Point-to-point speed enforcement: Recommendations for better practice

Soole, D.W., Fleiter, J.J., & Watson, B.

Centre for Accident Research and Road Safety - Queensland (CARRS-Q)

Abstract

Point-to-point speed cameras are a relatively new and innovative technological approach to speed enforcement that is increasingly been used in a number of highly motorised countries. Previous research has provided evidence of the positive impact of this approach on vehicle speeds and crash rates, as well as additional traffic related outcomes such as vehicle emissions and traffic flow. This paper reports on the conclusions and recommendations of a large-scale project involving extensive consultation with international and domestic (Australian) stakeholders to explore the technological, operational, and legislative characteristics associated with the technology. More specifically, this paper provides a number of recommendations for *better* practice regarding the implementation of point-to-point speed enforcement in the Australian and New Zealand context. The broader implications of the research, as well as directions for future research, are also discussed.

Introduction

A growing body of evidence suggests a positive relationship between increased vehicle speeds and increased crash risk and injury severity (Aarts & van Schagen, 2006). In addition, increased heterogeneity between vehicle speeds has also been linked with an increased risk of crash involvement (Cirillo, 1968; Solomon, 1964; Transportation Research Board, 1998). Specifically, increased speed variation disrupts homogenised traffic flow, reduces headway distances and increases the likelihood of conflict situations caused by human errors of judgement.

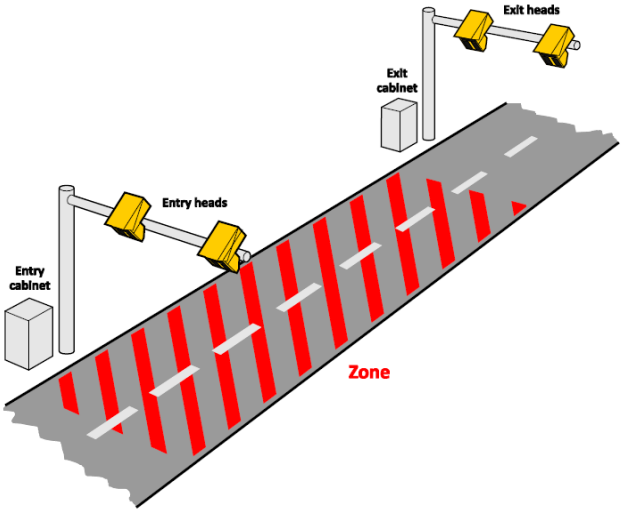
Despite these publicised risks, speeding remains a pervasive behaviour in Australia and a major contributor to traffic crashes and related trauma (Australian Transport Council, 2011; Glendon, 2007; Walker, Bryant, Barnes, Johnson, & Murdoch, 2009). Moreover, speeding is arguably a socially acceptable behaviour among many motorists, particularly at lower levels over the speed limit (Fleiter & Watson, 2006; Hatfield & Job, 2006; Ipsos Social Research Institute, 2013). Many drivers report adapting their speeding behaviour to accommodate traditional speed enforcement methods to avoid detection (Fleiter, Lennon, & Watson, 2007; Ipsos Social Research Institute, 2013), a phenomenon consistent with the concept of punishment avoidance (Stafford & Warr, 1993). Such behavioural modifications include site-learning and site-specific reductions in speeding behaviour (halo effects). The influence of punishment avoidance on continued offending has been highlighted, such that punishment avoidance may do more to reinforce speeding behaviour than punishment does to discourage it (Fleiter & Watson, 2006; Stafford & Warr, 1993).

To address the ongoing involvement of speeding in road crashes in Australia, a number of speed management countermeasures have been developed and implemented in recent decades, including enhanced road and vehicle engineering measures and increases in the intensity of a wide variety of speed enforcement approaches. Indeed, the National Road Safety Strategy (2011-2020) identifies speed management as an essential element of promoting safer road use across the road network (Australian Transport Council, 2011). The Strategy also highlights point-to-point speed enforcement as an innovative strategy that may assist in the achievement of this goal.

