

## Investigating Signal Violations in Mixed Traffic in Hanoi City

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**Abstract:** In mixed traffic with high proportion of motorbike users in Vietnam, traffic safety is a severe problem since conflicts between cars and motorcycles normally bring heavy damages and bad consequences. One major reason for traffic accident in heterogeneous traffic is signal violation, especially in big cities. However, researches on traffic violation in Vietnam remain rare. This study use empirical survey to investigate the influence of some typical factors included driver demographics, traffic factors, and road properties on current signal violation in Hanoi. It is important to identify the main indices in order to help traffic organizers and local authorities to reduce crash around intersection area.

*Keywords:* Traffic signal violations, mixed traffic

### 1. INTRODUCTION

In the last few decades, traffic is a prominent social issue in Hanoi City, the capital of Vietnam. The situation could not be solved properly up to now due to the fact that motorcycle is the main commuting mean of citizens. Despite the effort from the Government to fortify the public transport system as well as the rapid increase of around 10 percent annually of car owners, the two-wheelers still the dominant in the road, especially in central business districts. Until late 2018, the number of motorbikes is exceeded 5.2 million, representing around 70 percent of transportation mode share, and make Hanoi be one of the most motorcycle dependent city in the world.

Since cars and two-wheelers have to use same traveling spaces, conflicts between these two transportation modes are serious problems, especially in peak hours, and be the major sources for traffic accidents in Hanoi. In addition, in the mixed traffic regime, whenever traffic accidents happened, the consequences should be more severe because motor drivers are normally not well-protected. Statistics show that in 643 traffic accidents with 248 fatal and 443 injuries in the first half of 2018, 32.19 percent of cases caused by conflicts around the intersection area. Due to the flexibility of motorcycle, drivers tend to pass through intersections whenever they find an acceptable time gap. As a result, traffic violations, including illegal running in red-phase and early departure, are common reasons for junction crashes in Hanoi.

However, empirical researches of traffic signal violation in Vietnam in general and in Hanoi in particular still remain rare. Therefore, this paper aims to investigate the behavior of car and motorbike drivers at signalized intersections. By making several surveys, we consider both objective factors such as road properties, signal time splits and subjective factors from

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riders' view that could influence the traffic violation rate in junctions.

The remaining parts of this paper are organized as follows. Chapter 2 summarizes literature reviews of traffic signal violation, followed by the observation description in chapter 3. Next, results will be discussed in chapter 4. Finally, we conclude this paper in section 5.

## **2. LITERATURE REVIEW**

### **2.1 Traffic Signal Violation Definition**

There is no concrete definition of traffic signal violation. Base on the Manual on Uniform Traffic Control Devices (December, 2000), drivers need to reduce their speed when facing yellow light and stop completely when the signal change to red. However, in different studies, there are several ways to define the moment and the location that vehicles must stop. Some researchers strictly describe that if drivers move their car across the stop bar after the signal turn to red, they will be counted as traffic violation (Lum and Wong, 2003; Schatter et al., 2002). Retting and Williams, 1996 suppose that there should be a latency of 0.5 second, and vehicles that entering the junction after signal turn to red inside 0.5 second still be legal. In other empirical studies, Ruby and Hobeika, 2003 and Retting et al., 1999a, b point out that when passing the stop bar inside latency period, cars need to have lower speed than a dedicated value which refers that drivers have tried to reduce their velocity in yellow signal time.

On the other hand, early departure have not been discussed much in previous studies. The reason for this disregard is that in conventional homogeneous traffic, the proportion of this traffic violation kind is much smaller than red-light running.

### **2.2 Factor Affecting Traffic Signal Violations**

From preceding studies, factors affecting traffic violation could be divided into four main groups: driver demographics, traffic factors, road properties, and other environment indices.

Gender and age have a great influence on traffic signal violations. In some researches (Porter, 1999; Retting et al., 1999), results showed that young male drivers are the most aggressive group and account for a higher portion of illegal running in red time period. Retting et al., 1999 also pointed out that drivers tend to false traffic regulation if they travel alone. Other studies from Porter and England, 2000; Retting and Williams, 1996 concluded that drivers who not use a safety belt would have a higher probability of traffic violation. Harper et al., 1999 showed that drivers without not only safety belts but also appropriate driving license have a greater illegal tendency. Other distractions such as eating, chit-chatting, talking on mobile phone or using tablet while commuting should lead to improper reaction to traffic signal changes. (FHWA, 2005).

