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IMAGE PROCESSING ANALYSIS OF MOTORCYCLE ORIENTED MIXED TRAFFIC FLOW IN VIETNAM

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Abstract: The increase to the number of registered motorcycles in Vietnam is partly blamed for the serious traffic congestion in its main cities. Motorcycles share to its two main cities, i.e. Hanoi and Hochiminh, is 90% of the total traffic while bus accounted for just 6%. There is a growing concern that unless policy measures are implemented, the traffic problem would deteriorate. This study assesses the traffic situation in Hochiminh city using image processing technique and traffic simulation. Result shows that the high number of motorcycles in the network interfere other vehicles which reduces their average speed drastically. Application of measures such as increasing the share of public transport would improve the traffic speed as much as 10%. These results highlight the necessity to produce efficient public transportation that could provide alternative to motorcycles.

Key Words: Image processing, Traffic microsimulation

1. INTRODUCTION

In recent years, traffic congestion and traffic accidents are increasing rapidly due to minimal road maintenance and incipient traffic policies among the Asian countries.
In addition to that, rapid economic growth in Vietnam causes the number of registered motorcycle to increase.

In Vietnam, the motorcycle ownership ratio reaches 1 vehicle per 4 persons, representing over 90% of the traffic composition, where buses represent less than 6%. Moreover, car ownership seems to increases along the economic growth of Vietnam. There is a growing concern that unless policy measures are implemented, the traffic problem would increase.

Figure 1 shows the motorcycle and car ownership in Asian countries. Figure 2 shows the average traffic composition in Asian countries.

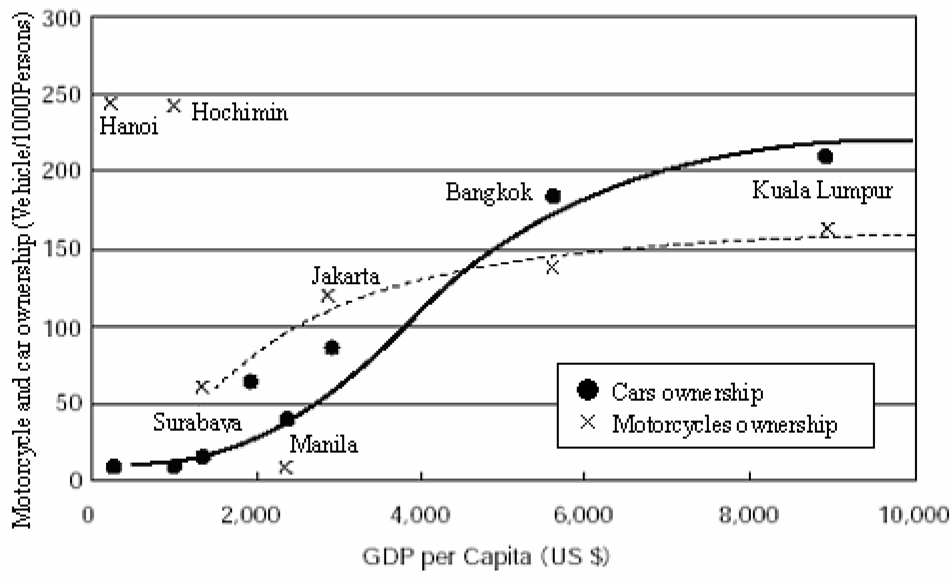

Figure 1 - Motorcycle and car ownership in Asian countries
(Mizuno,K. and Kino,N.,2000)

