Red light running, a significant road safety problem at signalized intersections

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Abstract

As red light running is defined any observation during which a vehicle crossed the stop line after the occurrence of a red traffic light. A number of studies on red light running behavior have indicated that red light running is a significant road safety problem.

In order to gain a better understanding of the occurrence of red light running and the characteristics of this high accident risk behavior, the Transport Study Unit of the University of Patras, Greece has carried out a relevant project. This work consisted of various parts:

1. Review of existing literature on red light running and its impact on road safety;
2. Analysis of accidents involving red light running;
3. Find out what measures have been taken elsewhere;
4. Conduct an observation pilot study for a signalized intersection in the Patras, to identify red light incidents.

In the conclusions it is found, that an analysis of accidents alone, does not provide information on the extent of red light running on a road network.

The study indicates that a number of other issues ought to be investigated, before countermeasures, such as e.g. red light cameras should be suggested.
1. Introduction-Review

As red light running is defined any observation during which a vehicle crossed the stop line after the occurrence of a red traffic light.

A number of studies on red light running behavior have indicated that red light running is a significant road safety problem. These studies have shown that between 10% and 30% of accidents at signalized intersections involve traffic signal violations, such as red light running.

One of the first papers to consider the impact of red light running on road safety was Croft (1980). Croft's review of accident types at signalized intersections revealed that 20% of fatalities at signalized intersections were a result of red light running.

Subsequent studies have revealed similar results. A study in Birmingham, Great Britain (Lawson 1991) on the occurrence of red light running accidents at a number of camera sites, found that the majority of violations occurred during high levels of traffic flow and on roads where there was most traffic. Violations also occurred during peak morning and afternoon/evening periods, indicating congestion is a factor in a driver's decision to disobey a red traffic signal. The study also found that red light accidents, in comparison to the frequency of all signalized intersection accidents, were over-represented in the evening periods and particularly so on weekends. Between 5pm on Saturday and 4am Sunday morning, 9.1% of red light accidents occurred, despite this representing 5.4% of the entire week.

A study by Ogden and Newstead (1994) found that 21.8% of all accidents at signalized intersections in Victoria, Australia (1987-1991) involved adjacent approach accidents, while 33.5% were of the 'right-through' types of collisions. For adjacent types of accidents it is known that one of the motorists involved ran the red light, while for right-through types of crashes it is expected that only a proportion may have done so. Such collisions may have been as a result of poor-gap selection by the turning driver.

A study by Kent, Corben, Fildes and Dyte (1995) compared the frequency of red light running incidents at six intersections. Three approaches had red light cameras installed, a further six approaches were used as controls. The study found there were 123 incidents in 54 hours of recording and more than 38,000 vehicles observed. The rate of incidents was 0.32 per 100 vehicles (3.2 incidents per 1,000 vehicles). Kent et al also found that the majority of red light violations occurred from the right turn lane and suggested red light camera operation should be altered to reflect this outcome.

A study by Andreassen (1995) based on 41 red light camera sites indicated that 19% of the total casualty accidents involved vehicles from adjacent directions. Although these are not exclusively 'red light running' crashes, the nature of this type of accident indicates one of the vehicles failed to obey a red traffic signal. A further 29% were vehicles from opposite directions, 'right-through', some of which are expected to involve vehicles running the red signal. However, poor gap selection may also be the reason in these cases.

The Insurance Institute for Highway Safety (IIHS) (1998) found that approximately 260,000 injuries resulted from red light running annually (approximately 11% of all injuries in the USA). Another USA study (Tarawneh, Singh and McCoy 1999) found that red light running accidents accounted for 24% of all intersection accidents.

A more recent study by Retting, Williams and Greene (1998) used vehicle speed on the approach to an intersection at the time of signal phasing changes to determine if a red light running event was about to occur. The speeds were detected using induction loop detectors embedded in the road pavement. The results indicated that 8121 incidences of red light running occurred over a period of 2694 hours at two sites in Virginia, USA. This is an incidence of three violations per hour. When broken down by site, the larger site had more than twice the number of violations (i.e. 5.4 per hour, compared to 1.3 per hour at the smaller site). Observation of the drivers involved in the accidents indicated that they were more likely to be younger, less likely to use a seatbelt, more likely to have previous driving violations, and more likely to be driving older and smaller cars.
Another study in Adelaide, Australia also found that middle aged drivers wearing seatbelts were more likely to be involved in red light running (Woolley and Taylor 1998). Woolley and Taylor also found that 1668 violations occurred over 96 hours of observation at 5 red light camera sites and 14 non-camera sites. This translates to one violation every 3.5 minutes, which equates to 17 violations per hour. The rate of incidents was calculated to be 5.9 per 1,000 vehicles.

