A review of intended and unintended consequences of the use of automated speed cameras to reduce road crash: lessons learnt

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Abstract

The pandemic of road traffic deaths and injuries is a public health issue which needs to be addressed in both developing and developed countries. The WHO report (2009) highlights that by 2030 Road traffic injuries will have moved from ninth (in 2004) to fifth in the world leading causes of deaths. Reviews of the mean cost of road traffic crashed in developed countries amount to 2-3% of GDP. Most public safety officials agree that speed limit enforcement measures including automated speed cameras are an effective intervention in reducing road crash. While it must be agreed that the issue of road crash in developing and developed countries cannot be compared, yet, international efforts should be made to share experiences and lessons learnt in developed countries to developing countries to successfully reduce the injury burden from road traffic crashes in developing countries. This paper examines the relationship between speeding, road crash and injury rate. Then, it reviews studies on the use of automated speed cameras to reduce road crash and its unintended consequences. Based on the above, the discussion will address some of the lessons learnt in the use of automated speed cameras in developed countries.

Key words: automated speed cameras, speeding, road crash

Introduction

Most public safety officials agree that speed limit enforcement measures including speed cameras are an effective intervention in reducing car crash. Setting speed limits as a strategy for controlling driving speeds started early in the twentieth century and the most common methods used is to set the speed limit near the 85th percentage speed that is the speed at or below which 85% of drivers travel in free flow conditions at specific locations.

In many countries speed camera programs are becoming an established part of transportation safety programs. The setting of speed limits intends to provide a basis for enforcement and sanctions for those who disregard information posted on sign posts in view of promoting safety to road users. However, strategies adopted by both drivers and other primary and secondary stakeholders involved with the transport industry might jeopardize the intended consequences of speed cameras and flout the speed limit established by the law. This paper aims firstly to examine why there is a concern on the number of deaths associated with road crash. Secondly, the relationship between speeding, car crash and injury rate will be established. Thirdly, does the aim of speed cameras actually lead to a reduction in the number of speeders and crashes? Fourthly, what are the unintended consequences of the use of speed cameras? Based on the above, the discussion will address some of the lessons learnt in the use of speed cameras in developed countries.

Deaths associated with road crash

Between 20 and 50 million are injured on disabled, every year, worldwide as a result at road traffic crashes (Penden 2004). According to the Global status report on road safety (WHO 2009) more than 1.2 million people die on the world’s roads every year. Over 90% of these deaths occur in low-income and middle-income countries which have only 48% of the world’s registered vehicles. The WHO report also highlights that by 2030 Road traffic injuries will have moved from ninth (in 2004) to fifth in the world leading causes of deaths. Reviews of the mean cost of road traffic crashed in developed
countries amount to 2-3% of GDP. (Elvik 2000; Jacob G 2000). On a more positive note, death rates associated with road accidents has been declining over the past four decades in many high-income countries where a road safety system framework built on three pillars namely (1) the drivers/road users (2) the infrastructure and (3) the vehicles has been implemented.

Current traffic safety conditions in most developing countries are already extremely serious and in face of the rapid increase in the use of motorised means it will undoubtedly worsen in the near future. For instance, with economic growth in China, the authorities are grappling with the associated challenges to enforce and regulate road traffic congestion and road crashes (WHO 2009). The increased use of motorised means, especially automobiles and motorcycles, have been pursued intensively by most developing countries in an irresponsible, socially unacceptable way: poor enforcement of traffic safety regulations, a culture of blame game where the police blame drivers and vice versa together with an inadequate road infrastructure seem to be the major cause of road crashes and associated deaths. Road crash is a good example of a 'disease of development' which is far more prevalent in developing countries than in developed ones and the issue of road traffic mortality and morbidity have traditionally been perceived mostly as a concern for primarily developed countries. At the same time, Nantulya and Reich (2002) point out that the injury profile for road traffic crashes in developing countries differs in important ways from the profile seen in developed countries. Road traffic injuries in developing countries mostly affect pedestrians, passengers, and cyclists—as opposed to drivers. While it must be agreed that the issue of road crash in developing and developed countries cannot be compared, yet, international efforts should be made to share experiences and lessons learnt in developed countries to developing countries to successfully reduce the injury burden from road traffic crashes in developing countries. The pandemic of road traffic deaths and injuries is a public health issue which needs to be addressed in both developing and developed countries.

