Preliminary analysis of Intelligent Speed Assist and Heavy Vehicles: A trial to assess safety, fuel consumption and driver acceptability

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Abstract

The road safety benefits of Intelligent Speed Assist (ISA) have been demonstrated in a number of projects worldwide. These benefits, however, are yet to be replicated in the heavy vehicle industry. With freight travel by road predicted to double by 2020, fuel costs predicted to rise and environmental issues looming large, the role of speed management in helping companies to reduce crashes, contain costs and remain competitive is likely to play an increasingly important role in the operational plans of many transport operators. In this regard, ISA may have an important role to play. A small-scale trial conducted by the Transport Accident Commission (TAC) in collaboration with the Victorian Transport Association (VTA) and with the cooperation of several heavy vehicle companies sought to assess the relative merits of ISA in terms of speed choice, fuel consumption, and driver acceptability. This paper discusses some preliminary results from Phase One of the data analysis.

Key words: Intelligent Speed Assist (ISA), Heavy Vehicles, acceptability

Introduction

In the 2008/2009 financial year, 222 people were killed as a result of 206 crashes that involved articulated trucks and heavy rigid trucks (i.e., heavy vehicles) in Australia [1]. With road freight predicted to double by 2020, fuel costs expected to rise and environmental issues looming ever larger [2], the role of speed management in helping companies to reduce crashes, contain costs and remain competitive is likely to play an increasingly important role in the operational plans of many transport operators.

A range of studies have documented the benefits of Intelligent Speed Assist (ISA) technology in 'reducing speed, speed variability and speed violations' [3] (p.936), though these effects are reportedly more likely to be associated with ISA devices that are more controlling than simply the provision of advisory warnings These effects have however been demonstrated in passenger cars but not heavy vehicles. In a comprehensive review, Regan, Young and Haworth [4] examined the likely benefits of the installation and rollout of ISA devices in light and heavy vehicles and concluded that ISA systems have the potential to deliver a range of benefits for the heavy vehicle industry, including improved speed control and improved fuel efficiency. It remains the case however that the on-road efficacy of ISA systems is yet to be determined.

To address this gap, the Transport Accident Commission (TAC) in collaboration with the Victorian Transport Association (VTA), and with the cooperation of three heavy vehicle transport companies, conducted a small scale trial in an attempt to assess the relative merits of ISA in terms of speed choice, driver acceptability and fuel consumption. This paper reports on the first phase of the analysis of the project, with particular emphasis on device acceptability, and an analysis of the on-road driving behaviour of two drivers before and after the installation of the device.

Method

Design of the trial

The trial was designed as a pre-post study of the effectiveness of an advisory ISA system installed into six trucks, two from each of the three participating companies. Seven drivers were the focus of the study, each of whom completed a questionnaire both before and after the completion of the study.

Participating companies/vehicles were selected based on the following criteria:

- significant Victorian-based long distance travel undertaken by a number of company vehicles;

- trucks in the study are similar makes and models and operate repeat trips within Victoria;
- the company is committed to providing data for evaluation purposes and to allow access to drivers for a briefing session and to complete pre-/post-questionnaires.

Device installation: The ISA technology deployed was advisory only - that is, it did not limit the speed of the vehicle but simply provided the driver with auditory and visual warnings when the speed limit was exceeded.

Prior to the installation of the ISA system, a GPS data logger was installed into the truck to collect speed and associated trip data. Drivers were aware of the data logging capability of the GPS device, however the drivers could not see or interfere with the device.

The ISA device was then installed a number of weeks following the installation of the GPS device. No data was collected by the advisory ISA device; rather it served purely to advise the driver of the speed limit at each particular moment in time. The driver could override and switch the ISA device off if needed. No data was collected from the ISA device or vehicle speedometer.

Data collected in the trial included a pre-post participation questionnaire, and the logged trip data, which is referred to as the GPS-Enhanced data. Each is discussed below.

Data sources

Survey data

A *pre-trial survey* was completed by each participating driver with the aim of capturing a range of attitudes to speeding and the likely benefits of smart technology in aiding the driving process.

A *post-trial survey* was completed with a view of collecting attitudes to the ISA device in terms of its usability and its acceptability. A number of attitudinal questions were repeated from the pre-trial survey, permitting a pre-post analysis to be undertaken.