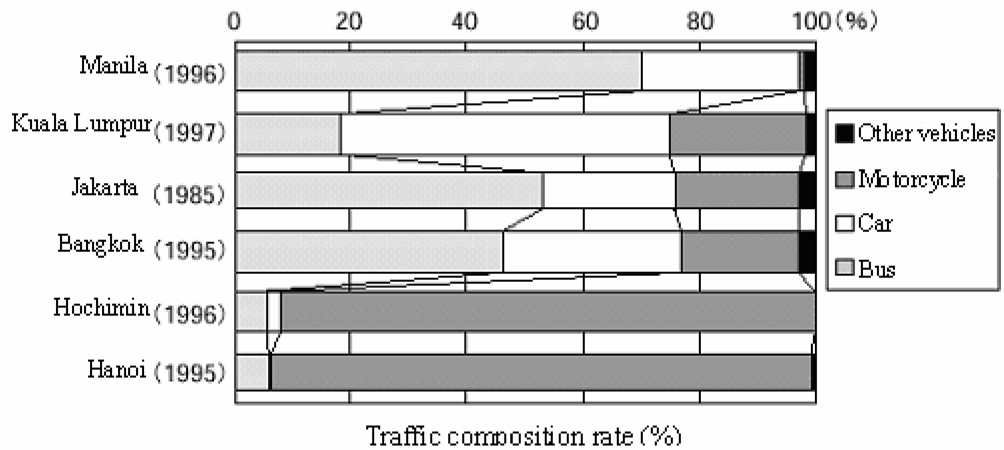

Figure 2 - Modal share in Asian countries
(Mizuno,K. and Kino,N.,2000)

2. OBJECTIVES

The main objective of this study is to analyze the traffic situation in Hochiminh City before the implementation of transport policy and modifications in the public transport system.
As secondary objective, simulation technique is used to evaluate the impacts of a possible future migration from motorcycle to private cars or to the public transport system.

3. METHODOLOGY

This study sets Hochiminh city as a study area. A recording set of the real traffic condition is used to obtain, through image processing technique, the data for the simulation analyses. Simulation method is then used to further understand the traffic problems in the network. At first, the traffic network was created and the present condition was modeled. Then, several changes were made to that model. Comparison analyses among the initial and the changed models were then performed. Finally, an analysis was performed considering the possibility that, in the future, motorcycle users would change to use cars.

3.1. Method of Image processing

The image processing procedure, which provides the base data for the whole study consists of the following steps:

a. A still picture is extracted from a movie file.

Figure 3 - Frame of original movie file

The original movie file was recorded on 2003/7/15, from 7:30 a.m. to 8:30 a.m. in Hochiminh city, Vietnam. The pictures to be analyzed were extracted in a 15 frames per second ratio.

b. The still picture is modified into a monochrome picture because this format uses a smaller quantity of information and processing is, then, simplified.

c. The background frame, which serves as reference for the imaging process, is obtained from one empty (no vehicles) frame.

Figure 4 - Background frame

d. The moving objects are obtained by difference with the background frame.

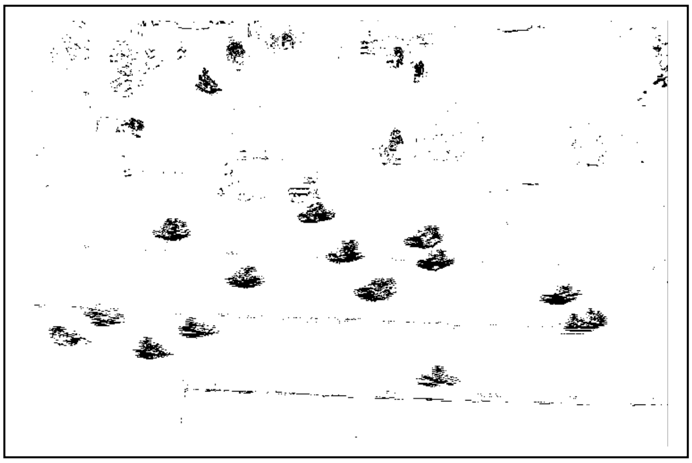

Figure 5 - Frame of moving objects

e. The template of a moving object is created using its bitmap-signature, as shown in Figure 6. In this study, only motorcycles are shown.

f. The template and the full set of moving objects' frames go through a matching process. The coordinates of the moving objects are, then, obtained.

