Advisory intelligent speed adaptation in government fleet vehicles

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Abstract

This paper details an economic analysis of the fitment of advisory intelligent speed adaptation (ISA) devices to state government fleets. Four devices were considered; two dedicated ISA devices, a navaid device that incorporates ISA functionality and a factory fitted multimedia centre that incorporates ISA functionality. Two installation scenarios were explored: the first where the ISA device can be taken from a government vehicle about to be sold and placed into a new government vehicle that has just been bought; the second where the device remains in the vehicle after it is sold to the public. The crash savings attributed to ISA were calculated by using the results of the New South Wales ISA trial and the Kloeden risk curve for travel speed. It was concluded that advisory ISA has the potential to reduce casualty crashes in government fleets by 20%. It was estimated that this would save 171 casualty crashes involving state government vehicles and $31.6 million in crash costs per year. The navaid device that incorporates ISA functionality would be the most cost effective, having a payback period of around a year in both scenarios considered.

Introduction

Intelligent speed adaptation (ISA), also referred to as intelligent speed assist, is a relatively new safety technology which has been demonstrated to reduce vehicle speeds in several trials overseas [1-8] and in Australia [9,10], and therefore has the potential to produce considerable safety benefits. ISA is a term that can refer to several types of device that help the driver adhere to the posted speed limit.

ISA devices can be divided into three categories: advisory, supportive and limiting. Advisory ISA devices use audio and visual signals to communicate to the driver that they are travelling above the speed limit. The audio signal might be a simple “beep” or a spoken warning. In any case, the driver is not forced to slow the vehicle to the speed limit (hence the term advisory). However some advisory devices may encourage the driver to slow down by issuing more annoying audio signals the longer the speed limit is exceeded, or the greater the amount the limit is exceeded by. Supportive devices prevent the vehicle breaking the speed limit by various methods such as ‘hardening’ the accelerator pedal, cutting fuel supply, electronically manipulating the throttle, applying the brakes or a combination of these methods. Supportive devices allow this control to be overridden. A limiting device works in the same way as a supportive device except that the driver cannot override it.

New safety technology can take a long time to become a common feature of vehicles [11]. Governments, and in particular state governments, are a significant purchaser of new vehicles in Australia. By requiring the installation of safety technology on these vehicles, governments can not only improve the safety of their fleet but also improve the safety of the general fleet as these vehicles are on-sold into the second-hand vehicle market. Government demand for new vehicle safety technology may also accelerate the introduction of these features as standard features in new vehicles sold to the general public. Government fleets may therefore have an important role to play in expanding the use of ISA in Australia.

This study had two aims: to estimate the likely reduction in crashes and crash costs that would occur if state government fleets were fitted with advisory ISA, and to assess the cost effectiveness of such a fitment. The assessment of cost effectiveness was conducted for two different scenarios:

- the advisory ISA device is kept within the government fleet by transferring a device from a vehicle that is about to be sold to a new government vehicle.
- the advisory ISA device is left in the government vehicle when it is sold.

The study only considered advisory ISA because it does not require specialist installation or total map accuracy. The analysis was also limited to the benefits within the Government fleets and did not consider any wider benefits to the general Australian fleet.

Data and methods

Payback period and benefit-cost ratio (BCR) were used as the indicators of cost effectiveness. The calculation of these indicators requires several things to be estimated or known; the cost of the ISA devices, the number of government vehicles affected, the annual number of crashes involving government vehicles, the cost of crashes involving government vehicles, the change in speeds ISA devices produce in government vehicles, and the relationship between speed and crash risk. An objective in the design of the study's methodology was to avoid having to assume that government vehicles are simply the same as other vehicles in respect of their crash involvement.

The payback period was used as the main indicator of cost effectiveness as its calculation is independent of a nominal discount period. Benefit cost ratios were also calculated using a discount rate of 8% and a discounting period of 20 years.