Logged data

GPS data - The GPS device collected detailed information in 15 second cycles continuously. For each timing cycle, speed (km/h) was captured as was GPS co-ordinates, time and date, distance covered (metres) and bearing / heading.

Enhanced data - The data was enhanced through the linkage of the Victorian road network by way of Geographic Information System GIS software, using the longitude and latitude of each cycle. Of particular relevance was the assignment of the speed limit of the relevant road for each recorded cycle. Allowance was given for school day periods and associated school speed zones and shopping zones with variable speed zones.

Data preparation and analysis

Survey data – a database was constructed to permit analysis of the survey data which is presented in Section 1 of the Results. Median values and the associated range among respondents were presented due to the ordinal nature of most of the items and the small sample size. Non-parametric statistics were used to examine pre-post survey responses where appropriate [5].

Logged data analysis – A single database was created which contained all logged data. Analysis of the effect of ISA is presented for two vehicles, and the analysis includes those time cycles 'where the vehicle was in motion and the speed limit of the road was known'. Hence, this excludes cycles: i) where the vehicle was not in motion (including when stationary at lights or off-road), and / or ii) where the assigned speed of the vehicle was unknown. To examine the change, if any, associated with the number of timed cycles the vehicle exceeded the assigned speed limit, calculation of the percentage point difference in cycles over the speed limit was determined overall and then individually for each speed zone. Logistic regression using robust standard error estimates to account for the repeated nature of the data were calculated to determine any difference in the odds of exceeding the assigned speed limit in the post-ISA installation period relative to the pre-ISA installation period [6].

Analysis was conducted in STATA and SPSS.

Results

Section 1: Pre-post questionnaires

Participant demographics

Seven drivers participated in the study and all were male. The median age-group was 40 to 49 years, with a range of 30 to 39 years to over 60 years. The majority (4, 57%) of drivers had between 17 to 20 years of driving experience, with one driver having 10 years of experience and another with 45 years of experience; the driving experience for the remaining participant was unknown.

Two of the seven drivers reported having been fined for speeding in a heavy vehicle within the last five years, with one being fined twice during that time-frame. None of the drivers had heard of ISA prior to discussions with the TAC about their participation in the trial.

Pre-ISA use

Prior to experiencing ISA, drivers were asked about the perceived usefulness of the system and their speeding behaviour by rating their agreement with a number of statements on a five point scale, ranging from (1) strongly agree to (5) strongly agree.

Six of the seven drivers agreed or strongly agreed that a device that informed them they were exceeding the speed limit would be useful, as would a device that prevented them from speeding (4 drivers). All but one of the drivers (6) indicated they sometimes exceeded the speed limit without realising it (Table 1.1).

Table 1.1. Perceived usefulness of ISA and speeding behaviour prior to using ISA.

	Median rating (range)
A smart device that told me whenever I went over the speed limit would be useful	4: agree (2: disagree to 5: strongly agree)
A smart device that stopped me from going over the speed limit would be useful	4: agree (2: disagree to 5: strongly agree)
I go over the speed limit sometimes without realising it	4: agree (3: neither agree nor disagree to 4: agree)
I am always aware of the speed limit	3: neither agree nor disagree (2: disagree to 5: strongly agree)

Post-ISA use

After their experience using ISA on-road, drivers were asked to rate ISA according to how useful it was, its road safety benefits, how helpful it was, and how accurate it was, using a 10 point scale.

Five of the seven drivers reported finding the system useful and to have road safety benefits, rating it as 5 or above on a 10 point scale. Six drivers reported finding the system helpful in preventing them from speeding, rating it as 5 or above on the 10 point scale. Drivers' opinions were more divided in terms of the accuracy of the speed limit map, with two drivers rating it as very poor, while four drivers gave it a better rating of 6 or above on a 10 point scale (Table 1.2).

