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Using GIS to interpret automated speed enforcement guidelines and guide deployment decisions in mobile photo enforcement programs

Yang Li [a], Amy Miyoung Kim [a,*], Karim El-Basyouny [a], Ran Li [b]

[a] Department of Civil and Environmental Engineering, University of Alberta, Canada
[b] Office of Traffic Safety, City of Edmonton, Canada

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ABSTRACT

Automated speed enforcement (ASE) guidelines are designed to guide enforcement agencies in operating ASE programs that are effective in improving traffic safety. Given that appropriate deployment decisions are essential to a program's effectiveness, a number of deployment priorities are generally included in most ASE guidelines. However, when implementing the guidelines, most descriptions of deployment goals are so qualitative that they might have multiple quantitative interpretations, and thus affecting the identification of specific deployment considerations. In addition, limited research has been done to improve the process by which guidelines are implemented. Therefore, this paper proposes quantitative measures for an ASE program, in order to facilitate interpretation of the main ASE principles and improve deployment decisions. To illustrate the various types of high-priority deployment considerations, a case study in the city of Edmonton in the province of Alberta, Canada is presented. It explores the deployment outcomes of the mobile photo enforcement (MPE) program in Edmonton, in relation to six priorities identified in the provincial enforcement guidelines. Two performance measures, spatial coverage and enforcement intensity, are assessed for priority sites and non-priority sites. Moreover, the distance halo effects of MPE are considered in the review of spatial coverage. All findings are visualized using Geographic Information Systems, such that high priority sites and coverage of these sites in the historical deployment can be visually assessed. A better understanding of the governing ASE guidelines and how to implement them can help enforcement agencies to improve decision-making and resource allocation, thereby increasing program effectiveness and efficiency.

1. Introduction

Speeding undermines road traffic safety around the world. Each year, more than one million people die in traffic collisions worldwide (WHO, 2006, 2008, 2013); 30% of these fatalities are due to speeding (OECD/ECMT, 2006). In order to protect citizens against the risks of collisions caused by speeding, the implementation of speed management programs has become a high priority for many governments around the world. Automated speed enforcement (ASE) is one countermeasure that has

* Corresponding author at: 6-269 Donadeo Innovation Centre for Engineering, University of Alberta, Edmonton, AB T6G 1H9, Canada. Tel.: +1 7804929203.
E-mail addresses: li18@ualberta.ca (Y. Li), amy.kim@ualberta.ca (A.M. Kim), karim.el-basyouny@ualberta.ca (K. El-Basyouny), ran.li@edmonton.ca (R. Li).

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been widely adopted throughout the world to manage speeding. Automated speed camera systems are used to assist police in enforcing speed limits. Specifically, the speed camera is mounted on the roadside or in an enforcement patrol vehicle to detect vehicle speeds and photograph vehicles violating speed limits. This technology has been shown to significantly improve traffic safety. According to a review of studies from the late 1990s and early 2000s, adopting an ASE program may lead to a 2–15% speed reduction and 9–50% decline in collisions (Rodier et al., 2008).

In some jurisdictions, the design and operation of ASE programs are governed by specific rules, which are set out in official guidelines. ASE program guidelines outline basic principles for how ASE programs should operate, providing a tool to assist local enforcement agencies in developing a successful ASE program with positive safety outcomes. ASE guidelines emphasize controlling the deployment of enforcement cameras, in order to ensure deployment at the right locations, thus improving the program's effectiveness in improving safety. However, when implementing guidelines, most descriptions of deployment goals are too qualitative to interpret, impacting the successful identification of specific deployment considerations. Guidelines provide general descriptions of where ASE should be deployed to achieve objectives of reducing speed and collisions, but they do not specifically define how site identification and ASE deployment should be conducted. Local enforcement agencies must rely only on their own interpretations during the design and implementation phase. Consequently, the potential benefits of using the guidelines are not entirely realized.

