Red-light Running in Developing Countries – The fact: A Case Study in Hanoi, Vietnam

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Abstract. Traffic safety has been a critical issue in Hanoi. The factors that affect safety may include the design of roads, vehicles, and road user's behavior. At signalized intersections, Red-Light Running (RLR) is the cause of severe injury crashes. As several studies have been conducted to identify the influencing factors of RLR behavior worldwide, no similar studies exist in Hanoi. For filling in this gap, this study was conducted to identify the key factors that affect RLR. We found that about 81% of respondents have committed RLR. The five most important factors that affect their RLR decisions are air pollution, the pressure of being late, hot weather, waiting time, and the rain. In addition, our result showed that the countdown signal is a factor associated with RLR. Based on the results, this paper proposed countermeasures to reduce the RLR. The countermeasures include the penalty of RLR, the use of enforcement cameras, the driving license deduction system, and educating awareness of citizens on RLR.

Keywords: Red-light running, Signalized intersections, Traffic accident, Traffic safety, Road user's behavior

1. INTRODUCTION

Signalized intersections are intended to reduce accidents and enhance the efficiency of traffic flow at busy intersections. However, the level of safety achieved is strongly dependent on drivers' compliance with the signals. In developed countries such as the United States, previous studies have shown that many drivers violate red signals, placing themselves and other road users at risk for serious collisions. Retting et al. (1999) found that 3% of all fatal crashes between 1992 and 1996 involved red-light running (RLR). Fatalities related to RLR increased by approximately 15% during this period (from 702 in 1992 to 809 in 1996). In addition, it is not surprising that the urban areas are at greater risk for RLR crashes (Retting et al.,1995). Brittany et al. (2004) estimated that 20% of vehicles involved in fatal crashes at signalized intersections failed to obey the traffic lights. In 2018, 846 people were killed, and an estimated 139,000 were injured in crashes that involved red-light running. About half of the deaths in these crashes were pedestrians and occupants in other vehicles who were hit by the red-light runners (Insurance Institute for Highway Safety, 2020). In developing countries, according to WHO (2018), there has been no reduction in the number of road traffic deaths in any low-income country since 2013 and the risk is more than three times higher in low-income countries than in high-income countries. Thus, more studies and actions about traffic safety are needed in these countries.

In Vietnam, the traffic is mixed, and motorcycles (MCs) are dominant. The MCs belong to a vulnerable groups and they are associated with a high rate of fatalities (WHO, 2018). The

general statistics office of Viet Nam reported that 5,508 traffic accidents occurred nationwide during the first five months of 2020 (General statistics office of Viet Nam, 2020). The accident caused 2,667 deaths. On average, 36 traffic accidents occurred nationwide each day during this period, causing 17 deaths per day. Therefore, taking action to reduce traffic accidents in general and to control RLR specifically is very important. For this purpose, the current paper analyses some reasons for RLR by using the questionnaire data collected in Hanoi. We expected that the findings from this research help to reduce traffic accidents at signalized intersections.

2. LITERATURE REVIEW

Jensupakarn and Kanitpong (2018) explored RLR including human characteristics, the physical condition of the intersection, traffic signal operation, and traffic condition using data collected at 92 intersections in Chiang Mai, Nakhon Ratchasima, and Chonburi, Thailand. In addition, they used the socio-economic characteristics of red-light runners obtained from a self-reported questionnaire survey. Their results showed that, for motorcycle riders and car drivers, factors including age, gender, occupation, driving license, helmet/seatbelt use, and the probability to be penalized when running the red light significantly affect RLR behavior. Moreover, the results indicated that some factors significantly affect RLR rates. They are, for example, the vehicle traveling direction, time of day, the existence of turning lane, number of lanes, lane width, intersection sight distance, type of traffic signal pole, yellow time interval, approaching speed. Ko et al. (2017) evaluated the safety impacts of RLR camera (RLC) system installation and then deactivation at 48 intersections in Houston, Texas. The results indicate statistically significant collision reductions on all red-light running (RLR) crash types (37 percent) as well as right-angle RLR crashes (47 percent) at the treated intersections after RLC activation. Fraboni et al. (2018) adopted an eye-observational methodology to investigate differences in cyclists' crossing behavior in Italia. The classification of cyclists' red-light behavior in risk-taking, opportunistic, and law-obeying, was adopted and re-adapted to reflect more objective behaviors, eliminating any inference or judgment. They concluded that more than 60% of the observed cyclists violated traffic control. Schleinitz et al. (2019) observed nearly 8000 red light situations in Germany. They found that, in 16.3% of these situations, they ran the red light. RLR rates were lowest when cyclists rode on the carriageway, while the complexity of the intersection appeared to play a role as well. In general, RLR was more common when riders were about to turn right instead of turning left or riding straight through the intersection. Chen et al. (2017) investigated RLR by utilizing high-resolution traffic and signal event data collected from loop detectors at five intersections on Trunk Highway 55, Minneapolis, MN, United States. A total of 6550 RLR cases were identified. The results showed that RLR is most likely to occur on weekdays during peak periods under the large traffic demands and longer signal cycles, and a total of 95.24% RLR events occurred within the first 1.5 s after the onset of the red phase. It confirmed that vehicles tend to run the red light when they are close to intersection during phase transition, and the following vehicles with short headways likely run the red light.