**Relationship between speeding road crash and injury rate.**

It has been clearly established that there is a positive relationship between higher vehicle speeds and crash rate. (Fildes et al, 1998; Taylor et al 2000). The OECD/ECMT (2006) estimate that speeding contributed to as much as one third of all fatal accidents. Speeding encompasses excessive speed (driving above the speed limit) or inappropriate speed (driving too fast for the prevailing conditions, but within the limits). One at the most often cited models used to investigate the effects of changes in average speed on traffic crash incidence and severity – the Power model – suggests that a 5% increase in average speed leads to an approximately 10% increase in crashes involving injury and a 20% increase in those involving fatalities. These predictions are supported by Elvik (2005) and Van Schagen (2006) in a review of not less than 100 studies. Similarly experiments carried out on the stopping distance in an emergency braking show that the stopping distance for a vehicle after a driver reacts and brakes will be longer at a greater travel speed. (Speed Management Transport Research Centre OECD 2006 p/6).

![Diagram showing braking distance and thinking distance at different speeds](https://www.learnerdriving.com/learn-to-drive/driving-lesson-briefs/)
Based on these findings a number of countries have adopted the vision zero initiated by the Swedish parliament in 1997, whereby ‘it can never be ethically acceptable that people are killed or seriously injured when moving’. (Tinguall 1999) Subsequently, based on this philosophy of vision zero, a combination at measures including credible speed limits, enforcement and education, tailored roads and vehicles have constituted the ingredients of a sound speed policy. It should be noted that this policy mix has been adopted by most countries in the EU and some other developed countries (USA and Australia in particular) and the outcome has been a reduction in road crashes.

This policy mix included the use automated speed cameras which were either installed in pole-mounted along roadside and on entries above the road (fixes position speed cameras) or in police cars (mobile speed cameras users). They both register speeding offences by identifying the identity of the vehicle owners based or the vehicle registration number by using the number plate recognition software. (Turner and Polkia, 1998). In general they are used in (a) places where there has been a relatively high number of road crashed (number of crashes per vehicle kilometer) and (b) where there is an apparent link between crashed and speed (c) in places where there is likely to be a high percentage of speed offenders and (d) when specific considerations such as visibility, accessibility and effect on traffic flow might be linked with road crashes. When a violation of the speed limit is detected by radar, the registration number of the vehicle is photographed automatically and sent to the operating body. The digital system set up ensure that no human manipulation is required thereby reducing the opportunity for corrupt practices and non-discriminatory law enforcement. (Lianos and Douglas 2000).

Several countries have adopted the implementation of speed camera surveillance: (for example Australia in 1985, Canada in 1988, Great Britain in 1991.)

**Evidence on the use of speed cameras to reduce car crash.**

In the wake of the implementation of speed cameras to promote road safety several studies have been carried out. Keall et al (2002) comparing the relative effectiveness at a two year speed camera programme in New Zealand found a reduction in crashes and injuries in hidden speed cameras as compared to open roads in New Zealand. Gains et al (2004) carried out an extensive evaluation study in Great Britain. Their evaluation which distinguished between fixed position and mobile cameras showed a reduction in personal injury crashes of 71% while using a fixed position and mobile cameras and a 74% reduction with the use of mobile cameras.

The European Road Safety Observatory (2006) concluded that the effects of speed cameras generally radiate in a radius of 3 – 10 kilometres around the camera location. However, the combination of visible fixed cameras and hidden mobile cameras can increase the distance halo. Similarly when cameras are easily visible the distance halo increases. A meta analysis by Wilson et al (2006) of 35 studies known as the Cochrane reviews of speed cameras and a review of 14 speed camera studies by Pilkington and Kinra (2005) conclude that high speed cameras are a worthwhile intervention for reducing road traffic injuries and road deaths. The key Scottish Safety Camera Programme Statistics (2011) reveals that “The number of people killed as seriously injured at safety camera site is 68 per cent lower after camera enforcement. The number of personal injury accidents at safety camera sites is 48 per cent lower after enforcement. “(p3). However, Wilson et al (2006) highlight that there is considerable heterogeneity across studies involving variations in speed limits, types and duration at interventions, length of follow-up periods and number of control sites. The heterogeneity and low level of methodological rigour should be addressed by an international standardization of data collection methods to enable cross-country comparisons. Similarly, there is a need for a comprehensive description of the study design to promote the development of indexing terms in road safety database.

