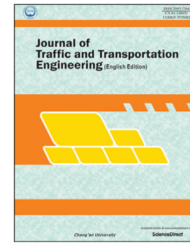
JOURNAL OF TRAFFIC AND TRANSPORTATION ENGINEERING (ENGLISH EDITION) 2018; X (X): 1–7

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/jtte



Original Research Paper

Evaluation of red-light camera enforcement using traffic violations

Khaled Shaaban [a,*], *Anurag Pande* [b]

[a] *Department of Civil and Architectural Engineering, Qatar University, Doha, Qatar*

[b] *Department of Civil and Environmental Engineering, California Polytechnic State University, San Luis Obispo, CA 93407, USA*

HIGHLIGHTS

- This study compares the red-light running violations on approaches with and without red-light cameras at the same intersections.
- The presence of the red-light cameras significantly lowered the red-light running violations.
- High-volume approaches without cameras had an approximately eight times higher rate of violations than high-volume approaches with cameras.
- The number of violations on low-volume approaches was five times higher than those on high-volume approaches.

ARTICLE INFO

Article history:
Received 21 August 2016
Received in revised form
21 February 2017
Accepted 18 April 2017
Available online xxx

Keywords:
Driver behavior
Traffic signal
Police enforcement
Risky driving
Automated enforcement
Road policing

ABSTRACT

The State of Qatar started to use red-light cameras in 2007 at key signalized intersections and the rate of installation has subsequently increased. In 2017, 19.2% of signalized intersections are equipped with red-light cameras. In many cases, the cameras are not installed on all approaches to the intersections. The purpose of this study is to compare the red-light running violations on approaches with and without red-light running enforcement cameras at the same intersections. Actual field observations were used in this study. Different variables were investigated, including the day of the week, time of day, traffic volume, the possibility of glare on an approach, and the lengths of the yellow and all-red times. A regression tree model was used to explain the characteristics associated with the violations. The results showed that the number of violations on low-volume approaches was five times higher than on high-volume approaches. The results also showed that the presence of the cameras significantly lowered red-light running violations. High-volume approaches without cameras had an approximately eight times higher rate of violations than high-volume approaches with cameras. The analysis also showed that bringing the all-red interval closer to the values recommended by the Institute of Transportation Engineers formula may bring down the rates of violations for low-volume approaches. As with any observational data mining method, the study could benefit from a larger sample size. The method used in the study was effective and is easily transferable to other locations. The results of this study can be used in developing new strategies to improve safety at signalized intersections.

* Corresponding author. Tel.: +974 4403 4185, Fax: +974 4403 4172.
E-mail addresses: kshaaban@qu.edu.qa (K. Shaaban), apande@calpoly.edu (A. Pande).

Peer review under responsibility of Periodical Offices of Chang'an University.
https://doi.org/10.1016/j.jtte.2017.04.005

1. Introduction

Red-light running (RLR) has been identified as a serious traffic safety concern that can lead to numerous and severe crashes. For example, according to the Insurance Institute for Highway Safety, RLR was responsible for 697 fatalities and 127,000 injuries in 2013 in the United States alone (McCarthy, 2015). Different engineering and enforcement countermeasures exist for this behavior. Red-light cameras (RLCs) are one type of enforcement countermeasure used at signalized intersections for detecting vehicles passing the approach during the red phase. This method of automatic enforcement addresses the issue of the high cost of manual enforcement. It also has the potential to change drivers' behavior through both general deterrence and punishment of individual violators.

In 2007, 80 cameras were installed at key intersections in Qatar for the first time (ITS International, 2012). The penalty for running a red light is one of the highest in the region. The fine starts from $1644 (US) and can reach $13,699 plus a significant impact on the driving history depending on the speed at the time of the violation and if the driver caused a crash as a result of running the red light. The number of cameras in Qatar is growing every year, especially after the decision to convert the major roundabouts into signalized intersections equipped with RLCs on some approaches. While this policy decision to convert to signalized intersections can be debated since something closer to the opposite is happening in much of the developed world, it is nevertheless the reality in Qatar. Although cameras have been widely implemented in Qatar and are perceived to be successful among the motorists in Qatar, information about their effectiveness is not conclusive (Shaaban, 2017). No studies have been conducted in Qatar to measure the effectiveness of camera enforcement.

The effectiveness of RLCs in reducing the number of red-light violations has been evaluated in many studies. A before and after study was used to evaluate the influence of a red-light camera enforcement program on red-light violation rates in the city of Oxnard, California, USA. A total of 14 intersections (nine camera sites, three non-camera sites, and two control sites) were studied. Baseline red-light violation data were collected before the warning period and again three to four months after the actual enforcement began. The violations for each site were recorded for a single intersection approach. At the camera sites, baseline data were recorded with the same red-light cameras that would later be mounted on poles and used for enforcement. Overall, the red-light violation rate was reduced by 42% several months after the enforcement program began (Retting et al., 1999). A follow-up study from the same authors on this issue also noted a reduction in injuries following the installation of camera enforcement (Retting and Kyrychenko, 2002).

Another study to assess the RLCs was conducted in Fairfax County, Virginia, USA. The RLC enforcement program involved ten cameras installed around the county. The data analysis identified improvements in violation rates of 36% over the first three months of automated enforcement and a 69% reduction after six months of camera operation. The crash rates data also showed a reduction of 40% in crashes (Retting et al., 2008).

Huang et al. (2006) investigated the effect of RLCs on crash risks at signalized intersections for both right-angle and rear-end crashes in Singapore. A binary logit model was preliminarily developed to examine how the stopping versus crossing decision of drivers at the onset of amber is affected by geometric, traffic, and situational variables. The results showed that the presence of RLCs is one of the five significant factors affecting a driver's decision to cross during the yellow phase. A multinomial logit model further indicated that RLCs are effective in reducing the RLR frequency. Further analysis of the fitted model revealed that while the presence of RLCs is effective in reducing the risk of right-angle crashes, it has a mixed effect on the risk of rear-end crashes. Whether the RLC reduces or increases the possibility of rear-end crashes is dependent on the speed of the trailing vehicle and the headway between vehicles.

In 2009, a study in Iowa compared the red-light violations at camera-enforced approaches against a set of control approaches at intersections where no cameras had been installed. The number of RLR violations for 21 intersection approaches for both study and control intersections was compared. The violation data were collected from the four camera-enforced intersections, and seven other non-camera enforced intersections, which were used as control sites. A cross-sectional analysis was used to compare the RLR violations at treatment locations to violations at control locations. A Poisson lognormal regression was used to evaluate the effectiveness of the cameras in reducing violations. The results indicated that RLCs substantially reduced the number of violations at camera-enforced approaches as compared to control approaches. In comparison to the camera-enforced approaches, the statistical model showed that RLR violations were 25 times higher at locations without RLCs than for locations with cameras (Fitzsimmons et al., 2009).

In 2011, another study in Iowa was conducted to assess the safety effectiveness of the RLCs installed at seven intersections. The intersections were chosen based on crash rates and whether cameras could feasibly be placed at the intersection approaches. The violations were collected before drivers were aware that the cameras were going to be installed. The data collected during this period were used as "before" data. Data used for the "after" time period were collected after the 30-d warning period and after the cameras had been active for at least a month. A comparison study was