3. DATA COLLECTION

In the current research, the questionnaire was distributed and collected by an online survey and in-person survey within two weeks (from 6th – 19th January 2020). The online survey was conducted by posting questionnaires through social media (e.g., Facebook, Twitter,

and so on). In the same duration, the in-person survey was conducted by interviewing respondents at their homes, at coffee shops, and while waiting to pick up their kids at school. Finally, 883 respondents agreed to answer the questionnaire. However, among 504 respondents collected online, it is needed to exclude 87 respondents because they ignored questions in the questionnaire sheets. So, the final 796 samples include 417 online and 379 in-person respondents. Table 1 shows some information on questionnaire data.

4. DATA ANALYSIS

4.1. Demographic characteristics

Of 796 samples, male occupies 61,4% and female shares 38,6%. The age from 18 – 25 years old has the largest share with 38,1%. It is followed by age group of 25 – 35 (30,7%) and 35 – 45 (21,6%). The remaining age group (45 – 75) corresponds to the smallest share (9,67%). Regarding the academic level, most of the respondents have a degree of bachelor (71,6%).

Table 1. Summary of information got from questionnaires.

Questionnaire group	Information asked
Demographic characteristics	Age*), gender, academic level, occupation, monthly income
Mobility characteristics	Driver license, commuting mode/frequency/time/purpose, children accompaied, experience of using mode, distance/time to work place
Knowledge of traffic law	How to stop at traffic light?, what is RLR, amercement for RLR
Opinions and awareness of road users	Dangerous level of yellow/red light running, safety level, consciousness of road users, congestion level, pollution level, feeling to wait under hot/ under rainy/ under cold weather, effect of waiting time
Questions related to RLR	Have you ever violated the red light? Factors affect your RLR (hot/rainy/cold weather, air pollution, pressure of being late, behavior of surounding people, police, waiting time)
What government should do to reduce RLR	Strengthen the penalty of, use enforcement cameras, publicize the violators, driving license point deduction, educate awareness of citizen

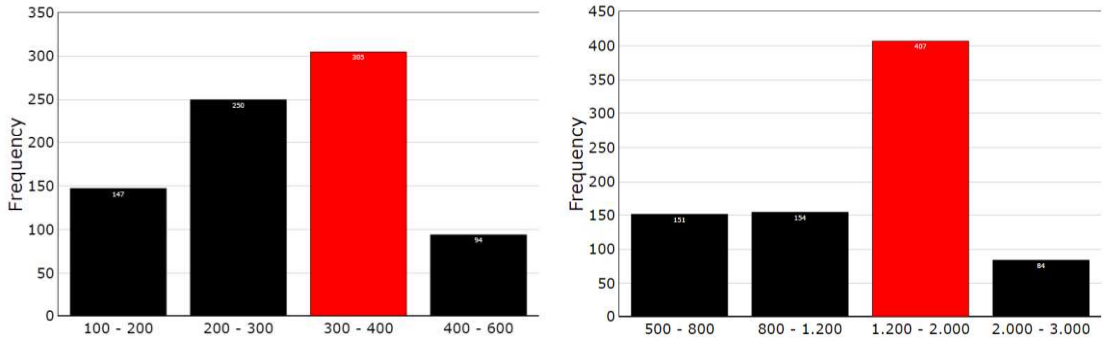
*) The respondent born after 2002 (under 18 years old) was not subjected for questionnaire. The oldest one in the data set was born in 1945 (75 years old).

