MONASH University

ACCIDENT RESEARCH CENTRE

RESEARCH NOTE

ANALYSIS TO ESTIMATE ROAD SAFETY BENEFITS OF EXPANDING THE NSW MOBILE SPEED CAMERA PROGRAM

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BACKGROUND AND OBJECTIVES

The New South Wales Centre for Road Safety (NSW CRS) has approached the Monash University Accident Research Centre (MUARC) to provide expert analysis on the potential road safety benefits of expanding the NSW mobile speed camera program.

Mobile speed cameras in NSW are currently used in a highly overt manner which is different from other jurisdictions in Australia. Sections of road are chosen for enforcement, presumably based on both road safety and camera operational criteria, and sites within these road lengths are chosen for enforcement. According to data provided by the NSW CRS, there are 1,024 road segments on which mobile speed cameras can be operated and 2,493 specific sites on these road segments where cameras can be placed for operation. The average length of an enforced road segment is around 13.1km with the average number of sites enforced per road length being around 2.5 although up to 23 sites are used in some segments. Since 2012, enforcement operations are scheduled at enforced sites for 7,000 hours per month with the sites chosen for enforcement in each time period understood to be allocated using a randomised scheduler.

Under current practice in NSW, mobile speed camera enforced sites are signed clearly 250m and 50m before the location of the camera as well as 50m after the camera. The camera vehicle is also extensively marked. Similar signage is also used at NSW fixed mid-block speed camera sites. Evaluation of the NSW fixed mid-block speed camera program (ARRB 2005) showed that crash effects of the program were localised to the area bounded by the signage either side of the camera consistent with the highly overt nature of the signage. It is likely that crash effects at the mobile camera sites are also likely to be localised to within 250m of the camera site reflecting the placement of the signage for identifying the sites.

Other jurisdictions in Australia have also implemented extensive mobile speed camera programs albeit with quite different operational practices to NSW, based on different proposed mechanisms of deterring drivers from exceeding the speed limit. Programs in Victoria and Queensland perhaps provide the greatest contrast in operation principles. The effectiveness of both programs has also been evaluated to allow contrast of their relative effectiveness.

The mobile speed camera program in Victoria operates cameras completely covertly with no signage advising of camera locations. The objective of the covert operation is to generalise the effects of the program in both time and space to create the perception amongst drivers that the camera can be ‘anywhere, anytime’ to encourage network wide compliance with speeds. Due to the covert nature of the cameras, the primary measure of deterrence generated by the program is specific deterrence facilitated through the detection and infringement of large number of motorists. Evaluation of the Victorian mobile speed camera program has confirmed the geographic spread of program reach well beyond the enforced sites. It has also confirmed the specific deterrence mechanism of the project with trauma reductions being highly correlated to the number of infringements issued from the camera operations (Cameron, Cavallo et al. 1992, Rogerson, Newstead et al. 1994).

Operation of the Queensland mobile speed camera program has taken a different philosophical approach to Victoria. In Queensland, mobile cameras have been operated largely overtly from the commencement of the program. Signage in Queensland is not as extensive as in NSW. Early in the program only a single sign was used being placed at the site of operation of the camera. For around the last 4 years, no sign has been used although the vehicles used for the program remain identified. In more recent years, Queensland has also moved to scheduling a percentage of covert mobile camera operations. Evaluation evidence has showed that the number of hours of deployment of the mobile cameras in Queensland has the strongest association with the road trauma reductions

associated with the program (Newstead and Cameron 2003). Evaluation evidence also showed that program crash effects were highly localised to the site of operation of the camera with the largest crash effects occurring within 2km of the camera site but with some effects extending up to 4km. In order to maximise the road safety benefits of the program across the state, sites for operation of the cameras have been carefully selected to cover the location of police reported crashes in Queensland with over 75% of crashes located within 4km of one of over 2,500 operational camera sites. Furthermore, Queensland also utilise a randomised process (run by an automated scheduler) for allocating mobile camera operations across operation sites with research evidence showing greater compliance with the scheduler by police being associated with greater crash reductions.

