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Modelling the Potential Trauma Reductions of Automated Mobile Phone Enforcement in NSW

Final Report

Karen Stephan, Amanda Stephens & Stuart Newstead

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Modelling the Potential Trauma Reductions of Automated Mobile Phone Enforcement in NSW

Author(s):

Karen Stephan, Amanda Stephens & Stuart Newstead

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Abstract:
This report describes the findings of research into modelling the potential trauma reductions of automated mobile phone enforcement in NSW. The maximum benefit that could be obtained if all illegal mobile phone use by NSW drivers (excluding those who live in remote or very remote areas) was prevented (that is 100% of drivers in non-remote areas were exposed to the cameras, and all who were illegally using a mobile phone stopped doing so) translates to a 1.13% reduction in crashes in metropolitan Sydney and 1.27% reduction in crashes in regional areas (excluding remote and very remote). This equates to 225 fewer casualty crashes, 289 fewer casualties, and savings of $84.5 million per year. The largest reduction in the absolute number of crashes would occur for crashes of lower severity; there would be approximately 4 fewer fatal crashes and fatalities, 60 fewer serious injury crashes and 67 fewer casualties with serious injuries, 100 fewer moderate injury crashes and 128 fewer casualties with moderate injuries, and 62 fewer minor/other injury crashes and 90 fewer casualties with minor/other injuries. This is not surprising given that there are fewer fatality crashes than serious injury crashes, and fewer serious injury crashes than other injury crashes. However, because the cost of a crash increases as the severity increases, the largest annual cost savings would be for fatal and serious injury crashes.

The overall maximum benefit is relatively small because the prevalence of illegal mobile phone use while driving in NSW is relatively low (on average, 1.43%) and the best evidence of the effect of visual-manual mobile phone use on crash risk indicates an 83% increase in risk of crashing whilst using a mobile phone. This maximum benefit is likely to be smaller than what the general public, and many in the field of road safety would expect, however, it still results in significant cost savings.

An automated mobile phone enforcement program, however, is unlikely to lead to total elimination of illegal mobile phone use while driving. The effect of the program on the prevalence of illegal mobile phone use whilst driving will be related to the program reach (that is, the proportion of drivers who are exposed to the cameras) and the level of deterrence (that is, the proportion of drivers who are deterred from using their mobile phone illegally).

Approximately 99.5% of the NSW population is based in major cities and inner and outer regional areas which are reasonably accessible and these will be the areas targeted by the program (advice from CRS, drawn from population information published by the ABS). Program reach within the targeted areas can be estimated using the estimated average number of checks per registered vehicle per year. While the probability of detection will be related to km driven and exposure relative to where the cameras are placed, which will vary by vehicle, this information is not available, so an equal probability of being detected for each registered vehicle was assumed. In this scenario, almost all drivers will be checked at least once per year from Year 1 of program roll-out, with close to 100% of vehicles being checked at least twice per year in Year 2, at least seven times per year in Year 3 and at least 9 times per year in Year 4. Therefore, it is reasonable to assume that over 90% of the NSW population will be reached by the program even from Year 1.

The level of deterrence that will be achieved from the mobile phone enforcement cameras is currently unknown, however, from previous research into the effectiveness of automated enforcement cameras, it can be reasonably assumed that between 30% to 40% of drivers would be deterred from using their mobile phone as a result of the program. If all of the 99.5% of the NSW population in metropolitan and inner and outer regional areas is reached by the program, and the level of deterrence is 30 to 40%, there would be 67 to 89 fewer casualty crashes and 86 to 115 fewer casualties, with an associated cost saving of between approximately $25.1 million to $33.6 million, per year. These estimates were calculated assuming that there is no overt signage indicating the location of the cameras. If the location of the cameras is overtly signed, the benefits would be expected to be reduced by 80%.

Key Words:	Disclaimer
mobile phone, enforcement, crash, safety camera, crash savings, economic analysis	This report is disseminated in the interest of information exchange. The views expressed here are those of the

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1. BACKGROUND

The NSW Centre for Road Safety (CRS) and NSW Road and Maritime Services (RMS) have recently tested and piloted fixed and transportable mobile phone detection cameras to detect drivers who are illegally using mobile phones. The trials established that the technology (both fixed and transportable) is viable and can be scaled for broader enforcement. NSW CRS has engaged the Monash University Accident Research Centre (MUARC) to estimate the potential reduction in road trauma that could be realised from a program of fixed and automated mobile phone enforcement.

This report presents the findings from modelling the effect of mobile phone enforcement cameras on road trauma, taking into account likely program reach and likely levels of deterrence.

2. METHOD

Estimating the potential reduction in road trauma that could be realised from a program of fixed and automated mobile phone enforcement requires an understanding of several factors relating to illegal mobile phone use by drivers and the risk associated with that activity, the number and cost of crashes in NSW and details of the proposed program itself. Specifically, information is required about the following:

1. the prevalence of illegal mobile phone use whilst driving
2. the crash risk associated with illegal mobile phone use whilst driving
3. the proposed reach of the automated mobile phone enforcement program (that is, what proportion of drivers would be exposed to the program?)
4. the expected deterrent effect of the program (that is, what proportion of drivers would cease using their mobile phone whilst driving as a result of the program?)
5. the number of crashes that would be expected to occur without the program
6. the cost of those crashes

Table 1 lists these required inputs along with the specific estimates used in this study and the sources. The sources of all but one of the estimates were from NSW, or from consultation with NSW CRS. The exception was the crash risk associated with mobile phone use whilst driving, which came from data collected in the USA.