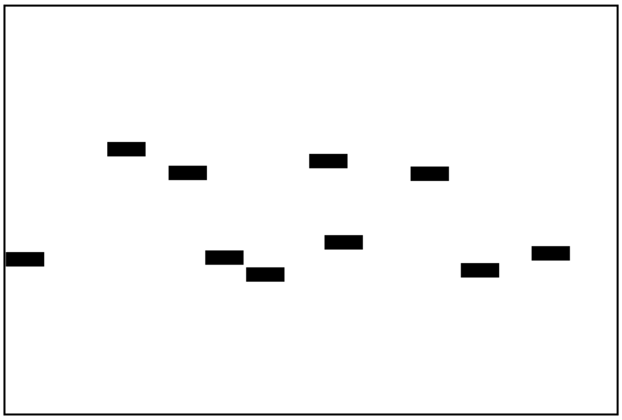

Figure 6 - Bitmap signature of moving objects

The procedure described above identifies only motorcycles. Therefore, other vehicles are recognized as groups of templates (motorcycles). Therefore, a programmed routine classifies the groups of templates into three kinds of vehicles: motorcycles, cars and buses. This analysis was designed for passing vehicles on a road with two lanes in each direction.

3.2. Accuracy of image processing

This section verifies the accuracy of the image processing technique. The verification was based on the comparison of the number of passing vehicles per minute in the movie file and in image processing. Figure 7 shows the result of that comparison.

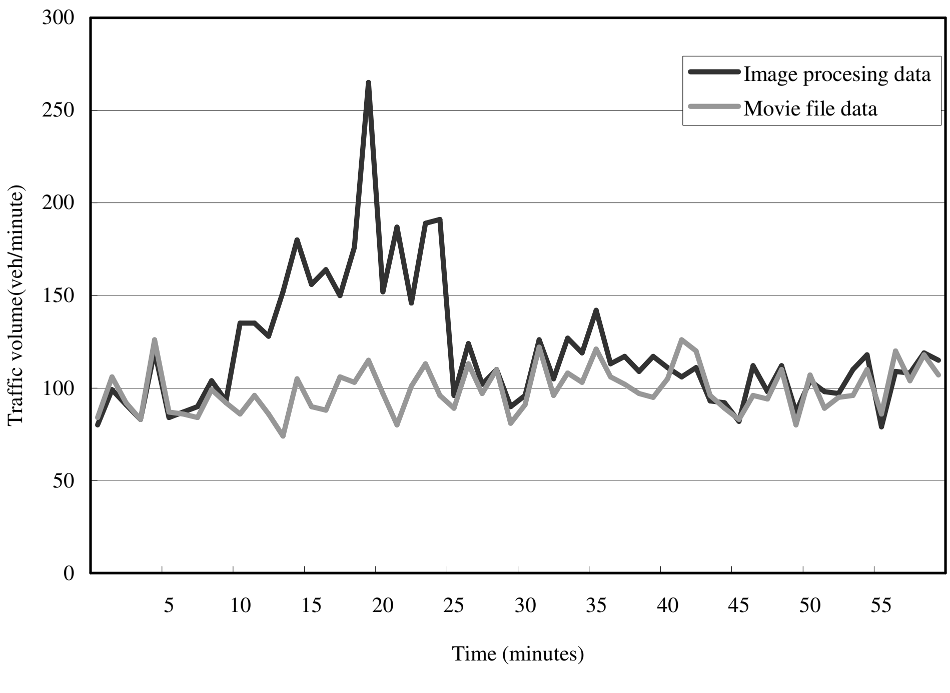

Figure 7 - Verification of image processing

The comparison is shown Figure 7 to a difference in the period from the 10th to the 25th minute of recording. That is caused by the shadows of the vehicles, which are extracted as vehicles by the image processing technique.
As the correction of such difference is very difficult in this stage of the study, the affected data will not be analyzed.

4. ANALYSIS OF THE PRESENT TRAFFIC SITUATION

In this section, the traffic situation acquired from the movie file is analyzed, and the vehicle coordinates acquired from the image processing are calculated.
Table 1 shows the volume of traffic, per type of vehicle, obtained from the movie file.