4.2. Mobility characteristics

Most of the respondents (81,9%) use MCs as their transportation mode. The people using the car and bus share 9,3% 5,53%, respectively. The remaining 3,27% includes electric MCs, bicycles, and walk. This share reflects a similar trend of the transportation mode component in Hanoi. As for distance to the workplace, the respondents tend to live near their workplace. Many of them (52,0%) live within 5km, and about one-third of respondents (30,9%) live within a distance from 5 to 10km. In addition, more than haft of them (53,1%) must accompany their kids to school.

4.3. Knowledge of traffic law

Figure 1 presents knowledge of traffic law. Notably, the red bar shows the correct answer based on Vietnamese traffic law. The figure shows that 35.1% of respondents reported waiting for traffic signals after the stop-line or any position. Surprisingly, 61.7% and 48.9% of respondents do not know the amercement for MCs and cars, respectively.



Amercement of MC (unit: thousand VND) Amercement of Car (unit: thousand VND)

Figure 1. Respondents' knowledge of traffic law.

4.4. Opinions on dangerous level

We requested the respondents to give opinions on the dangerous levels of yellow-light running, RLR, and traffic environment in Hanoi. From Figure 2, almost all respondents understood that both yellow and red-light running are dangerous situations. In addition, they realized that the RLR is riskier than yellow light running. In addition, the respondents also thought that the traffic environment in Hanoi is very unsafe. It might come from their experience of traveling in such a congested and dangerous environment in Hanoi.

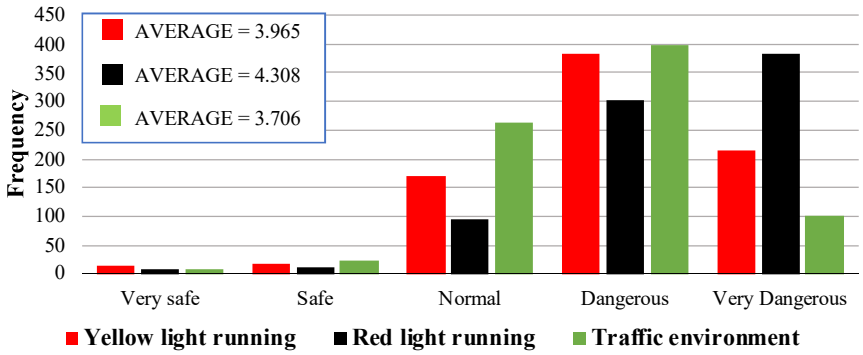


Figure 2. Opinion on dangerous level.

4.5. RLR frequency and affecting factors

Figure 3 illustrates the RLR frequency reported by respondents. It shows that of 796 respondents, only 150 (18,84%) reported that they have never violated the red light. The remained 81,16% of respondents reported having RLR. Most of them have seldom or sometimes made RLR. A few respondents (4,27%) have frequently violated the red light.

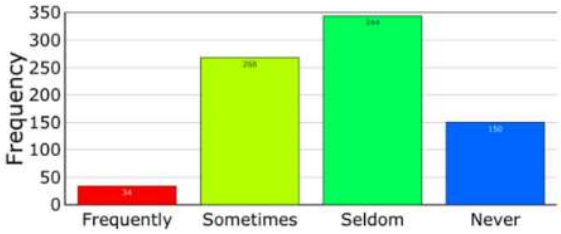


Figure 3. RLR frequency.

Table 2. Influencing factors on RLR.

No.	Influencing factors on RLR*	Mean	Standard deviation
1	The air pollution	1.39	0.6
2	The pressure of being late	2.31	1.13
3	The hot weather	2.63	1.23
4	The waiting time	2.72	1.13
5	The rain	2.75	1.12
6	The violation of surrounding people	2.87	1.2
7	The honking of the behind drivers	2.94	1.21
8	The absence of traffic police	2.98	1.16
9	The cold weather	3.25	0.97

Note: *1. Very affected 2. Affected 3. Normal 4. Unaffected 5. Very unaffected.

Table 2 presents some factors that affect on RLR of respondents. The table shows the mean and standard deviation of the respondents' answers with a Likert scale from 1 (Very affected) to 5 (Very unaffected). The most influencing factor for RLR is air pollution. And then, the pressure of being late, the hot weather, long waiting time and the rain. The least influencing factor is the cold weather. As mentioned above, about 82% of respondents use the motorcycle to travel, and more than haft of them have children accompanied. Therefore, the effects of air pollution and weather (i.e., hot and rainy conditions) on RLR are very much. In addition, congestion usually happens in Hanoi during peak hours. Consequently, it results in a high probability of being late. The respondents, especially the ones who need to take their kids to school, are easier to commit RLR since they do not want to be late.