Traffic volume are also significantly affect traffic violation. Porter and England, 2000; Brewer et al., 2002 indicated that higher traffic volume in wider intersections would result higher violation rates.

Road properties including intersection width, grade, approaching speed, stopping sight distance and approach lane width were proved to influence red-light running ratio (Chang et al., 1985). In other studies, Brewer et al., 2002; Eccles and McGee, 2001 showed that the frequency of illegal passing increases when yellow time splits less than 3.5 seconds.

Finally, factors such as weather, time of a day or time of a week also have the influence on riders' behavior. Retting et al., 1998 indicated that during rush hour, traffic signal

violation rate would be higher, while Lum and Wong, 2003; Kamyab et al., 2002 pointed out the greater ratio of weekdays' violation compared to weekends.

In summary, although many works have been made to analyze traffic signal violation, none has considered the situation in mixed traffic with high motorbike' share. This research tries to attempt this shortage by investigating in Hanoi, a typical location of mixed traffic region in developing countries. In addition, a specific illegal traffic violation in mixed traffic, which is early departure will also be discussed. In the early stage, empirical study by filed observation would be conducted to estimate the influence of driver, traffic factors, and road properties to the behavior of both car and motorcycle drivers.

### 3. OBSERVATION SURVEY

Observational surveys were conducted to determine the behavior of drivers in different intersections in Hanoi. Two intersections were chosen as summarized in Table 1. The disparities of two site are not only the lane width, but also the green splits. In site 1, the cross section of major roads are three lanes when in site 2, these value is two. The minor approaching road of site 1 also bigger than site 2. In addition, in Lang Ha – Lang intersection, there are protected left turn phase for main stream traffic, which lead to the total cycle time is 127 seconds. Site 2 is an ordinary traffic signal intersection with cycle length of 70 seconds. These two road properties factors will be used for investigating the influence on drivers' behavior. Since we do not consider the environment indices, traffic data were carried out by recorded cameras on a weekday October 24<sup>th</sup>, 2018 in morning and evening peak hour time frame. Overall, four videos with a total of four hours were used for observation data.

The map of experiment sites and screenshots from videos are shown in Figure 1. As can be seen from actual screenshots, due to the chaotic of vehicle movement in mixed traffic as well as high vehicle value in peak hours, up to now, there is no efficient and effective image processing tool to get traffic data automatically. Therefore, each video was counted manually, and sort as different categories included gender, directions, type of transportation mode, and types of traffic light violations. Results will be used in the following parts.

Table 1. Observation times and locations

Site	Location	Green splits	Cross section	Time
Site 1	Lang Ha – Lang Intersection	Protected left turn	Major road: 3 lanes	7 am – 8 am
			Minor road: 2 lanes	5 pm – 6 pm
Site2	Vu Pham Ham – Nguyen Khang Intersection	Permitted left turn	Major road: 2 lanes	7 am – 8 am
			Minor road: 1 lanes	5 pm – 6 pm

In general, the following observation data was noted.

- Traffic signal violation:
  - o The overall proportion of red-light passing and early departure corresponding to car and motorbike
  - o When going through during red-light periods, drivers go fast straight or run slow and find an acceptable gap?
  - o The typical time value for early departure
- Driver demographics:
  - o The percentages of male and female make illegal runs
- Road properties:
  - o How does lane width effect on driver behavior?

