Taylor & Francis
Taylor & Francis Group

International Journal of Injury Control and Safety Promotion

ISSN: 1745-7300 (Print) 1745-7319 (Online) Journal homepage: https://www.tandfonline.com/loi/nics20

An evaluation of the red-light camera programme in the city of Dammam, the Kingdom of Saudi Arabia

Mark Stevenson, Sayed Faruque, Abd Almajil, Muhammad Farhan, Brian Fildes & Brendan Lawrence

To cite this article: Mark Stevenson, Sayed Faruque, Abd Almajil, Muhammad Farhan, Brian Fildes & Brendan Lawrence (2017) An evaluation of the red-light camera programme in the city of Dammam, the Kingdom of Saudi Arabia, International Journal of Injury Control and Safety Promotion, 24:1, 84-88, DOI: 10.1080/17457300.2015.1132732

To link to this article: https://doi.org/10.1080/17457300.2015.1132732

Published online: 21 Jan 2016.

International Journal of Injury Control and Safety Promotion, 2017
Vol. 24, No. 1, 84–88, http://dx.doi.org/10.1080/17457300.2015.1132732

An evaluation of the red-light camera programme in the city of Dammam, the Kingdom of Saudi Arabia

Mark Stevenson[a,c], Sayed Faruque[c], Abd Almajil[c], Muhammad Farhan[c], Brian Fildes[b,c] and Brendan Lawrence[b]

[a]*The University of Melbourne, Melbourne, Australia;* [b]*Monash University Accident Research Centre, Monash University, Melbourne, Australia;* [c]*Saudi Aramco Chair of Traffic Safety, University of Dammam, Dammam, Kingdom of Saudi Arabia*

(*Received 17 April 2015; accepted 27 August 2015*)

This study evaluated the effectiveness of red-light cameras in Dammam, the Kingdom of Saudi Arabia. Two methods were used to assess changes in crash risk at the intersections at which the red-light camera programme had been operating. Geospatial analysis was used to visualize trends in road crash density over the geographical region of Dammam and a pre–post-camera crash analysis was undertaken. The distribution of injury crashes was greater than that of crashes which included property damage, the latter of which was concentrated around central Dammam. The five red-light cameras installed in 2012 were located outside areas of high-crash and injury density, and the total number of crashes reported in the three-month periods after installation was double that before the cameras were installed. This increase in the number of crashes also occurred at the five comparison sites (without red-light cameras), indicating a null effect. The findings from this study are contrary to previous evaluations of speed management programmes associated with red-light cameras. The study highlights the challenges in obtaining data for such research and illustrates that a reliance on overt, fixed camera's to manage speed is unlikely to deliver significant reductions in road trauma.

Keywords: Saudi Arabia; traffic safety; red-light cameras

Introduction

Crashes at intersections represent a significant proportion of road trauma in most urban areas across the world (World Health Organisation [WHO], 2004, p. 132). Although signalization at intersections is known to significantly reduce crash risk, crash risks generally remain (Elvik, 2009). These risks include running red lights and failure to give way to vehicles and pedestrians when only partial control of the intersection is maintained by the signals. In addition to red light running, speeding generally and speeding to beat signal phase changes can also be a problem, particularly when the signals are perceived by motorists and other road users to significantly impede mobility. Crashes at intersections typically result in some of the highest severity of injuries in urban areas due to the right-angle configuration of many crashes (Hoareau, Candappa, & Corben, 2011). Speed only serves to exacerbate the injury severity problem (Kloeden, Woolley, & McLean, 2004).

Red-light cameras are cited as an effective countermeasure to reduce injuries resulting from road crashes associated with red light running (Høye, 2013; Hu, McCartt, & Teoh, 2011). Specifically, red-light cameras have proved effective in reducing right angle and fail to give way crashes, which typically result in the most severe injuries. Whilst speeding is often an element of beating signal phase changes, it is important to note that red-light cameras have the purpose of capturing traffic light violations, which may not always involve speeding. On the other hand, speeding cameras are located in mid-blocks for the purpose of monitoring speeds. The combination of speed cameras and red-light cameras at intersections, however, has shown to be effective with a 47% reduction in crashes (Budd, Scully, & Newstead, 2011). Despite the positive findings, previous evaluations of red-light camera programmes have reported a negative effect of the cameras as they have resulted in an increase in rear-end crashes (Elvik, 2009). However, these crashes tend to result in less severe injuries and, therefore, the net effect of the cameras is a reduction in serious injury.