**Dilemmas associated with the use of speed cameras**

Goldenbeld (2002) identifies four types of dilemmas which are associated with the use of speed cameras. The **credibility dilemma** questions the aim of speed camera and whose interest is it pursuing: (i) In some jurisdictions it is perceived as having a dual role of raising revenue and
promoting road safety. In some others, it is considered as primarily a mechanism to raise revenue. (Queensland Police Union in Poyhoren 2010). The amount of revenue raised is either too excessive or the revenue collected instead of being reserved for road safety uses goes to a consolidated fund. Johnson (2004) points out that fine collected and used for other purposes quickly erode public acceptance of the programme. (ii) In terms of location of speed cameras some critics consider that speed cameras have been placed in areas where it is ‘safe’ to speed/ used in areas where there is no significant accident history (Soole, Lennon and Watson 2008) or seems to be located at the most ‘lucrative’ routes. Concerning the type of detection used (overt or covert) overt operations are likely to deter speeders at unsafe locations while covert operations primarily aim to raise revenue.

The social dilemma stems primarily from the belief that speeding slightly in excess of the limit (up to at least 5 km/h) is not associated with increased crash risk. There is a mismatch between individual preference and collective interest whereby the focus is on the ability of the individual driver and less attention is paid on the overall impact on road safety. The proven relationship between speed and injury risk as well as the stopping distance in cases of emergency braking seems to be ignored or unknown and the public needs to be sensitized through public campaigns.

The legitimate dilemma refers to rights of the person and the fairness of the countermeasure: the offender is not given the opportunity to explain the circumstances of the event, or that the automated enforcement is perceived as an infringement of civil liberties (Kendall, 2004) Offenders also question the fairness of penalties. Penalties for exceeding a speed limit by less than 10 km/h are viewed as less fair than those exceeding the speed limit by more than 10 km/h.

The implementation dilemma raises three concerns: (i) the reliability of the speed cameras when individual cameras prove faulty. Mah and Markusoff (2005) refer to the dismissal of 6800 speeding tickets in Edmonton, Alberta due to the improper use of the speed camera by an improperly trained operator. (ii) the speed limits set at particular locations- some drivers tend to decelerate as they approach an enforcement zone and to accelerate once they passed the enforcement zone. This is known as the kangaroo effect and although studies have not yet established the probability that such a behavior can lead to a road crash yet the dangerous traffic which might result is feared. In this respect, the road section control or average speed check measure whereby the speed is measured over a distance of at least five hundred metres to several kilometers has been introduced in some countries (Netherlands and United Kingdom). It is hypothesized that this measure would promote positive behavioural effect and a change in the culture of speeding (Goldenbeld 2005). To date no robust trials of the road section control has been undertaken to assess the effectiveness of this measure. (iii) the diversion of police resources away and the reduction of police patrols on the road (Marsh 2010). Speed cameras are considered as a long term strategy to change driver behavior whereas police patrols are an immediate response to motorists engaged in dangerous driving practices. Indeed several studies have shown that inattention (Spencer 2004) accounts for half of fatal crashes. The use of mobile (Government of Victoria 2008 in Spoer and Parnis 2010) while speeding increases the risk of an accident by four times, while speeding accounts for about 10% of fatal crashes.