A study in San Francisco, USA found that male, middle-aged drivers were more likely to disobey a red traffic signal than any other age group (Taylor 1999).

2. Characteristics of accidents involving red light running

Red light running accidents are not easily defined from the accident databases; estimates are usually made using the description of the accident type. The accident types identified, as most likely to involve at least one driver running a red light, are:

- Cross traffic
- Left-far
- Left near
- Two-turning left
- Right –near
- Left- through

The above movements are shown diagrammatically in the following Table 1. These categories were selected, because one of the drivers involved must have entered the intersection when facing a red signal. It is unlikely that these pairs of movement from adjacent directions would have been permitted by the traffic signals.

<table>
<thead>
<tr>
<th>Type</th>
<th>Category</th>
<th>Description</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cross traffic</td>
<td>Vehicles travelling in adjacent directions.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Left Far</td>
<td>One vehicle continuing straight ahead and the second vehicle turning left into same direction as the first vehicle.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Left Near</td>
<td>One vehicle continuing straight ahead and the second vehicle turning left into opposite direction as first vehicle.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Two left turning</td>
<td>Vehicles from adjacent directions, both turning left</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Movement</td>
<td>Description</td>
<td></td>
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<td>---</td>
<td>----------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Right near</td>
<td>One vehicle continuing straight ahead and the second vehicle turning right into same direction as first vehicle.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Left-Through</td>
<td>One vehicle straight ahead, second vehicle turns left from opposite direction across path of first vehicle.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Pairs of movements from adjacent directions, possibly associated with 'red light violation' accidents.

In a relevant study(6) it was found, that 77% of the accidents that involved red light running were identified using the accident types described above; therefore the accident analysis was considered to be satisfactory.

3. Collecting data on red light running

Various techniques have been used until now for observing red light running. These include:

1. Induction loops
2. Single approach video observations
3. Dual approach video observations

The first method uses induction loops located in the pavement on the approaches to a number of intersections. Problems arose using this approach, including:

- The need for double loops to be an accurate indication of speed;
- The capacity for vehicles to stop after the loops and not enter the intersection after the red light-indicating a possibility for false identification;
- The need to link the detection of red light violations using the inductive loops at intersections.

This method of observation was abandoned due to errors in recording.

The second method uses single approach video observations, which provide an accurate method of deducing which vehicles enter the intersection after the occurrence of the red signal. The time of the red signal can be identified in relation to the time the vehicle entered the intersection. However this approach is time consuming as only one approach can be observed for every cycle. In addition, there is also a problem of unusual video footage for traffic travelling in the adjacent.

The third method: in an attempt to increase the number of approaches that can be observed at a single intersection, the following technique was devised. A single camera (Camera 1) was used to view the entire intersection from a height of ten metres above the ground, with a second camera located approx. 1.5 metres above the ground in the same direction as Camera 1. The second camera(Camera 2) was used to record traffic signal operations for one approach. A third camera was located on the second approach to the intersection to record the traffic signal operations on the adjacent approach. Images from the three cameras were “mixed” onto a single videotape using picture-in-picture technology. The three images could then be used to identify red light violations in two directions effectively doubling the observations for the same period of recording.
4. Measures taken elsewhere- Red light cameras

Since the identification of red light running as a major problem, red light cameras have been introduced in a number of cases.

In various countries, research projects have been conducted to evaluate the red light camera program. The first in 1988 involved a comparison of accidents between 46 camera sites and 46 control sites (South et al 1988). The result was a statistically significant reduction in the number of right angle accidents (33%). The second study by Andreassen (1995), which examined the long term effect of red light cameras at 41 of the original 46 sites, reported that there were no long term benefits to be derived from the operation of red light cameras. There was no statistical significance between accidents at the sites and accidents at all signalized intersections.

Finally, a third study by Kent et al (1995) also showed that there was no significant reduction in the frequency of accidents at red light camera sites compared to non red light camera sites.