The Kingdom of Saudi Arabia (KSA) is one of the leading Gulf countries with a rapidly growing economy which is reflected, in part, by the government's extensive development of its road network. Associated with the increased infrastructure and hence motorization, road deaths and serious injuries have increased. In 2010, the estimated number of road deaths in KSA was 6800, or 24.8 deaths per 100,000 people (WHO, 2013).

As a consequence of the burgeoning road death and injury rates, the eastern province (EP) of the KSA (population of 4.5 million people) introduced legislation

Corresponding author. E-mail: mark.stevenson@unimelb.edu.au

whereby technologies were introduced to enhance the traffic police speed enforcement programme. These technologies included a red-light camera programme at signalized intersections in order to reduce serious crashes and to monitor motorist violations.

The EP red-light camera programme is an automated traffic control and management system which uses digital cameras linked with the National Information Centre of the Ministry of Interior. The system has a number of aims, namely to enhance public security, to assist with the management of traffic, to provide live monitoring of traffic events and crashes and, importantly, to improve traffic safety. As part of this programme, red-light cameras were installed in 32 locations in the EPs between 2010 and 2013.

Despite previous research highlighting elements of red-light camera programmes being successful, no research had been undertaken in the KSA to determine whether the cameras are effective in reducing motor vehicle crash risk at intersections. The current study evaluates the camera programme, with respect to the road crash risk at red-light camera sites operating in the city of Dammam (including Khobar).

Methods

Two methods were used to assess changes in crash risk at the intersections at which the red-light camera programme has been operating. The first method used a geospatial approach to visualize trends in road crash density over the geographical region of Dammam. This provided context for the second method, which involved comparing road crashes at intersections with (and without) red-light cameras three months before and after the time of installation.

The spatial analysis used road crash data obtained from the EP Traffic Police for all motor vehicle crashes involving motorists and vulnerable road users. Reliable estimates were only available for a 12-month period from January 2012 to December 2012. The data were enhanced by the Saudi Aramco Petroleum Company's Traffic Safety Signature Programme which geocoded the data as well as provided the specific time and date of the crash. Based on the road crash data, injury outcomes are either fatal, serious (requiring hospital admission), slight injury (injured but not requiring hospitalization), or non-injury, namely property damage only. All crashes, including those classified as a 'non-injury' outcome, are included in this analysis.

Road crash density (i.e. injuries/km^2/year) was adopted as the dependant variable which enabled us to visualize the trends in location-specific data over large geographical areas. Injury density was calculated using a Point Density Model (PDM) aided by Geographical Information System (GIS) software ArcGIS version 10 (ESRI, 2011). The dependent variable was most affected by the PDM search radius input parameter, as has been found in other studies (Anderson, 2009). To inform its selection, an Incremental Global Moran's I spatial autocorrelation was first used to examine the degree of road crash clustering in the EP under different search radii. Spatially coincident crash sites were accounted for in this step. Following this, a (visual) sensitivity analysis at search radius increments of 100 m was undertaken. The adopted band width was 3000 m (and cell size 50 m), which provided a suitable resolution and level of smoothing for this scale of analysis. See ArcGIS resource centre (http://resources.arcgis.com/en/home/) for more information on point density models.

Road crash density was calculated for a 12-month period from January 2012 through to December 2012 for those crashes with geo-coordinates, and plotted on density raster maps using classified symbology. This mapping technique allowed the spatial distribution of injury density to be readily examined across the EP. The spatial analysis was used to highlight the range of injury densities across the EP, providing context to the second method which looked more closely at the red-light camera sites.

The second analytical approach involved comparing road crashes at intersections with (and without) red-light cameras. Counts of intersection crashes were grouped into four-weekly periods and a minimum of three data points (three months) were required before the camera was installed and a minimum of three data points after the installation of the camera to be included in the analysis. Again, data were only available for the 12-month period from January 2012 to December 2012, meaning only those red-light cameras installed during this period were included ($n = 5$). Details on when a red-light camera was installed and became operational were provided by SAHER; the company responsible for implementing and monitoring the red-light camera programme. Crashes were selected for this analysis if they were located within 300 m of the intersections and they occurred on a road forming part of the intersection. Similarly, intersections without red-light cameras were included in the analysis to assess for secular trends. Each red-light camera site was matched with a site without a red-light camera, based on the number of lanes, the traffic volume, the presence/absence of on-street parking and the configuration of the intersection (elements such as the type of right-turn signal phasing).