The estimate of crash risk was obtained from recent analysis of data collected in the SHRP2 naturalistic driving study (NDS). The SHRP2 NDS collected naturalistic driving data from 3,542 drivers over a period of between one and two years. Owens, Dingus, Guo, Fang, Perez & McClafferty (2018) conduct a case-crossover study using data collected during the SHRP2 NDS to estimate of the relative risk of crashing whilst performing visual-manual tasks on a mobile phone (or more specifically, the odds of engaging in visual-manual tasks on a mobile phone prior to a crash, compared to the odds of engaging in visual-manual tasks on a mobile phone, during a non-crash period), adjusted for a large number of potential confounding factors.

This methodologically sound research provides the best available evidence of the crash risk associated with visual-manually interacting with a mobile phone whilst driving. The reasons for choosing this estimate over those derived from other analyses of the SHRP2 data, or from other NDS (including, for example, analyses of data collected in the 100 Car study, or the estimate of risk calculated by Simmons, Hicks and Caird (2016) in their meta-analyses of NDS) are:

- SHRP2 is the only NDS with a large enough sample size to use crashes as the sole outcome of interest when estimating crash risk. All of the other studies also included near-crashes and sometimes other safety related events as outcomes and it is unclear whether the relationship between mobile phone use and these other non-crash outcomes is the same as for crashes. Recent research suggests this is not the case (Kidd & McCartt, 2015, section 4.3.1), so it is best to avoid studies that included non-crash outcomes if good quality evidence from a crash-only study exists.
- The recent case-crossover analysis of the SHRP 2 study is the only study that has used crashes as the only outcome of interest, while also controlling for other potential confounding variables. It has been found in both the 100 car study and the SHRP2 study that when you control for potential confounders, the association between mobile phone use and crashes is smaller than when confounders are not controlled for (Klauer et al., 2010; Victor et al., 2015). Essentially this means that the studies that don't control for confounders are reporting an estimate that does not indicate the independent risk associated with mobile phone use, and that part of the risk in those studies is due to other risk factors that happened to co-occur with mobile phone use in those samples.

- The risk estimate specific to visual-manual interactions with the phone was chosen because these are the behaviours that are illegal to perform when driving, and importantly, will be detected by a camera enforcement program.

Table 1. Required inputs, and sources, for calculating the potential road trauma reductions of automated mobile phone camera enforcement

Information required	Specific data used	Data source	Estimate	
Prevalence of mobile phone use	Prevalence of mobile phone use in the NSW driving population	NSW trials of automated mobile phone camera (NSW CRS, personal communication)	1.2% (fixed camera trial) 1.9% (transportable camera trial) **Metropolitan Sydney**: Combined prevalence of 1.38% **Regional**: Combined prevalence of 1.55%	
Risk of crash associated with mobile phone use	Odds ratio (OR) comparing the odds of visual-manual mobile phone use prior to a crash with odds of visual-manual mobile phone use in a non-crash period, adjusted for confounding variables	SHRP2 (Owens, Dingus, Guo, Fang, Perez & McClafferty, 2018)	OR=1.83	
Proportion of the driving population exposed to the enforcement cameras		Consultation with NSW CRS Average number of checks (NSW CRS, personal communication)	99.5% of the population live in areas covered by the program (i.e. not remote or very remote) Average number of checks per registered vehicle per year Year 1: 5 Year 2: 10 Year 3: 18 Year 4: 20	
Expected deterrence effect of the program		Consultation with NSW CRS	Range: 20% to 100%	
Current size of the road trauma problem (excluding remote and very remote areas)	Average annual number of crashes over 2012-2017, by severity	NSW CRS (NSW CRS, personal communication)	**Metro** Fatal: 87 Serious injury: 2,650 Moderate injury: 4,532 Minor/other injury: 3,688 Total casualty: 10,957	**Rural** Fatal: 233 Serious injury: 2,350 Moderate injury: 3,801 Minor/other injury: 1,614 Total casualty: 8,006
Average crash costs	Inclusive Willingness to Pay costs per crash, by crash severity	Transport for NSW (2018, Table 54, page 277)	**Metro** Fatal: $7,653,597 Serious injury: $497,393 Moderate) injury: $83,423 Minor/other injury: $76,668	**Rural** Fatal: $9,058,911 Serious injury: $686,163 Moderate) injury: $110,188 Minor/other injury: $101,259