Closely linked with the implementation dilemma is the way drivers respond to the implementation of speed cameras. Corbett (1995) points out that some motorists display a defiant behavior such as flashing their headlights at incoming cars to inform them of the presence of a radar unit ahead or report speed cameras locations to radio stations. The outcome is that the effectiveness of speed cameras is reduced. Also, not all drivers react in the same way (Blincoe et al, 2006). Corbett (2000) identifies 4 types of drivers in relation with the enforcement of speed cameras : (a) conformers that is those who generally conform to speed limits and are quite unaffected by speed cameras (b) ‘deterred drivers’ who reduce their speed to avoid getting caught (c) ‘manipulators’ are those who provoke the kangaroo effect, that is, they slow down on the approach to a speed camera and accelerate once they have passed the zone, and (d) defiers who tend to speed regardless of the presence of speed cameras.
While it is claimed that manipulators might increase the risk of road crash it is even more of concern to take in consideration the behavior of ‘defiers’. If motorists continue to be convicted it would mean that the aim of having a speed camera to enforce road security is not achieved and these devices might end up alienating people on whose goodwill the police rely upon (Buckingham in Cadogan 2004). A fractured relationship would both inhibit the police’s ability to enforce road safety measures and worse, it can incite violence and forms of civil disobedience. Tactics of resistance range from discursive to physical actions. These actions are justified by the offenders by using narratives at resistance to surveillance. Three main narratives themes can be identified (Wells H and Wills D 2009): (1) Skepticism towards scientific expertise and attempts to establish counter-knowledge. Debates evolve around scientific expertise and statistical knowledge (2) a logic of equivalence (Laclan and Mouffe 2001) which considers individual drivers and activists as a non-deviant population of ‘normal’ people driven to resistance by the action of the state and (3) the threat posed by other deviant groups and individuals that deserve more surveillance than the ordinary ‘law abiding’ drivers. In terms of physical actions, Willis (2005) and de Bruxelles (2004) report several cases of offences such as arson (Scotland September 2004) carried out on speed cameras and photo radar vans. Some offenders even plan their offence: “Street racing demons in Hong Kong have been zooming past speed cameras and beating red lights without getting caught. They have only to press a red button next to their gear shift, and the rear car license plates will flip down so that cameras cannot capture their pale numbers”(Hong Kong February 2005 in Willis 2006).

“Rogue drivers are evading thousands of speeding tickets by exploiting a loophole in the law that enables them to ignore roadside cameras (…) the scam involves offenders registering their cars at one of a network of ‘mass mailing’ addresses used legitimately by businesses instead of at their own homes. When a driver triggers a camera, a penalty notice is sent to the mass-mailing address. Police seeking the motorist find only a shop front where nobody lives.”p86 (United Kingdom, April 2006 in Willlis 2006). The secondary effects of speed cameras also concerns service providers such as those marketing Global Positioning System Satellite (GPS)-based systems (Marston 2005). GPS-based detector units provide a daily updated map of fixed and mobile speed camera locations. Some car manufacturers equip new cars with cruise control devices from a luxury to a necessity item for some drivers.

Lessons learnt
It is agreed that the exact relation between crashes and speed depends on a large number of factors. However, the relation is very clear and irrespective of the method used, it has been shown in a large number of studies that, the higher the speed, the greater the probability of a crash. Well know researchers in this area such as Nilsson (1982; 2004), Elvik, Christensen & Amundsen (2004) and Elvik (2009) conclude that the crash rate increases more rapidly when the speed increases and vice versa. Similarly, as the speed increases, the injury severity in crashes also increases. Given these conclusions, approaches to reduce car crash should be based on short, medium and long term measures to reduce accidents on the roads through the 3 “Es” of education, engineering and enforcement of appropriate regulations. In terms of education, road users should be sensitized on: (i) the general causes of road crash, (ii) the relationship between speeding, road crash and injury severity and (iii) in cases of emergency breaking, how the stopping distance differs in wet and dry conditions. Measures targeting vehicle engineering as well as road engineering need to be envisaged. Concerning the enforcement aspect, adopting reasonable and enforceable traffic laws not liable to cause accidents need to be put in place.

A systematic “safe systems” approach having as its goal the elimination of death and serious injuries highlighting the shared responsibility and accountability by all parties to the road transport system for improved road safety performance has to be adopted. (Peden et al 2004, OECD/ITF, 2008). In view of promoting a holistic approach to reduce road crash, countries need to develop a legislative and regulatory framework that could be implemented through a national road safety plan. Furthermore, as
recommended by the United Nations 62nd General Assembly (GA/10694) on Easing Global Road Safety Crisis (2009) the annual World Day of Remembrance for Road Traffic Victims in December should be observed by organizing global road safety weeks and encouraging fleet-owning organizations in both the private and public sectors to develop policies and practices that would reduce road-crash risks. Another avenue to be investigated is the creation of a space for civil society organizations to support and advocate for road safety measures. Mothers Against Drunk Driving (MADD), a U.S. nonprofit organization set up in the 1980’s has been a successful grassroots advocacy group to promote and support road safety initiatives.