Results

A total of 20,536 crashes were reported in the year 2012, of which most resulted in property damage (87.8%, $n =$ 18,030). Serious injury outcomes represented 10.2% ($n =$ 2094) and fatalities a little over 1% (1.7%, $n = 349$), and minor injuries less than 1% of all crashes (0.4%). Reported crashes tended to peak between the months of June and September, with lowest number of crashes reported in November (see Figure 1).

Figure 2 illustrates the motor-vehicle-related density of crashes and injuries (with geo-coordinates, $n =$ 16,366) across the greater city of Dammam. It highlights that the density of crashes was the greatest and most concentrated

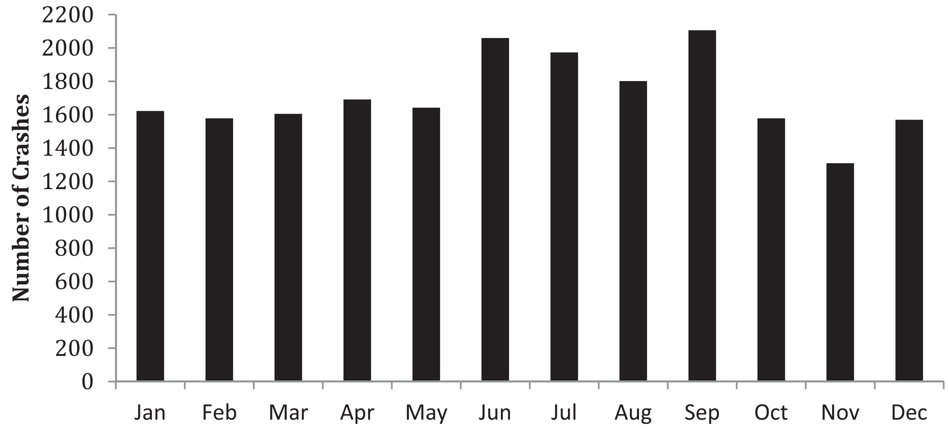

Figure 1. 2012 crashes per month.

