

Vehicle Speed Analysis Toward Traffic Safety at School Zones Considering Roadside Activities—Case Study in Vietnam



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Abstract In Vietnam, school traffic accident is an urgent problem that needs mitigation solutions. Schools such as primary and secondary schools are located in the roadside of streets/roads, national highways, and provincial roads. School children who usually walk, ride a bicycle, or taken by their parents by motorbikes going to school are considered as vulnerable road users. Meanwhile, solutions for traffic organization and traffic safety in these areas have not really ensured traffic safety. Motor vehicles often use high speed through schools, causing traffic safety problems. On that basis, this paper conducts observations and evaluates the speed of motor vehicles when passing through the school areas. Three sites (schools) with different levels of roadside activities in Pleiku city, Vietnam, were selected for observation and analysis. An image processing method is used for collecting speed data. It is found that there is a relationship between the free-flow speed of vehicles and roadside activities. The results of the paper help to provide solutions for improving traffic safety for school children.

Keywords Traffic safety · School zone safety · School children · Roadside activities

1 Introduction

In recent years, traffic accidents in Vietnam still remain high with more than 8000 deaths per year with the information announced by the country [1]. Meanwhile, according to organizations such as World Bank, WHO, this number can be estimated as higher than 20,000 fatalities. Children are particularly vulnerable with 1900 children's fatalities on Vietnam's roads each year. Road crashes are the second leading cause of death for Vietnamese children between the ages of 5 and 14 [2].

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There have been many studies around the world on traffic safety in school areas [3–7]. In general, these studies have spent efforts to assess traffic safety or speed at school gate areas, thereby suggesting solutions to improve traffic safety. The solutions proposed in these studies focus on reducing the accessibility of motor vehicles and reducing the speed in school areas. Sun et al. [3] found that by reducing speed limits from 50 to 30 kph at school zones can contribute to the significant reduction of fatal and injury collisions. However, in another study, Hidayati et al. [4] conducted a study in the Indonesia case and found that the School Safety Zone, which is a time-dependent speed control zone, does not reduce the speed of vehicles.

In Vietnam, schools are often located near the streets or even close to the roadside of busy streets, provincial highways, or national highways. In fact, there is a lack of reasonably protective measures and legal provisions to deal with traffic safety issues. Sidewalks/walking paths and crossing facilities on major roads or busy streets as well as other traffic regulation facilities that require drivers to slow down around schools are not adequately or properly arranged. Road traffic safety issues cause deep concern and worry for parents. Therefore, most parents will have to take their children to school, instead of letting them walk to school on their own. This even contributes to a negative impact on traffic safety, and even causes chaos and traffic jams when parents come to school to pick up and drop off students. With the goal of focusing on reducing the traffic accident of school children, the study aims to conduct an analysis of the speed of vehicles running through school zones with some specific cases in Vietnam. The study quantifies the relationship between roadside activities and vehicle speed, and that will help to find appropriate solutions to improve safety at schools in Vietnam.

2 Methodology and Results

2.1 Data Collection

The data to be surveyed includes two data types: road geometry and roadside activities and traffic data (type and speed of vehicles). Roadside activities that are considered in the study include some major factors such as the development of residential housing in the area around schools (high- or low-developed area), availability of sidewalks, and level of roadside trading. In this study, it is focused on free-flow vehicles on the interaction with those general roadside activities. This study does not focus on analyzing each specific activity such as cases of vehicles making U-turns, pedestrians crossing, vehicle parking, etc.

An image processing tool [8] is used to get data at measurement sites to analyze vehicle speed passing through the analyzed cross sections. Videos are then inputted into the image processing tool, through which spot speed data is collected. The method to get speed data in the image processing tool is a basic method that is calculated based on the distance and time a vehicle passing through two given points.

Three sites corresponding with three primary schools in Pleiku city, Vietnam, are selected for the study.

Three schools are located on the roadside of different streets with different levels of roadside activities (Table 1). At each site, two cross sections were selected for collecting vehicle speed data (spot speed data). These two cross sections include as follows: Cross section 1 locates in front of the school gate, and Cross section 2 locates at a distance of 200 m from the cross section 1 (before the speed limit zone). The analysis direction will be the vehicles moving in the direction from cross section 2 to cross section 1. The choice of the location of the second cross section is based on the conditions of the road through school and within the effective distance of the speed limit sign that can be provided (Fig. 1).

