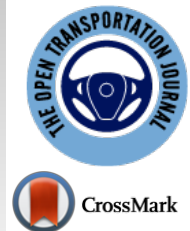# The Open Transportation Journal

RESEARCH ARTICLE

The Effects of Picking Up Primary School Pupils on Surrounding Street's Traffic: A Case Study in Hanoi

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Abstract:

Introduction:

One of the significant characteristics of schools in Vietnam is that almost all parents send their children to school and/or pick up their children from school using private vehicles (motorcycles). The parents usually stop and park their vehicle on streets outside the school gates, which can lead to serious congestion and increases the likelihood of traffic accidents.

Methods:

The objective of this study is to find out factors affecting the picking up of pupils at primary school by evaluating the typical primary schools in Hanoi city. A binary logistic regression model was used to determine factors that influence the decision of picking up pupils and the waiting duration of parents. The behavior of motorcyclists during the process of picking up pupils at the primary school gate has been identified and analyzed in detail by the Kinovea software.

Results and Discussion:

The study showed that, on the way back home, almost all parents use motorbikes (89.15%) to pick up their children. During their waiting time (8.48 minutes in average), they made a lot of illegal parking actions on the street there by, causing a lot of "cognitive" errors and "crash" points surrounding in front of the primary school entrance gate. Risky picking-up behaviors were significantly observed, *i.e.* picking-up on opposite side of the school, making a U-turn, backing-up dangerously, parking on the middle of street, and parking on the street next to sidewalk).

Conclusion:

Based on the analyzed results, several traffic management measures have been suggested to enhance traffic safety and reduce traffic congestion in front of school gates. In addition, the results of the study will provide a useful reference for policymakers and authorities.

Keywords: Traffic safety, Traffic congestion, Picking up behaviour, Motorcycles, Primary school, Hanoi.

1. INTRODUCTION

The number of primary schools in Hanoi city is currently 739, accounting for about 5% in the whole of Vietnam. Statistically, each primary school has about 500 to 700 students within the age range from 6 to 11. Some specific schools have more than 1,000 pupils that are mostly located in big cities [1]. One of the significant characteristics of schools in Vietnam is that almost all parents send their children to school and/or pick

up their children at school using private vehicles (bicycle, motorcycle, and car). The parents usually stop and park their vehicle on streets outside the school gates, which can lead to serious congestion and increases the likelihood of traffic accidents, especially during the daily rush period from 16:30 pm to 17:30 pm as shown in Fig. (**1**). Statistical data in 2018 shows that the percentage of fatal accidents is quite high for primary pupils in Hanoi, accounting for 7.38 cases per 100,000 pupils. This rate is the highest in the country and higher by 1.25, 2.73 and 1.84 times in comparison with Cambodia, Japan and Korea, respectively [2].

Previous studies have presented recommendations on

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school traffic management in Vietnam, such as introducing non-motorized lanes along with preventing the encroachment of sidewalks due to business activities, planning school zones in line with land-use planning, and promoting public bus routes for students in order to reduce traffic accidents and congestion [3 - 6]. However, there is limited research to figure out factors related to the consequence of traffic accidents and congestion surrounding school gate areas. Therefore, the objective of this study is to find out factors affecting the picking up of pupils at primary school, thereby suggesting appropriate solutions to reduce traffic congestion as well as to enhance traffic safety surrounding the school zone. Typical primary schools in Hanoi city are selected in a case study.

Fig. (1). Parents stop and park outside primary school gates.

2. LITERATURE REVIEW

The concentration of traffic surrounding school areas causing traffic congestion has been widely concerned and studied. Petrocelli [7] defined that "school-related traffic congestion" is overcrowding and blocking of streets on or near a school zone. The congestion is typically associated with car transportation of children to and from school during the drop-off / pick-up process. Vigne [8] showed that school traffic congestion causes a threat to the safety of pupils, teachers, parents, residents, and motorists in and around school sites. The parent of pupils attending Barron elementary school informed that many motorists frequently violated traffic and parking laws because they were late for work, their children were late for school, and they became frustrated with the lengthy wait in traffic [9].

A number of studies provide an approach based on the application of traffic demand management solution in order to reduce the concentration of vehicles at peak hours by changing time, organizing stop and parking areas to disperse traffic concentration [10, 11]. Their fundamentals are to use "push" schemes for making private vehicles more unattractive and introduce simultaneously "pull" measures for encouraging participants to use public transport. Intelligent transportation services are also proposed in managing traffic needs for the process of picking up children. Safe Routes to School Guide [12] shows some parents were reluctant to allow their children to walk or to ride bicycle to school due to the traffic congestion and perceived traffic danger during a student's arrival and dismissal. The reasons why parents dropped off / picked up their children have been analyzed in several studies [13, 14]. A number of proposals have been presented for ensuring traffic congestion at school gate areas and ensuring safety for pupils to go to school by organizing unique walking routes for pupils around the school area [15, 16].

In addition, there are some studies on evaluating the mode of choice and the behavior of motorbike users in Vietnam and other Asian countries. Nevelsteen *et al.* [17] showed that traffic infrastructure has a significant impact on the decision making of parents concerning picking up pupils, affecting both the real and the perceived traffic safety. Quy *et al.* [18] identified characteristics of pupils on the choice of walking such as age, gender, income and travel time. Their study showed that pupils who use motorcycles to schools were willing to switch to public transport if an efficient and reliable public transport system would be available. Meanwhile, illegal parking on streets and waiting duration of vehicles to pick up pupils was directly related to the safety of parents as well as pupils. Quyen and Nurhidayati [19] reviewed the relationship between motorcycles and traffic safety of motorcycle lane designed for safe mobility through experimental practices in Taiwan and Malaysia. Jittrapirom *et al.* [20] presented the comparison between cars and motorcycles. They proved that motorcycles need less space, consume fewer resources and pollute less than cars with typically low occupancy. Thus, the promotion of motorcycles potentially can improve the sustainability of urban transport systems within the Asian context. Frencha and Gumusb [21] showed in their findings that motorcyclists were at an elevated risk of being a victim of distracted driving. Rothman *et al.* [22] discussed built environment features associated with risky student drop-off and pedestrian behaviors.

Furthermore, Konkora *et al.* [23] carried out research on risk-taking behaviors and timing to first motorbike collision of motorcyclists. Grimm and Treibich [24] analyzed the behavior of motorcyclists using helmets in comparison with other motorcyclists without helmets for a case study in Delhi. Yoshida and Koyanagi [25] conducted a statistical comparative analysis of driving attitude and behavior of motorcycle users before and after the workshop at the high school and college students. Stephens *et al.* [26] indicated that violations of speed and errors related to the control of motorcycles increased the odds of near-crash involvement, whilst stunt behaviors were associated with increased odds of crash involvement. Chang *et al.* [27] demonstrated that the illegal behavior of striking motor-vehicle drivers was one of the most dominant factors contributory to a motorcycle killed or severely injured (KSI) crashes. Their study also shows that collision objects (*i.e.*, collision with heavy or light vehicles) and helmet use of motorcyclists as determinants influenced motorcycle rider injury severities. Lee and Outlaw [28] showed that favorable opinions regarding helmet safety result in a 10–20 percentage point increase in helmet use depending on the beliefs regarding death and injury risks or vision obstruction. Meyer *et al.* [29] demonstrated that children under 13 years of age have significantly longer hazard perception latencies and lower response rates to some traffic hazards compared to teenagers or adults.