2.1. ESTIMATING THE NUMBER OF CRASHES THAT COULD BE PREVENTED BY ELIMINATING ILLEGAL MOBILE PHONE USE

The proportion of crashes within a population (e.g. NSW drivers) that could be prevented by preventing exposure to a risk factor (e.g. illegally using a mobile phone whilst driving) can be estimated by calculating the quantity known, in epidemiological terms, as the Population Attributable Fraction (PAF). The formula includes two variables: i) an estimate of the prevalence of the risk factor (illegal mobile phone use while driving), and ii) the relative risk associated with the risk factor:

$$\text{Population Attributable Fraction (PAF)} = (P_p \text{ X } (RR\text{-}1))/(P_p \text{ X } (RR\text{-}1)+1),$$

where P_p is the proportion of people in the general population exposed to the risk factor, that is, the proportion of drivers in the NSW population who illegally use mobile phones while driving;

and RR= the relative risk = the risk of crashing whilst using a mobile phone compared to the risk of crashing whilst not using a mobile phone, estimated from a cohort study. For rare outcomes (such as crashes), the odds ratio (OR) derived from a case-control or case-crossover study is a good estimate of the RR. There are no good direct estimates of the RR associated with mobile phone use, therefore, the estimates of the OR will be used.

The PAF (the proportion of crashes that would be prevented if illegal mobile phone use was eliminated) can be directly applied to calculate the number of crashes in NSW that would be prevented if all illegal mobile phone use was eliminated. Adjustments can also be made to take into account program reach (the proportion of drivers exposed to automated mobile phone enforcement cameras) and likely deterrence (proportion of drivers who would be deterred from illegally using a mobile phone by the camera program).

3. RESULTS

3.1. MAXIMUM POSSIBLE BENEFIT: OPTIMAL SCENARIO WITH 100% OF DRIVERS IN NON-REMOTE AREAS REACHED BY THE MOBILE PHONE CAMERA ENFORCEMENT PROGRAM, AND 100% DETERRENCE

Maximum benefits would be achieved with the ideal scenario that all mobile phone use whilst driving was eliminated by the automated mobile phone enforcement program (that is, that the program achieved 100% deterrence) and that 100% of drivers were exposed to the enforcement. Although this is unlikely, it does provide an estimate of the absolute maximum benefit of eliminating mobile phone use. According to advice received from NSW CRS, a mobile phone camera detection program in NSW would reach almost all drivers in NSW, apart from those in remote or very remote areas (who comprise approximately 0.5% of the NSW population).

In metropolitan Sydney, 75% of drivers would be reached via fixed cameras, and 25% via transportable cameras. Considering the NSW fixed-camera trial detected 1.2% of drivers illegally using their mobile phones and the NSW transportable camera trial detected 1.9% of drivers illegally using their mobile phones, this gives a combined overall prevalence of illegal mobile phone use in metropolitan Sydney of 1.38% (75% x 1.2% + 25% x 1.9%). Using this information and the relative of risk of crashing whilst illegally using a mobile phone of RR=1.83, the PAF in metropolitan Sydney is therefore equal to 1.13%. That is, 1.13% of all crashes in metropolitan Sydney could be prevented if illegal use of mobile phones could be completely prevented.

In rural areas (excluding the 0.5% of the population in remote or very remote areas), NSW CRS advises that 50% of drivers would be reached via fixed cameras and 50% via transportable cameras. The combined prevalence of illegal mobile phone use in rural areas is 1.55% (50% x 1.2% + 50% x 1.9%), which corresponds to a PAF of 1.27%. Therefore, 1.27% of all crashes in rural NSW (excluding remote and very remote areas) could be prevented if illegal use of mobile phones could be completely prevented.

Table 2 shows that with 100% program reach in areas of NSW that were not remote or very remote and 100% deterrence, there would be approximately 124 fewer casualty crashes in metropolitan Sydney and 102 fewer casualty crashes in rural areas (a total of 225 fewer casualty crashes state-wide). On average, this corresponds to 289 fewer casualties (154 in metropolitan areas and 135 in rural areas), and $84,517,986 saved annually ($29,801,779 in metropolitan areas and $54,716,206 in rural areas) if all illegal mobile phone use amongst drivers was eliminated. This is comprised of approximately 4 fewer fatal crashes, 60 fewer serious injury crashes, 100 fewer moderate injury crashes and 62 fewer minor/other injury crashes.

Table 2. Optimal scenario: Yearly crash and cost savings if all illegal mobile phone use amongst NSW drivers was eliminated (excluding remote and very remote areas)

Quantity	Metropolitan areas	Rural areas (excluding remote and very remote areas)	NSW (excluding remote and very remote areas)
Mobile phone prevalence prior to automated mobile phone enforcement cameras	1.38%	1.55%	1.43%
Population Attributable Fraction (PAF)	1.13%	1.27%	1.17%
Number of fatal crashes prevented	0.98	2.96	3.94
Number of serious injury crashes prevented	29.91	29.85	59.75
Number of moderate injury crashes prevented	51.14	48.38	99.51
Number of minor/other crashes prevented	41.62	20.45	62.12
Total number of casualty crashes prevented	**123.64**	**101.69**	**225.32**
Number of fatalities prevented	1.02	3.24	4.26
Number of serious injuries prevented	32.52	34.56	67.08
Number of moderate injuries prevented	63.60	64.23	127.83
Number of minor/other injuries prevented	57.27	32.52	89.79
Total number of casualties prevented	**154.41**	**134.54**	**288.95**
Fatal crash $ saved per year	$7,470,233	$26,828,765	$34,298,999
Serious injury crash $ saved per year	$14,874,852	$20,841,105	$35,355,957
Moderate injury crash $ saved per year	$4,265,915	$5,330,703	$9,596,618
Minor/other crash $ saved per year	$3,190,779	$2,075,633	$5,266,412
Total $ saved per year	**$29,801,779**	**$54,716,206**	**$84,517,986**