Table 1 - Volume of traffic of each vehicle

	Motorcycle	*Bike*	*Car*	*Bus*	*Other vehicle*	*Total*
Volume (Veh/hour)	5,308	303	271	33	22	5,937
Average volume (Veh/minute)	88.47	5.05	4.52	0.55	0.37	98.95

As it can be observed, motorcycle volume is much higher then the other types of vehicles and the total volume is also high, almost 6000 veh/hour, for a 2 lanes road.

In Table 2, the number of motorcycles and bikes are segmented according to its occupancy, which impressively reaches to 3 passengers per motorcycle.

Table 2 - Observed passenger occupancy of motorcycles and bikes
(counted from the movie file)

	Only driver	*Driver + 1 Passengers*	*Driver + 2 Passengers*	*Average occupancy (person/Vehicle)*
Motorcycle	4,076	1,189	43	1.24
Bike	293	10	0	1.03

Those figures show that over 20% of the motorcycle traffic volume has occupancy of 2 persons. Moreover the average occupancy for motorcycle is also high.

Through the image processing technique, the speed of each vehicle is obtained from the calculated coordinates of the vehicles. They are expressed as probability density in Figure 8.

Table 3 - Average speed of each vehicle (km/h)

	Motorcycle	*Car*	*Bus*
Average speed	22.35	20.91	22.28

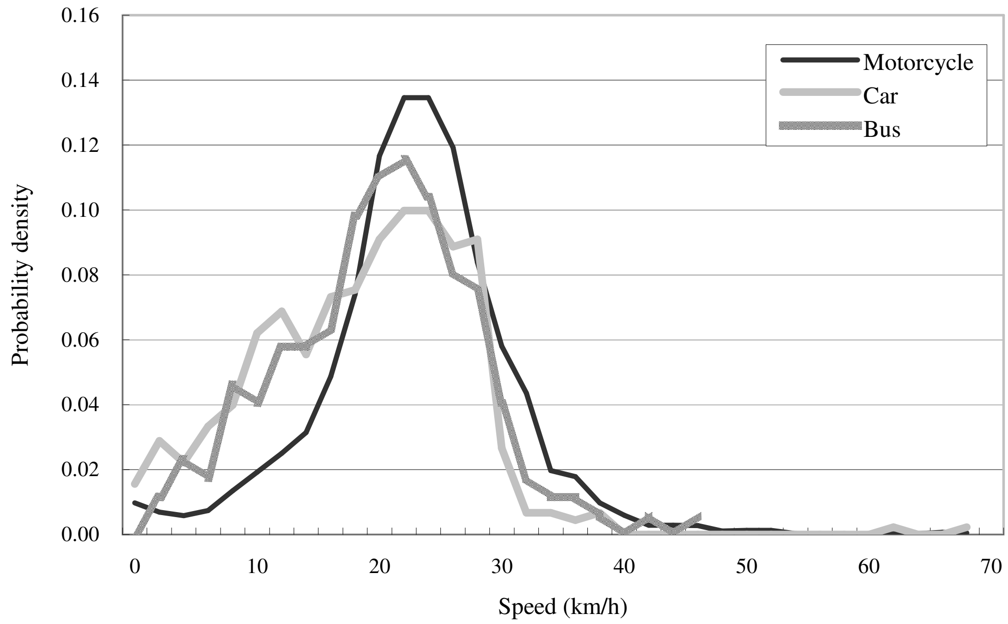

Figure 8 - Calculated density of speed of each vehicle

Figure 8 shows that the cars and the buses have a lower speed comparing with the motorcycles. The average speed for all types of vehicles is very low, probably because of the large volume of motorcycles, which interfere the flow of other vehicles. From those analyses, the general condition of the traffic can be considered extremely inefficient.