Cost of the ISA devices

Several devices are currently available on the market that provide advisory ISA functionality. Four devices were considered; two dedicated ISA devices (device A and device B), a navaid device that incorporates ISA functionality (device C) and a factory fitted multimedia centre that incorporates ISA functionality (device D). All suppliers were asked to provide information on the operation of their device and estimate a price given the quantity of units that state government fleets would purchase if they were fitting all their vehicles with the device. The costs of installation and map updates were also taken into account. Where no information on map update costs could be provided, the cost of map updates for device C was used.

The number of government vehicles

The number of government vehicles in Australia is difficult to measure precisely, as each state has different policies in respect of how their government fleets are managed and how they are registered. Many state governments have a central fleet management service, but this service is not necessarily used by all government departments in all states. Three approaches were taken:

- The use of registration data was preferred, as the registration data were also used to determine the corresponding crash statistics and this would provide consistency (see later).
- If registration data was not useable or available, the number of vehicles managed by the state fleet management service was used.
- If neither of these were available, the size of the fleet was calculated using new vehicle sales data and the average time that a vehicle spent in the state government fleet.

The number and cost of crashes involving government vehicles

Crash data were collected from several states, and registration records were used to identify those crashes involving a government vehicle. Crash data were disaggregated by severity and speed zone so that the effect of ISA could take account of speed zone, and so the costs of the crashes could take account of severity.

Data on crashes involving government owned vehicles were obtained from South Australia and New South Wales, with Queensland and Victoria providing limited data. As South Australia and New South Wales provided data on the size of the government fleets, it was possible to calculate crash rates for these states. These crash rates were applied to the number of government vehicles in the other states. Then, crash numbers were distributed amongst speed limits according to the unweighted average proportion of crashes occurring in different speed limit areas in New South Wales, Victoria and South Australia.

Crash costs were based on the social cost of crashes as determined by the Bureau of Infrastructure, Transport and Regional Economics [12]. Some adjustments were made to reflect consumer price index changes and the under-reporting of crashes in police data [13]. The average cost of a government crash was calculated using the percentage of crashes involving a government vehicle of a given severity and the costs of a crash at such a severity. These average costs per crash were calculated for each state.

The speed change due to ISA in government vehicles

For this study, the effect that advisory ISA has on travel speed was taken from a recent trial conducted by the New South Wales Centre for Road Safety in the Illawarra region of New South Wales. The results of this trial were chosen because it was undertaken in Australia, used an advisory ISA device which is commercially available in Australia and included 41 fleet vehicles from private companies. The travel speeds and the responses to the ISA system of these 41 vehicles were used in the analysis on the basis that the style of driving in these vehicles might best reflect the behaviour of government fleet vehicle drivers. For more information on the New South Wales ISA trial see the report from the New South Wales Centre for Road Safety [9].

In order to use the speed measurements from the New South Wales ISA trial to calculate relative crash risk, they were first weighted by speed to produce distance-based distributions of travel speeds. The percentage of distance travelled at each speed was calculated separately for the periods with and without ISA.

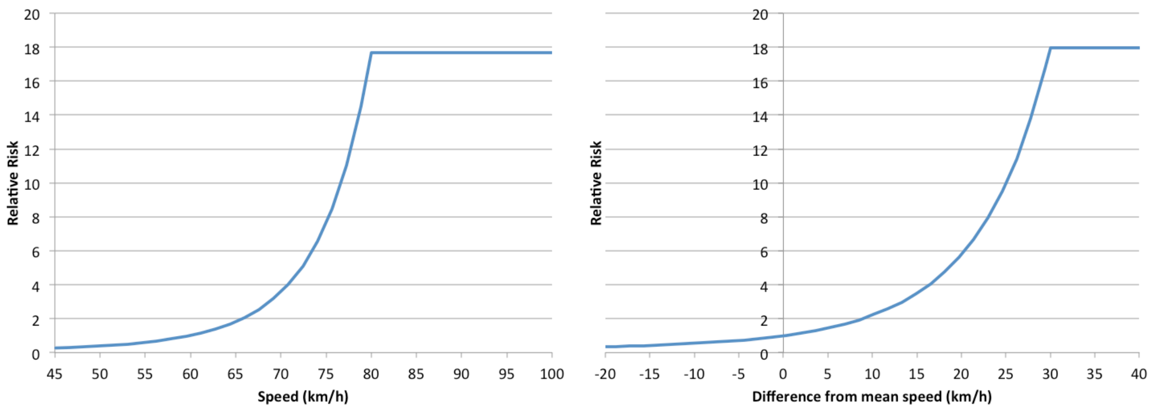
The relationship between speed and crash risk