International experience demonstrates that traffic management and transport planning specifying the school zones and its surrounding areas are very important to ensure the convenient traffic flow and traffic safety for children. These issues have not yet been discussed in Vietnamese standards for planning and designing of schools, only general remarks on the land area for school construction, drainage system, and other

infrastructure issues are presented, for example, TCVN 3907:2011 [30], TCVN 8793:2011 [31], TCVN 8794:2011 [32]. There are no specific, clear specifications for organizing and managing traffic surrounding school areas as well as considering the traffic impact assessment of schools on regional transport networks.

Practically, there are few studies in Vietnam that addressed the issue related to school traffic, including the application of intelligent transportation systems in managing and operating urban traffic, concerning the traffic safety for students in Hanoi [1 - 6]. Vu and Nguyen [33] have identified trends, patterns, and causes of road traffic accidents involving children, based on the analysis of road traffic accident data over the period 2010-2015 and video-based observations. The United Nations has discussed traffic safety education at all levels of school in Vietnam [34]. Nguyen *et al.* [35] presented that the location of schools would be one of the biggest barriers to promote the use of public transport system. Thanh and Friedrich [36] examined the parking conditions, parking user's behavior and the consequence of illegal parking spaces in the core city centre in Hanoi. Hiep [4] analyzed and evaluated the feasibility and reliability of applying a Parking Demand Management (PDM) solution to reduce the concentration of parking demands by limitation of unnecessary trips using private vehicles and increase in the shift to public transport in central areas, including distribution of parking demand reasonably to adjacent areas as well.

However, the previous studies only discussed general issues on urban transport issues rather than figuring out potential factors that cause traffic congestion and accidents surrounding the school gate areas in Vietnam. There is a lack of studies on transporting children to and from school and its impact on traffic congestion and safety surrounding schools, especially at the primary level in Hanoi city where motorbikes are dominated. Therefore, the present study will address these remaining issues for school-related traffic situations in Hanoi city. The result of this research will provide a useful reference for policymakers and authorities.

3. METHODS

The study is to evaluate factors that influence the tendency of picking up pupils and the waiting duration of parents surrounding the entrance gates of primary schools. A binary logistic regression model is employed for this statistical evaluation. The observation analysis using Kinovea software is utilized for identifying the driving behaviors of parents before and after picking-up their children. The results of such analyses will support to find out solutions for traffic organization and management surrounding school entrance areas. The following sections are illustrated for the survey and analysis procedure of the study.

3.1. Selected Locations

The study concentrates on peoples picking up pupils in the area of three selected school gates in Hanoi as shown in Fig. (**2**) (*i.e.* Le Ngoc Han, Chu Van An, and Nghia Do primary schools). The selection of schools should reflect the typical geographic location arrangement in Hanoi. Le Ngoc Han primary school is located in the old town and Chu Van An primary school is located at the area where the traffic is very high. Nghia Do primary school is located in the new urban area. The three schools were considered in the survey for the comparison of different geographic locations.

3.2. Questionnaire Survey

The behavior data of the picking up process was collected from a paper-based questionnaire survey in March 2019. The questionnaires were distributed to teachers; then the teachers provided them to parents through pupils. The completed questionnaires were collected and returned to surveyors by teachers. There are 289 responders, including parents and teachers whose children are studying at the same school. Three characteristic groups (*i.e.* socioeconomic, residential location, and travel) are employed in the analysis. The age is divided into two categories (*i.e.* 18-55 and more than 55 years old) and there are no responders less than 18 years old. The occupation

Fig. (2). Location map of three primary schools.

is divided into two groups (*i.e.* office employees and others). Office employees usually come to their company at 8:00 am and go home at 17:00 pm. The grade of children includes grade-one and others. The grade-one group (6 years old) is mostly sent to and collected from school by their parents.

3.3. Analysis Models

Based on the literature review, relevant variables affecting the tendency of picking up process do not only depend on socioeconomic characteristics, but also on residential location and travel characteristics. The variables considered in the study are as follows: age, gender, income, occupation, distance from home to school, time from school to home, waiting duration of "shuttle motorcycle", number of pupils in a household, and number of pupils in a household studying in the same school. "Shuttle motorcycle" is defined as the parent who uses a motorcycle to send their children to school and / or to pick up their children from the school. Parent is defined in general as a person who sends children to school and / or picks up children from the school.

In the analysis, a Binary Logistic Regression (BLR) model is used to determine factors that influence the decision of picking up pupils and the waiting duration of parents. The BLR models are expressed in equations (1) and (2) as below.

$$ln\left(\frac{p_1}{1-p_1}\right) = X\alpha + Y\beta + Z\delta + \varepsilon \qquad \textbf{(1)}$$

$$ln\left(\frac{p_2}{1-p_2}\right) = X\alpha + Y\beta + Z\delta + \varepsilon \qquad \textbf{(2)}$$

Where, p_1 is the probability of parents picking up their children regularly; p_2 is the probability of waiting duration of parents. X is a vector of socioeconomic characteristics; Y is a vector of residential location characteristics; Z is a vector of travel characteristics; α, β, δ, and ε are the vectors of the model parameters. All models are analyzed by R programing language.

3.4. Video Observation Analysis

Video observation surveys were implemented at rush hours (4:30 pm - 5:30 pm) and off-peak hours (3:00 pm – 4:00 pm) on a working day at the gate of Le Ngoc Han primary school. The camera was installed at a suitable location by surveyors. After obtaining satisfactory video, data information was rechecked and collected as in the following steps: firstly, traffic volume was counted for different types of transport modes; secondly, the behavior of motorists and the location of shuttle motorcycle was identified by Kinovea software; thirdly, the "approaching time", "leaving time" and "actual waiting time" of shuttle motorcycles were recorded by the observation. "Approaching time" is defined as the time when a shuttle motorcycle gradually reduces speed and approaches a parking location on a street and / or sidewalk, while "leaving time" is defined as the time that a shuttle motorcycle gets out of the parking location and returns to the traffic lane for going to its next destination.