Table 1.2. Usefulness and accuracy of ISA

	Rating scale	Median rating (range)
How useful was the ISA system	1= Not at all useful 10= Extremely useful	5 (2 to 8)
How would you rate the road safety benefits of ISA	1= No road safety benefits 10=Excellent road safety benefits	6 (2 to 8)
How helpful was ISA in preventing you from speeding	1= Not helpful at all 10= Very helpful	6 (2 to 10)
How accurate were the speed limits in the digital map database	1=Very poor 10= Excellent	6 (1 to 7)

Drivers were also asked to rate their level of agreement with certain statements about the ISA system and their driving behaviour while using ISA. Driver opinion was divided with regard to these statements (Table 1.3). Three drivers disagreed that ISA warnings were unnecessary in lower speed zones, while two drivers agreed with this statement. While three drivers agreed that they looked at the speedometer less often when ISA was active, two drivers strongly disagreed with this statement. Four drivers agreed or strongly agreed that they were tailgated because they were driving at the speed limit, whereas two disagreed. None of the drivers felt that after having ISA fitted that they drover faster around corners and bends. Three drivers disagreed or strongly disagreed that using ISA allowed them to concentrate more on driving, whereas two drivers agreed with this statement.

Table 1.3. Driving behaviour when using ISA

	Median rating (range) on 5 point scale
Warnings from the ISA were unnecessary in speed zones of 70 km/h or less	3: neither agree nor disagree (2: disagree to 4: agree)
I looked at the speedo less often with the ISA in the truck	3: neither agree nor disagree (1: strongly disagree to 4: agree)
I was tailgated because I was driving at the speed limit	4: agree (2: disagree to 5: strongly agree)
After having ISA fitted, I drover faster around corners and bends	2: disagree (1: strongly disagree to 3: neither agree nor disagree)
Use of the ISA allowed me to concentrate more on my driving	3: neither agree nor disagree (1: strongly disagree to 4: agree)

Attitudes to speeding before and after using ISA

Both before and after using ISA, drivers were asked to rate their level of agreement on a five point scale with various statements relating to their knowledge of the relationship between speeding and crash and injury risk, and attitudes of the acceptability of speeding and speeding enforcement. In general, drivers expressed fairly conservative views about the acceptability of speeding, indicating that they did not believe it was safe and that it was not OK to speed if 'you were driving safely or on familiar roads' (Table 1.4). Where data was available for drivers' opinions both before and after ISA use, the Wilcoxon signed ranks test was used to determine if the level of agreement changed over time. The drivers' level of agreement, i.e. their opinions, did not differ significantly after using the ISA for any of the statements ($p>0.05$). It must be noted that with only seven participants, it is unlikely there is sufficient statistical

power to detect any effects however visual inspection of the data does not reveal any notable changes over time.

Table 1.4. Drivers' opinions of the relationship between speeding, crash risk and injury severity and the acceptability of speeding and speeding enforcement

	Median rating (range)	
	Before ISA	**After ISA**
Driving 5 km/h over the speed limit is not really speeding	2: disagree (1: strongly disagree to 3: neither agree nor disagree)	Not asked at this time
In a crash speeding by even a couple of kilometres per hour can make a difference to the severity of injuries	4: agree (3: neither agree nor disagree to 5: strongly agree)	Not asked at this time
Speeding is always wrong	4: agree (2: disagree to 5: strongly agree)	4: agree (2: disagree to 5: strongly agree)
I think it is ok to drive a little bit faster if you are a good driver	2: disagree (1: strongly disagree to 3: neither agree nor disagree)	2: disagree (1: strongly disagree to 3: neither agree nor disagree)
I think it is ok to drive in excess of 100 km/h in a 80 km/h zone if the road conditions are good and there is nobody around	1: strongly disagree (1: strongly disagree to 2: disagree)	1: strongly disagree (1: strongly disagree to 3: neither agree nor disagree)
I think it is ok to drive over the speed limit if you are driving safely	2: disagree (1: strongly disagree to 4: agree)	2: disagree (1: strongly disagree to 3: neither agree nor disagree)
You are more likely to be involved in a crash if you increase your speed by 5 km/h	3: neither agree nor disagree (2: disagree to 5: strongly agree)	4: agree (2: disagree to 5: strongly agree)
A crash at 70 km/h will be much more severe than a crash at 60 km/h	5: strongly agree (2: disagree to 5: strongly agree)	4: agree (4: agree to 5: strongly agree)
It is easy to avoid being caught speeding	2: disagree (1: strongly disagree to 3: neither agree nor disagree)	2: disagree (1: strongly disagree to 3: neither agree nor disagree)
It does not bother me if other people drive over the speed limit	2: disagree (1: strongly disagree to 4: agree)	2: disagree (1: strongly disagree to 4: agree)
It is safe to drive over the speed limit on roads that are familiar	2: disagree (1: strongly disagree to 3: neither agree nor disagree)	2: disagree (1: strongly disagree to 3: neither agree nor disagree)
Speeding enforcement is more for revenue raising than for safety	3: neither agree nor disagree (1: strongly disagree to 4: agree)	3: neither agree nor disagree (2: disagree to 5: strongly agree)
Speed limits on most roads are too low	3: neither agree nor disagree (2: disagree to 5: strongly agree)	2: disagree (2: disagree to 5: strongly agree)
People who drive over the speed limit are major contributors to crashes	4: agree (2: disagree to 5: strongly agree)	4: agree (2: disagree to 5: strongly agree)

