education. Other reviews of fleet safety policies by Haworth, Tingvall & Kowadlo (2000) and the Western Australia Road Safety Council (2001) also showed that many existing fleet policies focus on driver training and education and have limited emphasis on fleet purchasing practices. This is despite research by Haworth et al. (2000) that stressed that purchasing safer vehicles is an important component to improving the safety of Australian fleets.

It may be true that vehicle purchasing practices have received less attention than the promotion of improved safety culture among employees and drivers, but the selection of safer vehicles has not been ignored entirely. In fact, Murray et al. (2002) note that New Zealand, NSW, Queensland and Western Australia all have sections on the selection of

safe vehicles in the resources they provide to help fleet managers develop greater safety within their fleets. Furthermore, the Victorian Government's Whole-of-Government Standard Motor Vehicle Policy (Allen, Portnoi & L'Etang, 2004) recommends that if particular safety features, including side curtain airbags and Electronic Stability Control (ESC), are available, then they should be fitted to fleet vehicles purchased.

Road safety benefits of three broad classes of purchasing policies for light passenger vehicles and light commercial vehicles have been considered in this study:

Choosing safest vehicle in market group policy: These scenarios considered the selection of vehicles with the best overall safety performance within the types of vehicles currently purchased. These scenarios acknowledge the current utility of the vehicles purchased and hence consider the benefits of purchasing safer vehicles within the same market group.

Market group substitution scenarios: These scenarios acknowledge that often vehicles are purchased based on style and image rather than actual utility and hence examine the benefits of purchasing the safest vehicle within a different market group (for example, substituting Large SUVs for large cars).

Technology Purchase Scenarios: Consider the benefits of specifying vehicles with each of the vehicle technologies listed previously.

In formulating the scenarios around safest vehicle choices, there are several ways of rating the degree of injury protection different vehicles provide to occupants in a crash. The Australasian New Car Assessment Program (ANCAP) rates vehicles according to their performance in a series of crash tests with the latest scoring system also accounting for the presence of driver assist (crash avoidance) technologies. There are numerous difficulties in using ANCAP to assess potential fleet purchases, including problems involving the timing of ANCAP tests. The tendency for many fleet vehicles to be changed every two years and the fact that ANCAP only have limited testing programs per year, means that a new model may not be tested until quite some time after it is released. Furthermore, ANCAP only test a limited selection of vehicles and does not assess a vehicle's aggressivity towards the occupants of other vehicles which is important for minimising overall road trauma.

Because of these limitations it was decided that the ratings given to different makes and models of vehicles by Newstead, Watson & Cameron (2012) in their Used Car Safety Ratings report would be used to determine the safest vehicle in each class. As Newstead, Watson & Cameron's (2012) Used Car Safety Ratings also provides estimates of the both the crashworthiness and aggressivity of different makes and models towards other road users, the influence of purchasing decisions on the safety of all road users can be assessed. Newstead & Cameron (1999) provide evidence that those cars that score well in ANCAP crash tests also perform well in real life crashes. Choosing the most-crashworthy vehicle in a market group category was previously used by Newstead, Delaney et al. (2004) as a scenario for determining the mix of vehicles in the Australian light passenger fleet that would optimise secondary safety outcomes. Choosing the most-crashworthy vehicle in a market group category was also previously used by Newstead (2007) in the scenarios developed in the Austroads 'Safer Vehicle Purchases' study.

Each of the scenarios formulated applies to new vehicles entering the fleet. In order to assess the road safety benefits of each scenario, they were applied to the set of new vehicles entering the Western Australian fleet in 2012. This cohort was used as a basis for

modelling since the cohort was the most recent available and likely to be representative of future Western Australian new vehicle cohorts. In addition, detailed information on the cohort and its safety performance were readily available from the Western Australian vehicle register. Analysis estimated the road trauma savings associated with each scenario considered across the predicted lifetime the cohort was registered in the WA fleet.

The study was conducted in a number of key stages:

1. Describe current status of the WA light passenger vehicle fleet and crashes in WA:
 - a. Describe the profile of vehicles in the WA fleet and how this has changed over time
 - b. Describe the profile of crashes in which each vehicle class is involved and how this has changed over time
2. Construct a model to describe the primary and secondary safety profile of a cohort of vehicles in the WA fleet from the time the cohort enters the fleet until the time each vehicle is scrapped.
3. Apply the model to the 2012 WA new vehicle cohort and predict the number of crashes and injuries likely in the cohort over its life based on past trends (the baseline scenario)
4. Apply the various purchasing scenarios to the base cohort to estimate cohort lifetime benefits in terms of crashes, injuries and crash costs saved. Where reliable scenario implementation costs are available, estimate the economic worth of each scenario.

This document summarises the key results from the study which are given in detail in a full technical report on the study. Reference is made to the full technical study where appropriate.

2.0 DATA SOURCES AND MANAGEMENT

2.1 REGISTRATION DATA

Data on the Western Australian registered vehicle fleet was provided by the WA Department of Transport. A snapshot from the vehicle register was taken at 30/12/2006, 1/1/2007, 1/1/2008, 30/12/2008 and 30/3/2012. This data contained: registration plate number, make, model, body, and VIN of the vehicle, postcode of registered owner and the date that the vehicle was first registered with these plates (this date does not change if the ownership of the vehicle is changed, but may change if registration has lapsed). Additional registration information, including fleet status, government ownership and hire and drive status was assembled for passenger vehicles and an attempt was made to simulate vehicle register snapshots by year for the years 2005 to 2010. This process proved difficult due to the structure of the provided data and the results were found not to reliably reflect a “snapshot”. Instead, the assembled information was merged onto actual snapshots (2006-2009) to provide information on vehicle fleet status required for analysis. The final snapshot (30/3/2012) was provided with the additional variables already merged. The resulting data was five snapshots of the WA vehicle register at distinct time points, each containing the 17 variables found in Table 1 . For privacy reasons, only the first 12 of the 17 digit Vehicle Identification Numbers (VINs) characters were provided. Cleaning of the data to identify errors and out of range values was carried out.

The snapshots were matched so that registration of individual vehicles could be tracked from snapshot to snapshot. Due to the truncated vehicle VIN and other technical problems detailed in Section 2 of the full project technical report not all vehicles in a snapshot could be allocated the additional variables required to identify fleet membership. 18% of the 30/12/2006 snapshot, 12% of the 21/1/2007, 13% of the 01/01/2008 and 9% of the 30/12/2008 snapshots could not be matched with the vehicle fleet membership variables. The 30/3/2012 snapshot was prepared with the same exclusions as the other snapshots which contained only the light passenger vehicle sub-set of the registered vehicle fleet.

Table 1 : Registration Fleet Database variables

| Variable | | | Values |
|---|--------------|--------|--|
| Year of Manufacture | | | |
| Make | | | |
| Model | | | |
| Vehicle Body Style | | | |
| Vehicle Identification Number | | | |
| Postcode of registered owner | | | |
| Registration Vehicle Plate | | | |
| Date Plates were first issued | | | |
| End of Registration Date | | | |
| Client Type | | | 0 body corporate organisations 1 individuals |
| Client Organisation Type Code | | | G government vehicles |
| Organisation Type | | | Owner has vehicles listed under coded entity B P and G for government and M R Z for others |
| Insurance Class Code | | | 3G Hire and Drive (e.g. AVIS, HERTZ) 02 Goods Vehicle 06 Trailers/Caravans 1A Motor Car 1B Social Services Vehicle 2F WA DoT did not disclose this category. 3A & 3B & 3E Omnibus Metro & Country & School (respectively) 3C & 3D Taxi Metro & Country (respectively) 3F Other Hire Vehicles 5C Tow Trucks 7A Motorcycles, Farm Vehicles, Veterans/Vintage, Fire Vehicle 7B & 8A Tractor Plant- class A , B and C 8B Mobile Cranes |
| Family Flag | | | Y-last registration renewal was paid at family rate (vehicle for private use) N- last registration was paid at the standard rate- business purposes (all government owned vehicles are in this group) |
| Vehicle Code | Registration | Status | CA cancelled EX expired NR new registration RG Registered RV Reversed SP Suspended SR Surrendered UN Unregistered |
| NHV category code for vehicles 4.5tonne and above | | | Presence of a code indicates it is a heavy vehicle |
| Vehicle Code | Registration | Type | Standard or Interstate/Federal |

2.1.1 Identification of fleet vehicles and vehicles entering and departing from the government or commercial fleets

Vehicles registered to government, corporations and private owners were identified through various variables in the WA vehicle register. 'Hire and Drive' vehicles were also identified and were made up of taxis and rental passenger vehicles (e.g. Hertz, Avis, Thrifty etc.).

Private vehicles were assumed to be those that were ***not*** owned by corporations and included privately owned vehicles registered at the business rate.

Commercial, non- government corporate fleet vehicles were identified with a value of 0 in the *Client Type* variable and no value in the *Client Organisation Type Code* variable. Privacy issues meant that vehicles owned by mining companies could not be identified; however, vehicles registered to corporate owners in rural areas could be identified. Novated lease vehicles could not be identified and were generally classified as private, appropriate given the lease is owned by the individual and not the corporation.

Government fleet vehicles were assumed to be fleet vehicles registered by a government agency, identified with a 'G' in the *Client Organisation Type Code* variable and a *Client Type* value of 0. Government.

Taxi (metropolitan and non-metropolitan) and Hire and Drive vehicles (e.g. Hertz, Avis, etc.) were identifiable by the *Insurance Class Code* variable. Taxis made up only a very small proportion of the corporate fleet.

Movement of a vehicle from corporate fleet to private ownership was indicated by a change in *Client Type* from 0 to 1 between annual snapshots. There were some limitations to this approach detailed in the full technical report on the project. A similar approach was used to identify movements to and from the government fleet. Date of plate issue (registration), for all vehicles, indicated time of entrance, or re-entrance of a vehicle into the registered fleet. The first entrance of the vehicle into the registered fleet for newly manufactured vehicles was identified when the year of manufacture matched the year of plate issue. A vehicle entering or re-entering the registered fleet as a second-hand vehicle had a plate issue year greater than the year of manufacture. A vehicle was considered to have departed the registered fleet when it no longer appeared in any of the following snapshots.

2.1.2 Identification of Vehicle Details

Vehicle model details were determined by decoding the 11 or 12 (for 2012 snapshot) digits of the Vehicle Identification Number recorded on the vehicle register using the Used Car Safety Ratings VIN decoding system. This procedure is described in detail in Cameron et al (1994). Only passenger vehicles manufactured within the periods 1982-2009 could be decoded into market groups in this manner with the existing software. A further decode, using additional syntax for the project was possible for this period for passenger vehicles with incomplete VIN information utilising make, model and year of manufacture from the register. Minor modifications were made to these decoding programs to extend the years of manufacture of vehicle models to include 2010-2012 and the years prior to 1982. Light passenger vehicles were categorised into market groups to match those used in the MUARC Used Car Safety Ratings (Newstead, Watson et al. 2012). This allowed subsequent matching of vehicle secondary safety estimates by market group where

required. These market groups are based on those used by the Federal Chamber of Automotive Industries (FCAI, www.fc.ai.com.au) and are shown in Table 2. Other similar methods were employed for passenger vehicles whose manufacture lay completely outside of the 1982-2009 manufacturing period and for non-passenger vehicles. The market group for these vehicles was determined using make, model, body type and year of manufacture of the vehicle. These variables were used to gather information on body size, number of cylinders, SUV status and weight of vehicle which, where possible, was used to classify the vehicle into a market group.

Table 2 : Market Groups with possible body type.

| Market Group | Description [†] | Body Types |
|---|---|--|
| Traditional Passenger Vehicles | | |
| SL Light | 3 or 4 cylinder engine, up to 1,500cc, tare mass <1150kg | Hatch, Sedan, coupe, convertible |
| S Small | 4-6 cylinder engine, 1500cc-2000cc, tare mass 1150-1350kg | Hatch, Sedan, coupe, convertible, station wagon, station sedan |
| M Medium | 4+ cylinder engine, 2001cc upward, tare mass 1350-1550kg | Hatch, Sedan, coupe, convertible, station wagon, station sedan |
| L Large | 6-8+ cylinder engine, tare mass >1550kg | Sedan, coupe, convertible, station wagon, station sedan |
| PM People Mover | Passenger seating capacity >5 people. 4-8 cylinders. | Vans, station sedans |
| Sports Utility Vehicles (Four Wheel Drive Vehicles with high ground clearance and generally a wagon with off road potential.) | | |
| SUVC- Compact | Index Rating <550, typically 1700kg tare mass | Station sedans |
| SUVM- Medium | Index Rating 550-700, typically 1700-2000kg tare mass | Station sedans |
| SUVL- Large | Index Rating >700, typically >2000kg tare mass | Station sedans |
| Light Commercial Vehicles (<3.5t) | | |
| CU -Utility | 2 and 4 wheel drive, normal control (bonnet), utility, cab chassis and crew cabs. | Utilities |
| CV -Van | Blind and window vans. | Vans, station wagon |

The age of a vehicle at the time of a snapshot was determined by the year of manufacture subtracted from the snapshot year. Postcode of the registered owner was used to classify registered owners as residing in Metropolitan Perth or in other parts of WA. Metropolitan postal box codes were assumed to belong to Metropolitan residents. Vehicles newly manufactured and newly registered for 2012 were defined as those present in the 30/3/2012 snapshot, with a year of manufacture of 2012 or 2011 and first registered in the 12 months from 1/4/2011 to 30/3/2012.

2.1.3 Vehicle safety measures

Measures of vehicle secondary safety performance were taken from the MUARC vehicle safety ratings of Newstead et al. (2012). They included:

- crashworthiness rating: a measure of the risk of death or serious injury to the driver of that vehicle when it is involved in a crash where a vehicle is towed away or someone is injured;
- aggressivity ratings: a measure of the serious injury rate for drivers of other vehicles and unprotected road users involved in collisions with vehicles from the given market group; and
- total safety rating: a measure of the combined crashworthiness and aggressivity performance of the vehicle with each component weighted by its relevance to the total injury burden.

There were 506 individual vehicle models with a crashworthiness rating and 458 with an aggressivity rating. Vehicles appearing in the crash and registration data were assigned each of these ratings by vehicle model where possible. For vehicle models manufactured from 1982 onwards without a specific rating, ratings by market groups and year of manufacture were assigned for vehicles manufactured from 1964 to 1981 and for vehicles with unknown market groups and year of manufacture from 1982 to 2010, ratings by year of manufacture were assigned. These represented the minority of cases in the data.

2.2 CRASH DATA

Western Australia Crash Data for the years 2005 to 2009 was provided by Main Roads Western Australian. This police reported crash data included all vehicles and road user types for crashes that resulted in death, injury or a vehicle being towed away. The data was reduced to just WA registered light passenger vehicles that were in crashes that resulted in death, injury or a vehicle being towed away. The data included information on both driver and other occupant injuries as well as property damage only crash information under two classifications: major (>\$1000) and minor (<\$1000). Each line of the crash data represented a road user unit. Units could be a motor vehicle, horse and cart, horse being ridden, motorised wheelchair, pedestrian or cyclist. Persons associated with a vehicle unit could only be the driver or passengers.