Point-to-point speed cameras are a relatively new technological approach increasing in popularity in a number of highly motorised countries. The terminology used to refer to the approach varies depending on the jurisdiction in question, including average speed enforcement (United Kingdom) and section/trajectory control (Netherlands, Austria, Italy and other European countries). The use of

point-to-point speed enforcement can be considered still in its infancy in Australia and New Zealand. Currently, point-to-point systems operate to varying extents in Victoria, Queensland, the Australian Capital Territory, South Australia and New South Wales (for heavy vehicles only), as well as New Zealand. However, the use of the approach is far more extensive in the United Kingdom and throughout Europe, including the Netherlands, Austria, Italy, Switzerland, Belgium and Finland (see Soole, Fleiter, & Watson, 2012 for an extensive review).

A basic overview of a point-to-point system can be seen in Figure 1. Briefly, the technology involves the installation of a series of two or more camera sites along a section of the road network. Cameras may be forward or rearward facing (or both) depending on the requirements of the system (e.g., identifying the driver, applying enforcement to motorcycles). An image and vehicle registration data are collected from vehicles at each point and matched using automatic number plate recognition (ANPR) technology. The average speed of a vehicle between two camera sites is then calculated by dividing the known specified distance between the two camera sites by the time taken for the vehicle to travel between those two sites. If the corresponding average speed of a vehicle is found to be exceeding the legal posted speed limit for that road section (plus any enforcement tolerance), images and offence data are transmitted to a central processing unit (or back office) from the local processor via a communication network, where human verification occurs to assess the validity of detected infringements. Data on non-offending vehicles are typically erased (see Soole, et al., 2012 for an extensive technological overview).



Source: RedSpeed International personal communication.

Figure 1. Basic diagram of a point-to-point speed enforcement system.

The underlying premise of point-to-point speed enforcement is that it promotes reductions in vehicle speeds that are achieved over a larger section of the road network, compared to other speed camera approaches. Comparatively, a common finding associated with instantaneous speed cameras is that their effects are localised (e.g., they have a minimal zone of influence which is typically restricted to the immediate vicinity of the camera). Indeed, vehicle speeds have been reported to return to pre-camera levels, or even to speeds greater than that of pre-camera levels, within as little as 200 metres after the instantaneous speed camera site (Champness, Sheehan, & Folkman, 2005; Charlesworth, 2008; Keenan, 2002). In addition, the very nature of point-to-point speed enforcement systems makes punishment avoidance within the enforced section of road inherently difficult and increases the focus on enforcing persistent speeding behaviour.

The effectiveness of point-to-point enforcement has been reviewed in previous publications by the current authors (see Soole, et al., 2012; Soole, Watson, & Fleiter, 2013 for a detailed review of prior evaluation studies). Briefly, the review of the research suggests that point-to-point speed enforcement shows promise as an effective approach for reducing vehicle speeds, in particular high-range speeding behaviour, and reducing speed variability (see Soole, et al., 2012 for a comprehensive review of these studies; Soole, et al., 2013). A number of studies have also highlighted the positive impacts on fatal and serious injury crash rates associated with these reductions in vehicle speeds (see Soole, et al., 2012 for a comprehensive review of these studies; Soole, et al., 2013). Moreover, the research suggests that the approach produces a number of ancillary benefits such as homogenised traffic flows (as a result of the reduced speed variability) (Cascetta, Punzo, & Montanino, 2011; Malenstein, 1997), and environmental benefits such as reduced fuel consumption and traffic emissions (Cascetta & Punzo, 2011; Punzo & Cascetta, 2010; Thornton, 2010). However, the relatively poor methodological rigor in much of the evaluation literature must be acknowledged.

This paper reports on the conclusions and recommendations of a large-scale project reviewing the development and implementation of point-to-point speed enforcement systems throughout the world. The primary outcome of this project was a number of principles for *better* practice regarding the use of point-to-point speed enforcement in the Australian and New Zealand context. The term better practice, as opposed to best practice, was deliberately chosen by the research team, given that the evidence for this approach is still in its infancy and further research and experience is necessary to develop *best* practice guidelines. Specifically, this paper provides a number of recommendations associated with technological, operational, and legislative characteristics of point-to-point systems, as well as recommendations for evaluations and public education.