- How does green splits effect on traffic violation?
- Traffic factors:
  - The traffic volume of each phase

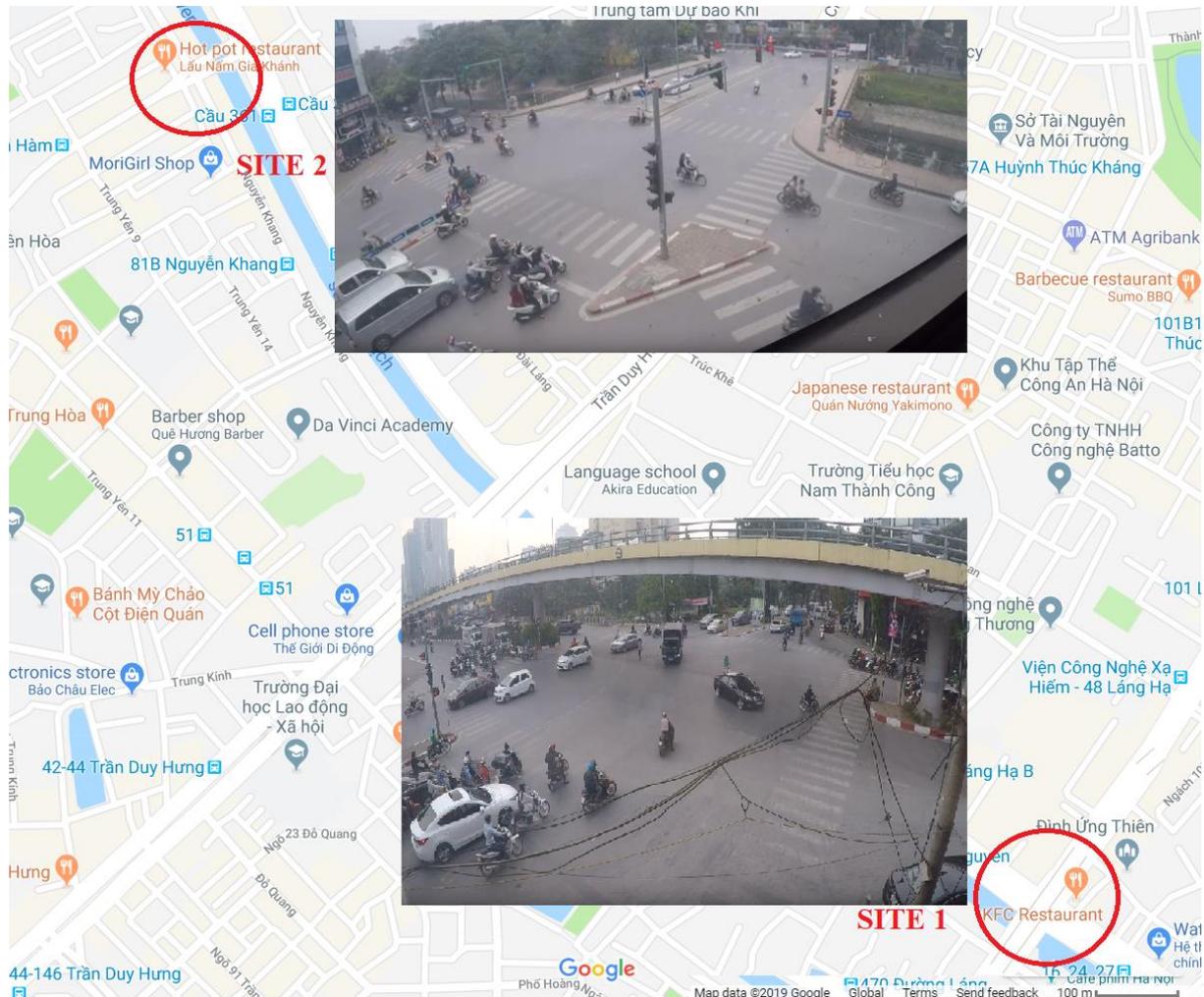


Figure 1. Observation survey map

#### 4. RESULTS AND DISCUSSION

As discussed in literature reviews, there is no concrete definition of traffic signal violations. In order to harmonized with Vietnamese traffic regulations, in these study, two types of violations are defined as below:

- Red-light passing violation counted when drivers go through the stop bar inside red phase. In mixed traffic in Vietnam, there is another type of violation, which refers to drivers pass the stop bar, but they do not continue go, and wait until green phase to continue their journeys. This group is consider as wrong stop violation.
- Early departure violation counted when drivers start their vehicles 5 seconds before the traffic light turn to green. Since motorcycles are transportation means with high level of mobility, this is a typical violation at intersections in Vietnam.