Research tackling this shortcoming of ASE guidelines is very limited. Therefore, this paper proposes quantitative measures based on the main guiding principles of ASE to facilitate interpretation of the guidelines and deployment decisions that well reflect these guiding principles. In order to illustrate the outcomes of adopting quantitative measurements, a case study of the mobile photo enforcement (MPE) program in the city of Edmonton (COE), in the province of Alberta, Canada, is presented. MPE is a subset of ASE technology, and therefore should adhere to ASE program guidelines. In particular, the case study explores the relationship between ASE principles and the interpretation and application of guidelines by a local enforcement agency. The results are visualized using Geographic Information System (GIS) plots, through which this paper provides insight into the geographic distribution of enforcement throughout the city, in terms of where enforcement should take place and where it is actually conducted. Two MPE program indicators – spatial coverage and intensity – are used to investigate the interpretation and application of the provincial ASE guidelines. Given that MPE activities have distance halo effects, which are safety effects that extend upstream and downstream of the camera site (Vaa, 1997), this paper also considers these effects. Coverage of the MPE program is also considered using a measure of the distance halo effect. The results of this paper can help enforcement agencies gain greater clarity on how to improve program performance with the help of ASE guidelines, in order to achieve increased efficiency and effectiveness.

2. Main guiding principles of the ASE program

A number of ASE guidelines were published by local, provincial or national governments in the U.S., Canada, Australia and the U.K. during the early 2000s. All of these guidelines have similar principles that primarily focus on outlining an efficient way to deploy enforcement cameras. They recognize that making good decisions regarding ASE deployment during program design and operation is essential to a program's effectiveness (NHTSA, 2008; Victoria Police Traffic Camera Office, 2006). Specifically, six considerations for enforcement attention are most commonly addressed in deployment guidelines; these include (1) high collision sites; (2) high speed violation sites; (3) school zones; (4) construction zones; (5) high pedestrian volume sites; and (6) sites with community speeding complaints. Local enforcement agencies should identify and prioritize these sites accordingly, in order to efficiently manage their resources and safety outcomes.

2.1. High collision sites

Traffic collisions are responsible for over 1.2 million fatalities and 20 million injuries every year worldwide (WHO, 2006). 90 people are killed on U.S. roads and five on Canadian roads nearly every day (NHTSA, 2015; Transport Canada, 2015).

However, these figures are decreasing gradually with government interventions (NHTSA, 2015; Transport Canada, 2015). Automated speed enforcement (ASE) programs are one type of intervention shown to significantly reduce the frequency and severity of collisions. Previous studies indicate that ASE reduced collisions by 8.9–51%, and collision-related injuries and fatalities by 12–50% (Coleman et al., 1995; Elvik, 1997; Berkuti and Osburn, 1998; Chen et al., 2000; Christie et al., 2003; Hess, 2004; Goldenbeld and van Schagen, 2005; OECD/ECMT, 2006). In Canada, ASE programs have been successfully operating in the cities of Edmonton, Calgary and Winnipeg. Empirical data from Edmonton show that ASE is effective in reducing collisions by 14–20% (Li et al., 2015). Given that the primary objective of ASE programs is to reduce traffic collisions and in turn improve traffic safety, prioritizing high collision and collision risk sites for ASE attention in ASE guidelines is critical.

Although all ASE guidelines indicate the need for deploying enforcement cameras to high collision sites, the level of detail provided on how to identify these sites vary among different jurisdictions. Guidelines from the Province of Alberta (Canada) and the State of Victoria (Australia) identify high collision sites as a major deployment focus (Alberta Justice and Solicitor General, 2014; Victoria Police Traffic Camera Office, 2006), but present little further detail. In contrast, the U.S. Department of Transportation, the State of Queensland in Australia and the County of Humberside in the U.K. propose criteria for evaluating high collision sites in their guidelines. Four key elements – collision frequency, collision severity, exposure measure of collision risks and data analysis period – are most commonly included in the evaluation procedures (NHTSA, 2008;