Methodology

In order to assess the current state-of-play regarding the use of point-to-point enforcement throughout the world, as well as the technological, operational and legislative characteristics of these systems, extensive stakeholder consultations were conducted. Specifically, stakeholders were consulted, either by face-to-face or telephone interview or by completing a survey. The survey/interview questions were based on information collected during the literature review, which was conducted as part of the larger project.

A total of 46 stakeholders were consulted, of which 24 organisations were from Australia and New Zealand, and 22 were from international organisations, including from England, Scotland, the Netherlands, Austria, Italy, France, Switzerland, Finland, Belgium and Slovenia. Organisations consulted included police agencies, transport and highway authorities, motoring groups, manufacturers of speed detection equipment, other road safety research centres, and measurement and privacy departments within government.

Initial contact with relevant stakeholders was made via email and/or telephone. During this process, the purpose of the project was explained and a formal invitation for representatives from the organisation to participate was provided. Face-to-face meetings were conducted for the majority of organisations located in Queensland, New South Wales and Victoria. For all other Australian, New Zealand and international jurisdictions, stakeholder interviews were conducted via teleconferences or surveys. Stakeholder interviews typically took between 30-90 minutes.

In addition to the extensive stakeholder interviews and surveys, a full-day working group involving key Australian and New Zealand stakeholders (e.g., Police and transport authorities in each jurisdiction) was convened. The proceedings involved a presentation by the research team outlining the key findings from the draft report (which included an extensive literature review), followed by

group discussion on many of the key aspects presented and feedback regarding proposed recommendations towards better practice.

A content analysis of the qualitative responses from the stakeholder consultation process was conducted, using the transcripts provided from the audio recordings and/or the written responses to surveys. The analysis assessed information based on the themes covered in the consultation process. Those issues most uniformly identified as important by stakeholders were given prominence in the content analysis. These issues included: the extent of use of point-to-point systems; technological and operational characteristics of the systems; legislative particulars associated with use of the technology; and, broader issues including barriers to effective implementation, public education, evaluation of the systems and where point-to-point fits within the overall speed management strategy adopted in each jurisdiction.

The remainder of this paper reports on these findings and the corresponding recommendations derived from this information. Specifically, the authors of this paper developed recommendations primarily based on the stakeholder consultation process, with additional information from the literature review also drawn upon. When formulating the wording of recommendations, consideration was given to the importance of particular information as identified in the content analysis.

Results

Based on the findings from the stakeholder consultation process, as well as the literature review, a number of recommendations for better practice were formulated. The recommendations related to the development and implementation of point-to-point speed enforcement systems in the Australian and New Zealand context and are discussed in the following sections in relation to: (a) operational recommendations; (b) technological recommendations; (c) legislative recommendations; (d) public education recommendations; and (e) evaluation recommendations. This paper highlights the key recommendations made in these areas; for a more extensive discussion of these and other recommendations refer to Soole, et al. (2012).

Operational recommendations

Similar to the selection of enforcement locations for other approaches to speed enforcement, it is recommended that the selection of sites for point-to-point systems should be based on strict criteria aimed at maximising road safety benefits. While such criteria will invariably differ between jurisdictions, they should at the very least include crash history. Moreover, this should include a high rate of speed-related crashes occurring along a section of road, rather than at a single location which may be more efficiently enforced using fixed or mobile speed cameras or manual approaches. Other additional criteria could include road sections with high-risk speed profiles, the proactive identification of potential crash sites (e.g., around new residential or business developments with increased traffic volume), or locations where other forms of enforcement are not safe or viable (e.g., in tunnels). In addition, the cost-effectiveness of point-to-point systems should be considered, however the underlying goal should not be to raise revenue from infringements.