5. SIMULATION OF THE PRESENT TRAFFIC SITUATION

This section describes the reproducing of the present traffic situation using traffic simulation software. “VISSIM” 3.7 was used to perform the simulations in this study. “VISSIM” is software developed by PVT AG (Germany) for traffic simulation analyses. “VISSIM” is a microscopic, time step and behavior based simulation model developed to model urban traffic and public transit operations. The program can analyze traffic and transit operations under constraints such as lane configuration, traffic composition, traffic signals, transit stops, etc., thus it can be a useful tool for the evaluation of various alternatives based on transportation engineering and planning measures of effectiveness. It is known that simulation of traffic flows composed by high rates of motorcycles and bicycles, which are characteristics of many Asian countries, is very difficult and usually not perfect. However, using adequate network and behavior configuration, the results are mostly acceptable when the driving behavior of such type of vehicles themselves are not the main focus of the study. As this study focus on the overall characteristics of the traffic flow, the restrictions of the software are not considered to invalidate the analyses.

This study's object is the analysis on motorcycle oriented mixed traffic. Thus, "VISSIM" was adopted due to its possibility of simulating motorcycles' overtaking on the same lane. This was achieved through alternative configuration of the network elements.

The simulation was performed with the calculated coordinates acquired from the image processing. The parameters used in the simulation are expressed below.

a) Network parameter
   Number of lanes: 2
   Lane width: 3.00m, 3.50m
b) Traffic parameter
   Traffic volume: 6000vph
   Composition: motorcycles 89.6%, cars 4.2%, buses 1.5%, bikes 4.7%
c) Vehicle parameter
   Desired speed (min, max) in km/h: motorcycle (20.0, 50.0), car (58.0, 68.0), bus (48.0, 58.0), and bicycle (15.0, 25.0)
d) Driving behavior parameter
   Lane change: Free Lane Selection (Vehicles are passed from every lane.)
   Min. headway: 1.0m
   Look-ahead distance: Minimum 0.0m, Maximum 100.0m
   Additive part of desired safety: 1.0m
   Overtake on same lane: only motorcycle and bike

Figure 9 shows an excerpt image of the simulation.

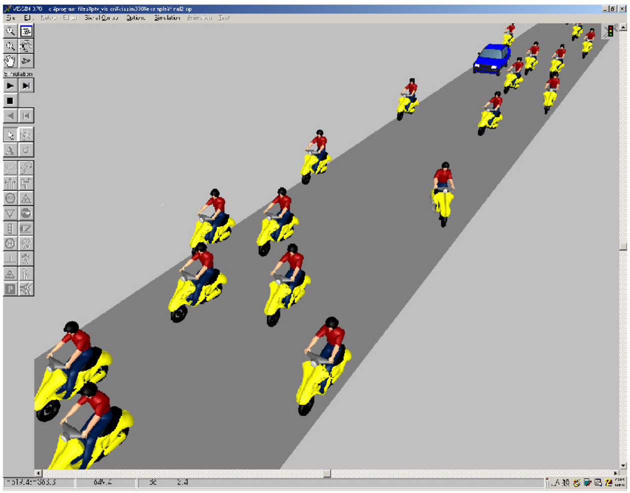

Figure 9 - The simulation process

5.1. Accuracy of simulation

In this section, the accuracy of the simulation should have been compared of each case of real traffic conditions and the simulated condition. Figure 10 shows the average simulated speed of three types of vehicles as motorcycle, car and bus expressing as the probability of density.

Table 4 - Simulated of each vehicle's speed (km/h)