The difference in crash risk between two speed distributions can be calculated by applying a crash risk function to each distribution. The crash risk functions reported by Kloeden and colleagues [14, 15] were used. For this study, the risk curve was capped above 80km/h in 50, 60 and 70km/h zones and at 30km/h above the mean speed in 80, 100 and 110km/h zones. The curves were capped for two reasons:

- to minimise the impact of small, potentially variable, amounts of high level speeding, and
- because the validity of risk curves at high speeds is uncertain.

The effect of capping the risk curves was to produce a conservative estimate of benefit. The risk curves can be seen in Figure 1.

Figure 1: The risk curves for speed zones less than 80km/h (left) and 80 km/h and higher (right)



Combining crash risk and speed distributions to estimate changes in crash numbers

The relative crash risk of the speed distributions measured in the "before" and "during" ISA periods were calculated by multiplying each respective distribution by the relevant risk curve in Figure 1 – that is, the relative risk at a given speed was multiplied by the frequency of that speed in the distribution. The total relative risk for each distribution was then given by the summing the product over all speeds.

The reduction in relative risk in the "during" period indicates the proportional crash reduction due to ISA. Potential crash reductions can then be calculated by multiplying this change in risk by the number of crashes involving government vehicles. These reductions can then be monetised to estimate the resulting reduction in crash costs.

Scenarios for economic analysis

Two scenarios were considered for the economic analysis. In Scenario 1 the device is removed from the government vehicle when that vehicle is sold and placed in a new government vehicle. In Scenario 2 the device is left in the government vehicle when it is sold. In the latter scenario, the benefit is transferred to a new owner, but for the present purpose, this benefit is neglected. Device D could only be considered in the context of the second scenario, as it cannot be transferred to another vehicle.

Results

Table 1 shows the costs of the ISA devices in the quantities that state governments might purchase them. Annual data costs refers to costs associated with updating the data on the device, such as speed limit locations. Note that Device C is much cheaper than the other devices.

Table 1: The costs of the ISA devices

	Device A	Device B	Device C	Device D
Purchase price	500	800	135	777
Installation price	100	250	0	-
Annual data costs	60	50*	50	50*

*assumed value

Benefit of advisory ISA on government vehicles

The percentage reductions in crash risk for fleet vehicles in the New South Wales ISA trial were calculated as described earlier. The results are shown, by speed zone, in Table 2.

Table 2: Percentage reduction in fleet vehicle crash risk produced by advisory ISA in the NSW ISA trial, by speed zone

Speed Limit	Crash risk reduction
50	18.8%
60	22.8%
70	27.2%
80	15.3%
90	21.2%
100	18.2%
110	19.6%

Table 3 shows the estimated yearly reductions in government vehicle casualty crashes, as well as the monetary savings that are produced by these reductions. Casualty crashes would be reduced by around 20% in all states. Note that the percentage reductions are the same for Queensland, Tasmania and Western Australia because the crash numbers are derived from a common source, as described earlier. Overall, around 170 casualty crashes and 31.6 million dollars could be saved per year by fitting ISA to government vehicles.

Table 3: Government vehicle casualty crashes saved per year with ISA by state and speed zone

	State						
Speed Limit	NSW	QLD	SA	TAS	VIC	WA	Total
50	26.8	6.6	2.8	1.5	4.1	4.0	45.8
60	35.6	11.5	6.5	2.7	7.4	6.9	70.6
70	11.1	2.6	0.5	0.6	2.5	1.6	18.9
80	5.0	1.6	0.6	0.4	1.4	1.0	10.0
90	1.1	0.3	0.3	0.1	0.1	0.2	2.1
100	6.6	3.2	1.3	0.7	3.5	1.9	17.2
110	1.8	1.3	1.5	0.3	0.2	0.8	5.9
Total	88.0	27.2	13.5	6.3	19.2	16.3	170.7
Percentage	20.4%	20.0%	19.9%	20.0%	19.8%	20.0%	20.2%
Savings ($)	14,701,625	5,635,478	1,946,866	1,068,315	4,892,410	3,363,390	31,608,085