The use of point-to-point speed enforcement should be complementary to other automated and manually-operated approaches to speed enforcement, rather than being viewed as a replacement for existing efforts. The optimal mix of various approaches is likely to vary substantially between and within jurisdictions, based on numerous road network and socio-political factors. In addition, point-to-point speed enforcement should not represent a long-term alternative to addressing underlying road design or maintenance deficiencies on sections of road, which would be better addressed through engineering solutions. Finally, the implementation of a point-to-point system should not preclude the continuation of other enforcement activities (e.g., failure to wear restraints, drink and

drug driving) within the enforced section. Thus, routine patrols should continue to be conducted within the enforcement corridor, particularly when it is relatively lengthy.

It is recommended that point-to-point speed enforcement systems should continue to be operated overtly. This is particularly important given the relative infancy of point-to-point speed enforcement in Australia and New Zealand, and the need to provide motorists with an opportunity to become familiarised with the approach. Specifically, the implementation of these systems should include advance signage placed prior to the enforcement corridor that, if feasible, highlights the extended nature of enforcement activities. Additional reminder signs located within the enforcement corridor (for longer sections), and having no signage to signify the end of the enforcement corridor, may also increase the deterrent impact of the approach and extend the zone of influence.

Excessively long distances between camera sites should be avoided, particularly when there are many opportunities for access and egress within the enforcement corridor; however there is currently not sufficient information on which to base recommendations regarding the maximum distances between camera sites. When lengthy enforcement corridors are desired, contiguous enforcement corridors (e.g., a series of camera banks) should be used. It is also recommended that locations where point-to-point speed enforcement is implemented should have relatively high traffic volumes, no major foreseeable infrastructure changes planned for the section (as this would require re-surveying the shortest practicable distance), and proximity to mains power. In addition, site selection should consider the implications of drivers seeking alternative routes, features that increase the likelihood that a vehicle will exit the road or stop (e.g., service stations, rest stops, traffic lights), common traffic congestion during peak travel times, and the displacement of road safety issues (e.g., congestion shifted to rat-running on local back streets).

To maximise the certainty of punishment associated with the approach, point-to-point speed enforcement systems should monitor and enforce all lanes of traffic. In addition, consideration should be given to monitoring vehicles travelling in emergency lanes and traffic lanes travelling in the opposite direction, given that such examples have been highlighted as opportunities for punishment avoidance to occur. Moreover, consideration should be given to ensuring division between directions of traffic flow (e.g., via the use of median strips, guardrails) at each camera site to prevent vehicles avoiding detection by crossing to the opposite side of the road. To further deter such behaviour, penalties for attempted avoidance behaviours should be implemented and made publicly known.

Each jurisdiction should be responsible for managing the enforcement tolerances associated with point-to-point speed enforcement systems, according to their own jurisdictional needs and practices. Furthermore, it is recommended that all jurisdictions should have a multiple infringement policy, however such a policy should not necessarily prescribe that only one infringement can be issued for multiple offences within the enforcement corridor. Rather, it is suggested that policies should aim to avoid instances where drivers receive multiple infringements for low-level speeding offences, but that administering multiple infringements to motorists who have committed persistent and excessive speeding offences may be appropriate.

Technological recommendations

Given the continually evolving nature of the technological characteristics associated with point-to-point speed enforcement systems, it must be acknowledged that various approaches are capable of achieving effective enforcement and cost-effective outcomes. That is, the adoption of alternative approaches does not necessarily reflect poorer practice, and future technological advancements are likely to further enhance the effectiveness and efficiency of systems.

Whenever feasible, cameras should be mounted above the lanes of traffic (e.g., on gantries, roadside cantilevers with extending arms) to minimise loss in capture rates associated with larger vehicles obstructing the view of the camera from detecting other vehicles. When side-mounted poles are used, poles should be located such that roadside clutter and potential hazards are reduced (e.g., guardrails installed to protect motorists), and cameras should be installed at an appropriate height off the ground to minimise loss in capture rates. In addition, the installation approach should consider the impact that maintenance requirements will have on traffic flow at the camera site.