Driver preference for ISA design

Drivers were asked to indicate their preferences for the design of the human machine interface and level of control for the ISA system. Two drivers stated they would prefer an ISA that only displays the speed limit when they are speeding, while three drivers would prefer the speed limit to be constantly displayed. Three drivers indicated a preference for an advisory system that only warns the driver if they are over the speed limit, while only one driver would prefer a system that physically prevented the driver from speeding. Two drivers would prefer a system that could not be turned off, while two preferred a system that could be turned on or off depending on the driving conditions.

All drivers also felt that the default setting of the ISA was bright enough during both the day and the night. Most (6) drivers felt the default volume of the auditory warnings was acceptable; however one driver found it was too loud. Six drivers found that they could hear the ISA system when the vehicle radio was used at a normal volume, while the remaining driver stated that it depended on the song that was being played. Most (6) felt that you should be able to adjust the volume control.

Drivers were asked about the position of the ISA unit, specifically whether it blocked visibility and whether it was easy to reach and operate. Most drivers found that the unit was positioned appropriately (Table 1.5). Two drivers provided extra comments about the position; one suggested it was fine, another requested for it to be in the dash so as not to be in the line of sight.

Table 1.5. Driver opinion of position of ISA unit

	Median rating (range)
The position of the unit does not block visibility of the road	4: agree (2: disagree to 5: strongly agree)
I can reach and operate the ISA easily	4: agree (2: disagree to 5: strongly agree)

Practical issues with the ISA system

Three of the seven drivers expressed that they needed to override the ISA system during the trial period. The reasons for this related to the ISA system displaying the incorrect speed zone; in one case the driver was out of the map zone, in another, the system was detecting speed zones of side-roads while he was on the freeway. In the final case, the system indicated that the driver was in an 80 km/h zone when in fact he was in a signed 100 km/h zone.

Two drivers needed to turn off the ISA during the trial period. One driver disliked the auditory warnings while the other disliked the system due to inaccuracies in the speed zoning.

All drivers that received the printed instruction card found it easy to understand and follow.

Future trial involvement & additional comments

Drivers were asked about their desire to be involved with ISA trials in the future. Five drivers indicated that they would not be interested if ISA was made available to them for a further trial, while only one driver indicated that they would be interested. Only two drivers believed that all heavy vehicles should have an ISA system installed, while four drivers did not share this belief.

Finally, drivers were asked if they had any additional comments about the system. One driver expressed the opinion that the digital map needs to be improved, presumably for the accuracy of speed limit information. Another driver suggested that although it is fine to inform a driver if they are going over the speed limit, he would prefer a system that shows when you are about to go over the speed limit instead.

One driver expressed the opinion that the ISA system is unnecessary, because he believes there are more than enough speed signs to inform drivers of the speed limits.

Section 2. Speed-based ISA analysis

Table 2.1 presents the data collected by the GPS unit and the post-trial linkage with the latitude and longitude specific speed zone for two of the trucks in the trial. In total, 242,148 15-second data cycles were recorded for Truck 1 and of these a speed zone was assigned for 85.6% of cycles. Truck 2 had fewer recorded cycles (135,703), of which 81.8% of co-ordinate sites were assigned a speed zone by the post-trial linkage with the Victorian Road Network Database. The table also differentiates between the vehicles 'not moving' – either at lights or parked on-road, and the GPS recorded speed relative to the speed limit. Table 2.1 also presents the number of pre and post ISA installation days.

In addition to cycles where the assigned speed limit was unknown, it is critical to note that the assignment of speed zones is subject to a small degree of error due to the data logged by the GPS unit and the post-trial matching and assignment of speed zones. In-depth analysis indicates that this matching error is more likely to be associated with the lower speed zones – particularly the 50km/h zones, where the longitude and latitude co-ordinates assigned the lower limit perpendicular (side) road to the road being driven on. It is most likely that the error was systematic, and hence the same before and after the ISA device was installed into the vehicles. Consequently, the percent difference in cycles over the assigned limit is presented and further work is being undertaken in an attempt to i. determine the error rate, and ii. correct the speed zone assignment where necessary.