The objectives of the current analysis were to estimate the potential road safety benefits of expanding the NSW mobile speed camera program. Expansion was considered both in terms of the hours of operation of the cameras as well as changing the mode of operation of the program with respect to signage to increase the geographical area of influence impacted by each camera site. In terms of increasing the hours of operation of the program, expansion of the current 7,000 hours per month of camera deployment to 10,500, 13,000 and 21,000 hours per month has been considered. This component of the expansion has been considered not as additional enforcement at existing camera sites but as a proportionate expansion of the locations used for enforcement assuming the same average enforcement density (enforcement hours per site). Three different modes of operation of the program with respect to signage were considered. The first is expansion using the current NSW signage regime (overt operations) assuming crash effects are contained to within 250m of the camera site. The second considers using the Queensland model for signage, still largely overt but with identification of the camera vehicle, assuming crash effects are contained to within 1km of the camera site. The final scenario considers the benefits of moving to a covert program with no signage or other identification of camera locations paralleling the Victorian program. For this final scenario, rather than assuming crash effects spread across the whole state, it has been assumed instead that effects spread across the entire road length chosen for enforcement as distinct from only sites where cameras are placed within the road length.

In summary, the expansion scenarios considered are as follows:

Deployment Model	**Hours of deployment (per month)**
New South Wales (overt, signage at 50m & 250m from camera, crash effects within signed area)	7,000 (current program) 10,500 13,000 21,000
Queensland (largely overt, identified vehicle, crash effect within 1000m of camera site)	7,000 10,500 13,000 21,000
Victoria (covert, crash effect across whole of enforced road length)	7,000 10,500 13,000 21,000

DATA

NSW CRS provided data on the NSW mobile speed camera program including the road lengths enforced, the date from which they were first enforced and the crash populations which existed at the enforced sites before they were enforced. For sites first enforced prior to 2017, data on the full

set of 640 enforced lengths was provided. These lengths covered a total of 8,401km of the NSW road network with an average enforced road segment length of 13.1km. From 2017, the NSW mobile camera program geographical coverage was expanded to cover 1,024 road lengths. No individual or total road lengths were available for the new sites added from 2017. Of the total 1,024 road lengths on which mobile cameras were operated, 296 were in metropolitan Sydney whilst the remaining 728 were in the remainder of the state. Within the 1,024 road lengths enforced by mobile speed cameras in NSW, there are 2,493 sites at which cameras are placed for operation, an average of 2.4 operational sites per enforced road length.

Crash data on each enforced road segment was provided by TfNSW CRS covering the 5 years prior to enforcement of each road length. Fatalities and serious injuries on these segments were the primary focus of the analysis. Across the 1,024 enforced road segments, an average of 119.4 fatalities and 2,134 serious injuries a year occurred on the road lengths. TfNSW CRS also provided data on crashes within 250m of the camera sites, the parts of the enforced road segments covered by the camera signage. Within these areas an average of 22.4 fatalities per year and 310.4 serious injuries per year occurred.

Estimating the road safety benefits of the NSW mobile speed camera program requires the use of estimated crash reductions associated with program outputs. The most robust estimates of likely crash effects associated with the NSW mobile speed camera program as it is currently implemented and that are likely to be achieved under the proposed expansion scenarios come from robust evaluation evidence of the impacts of mobile speed camera programs operational in other jurisdictions. The mobile speed camera program most similar to NSW that has been comprehensively evaluated is that in Queensland. Specifically, results from the most recent evaluation of the Queensland mobile speed camera program have been used (Newstead 2017) which give average estimated crash reductions associated with the Queensland program over the years 2014-15 along with statistical 95% confidence limits. It should be noted in this study that crash effects were estimated for fatal and serious injury crashes combined and not separately so the same effect has been assumed for fatal and serious injury crashes as well as for fatalities and serious injuries resulting from these crashes. Estimates of crash reductions from the Queensland study are summarised in Table 1.

Table 1: Crash Reduction from Queensland mobile camera evaluation 2014-2015

	% Crash Reduction	Lower 95% CL	Upper 95% CL
Fatal	28.5%	22.4%	33.3%
SI	28.5%	22.4%	33.3%
Casualty	28.5%	24.4%	32.0%

METHODOLOGY

To estimate the road safety benefits of various expansion options for the NSW mobile speed camera program, a number of assumptions regarding the nature of the expansion needed to be made to establish a viable methodology. Key assumptions made were:

- Any expansion of the program would involve the enforcement of additional road segments, with the increase in the number of road segments enforced proportionate to the increase in the number of hours enforced. This means that the enforcement density in terms of hours enforced per road segment remains constant.

- Any increase in geographical area influenced by the mobile speed cameras through either changing the signage policy or including additional enforced road lengths in the program would achieve the same crash reduction benefits on the newly enforced areas as given in Table 1.
- The proportionate coverage of fatalities or serious injuries of the total NSW fatal or serious injury population from road crashes per area covered by enforcement will remain the same for any additional road lengths chosen to enforce in any expansion of the program (the current program covers around 6% of the NSW fatality population and 2.9% of the serious injury population.