To ensure that all vehicles entering the enforcement corridor are monitored, it is recommended that a designated camera is used to monitor each individual lane of traffic of the enforced section. At a minimum, systems should include plate cameras with sufficient resolution to accurately recognise the letter and numerical sequences of captured number plates; however the additional use of scene cameras can provide verification of a variety of road environment factors, such as lane position and vehicle characteristics, which may have important implications for evidentiary purposes. Whenever feasible, both forward facing and rearward facing cameras should be used to ensure all vehicles, including motorcycles, can be monitored by the system, however the significantly greater infrastructure costs and system requirements may prevent this from being feasible. Finally, monochrome digital cameras (with infrared flash) are recommended, given that they are more efficient and cost-effective.

It is also recommended that, where feasible, ANPR processing is conducted at the location of the camera site (e.g., the local processor), such that only data on offending vehicles need be transmitted to the back-office via the communication network. However, if the system has sufficient capabilities to transfer the necessary data associated with the traffic volume of the enforced section, such a practice is not critical, although appropriate security protocols should be developed to prevent unauthorised access to data and protect data transmission. It is strongly recommended that all images and details associated with infringements detected by point-to-point enforcement systems should be manually verified during back-office processing. In addition, the ANPR software employed as part of the system should be rigorously tested prior to use to ensure appropriate degrees of accuracy regarding both plate recognition and plate reading accuracy.

Legislative and evidentiary recommendations

A legislative framework associated with the introduction and approval of point-to-point speed enforcement should cover all aspects of the system. Specifically, it should be ensured that the enforcement device is appropriately gazetted and approved (e.g., prescribed device). In addition, the processes involved in the administration of infringements associated with offences detected by the system (such as the specific formula used to calculate speed and the collection and integration of data from two or more detection devices) should also be appropriately approved (e.g., prescribed process). It is also necessary to ensure that measurement of average speed can be used as prima facie evidence of actual speed.

Shortest practicable distance should be assessed by an independent and certified surveyor using measurement methods that are traceable to national standards of distance measurement. In addition, it is critical to the accuracy of the system that this distance be resurveyed following any changes to the road alignment or associated infrastructure within the enforcement corridor that may affect this distance. Time clocks should be synchronised with a single common time source (using traceable measurements), with a secondary reference system used to ensure accuracy and safeguard against malfunctions. It is critical for synchronisation to be performed regularly (with drift logs recorded), and for this component of the system to be regularly tested and certified.

It is recommended that mandatory maintenance schedules, calibration and/or testing, and recertification procedures be instituted that require such tasks to be conducted at least annually,

although it is strongly recommended that performing such tasks as regularly as feasibly possible would be associated with greater system efficiency. Such requirements would facilitate ongoing accuracy of the system and support the integrity of prosecutions associated with the technology.

Public education recommendations

As stated earlier, prior research has shown that point-to-point enforcement is associated with very high rates of compliance with speed limits and appears to be an effective approach for dealing with persistent, intentional speeders within enforcement corridors. Thus, point-to-point speed enforcement represents an effective approach to speed management that can increase both general and specific deterrence associated with enforcement efforts and should be promoted as such in education campaigns. Other issues which might be addressed in media campaigns include a basic overview of how the approach operates, the number of operating systems in the jurisdiction, and the reliability and integrity of the systems. Explanations of these issues may assist in promoting awareness of how point-to-point enforcement differs to traditional speed enforcement approaches with a view to enhancing support for this relatively new enforcement technique.

Prior driver survey research has suggested that motorists typically perceive point-to-point speed enforcement to be a 'fairer' approach, compared to other forms of automated speed enforcement (Malenstein, 1997; Stefan, 2005). However, it is recommended that the use of the term 'fairer' be avoided in public education campaigns, given that it may send an inappropriate and inaccurate message to the public that other forms of speed enforcement are not fair or less fair.

Evaluation recommendations

The evaluation of point-to-point speed enforcement systems is critical, particularly in light of the limited number of rigorous and scientifically sound evaluations conducted to date. Outcome, process, driver acceptance and cost-benefit evaluations should be conducted and rigorous scientific methodologies should be adopted, including: the inclusion of matched comparison sites; statistical significance testing; control for confounding factors; and, sufficient baseline and follow-up data periods. It is recommended that the cost of conducting the evaluation be factored in to project development costs.