Table 2.1. Overall data collected, including data relating to speed limit assignment

	Truck 1	Truck 2
Time cycles captured	242,148	135,703
Assigned limit known	207,455 (85.6%)	110,981 (81.8%)
Under or at limit	158,187 (65.3%)	92,518 (68.2%)
Over limit	26,455 (10.9%)	6694 (4.9%)
Vehicle not moving	22,813 (9.4%)	11,769 (8.7%)
Limit unknown	34,693 (14.4%)	24,722 (19.2%)
Vehicle moving	9534 (3.9%)	16,092 (11.9%)
Vehicle not moving	25,159 (10.4%)	8630 (6.4%)
Pre-ISA data collection period (days)	24	23
Post-ISA data collection period (days)	36	36

Effect of the ISA device on driving performance

Analysis of Driver 1 (Truck 1) data

Data was captured for 184,642 15-second cycles, of which 43,442 were captured prior to the installation of ISA (23.5%). Table 2.2 presents the percentage point difference in the number of 15-second logged data cycles where the truck travelled above the specified speed in the post-ISA installation period compared to the pre-installation period. In addition, odds ratio information is presented and these indicate the degree, or odds of exceeding the assigned speed limit for the post-ISA installation period compared to the pre-installation period.

Across all speed zones, the percentage difference in the number of 15-second logged data cycles travelling >= 5km/h over the assigned speed limit was +0.5%; that is, in the pre-ISA installation period, the percentage cycles over-limit was 4.6% while in the post-ISA installation period drivers exceeded the limit in 5.1% of recorded cycles. For exceeding the limit by >=10 km/h, the percent difference was +0.1%, while the pre-post difference for exceeding the assigned speed limit by 25km/h or more was -0.2%.

For Driver 1, modelling of the effect of the installation of ISA indicated a 12% increase in the odds of driving 5km/h or beyond the posted limit in any one cycle (OR: 1.12, CI: 1.06-1.18, p<0.05), however there was no difference pre-post in exceeding the limit by 10km/h or more (OR: 1.05, CI: 0.98-1.13). There was an observed reduction (33%) in the odds of exceeding the speed limit by 25km/h or more, across all speed zones (OR: 0.67, 0.58-0.79, p<0.05).

Table 2.2. Percentage of recorded 15 second cycles exceeding the limit (by specified amount), by speed zone, and associated Odds Ratios, Truck 1

Speed zone and over-limit speed	Percentage point difference in cycles over-limit	Over-limit cycles in the post period relative to the pre-period		
		Odds ratio	CI	P
40 km/h speed zone				
Over limit >=5km/h	-1.9%	0.82	0.51 - 1.31	0.4
Over limit >=10km/h	-1.0%	0.75	0.36- 1.57	0.4
Over limit > = 25km/h	-1.7%	0.21	0.05 – 0.80	0.02*
50 km/h speed zone				
Over limit >=5km/h	-0.8%	0.95	0.84 – 1.07	0.4
Over limit >=10km/h	-1.3%	0.89	0.77 -1.02	0.1
Over limit > = 25km/h	-2.1%	0.74	0.62 – 0.88	<0.001*
60 km/h speed zone				
Over limit >=5km/h	+1.6%	1.23	1.10-1.38	<0.001*
Over limit >=10km/h	+0.4%	1.11	0.94-1.31	0.2