The driving behaviors of shuttle motorcycles before and after picking-up are divided into different categories based on the observation of travelling characteristic in Hanoi due to the unique situation of motorcycles. Nine different types (*i.e.* the number from 1 to 9) of approaching and parking motorcycles on the street are considered before picking-up as shown in Fig. (**3**), while eight different ways (*i.e.* the number from 10 to 17) of leaving from parking positions are defined after picking-up as illustrated in Fig. (**4**). Each driving behavior has different characteristics and different numbers of "cognitive error" and "crash point". "Cognitive error" is defined as the error when the driver has a misunderstanding regarding the action of shuttle motorcycles. "Coefficient of cognitive error" is recorded as "1" if there is any misunderstanding of shuttle motorcycles otherwise, it is zero. Regarding "crash point", it is defined as an action when a shuttle motorcycle and another commuter move reversely and they meet each other. "Coefficient of crash point" is identified as the number of crashes occurring according to each driving behavior.
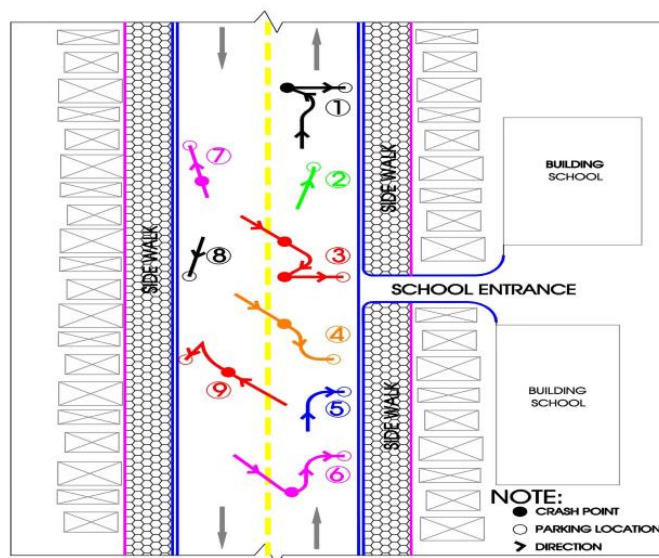

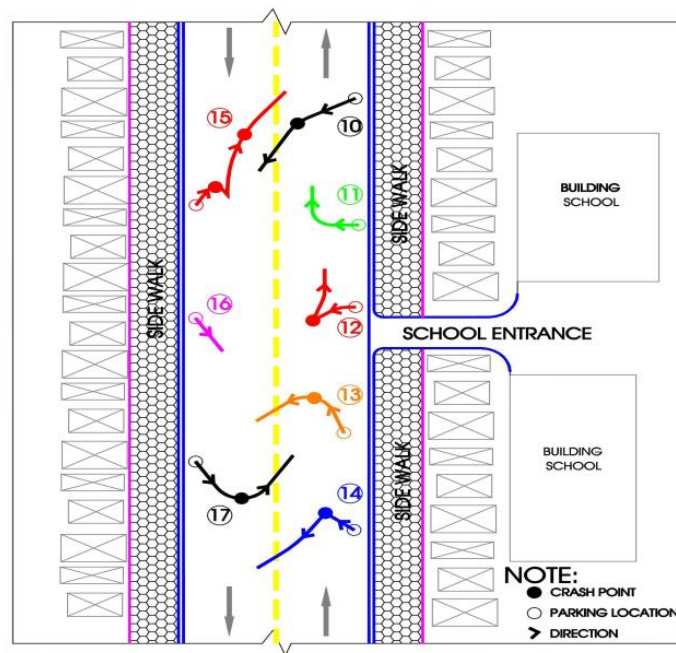**Fig. (3).** Typical cases of shuttle motorcycles before picking-up.

Fig. (4). Typical cases of shuttle motorcycles after picking-up.

In addition, other risky pick-up behaviors are also considered in the observation, such as picking-up on the opposite side of the school, making a U-turn, backing up dangerously, parking on the middle of street, and parking on the street next to the sidewalk.

4. SURVEY DATA ANALYSIS

There are 289 respondents who are listed in Table **1**. The respondents are mainly parents and teachers. We define the "shuttle people" as those who usually take their children to school and take them home. We assume that all people who take care of children are "parents".

Table 1. Summary of respondents' characteristics of three primary schools.

Survey Characteristics	Value	Different travel modes			
		Walk	Motor-Cycle	Car	Others
Numbers of responders who completed the questionnaire	289	29	248	9	3
Teacher (%)	21.80	6.35	93.65	0.00	0.00
Parent (%)	78.20	11.06	83.63	3.98	1.33
Often sending children to school and taking them home	253	18	225	7	3
Yes (%)	87.54	7.11	88.93	2.77	1.19
No (%)	12.46	-	-	-	-
Age (years)					
< 18 (%)	-	-	-	-	-
18-55 (%)	80.62	7.73	87.55	3.43	1.29
> 55 (%)	19.38	19.64	78.57	1.79	0.00
Gender					
Male (%)	38.41	5.41	88.29	4.50	1.80
Female (%)	61.59	12.92	84.27	2.25	0.56
Occupation					
Office employee (%)	87.20	9.92	86.51	2.78	0.79
Others (%)	12.80	10.81	81.08	5.41	2.70
Income (million VND)					
< 3 (%)	1.73	20.00	60.00	20.00	0.00
3 - 5 (%)	4.15	41.67	41.67	16.67	0.00

(Table 1) contd.....

Survey Characteristics	Value	Different travel modes			
		Walk	Motor-Cycle	Car	Others
5 - 10 (%)	35.64	12.62	85.44	0.97	0.97
10 - 15 (%)	34.95	9.90	88.12	1.98	0.00
15 - 20 (%)	7.61	0.00	100.00	0.00	0.00
> 20 (%)	15.92	0.00	89.13	6.52	4.35
Numbers of children in a household					
One child (%)	30.80	17.98	79.78	2.25	0.00
More than one child (%)	69.20	6.50	88.50	3.50	1.50
Numbers of children in a household studying in the same school					
One child (%)	73.36	11.79	83.96	3.77	0.47
More than one children (%)	26.64	5.19	89.61	1.30	3.90
Average distance from school to home (km)	3.31	0.88	3.56	4.89	1.83
Average waiting duration of parents (minute)	8.47	7.62	8.53	6.67	16.67
Average total time to home (minute)	23.36	9.83	24.83	28.67	16.67

The number of shuttle people is very high and was up to 87.54% on average for the three schools. The age of shuttle people from 18 to 55 accounted for 80.62% as the majority in the survey. No one under the age of 18 regularly goes to pick up pupils. There are 87.20% of parents who are office employees following the daily timetable from 8:00 am to 5:00 pm. The shuttle people group that has an income from 5 to 15 million VND accounts for the highest proportion (70.59%). The percentage of households with more than one child is 69.20%, while households that have children studying in the same primary school accounts for only 26.64%. The average distance from school to home is 3.31 km for all three schools. The parents have to wait for their children for about an average of 8.47 minutes. The average total time in which the parents bring their children home is 23.36 minutes.