Data provided gives the coverage of the fatal and serious injury crashes by the NSW mobile speed camera program under the current signage regime (250m from a camera site - known as the NSW method) and on the whole enforced road length (known as the Victorian method). Crash coverage of the program assuming a 1000m halo of influence form the camera site (known as the Queensland method) was not available in the data so was assumed to be 4 times the NSW method coverage.

The following methodology was used to estimate the fatal and serious injury reductions associated with both changing the enforcement method of the current NSW mobile camera program to either the Queensland or Victorian methods, and expanding the geographical coverage of the program at the same enforcement density by increasing the operation hours from the current 7,000 per month to 10,500 per month, 13,000 per month or 21,000 per month. For each enforcement method considered, the incremental benefits of increasing monthly enforcement hours between *a* and *b* was estimated by the following equation:

$$S_b = CRF \; x \; COV \; x \; POOL_b \; x \; \frac{(H_b - H_a)}{H_a}$$

In the equation, *CRF* is the crash reduction factor from Table 1, *COV* is the proportion of the crash population covered by the program (estimated from the NSW method at the current 7,000 hours per month), $POOL_b$ is the remaining crash pool at enforcement level *b* after subtracting the crash pool already covered at enforcement level a (= $POOL_a - S_a$) and H_a and H_b are the hours of enforcement at levels *a* and *b*. To estimate the total fatality or serious injury savings at an enforcement hour level, the incremental benefits across all levels from 7,000 hours per month to that level are added. For example, the total benefits at 21,000 hour per month will be the sum of incremental benefits from steps 7,000 to 10,500, 10,500 to 13,000 and 13,000 to 21,000 hours. Incremental benefits have been used to sum to the total benefits rather than estimating a single increase from 7,000 hours to reflect the diminishing potential of the program in absolute savings as it expands.

RESULTS

Using the methodology described above, the incremental benefits of expanding the NSW mobile speed camera program from the current 7,000 hours per month to 10,500, 13,000 and 21,000 hours per month have been estimated. The current NSW method of enforcement (signs 250m before the camera site) has been considered along with the Queensland method (single sign at camera site) and the Victorian method (no signage, covert cameras). All incremental benefits are expressed relative to the current NSW method at 7,000 hour per month (hence the zero benefit estimate in this cell). Estimated incremental benefits for fatalities are presented in Table 2. Measures presented in Table 2 for each level of enforcement include the fatality pool covered by the incremental expansion of the program, the residual total fatality pool across the state, the percentage of the residual pool covered

by the incremental camera expansion and the fatality savings in the residual pool coverage based on the estimated camera effectiveness with 95% confidence limits.

Table 2: Incremental fatality savings associated with expansion of the NSW mobile speed camera program under various operational scenarios

			Incremental benefits above current practice (7,000 hours NSW method) with each increase			
			Monthly Hours			
Deployment Model	Distance from camera on enforced road length impacted	Measure	7,000	10,500	13,000	21,000
NSW (overt, signage at 50m & 250m from camera, crash effects within signed area)	250m	Fatality Pool Covered	22.4	10.5	4.9	12.4
		Total Fatal pool (residual)	372	349.6	339.07	334.21
		% Total Residual Covered	6.02%	3.01%	1.43%	3.71%
		Fatal Savings	0.00	3.00	1.39	3.53
		Lower Bound	0.00	2.36	1.09	2.77
		Upper Bound	0.00	3.51	1.62	4.12
QLD (largely overt, identified vehicle, crash effect within 1000m of camera site)	1,000m	Fatality Pool Covered	89.6	34.0	14.2	34.7
		Total Fatal pool (residual)	372	282.4	248.39	234.15
		% Total Residual Covered	24.09%	12.04%	5.73%	14.82%
		Fatal Savings	19.15	9.69	4.06	9.89
		Lower Bound	15.05	7.62	3.19	7.77
		Upper Bound	22.38	11.33	4.74	11.56
VIC (covert, crash effect across whole of enforced road length)	Whole Rd Length	Fatality Pool Covered	119.4	40.5	16.2	38.7
		Total Fatal pool (residual)	372	252.6	212.06	195.86
		% Total Residual Covered	32.10%	16.05%	7.64%	19.75%
		Fatal Savings	27.65	11.55	4.62	11.03
		Lower Bound	21.73	9.08	3.63	8.67
		Upper Bound	32.30	13.50	5.40	12.88

Table 3 presents the corresponding cumulative benefits obtained by summing the incremental additional benefits across all incremental increases up to the enforcement hours of interest. The black boxes show the estimated fatality savings below which are the 95% confidence limits on the estimates. For example, expanding the NSW mobile speed camera program to 21,000 hours of enforcement per month using the current NSW method of signage is estimated to save 7.92 fatalities per annum with 95% confidence limit (6.22, 9.25).