Over limit > = 25km/h	+0.1%	0.92	0.63-1.33	0.6
70 km/h speed zone				
Over limit >=5km/h	+3.1%	1.51	1.21 – 1.89	<0.001*
Over limit >=10km/h	+0.9%	1.85	1.08-3.18	0.02*
Over limit > = 25km/h	+0.2%	4.20	0.54 – 32.5	0.2
80 km/h speed zone				
Over limit >=5km/h	+2.5%	1.33	1.21 – 1.45	<0.001*
Over limit >=10km/h	+1.1%	1.25	1.11 – 1.41	<0.001*
Over limit > = 25km/h	-0.0002%	0.30	0.04-2.20	0.2
90 km/h speed zone				
Over limit >=5km/h	+3.1%	1.17	0.96-1.44	0.1
Over limit >=10km/h	+0.9%	1.07	0.84 – 1.38	0.5
Over limit > = 25km/h	N/A	N/A		
100 km/h speed zone				
Over limit >=5km/h	-0.2%	0.80	0.68-0.96	0.02*
Over limit >=10km/h	-0.0001%	0.54	0.09-2.94	0.5
Over limit > = 25km/h	N/A	N/A		
110 km/h speed zone				
Over limit >=5km/h	-0.00004%	1.17	0.24 – 5.80	0.8
Over limit >=10km/h	N/A	N/A		
Over limit > = 25km/h	N/A	N/A		

Analysis of individual speed zones was undertaken to determine ISA benefits across a range of road contexts. The percentage point difference in cycles where the driver was above the assigned speed limit is presented in Table 2.2, and was seen to range from 1.9% fewer incidents over the assigned speed limit to a 3.1% higher number of cycles over the assigned limit. For driving in the 40km/h and 50km/h speed zones, there was no difference in the proportion of recorded cycles 5km/h and 10km/h over-limit, though a significant reduction in the odds of exceeding the limit by more than 25km/h following the installation of the ISA system was observed (40km/h: OR 0.21, CI: 0.05-0.80, p=0.02; 50km/h: OR 0.74, CI: 0.62-0.88, p<0.001); the reduction translates to a 79% and 26% reduction in the odds of exceeding the limit by more than 25km/h. In contrast, for driving in the 60km/h, 70km/h and 80km/h speed limit, the odds of

exceeding the speed limit by more than 5 km/h and also by more than 10km/h was higher in the post-installation period compared to the pre-installation period. There was no difference in these speed zones for driving at 25km/h or more.

While the mid-range speed zones saw an increased odds of exceeding the limit for this driver following installation of the ISA device, there was a 20% reduction in the odds of exceeding the limit in 100km/h zones by 5km/h or more (OR: 0.80, CI: 0.68-0.96, p=0.02), however this did not hold for more than 10km/h above the limit. There were no effects in the 110 km/h zone for this driver. Importantly, driving at these high speeds above the post speed limit was rare, particularly in the top-end speed zones.

Analysis of Driver 2 (Truck 2) data

Data was captured for 99,212 15-second cycles, of which 48,749 were captured prior to the installation of ISA (49.1%). Table 2.3 presents the percentage point difference in the number of 15-second logged data cycles when the truck exceeded the specified speed in the post-ISA installation period compared to the pre-installation period. In addition, odds ratio information is presented and these indicate the degree, or odds of exceeding the assigned speed limit for the post-installation period compared to the pre-installation period.

Across all speed zones, the percentage difference in the number of 15-second logged data cycles travelling >= 5km/h over the assigned speed limit was -0.5%; that is, in the pre-ISA installation period, the percentage cycles over-limit was 2.9% compared to the post-ISA installation period where drivers exceeded the limit in 2.4% of recorded cycles. For exceeding the limit by >=10 km/h, the percent difference was -0.1%, while the pre-post difference for exceeding the assigned speed limit by 25km/h or more was -0.1%.

For Driver 2, modeling of the effect of the installation of ISA indicated a significant reduction in the odds of exceeding the posted speed limit beyond 5km/h following the installation of the ISA system (OR: 0.83, CI: 0.77-0.90, p<0.001), however this was not observed for violations beyond 10km/h (OR: 0.96, CI: 0.86-1.06, p=0.4), nor for exceeding the limit beyond 25km/h (OR: 0.83, CI: 0.64-1.07, p=0.1).

The percentage point difference in cycles where the driver was above the assigned speed limit for each speed zone is presented in Table 2.3, and was seen to range from 9.9% fewer incidents over the assigned speed limit to a 4.9% higher number of cycles over the assigned limit. While there was no difference in the odds of violations in the 40km/h zone, for driving through 50km/h zones there was a significant reduction in the odds of violations of the speed limit, across 5, 10 and 25km/h thresholds; these reductions were 21%, 26% and 41% respectively. At each of the speed zones – 60km/h, 70km/h, 80km/h, 90km/h – there was an observed reduction in the odds of exceeding the posted speed limit by 5km/h, however only in the 60km/h speed zone did this carry onto exceeding the limit by 10km/h or more.