Fig. (**5**) shows the proportion of picking up pupils that is high in all three schools with the average value of 87.54%. The percentage of picking up at Chu Van An primary school is highest (96.08%) and the survey data showed that there were more than 60% of pupils coming from other districts due to high-ranking of the school. The percentage of Nghia Do primary school is lowest with the value of 81.52%. The reason can be explained that its location is in a new urban area and out of the Central Business District (CBD) of Hanoi. Therefore, pupils can walk to the school by themselves due to non-busy streets. Regarding Le Ngoc Han primary school, it is located in an ancient quarter of Hanoi, thus pupils can walk to the school by themselves due to a short distance.
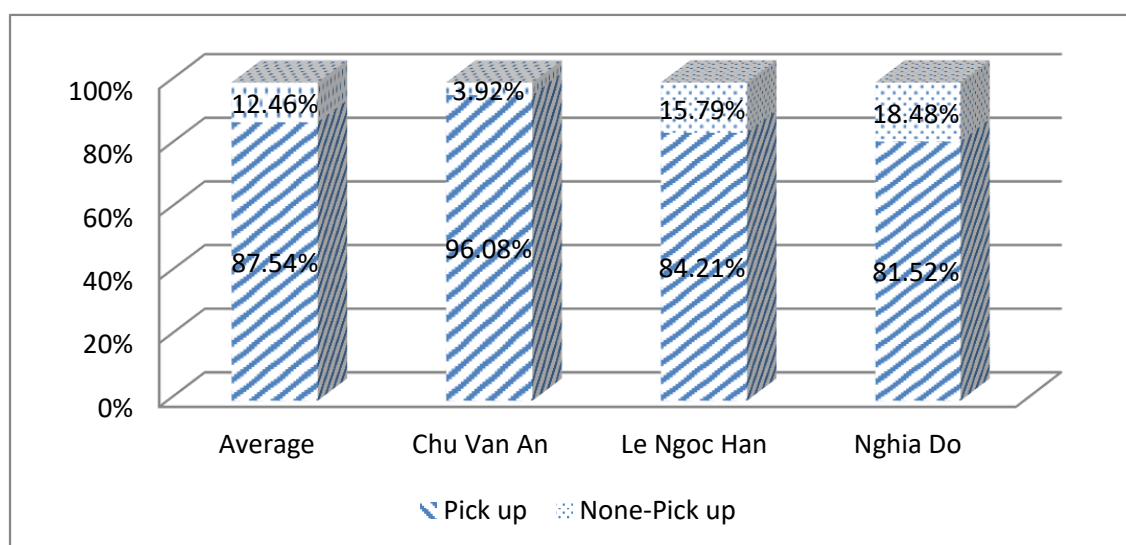

Fig. (5). The proportion of picking up pupils at three schools.

The proportion of picking up children using different types of vehicles for three schools as shown in Fig. (**6**). Almost all people use motorcycles for collecting their children and the average proportion is 89.15%. Some others walk to pick up their children while very few people use cars or e-bicycles.

5. SURVEY ESTIMATION RESULTS

Binary Logistic Regression (BLR) models are used to determine factors that influence the decision of picking up pupils and the waiting duration of parents.

5.1. The BLR Model of Picking Up Pupils

The estimation results of the BLR model for picking up pupils are presented in Table **2**. The coefficients for the explanatory variables include age, income, grade-1, the waiting duration of parents (0-10 minutes) and the purpose of the next trip (to home) are statistically significant ($p < 0.05$). Nevertheless, other factors are not significant ($p > 0.05$), such as gender, office employee, the number of children in a household, the number of children in a household studying in the same school, residential location characteristics, and total time required for travelling home. The less significant factors are ($p < 0.01$), the more statistical relationships are obtained.

For the significant factors, the positive sign of the coefficient (except for income factor) indicates that if other factors are equal, a larger number of shuttle people are in the age range of 18-55 years, with children in grade 1, waiting within 10 minutes and going home directly; the higher proportion of people pick up their children regularly. The reasons for obtaining these results are as follows: (1) Parents with the age from 18 to 55 years are at work and they usually pick up their children on the way from office to home; (2) Parents of children in grade 1 worry about letting them go to school alone; (3) Parents who wait over 10 minutes will feel annoyed; (4) Parents working in the office have a tendency to pick up their children on the way, then go home straightaway instead of doing other things. The absolute value of coefficient of age is the highest (2.43), while the absolute coefficient of income is the lowest (0.67). It shows that the factor of age has the greatest impact and the factor of income has the lowest influence on the picking up of pupils.
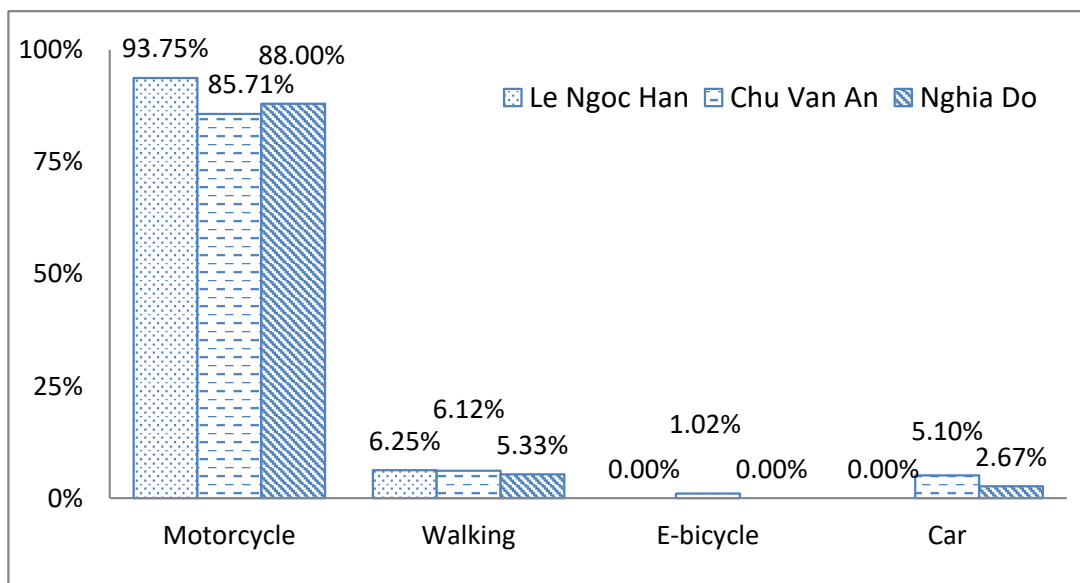

Fig. (6). The proportion of using vehicle types for picking up pupils.

Table 2. The results of the BLR model for picking up children.

Explanatory Variables	Coefficient	S.E.	Wald	p
Socioeconomic characteristics				
Gender (male=1)	0.1133	0.4835	0.23	0.8147
Age (18-55 years old =1)	2.4347	0.4768	5.11	**<0.0001****
Office employee (employee=1)	0.3071	0.6955	0.44	0.6588
Income	-0.6748	0.2032	-3.32	**0.0009****
Numbers of children in a household (one=1)	-0.5788	0.4990	-1.16	0.2461
Numbers of children in a household studying in the same school (one=1)	-0.8395	0.6368	-1.32	0.1874
Grade of children (grade-1=1)	2.0581	0.8415	2.45	**0.0145***

(Table 2) contd.....