Table 3: Cumulative fatality savings associated with expansion of the NSW mobile speed camera program under various operational scenarios

			Cumulative benefits with each increase			
Deployment Model	Distance from camera on enforced road length impacted	Measure	7,000 Hours	10,500 Hours	13,000 Hours	21,000 Hours
NSW (overt, signage at 50m & 250m from camera, crash effects within signed area)	250m	Fatality Pool Covered	22.40	32.93	37.79	50.17
		Total Fatalities	372	372	372	372
		% Total Fatalities Covered	6.02%	8.85%	10.16%	13.49%
		Annual Fatalities Saved	0.00	3.00	4.39	7.91
		Lower Bound	0.00	2.36	3.45	6.22
		Upper Bound	0.00	3.51	5.12	9.25
QLD (largely overt, identified vehicle, crash effect within 1000m of camera site)	1,000m	Fatality Pool	89.60	123.61	137.85	172.56
		Total Fatalities	372	372	372	372
		% Total Fatalities Covered	24.09%	33.23%	37.06%	46.39%
		Annual Fatalities Saved	19.15	28.84	32.90	42.80
		Lower Bound	15.05	22.67	25.86	33.64
		Upper Bound	22.38	33.70	38.45	50.00
VIC (covert, crash effect across whole of enforced road length)	Whole Rd Length	Fatality Pool	119.40	159.94	176.14	214.83
		Total Fatalities	372	372	372	372
		% Total Fatalities Covered	32.10%	42.99%	47.35%	57.75%
		Annual Fatalities Saved	27.65	39.20	43.82	54.84
		Lower Bound	21.73	30.81	34.44	43.10
		Upper Bound	32.30	45.80	51.20	64.08

Tables 4 and 5 provide the analogous estimates to Tables 2 and 3 for serious injuries. Interpretation of Tables 4 and 5 is the same as for Tables 2 and 3. It should be noted that the serious injury data is based upon that resulting from crashes reported to police and recorded in Crashlink. Serious injuries from unreported crashes are not included in the tables.

Table 4: Incremental serious injury savings associated with expansion of the NSW mobile speed camera program under various operational scenarios

			Incremental benefits above current practice (7,000 hours NSW method) with each increase Monthly Hours			
Deployment Model	Distance from camera on enforced road length impacted		7,000	10,500	13,000	21,000
NSW (overt, signage at 50m & 250m from camera, crash effects within signed area)	250m	SI Pool Covered	310.4	150.8	70.8	181.7
		Total SI pool (residual)	10,868	10,557.6	10,406.83	10,336.06
		% Total Residual Covered	2.86%	1.43%	0.68%	1.76%
		SI Savings	0.00	42.97	20.17	51.77
		Lower Bound	0.00	33.77	15.85	40.69
		Upper Bound	0.00	50.21	23.57	60.49
QLD (largely overt, identified vehicle, crash effect within 1000m of camera site)	1,000m	Pool Covered	1241.6	549.9	246.9	620.8
		Total SI pool (residual)	10,868	9,626.4	9,076.52	8,829.63
		% Total Residual Covered	11.42%	5.71%	2.72%	7.03%
		SI Savings	265.39	156.72	70.36	176.92
		Lower Bound	208.59	123.17	55.30	139.05
		Upper Bound	310.09	183.11	82.21	206.71
VIC (covert, crash effect across whole of enforced road length)	Whole Rd Length	Pool Covered	2134	857.5	368.2	907.3
		Total SI pool (residual)	10,868	8,734	7,876.51	7,508.27
		% Total Residual Covered	19.64%	9.82%	4.68%	12.08%
		SI Savings	519.73	244.38	104.95	258.57
		Lower Bound	408.49	192.08	82.49	203.23
		Upper Bound	607.26	285.54	122.62	302.12

Table 5: Cumulative serious injury savings associated with expansion of the NSW mobile speed camera program under various operational scenarios