Table 2.3 Percentage of recorded 15 second cycles exceeding the limit (by specified amount), by speed zone, and associated Odds Ratio information, Truck 2

Speed zone and over-limit speed	Percentage point difference in cycles over-limit	Over-limit cycles in the post period relative to the pre-period		
		Odds ratio	CI	P
40 km/h speed zone				
Over limit >=5km/h	+0.2%	1.01	0.69-1.47	0.9
Over limit >=10km/h	+4.9%	1.47	0.94-2.29	0.09
Over limit > = 25km/h	+1.1%	1.49	0.57-3.91	0.4
50 km/h speed zone				
Over limit >=5km/h	-2.8%	0.79	0.65-0.95	0.01*
Over limit >=10km/h	-2.7%	0.74	0.59-0.92	0.007*
Over limit > = 25km/h	-2.1%	0.59	0.43-0.83	0.002*
60 km/h speed zone				
Over limit >=5km/h	-1.7%	0.70	0.59-0.83	<0.001*
Over limit >=10km/h	-0.5%	0.74	0.56-0.98	0.03*
Over limit > = 25km/h	-0.2%	0.68	0.41-1.10	0.1
70 km/h speed zone				
Over limit >=5km/h	-2.4%	0.61	0.44-0.84	0.002*
Over limit >=10km/h	-0.4%	0.70	0.38-1.28	0.2
Over limit > = 25km/h	+0.2%	2.20	0.43-11.5	0.3
80 km/h speed zone				
Over limit >=5km/h	-1.7%	0.79	0.70-0.90	<0.001*
Over limit >=10km/h	-0.2%	0.95	0.82-1.11	0.5
Over limit > = 25km/h	-0.0006%	0.19	0.02-1.66	0.1

90 km/h speed zone				
Over limit >=5km/h	-9.9%	0.10	0.01-0.85	0.03*
Over limit >=10km/h	-6.6%	-		
Over limit > = 25km/h	N/A	N/A		
100 km/h speed zone				
Over limit >=5km/h	-0.4%	0.76	0.55-1.04	0.09
Over limit >=10km/h	-0.0001%	0.61	0.05-6.81	0.7
Over limit > = 25km/h	N/A	N/A		
110 km/h speed zone				
Over limit >=5km/h	-0.00004%	-		
Over limit >=10km/h	N/A	N/A		
Over limit > = 25km/h	N/A	N/A		

Discussion

The findings reported here indicate differential levels of acceptability of the ISA device with a range of attitudes expressed. Prior to the drivers experience with the ISA device, most agreed or strongly agreed that a device that informed them they were exceeding the speed limit would be useful, as would a device that prevented them from speeding. The ISA device appears to be one such technology that can assist the drivers in this regard as results from the post-ISA experience survey data showed most drivers found the technology helpful in preventing them from speeding and rated the technology as having road safety benefits.

Despite most drivers regarding ISA as helpful in preventing them from speeding, the majority were not interested in being involved in future ISA trials. This finding could be due to some of the practical issues and perceived limitations of the ISA device and the rollout of the trial. Three of the seven drivers reported needing to override the system during the trial, and two drivers needed to turn the system off. The need to override and turn the system off was related mainly to the inaccuracies in the speed limit map while one case was related to a dislike of the auditory warnings. It is possible that modifications to the devices (e.g. inclusion of a volume control button), redesigning the auditory warnings to be more acceptable to drivers, and installation of an accurate map could help build greater acceptance of the technology among heavy vehicle drivers.

An analysis of the attitudes of the drivers with respect to speeding, crash risk and injury severity and acceptability of speeding and speed enforcement between pre and post experience - as reported by the survey, with ISA revealed no significant differences. These results are not surprising for a number of reasons. First, due to the small sample size, the analysis lacked statistical power and thus any effects would be hard to detect. Second, a visual inspection of the data reveals that the drivers expressed fairly conservative views about the acceptability of speeding, indicating that they did not believe it was safe and that it was not OK to speed if you were driving safely or on familiar roads. The drivers were generally road safety conscious prior to their experience with ISA and the fact that there was no significant change

in attitude after their experience with ISA suggests that ISA did not have any adverse impact on their attitude towards speed in that period of time. Finally, the drivers were exposed to the ISA device for approximately one month. It is thus not realistic to expect the drivers' attitudes, which were conservative to begin with, to significantly alter and for them to become even more road safety conscious in a short period of time.