The survey was conducted in Pleiku in April 2022 (just after the lockdown duration of Covid pandemic). The video data was collected in one day (on weekdays) for each site. Time survey was conducted at each school with four time frames/day, including:

Table 1 Basic information of the survey sites

Site	Name of school	Carriage-way width (m)	No. of lane	Roadside activities
NVT	Nguyen Van Troi Primary School	10.0	2	High-developed area, sidewalk available, low level of roadside trading
NDC	Nguyen Duc Canh Primary School	9.3	2	Low-developed area, sidewalk not available, very low level of roadside trading
CCL	Cu Chinh Lan Primary School	7.0	2	High-developed area, sidewalk available, high level of roadside trading

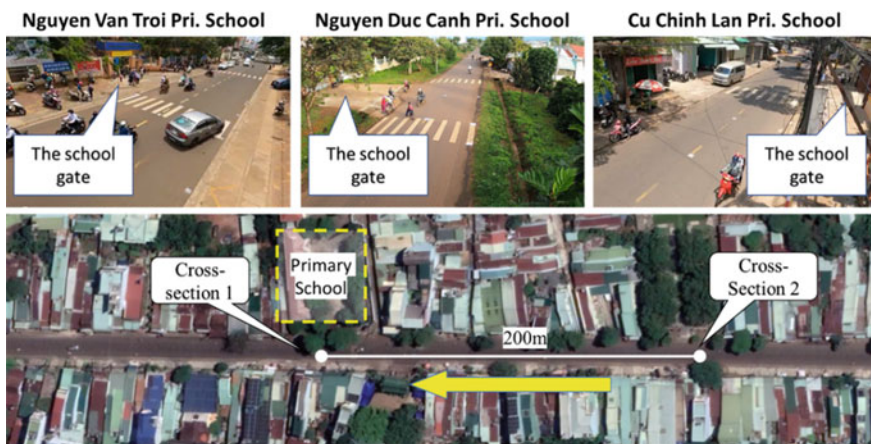


Fig. 1 Relative position of two cross sections

from 6:00 to 7:00, from 10:30 to 11:15, from 12:15 to 13:00, and from 16:30 to 17:30, and these are the times when students go to school or come back home. Speed limits in these school zones are 30 kph, but the speed is only limited during the above four time frames.

In this study, vehicles with free-flow speed were selected for analysis while crossing the analyzed cross sections. A certain number of samples are randomly selected at each time frame. However, because the number of data is limited, this analysis does not separate each time frame, but aggregates into a dataset for each cross section. Moreover, in this analysis due to the low traffic volume of cars (passenger cars, buses, trucks, etc.), statistical results of vehicle speed are aggregated into two categories: motorbikes and cars, regardless of car types. The number of samples is attempted to be as large as possible to warrant the presentation of statistical distributions.

2.2 Data Analysis, Results, and Discussion

The analysis results are shown from Figs. 2, 3, 4, 5, 6 and 7; Tables 2 and 3. Figures 2 and 3 show the histogram and the cumulative frequency distribution of vehicle speeds at cross sections 1 and 2 of the Nguyen Van Troi site (NVT). Figures 4 and 5 show the histogram and the cumulative frequency distribution of vehicle speeds at cross sections 1 and 2 of Nguyen Duc Canh site (NDC). Figures 6 and 7 show the histogram and the cumulative frequency distribution of vehicle speeds at cross sections 1 and 2 of Cu Chinh Lan site (CCL). Tables 2 and 3 show statistical values of vehicle speed at cross sections 1 and 2 at all observed sites corresponding with Figs. 2, 3, 4, 5, 6 and 7.

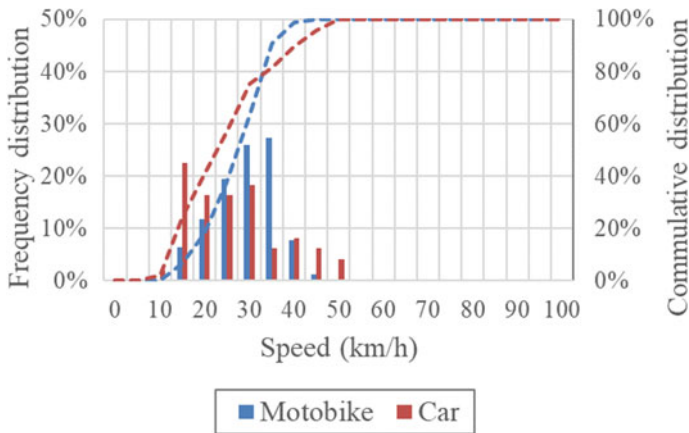


Fig. 2 Histogram and cumulative frequency distribution of vehicle speed at cross section 1—site NVT