Passenger vehicles, heavy vehicles, unprotected road user vehicles, passengers and pedestrians were each identified as a unit within a crash enabling the types of road users involved in each passenger vehicle crash to be identified. This summary crash information was kept when the data was reduced to just passenger vehicle units. This included information such as the number of occupants in a vehicle and whether the crash was with a heavy vehicle, unprotected road user vehicle, passenger vehicle or pedestrian; or whether the crash involved a combination of these road user types. Single vehicle crashes were identified when only one vehicle unit was recorded for the crash. The crash was considered a tow-away crash if at least one of the crash road user vehicle units was towed away. Specific crash types were identified using several crash and unit based variables. Variables which identify crash features for all units within a crash include *RUM code*, *MRNature Code*, *MR Type Code* and *Non-Collision Accident Type*. Summary crash based information for road user injuries were kept for each passenger. Information on fatalities, serious injury and minor injury was available for each crashed unit: pedestrian, driver and passenger.

Once crash data was reduced to just passenger vehicle cases, registration data was merged onto crash data by plate, year of manufacture and 11 digit VIN. 16% of the passenger vehicles involved in police reported crashes could not be matched to registration data.

This is most likely due to missing data or the fact that the registration data is not from a snapshot available for the study. For injury outcome analysis related to the vehicle, the merged passenger vehicle crash data set was reduced to a consistent set of tow-away crashes. 66% of the merged unique passenger crashed vehicles were not involved in crashes where at least one vehicle required a tow. Unique crashed passenger vehicles involved in tow-away crashes totalled 9,882 in 2006, 18,039 in 2007, 17,859 in 2008 and 17,090 in 2009.

3.0 PROFILE OF WA REGISTERED VEHICLES

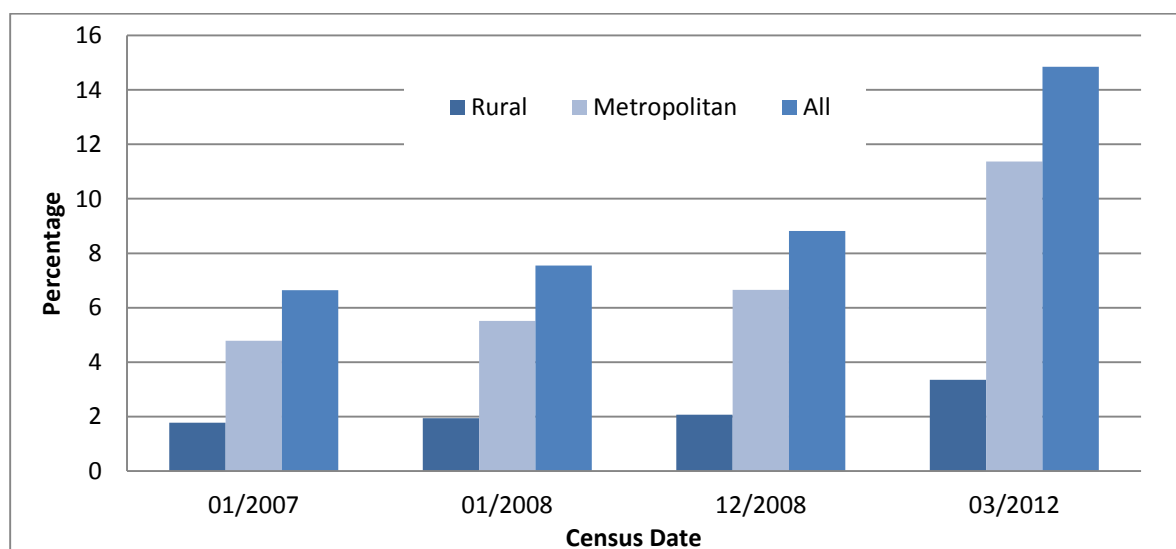
3.1 SIZE OF FLEET

The size of the WA registered passenger vehicle fleet over the four census dates is displayed in Table 3. Over the period, the proportion of passenger vehicles registered to corporate owners more than doubled and the proportion of government owned passenger vehicles also increased significantly although still remained a small proportion of the overall fleet.

Table 3 : Registered passenger fleet at Census Dates -by percentage of ownership

| | Census Date | | | |
|----------------------------------|-------------|-----------|-----------|------------|
| | Jan-07 | Jan-08 | Dec-08 | Mar-12 |
| Total Fleet | 1,473,759 | 1,561,070 | 1,598,742 | 1,894,213 |
| % Private | 93 | 92 | 91 | 84 |
| % Corporate | 6.6 | 7.5 | 8.8 | 15 |
| <i>Metropolitan</i> | 4.8 | 5.6 | 6.7 | 11.9 |
| <i>Rural</i> | 1.8 | 1.9 | 2.1 | 3.1 |
| % Government | 0.06 | 0.1 | 0.29 | 0.66 |
| % growth in registrations | | 5.92 | 2.4 | 18 (5.9pa) |

In addition to the corporate (commercial), government and private ownership categories, corporately owned vehicles were examined by location of owner. This was done in order to approximate the vehicles owned by rural and remote companies. Figure 1 shows a growing trend for rural and metropolitan corporately owned vehicles as a proportion of the total passenger vehicle fleet.



*Figure 1
Proportion of Total Passenger Vehicle Registration Represented by Corporate Vehicle Type*

Registrations of 'Hire and Drive' and Taxis were found to be increasing similarly but represented less than 1% of total registrations. It can be seen that Taxis represent a significant percentage of privately-owned business registered Hire and Drive vehicles and within this group they are increasing in proportion over the period.

3.2 TRENDS IN MARKET GROUP DISTRIBUTION

The following figure shows the distribution percentage representation of each vehicle market groups in each fleet by census year.

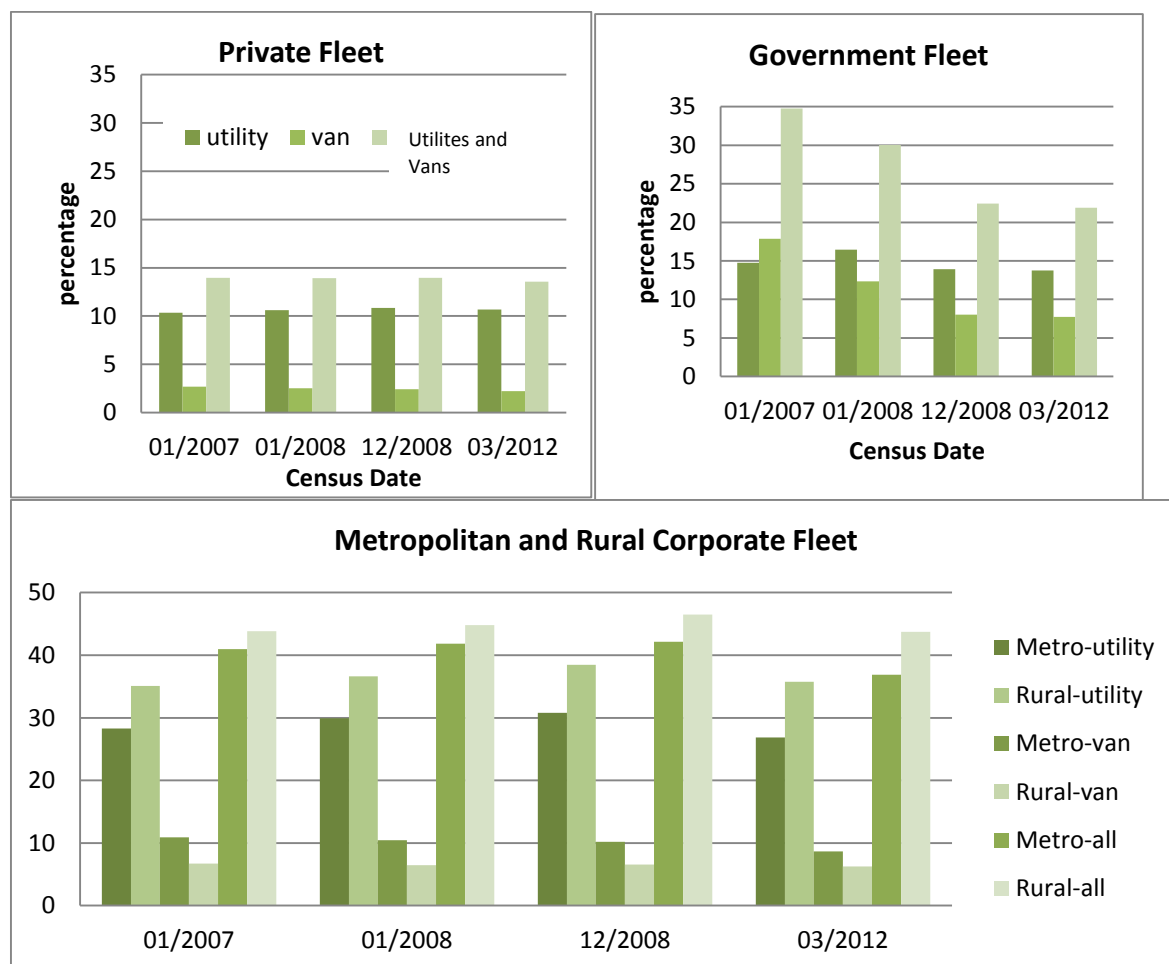


Figure 2a
Light Commercial vehicles as a proportion of the Private, Government and Corporate Passenger Vehicle Registrations

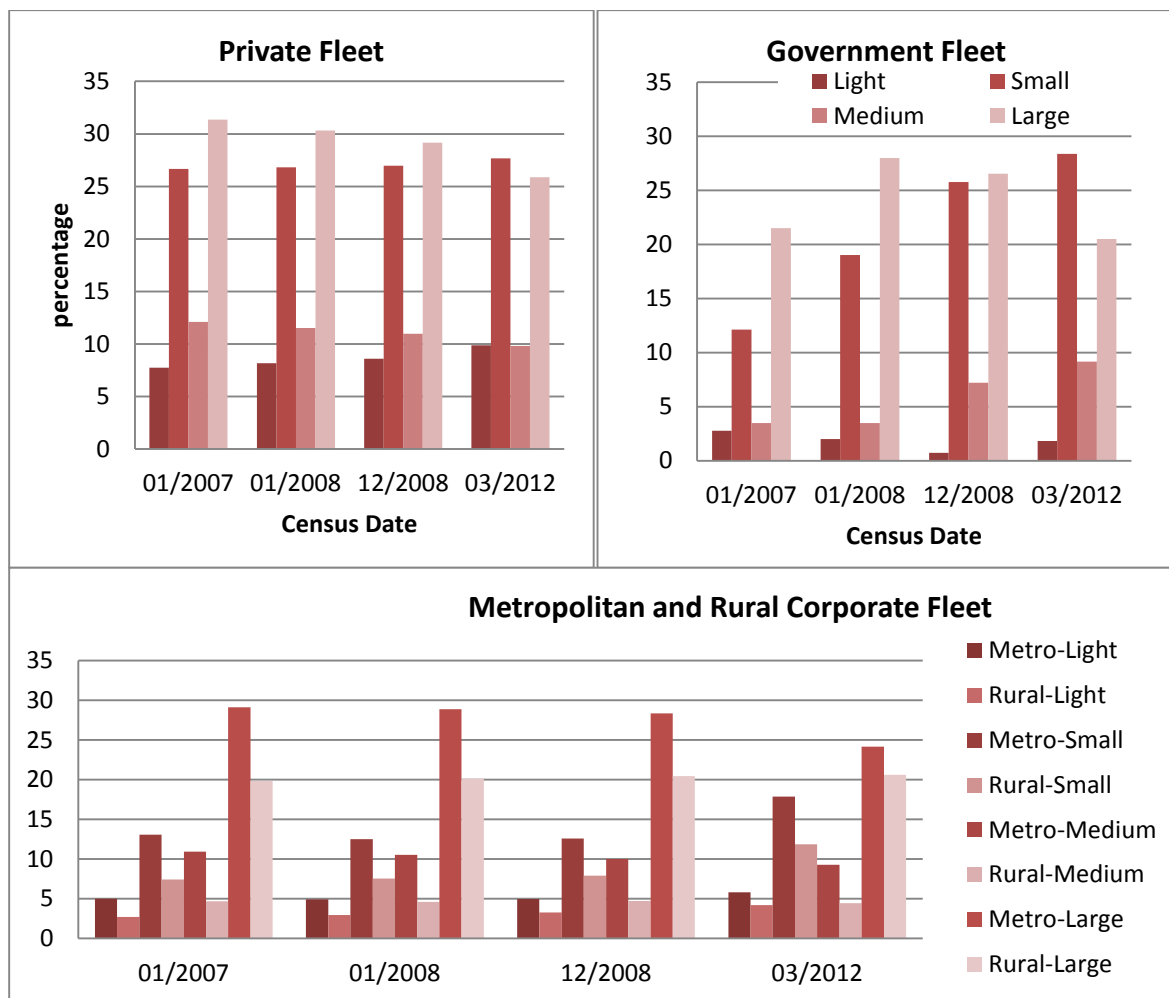


Figure 2b
Light, Small, Medium and Large Vehicles as a proportion of the Private, Government and Corporate Passenger Vehicle Registrations (excl. LCV)