Explanatory Variables	Coefficient	S.E.	Wald	p
Residential location characteristics				
Distance from home to school	0.0717	0.0968	0.74	0.4588
Residential location in R500 ("distance 0-500 m" =1)	0.0744	1.0227	0.07	0.9420
Travel characteristics				
Waiting duration of the parent ("0-10 minutes"=1)	1.1345	0.5555	2.04	**0.0411***
Total time to home ("0-10 minutes"=1)	-0.7208	0.7423	-0.97	0.3315
Next trip purpose (to home = 1)	1.4620	0.6620	2.21	**0.0272***
Constants	1.3597	1.4859	0.92	0.3602
Numbers of observation	289			
LR chi-square	78.31			
d.f.	12			
Pr (>chi-square)	<0.0001			
Discrimination index				
R-square	0.449			
Brier	0.071			
Rank discrimination index				
C	0.889			
Dxy	0.778			

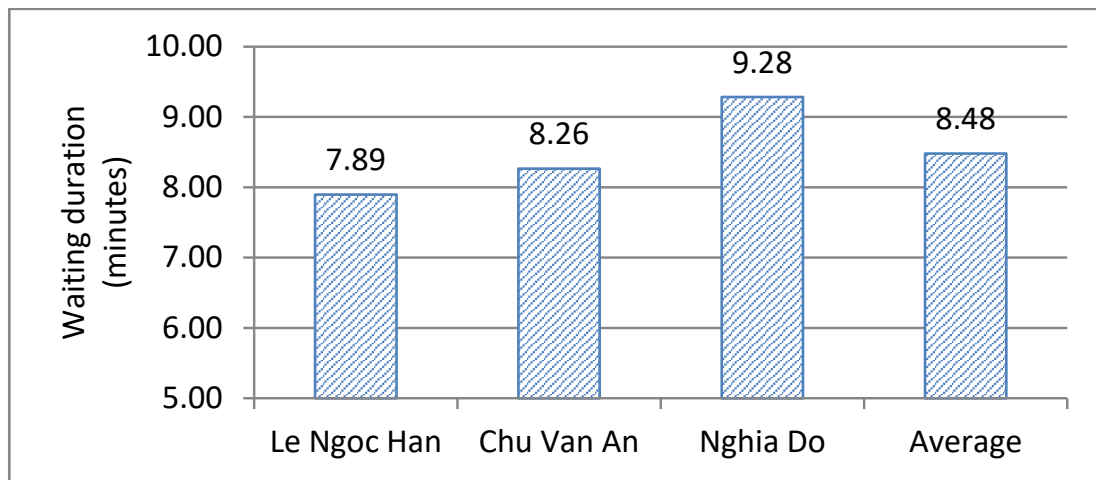** Significant at p<1% * Significant at p<5%

Fig. (7). The duration of waiting for picking up pupils at three schools.

On the contrary, the negative sign of the coefficient of income suggests that people who have lower salaries will more likely pick up their children than people with higher income. The parents who have higher salaries can afford to hire other people to pick up children or let their children go home by reserved taxi. Notably, none of the variables of the residential location characteristics are statistically significant in the model. Finally, the estimation results of the BLR model for picking up pupils prove that the travel characteristics of shuttle people influence the probability of collecting pupils.

Table **3** indicates the odds ratio and the confidence interval 95% of factors affecting the possibility of picking up pupils.

These numbers show that if we repeat the study 100 times, the odds ratio still is in a suitable confidence interval and the considered factors always affect collecting pupils.

5.2. The BLR Model of Waiting Duration

The waiting durations of parents surveyed at three schools are shown in Fig. (7). The parents at Nghia Do primary school spent their longest waiting time of 9.28 minutes, while the average duration of three schools is 8.48 minutes. It can likely be explained that Nghia Do primary school is located outside the center of Hanoi and the parents, therefore, have a tendency to leave the office earlier to avoid the rush hour to pick-up their children.

Table 3. Odds ratio and confidence interval 95%.

Odds ratio	Coefficient	Lower 0.95	Upper 0.95
Age (18-55 years old=1)	11.412	4.4823	29.055
Income	0.5092	0.34197	0.75838
Grade of children (grade 1=1)	7.8311	1.5051	40.746
Waiting duration of parent ("0-10 minutes"=1)	3.1097	1.0468	9.2377
Purpose of next trip (to home = 1)	4.3147	1.1788	15.794

Table 4. The results of the BLR model for waiting duration.

Variables	Coefficient	S.E.	Wald	p
Socioeconomic characteristics				
Gender (male=1)	0.3904	0.3497	1.12	0.2642
Age (18-55 years old =1)	0.2763	0.397	0.7	0.4864
Office employee (employee=1)	-0.5188	0.5811	-0.89	0.3719
Income	-0.5877	0.1548	-3.8	**0.0001****
Numbers of children in a household (one=1)	0.3255	0.408	0.8	0.425
Numbers of children in a household studying in the same school (one=1)	1.0197	0.3631	2.81	**0.005****
Grade of children (grade 1=1)	-0.0551	0.3893	-0.14	0.8874
Residential location characteristics				
Distance from home to school	-0.0957	0.0613	-1.56	0.1188
Residential location in R500 ("distance 0-500 m" =1)	-2.2799	1.2672	-1.8	0.072
Travel characteristics				
Total time to home ("0-10 minutes"=1)	1.2823	1.08	1.19	0.2351
Next trip purpose (to home = 1)	0.1076	0.4665	0.23	0.8176
Constants	3.4408	1.1533	2.98	0.0028
Numbers of observation	289			
LR chi-square	41.56			
d.f.	11			
Pr(>chi-square)	<0.0001			
Discrimination indexes				
R-square	0.214			
Brier	0.13			
Rank Discrimination Indexes				
C	0.743			
Dxy	0.487			

** Significant at p<1% * Significant at p<5%

Table **4** presents the estimation results of BLR models of waiting duration for picking up pupils. The coefficients for the explanatory variables (income, the number of children in a household studying in the same school) are statistically significant (p<0.05). The less significant factors are (p<0.01), the more statistical relationships are obtained. However, other factors are not significant (p>0.05), such as gender, age, office employee, the number of children in a household, residential location characteristics and travel characteristics. For the significant factors, the negative sign of the coefficient of income indicates that if other factors are equal, those who have a higher income will have less time for picking up their children.

In contrast, the positive sign of the coefficient (for the case of the number of children in a household studying in the same school) shows that the parent who has more children studying in the same school has to wait longer. The reasons are as follows: (1) The people who have high salary are often busy with work, they finding the fastest way to save time for picking up; (2) Parents who have more children studying in the same school will have to wait longer. The absolute value of coefficient of numbers of children studying in the same school is highest (1.02), which means that numbers of children studying in the same school have more impact on the waiting duration.

Table **5** shows the odds ratio and the confidence interval 95% of factors affecting waiting time for collecting children. These numbers show that if we repeat the study 100 times, the odds ratio is still in a suitable confidence interval and the considered factors always affect collecting children.

Table 5. Odds ratio and conference interval 95%.