3.2. BENEFIT DERIVED WITH VARYING LEVELS OF DETERRENCE

The benefits that would be achieved with 100% of drivers (excluding those in remote or very remote areas) exposed to the enforcement and different levels of deterrence (from 20% to 100%) were modelled metropolitan Sydney (refer to Table 3) and rural NSW (excluding remote and very remote areas, refer to Table 4). The state-wide benefits were calculated by adding the metropolitan and rural benefits (refer to Table 5.)

*Table 3. Annual benefits obtained **in metropolitan Sydney** and varying levels of deterrence*

Deterrence fraction	20% deterrence	30% deterrence	40% deterrence	50% deterrence	60% deterrence	70% deterrence	80% deterrence	90% deterrence	100% deterrence
Mobile phone prevalence before cameras (%)	1.38%	1.38%	1.38%	1.38%	1.38%	1.38%	1.38%	1.38%	1.38%
Mobile phone prevalence after cameras (%)	1.10%	0.96%	0.83%	0.69%	0.55%	0.41%	0.28%	0.14%	0.00%
PAF % before	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%
PAF % after	0.90%	0.79%	0.68%	0.57%	0.45%	0.34%	0.23%	0.11%	0.00%
% crash reduction	0.22%	0.34%	0.45%	0.56%	0.67%	0.79%	0.90%	1.01%	1.13%
No. fatal crashes prevented	0.19	0.29	0.39	0.49	0.58	0.68	0.78	0.88	0.98
No. serious inj crashes prevented	5.93	8.90	11.88	14.87	17.86	20.86	23.87	26.88	29.91
No. moderate inj crashes prevented	10.13	15.22	20.32	25.42	30.54	35.67	40.82	45.97	32.52
No. minor/other inj crashes prevented	8.25	12.39	16.53	20.69	24.86	29.03	33.22	37.41	41.62
Total no. casualty crashes prevented	**24.50**	**36.80**	**49.12**	**61.47**	**73.84**	**86.25**	**98.68**	**111.15**	**123.64**
No. fatalities prevented	0.20	0.30	0.40	0.51	0.61	0.71	0.81	0.92	1.02
No. serious injuries prevented	6.45	9.68	12.92	16.17	19.42	22.69	25.96	29.24	32.52
No. moderate injuries prevented	12.61	18.93	25.27	31.62	37.99	44.39	50.76	57.18	51.14
No. minor/other injuries prevented	11.35	18.93	22.75	28.47	34.21	39.95	45.71	51.49	57.27
Total no. casualties prevented	**30.60**	**45.96**	**61.35**	**76.77**	**92.23**	**107.72**	**123.25**	**138.81**	**154.41**
Fatal crash $ saved	$1,480,529	$2,223,309	$2,967,772	$3,713,924	$4,461,772	$5,211,321	$5,962,577	$6,715,546	$7,470,233
Serious inj crash $ saved	$2,948,055	$4,427,089	$5,909,476	$7,395,227	$8,884,354	$10,376,868	$11,872,782	$13,372,106	$14,874,852
Moderate inj crash $ saved	$845,464	$1,269,632	$1,694,761	$2,120,855	$2,547,918	$2,975,952	$3,404,960	$3,834,947	$4,265,915
Minor/other inj crash $ saved	$632,382	$949,647	$1,267,632	$1,586,338	$1,905,768	$2,225,925	$2,546,810	$2,868,428	$3,225,960
Total $ saved	**$5,906,430**	**$8,869,676**	**$11,839,640**	**$14,816,344**	**$17,799,812**	**$20,790,066**	**$23,787,129**	**$26,791,026**	**$29,801,779**

Table 4. Annual benefits obtained with ***in regional NSW (excluding 0.5% of residents in remote and very remote areas)*** *and varying levels of deterrence*