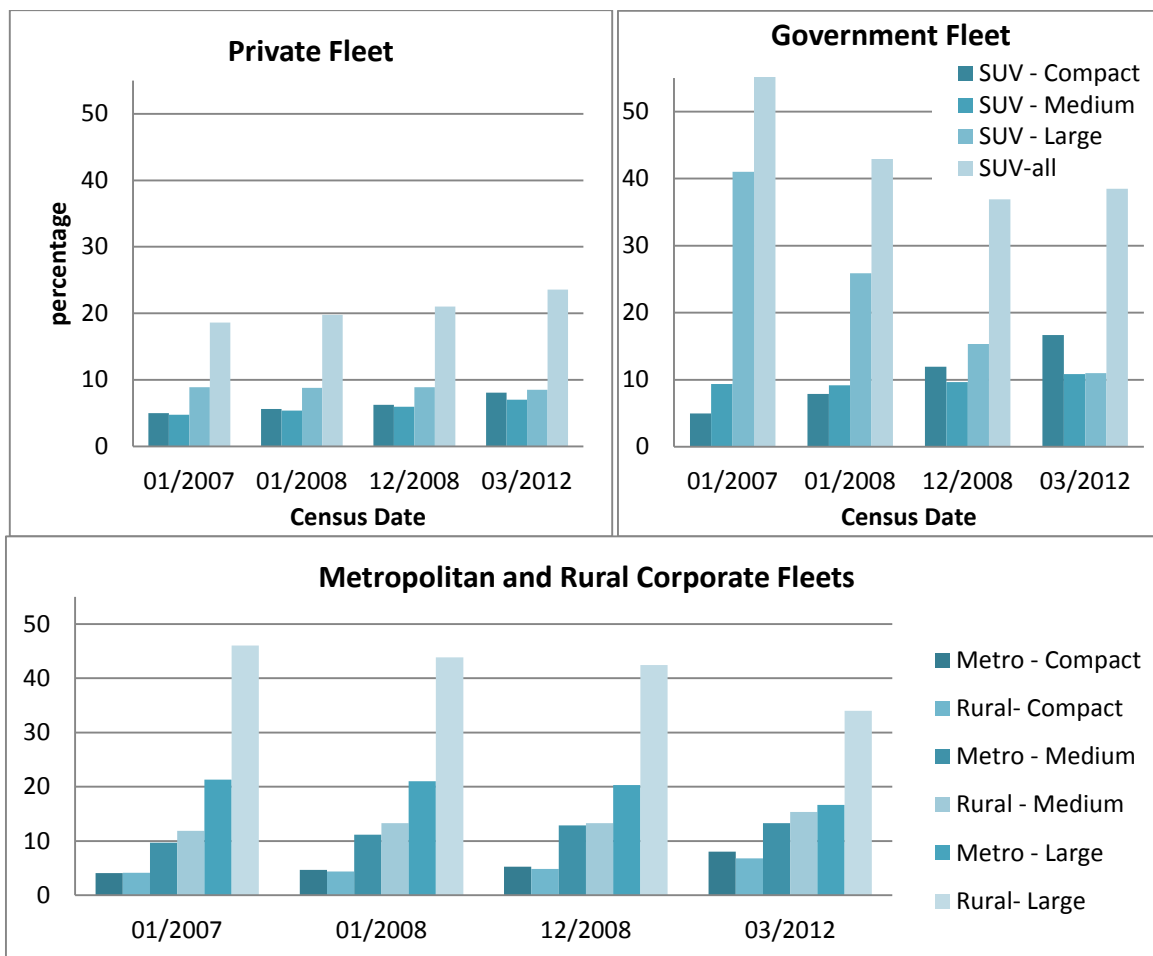


Figure 2c
Compact, Medium and Large Sports Utility Vehicles as a proportion of the Private, Government and Corporate Passenger Vehicle Registrations (excl. LCV)

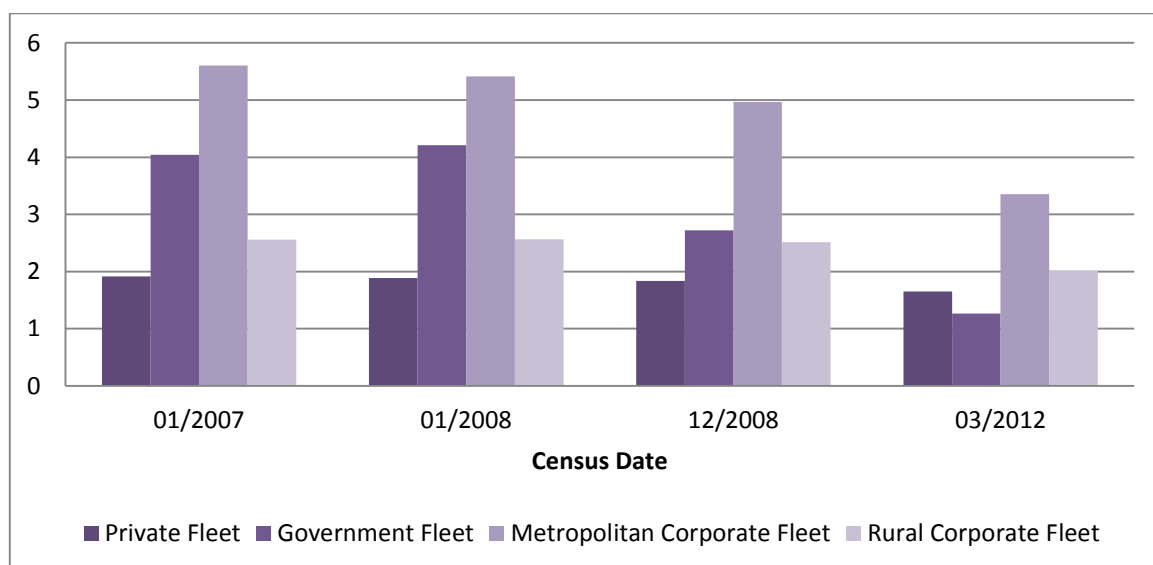


Figure 2d
People Movers as a proportion of the Private, Government and Corporate Registrations (excl. LCV)

The following summary points can be made:

- The proportion of vans and utilities in the private and corporate fleets has remained stable over time whilst there has been an overall decrease in the proportion of vans and utilities in the Government fleet over the same period. These vehicles are much more prevalent in government and corporate fleets
- Considering regular passenger cars (light, small, medium and large) there is a general trend for light and small vehicles to increase in proportion and large and medium vehicles to decrease in all fleets. This was also observed in hire and drive fleets.
- The proportionate prevalence of large SUVs has decreased over time, particularly in the government fleet. There have been increases in the proportions of compact and medium SUVs in all fleets. Overall, SUVs have increased as a percentage of the private sector and decreased in the government fleet.
- The percentage of people movers in the private, corporate and government fleets is small and has fallen over the period.

3.3 VEHICLE AGE

Figure 3 shows the age profile of vehicles within each fleet type by census time. The following summary observations are made from these figures and supplementary analysis given in Section 3 of the technical report:

- With each fleet, the age distributions show an increasing modal age, which at March 2012 is six years for private, about two years for government and one year for corporate vehicles. In 2012, most vehicles had left the government fleet by five years and the corporate fleet by 12 years.
- Government registered utilities, vans, SUVs and other passenger vehicles showed a trend for a decrease in average age.
- All non-privately owned SUV fleet types except rural corporately registered SUVs trended to decrease in average age.

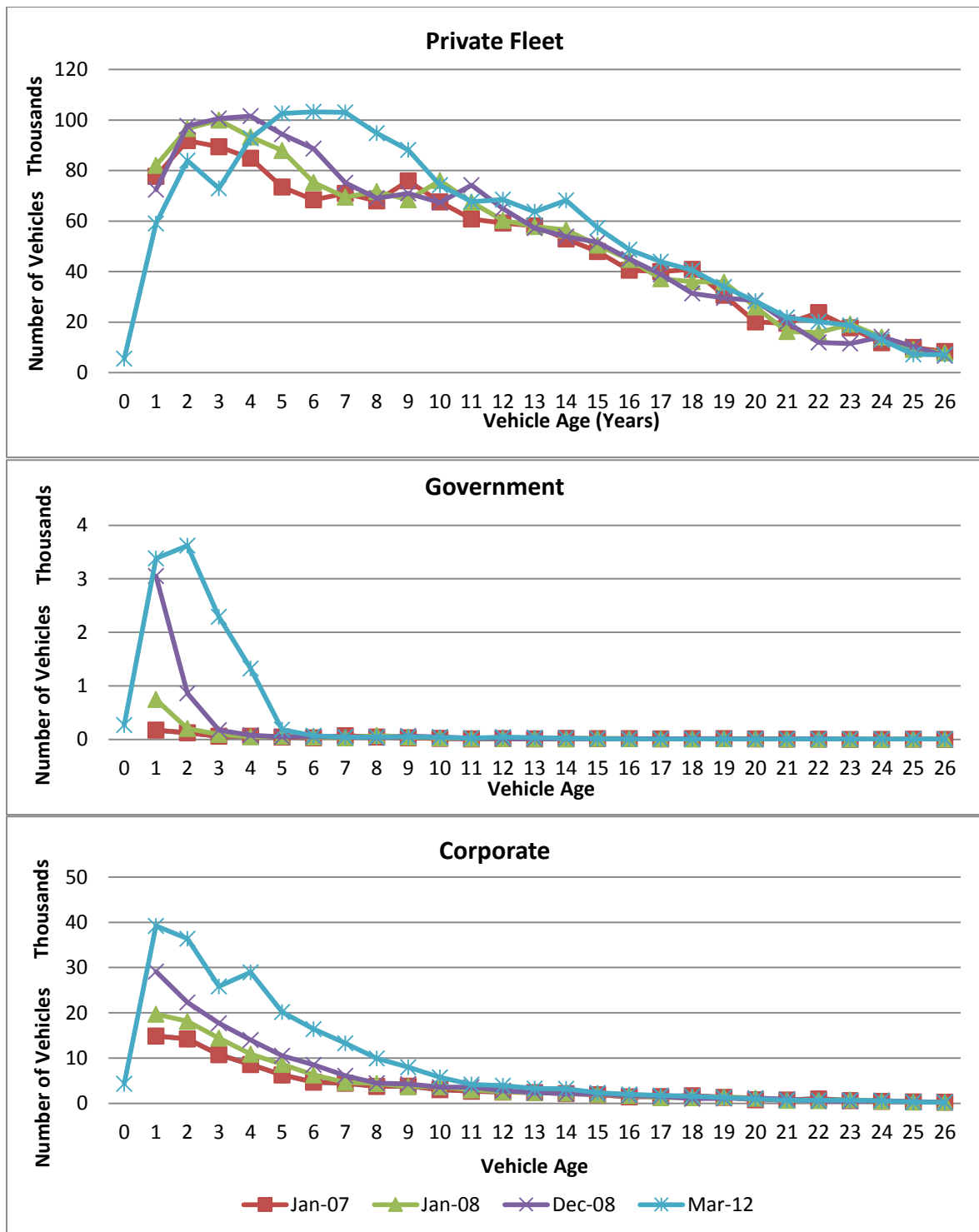


Figure 3
Age Profiles of Non-Commercial, Government and Commercial Fleet.

3.4 VEHICLE CRASHWORTHINESS, AGGRESSIVITY AND TOTAL SAFETY RATING

The average crashworthiness (CWR), aggressivity (AGG) and total secondary safety (TSR) for registered passenger vehicles was calculated for each fleet type by broad market

group categories. In order to keep sufficient data for meaningful averages, the market groups were combined into three categories: utilities and vans, SUVs and the remaining other passenger vehicle market groups. Trends by census period for each rating are shown in Figures 4, 5 and 6.

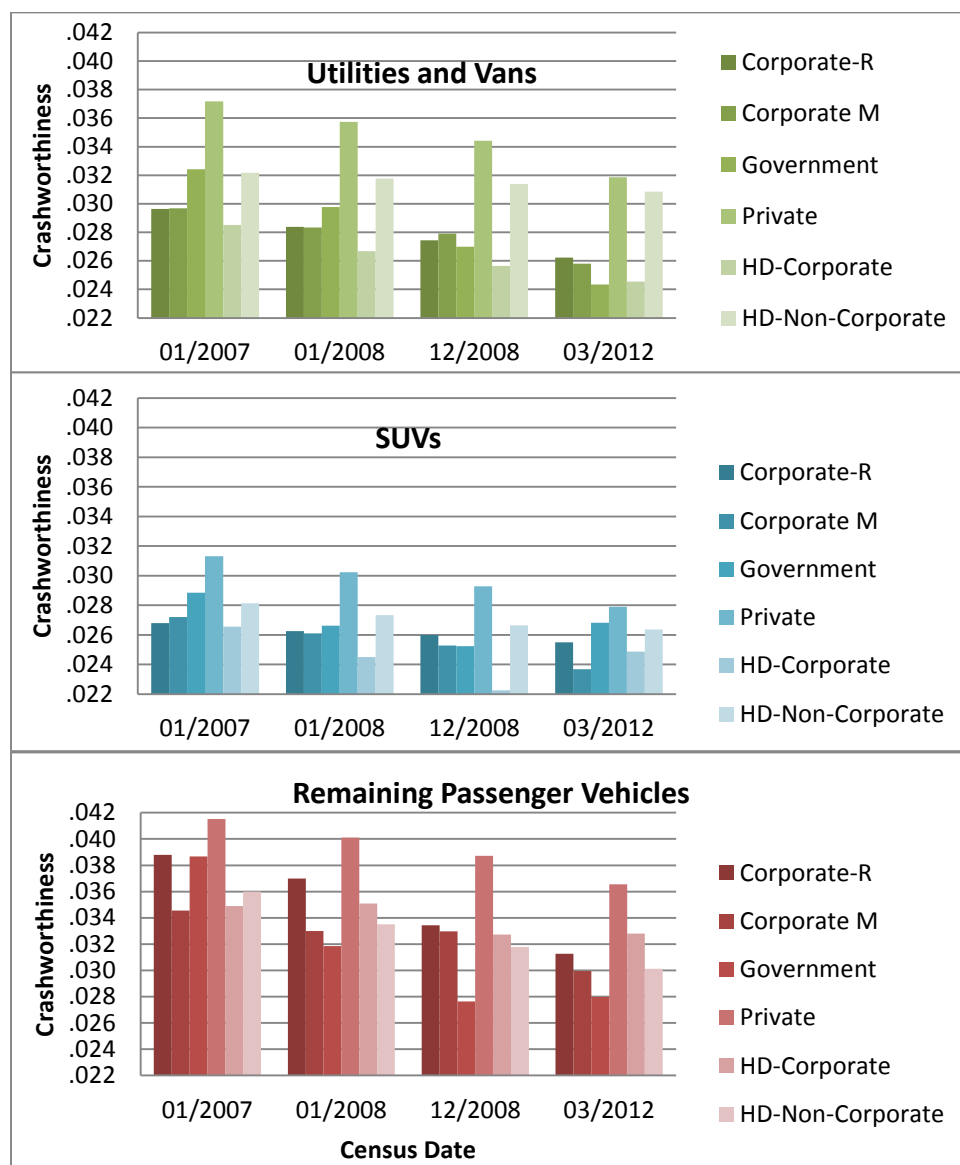


Figure 4
Average Crashworthiness by Private, Government and Corporate Fleet.
 (R=Rural M=Metropolitan HD= Hire and Drive)