Odds Ratio	Coefficient	Lower 0.95	Upper 0.95
Income	0.55562	0.41022	0.75256
Numbers of children in a household studying in the same school (one=1)	2.7724	1.3608	5.6483

Table 6. Through traffic volumes on the street in front of Le Ngoc Han primary school.

Type of Vehicle	Left Lane (vehicle/hour)	Right Lane (vehicle/hour)	Total (vehicle/hour)
Peak hour			
Car	146	244	390
Bus	0	16	16
Truck / Van	2	5	7
Motorbike	2,036	2,022	4,058
Off-peak hour			
Car	174	254	428
Bus	2	20	22
Truck / Van	2	6	8
Motorbike	1,016	1,618	2,634

6. RESULTS AND DISCUSSION

Le Ngoc Han primary school was selected in the case study which is located at the Central Business District (CBD) of Hanoi city. The number of vehicles is counted. The behavior of motorists and the location of shuttle motorcycles were identified by Kinovea software as summarized in Table **6**. It is quite interesting to show that the number of car, bus, truck /van vehicles is not different between off-peak and peak hours. The result can be explained that the drivers have significantly avoided travelling during peak hours and few people used their car for going to the office in the CBD. The right lane is defined as the lane next to the school.

Fig. (**8**) shows the image of traffic situation in the peak hours. While motorcycle traffic was significantly different between off-peak and peak hours, it was also different between the left and right lanes. The right lane is next to the school. The motorcycle traffic volume in the right lane was much higher than the one in the left lane. The unexpected conflicts between shuttle motorcycles, pupils and other through vehicles create a lot of "crash" points and "cognitive" errors.

Table **7** summarizes the number of observations and the characteristics of each type of driving behaviors before picking-up, which is illustrated in Fig. (**4**). There are 494 cases where parents parked their motorcycles illegally in front of the school gate and picked-up their children. The coefficients of "cognitive error" and "crash point" are determined according to each type of driving behaviors. The number of "cognitive

errors" and "crash points" are 104 and 206, respectively. The average "approaching time" is estimated as 7.96 second.

Similarly, Table **8** presents the number of observations and the characteristics of each type of driving behavior after picking-up, which is illustrated in Fig. (**4**). The number of observations is 494, the same as before picking-up. The coefficients of "cognitive error" and "crash point" are determined according to each type of driving behaviors. There are 62 "cognitive errors" and 295 "crash points". The average "leaving time" is estimated as 9.85 seconds.

Fig. (8). Image of traffic situation at the start period of peak hours.

Table 7. Driving behaviors of shuttle motorcyclists before picking-up.

Items	Type index of driving behaviors before picking-up									Total
	1	2	3	4	5	6	7	8	9	
Numbers of observations	77	153	24	64	108	12	2	51	3	494
Coefficient of cognitive error	1	0	1	0	0	0	0	0	1	-
Numbers of cognitive errors	77	0	24	0	0	0	0	0	3	104

(Table 7) contd.....

Items	Type index of driving behaviors before picking-up									Total
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Coefficient of crash point	1	0	2	1	0	1	1	0	1	-
Numbers of crash points	77	0	48	64	0	12	2	0	3	206
Approaching time (sec.)	957	824	485	579	699	131	22	204	31	3,932
Average approaching time (sec.)	12.43	5.39	20.21	9.05	6.47	10.92	11.00	4.00	10.33	-

Table 8. Driving behaviors of shuttle motorcyclists after picking-up.

Items	Type index of driving behavior after picking-up								Total
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	
Numbers of observations	147	162	25	71	33	4	41	11	494
Coefficient of cognitive error	0	0	1	0	1	1	0	0	
Numbers of cognitive errors	0	0	25	0	33	4	0	0	62
Coefficient of crash point	1	0	1	1	1	2	0	1	
Numbers of crash points	147	0	25	71	33	8	0	11	295
Leaving time (sec.)	1,759	875	365	722	768	96	170	109	4,864
Average leaving time (sec)	11.97	5.40	14.60	10.17	23.27	24	4.15	9.91	-

Regarding shuttle motorcyclists who illegally parked their vehicles on the street, Fig. (**9**) presents risky picking-up behaviors as follows: picking-up on opposite side of the school, making a U-turn, backing-up dangerously, parking on the middle of street, and parking on the street next to sidewalk. Significantly, the behavior of making U-turn is very high, as recorded at 37.35%. Therefore, enforcement along with traffic management measures are required to reduce the risk for both shuttle motorcyclists and through vehicle drivers.

Fig. (**10**) shows the number of shuttle motorcyclists waiting for their children during the observation of one rush hour period. The number tends to increase gradually from the beginning to the 8 (th) minute and maintains until the 45 (th) minute and the average number of shuttle motorcyclists during this period is about 46. It proves that Le Ngoc Han primary school has a proper division of closing time for different classes. The number is decreased after the 45 (th) minute. The highest number of shuttle motorcyclists waiting for their children is 53. Based on the analysis data obtained, traffic management solutions are accordingly suggested, such as making a layout of parking areas, organizing one-way street and/or limiting vehicles during the concentration of shuttle motorcyclists.
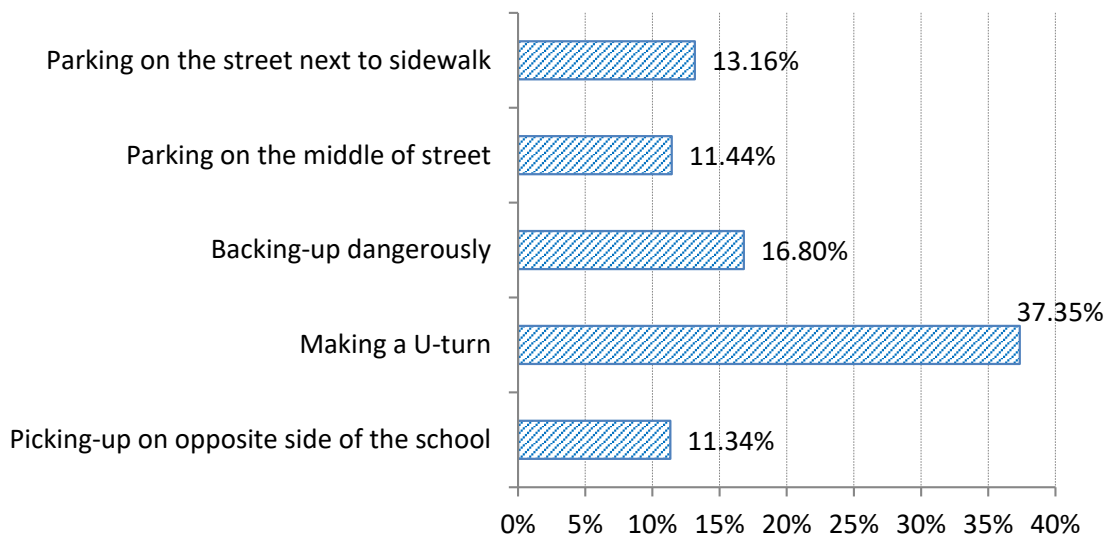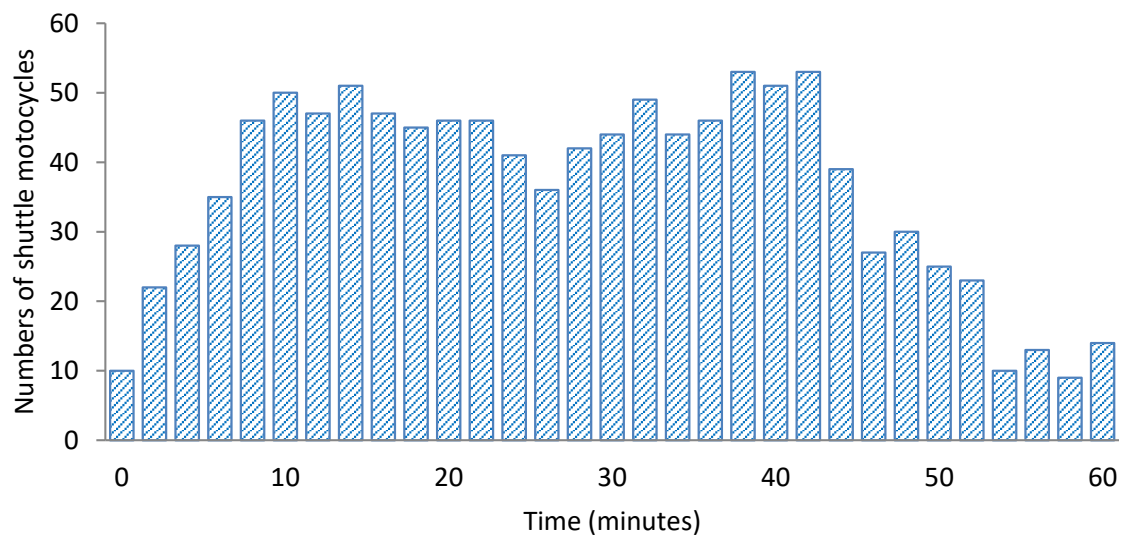