	Motorcycle	*Car*	*Bus*
Average speed	21.99	18.85	17.81

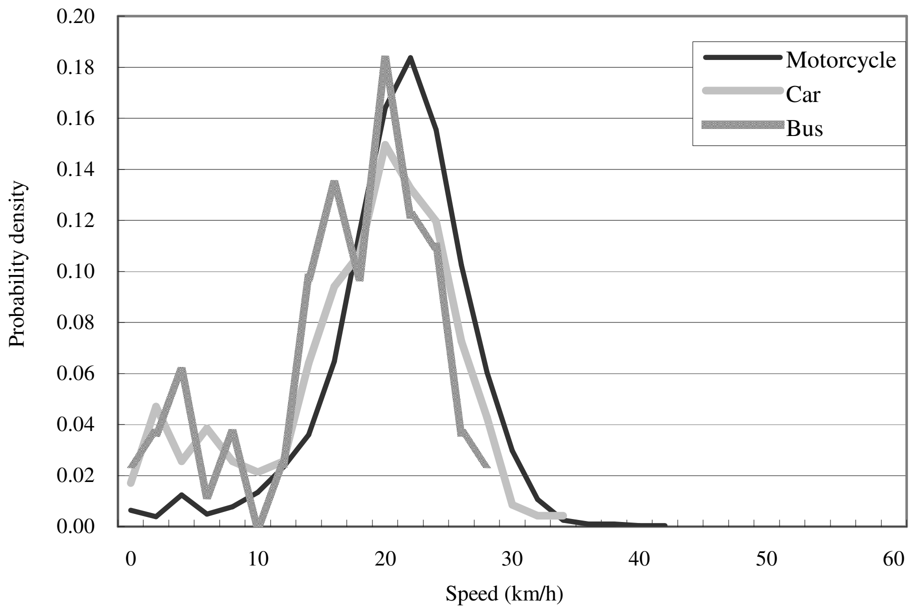

Figure 10 - Simulated probability of density of each vehicle's speed

Cars and buses show a simulated speed lower than the simulated speeds of the motorcycles, just as in the observed speeds.

Figure 11 shows the comparison between the traffic volume and vehicles density for both observed and simulated data.

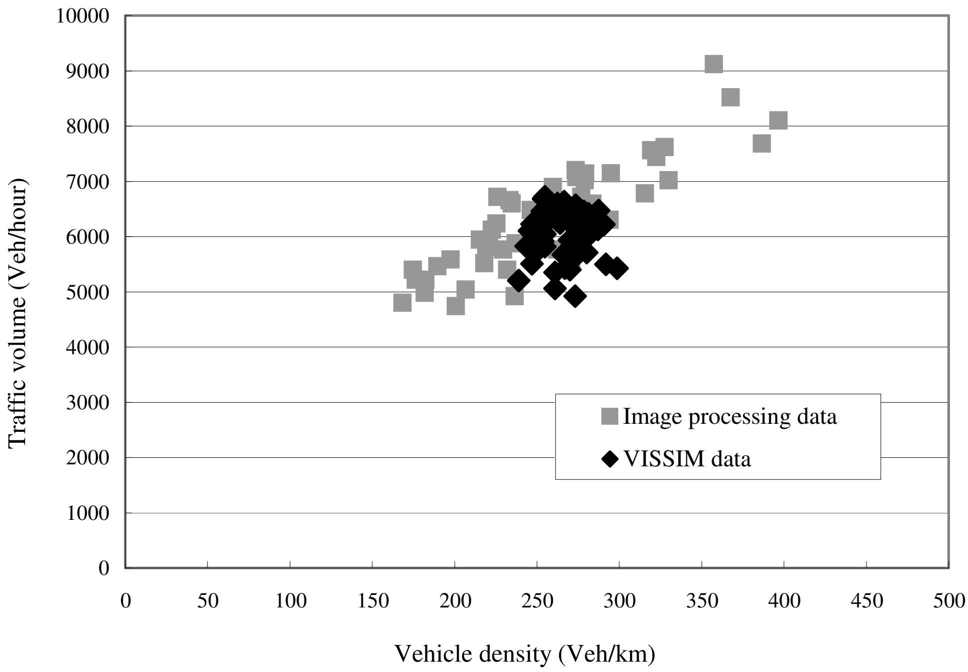

Figure 11 - Traffic volume and vehicles density (Observed versus Simulated)

Figure 11 shows the comparison between the simulated data and image processed data. It can be observed that the two sets of data present similar averages, however image processed data presented higher dispersion than the simulated data. The reduced number of simulation rounds, due to time restrictions, explains this difference in dispersion. The validation of the model was guaranteed by the average volume and density of vehicle, which were reasonably close.

6. ANALYSIS OF TRAFFIC SITUATION USING MICROSIMULATION

In this section, different cases are considered for analyses. These cases include the influence of future changes in traffic composition and changes in traffic volume. The numbers of trips, which represent the passenger occupancy for each vehicle, is also considered.