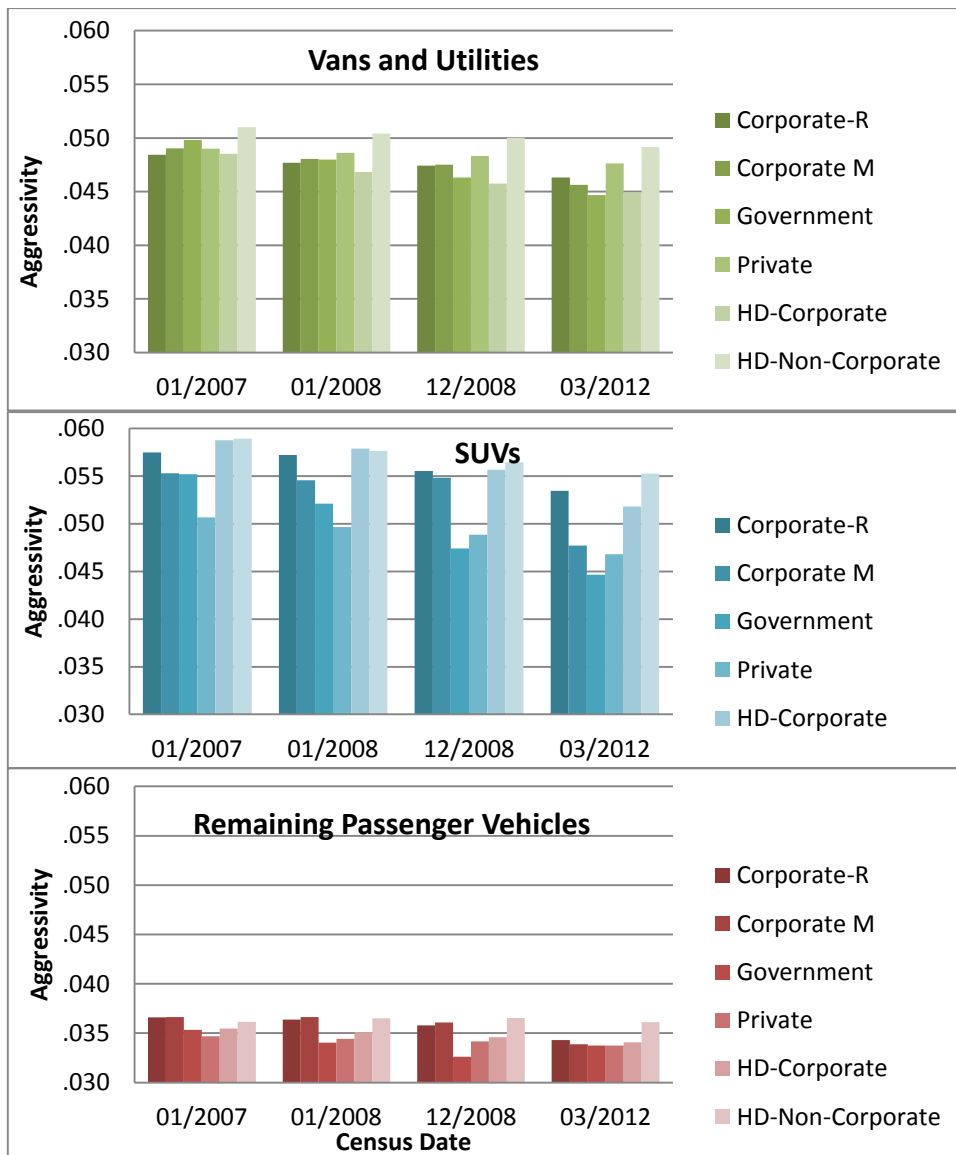


Figure 5
Average Aggressivity by Private, Government and Corporate Fleet for vehicles with >1982 year of manufacture
 (R=Rural M=Metropolitan HD= Hire and Drive)

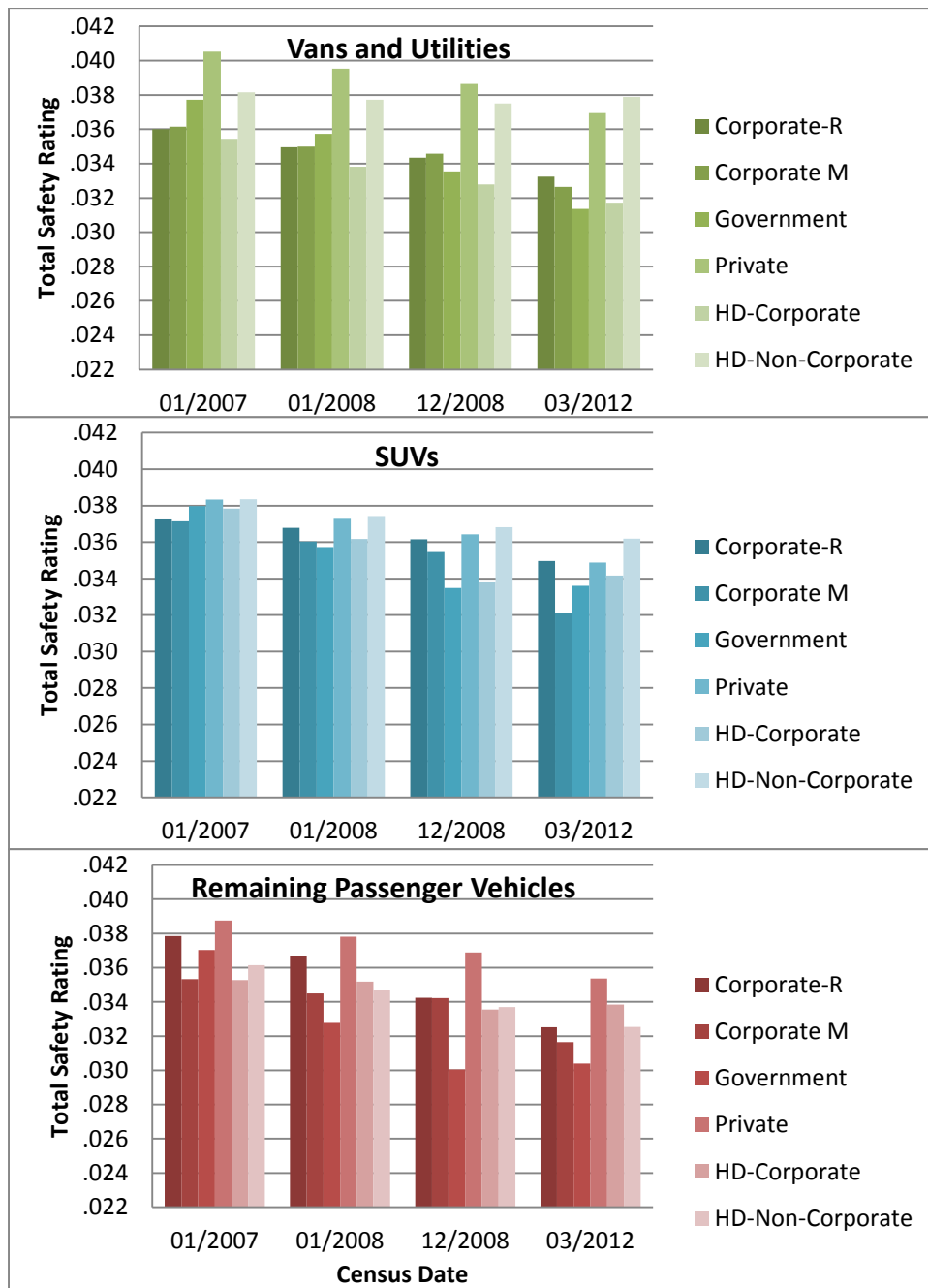


Figure 6
Average Total Safety Rating by Private, Government and Corporate Fleet for vehicles with >1982 year of manufacture
 (R=Rural M=Metropolitan HD= Hire and Drive)

The following observations on trends in relative vehicle secondary safety were observed from Figures 4-6:

- Average CWR is generally improving with increasing year of census;
- Privately owned vehicles have the worst average CWR for all three market categories reflecting their higher average age;
- Over the period, government vehicles have improved in average CWR at a faster rate than corporate vehicles;

- Average aggressivity has improved slightly across all fleet types and market groups; and
- SUVs, vans and utilities have worse average AGG than other vehicles with SUVs having the worst aggressivity.

3.5 VEHICLE SCRAPPAGE AND TRANSFER

Registered vehicles from different registration snapshots were matched by plate, partial VIN and year of manufacture and those vehicles which were present in one snapshot but not in a subsequent snapshot were identified, to compute the Scrappage Rate. Scrappage from the government fleet is minimal with the highest rates of scrappage from the private fleet. Annual scrappage rates for the private and corporate fleets are shown in Figure 7, being similar for the two fleets. Scrappage rates by market group of vehicle were also estimated and are given in Section 3 of the Technical Report. Smaller vehicles are generally scrapped at a higher rate than larger ones at each vehicle age.

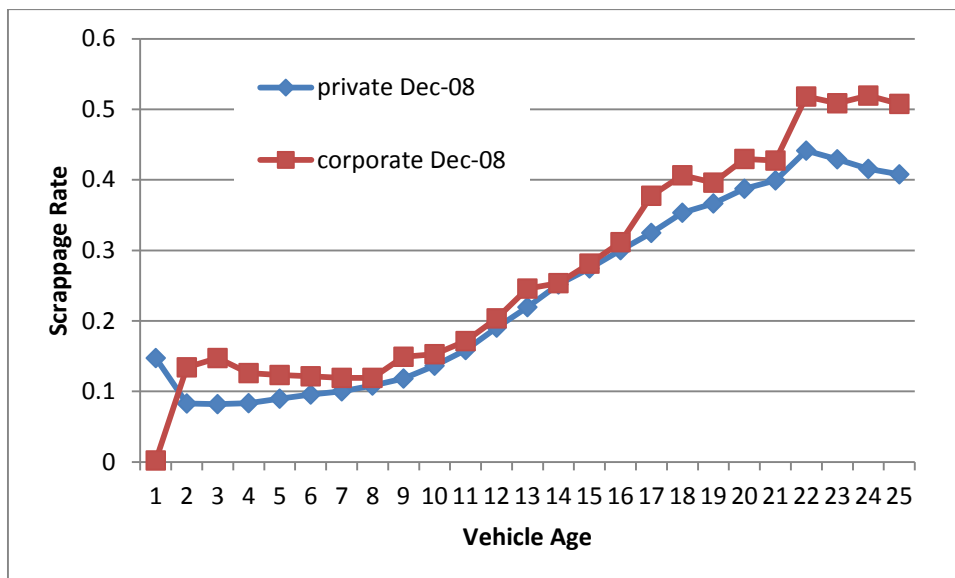


Figure 7
Scrappage Rates by age of registered passenger vehicle, and fleet type for the 12/2008 snapshot, including vans and utilities.

Registered vehicles from different snapshots were matched and those commercial vehicles, which were able to be seen as transferred to the regular fleet, were identified and counted. Figure 8 displays the resulting transfer rates from the corporate and government fleets to private ownership. Volatility in the government fleet estimates is a reflection of the small number of vehicles.

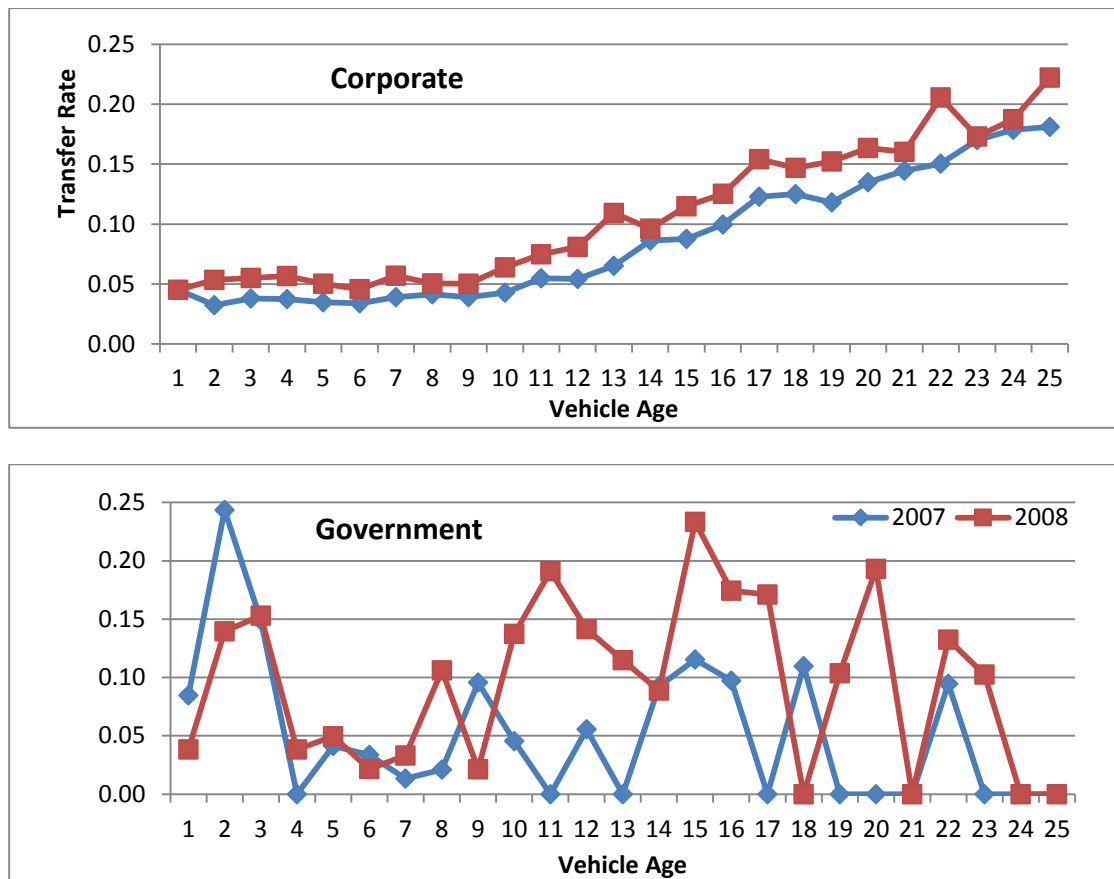


Figure 8

Estimated Transfer rates of corporate and government vehicles to the private fleet, for 2007 and 2008 vehicle registrations

3.6 PROFILE OF NEW VEHICLES REGISTERED IN 2012

The 2012 registration profiles of corporate, government and private vehicles by passenger vehicle market were used to project crash outcomes associated with vehicles first registered in 2012 forward in time. Counts of the vehicles registered in the past 12 months from the snapshot date of 31/3/2012 are tabled by fleet type and market group below. Table 10 follows with the most frequent models which make up government and corporate new vehicle fleets in 2012. 42% of 2012 new vehicle registrations are corporate or government fleet vehicles. Section 3 of the Technical Report lists the most frequent models within each market group along with a rough costing from Redbook.com.au.

Table 4 : Total 2012 new passenger vehicle registrations by market group

| Market Group | Corporate | | | Private | Government |
|---------------------------|------------------|--------------|-------|----------------|-------------------|
| | All | Metropolitan | Rural | | |
| SUV - Compact | 3,533 | 3,050 | 483 | 10,291 | 530 |
| SUV - Medium | 3,694 | 3,092 | 602 | 5,392 | 267 |
| SUV - Large | 3,723 | 2,985 | 738 | 2,944 | 189 |
| Commercial - Ute | 8,102 | 6,492 | 1,610 | 4,214 | 335 |
| Commercial - Van | 2,138 | 1,857 | 281 | 608 | 219 |
| Large | 4,987 | 4,333 | 654 | 3,492 | 477 |
| Medium | 2,206 | 2,055 | 151 | 3,018 | 326 |
| Small | 6,371 | 5,696 | 675 | 15,722 | 655 |
| Light | 1,388 | 1,203 | 185 | 7,370 | 78 |
| People Mover | 275 | 237 | 38 | 300 | 23 |
| unknown | 2,321 | 2,020 | 301 | 2,796 | 45 |
| All Known Vehicles | 36,417 | 31,000 | 5,417 | 53,351 | 3,099 |

4.0 WA CRASH DATA PROFILE

A full profile of the crashed vehicle fleet in WA over the period 2006-2009 appears in the Technical Report Section 4 with analysis presented on a vehicle basis with vehicles classified according to fleet membership at time of crash.