Fig. (9). Evaluation of risky picking-up behaviors.

Fig. (10). Relationship between the number of shuttle motorcyclists and their waiting time.

The observation also identified the actual waiting duration of shuttle motorcycles parked on the street that are 40.55 minutes and 2 seconds for maximum and minimum values, respectively. The average waiting duration is estimated at 4.65 minutes. This result is much less than the one obtained from the questionnaire survey (*i.e.* 8.47 minutes). The locations that motorcyclist parked are 1.8 meters far from the sidewalk on average. The maximum and minimum values are 3.5 meters and 0.5 meters, respectively. The far location is risky for both pupils, parents and other commuters. According to the observation results, appropriate measures can be suggested such as to apply smart devices to communicate between the school teachers and parents to reduce the waiting duration, and to arrange suitably parking areas to avoid illegal parking cases.

CONCLUSION

The study has utilized a binary logistic regression model to determine factors that influence the decision of picking up pupils and the waiting duration of parents. The analysis shows that the proportion of parents using private vehicles to bring their children to school and back home is very high in Hanoi, which is also prevalent in other urban areas of Vietnam. There are some influencing factors such as age, income, the grade of children (grade 1), the waiting duration (0-10 minutes) and the purpose of the next trip (to home). The study also indicates that the proportion using motorbikes to transport pupils is significantly dominant. Several parameters affect the parent's selection of motorbikes to pick up their children instead of walking, such as age, income, distance from school to home, and next trip to home. There is a relative coincidence between the closing time of schools and offices. Therefore, on the way back home, parents use motorbikes to pick up their children. During the waiting time of parents, they make a lot of illegal parking actions on the street. Consequently, it not only impacts directly on traffic safety at the school gate but also causes traffic jams in the surrounding school area.

In addition, the behavior of motorcyclists during the process of picking up pupils at the primary school gate has been identified and analyzed in detail by Kinovea software. The study shows that there are a lot of "cognitive" errors and "crash" points surrounding in front of the primary school entrance gate. The "approaching" and "leaving" time intervals are quite high, which cause a traffic danger to parents, pupils, and other people. Risky picking-up behaviors (*i.e.* picking-up on opposite side of the school, making a U-turn, backing-up dangerously, parking on the middle of street, and parking on the street next to sidewalk) are significantly observed while making a U-turn is highest. Therefore, enforcement along with traffic management measures should be taken to reduce risk for both parents, pupils and vehicle drivers.

Furthermore, the study has provided a view of the number of parent's motorcycles waiting for their children in front of primary school gates. In order to improve the traffic conditions around the school area, we need to mitigate the number of picking up pupils, reduce the use of private vehicles (motorcycle), decrease the waiting duration of parents and understand their habit of picking up. Traffic management measures are practically introduced, such as making a layout of parking areas, organizing one-way street and/or limiting vehicles during the concentration of shuttle motocyclists. Smart solutions can also be suggested, such as to apply information and communications technology (ICT) based devices to communicate between the school teachers and parents to reduce the waiting duration, and to arrange suitably parking areas to avoid illegal parking cases.

Nevertheless, the scope of the survey is still limited, and thus, the study needs to be addressed in more detail in order to acquire more suitable solutions to enhance traffic safety and reduce traffic congestion in front of school gates in Hanoi city. There are also factors which directly affect the behavior of parents to pick up their children, such as concern about pupils safety, traffic safety, social safety (kidnapping, harassment, *etc.*). These factors need to be examined in subsequent studies

to understand the psychological requirements of parents for their children.

CONSENT FOR PUBLICATION

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Not applicable.

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REFERENCES

[1]   D.V. Hiep, *Research report on solutions of traffic management to reduce traffic congestion surrounding school's gates during rush hours in the center of Hanoi.,* Ministry of Education and Training of Vietnam, B2018-XDA-16, 2020.

[2]   AIP, *Annual report of 2018.,* AIP Foundation, 2018.

[3]   D.V. Hiep, "Solutions for applying intelligent transportation systems to operation and management of urban transport in Vietnam", *J Sci Tech Civil Eng, Vietnam,* vol. 11, no. 5, pp. 66-74, 2017.

[4]   D.V. Hiep, "Research on application of parking demand management solution for urban centers in Vietnam", *J. Sci Technol Civil Eng, Vietnam,* vol. 11, no. 3, pp. 50-58, 2017.

[5]   D.V. Hiep, and E. Trel, "Public transport authority as an efficient solution for sustainable urban transport development: A case study in Hai Phong city", *J. East. Asia Soc. Transp. Stud.,* vol. 12, pp. 356-374, 2017.

[6]   D.V. Hiep, *Intelligent transportation system in urban areas.,* Construction Publisher House: Vietnam, 2017.

[7]   J. Petrocelli, *Traffic congestion around schools.,* Office of Community Oriented Policing Services: USA, 2008.

[8]   N.L. Vigne, *The problem of traffic congestion around schools.,* Center for Problem, University at Albany-State University of New York: USA, 2007.