Economic analysis

The payback periods calculated for scenario 1 are shown in Table 4. Although a discount rate of 8% was used in the analysis, sensitivity testing showed that there was little difference in the results when other discount rates, even as low as 4%, were used. In some cases the devices do not return benefits that exceed their costs. Payback periods for device A varied from 4.2 years to 12 years. It appears that device B would generally not pay for itself under the assumptions made in this analsysis. Device C would appear to be able pay for itself in less than a year.

Table 4: Payback period (years) for installing advisory ISA in government vehicles – scenario 1

State	Device A	Device B	Device C
NSW	5.5	NA	0.7
QLD	4.7	NA	0.5
SA	11.6	NA	0.8
TAS	8.1	NA	0.7
VIC	12.0	NA	0.8
WA	5.2	NA	0.6

Table 5 shows the BCRs for Scenario 1 by device and state. While there is variation between states this does not cause the BCR to be above one in some states and below one in others, for a given device.

Table 5: BCRs for installing advisory ISA in government vehicles – scenario 1

State	Device A	Device B	Device C
NSW	1.45	0.87	3.98
QLD	1.48	0.83	4.74
SA	1.10	0.63	3.43
TAS	1.21	0.68	3.87
VIC	1.09	0.61	3.49
WA	1.39	0.77	4.71

The payback periods calculated for Scenario 2 were calculated. Under the assumptions of this scenario (that the device is only in possession of the government as long as the host vehicle) only device C has a calculable payback period and this figure ranged across periods of 0.8 to 1.2 years (which were slightly higher than under Scenario 1, given the ongoing replacement costs).

Table 6 shows the BCRs for scenario 2 by device and state. As in scenario 1, variation between states does not cause the BCR to be above one in some states and below one in others, for a given device.

Table 6: BCRs for installing advisory ISA in government vehicles – scenario 2

State	Device A	Device B	Device C	Device D
NSW	0.90	0.58	2.60	0.76
QLD	0.82	0.52	2.61	0.68
SA	0.63	0.39	1.95	0.52
TAS	0.67	0.42	2.13	0.55
VIC	0.61	0.38	1.92	0.50
WA	0.75	0.46	2.44	0.61

Device D has many multimedia functions besides advisory ISA that may have a residual value that adds to the resale value of the vehicle. The residual values of device D required to produce a BCR of one (break even) were found to range from $294 to $539, or 37 to 70% of the devices original cost (using an 8% discount rate).

Discussion

Data on government vehicles are not easily obtained, especially crash data. Ideally the analysis in this report would have utilised detailed crash and general data on government vehicles from every state. As such data were not readily available from every state, the data that could be obtained had to be generalised to those states in which the applicable data could not be obtained. The validity of the results is therefore partly dependant on the accuracy of such generalisations. However, such generalisations were made on the assumption that a reasonable approximation of the actual result would be achieved.

The effectiveness of advisory ISA is based on the speed behaviour of 41 private fleet vehicles in the New South Wales trial. The analysis in this report assumes that the effect of advisory ISA on the drivers of these fleet vehicles in Illawarra, New South Wales, is representative of the effect that advisory ISA would have on the drivers of government vehicles across Australia. It should be noted that this represents and improvement over previous work that, by necessity, relied on the results of international trials, but nevertheless brings with it its own limitations.

The safety effect of ISA was limited to the change in speed behaviour. While some secondary effects of ISA have been noted in the literature (both positive and negative) these were considered outside the scope of this study.

The analysis assumed that every device was equal in effectiveness to device A, the device used in the New South Wales trial. This assumption is likely to be more accurate for some devices than others. Device B is a dedicated ISA device, like device A, and should therefore have similar effectiveness. Device C is a navaid device with advisory ISA functionality. With appropriate customisation (such as repetition of audible warnings if speeding continues) this device is likely to be similar in effectiveness to device A (the cost of customisation has been included in the price). In its current format, device D is unlikely to be as effective as device A as it includes no audible warning that the speed limit is being exceeded. At the time of writing the authors were advised that customisation of this device to include an auditory warning is not currently an option. For this reason the economic analysis of device D should be treated with caution.