The following salient features were identified:

- Of the crashed corporate fleet vehicles, 74% were driven by males. In contrast, the crashed privately owned vehicles were driven by males only 52-54% of the time.
- Drivers aged 18-22 and older drivers are more highly represented in privately owned vehicle crashes. In contrast, drivers of crashed corporate and government vehicles are more frequently middle aged.
- Over 90% of crashes involve privately owned vehicles with government vehicles involved in less than 0.3% of crashes. The proportion of corporate owned vehicles involved in crashes has been increasing over time. The proportion crashed vehicles that are SUVs is also increasing over time.

Analysis of the number of crashes relevant to each vehicle safety technology considered in the safe purchasing scenarios is also presented in the Technical Report Section 4.

Using crashed vehicle numbers in conjunction with the size of the registered fleet, crash risks per registered vehicle were calculated. Figure 9 summarises the estimates by fleet and year.

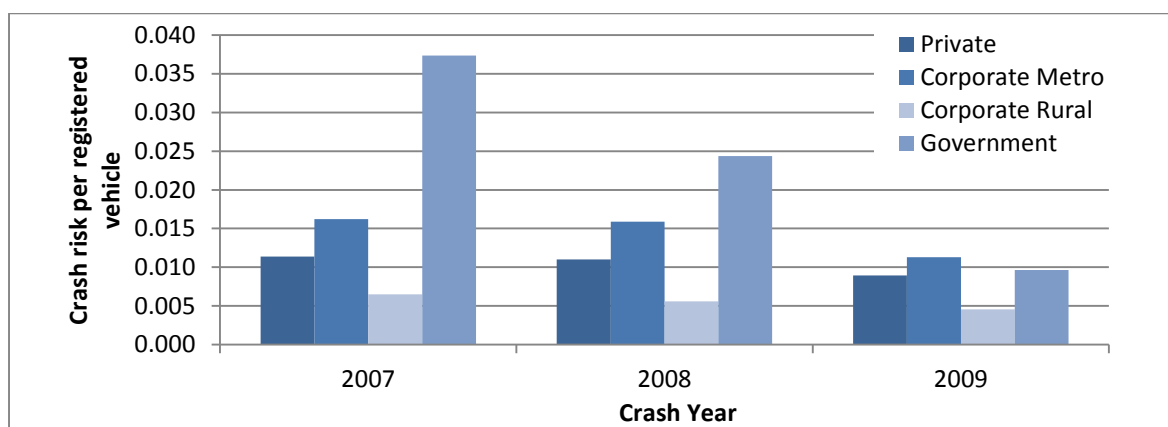


Figure 9
Crash Risk per Registered Vehicle by fleet type and crash year, 2007-2009

Analysis by vehicle type showed that utilities and vans had an approximately 80% higher crash risk, SUVs had an approximate 50% higher crash risk and the remaining passenger vehicles had an approximately 50% higher crash risk in the metropolitan corporate fleet relative to the crash risk of private vehicles.

Crude injury risk rates by fleet were calculated as a whole (Figure 10) and by vehicle type (see Technical Report Section 4). Crude serious injury rates were similarly calculated (Figure 11). Finally crash types by fleet type, vehicle type and injury outcome were also investigated with results summarised Section 4 of the Technical Report.

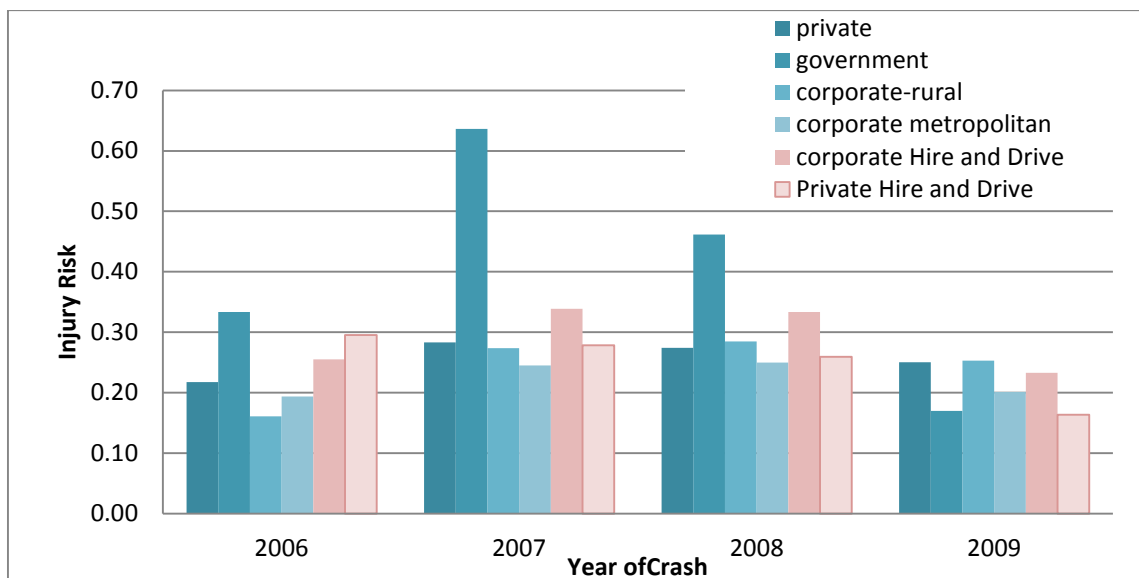


Figure 10
Distribution of driver injury risk by fleet type, 2006-2009

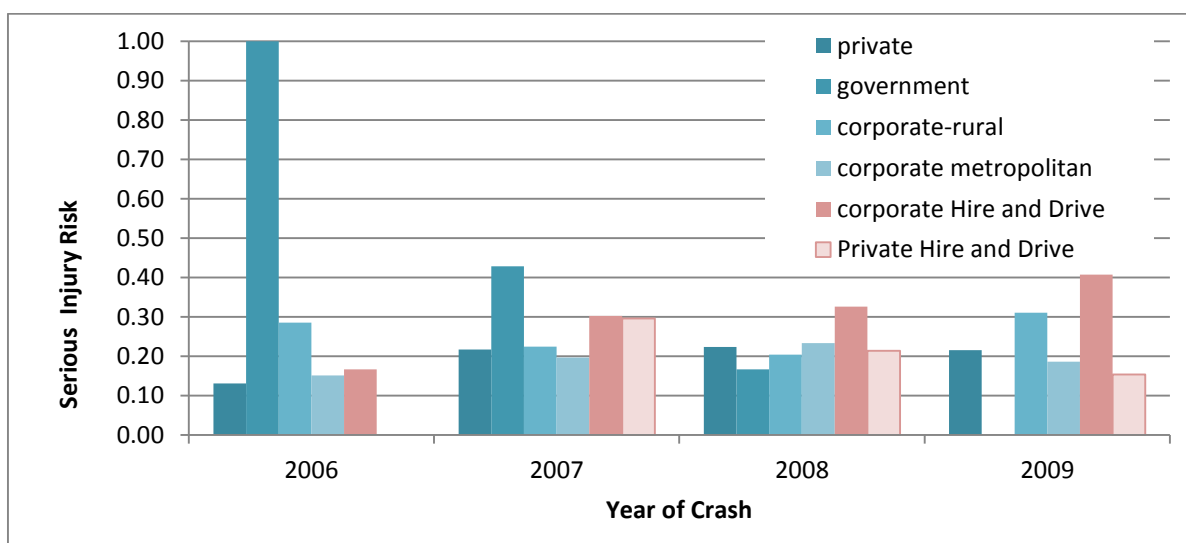


Figure 11
Distribution of serious injury risk by fleet type, 2006-2009

Salient outcomes of these analyses were:

- Metropolitan corporate vehicles were found to have a higher crash risk but lower driver injury risk than for private vehicles reflecting the likely greater travel exposure of corporate vehicles (higher crash risk) and newer, larger vehicles in the corporate fleet (lower driver injury risk) compared to private vehicles.
- Significant differentials, when compared with the private fleet were seen for corporate vehicles of the following crash types: rear-end, single vehicle rollover, single vehicle 'hit object' and 'hit animal', heavy vehicle and head on. These crash types, along with 'side swipe' crashes were the dominant crash types observed.

This report examines scenarios in which emerging technology, specific to reducing these crash types, is adopted.

- Alcohol was not considered a major contributing factor to corporate and government vehicle crashes, so technology addressing alcohol use was not considered within the scenarios.

5.0 METHODOLOGY FOR ESTIMATING BENEFITS OF SAFER VEHICLE PURCHASING SCENARIOS

A comprehensive methodology was derived for estimating the benefits of safer vehicle purchasing scenarios. The methodology centred on analysis of the 2012 cohort of newly registered vehicles in Western Australia which was known for the study and estimating the likely crash and injury outcomes related to this cohort over its useful lifetime. Following safety outcomes of a cohort of vehicles through their lifetime was considered the most effective way to assess the impact of changes in fleet purchasing policies. It enabled a model to be constructed that considered the initial composition of the cohort by market group and model of vehicle, the transfer between fleet and non-fleet usage of the vehicles over time and the eventual scrapping of those vehicles. This process could be undertaken for registration years beyond 2012 but there is little point since the results that would be obtained for years beyond 2012 would only reflect the incremental improvements in average crashworthiness expected over time. The net benefits of the fleet purchasing policy changes would be the same. Hence the fleet purchasing benefits, and particularly the cost to benefit ratios, are adequately estimated from a single cohort year tracked through the useful life of these vehicles. Whilst the methodology will not give estimates of the year on year benefits to Western Australia from a modified vehicle purchasing scenario, if the scenario were to be adopted permanently from a point in time, the benefits estimated for the single cohort in each year of its life will combine additively as each new cohort is affected.

Full details of the methodology used to construct the analysis model are given in Section 5 of the Technical Report. The model forecasts safety outcomes of the baseline scenario in terms of the number of police-reported tow-away crashes that involved 2012-registered vehicles as well as the number of seriously injured road users involved in these crashes. The model allows tow-away crash counts and serious injury counts to be disaggregated for different cohorts of 2012-registered vehicles based on the following three characteristics:

- Market Group;
- Fleet Status; and
- Vehicle Age.

Furthermore, the model allows categorisation of tow-away crashes by crash type. This functionality will allow the numbers of seriously injured road users to be disaggregated not only by the three vehicle characteristics mentioned in the previous paragraph, but also by their role in the collision. The model will allow seriously injured road users to be categorised into the following groups:

- Drivers of 2012-registered vehicles;
- Passengers travelling in 2012-registered vehicles; and
- Other road users involved in collisions with 2012-registered vehicles.

The last road user category includes unprotected road users defined as motorcyclists, bicyclists and pedestrians.

A brief summary of the key steps in the methodology is as follows:

1. The number of crashes involving a 2012-registered vehicle for each year in the period 2012-2034 was estimated for each market group category and for each fleet status classification from the number of vehicles registered new in 2012. Exposure, crash risk and injury outcome associated with these vehicles throughout their useful lives were estimated to achieve this. Exposure of these vehicles was adjusted for

the movement of these vehicles between the fleet and non-fleet vehicle sectors and scrapping of these vehicles from both the fleet and the non-fleet vehicle sectors.

2. For each year in the period 2012-2034, the number of injuries and serious injuries resulting from crashes involving 2012-registered vehicles was calculated. The number of injured occupants of the 2012-registered vehicle was estimated along with the number of other road users injured (such as occupants of other vehicles or unprotected road users) injured in collisions with the 2012 vehicle. The sum of these two values gave the number of injured and seriously injured road users involved in crashes with 2012-registered vehicles.
3. The cost effectiveness of each scenario was estimated. The cost of the projected total number of injured road users and the total number of property damage-only crashes over the 22 year period were determined using unit crash and injury costs to establish a baseline for which to compare the crash cost of alternative fleet purchasing strategies against. The benefits of each alternative fleet purchasing strategy were expressed in terms of the extent to which the strategy reduced the present value costs associated with crashes involving vehicles from the cohort group. For each alternative strategy, costs (and savings) were disaggregated by the current fleet status of the vehicles from the cohort group (i.e. whether the vehicles are still fleet vehicles, were previously fleet vehicles or were first registered as private vehicles).

Evaluating alternative strategies in terms of break-even costs was used due to the difficulty in estimating the cost of fitting new safety technologies to vehicles, which changes continually over time as the technology becomes more prevalent and ultimately standard on the majority of cars. Break-even costs were estimated in terms of the expected benefits of each alternative fleet purchasing policy for society as a whole, as well as with respect to the expected benefits that apply specifically to fleet owners. Per person injury, vehicle and general costs associated with the crashes used were those estimated by BITRE (2009).

In addition to break-even costs, the fleet cost differential was calculated for the scenarios where vehicle substitutions were made. Expressed as a per affected vehicle rate, the fleet differential costs were then able to be compared with the break-even costs. Vehicle costs at baseline and vehicle costs for two scenarios were made using estimated new vehicle costs determined from www.redbook.com.au. The fleet purchase cost for the other scenarios could not be adequately determined.

5.1 SCENARIOS CONSIDERED

In all nine different fleet purchasing scenarios were considered. These scenarios were chosen with consideration of current fleet purchasing practices but also with respect to alternative fleet purchasing practices that may be available to fleet buyers in the future. Although some of the fleet purchasing alternatives presented might not be accessible to some fleets, in general all the scenarios considered have been chosen to reflect purchasing decisions that may be considered for adoption. Full consideration of the crash types targeted by each scenario and the calculated effectiveness of each scenario in reducing crashes is given in the Technical Report Section 5. The choice of scenarios was also based on information derived from the Austroads 'Safer Vehicle Purchases' study (Newstead,

2007), by Anderson (2011) in the CASR Road Safety Research Report, *Analysis of crash data to estimate the benefits of emerging vehicle technology* and from WA crash data.

| Scenario Number | Title | Description |
|-----------------|--|---|
| 1 | Choose the most crashworthy vehicle in each market group | Each fleet vehicle actually purchased is replaced by the safest vehicle in its market group as identified by the Used Car Safety Ratings. |
| 2 | Replacement of Market Group with: a) average vehicle from other market group b) safest vehicle from other market group | Each vehicle actually purchased in certain market groups are replaced by vehicles from another market group with greater overall secondary safety. Specifically considered were metropolitan corporate fleets replacing medium and large SUVs with large cars and rural corporate fleets replacing large SUVs with medium SUVs. |
| 3 | Mandatory fitment of forward collision warning systems with autonomous braking: Speeds ≥ 80 km/h | All vehicles in the 2012 new cohort not currently equipped are fitted with forward collision warning systems with autonomous braking for travel speeds of 80km/h or more. |
| 4 | Mandatory fitment of forward collision warning systems with autonomous braking: All Speeds | All vehicles in the 2012 new cohort not currently equipped are fitted with forward collision warning systems with autonomous braking for all travel speeds. |
| 5 | Mandatory fitment of Fatigue Detection Systems | All vehicles in the 2012 new cohort not currently equipped are fitted with a fatigue detection and warning system. |
| 6 | Mandatory fitment of Lane Departure Warning Systems | All vehicles in the 2012 new cohort not currently equipped are fitted with a lane departure warning system. |
| 7 | Mandatory Fitment of Lane Change Blind Spot warning systems | All vehicles in the 2012 new cohort not currently equipped are fitted with a lane change blind spot warning system. |
| 8 | Mandatory fitment of Side Curtain Airbags | All vehicles in the 2012 new cohort not currently equipped are fitted with side curtain airbags. |
| 9 | Mandatory fitment of ESC to light commercial vehicles | All light commercial vehicles in the 2012 new cohort not currently equipped are fitted with electronic stability control (ESC). |

6.0 NEW 2012-REGISTERED - VEHICLE PROJECTION RESULTS

Using the information on 2012 new vehicle registrations, crash risk by vehicle age and market group, secondary safety of vehicles in the cohort, transfer and scrappage rates over time, a model of the lifetime crash and injury outcomes of the 2012 new vehicle cohort was constructed.