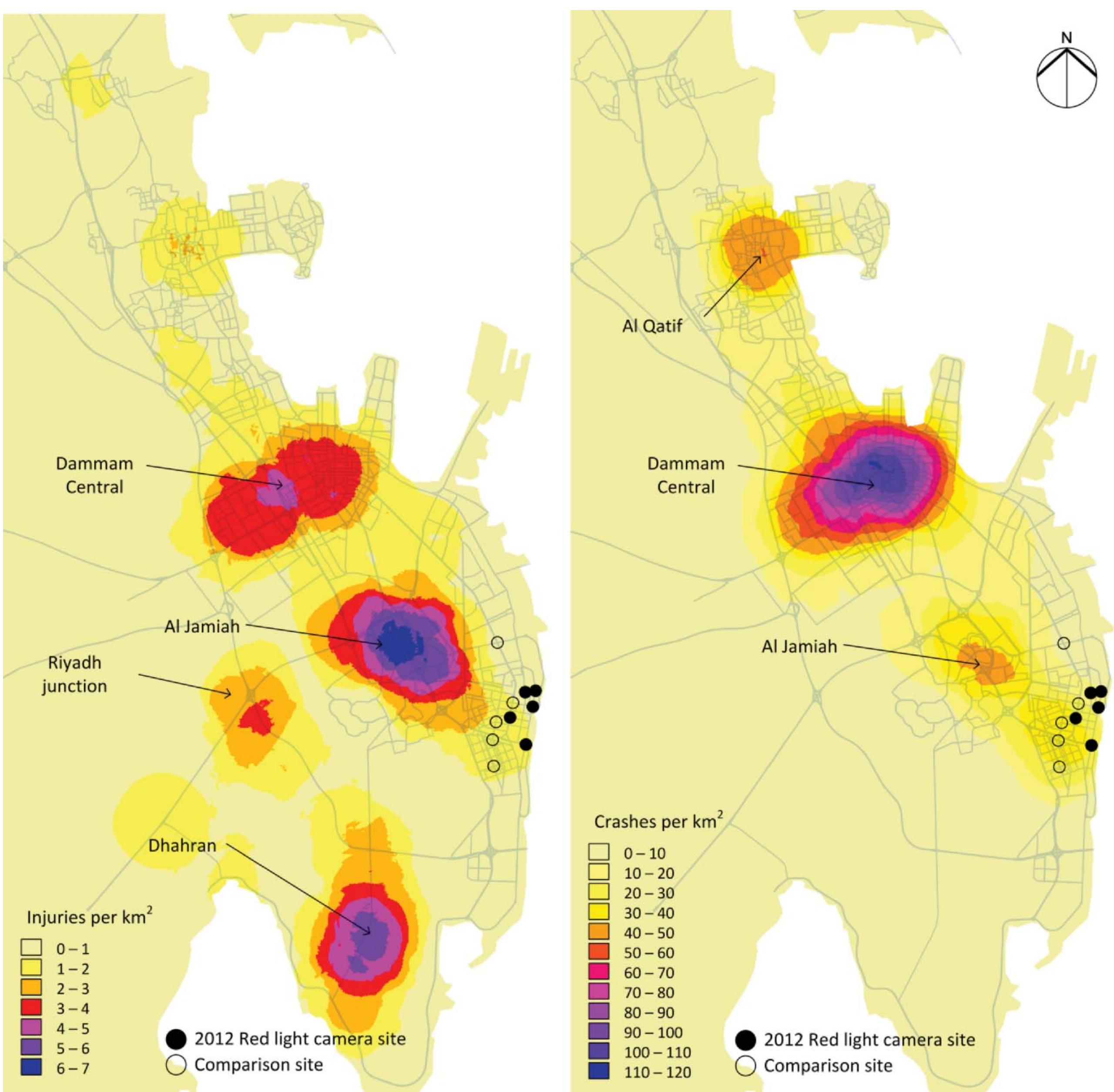

Figure 2. Crash and injury densities for 2012, with red-light camera sites.

around the central Dammam Business District where the crash density peaked at 120 crashes/km^2 for the year. Moderate crash densities were also observed to the north of the Dammam Central Business District near Al Qatif, and south near Al Jamiah. The density of injuries was most prominent near Al Jamiah, the north of Dahran, and in the Dammam Central Business District, with a concentration of injuries also occurring the south of Riyadh junction. The distribution of injuries was more broadly dispersed across the city of Dammam compared to non-injury crash events. Figure 2 also highlights that the location of red-light camera installations in 2012 was on the periphery of the high crash (and injury) densities observed in Al Jamiah, where the crash density ranging from a moderate 10−31 crashes/km^2; this is atypical of most protocols associated with red-light camera programmes.

A total of six crashes were reported (within a 300 m radius of the red-light camera sites) in the three-month period before the red-light cameras were installed. In the following three-month period, post-camera installation period, a total of 14 crashes were reported at the red-light camera sites. This compares similarly to the comparison sites, where 7 and 14 crashes were reported before and after the installation date, respectively.

Discussion

A key finding from the study is that there are two distinct geospatial distributions of road traffic crashes in the city of Dammam, with a preponderance of property-only crashes in the central area of Dammam. Crashes resulting in injury had a greater geospatial distribution than all crashes, and the location of the greatest injury density (Al Jamiah) was not the same location as the greatest crash density (central Dammam). This may point to a difference in key urban design and traffic characteristics of the two areas, such as average vehicle speeds and congestion levels, intersection spacing and control, and general infrastructure condition.

The study also found that the installation of the red-light cameras during the observational period was not in the vicinity of the areas of the greatest traffic conflicts (as determined by the injury and crash densities). This appears counterintuitive to the purpose of automated speed management, which suggests speed limits should be well below the 85% of the posted speed band of the approach roads (30−50 kph). The utility of the other red-light cameras in reducing injurious crashes was not examined in this study as they have only been installed in the past two years; it may be that some of these cameras are located within areas of greater crash and injury density. However, local knowledge in relation to the location of the recently installed cameras suggests that the majority of the cameras have not been installed in the high crash and injury density areas. This is a significant concern as the effectiveness of red-light camera programmes is on the premise that the cameras are installed in the areas of the greatest conflict and, importantly, in areas where levels of road trauma are the highest.

The study found a doubling in the reported crashes at intersections where red-light cameras had been installed. This finding is in contrast to almost all of the literature evaluating such camera technology. However, one must be very cautious in interpreting this finding as it is based on few installed cameras ($n = 5$) and a three-month observational period before and after the installation of the cameras. As a consequence, the observed number of crashes was small with 6 before-installation crashes and 14 crashes after the red-light camera installation. The small numbers observed prevented rigorous statistical analysis which is a limitation of the current study. However, the descriptive findings reported in the paper (both the spatial and frequency count data) point to the conclusions reported herein.