Deterrence fraction	20% deterrence	30% deterrence	40% deterrence	50% deterrence	60% deterrence	70% deterrence	80% deterrence	90% deterrence	100% deterrence
Mobile phone prevalence before cameras (%)	1.55%	1.55%	1.55%	1.55%	1.55%	1.55%	1.55%	1.55%	1.55%
Mobile phone prevalence after cameras (%)	1.24%	1.09%	0.93%	0.78%	0.62%	0.47%	0.31%	0.16%	0.00%
PAF % before	1.27%	1.27%	1.27%	1.27%	1.27%	1.27%	1.27%	1.27%	1.27%
PAF % after	1.02%	0.89%	0.77%	0.64%	0.51%	0.38%	0.26%	0.13%	0.00%
% crash reduction	0.25%	0.38%	0.50%	0.63%	0.76%	0.89%	1.01%	1.14%	1.27%
No. fatal crashes prevented	0.59	0.88	1.18	1.47	1.77	2.07	2.36	2.66	2.96
No. serious inj crashes prevented	5.91	8.87	11.85	14.83	17.82	20.81	23.82	26.83	32.52
No. moderate inj crashes prevented	9.60	14.38	19.20	24.03	28.88	33.73	38.60	43.48	45.73
No. minor/other inj crashes prevented	4.06	6.09	8.14	10.18	12.24	14.29	16.36	18.42	20.45
Total no. casualty crashes prevented	**20.13**	**30.23**	**40.36**	**50.52**	**60.70**	**70.91**	**81.14**	**91.40**	**101.65**
No. fatalities prevented	0.64	0.96	1.28	1.61	1.93	2.26	2.58	2.91	3.24
No. serious injuries prevented	6.84	10.28	13.72	17.17	20.63	24.10	27.58	31.06	37.90
No. moderate injuries prevented	12.71	19.10	25.49	31.91	38.34	44.79	51.25	57.73	60.90
No. minor/other injuries prevented	6.44	9.67	12.91	16.15	19.41	22.67	25.95	29.23	32.46
Total no. casualties prevented	**26.63**	**40.00**	**53.40**	**66.84**	**80.31**	**93.81**	**107.35**	**120.93**	**134.49**
Fatal crash $ saved	$5,311,091	$7,796,795	$10,649,304	$13,328,646	$16,014,847	$18,707,932	$21,407,930	$24,114,865	$26,828,765
Serious inj crash $ saved	$4,054,492	$6,089,493	$8,129,689	$10,175,101	$12,225,749	$14,281,653	$16,432,834	$18,409,311	$20,481,105
Moderate inj crash $ saved	$1,055,280	$1,584,938	$2,115,948	$2,648,316	$3,182,047	$3,717,146	$4,253,618	$4,791,469	$5,330,703
Minor/other inj crash $ saved	$410,898	$617,132	$823,894	$1,031,183	$1,239,004	$1,447,357	$1,656,245	$1,865,669	$2,075,633
Total $ saved	**$10,831,761**	**$16,268,357**	**$21,718,835**	**$27,183247**	**$32,661,647**	**$38,154,089**	**$43,660,626**	**$49,181,314**	**$54,746,206**

Table 5. Annual benefits obtained ***in NSW (excluding 0.5% of residents in remote and very remote areas)*** *and varying levels of deterrence*

Deterrence fraction	20% deterrence	30% deterrence	40% deterrence	50% deterrence	60% deterrence	70% deterrence	80% deterrence	90% deterrence	100% deterrence
No. fatal crashes prevented	0.78	1.17	1.56	1.96	2.35	2.75	3.14	3.54	3.94
No. serious inj crashes prevented	11.84	17.78	23.73	29.70	35.68	41.68	47.69	53.71	59.75
No. moderate inj crashes prevented	19.71	29.60	39.52	49.46	59.42	69.41	79.42	89.45	99.51
No. minor/other inj crashes prevented	12.31	18.48	24.67	30.87	37.09	43.33	49.58	55.84	62.12
Total no. casualty crashes prevented	**44.63**	**67.03**	**89.48**	**111.99**	**134.54**	**157.16**	**179.82**	**202.55**	**225.32**
No. fatalities prevented	0.84	1.27	1.69	2.11	2.54	2.97	3.40	3.83	4.26
No. serious injuries prevented	13.29	19.95	26.64	33.34	40.05	46.79	53.53	60.30	67.08
No. moderate injuries prevented	25.32	38.02	50.76	63.53	76.33	89.15	102.01	114.90	127.83
No. minor/other injuries prevented	17.79	26.71	35.66	44.63	53.62	62.63	71.66	80.71	89.79
Total no. casualties prevented	**57.24**	**85.96**	**114.75**	**143.61**	**172.54**	**201.54**	**230.60**	**259.74**	**288.95**
Fatal crash $ saved	$6,791,621	$10,200,103	$13,617,076	$17,042,570	$20,476,619	$23,919,253	$27,370,507	$30,830,411	$34,298,999
Serious inj crash $ saved	$7,002,547	$10,516,581	$14,039,164	$17,570,328	$21,110,103	$24,658,522	$28,215,616	$31,781,416	$35,355,957
Moderate inj crash $ saved	$1,900,744	$2,854,570	$3,810,709	$4,769,172	$5,729,965	$6,693,098	$7,658,578	$8,626,416	$9,596,618
Minor/other inj crash $ saved	$1,043,280	$1,566,780	$2,091,525	$2,617,521	$3,144,772	$3,673,281	$4,203,055	$4,734,097	$5,266,412
Total $ saved	**$16,738,191**	**$25,138,033**	**$33,558,475**	**$41,999,591**	**$50,461,458**	**$58,944,154**	**$67,477,756**	**$75,972,340**	**$84,517,986**

3.3. REDUCTION IN BENEFIT WITH OVERT SIGNAGE OF CAMERAS

The estimates provided up to this point have assumed that the location of the cameras is not overtly signed. If the location of the cameras is not overtly signed, then the geographical influence of the camera may be much greater, which means more crashes would be expected to be prevented. If the location of the cameras is advertised to drivers using signage local to the site then the geographical influence of the camera is likely to be contained to the signed area of the camera. The signage of mobile road safety cameras in NSW is typically placed 250m up and downstream from the camera site. An indication of the reduction in the number of crashes that would be expected to be prevented with overt signage can be obtained using data relating to the mobile speed camera program in NSW. If it is assumed that overt signage means the crash reductions are restricted to an area within 250 metres of the location of the camera, rather than along the whole road length where the cameras are operated, then the crash population covered by the enforcement (that is, the number of crashes that are affected by the cameras) is reduced by around 80%. The expected benefits of the mobile phone detection cameras if the location was overtly signed is shown in Table 6.