[9]   Plano Police Department, *Easing traffic congestion around Barron Early Childhood School.,* Neighborhood Police Officer Unit: USA, 2004.

[10]   GTZ, *Mobility management, sustainable transport: A sourcebook for policy-makers in developing cities. German Technical Cooperation Agency.,* GTZ: Eschborn, Germany, 2004.

[11]   GTZ, *Transportation demand management, sustainable transport: A sourcebook for policy-makers in developing cities. German Technical Cooperation Agency.,* GTZ: Eschborn, Germany, 2009.

[12]   Pedestrian and Bicycle Information Center, Safe Routes to School Guide, *National Center for Safe Routes to School.,* The UNC Highway Safety Research Center, 2019.

[13]   D. Halden, *Review of research on school travel.,* Scottish Executive

Central Research Unit: Edinburgh, Scotland, 2002.

[14]   S. Granville, A. Laird, M. Barber, and F. Rait, *Why do parents drive their children to school?,* Scottish Executive Central Research Unit: Edinburgh, Scotland, 2002.

[15]   C. Black, A. Collins, and M. Snell, "Encouraging walking: The case of journey-to-school trips in compact urban areas", *Urban Stud.,* vol. 38, no. 7, pp. 1121-1141, 2001.
[http://dx.doi.org/10.1080/00420980124102]

[16]   R. Kennedy, and A. McMullen, *Safe routes to school: Programs across the nation.,* Alexandria Health: Alexandria, Egypt, 2003.

[17]   K. Nevelsteen, T. Steenberghen, A. Van Rompaey, and L. Uyttersprot, "Controlling factors of the parental safety perception on children's travel mode choice", *Accid. Anal. Prev.,* vol. 45, pp. 39-49, 2012.
[http://dx.doi.org/10.1016/j.aap.2011.11.007] [PMID: 22269483]

[18]   N.P.D. Quy, R.A. Gyimah, T.T.P. Anh, and C.T. Phan, "Mode choice among university students to school in Da Nang, Vietnam", *Travel Behav. Soc.,* vol. 13, pp. 1-10, 2018.
[http://dx.doi.org/10.1016/j.tbs.2018.05.003]

[19]   T.L. Quyen, and Z.A. Nurhidayati, "A study of motorcycle lane design in some Asian countries", *Procedia Eng.,* vol. 142, pp. 292-298, 2016.
[http://dx.doi.org/10.1016/j.proeng.2016.02.044]

[20]   P. Jittrapirom, "Knoflacher, H. Mailer, Markusb, Understanding decision makers' perceptions of Chiang Mai city's transport problems an application of causal loop diagram methodology", *Transp. Res. Procedia,* vol. 25, pp. 4438-4453, 2017.
[http://dx.doi.org/10.1016/j.trpro.2017.05.350]

[21]   M.T. French, and G. Gumus, "Watch for motorcycles! The effects of texting and handheld bans on motorcyclist fatalities", *Soc. Sci. Med.,* vol. 216, pp. 81-87, 2018.
[http://dx.doi.org/10.1016/j.socscimed.2018.09.032]   [PMID: 30273776]

[22]   L. Rothman, R. Buliung, A. Howard, C. Macarthur, and A. Macpherson, "The school environment and student car drop-off at elementary schools", *Travel Behav. Soc.,* vol. 9, pp. 50-57, 2017.
[http://dx.doi.org/10.1016/j.tbs.2017.03.001]

[23]   I. Konkora, M. Kansangaa, Y. Sanob, K. Atuoyea, and I. Luginaaha, "Risk-taking behaviors and timing to first motorbike collision in the upper west region of Ghana", *J. Transp. Health,* vol. 12, pp. 105-114, 2019.
[http://dx.doi.org/10.1016/j.jth.2019.01.001]

[24]   M. Grimm, and C. Treibich, "Why do some motorbike riders wear a helmet and others don't? Evidence from Delhi, India", *Transp. Res. Part A Policy Pract.,* vol. 88, pp. 318-336, 2016.
[http://dx.doi.org/10.1016/j.tra.2016.04.014]

[25]   N. Yoshida, and T. Koyanagi, "Empirical analysis of hazard perception and driving behaviors among high school and college students on motorcycles in PhnomPenh, Cambodia", *IATSS Res.,* vol. 42, pp. 171-179, 2018.
[http://dx.doi.org/10.1016/j.iatssr.2018.12.004]

[26]   A.N. Stephens, J. Brown, L. de Rome, M.R.J. Baldock, R. Fernandes, and M. Fitzharris, "The relationship between Motorcycle Rider Behaviour Questionnaire scores and crashes for riders in Australia", *Accid. Anal. Prev.,* vol. 102, pp. 202-212, 2017.
[http://dx.doi.org/10.1016/j.aap.2017.03.007] [PMID: 28324820]

[27]   F. Chang, P. Xu, H. Zhou, J. Lee, and H. Huang, "Identifying motorcycle high-risk traffic scenarios through interactive analysis of driver behavior and traffic characteristics", *Transp. Res., Part F Traffic Psychol. Behav.,* vol. 62, pp. 844-854, 2019.
[http://dx.doi.org/10.1016/j.trf.2019.03.010]

[28]   J.M. Lee, and N.L. Outlaw, "The antecedents of mandatory motorcycle helmet legislation enhancing behavior", *Transp. Res., Part F Traffic Psychol. Behav.,* vol. 59, pp. 330-347, 2018.
[http://dx.doi.org/10.1016/j.trf.2018.09.015]

[29]   S. Meyer, F. Sagberg, and R. Torquato, "Traffic hazard perception among children", *Transp. Res., Part F Traffic Psychol. Behav.,* vol. 26, pp. 190-198, 2014.
[http://dx.doi.org/10.1016/j.trf.2014.07.007]

[30]   *TCVN 3907:2011, Kindergarten – Design requirement. Vietnam National Standard,,* 2011.

[31]   *TCVN 8793:2011, Primary school – Design requirement. Vietnam National Standard,* 2011.

[32]   *TCVN 8794:2011, Secondary school – Design requirement. Vietnam National Standard,* 2011.

[33]   A.T. Vu, and D.V.M. Nguyen, "Analysis of child-related road traffic accidents in Vietnam", *IOP Conference Series: Earth and Environmental Science,* 2018
[http://dx.doi.org/10.1088/1755-1315/143/1/012074]

[34] United Nations, *Road safety performance review in Viet Nam.,* New York, Bangkok, 2018.

[35] H.T. Nguyen, M. Chikaraishi, and A. Fujiwara, "Influence of pick-up / drop-off trips for children at school and parents' commuting mode choice in Ho Chi Minh City: A stated preference approach", *J. East.*

Asia Soc. Transp. Stud., vol. 12, pp. 652-671, 2017.

[36] T.T.M. Thanh, and H. Friedrich, "Legalizing the illegal parking, a solution for parking scarcity in developing countries", *Transp. Res. Procedia,* vol. 25, pp. 4950-4965, 2017.
[http://dx.doi.org/10.1016/j.trpro.2017.05.374]