The most significant limitation of the study relates to the data that were available to answer the aims of the research. First, to estimate the true crash risk at intersections operating under the red-light camera programme, it is necessary to have specific details on the crash type; for example, it is known that red-light cameras aim to reduce crashes resulting from vehicles proceeding straight through the intersection (right angle crashes) or vehicles approaching from opposite directions with one of the vehicles turning in front of the other (left turn against crashes) (Budd et al., 2011). The data available for this evaluation did not provide this level of sensitivity. In the absence of this data, there is no opportunity to link the crash event to the injuries sustained and the severity of the injury. As well, there were limited data available on the timing of the installation of the cameras, and in fact the site of the cameras, and to obtain this information we utilized time-based Google earth maps to observe the presence of cameras at intersections across Dammam; a rather crude measure, but nonetheless, provided the data suitable for analysis.

In previous studies evaluating red-light cameras where reductions in crashes at sites in which red-light cameras had been installed were observed, it is difficult to exclude the possibility that the reduction reflects the statistical phenomenon, namely regression-to-the-mean. Since the red-light cameras were installed at intersections with high crash rates and high traffic volumes, there is the likelihood that an observed reduction in crash rates could be attributed to this phenomenon rather than a true reduction in crash rates. This study, in contrast, does not have such a limitation as the cameras did not appear to be installed in areas of high crash.

Aside from the limitations in obtaining data suitable to rigorously evaluate this new road safety program, what this paper highlights from the geospatial analysis is the need for a comprehensive speed management strategy that includes a focus on the key factors that influence effectiveness, namely the placement of fixed cameras at sites of greatest risk of crash and injury. The findings from this study suggest this element of the strategy is not being addressed which could have a significant impact on delivering the *a priori* benefit identified from such programmes reported elsewhere (Budd et al., 2011). This is an important point as road trauma in Saudi Arabia continues to contribute significantly to the countries' burden of disease. The response to the challenge is the implementation of known efficacious interventions such as red-light camera programmes. As this study highlights, however, if such programmes are not implemented in a manner that reflects the efficacy of these programmes as reported globally, it is unlikely the city of Dammam and Saudi Arabia, specifically, will measure demonstrable reductions in road trauma.

Finally, the research has highlighted (Diamantopoulou & Cameron, 2002) that an array of covert along with overt speed enforcement is needed in order to observe measureable reductions in crash rates; the sole use of overt fixed red-light camera's is unlikely to deliver the measureable reductions in road trauma that is urgently needed.

Acknowledgments

M. Stevenson is funded by a National Health and Medical Research Council Fellowship, all authors other than B. Lawrence are supported through the Saudi Aramco Chair in Traffic Safety. All funding was provided by Saudi Aramco.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Anderson, T. (2009). Kernel density estimation and K-means clustering to profile road accident hotspots. *Accident Analysis & Prevention, 41*(3), 359−364.

Budd, L., Scully, J., & Newstead, S. (2011). *Evaluation of the crash effects of Victoria's fixed digital speed and red-light cameras*. (Report No. 307). Melbourne, Australia: Monash University Accident Research Centre.

Diamantopoulou, K., & Cameron, M. (2002). *Evaluation of the effectiveness of overt and covert speed enforcement achieved through mobile radar operations* (Report No. 187). Melbourne, Australia: Monash University Accident Research Centre.

Elvik, R. (2009). *The handbook of road safety measures* (2nd ed.). Bingley.

Environmental Systems Research Institute. (2011). *ArcGIS desktop (version 10)*. Redlands, CA: Author.

Hoareau, E., Candappa, N., & Corben, B. (2011). *Intersection study, task 1 report: Problem definition*. Retrieved from http://www.monash.edu.au/miri/research/reports/rpts13.html

Høye, A. (2013). Still red light for red light cameras? An update. *Accident Analysis and Prevention, 55*, 77−89. doi: 10.1016/j.aap.2013.02.017

Hu, W., McCartt, A.T., & Teoh, E.R. (2011). Effects of red light camera enforcement on fatal crashes in large US cities. *Journal of Safety Research*, *42*(4), 277−282. doi: 10.1016/j.jsr.2011.06.002

Kloeden, C., Woolley, J., & McLean, A. (2004). *Evaluation of the South Australian default 50 km/h speed limit*. Adelaide, Australia: Centre for Automotive Safety Research, University of Adelaide.

World Health Organisation. (2013). *Global status report on road safety 2013: Supporting a decade of action*. Geneva, Switzerland: World Health Organisation.

World Health Organisation. (2004). *World report on road traffic injury prevention*. Geneva, Switzerland: World Health Organisation.