Table 6 Annual benefits obtained in NSW (excluding 0.5% of residents in remote and very remote areas) with varying levels of deterrence and ***overt signage***

Deterrence fraction	20% deterrence	30% deterrence	40% deterrence	50% deterrence	60% deterrence	70% deterrence	80% deterrence	90% deterrence	100% deterrence
No. fatal crashes prevented	0.16	0.23	0.31	0.39	0.47	0.55	0.63	0.71	0.79
No. serious inj crashes prevented	2.37	3.56	4.75	5.94	7.14	8.34	9.54	10.74	11.95
No. moderate inj crashes prevented	3.94	5.92	7.90	9.89	11.88	13.88	15.88	17.89	19.90
No. minor/other inj crashes prevented	2.46	3.70	4.93	6.17	7.42	8.67	9.92	11.17	12.42
Total no. casualty crashes prevented	8.93	13.41	17.90	22.40	26.91	31.43	35.96	40.51	45.06
No. fatalities prevented	0.17	0.25	0.34	0.42	0.51	0.59	0.68	0.77	0.85
No. serious injuries prevented	2.66	3.99	5.33	6.67	8.01	9.36	10.71	12.06	13.42
No. moderate injuries prevented	5.06	7.60	10.15	12.71	15.27	17.83	20.40	22.98	25.57
No. minor/other injuries prevented	3.56	5.34	7.13	8.93	10.72	12.53	14.33	16.14	17.96
Total no. casualties prevented	11.45	17.19	22.95	28.72	34.51	40.31	46.12	51.95	57.79
Fatal crash $ saved	$1,358,324	$2,040,021	$2,723,415	$3,408,514	$4,095,324	$4,783,851	$5,474,101	$6,166,082	$6,859,800
Serious inj crash $ saved	$1,400,509	$2,103,316	$2,807,833	$3,514,066	$4,222,021	$4,931,704	$5,643,123	$6,356283	$7,071,191
Moderate inj crash $ saved	$380,149	$570,914	$762,142	$953,834	$1,145,993	$1,338,620	$1,531,716	$1,725,283	$1,919,324
Minor/other inj crash $ saved	$208,656	$313,356	$418,305	$523,504	$628,954	$734,656	$840,611	$946,819	$1,053,282
Total $ saved	**$3,347,638**	**$5,027,607**	**$6,711,695**	**$8,399,918**	**$10,092,292**	**$11,788,831**	**$13,489,551**	**$15,194,468**	**$16,903,597**

3.4. ESTIMATED PROGRAM REACH

The planned roll-out of the program across four years is shown in Table 7, including information on the number of fixed and transportable cameras, the estimated total number of vehicles checked per year and the average number of checks per registered vehicle per year.

Table 7. Planned program roll-out

Year	No. fixed sites	No. transportable cameras	Total number vehicles checked	Average number of checks per registered vehicle
1	4	2	30 million +	5
2	7	5	60 million +	10
3	11	10	100 million +	18
4	11	10	120-125 million +	20

Assuming that the probability of being detected is the same for every registered vehicle, the estimated reach of the program can be calculated from this information using the Poisson distribution. The Poisson distribution is the discrete probability distribution of the number of events occurring in a given time period, given the average number of times the event occurs over that time period. Knowing the expected average number of checks per registered vehicle per year (μ), the probability of being detected X times per year can be calculated using the following equation:

$$\text{Probability of being checked X times per year} = (e^{-\mu})(\mu^{x})/x!$$

This can then be used to calculate the probability of a registered vehicle being checked at least a certain number of times per year, across the four years of the planned program roll-out (refer to Figure 1).