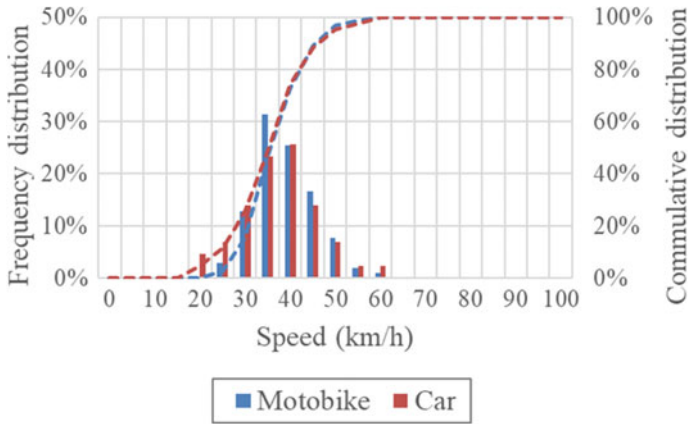


Fig. 3 Histogram and cumulative frequency distribution of vehicle speed at cross section 2—site NVT

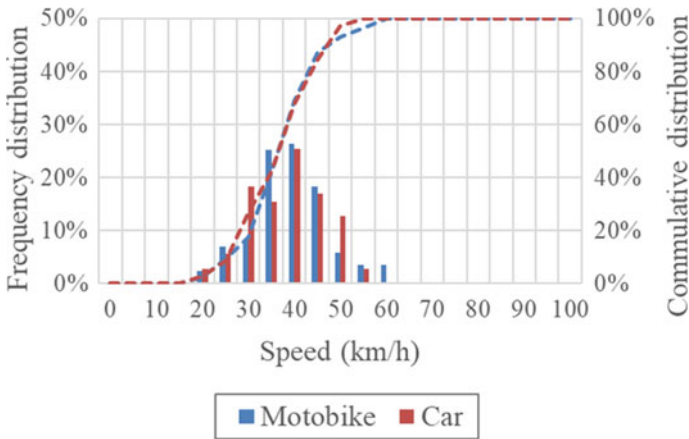


Fig. 4 Histogram and cumulative frequency distribution of vehicle speed at cross section 1—site NDC

The results show that at all three road segments, vehicle speed decreases when passing through the school gate (from cross section 2 to cross section 1). The results also indicate that vehicles have greater speeds and higher variation when the width of the road segment is wider and the speed of vehicles in the street with low roadside activities is higher than in roads with higher roadside activities. Moreover, there are differences between the speed of cars and motorbikes, but not clear at all sites. At cross section 2, the highest 85% speed is found at the NDC site with low roadside activities (51.62 kph for cars and 45.80 kph for motorbikes), and the lowest 85% speed is at the CCL site with high roadside activities (33.59 kph for cars and 36.07 kph for motorbikes). This similarity can be seen at cross section 1. Although

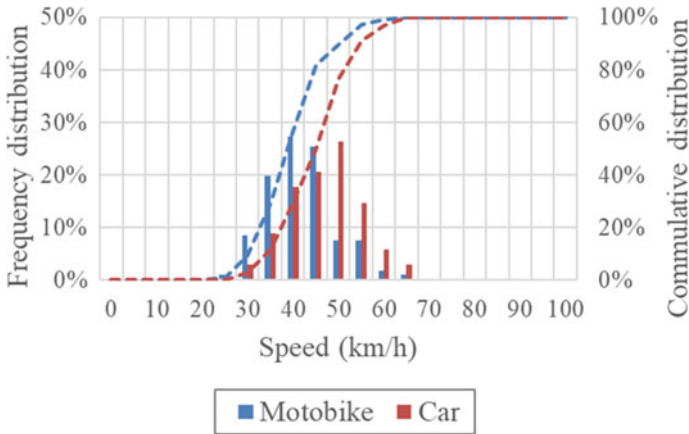


Fig. 5 Histogram and cumulative frequency distribution of vehicle speed at cross section 2—site NDC

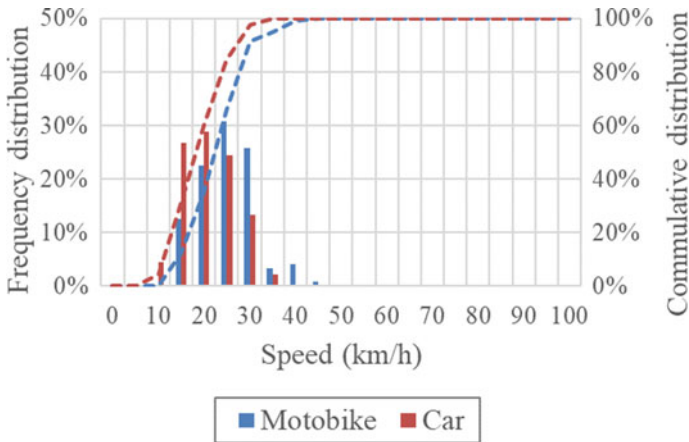


Fig. 6 Histogram and cumulative frequency distribution of vehicle speed at cross section 1—site CCL

vehicles tend to slow down when going through the school gate, it is still higher than the 30 kph speed limit. Especially with the NDC site, the vehicles were still running at 85% speed higher than 40 kph, especially, there were some vehicles running with speed higher than 50 kph at the cross section 1.