Devices A, B and C can be switched off by the driver when the vehicle is being driven. This is not currently an option on device D. Ideally, an advisory ISA device should not be able to be switched off. Jamson [16] found that, if given an option, those that are most in need of ISA are the least likely to use it. Deactivation of advisory ISA is included in the results of the New South Wales ISA trial and therefore did not need to be accounted for specifically in this study. The New South Wales Centre for Road Safety was not able to directly measure the prevalence of ISA device deactivation in the New South Wales ISA trial, but rather it relied upon an online questionnaire administered after the effect stage. This survey showed that 10% of the exclusive drivers of vehicles reported that they turned off the ISA device regularly [9]. If an advisory ISA device can be made in such a way that it cannot be switched off when the vehicle is in motion the effect of ISA, and therefore the cost effectiveness shown in the results, would be expected to increase. An ISA device should only allow temporary ‘override’ to allow for map inaccuracies.

The prices used in the economic analysis were provided by the manufacturers of the devices for the purposes of research. While every endeavour was made to ensure they were an accurate representation, they were not official quotes and therefore the price may vary somewhat if a government negotiates an actual order. It is also possible that the prices of devices may reduce in time, especially the price of dedicated ISA devices. If this were to occur the payback periods would reduce and the BCRs would increase.

In scenario 2 the ISA device remains in the vehicle when it is sold. This scenario would, over time, result in about four to five per cent of vehicles in Australia being equipped with advisory ISA. If advisory ISA can reduce casualty crashes by 20%, scenario 2 would eventually produce a casualty crash reduction of around one per cent. This may seem insignificant; however, given the national cost of casualty crashes in Australia is around $13.48 billion (2006 dollars) [12], a one per cent reduction in casualty crashes would produce crash cost savings of $135 million. Such savings were not included in the economic analysis as it was considered outside the scope of this report; however, such benefits should not be ignored when comparing scenario 1 and 2.

The analysis assumed that speed limit maps are complete, as they were for the New South Wales ISA trial in Illawarra. Currently speed limit maps used by the devices cover major cities, some rural centres, and major interconnecting highways. The coverage of the commercial speed limit maps is increasing. The exact coverage may vary from device to device, depending on the map provider the device uses. Most states are progressing towards producing completed speed limit maps of their states, with Victoria and Western Australia having completed theirs already. Unless government vehicles spend a significant proportion of their journeys on minor rural roads the assumption of map completeness is reasonably close to the current and future situation, albeit an overestimation. It should also be noted possible differences in map coverage between the devices was considered outside the scope of this report and was not taken into account in the analysis.

Factors other than the calculated payback period and BCR may be important when comparing the devices:

- Device A can automatically update its speed limit maps producing greater map accuracy.
- It is likely that the speed limit maps of Device A are more comprehensive than device C and D.
- Device B does not currently include a speed limit map.
- Device A has the capability to transmit data and can therefore be used for monitoring purposes. It can also be expanded to include a vibrating accelerator pedal.
- Device B can be expanded to function as a supportive or even limiting ISA.
- Device C is not wired into the vehicle. This results in no installation costs, but makes it less secure and more likely to be switched off.
- Device D may have a residual value that adds to the resale value of the vehicle. This residual value must be at least $539 for it to be cost effective in all situations considered. This is equivalent to 70% of its original value.

Conclusions

Advisory ISA has the potential to reduce casualty crashes in government fleets by 20%. It was estimated that this would eliminate 171 casualty crashes involving state government vehicles per year and save $31.6 million in crash costs per year.