Discussion & Conclusions

Point-to-point speed enforcement represents an exciting and innovative approach to managing vehicle speeds. While the approach has been used extensively throughout the United Kingdom and many parts of Europe for some time, its use in the Australian and New Zealand context is relatively recent and is still developing. Nonetheless, Australia and New Zealand stand to benefit from being able to draw upon the experiences and developments which have occurred in other parts of the world. Given the perception of unfairness held by some sections of the community towards the measurement of instantaneous speeds, the use of point-to-point speed enforcement systems may assist in promoting greater overall community acceptance of speed enforcement efforts.

Determining how point-to-point enforcement fits within an overall speed management strategy will invariably differ from jurisdiction to jurisdiction. However, one critical consideration is that point-to-point enforcement represents just one approach, and should be employed such that it complements existing automated and traditional forms of speed enforcement. Each jurisdiction is likely to differ regarding their perceptions of the optimal circumstances for using the approach, including varying road types and types of vehicles to be monitored.

In addition, it is important to acknowledge that the evolution of point-to-point speed enforcement is in its infancy. For example, the use of mobile point-to-point operations is particularly interesting,

yet has had limited application to date. Mobile operations provide additional flexibility to enforcement capabilities, allowing them to be installed at locations with specific and short-term road safety concerns (e.g., road works sites with reduced speed limits) at significantly lower costs and in a timelier manner than a permanent system. Moreover, mobile point-to-point operations may increase the deterrent effect of existing mobile speed camera operations because motorists would be unsure when passing a mobile speed camera van as to whether they were passing a camera operating in isolation or as part of a system that will measure average speed between two points. This may, therefore, encourage motorists to comply with posted speed limits across greater segments of the road network, particularly if used in conjunction with existing programs and randomly scheduled across sites.

Taken together, the findings from the literature review and stakeholder consultation process lend support to increased implementation of point-to-point speed enforcement systems as a complementary approach to existing automated and non-automated approaches employed as part of a speed management strategy. However, future research should aim to strengthen the existing evidence regarding the effectiveness of the systems on reducing crashes. That is, current studies are fraught with a number of methodological limitations including, confounding factors (e.g., driving exposure and regression-to-the-mean), lack of comparison/control sites, lack of statistical significance testing, and questions regarding research independence (e.g., conducted by equipment manufacturers or the road safety organisations responsible for the operation and management of the systems being evaluated). Nonetheless, the consistency of findings is encouraging and has been demonstrated in relation to both permanent and temporary systems employed in various countries throughout the world.

Overall, it appears that the approach can be most effectively used on road sections with historically high crash rates or documented problems associated with excessive vehicle speeds, and particularly when other enforcement strategies have been demonstrated as being less effective or would be difficult to implement in a sustained manner. In addition, vehicle speed reductions and subsequent crash reductions should be the primary focus of site selection, rather than improvements in traffic flow or reductions in vehicle emissions and noise, although they may be ancillary benefits.

While there appears to be no current guidelines for best practice regarding point-to-point speed enforcement around the world, this article has attempted to identify approaches to ensure better practice of point-to-point speed enforcement for Australia and New Zealand, drawn from current international evidence and practice. However, it is acknowledged that as the field develops further, these principles will undoubtedly shift in line with enhanced knowledge and empirical evidence.

Future research should seek to improve the scientific rigor of evaluations. Process and outcome evaluations conducted by independent research bodies employing more rigorous methodologies are strongly encouraged. Moreover, the impact of point-to-point speed enforcement on speeding behaviour and crashes across the wider road network should be more readily explored, as should the impact of the approach on other key environmental and social outcomes such as vehicle emissions and noise. Finally, the potential to expand the application of point-to-point speed enforcement systems also warrants further investigation, in particular the use of mobile average speed enforcement systems.

Acknowledgements

The authors would like to acknowledge the funding support provided by Austroads for conducting the research.

References

Aarts, L., & van Schagen, I. (2006). Driving speed and the risk of road crashes: A review. *Accident Analysis & Prevention, 38*(2), 215-224.