The on-road driving performance of the two drivers indicated a contrast in the effectiveness of ISA. That is, with exception at the slower speed zones, the percentage of data capture cycles above the assigned limit increased for the driver of Truck 1, while the driver of Truck 2 demonstrated a significant reduction in violations across the range of speed zones. It is also interesting to note that the acceptability of the device differed between these two drivers, with the driver of Truck 1 reporting higher levels of dissatisfaction with the ISA device, which were in contrast to the opinions expressed by the driver of Truck 2. There are a number of possible explanations for the findings reported here. The driver of Truck 1 indicated he manually turned the ISA system off at some point during the trial whilst driver of Truck 2 reported that the ISA device was always on. In the case of Driver 1, it is not known how often the system was turned off, however it is obvious that by not receiving the over-speed warnings the effectiveness of the ISA device would clearly be constrained. It is also possible that the increase in violations observed for the driver of Truck 1 was due to the driver's attempts to calibrate his driving style against the ISA and to test its effects and the subsequent warnings from the ISA device. In direct contrast, the driver of Truck 2 indicated a high degree of acceptability of the ISA technology, and it was also the case that this driver exceeded the limit on fewer occasions following the installation of the ISA system. The divergent results of the two drivers suggest that further research into the relationship between ISA effectiveness and user acceptability is needed.

The preliminary results from this study may have implications for any future rollout of ISA in the heavy vehicle industry. If acceptability of the technology is indeed a factor in whether the driver will derive any safety benefits from their interaction with the ISA device, inadequacies of the technology will need to be addressed in order to increase driver acceptability. The main concerns towards ISA in this study were related to inaccuracies in the speed limit map. In the case of Victoria, this issue can be resolved as an accurate and complete speed limit map of Victoria is now available, after considerable investment by the TAC and VicRoads. It is intended that the map will be regularly updated to ensure the latest speed limit changes are captured and can be used in any future rollouts of ISA. Revisions to the ISA design, such as the inclusion of a volume control button with a minimum default as per the stated preference by most drivers, or a redesign of the auditory warnings to be more acceptable, could also be considered. Correction of these inadequacies of the ISA device could enhance the level of acceptability of the technology in future rollouts. It could be anticipated that these improvements to the system would reduce the amount of time the technology is turned off and thus increase the amount of time the drivers are exposed to the technology and hence improve the likelihood of drivers deriving optimal safety benefits. Further work is required to determine the exact alterations necessary to improve the acceptability of ISA to heavy vehicle drivers.

Limitations

The on-road analysis presented here included only two of the seven drivers involved in the study and this constrained the type and breadth of statistical analysis conducted. Future analysis will utilize alternative statistical models where appropriate and all available data from each of the participating drivers.

A technical issue that requires redress is the imperfect matching of the longitude and latitude co-ordinates of the road on which the vehicle was travelling with respect to assignment of the speed limit, a matter noted earlier in this paper. On the basis of a preliminary investigation it would appear that i.) the error rate is low, and ii.) the error would be systematic and hence unbiased with respect the pre-post installation of the ISA device; hence the reason for presenting the percent difference in data cycles above the assigned limit rather than time above the speed limit. Future analyses will address this issue and attempts to correct the matching will be made.

Finally and as already noted, we report the difference in the percentage of cycles over the assigned speed limit. This is an important methodological consideration as the 15 second interval, while used to capture cycles over the assigned speed limit, is unlikely to represent a singular speed violation episode. That is, it is most probable that a number of sequential 15-second cycles represent a singular speed violation

episode. Future analysis will need to determine an appropriate algorithm in order to discriminate 'speeding' behavior associated with throttle control from braking and gliding to slow down once an ISA speed alert is activated.

Conclusion

In summary, the TAC in collaboration with the Victorian Transport Association (VTA) and with the cooperation of several heavy vehicle companies conducted a small scale trial in an attempt to assess the relative merits of ISA in terms of driver acceptability and speed choice. Phase One analysis of the data indicated the drivers found the ISA technology helpful in preventing them from speeding and the divergence of opinion with respect to driver acceptability and speed violations suggests the relationship between ISA effectiveness and user acceptability requires further investigation. Further work is required to determine which particular useability and functionality aspects of the current ISA system need to be modified to increase its acceptability to heavy vehicle drivers.

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