Other studies indicate accident reductions following the installation of red light cameras. Hillier et al (1993) determined that introduction of red light cameras reduced the number of cross traffic accidents from 25% in the 'before' period to 19% in the after period. ‘Cross traffic’ accidents reduced by approximately 50% at red light camera sites compared with a 22% reduction at the other sites over the same period. Rear end accidents increased by 62% at the camera sites and reduced by 29% at the control sites.

Mann, Brown and Coxon (1994) conducted a study on the effect of fourteen red light camera intersections around Adelaide. The analysis of casualty accidents indicated a reduction of 54% in right-angle accidents and a 38% reduction in right-turn accidents. A 27% reduction in rear
end accidents was also observed. This compared to 38%, 19% and 27% reductions, respectively, at the control sites. The results however were not statistically significant.

A further study found a 44% reduction in red light running incidences following the introduction of red light cameras (Fox 1999).

5. A pilot study to identify red light running

The analysis of accidents alone does not provide information on the extent of red light running on a road network (red light running accidents are not easily defined from the accident database), nor it gives concrete conclusions on this type of road safety problem. It is better to study and analyze red light incidents. A relevant pilot study was conducted by the Transport Study Unit of the University of Patras, Greece, at an intersection within the Patras’ urban area.

The intersection used for this pilot study was selected based on a high accident history of red light crashes.

Seven crashes in five years were the result of red light running. One crash involved a fatality and another three crashes involved serious injuries. The high level of crash severity indicated a considerable red light running problem.

The intersection was a four-leg signalized intersection. The pilot study lasted for 4.5 hours, and it was repeated for five working days. Counts were made by observers, who were located at 3 different approaches within the intersection area, and were keeping records of the incidents. These approaches were those which were involved in the majority or red light running crashes.

The average yellow was 3 secs.

The violation is defined as any vehicle that was not fully in the intersection when the signal changed to red, but completed their manoeuvre through the intersection. Hence vehicles that were partially over the stop line at the time of the change to a red traffic signal were considered violations if they continued through the intersection. If the driver stopped partially over the stop line they were not included.

In the 22.5 hours recorded, there were 149 violations, of these violations 48 incidences were clearly after the red varying from 0.004 secs to 0.48 secs. The remaining 101 incidences occurred with the vehicle partially over the line or on the line as the red light traffic signal was activated but completed their manoeuvres through the intersection.

90% of vehicles completed a left-turn when disobeying the red traffic signal and in most cases followed a queue of four vehicles. A number of the left-turn red light running events followed a delay to the leading vehicle waiting in the opposing direction.

The results revealed a rate of occurrence of 3.6 incidents per 1,000 vehicles. The method adopted was successful, but the need to ensure a better view of all approaches was highlighted.

Analysis of the data indicated:

• the number of red light running incidents was greater on weekends than expected.
• the number of incidents involving left turning vehicles was greater than expected.
• the number of incidents involving trucks was higher than expected.
• the number of incidents involving motorcycles was higher than expected.
Fig. 1: The four-leg intersection under study
7. Conclusions and recommendations

The objectives of this study were to:

- provide a better understanding of accidents involving red light running;
- develop a better understanding of red light running behavior
- develop a method of collecting data on red light running, on-site.

The analysis of accidents alone however does not provide information on the extent of red light running on a road network.

From this study a number of other issues warrant further investigation, these include:

- Understanding when red light running becomes a red light running accident: this may be achieved through the investigation of red light camera information and police reports on fatal accidents that were believed to have involved red light running.
- Investigation of the geometric features of intersections that may affect red light running.
- Investigation of the characteristics and circumstances of drivers involved in red light offences and accidents.

Observation of the behavior of motorists at the intersections, coupled with analysis of accidents aggregate data, has indicated that there may be different categories of drivers that run red lights. Each category requires further investigation as countermeasures may not be applicable to all drivers. The categories of drivers that have been revealed include:

- drivers that deliberately run red lights to avoid delays;
- drivers who through sun glare, faulty signals or overhanging signs do not see the red light; and
- drivers who, through distraction, do not see the red light. A distraction could result from the driver paying more attention to something happening either inside or outside its vehicle rather than to the traffic and road environment.

The above consist another field for further research, before countermeasures to be introduced—such as e.g. red light cameras.
References