Australian Transport Council. (2011). *National Road Safety Strategy 2011-2020*. Canberra: Australian Transport Council.

Cascetta, E., & Punzo, V. (2011). *Impact on vehicle speeds and pollutant emissions of an automated section speed enforcement system on the Naples urban motorway*. Paper presented at the TRB 2011 Annual Meeting.

Cascetta, E., Punzo, V., & Montanino, M. (2011). *Empirical evidence of speed management effects on traffic flow at freeway bottleneck*. Paper presented at the TRB 2011 Annual Meeting.

Champness, P., Sheehan, M., & Folkman, L.-M. (2005). *Time and distance halo effects of an overtly deployed mobile speed camera.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Wellington, New Zealand.

Charlesworth, K. (2008). *The effect of average speed enforcement on driver behaviour*. Paper presented at the Road Transport Information and Control - RTIC and ITS United Kingdom Members' Conference, Manchester.

Cirillo, J. A. (1968). Interstate system crash research; Study II, interim report II. *Public Roads, 35*(3), 71-76.

Fleiter, J., Lennon, A., & Watson, B. (2007). *Choosing not to speed: a qualitative exploration of differences in perceptions about speed limit compliance and related issues*. Paper presented at the Australasian Road Safety Research Policing and Education Conference, October 2007, Melbourne, Victoria.

Fleiter, J., & Watson, B. (2006). The speed paradox: the misalignment between driver attitudes and speeding behaviour. *Journal of the Australasian College of Road Safety, 17*(2), 23-30.

Glendon, A. I. (2007). Driving violations observed: An Australian study. *Ergonomics, 50*(8), 1159-1182.

Hatfield, J., & Job, R. F. S. (2006). *Beliefs and Attitudes about Speeding and its Countermeasures*. Canberra: Australian Transport Safety Bureau.

Ipsos Social Research Institute. (2013). *Driver Attitudes to Speed Enforcement*: Austroads Publication No. AP-R433-13.

Keenan, D. (2002). Speed cameras: The true effect on behaviour. *Traffic Engineering and Control, 43*, 154-160.

Malenstein, J. (1997). *Automated Video Speed Enforcement and Trajectory Control Combined with Fully Automated Processing*. Driebergen, Netherlands: Dutch National Police Agency, Traffic and Transport Division

Punzo, V., & Cascetta, E. (2010). *Impact on vehicle speeds and pollutant emissions of the fully automated section speed control scheme "Safety Tutor" on the Naples urban motorway*. Paper presented at the SIDT - Scientific Seminar - External costs of transport systems: theory and applications, Rome.

Solomon, D. (1964). *Crashes on Main Rural Highways Related to Speed, Driver and Vehicle*. Washington, D.C.: Bureau of Public Roads. U.S. Department of Commerce

Soole, D. W., Fleiter, J., & Watson, B. (2012). *Point-to-Point Speed Enforcement*. Sydney: Austroads.

Soole, D. W., Watson, B. C., & Fleiter, J. J. (2013). Effects of average speed enforcement on speed compliance and crashes: a review of the literature. *Accident Analysis & Prevention, 54*, 46-56.

Stafford, M. C., & Warr, M. (1993). A reconceptualization of general and specific deterrence. *Journal of Research in Crime & Delinquency, 30*(2), 123-135.

Stefan, C. (2005). *Automatic Speed Enforcement on the A13 Motorway (NL): Rosebud WP4 - Case B Report*. Austria: Austrian Road Safety Board (KfV).

Thornton, T. (2010). *Reductions in fuel consumption and CO2 emissions with specs average speed enforcement*. Paper presented at the Road Transport Information and Control Conference and the ITS United Kingdom Members' Conference - Better transport through technology, London.

Transportation Research Board. (1998). *Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits*. Washington, D.C.: National Academy Press.

Walker, E., Bryant, P., Barnes, B., Johnson, B., & Murdoch, C. (2009). *Quantitative study of attitudes, motivations and beliefs related to speeding and speed enforcement*. Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Sydney, Australia.