6.1 NUMBER OF REGISTERED VEHICLES

Figure 12 shows the estimated number of vehicles in each current fleet according to the fleet to which they were originally registered. It reflects both the original registrations by fleet, transfer between fleets and scrappage. Section 6 of the Technical Report also presents estimates by vehicle market group.

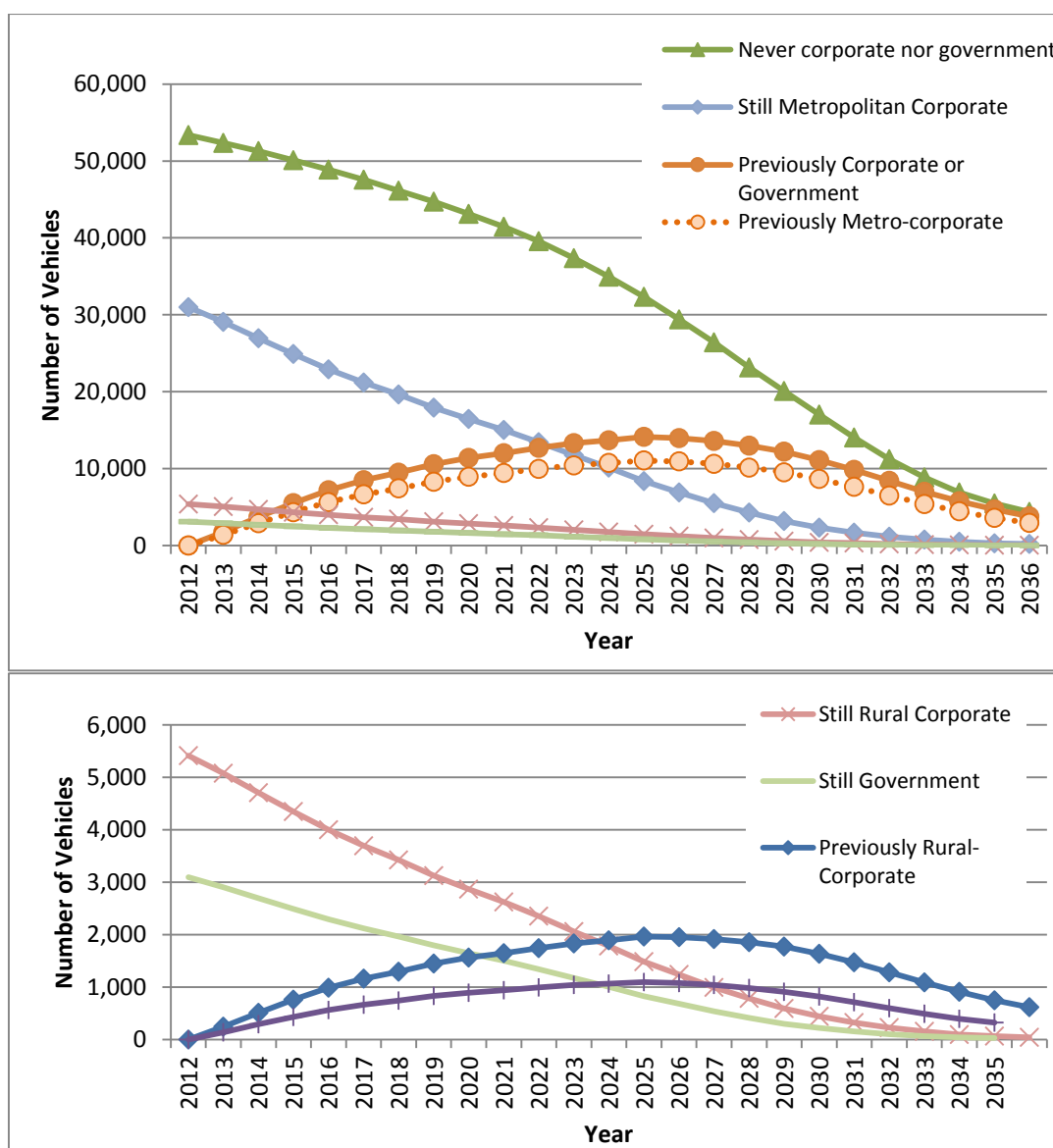


Figure 12
Number of 2012-registered vehicles at the beginning of each calendar year by fleet status

6.2 NUMBER OF CRASHED VEHICLES

The number of vehicles in each fleet at each time point were combined with crash risk estimates by age of vehicle and fleet to estimate the number of tow-away or higher severity crashes over the period 2012 to 2034 for vehicles first registered in 2012 by their market group status and their original fleet status as well as their current fleet status. These estimates are shown in Figure 13 for all market groups combined and in the Technical Report Section 6.2 by market group.

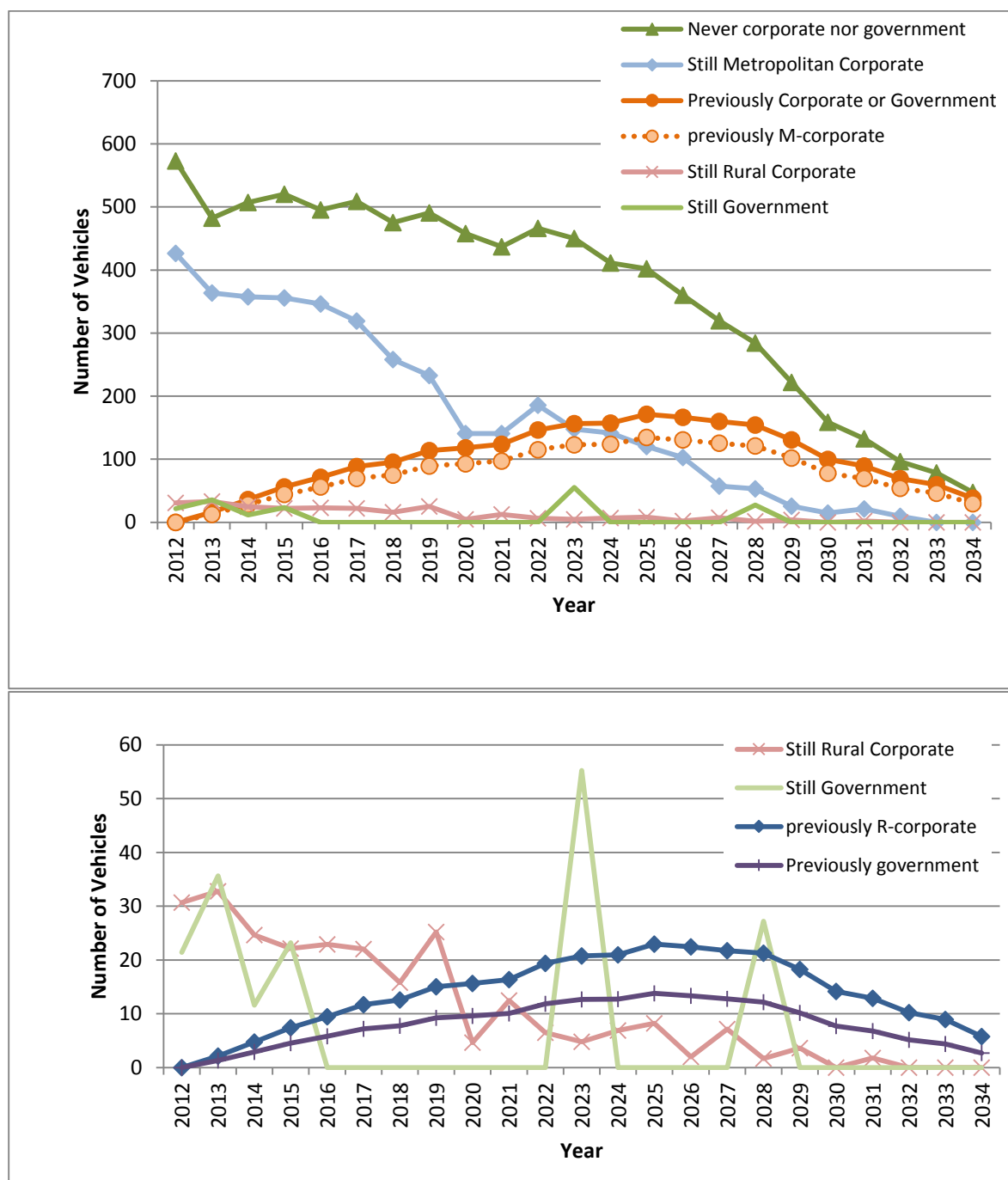


Figure 13
Number of 2012-registered vehicles involved in crashes in each year in the period 2012-2034 by fleet status

6.3 NUMBER OF SERIOUS INJURIES

Crashworthiness and aggressivity ratings applied to the estimated number of crashed vehicles in the previous section were used to estimate the number of seriously injured or killed road users that were involved in crashes involving 2012-registered vehicles. Figure 14 presents the total injured road users each year of life of the 2012 vehicle fleet by original and current fleet status of the vehicle. Estimates separated by 2012 new vehicle occupants and other road users are given in the Section 6.3 of the Technical Report along with estimates by vehicle market group.

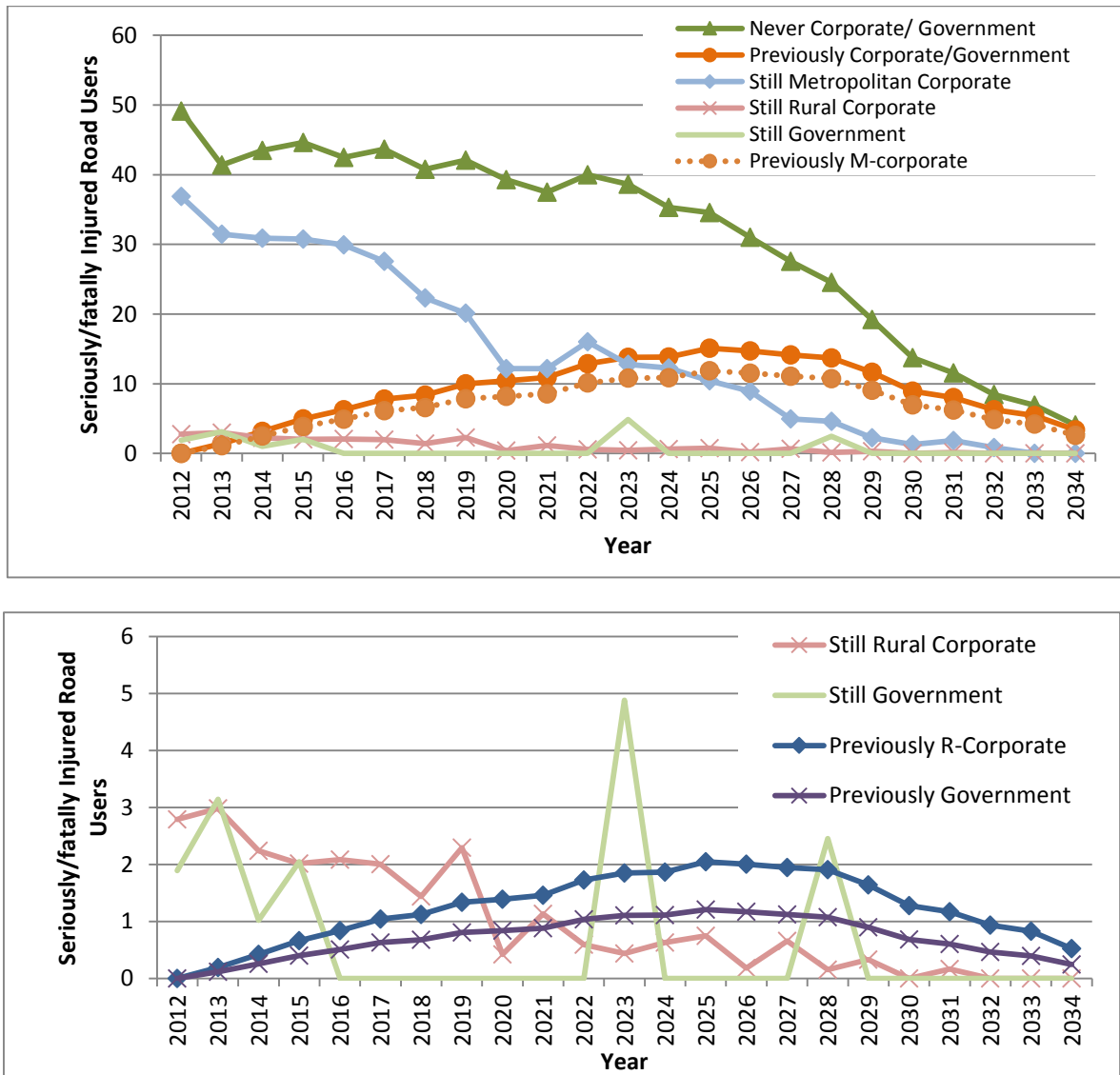


Figure 14
Estimation of the number of seriously or fatally injured road users from crashes involving 2012-registered vehicles by the fleet status of the 2012-registered vehicle

Sections 6.4 and 6.5 of the Technical Report also present comparable estimates of the number of minor injuries and property damage crashes which follow similar trends. Data in tabular form from all the charts presented is also given in the Technical Report.