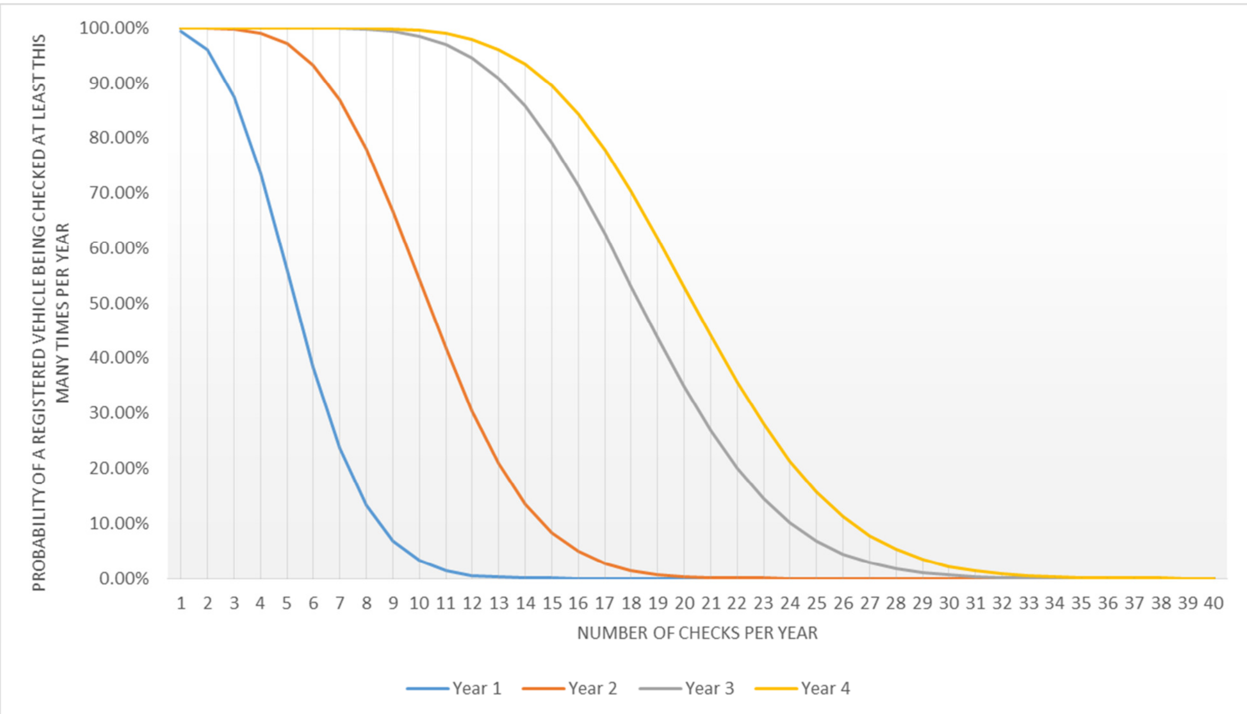

Figure 1. Estimated reach of the program: Probability of a registered vehicle being checked across Years 1 to 4 of program roll-out

Even from the first year, almost the entire population of registered vehicles is likely to be checked at least once during the year; in Year 1, 99.33% of the registered vehicle population will be checked at least once and this rises to 100% in Year 2. Multiple checks per registered vehicle per year are highly likely; for example, approximately 87% of vehicles can be expected to be checked at least three times in Year 1, seven times in Year 2, 13 to14 times in Year 3 and 15 to 16 times in Year 4.

4. DISCUSSION

The maximum benefit that could be obtained if all illegal mobile phone use by NSW drivers was prevented (that is 100% of drivers in non-remote areas were exposed to the cameras, and all stopped using their mobile phone illegally whilst driving) is a 1.17% reduction in crashes. This equates to 225 fewer casualty crashes, 289 fewer casualties, and savings of over $84.5 million per year. The largest reduction in the absolute number of crashes occurred for crashes of lower severity; there would be approximately 4 fewer fatal crashes and fatalities, 60 fewer serious injury crashes and 67 fewer casualties with serious injuries, 100 fewer moderate injury crashes and 128 fewer casualties with moderate injuries, and 62 fewer minor/other injury crashes and 90 fewer casualties with minor/other injuries. This is not surprising given that there are fewer fatality crashes than serious injury crashes, and fewer serious injury crashes than other injury crashes. However, because the cost of a crash increases as the severity increases, the largest annual cost savings were for fatal and serious injury crashes.

The overall maximum benefit is relatively small because the prevalence of illegal mobile phone use while driving in NSW is relatively low (1.43%) and the best evidence of the effect of visual-manual mobile phone use on crash risk indicates an 83% increase in risk of crashing whilst using a mobile phone. This maximum benefit is likely to be smaller than what the general public, and many in the field of road safety would expect, however, it still results in significant cost savings.

The program, however, is unlikely to lead to total elimination of illegal mobile phone use while driving. The effect of the program on the prevalence of illegal mobile phone use whilst driving will be related to the program reach (that is, the proportion of drivers who are exposed to the cameras) and the level of deterrence (that is, the proportion of drivers who are deterred from using their mobile phone illegally).

Approximately 99.5% of the NSW population is based in major cities and inner and outer regional areas which are reasonably accessible and these will be the areas targeted by the program (personal communication, NSW CRS). Program reach can also be estimated using the estimated average number of checks per registered vehicle per year. While the probability of detection will be related to km driven and the exposure to roads on which the cameras are placed, which will vary by vehicle, this level of detailed information is not available, so it was assumed that each registered vehicle has an equal probability of being detected. In this scenario, almost all drivers will be checked at least once per year from Year 1 of program roll-out, with close to 100% of vehicles checked at least three times per year in Year 2, at least eight times per year in Year 3 and at least 10 times per year in Year 4. Therefore, it is reasonable to assume that the 99.5% of the NSW population who do not reside in remote or very remote areas will be reached by the program even from Year 1.