Besides some factors presented in Table 2, another significant factor that affects RLR is the countdown signal. Recently, almost all signalized intersections in Hanoi have the countdown signal. Pan et al. (2017) concluded that the countdown signal improves both traffic safety and operational efficiency. In addition, Long et al. (2011) also found that countdown signal has impacted driving psychologies and behaviors. The road users may feel comfortable since they know how long they must wait for the green light. However, some studies have shown that the presence of the countdown signal may increase RLR and cause safety problems (Long et al., 2011, Barbara, 2018). In this paper, the effect of the countdown signal is investigated. We found that the countdown signal has influenced the RLR of 61,93% of respondents (Figure 4). Red-light runner usually violated the red time remains 1-2 sec (48,49%) and 2-3 sec (21,73%). It may result in a safety problem with other road users who enter the intersection at the end of green time or during the yellow time.

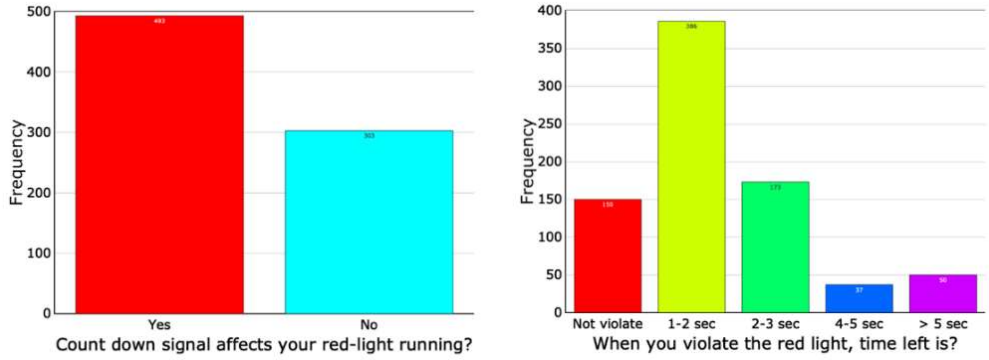
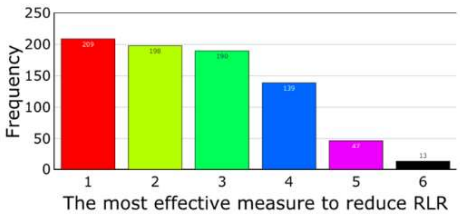


Figure 4. Effect of countdown signal on RLR.



1. Strengthen the penalty of RLR
2. Use enforcement cameras for RLR
3. Use driving license point deduction system for RLR
4. Educate awareness of citizen on RLR
5. Publicize the violators

Figure 5. Effect of countdown signal on RLR.

4.6. Opinions on solutions to reduce RLR

As presented in Figure 5, we asked the respondents to give opinions on solutions to reduce RLR. From the figure, it is evident that the most effective measure is to strengthen the penalty of RLR. It means that the punishment of RLR should be stricter. The second effective measure is the use of an enforcement camera. The enforcement cameras installed at the signalized intersection will record the RLR behavior. And violators are penalized based on the record. Another significant countermeasure is a driving license deduction system. The red-light runners will be deducted one point for one violation. And they need to retake the driving test if their driver's license points become zero. The other less effective measure is to educate awareness of citizens on RLR.

5. CONCLUSION

This paper examined the RLR behavior from questionnaire data collected in Hanoi - a typical city with mixed traffic. We got a total of 796 valid samples from the online and in-person surveys. Our analysis indicated that almost all the respondents (81,16%) reported committing RLR. The violators usually commit RLR when the red time remains 1-2 sec (48,49%) and 2-3 sec (21,73%). Regarding the factors affecting RLR, we found that air pollution, the pressure of being late, the hot weather, long waiting time, and the rain are significant factors affecting the RLR. More importantly, the countdown signal has a significant impact on the RLR. 61,93% of respondents have reported that the countdown signal affects their decision on RLR. Together with discovering factors that affect RLR, this paper also proposes potential countermeasures to reduce the RLR. The most significant countermeasures include the penalty of RLR, enforcement cameras, driving license deduction system, and education of citizens' awareness. The current paper is limited to analyses only. In future work, we need to develop a statistical model to generalize red-light runner behavior. In addition, the

data is limited in terms of sample size and site-specific location. Thus, collecting more samples in other cities is very important.

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