Deployment Model	Distance from camera on enforced road length impacted		Cumulative benefits with each increase			
			7,000 Hours	10,500 Hours	13,000 Hours	21,000 Hours
NSW (overt, signage at 50m & 250m from camera, crash effects within signed area)	250m	SI Pool	310.40	461.17	531.94	713.60
		Total SI	10,868	10,868	10,868	10,868
		% Total SI Covered	2.86%	4.24%	4.89%	6.57%
		Annual SI Saved	0.00	42.97	63.14	114.91
		Lower Bound	0.00	33.77	49.62	90.32
		Upper Bound	0.00	50.21	73.77	134.27
QLD (largely overt, identified vehicle, crash effect within 1000m of camera site)	1,000m	SI Pool	1,241.60	1,791.48	2,038.37	2,659.12
		Total SI	10868	10868	10868	10868
		% Total SI Covered	11.42%	16.48%	18.76%	24.47%
		Annual SI Saved	265.39	422.11	492.47	669.39
		Lower Bound	208.59	331.76	387.06	526.11
		Upper Bound	310.09	493.20	575.41	782.12
VIC (covert, crash effect across whole of enforced road length)	Whole Rd Length	SI Pool	2,134.00	2,991.49	3,359.73	4,266.99
		Total SI	10868	10868	10868	10868
		% Total SI Covered	19.64%	27.53%	30.91%	39.26%
		Annual SI Saved	519.73	764.11	869.06	1127.63
		Lower Bound	408.49	600.56	683.05	886.28
		Upper Bound	607.26	892.80	1,015.43	1,317.54

CONCLUSIONS

Analysis presented in this paper has estimated the potential road safety benefits in terms of reduced fatalities and serious injuries from expanding the NSW mobile speed camera program. Expansion has been considered firstly in terms of the number of road lengths enforced under the program at the current hours of enforcement per site, increasing the coverage up to 3-fold by trebling the number of hours the cameras are used. It has also considered the potential injury savings from increasing the actual proportion of the enforced road lengths which are influenced by camera operations through changing signage used to identify the cameras from the current highly visible signage 250m and 50m from the camera currently used in NSW, to the Queensland model of an identifiable camera vehicle to a fully covert program such as used in Victoria.

Based the analysis methodology developed and overlaying the crash effects estimated from rigorous evaluations of mobile speed camera programs in other jurisdictions, the following potential fatality and injury savings were estimated for the NSW mobile speed camera program relative to the current program benefit using signage at 250m and 50m with 7,000 hours of camera enforcement per month:

Deployment Model		Number of camera enforcement hours per month			
		7,000 Hours	10,500 Hours	13,000 Hours	21,000 Hours
Current NSW (overt, signage at 50m & 250m from camera, crash effects within signed area)	Annual Fatality Savings	0.00	3.00	4.39	7.91
	Annual SI Savings	0.00	42.97	63.14	114.91
	F + SI cost savings	$0	$44,563,815.45	$65,306,357.11	$118,344,046.39
Queensland (largely overt, identified vehicle, crash effect within 1000m of camera site)	Annual Fatality Savings	19.15	28.84	32.90	42.80
	Annual SI Savings	265.39	422.11	492.47	669.39
	F + SI cost savings	$280,082,350.08	$432,938,697.08	$499,304,214.70	$663,715,409.21
Victoria (covert, crash effect across whole of enforced road length)	Annual Fatality Savings	27.65	39.20	43.82	54.84
	Annual SI Savings	519.73	764.11	869.06	1,127.63
	F + SI cost savings	$472,044,379.49	$682,799,064.19	$770,647,824.09	$984,342,026.49

In addition, the potential crash savings given in the above table have been converted into community cost savings based on the accepted per person cost estimates used by the NSW Government in valuing road trauma. The per person costs used have been estimated using the willingness to pay methodology being $7,752,786 per fatality and $495,874 per serious injury. As shown in the table, the value of estimated trauma savings across the scenarios explored range from $44M to $984M.

Whether these potential savings are ultimately realised through expansion of the program depends on a number of factors including the validity of the modelling assumptions and the way in which the program expansion is implemented. Implementation factors critical to realising benefits under the expansion include appropriate selection of new road lengths to enforce and the selection of actual sites within these to place the cameras. Adoption of the Victorian model will also likely involve the selection of additional sites for camera operations on the currently enforced road lengths. Appropriate scheduling of operations across existing and expansion sites using randomised scheduling within time and location is likely to be required to fully realise program benefits.

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