The level of deterrence that will be achieved from the mobile phone enforcement cameras is currently unknown, however, from previous research into the effectiveness of automated enforcement cameras, it can be reasonably assumed that between 30% and 40% of drivers that illegally use a mobile phone will be deterred from using their mobile phone as a result of the program. If 100% of the NSW population who do not reside in remote or very remote areas is reached by the program, and the level of deterrence is 30 to 40%, there would be 67 to 89 fewer casualty crashes and 86 to 115 fewer casualties, with an associated cost saving of between approximately $25.1 million and $33.6 million per year (refer to Table 8).The benefits over five years (equal to the annual benefits multiplied by five) are also presented in Table 7.

There are several important issues to consider in terms of the operation of the program that could not be explicitly modelled in this study but would be expected to have an impact on the effectiveness of the program. The first is the transportability of the mobile cameras. Previous experience with mobile speed cameras has shown that for maximum general deterrence, the cameras should be moved regularly (e.g. every few hours); for example, 60 to 70 mobile speed cameras can be used to enforce up to 2,500 sites based on enforcing 3 sites per day per camera in 2-3 hour shifts. If the cameras are not readily transportable then there is less opportunity to vary the placement of the cameras in space (location) and time, which may reduce the geographical coverage of the program. This would reduce the impact as fewer drivers would be reached and may also reduce the deterrence effect of the program as drivers may not believe they would be caught. Alternatively, more cameras would be required to enforce the same area.

The other operational issue relates to whether or not overt signage is used to inform drivers of the location of the cameras at times they are in use. If the location of the cameras is advertised to drivers using signage local to the site, which is typically placed 250m upstream and downstream from the site of mobile cameras in NSW, then the geographical influence of the camera is likely to be contained to the signed area of the camera. If the location of the cameras is not overtly signed, then the geographical influence of the camera may be much greater, which means more crashes would be expected to be prevented. An indication of the reduction in the number of crashes that would be expected to be prevented with overt signage can be obtained using data relating to the mobile speed camera program in NSW. If it is assumed that overt signage means the crash reductions are restricted to an area within 250 metres of the location of the camera, rather than along the whole road length where the cameras are operated, then the crash population covered by the enforcement (that is, the number of crashes that are affected by the cameras) is reduced by around 80% and the likely benefits are therefore substantially reduced (refer to Table 8). All other things being equal, if the camera locations are overtly signed, it would take five years to achieve the same benefits that a program that does not use overt signage would achieve over one year. Alternatively, maintaining the geographical influence of a program with overt signage may require more sites to be enforced more often.

Table 8. Annual and 5 yearly benefits obtained ***(excluding 0.5% of residents in remote and very remote areas)*** *for likely levels of deterrence; benefits obtained with overt signage of cameras shown in parentheses*

	Time	1 year	5 years	1 year	5 years
	Deterrence	30%	30%	40%	40%
No. Casualty Crashes prevented	Fatal	1.17 (0.23)	5.86 (1.17)	1.56 (0.31)	7.82 (1.56)
	Serious	17.78 (3.56)	88.88 (17.78)	23.73 (4.75)	118.64 (23.73)
	Moderate	29.60 (5.92)	148.02 (29.60)	39.52 (7.90)	197.59 (39.52)
	Minor/other	18.48 (3.70)	92.41 (18.48)	24.67 (4.93)	123.35 (24.67)
	Total	**67.03** **(13.41)**	**335.15** **(67.03)**	**89.48** **(17.90)**	**447.41** **(89.48)**
No. Injuries prevented	Fatal	1.27 (0.25)	6.33 (1.27)	1.69 (0.34)	8.45 (1.69)
	Serious	19.95 (3.99)	99.77 (19.95)	26.64 (5.33)	133.19 (26.64)
	Moderate	38.02 (7.60)	190.12 (38.02)	50.76 (10.15)	253.80 (50.76)
	Minor/other	26.71 (5.34)	133.57 (26.71)	35.66 (7.13)	178.30 (35.66)
	Total	**85.96** **(17.19)**	**429.79** **(85.96)**	**114.75** **(22.95)**	**573.74** **(114.75)**
$ saved	Fatal	$10,200,103 ($2,040,021)	$51,000,515 ($10,200,103)	$13,617,076 ($2,723,415)	$68,085,378 ($13,617,076)
	Serious	$10,516,581 ($2,103,316)	$52,582,906 ($10,516,581)	$14,039,164 ($2,807,833)	$70,195,822 ($14,039,164)
	Moderate	$2,854,570 ($570,914)	$14,272,848 ($2,854,570)	$3,810,709 (762,142)	$19,053,547 ($3,810,709)
	Minor/other	$1,566,780 ($313,356)	$7,833,898 ($1,566,780)	$2,091,525 ($418,305)	$10,457,626 ($2,091,525)
	Total	**$25,138,033** **($5,027,607)**	**$125,690,167** **($25,138,033)**	**$33,558,475** **($6,711,695)**	**$167,792,373** **($33,558,475)**

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MONASH University

ACCIDENT
RESEARCH
CENTRE

Further information

Dr Karen Stephan
Monash University Accident Research Centre
21 Alliance Lane
Clayton, Victoria 3800
Australia

T: +61 3 9905 1802
E: Karen.Stephan@monash.edu

monash.edu/muarc