Two main scenarios were constructed for this analysis. Scenario 1, described in section 6.1, considers simply the change in traffic composition, keeping the total traffic volume constant.

Scenario 2 considers the current passenger occupancy to obtain the present number of trips and its future estimative, which is converted into a future traffic volume. This volume is associated to the changes in traffic composition in the analyses presented in section 6.2.

6.1. Analysis of Scenario 1

In Scenario 1, three cases are considered. These cases present future possibilities in traffic compositions, as shown in Table 5.

Table 5 – Scenario 1: Traffic composition (%)

	Present condition	*Case 1*	*Case 2*	*Case 3*
Motorcycle	94.0	80.0	70.0	50.0
Car	5.0	10.0	20.0	40.0
Bus	1.0	6.0	6.0	6.0

For the simulation analysis of this scenario, the total volume of 6,000 vehicles per hour has created some errors in the simulation regarding traffic overflow in the network. As an alternative solution, the input volume has been reduced so that such errors were avoided. The impact of this solution does not interfere in the condition of the traffic in the network, but in how long the condition would be observed.

The impact in the traffic situation of the changes in traffic composition considered in Cases 1, 2 and 3 can be observed through the average speed in the network. The results for all the cases, including the present situation, are presented in Figure 12.

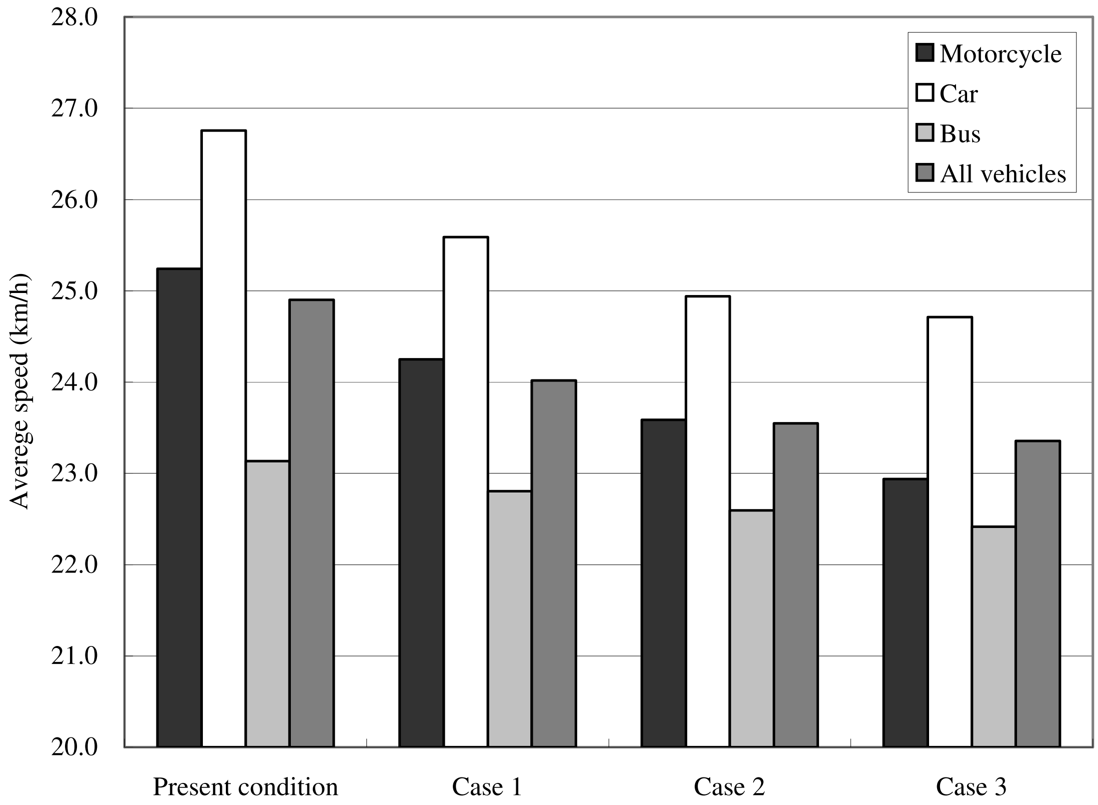

Figure 12 – Scenario 1: Results of average speed

As it can be seen in Table 6, the comparative analyses of the average speed among the present condition and the other cases show that the increase in the share of cars in will generate a reduction in the average speed for all types of vehicles. The motorcycles will suffer the strongest impact, having its average speed reduced by over 9%. The public transport will also be affected, with an average speed reduction of around 6%.