7.0 BASELINE COST ESTIMATES OF FLEET AND PROJECTED INJURY AND CRASH COUNTS

7.1 CRASH COSTS OF THE BASELINE SCENARIO

Estimated lifetime crash numbers by severity for the 2012 new vehicle cohort were translated to societal costs using the unit community crash costs estimated by BITRE. The estimated present value of community costs due to crashes that involved 2012-registered vehicles over their useful lives (2012-2034) was equal to \$645,140,000 of which 42% was attributed to crashes involving vehicles that were first registered in 2012 as corporate fleet vehicles. Full tabulations of costs by level of injury costs separately for occupants of 2012 new registered vehicles, other road users and by original fleet membership are given in Section 7 of the Technical Report.

Of the \$645million dollars that was the present value of costs associated with crashes involving 2012-registered vehicles over their useful lives, \$431 million (67%) was attributed to the human cost of serious or fatal injuries. Of this \$431 million, \$218 million (50%) was attributed to fatally or seriously injured occupants of the 2012-registered vehicles with the remainder borne by other road users. Pie charts in Figures 15 and 16 show the proportion of the total present value of costs due to crashes involving 2012-registered vehicles that were attributed to each fleet category and by injury severity and road user type respectively. The Technical Report also displays cost information by age of vehicle.

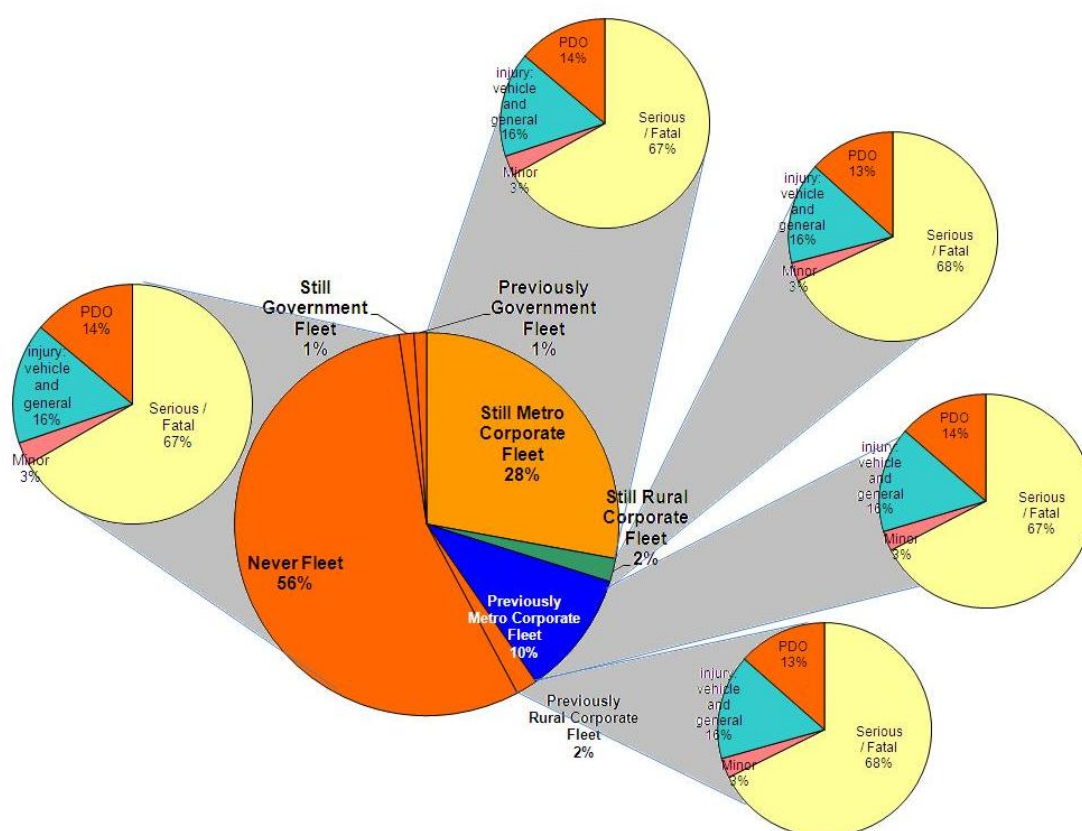


Figure 15
Proportion of total cost (\$645M) due to crashes occurring during the period 2012-2034 that involved 2012-registered vehicles by fleet status and crash/injury severity

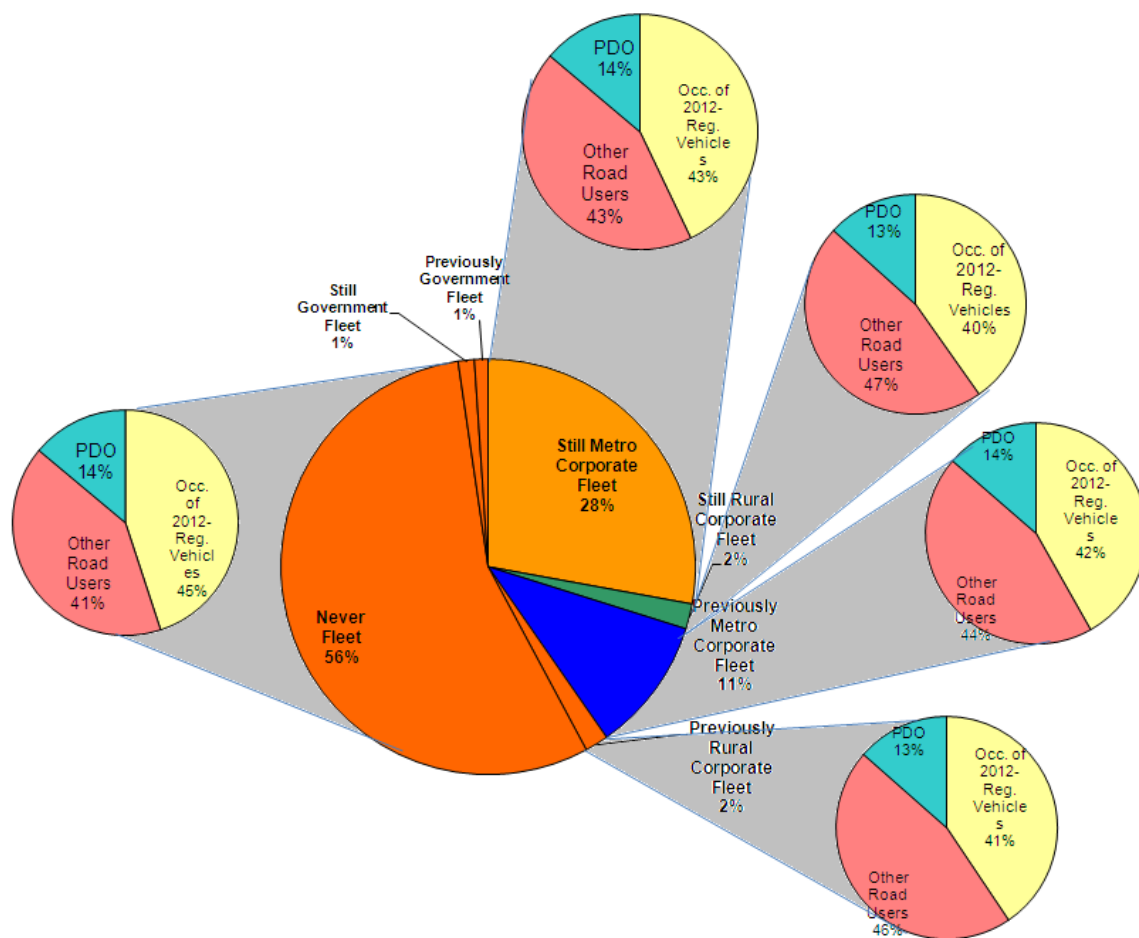


Figure 16
Proportion of total cost (\$645M) due to crashes occurring during the period 2012-2034 that involved 2012-registered vehicles by fleet status and whether the injured occupant was an occupant of the 2012-registered vehicle

8.0 CRASH SAVING DIFFERENTIALS FROM BASELINE FOR SCENARIOS

Crash, injury and societal cost savings made by employing the nine alternative fleet purchasing scenarios in terms of reductions in number of and associated costs were estimated by applying the crash reductions associated with each scenario to the baseline projection detailed in the previous section. Tables 5, 6 and 7 display the estimated total community cost savings for each scenario for the metropolitan corporate, rural corporate and government fleets respectively. Also shown are the serious injury savings and their societal costs derived for each scenario by occupants of the 2012 new vehicles and the other road users. Scenarios were ranked from those in which the greatest total savings were estimated to those in which the least total savings were predicted (the top of the table to the bottom). In these tables serious injury savings were rounded to the nearest integer and crash cost savings have been rounded to the nearest thousand for ease of reading. Serious injury savings projections amounting to a fraction less than 0.5 were indicated where serious injury savings is presented as having a non-zero cost with a zero count. Serious injury counts by road user may not sum to the total because of rounding.

Scenario 4, mandating forward collision warning and autonomous braking across all speed zones, resulted in the greatest savings in terms of total savings due to reduced injury and crash occurrence (\$100M for metropolitan corporate). This scenario also offered the greatest saving in terms of serious injury reductions over all road users, over 2012 vehicle occupants and over just the 'other' road users. This technology reduced crashes in the most frequent crash type (rear-end crashes) and demonstrated the cost reductions possible in a fleet with a large proportion of more aggressive vehicles, without compromising vehicle choice. Scenario 1, which ranked second overall, offered the greatest savings in human injury costs to occupants of 2012 registered vehicles. In this scenario, actual vehicles purchased were substituted with the most crashworthy model within the same market group as that purchased.

Table 5 : Summary of the savings associated with each of the alternative fleet purchasing scenarios that were estimated over the useful lives of the 2012-purchased METROPOLITAN CORPORATE fleet vehicles

| Scenario | Total Savings | Serious Injury Savings (Human Cost) | | | | | |
|-----------|---------------|-------------------------------------|------------|---------------------------------------|------------|-----------------------|------------|
| | | All Road Users | | Occupants of 2012 Registered Vehicles | | Other Road Users Only | |
| | | \$ | N | \$ | N | \$ | N |
| 4 | 100,678,000 | 197 | 66,443,000 | 96 | 32,595,000 | 100 | 33,849,000 |
| 1 | 47,643,000 | 144 | 48,828,000 | 123 | 41,744,000 | 21 | 7,085,000 |
| 3 | 15,607,000 | 32 | 10,972,000 | 16 | 5,383,000 | 17 | 5,589,000 |
| 2b | 14,229,000 | 42 | 13,588,000 | 20 | 6,323,000 | 23 | 7,265,000 |
| 7 | 8,096,000 | 13 | 4,227,000 | 6 | 2,074,000 | 6 | 2,153,000 |
| 6 | 5,820,000 | 12 | 4,100,000 | 6 | 2,011,000 | 6 | 2,088,000 |
| 2a | 4,725,000 | 17 | 5,353,000 | 8 | 2,529,000 | 9 | 2,824,000 |
| 8 | 2,587,000 | 8 | 2,619,000 | 8 | 2,619,000 | 0 | 0 |
| 5 | 2,576,000 | 6 | 2,089,000 | 3 | 1,025,000 | 3 | 1,064,000 |
| 9 | 875,000 | 2 | 659,000 | 2 | 659,000 | 0 | 0 |

Table 6 : Summary of the savings associated with each of the alternative fleet purchasing scenarios that were estimated over the useful lives of the 2012-purchased RURAL CORPORATE fleet vehicles

| Scenario | Total Savings | Serious Injury Savings (Human Cost) | | | | | |
|----------|---------------|-------------------------------------|-----------|---------------------------------------|-----------|-----------------------|-----------|
| | | All Road Users | | Occupants of 2012 Registered Vehicles | | Other Road Users Only | |
| | | \$ | N | \$ | N | \$ | N |
| 4 | 9,965,000 | 21 | 6,671,000 | 10 | 3,093,000 | 11 | 3,578,000 |
| 1 | 3,906,000 | 13 | 4,085,000 | 11 | 3,687,000 | 1 | 397,000 |
| 3 | 1,541,000 | 3 | 1,095,000 | 2 | 508,000 | 2 | 587,000 |
| 2b | 1,491,000 | 5 | 1,484,000 | 2 | 660,000 | 3 | 824,000 |
| 2a | 830,000 | 3 | 835,000 | 1 | 431,000 | 1 | 403,000 |
| 7 | 796,000 | 1 | 424,000 | 1 | 196,000 | 1 | 227,000 |
| 6 | 573,000 | 1 | 407,000 | 1 | 189,000 | 1 | 218,000 |
| 8 | 316,000 | 1 | 320,000 | 1 | 320,000 | 0 | 0 |
| 5 | 252,000 | 1 | 204,000 | 0 | 95,000 | 0 | 110,000 |
| 9 | 132,000 | 0 | 99,000 | 0 | 99,000 | 0 | 0 |

Table 7 : Summary of the savings associated with each of the alternative fleet purchasing scenarios that were estimated over the useful lives of the 2012-purchased GOVERNMENT fleet vehicles

| Scenario | Total Savings | Serious Injury Savings (Human Cost) | | | | | |
|----------|---------------|-------------------------------------|-----------|---------------------------------------|-----------|-----------------------|-----------|
| | | All Road Users | | Occupants of 2012 Registered Vehicles | | Other Road Users Only | |
| | | \$ | N | \$ | N | \$ | N |
| 4 | 6,048,858 | 13 | 3,999,413 | 6 | 1,932,859 | 6 | 2,066,555 |
| 1 | 3,087,273 | 10 | 3,124,768 | 8 | 2,575,189 | 2 | 549,579 |
| 2b | 1,197,975 | 4 | 1,149,236 | 2 | 515,334 | 2 | 633,901 |
| 3 | 952,679 | 2 | 668,866 | 1 | 323,056 | 1 | 345,811 |
| 7 | 494,003 | 1 | 255,574 | 0 | 123,489 | 0 | 132,086 |
| 2a | 463,478 | 2 | 512,799 | 1 | 222,141 | 1 | 290,659 |
| 6 | 362,799 | 1 | 252,823 | 0 | 122,044 | 0 | 130,779 |
| 5 | 168,823 | 0 | 132,460 | 0 | 63,859 | 0 | 68,601 |
| 8 | 140,845 | 0 | 142,590 | 0 | 142,590 | 0 | 0 |
| 9 | 31,000 | 0 | 23,000 | 0 | 23,000 | 0 | 0 |

Scenarios 2b and 3 produced the next best rankings for savings, providing total estimated savings of similar magnitude. Scenario 2b modelled substitution of government and metropolitan corporate large and medium SUVs with the safest large vehicle model vehicle and substitution of large rural SUVs with the safest medium SUV model. Scenario 2 generally aimed to reduce the aggressivity of the corporate and government fleets. Scenario 3 mandated forward collision warning and autonomous braking technology to zones with speed limits greater than 80 km/h.

Of the remaining new technology fitment scenarios, Scenario 7 ranked next best; ranking fifth for metropolitan and government fleets and sixth for rural fleets. This scenario was designed to reduce crashes resulting from intentional lane changes. Scenarios 2a, 5, 6, 8 and 9 resulted in smaller estimated cost savings compared with other scenarios. For Scenarios 8 and 9 the smaller estimated saving was partially explained by the fact that the scenario did not involve changes to the whole fleet. Scenario 9 involved fitment of ESC only to light commercial vehicles without ESC standard to the model. The next section will address the savings relative to the number of vehicles affected, so the modest overall savings seen here for scenarios such as Scenario 9 were put into proper perspective.