Four devices currently available that provide advisory ISA functionality were identified and analysed for their cost effectiveness. This economic analysis revealed that the navaid device that included ISA functionality (device C) had a payback period of around a year, and was cost effective regardless of the scenario being considered. The two dedicated ISA devices considered produced varied results. Device B was not cost effective for either scenario. Device A produced payback periods between four and 12 years and was cost effective for the scenario where the ISA device was removed and recycled into a new government vehicle when the original vehicle was sold (scenario 1), but was not cost effective for the scenario in which the ISA device remains in the government vehicle when it is sold (scenario 2). The multimedia centre that includes basic advisory ISA functionality (device D) was not found to be cost effective when residual value was not considered. To be cost effective under all circumstances that were considered in the analysis, device D would need to retain 70% of its original value when the government vehicle is sold.

References

1. Adell E, Várhelyi A, Hjälmdahl M (2008), 'Auditory and haptic systems for in-car speed management: a comparative real life study', Transportation research part f, 11, pp. 445-458.

2. Biding T, Lind G (2002). Intelligent speed adaptation: results of large-scale trials in Borlänge, Lidköping, Lund and Umeå during the period 1999-2002. 2002:89 E. Borlänge: Vägverket – Swedish National Road Administration.
3. Carsten O, Fowkes M, Lai F, Chorlton K, Jamson S, Tate F, Simpkin B (2008). ISA – UK: final report. Leeds: Institute for Transport Studies, University of Leeds and MIRA Ltd.
4. Driscoll R, Page Y, Lassarre, Ehrlich J (2007) 'LAVIA – an evaluation of the potential safety benefits of the French intelligent speed adaptation project' in Proceedings of the 51st AAAM Conference, Melbourne, Australia, 15-17 October 2007.
5. Oei HL, Polak PH (2002), 'Intelligent speed adaptation (ISA) and road safety' International association of traffic and safety sciences research, 26(2), pp 45-51.
6. Taylor GW (2006). Speed choice and modelling of the impacts of speed on safety and the environment, Ontario: G.W. Taylor Consulting
7. Várhelyi A, Hjälmdahl M, Hydén C, Draskóczy M (2004), 'Effects of an active accelerator pedal on driver behaviour and traffic safety after long-term use in urban areas', Accident analysis and prevention, 36, pp. 729-737.
8. Vlassenroot S, Broekx S, De Mol J, Int Panis L, Brijs T, Wets G (2007), 'Driving with intelligent speed adaptation: final results of the Belgian ISA-trial', Transportation Research Record Part A, 41, pp. 267-279.
9. New South Wales Centre for Road Safety (2010). Results of the NSW intelligent speed adaptation trial: effects of road safety attitudes, behaviours and speeding. RTA/Pub. 10.327. Wollongong: New South Wales Centre for Road Safety.
10. Regan M, Young K, Tomasevic N, Mitsopoulos E, Tierney P, Healy D, Connelly K, Tingvall C (2005) 'Final results of a long-term evaluation of intelligent speed adaptation, following distance warning and seatbelt reminder systems: system and interactive effects' in Proceedings of 12th World Congress on ITS, San Francisco, United States of America, 6-10 November 2005.
11. Truong J, Cockfield S, Thompson J, Gubana J and Mulholland E (2010). 'Case study – penetration of electronic stability control and curtain airbags in the Victorian market' in Proceedings of the 2010 Australasian Road Safety Research, Policing and Education Conference, Canberra, Australia, 31 August – 3 September 2010.
12. BITRE (2009). Cost of road crashes in Australia 2006. BITRE118, Canberra: Bureau of Infrastructure, Transport and Regional Economics.
13. Doecke S and Woolley JE (2011). Cost benefit analysis of intelligent speed assist. CASR093. Adelaide: Centre for Automotive Safety Research.
14. Kloeden CN, Ponte G, McLean AJ (2001) Travelling speed and the risk of crash involvement on rural roads, CR 204, Adelaide: Road Accident Research Unit for Canberra: Australian Transport Safety Bureau.
15. Kloeden CN, McLean AJ, Glonek G (2002) Reanalysis of travelling speed and the risk of crash involvement in Adelaide South Australia, CR 207, Adelaide: Road Accident Research Unit for Canberra: Australian Transport Safety Bureau.
16. Jamson S (2006), 'Would those who need ISA, use it? Investigating the relationship between drivers' speed choice and their use of a voluntary ISA system' Transportation research part f, 9, pp. 195-206.