Table 2 shows the number of violation cases during the survey period for car and motorbike. It is clear from the table that the proportion of car's violation is below 2% of the total car volume, which is much lower than motorcycle's results. These results are reasonable

since car drivers in general should have better awareness than motor riders when commuting. In addition, the transportation fines for any type of violations for car are much higher comparing with two-wheelers vehicles, especially, recently, Hanoi city has announced the video enforcement cameras to punish illegal runs around the central business districts. The red-light passing cases of cars in these experiments are all happened right after the end of yellow time. On the other hand, motorcycle' red runs also occurred inside the middle of red phase, when they found an acceptable gaps. Early departure values of cars also small due to the fact that with the chaotic movements of drivers in Hanoi, car normally could not get in the first waiting line. As a result, they have lower chance to break the rules. It is also clear from Table 1 that between two types of signal violations, early departure has higher number of cases for both transportation modes. When comparing two survey sites, results show that site 1 with bigger road cross section has higher violation rates for both early departure and red-light illegal run. Traffic violations were counted case by case for each cycle of both site. However, during the peak hours, the traffic volume do not change much, and violation cases distributed nearly even among cycles. Therefore, the interactions between traffic volume and signal violation could not be examined.

Table 2. Traffic violation at each site

Site	Location	Violation type	Car	Motorbike
Site 1	Lang Ha – Lang Intersection	Early departure	15 (0.68%)	2238 (15.82%)
		Red-light passing	11 (0.50%)	1565 (11.06%)
		Total volume	2204 (100%)	14148 (100%)
Site2	Vu Pham Ham – Nguyen Khang Intersection	Early departure	20 (1.61%)	659 (13.55%)
		Red-light passing	12 (0.96%)	469 (9.64%)
		Total volume	1242 (100%)	4865 (100%)

From recorded videos, it also noted that the number of male motorbike drivers is far more than female riders. There are 2,381 and 725 male violation cases for two sites, respectively, while female values only a half, 1432 and 403 cases, respectively. It is obviously result since in general, male drivers are more aggressive ones. However, we could not conclude the influence of gender to the signal violation rate due to the fact that number of personal vehicles in mixed traffic is a huge value. Without image processing tools, it is too tough to get the precise results of driver demographics from videos of empirical survey.

Violation rates for different traffic flows are summarized in Table 3. From the motorbike results, it is clear that in site 1 with bigger approaching roads and protected left turn phases, traffic violation rate of minor stream is much higher than the main one. The reason for this fact should be drivers have to wait too long for their green time, then they decided to move earlier than they should do. In survey videos of site, a large amount of motorcycle of minor flow runs into the middle of the intersection and wait for passing when time phase changes. There are also several cars with this dangerous act during their stopping phase. On the other hand, in site 2, main stream traffic has higher proportion of both violation types. With higher volume in peak hour, drivers in major flow seems to be more aggressive and go through the intersection when they get the opportunities. In addition, there are protected right turn lanes for vehicles in this intersection. During the waiting time phase, motorbike drivers have the tendency to go inside this lane and try for crossing over the junction. This results imply that geometry properties of intersections may bring influence on traffic violation as well.

Table 3. Traffic violation cases by flow (unit: %)

Site	Direction	Car		Motorbike	
		Red run	Early run	Red run	Early run
1	Go-through major traffic	0.27	0.27	6.49	9.45
1	Protected left turn	0.00	0.00	10.26	5.10
1	Minor traffic	3.36	4.04	36.25	60.40
2	Go-through major traffic	1.28	1.79	16.26	12.61
2	Permitted left turn	0.00	3.08	1.84	0.52
2	Minor traffic	0.51	1.02	3.38	15.10

## 5. CONCLUSION

In the early state of the project, preliminary analysis of traffic violation in Hanoi have been made. Results show that some typical factors of driver demographics, traffic factors, and road properties might have effect on driver behavior at signalize intersection. However, in mixed traffic cases, it is not easy for imperial survey to collect some data such as driver gender. In the future research, we try to gather sufficient data and making traffic model to verify the impact of each factors.

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