Tables 5 , 6 and 7 show that fitment of SCA to vehicles without SCA as standard resulted in the reduction in seriously injured occupants of vehicles first registered as fleet vehicles in 2012 by 9, which was equivalent to a saving of \$2.6M, \$0.3M and \$0.1M respectively for corporate metropolitan, corporate rural and government fleets respectively. It was true that this feature was effective at improving the safety of occupants of the 2012-registered vehicles, but it did not affect the safety of other road users. This suggests that if a proposed fleet purchasing policy was to maximise the benefits it provides to society by reducing the incidence of serious injury, the policy must also address how vehicles purchased affect the safety of other road users. For example, SCA fitment could be combined with less aggressive vehicle substitution as presented in Scenario 2.

9.0 BREAK-EVEN COSTS

The break-even costs per vehicle, where the present values of the savings to society as a whole are considered, are presented in this section. Break even costs are the additional cost that can be spent per vehicle to achieve the requirements of the scenario to produce a benefit to cost ratio of 1. The break even cost is determined by the total societal cost savings estimated in the previous section along with the number of new 2012 vehicles affected by the scenario. Table 8 shows the number of 2012 new vehicles affected by the scenario and has been used in conjunction with the information in Tables 5-7 to give the gross cost savings per vehicle. The gross cost savings per vehicle are the break even costs and give an indication of the maximum additional cost per vehicle that can be borne before the benefits in crash savings to society are exceeded by the additional cost of the vehicle.

Table 8 : Gross average per vehicle savings in societal crash costs as a whole from alternative fleet purchasing policies when compared to the baseline scenario

| Scenario | 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 |
| 1 | 29,095 | \$1,638 | 4,935 | \$792 | 2,880 | \$1,072 |
| 2a | 6,077 | \$778 | 738 | \$1,125 | 456 | \$1,016 |
| 2b | 6,077 | \$2,341 | 738 | \$2,020 | 456 | \$2,627 |
| 3 | 31,000 | \$503 | 5,417 | \$285 | 3,099 | \$307 |
| 4 | 31,000 | \$3,248 | 5,417 | \$1,840 | 3,099 | \$1,952 |
| 5 | 31,000 | \$83 | 5,417 | \$47 | 3,099 | \$54 |
| 6 | 31,000 | \$188 | 5,417 | \$106 | 3,099 | \$117 |
| 7 | 31,000 | \$261 | 5,417 | \$147 | 3,099 | \$159 |
| 8 | 11,597 | \$223 | 2,381 | \$133 | 922 | \$153 |
| 9 | 5,455 | \$160 | 1,215 | \$109 | 376 | \$82 |

Table 8 shows that three of the top four ranking Scenario *crash cost savings* (1, 2b, 3 and 4) remained top ranking even after cost savings per vehicle was considered. Scenario 2A passes Scenario 3 in per vehicle value of savings. Of the remaining scenarios, Scenarios 7 and 8 offer the best per vehicle savings.

Section 9 of the Technical Report also considers the likelihood of the additional cost per vehicle of achieving each scenario in comparison to the break even cost presented in Table 8. The largest amount of additional vehicle costs can be borne in both the vehicle

substitution scenarios (Scenarios 1 and 2). Achieving the scenario aims within this cost will vary over time as different alternative safe vehicles become available. As demonstrated by the Used Car Safety Ratings, the safest vehicle in class is often not the most expensive. This means it is likely to be possible to achieve these scenarios for relatively little additional cost through careful vehicle choice.

Of the technology adoption scenarios, the most can be spent on forward collisions warning and autonomous braking systems that operate at all speeds. It is difficult to predict what these systems will cost in the longer term since there are so few vehicles currently with such a system and these vehicles are generally expensive luxury vehicles. Low speed autonomous emergency braking systems are becoming available in an increasingly wide range of vehicles for very little additional cost so it is envisaged that systems operating at all speeds will follow similarly in future years. These calculations suggest that early adoption even at significant optional cost is justified.

Break even costs for the remaining scenarios are relatively small. This suggests that systems will need to be available on a wide scale for relatively little or no extra cost before the full benefits of these scenarios can be fully realised. Fortunately systems such as commercial vehicle ESC, side curtain airbags and even fatigue and blind spot warning systems are becoming much more widely available as standard or as low cost options.

Section 9 of the Technical Report considers the direct benefits economics of the safer vehicle purchasing scenarios to fleet owners. This is similar to the objectives of the previous Austroads report which estimated national benefits of safer fleet purchases directly to the fleet owner. Since fleet owners own vehicles for a relatively short time, the proportions of lifetime vehicle benefits summarised above that translate directly to the fleet owner are necessarily small. Calculations in the Technical Report confirm this is the case for Western Australia also. In practice, this means from a pure economic sense the fleet owner can justify only very small additional expenditure on vehicles before the additional costs exceed the likely direct benefits. It is difficult to assess how much additional cost the fleet is likely to bear under each scenario since the net cost is determined not only by purchase price but also retained value at resale. Resale is affected by a number of factors which are difficult to predict and may change significantly over time. In general, convincing fleet owners to adopt the scenarios considered in this study is likely to have to be based on presenting the argument about the benefits to society as a whole and hence appealing to fleet owners' sense of community responsibility and leadership in the vehicle safety domain.

10.0 SUMMARY AND IMPLICATIONS

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 has been disproportionately greater for corporate and government fleet vehicles. Passenger vehicle registrations were found to have grown 18% from December 2008 to March 2012. Over this period the proportion of metropolitan corporate fleet vehicles grew from 7 to 12%, the proportion of rural corporate vehicles increased by 1% unit and the proportion that were government fleet vehicles more than doubled.

With greater proportions of new government and corporate vehicles becoming registered, the average age of these vehicles was observed to decrease, so newer and generally safer vehicles are trending to make up a larger proportion of the corporate and government fleets. However, a trend for increasing average age in rural corporate SUVs was observed, indicating that proportionally fewer new vehicles are entering this market group sector. In fact, generally more aggressive market groups were held onto by the corporate fleet for longer periods. After fleet vehicles reached 11 years, market group differences in scrappage rates were observed with lower scrappage rates for the more aggressive market groups. These trends result in potentially less safe light commercials and SUVs in corporate fleets; particularly in the rural corporate fleet.

Government and corporate fleet vehicles in WA currently consist of greater proportions of vehicles from aggressive market groups than within the private vehicle fleet. The proportion of light commercial vehicles within the corporate passenger fleet has remained steady at 37% for metropolitan registrations and 44% for rural registrations, and although large SUVs are trending to decrease in the corporate and government fleets, the proportion all SUVs make within the corporate fleet is 24% for metropolitan, and 32% for rural registrations. This means that in March 2012, these aggressive market groups 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. These trends have continued in new vehicle purchases by fleets in 2012.

Newstead (2012) has shown that higher aggressivity in vehicles indicates that when they are involved in a crash they put the occupants of the “other” vehicle and “other” road users at higher risks of injury and more serious injury. Thus, the large and continuing large proportions of more aggressive market groups in the corporate and government fleets is of concern because of the injury and cost of injury burden it places on society. The flow on effect of the more aggressive corporate and government fleet is that greater proportions of vehicles from aggressive market groups are entering the private fleet when they are transferred from corporate or government ownership. Most corporate and government fleet vehicles were under 3 years of age when transferred to the private fleet and almost all government vehicles were scrapped or transferred to the private by the time they were 5 year old. Thus the large proportions of aggressive market groups in the corporate and government fleets are not only a concern for fleet buyers, but also for society in general as these vehicles transfer to private ownership.

Generally fleet buyers were found not to purchase the safest (most crashworthy) vehicle within the market groups. In metropolitan corporate fleets the most crashworthy model in 2012 amounted to 7% of utility, 6% of van 16% of large vehicle, 0.05% of medium

vehicle, 0.1% of small vehicle, 11% of light vehicle, 73% of people mover, 3% of compact SUV, 1% of medium SUV and 9% of large SUV purchases. So with the exception of people movers there was much room for improvement in safety of fleet vehicles purchased within chosen market groups.

Corporate and government fleet vehicles also experience a substantially higher crash risk per registered vehicle than private vehicles in WA over the 2006-2009 period. This is despite most corporate and government fleet drivers being middle age and hence in the lowest crash risk age category and despite most corporate vehicles being newer and thus more likely to be fitted with newer safety technology. The higher crash risk is likely attributable to greater travel exposure in corporate and government fleet vehicles. Metropolitan corporate utilities and vans had a higher relative crash risk compared to privately owned utilities and vans, relative to the rest of their respective fleets. When comparing metropolitan corporate vehicle crashes to private vehicle crashes by crash type and broad market group, metropolitan corporate utilities and vans were found to be more likely to be in a rear-end crash, more likely to be in a crash with a heavy vehicle, more likely to be in a fatal or serious injury crash and more likely to be in a fatal or serious injury head on crash. Rural corporate SUVs, vans and utilities had a higher relative risk of roll-over crashes compared to their privately owned counterparts. 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 some crash types. They had a higher than expected percentage of roll-over crashes, proportionally more of hit object crash types and were over-representation in heavy vehicle crashes

Scenarios were proposed to increase the proportion of more crashworthy vehicles or decrease the aggressivity of vehicles in the government and corporate fleets. Scenarios were also proposed to evaluate crash reductions associated with increased uptake of ESC in light commercial vehicles and side curtain airbag technology in all light vehicles. In addition scenarios were evaluated which embraced uptake of emerging crash avoidance technologies that specifically targeted the most frequent crash types in WA. Forward collision warning systems with autonomous emergency braking were considered to address rear-end collision types. Lane departure and fatigue warning systems were considered to address out of control crashes such as single vehicle roll-overs and hit object crashes. Lane change/blind spot warning systems were considered to address crashes from intentional lane changes such as side-swipes.

A baseline model was developed on which to test the scenarios. It focused on new vehicles first registered in 2012 projecting their crash involvements and injury outcomes over a 22 year life. The model estimated a total of 5,635 crashes and 2,320 injured occupants from crashes involving vehicles that were originally metropolitan corporate fleet vehicles, 571 crashes and 235 injured occupants involving vehicles that were originally rural corporate fleet vehicles and 359 crashes and 147 injured occupants from crashes involving vehicles that were originally government fleet vehicles. The present value total costs of these crashes to society were determined to be \$640M over the cohort lifetime using a 4% discount rate and 2006 crash and injury costs from BITRE (2009) adjusted with the CPI to 2012 values. Of the total cost, \$247M related to vehicles that were originally metropolitan corporate, \$24M to vehicles originally rural corporate vehicles and \$15M to vehicles that were originally registered as government.

Each scenario considered was applied to the baseline estimate to give total savings in crashes and costs to the community. The efficacy of each scenario at reducing the present value of crash costs was largely driven by 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 human cost of minor injuries.

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 SUVs with large vehicles and rural large SUVs with medium SUVs
 - C. Using a fleet average vehicle for the market group
 - D. Using the least aggressive model in the market group
3. Fitment of active forward collision detection and intervention operational at speeds of 80 km/h and greater
4. Fitment of active forward collision detection and intervention 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

Table 9 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. It also gives the expected number of savings in deaths and serious injuries for the cohort over its lifetime and the community social costs specifically related to deaths and serious injuries.

Table 9 : Estimated savings in community social costs associated with each alternative fleet purchasing scenario over the useful lives of the 2012-purchased fleet vehicles

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

Results in Table 9 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 most effective 4 scenarios considered.

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. Fitment costs will inevitably vary between vehicles and will reduce over time as the technology becomes more prevalent. Table 10 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.

Table 10 : 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 | |
|-----------------|------------------------------------|----------------------------------|------------------------------------|----------------------------------|------------------------------------|----------------------------------|
| Scenario | Number of affected vehicles | Gross savings per vehicle | Number of affected vehicles | Gross savings per vehicle | Number of affected vehicles | Gross savings per vehicle |
| 1 | 29,095 | \$1,638 | 4,935 | \$792 | 2,880 | \$1,072 |
| 2a | 6,077 | \$778 | 738 | \$1,125 | 456 | \$1,016 |
| 2b | 6,077 | \$2,341 | 738 | \$2,020 | 456 | \$2,627 |
| 3 | 31,000 | \$503 | 5,417 | \$285 | 3,099 | \$307 |
| 4 | 31,000 | \$3,248 | 5,417 | \$1,840 | 3,099 | \$1,952 |
| 5 | 31,000 | \$83 | 5,417 | \$47 | 3,099 | \$54 |
| 6 | 31,000 | \$188 | 5,417 | \$106 | 3,099 | \$117 |
| 7 | 31,000 | \$261 | 5,417 | \$147 | 3,099 | \$159 |
| 8 | 11,597 | \$223 | 2,381 | \$133 | 922 | \$153 |
| 9 | 5,455 | \$160 | 1,215 | \$109 | 376 | \$82 |

Table 10 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 a 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.

10.1 IMPLICATIONS OF THE RESEARCH

- This research has identified a set of priorities on which the WA government can focus to maximise the future safety of the WA vehicle fleet. It has also established a data system and analysis framework to which other vehicle safety policy and strategy options 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 WA. 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 effectiveness in a range of environments is limited.
- Improving two critical areas of fleet purchasing behaviour also offers the potential for significant road trauma savings in WA:
 - Purchase of vehicles with the highest possible crashworthiness is the first priority. It can be supported through more vigorous promotion of vehicle safety consumer information including ANCAP and the Used Car Safety Ratings 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 vehicles could be considered.
 - Reducing the aggressivity of the commercial SUV fleet through encouraging or incentivising downsizing of the SUV fleet or substitution for large cars and making good aggressivity performance a priority in the purchasing process. The ANCAP pedestrian protection test and UCSR aggressivity rating are relevant sources of consumer information that can be promoted.
- Low cost mechanisms to increase fitment of other vehicle safety technologies should be investigated. This could include the enhanced use of consumer programs to encourage manufacturer competition to fit vehicle safety technologies as standard.
- One of the major difficulties in undertaking this research was the assembly of registration data to facilitate the analysis. It is recommended that the WA Department of Transport archive snapshots of the registration system at regular intervals (say 6 monthly) including the full range of data fields. This would allow retrospective longitudinal research on the composition of the WA vehicle fleet to be undertaken more readily and accurately. It is also recommended that access to the full vehicle identification numbers for vehicles in the WA vehicle register be granted for research purposes subject to appropriate constraints on data security and use. This would allow vehicles to be tracked through the fleet over time more accurately, particularly in instances where the registration plate allocated to a vehicle has changed.

- 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. This study 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.
- It is recognised that light commercial vehicles were 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 owners greater safer and less aggressive choices, so continuing in the reduction of crash costs to society.

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