Although there are speed limit zones in existence on these streets, however, the effectiveness is not so high. Some of the reasons that vehicles still maintain high speeds can be mentioned as follows:

- Generally, the behavior of road users is not so good. The reality of participating in traffic on the road shows that many road users do not fully comply with traffic

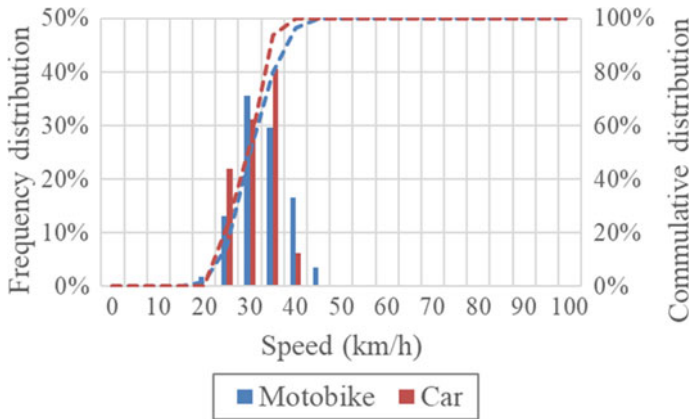


Fig. 7 Histogram and cumulative frequency distribution of vehicle speed at cross section 2—site CCL

Table 2 Statistic values of vehicle speed at cross section 1

Statistic index	Unit	Cross section 1					
		Motorbike			Car		
		NVT	NDC	CCL	NVT	NDC	CCL
Maximum	kph	43.57	59.84	40.94	48.83	51.64	32.32
85%	kph	33.35	43.34	28.37	36.44	44.64	24.89
Average	kph	26.72	36.72	22.60	24.40	36.22	18.76
15%	kph	18.67	29.05	16.47	13.61	27.53	13.58
Minimum	kph	12.28	18.89	10.73	9.72	16.07	7.44
Stdev		6.86	8.33	6.14	10.22	8.06	5.67
No of sample		77	87	120	49	71	45

Table 3 Statistic values of vehicle speed at cross section 2

Statistic Index	Unit	Cross section 2					
		Motorbike			Car		
		NVT	NDC	CCL	NVT	NDC	CCL
Maximum	kph	55.27	61.97	42.14	55.33	60.24	36.96
85%	kph	43.36	45.80	36.07	43.09	51.62	33.58
Average	kph	36.27	39.21	30.35	34.92	44.20	28.78
15%	kph	29.92	31.12	25.24	26.82	37.32	23.55
Minimum	kph	22.61	23.06	18.59	17.26	29.15	21.19
Stdev		6.60	7.41	5.15	8.47	7.38	4.44
No of sample		102	106	115	43	34	32

laws. The traffic police patrol can contribute to improve the efficiency of law enforcement; however, it is difficult to carry out in a large area. Local road users are familiar with road activities, and when they know the rules of traffic police activities, they may avoid the control of the authorities.

- Solutions for speed limit signs according to four time frames are complicated and also make it difficult for road users to recognize and comply.
- The social isolation period of the Covid epidemic has reduced traffic volume, and schools are not working. While the survey was carried out just right after the isolation time of the Covid pandemic, students just started going to school, so traffic users still have a subjective mentality, not complying with speed limit solutions.
- Other speed reduction countermeasures such as rumble strips, road making, and road signs have not been used effectively.

3 Conclusion

In general, the study is a part of a topic for traffic assessment at school zones. In this paper, it is focused on the analysis of the speed of free-flow vehicles running on three streets through school zones in Pleiku, Vietnam. The observed streets have different levels of roadside activities. An image processing tool is used for getting speed data. It is found that there is a reduction of speed of vehicles running through the school gate. Vehicle speed is higher at wider streets and lower levels of roadside activities. The difference in speed between cars and motorbikes is not really clear. However, the speed limit zones of 30 kph are not so effective in reducing speed. Many vehicles still run with speeds of over 50 kph, even over 60 kph.

For further study, it is necessary to focus on analyzing the conflicts between road users, especially school children and motor vehicles in the vicinity of schools, from which more specific solutions can be found to improve traffic safety for pedestrians.

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