It is generally agreed that traffic law enforcement influences driving behaviour through two processes: general deterrence and specific deterrence. Measures to discourage speeding could be based on the principles of the general deterrence theory. General deterrence is achieved by increasing the subjective risk of apprehension: the higher the subjective risk of apprehension, the higher the effectiveness of police enforcement. According to Goldenbeld (2005) if police enforcement is (i) accompanied by publicity,(ii) implemented through a mix of highly visible and less visible activities, (iii) are primarily focused on times and locations with high violation speed (maximum feedback to potential offenders) and (iv) continued over a longer period of time, the subjective risk of apprehension increases. Yanis et al (2004) describe the hierarchy of road safety enforcement whereby a legal and organizational framework for police enforcement of controls on selected locations of the road network during selected time periods increase the perceived risk of apprehension. Subsequently, violation rates will decrease and changes in road user behaviour will result in less traffic crashes and less traffic victims.

However, these propositions on road safety measures and the behaviour of drivers are based on a parametric rational-choice theory. It predicts that drivers’ actions are a rational response to enforcement level and severity of the penalty. It has been found that there are several types of response (Corbett 2000) following the enforcement of speed cameras and not all drivers respond rationally. Hatakka et al. (2002) consider that driving behavior is not an isolated behaviour and that it is linked with other aspects of life and is affected by motivational, attitudinal issues and individual driving skill. Similarly, according to Gottfredson and Hirsch (1990) theory of self-control, people with low levels of self-control are likely to be guided by short-term pleasures with little attention paid to long-term consequences. These individuals tend to be engaged in risky behaviours such as speeding. Risky driving has also been found to serve as a means of increasing feelings of self-determination and personal efficacy.(Donovan et al 1988). Papadakis and Moore (1991) point out that dangerous driving may be a way for young men to create gender identities. Hence, issues of self control, self efficacy and self image cannot be ignored in designing road safety measures likely to have a general deterrent effect.

As far as the specific deterrent effect is concerned, this effect is typically assessed by measuring changes in re-offence or recidivism rates. The driving behavior of people who have already been apprehended and punished at least once for the behaviour in question needs to be assessed to establish whether a specific deterrent effect has been achieved or not. A recidivist is likely to be a ‘persistent’ or ‘hard core’ speeding offender and if the rate of recidivism is high, it could be deduced that the enforcement of the speed limit did not deter the driver from speeding. While it is acknowledged that there are many factors that can influence driver behaviour beyond a mere penalty change, yet one way of reducing recidivism would be to review the penalties and sanctions associated with speeding offences. For instance, levels of illegal speeds (level 1 speeding in excess of posted speed limit but within 10km/h, level 2 speeding in excess of 10-25 km/h over the posted speed limit etc.) could be matched by a proportional increase in the monetary sanction and a demerit point system can be linked with the level of speeding.

Media discourses also contribute to frame the debate about speed cameras: Discourse analysis on articles can reveal the ratio of anti-speed and pro-speed cameras. These discourses can also either
promote the road safety aims in the use of speed cameras or trigger the public’s skepticism on the implementation of road safety cameras. The anti-speed camera discourse is likely to promote the idea that speeding is not necessarily a cause of injury and that speed cameras are an infringement of our privacy or the use of speed cameras is merely to raise revenue for the authorities. They distort the message of preventive practices as a public health issue and position the crash as an individual issue. Connor and Wesolouski (2004) have noted that by presenting fatal crashes as a divergence from the norm and assigning the blame to a single party, the media thereby frames both the problem and the solution in their coverage of road crashes. Since the media has significant power to shape public attitudes these discourses need to be reframed to get maximum effectiveness from speed cameras. The media need to promote the idea that speed causes road crash and that speed cameras are a legitimate deterrent. The public’s sense of social responsibility should be developed.

Conclusion

The relationship between the use of speed cameras and the reduction of road crash has been established and supported by several studies. The adoption of a safe system approach in developed countries has produced a fall in the number of road crash. Many middle and low income countries are gradually introducing speed cameras. However, the findings of studies from high-income countries cannot be assumed to apply to these countries as the driving culture as well as the road infrastructure is not comparable to those existing in less developed countries. Furthermore, speed cameras need to be implemented together with a whole range of safety road measures to increase the probability of reducing road crash. Since driving is a socially regulated behavior, a range of factors affecting motivational sources of driving should be harnessed to meet the vision of ‘it can never be ethically acceptable that people are killed or seriously injured when moving’. Transport professionals, the state, the public and private sector, civil society organizations, the judiciary, the media and other stakeholders should promote the intended consequences of the use of speed cameras. The reliance on technology alone will bring along unintended consequences and the pandemic of road traffic deaths and injuries as a public health issue will not be addressed.

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