Table 6 - The speed difference from the present condition (%)

	Case 1	Case 2	Case 3
Motorcycle	-3.93	-6.55	-9.12
Car	-4.36	-6.78	-7.63
Bus	-1.41	-2.33	-3.10
All vehicles	-3.55	-5.43	-6.20

Figure 12 also shows that average speed decreases when the share of cars increases while share of motorcycles share decreases. Thus, if present trend continues, it is likely that traffic problems, mainly congestion, will increase.

6.2. Analysis of Scenario 2

Scenario 2 presents an alternative approach for estimating the future traffic volume for the studied system. Here it is considered that the number of person trips will keep constant, not the traffic volume. In this sense the present number of person trips must be obtained from the real data.

Table 7 shows the occupancy considered for each type of vehicle. The figure for motorcycle was obtained from the real data, while the figures for cars and buses were obtained from the literature.

Table 7 - Occupancy (persons/vehicle)

	Motorcycle	*Car*	*Bus*
Occupancy	1.25	1.50	15.00

Based on the traffic volume for each type of vehicle, the number of person trips for the present situation was estimated at around 8,000 persons/hour.

In order to estimate the future situation for the studied network, six cases are considered. Each case represents a different possibility in terms of utilization rate of type of vehicle for the person trips, as presented in Table 8.

Cases 4, 5, and 6 consider 70% share for motorcycle utilization. Cases 7, 8, and 9 consider increasing bus utilization share, while motorcycle utilization share remain fixed in 50%.

Table 8 - Utilization shares for person trips (%)

	Present condition	*Case 4*	*Case 5*	*Case 6*	*Case 7*	*Case 8*	*Case 9*
Motorcycle	88	70	70	70	50	50	50
Car	6	20	15	10	40	25	10
Bus	6	10	15	20	10	25	40

As for the simulation analysis, the input data is traffic composition and not the utilization rate of type of vehicle for the person trips. Therefore, the traffic composition is calculated in order to perform the simulation. The calculated traffic composition for each case is showed in Table 9.

Table 9 - Traffic composition (%)

	Present condition	*Case 4*	*Case 5*	*Case 6*	*Case 7*	*Case 8*	*Case 9*
Motorcycle	94	80	84	88	59	69	81
Car	5	19	15	10	40	29	14
Bus	1	1	1	2	1	2	5

As a verification of the simulation procedure, the simulated results of traffic volume are compared with the inputted traffic volume. This comparison allows evaluating whether any error is occurred. Table 10 shows the comparison results.

Table 10 - Traffic volume comparison (vehicle/hour)

	Present condition	*Case 4*	*Case 5*	*Case 6*	*Case 7*	*Case 8*	*Case 9*
Input parameter	6,000	5,600	5,360	5,120	5,390	4,670	3,950
Simulated volume	5,974	5,421	5,345	5,099	4,788	4,653	3,933
Difference (%)	-0.4	-3.2	-0.3	-0.4	-11.2	-0.4	-0.4

Case 7 shows higher differences between the input value and the simulated value, which is caused by overflow errors in the simulation. Thus, it is not included in the following analyses. The other results have been considered acceptable.

Continuing the procedure used in section 6.1, the average speed in the network have been used as criteria for the analyses of the traffic situation. Table 11 shows the speed difference among the present condition and individual cases. Once more, the increase in the share of cars in the traffic composition forces the overall speeds towards lowering the results. Case 9 has confirmed the general idea concerning the need for an efficient public transport, when the increase of the bus share in the traffic composition resulted in a increase in the average speed for all vehicles over 10%.

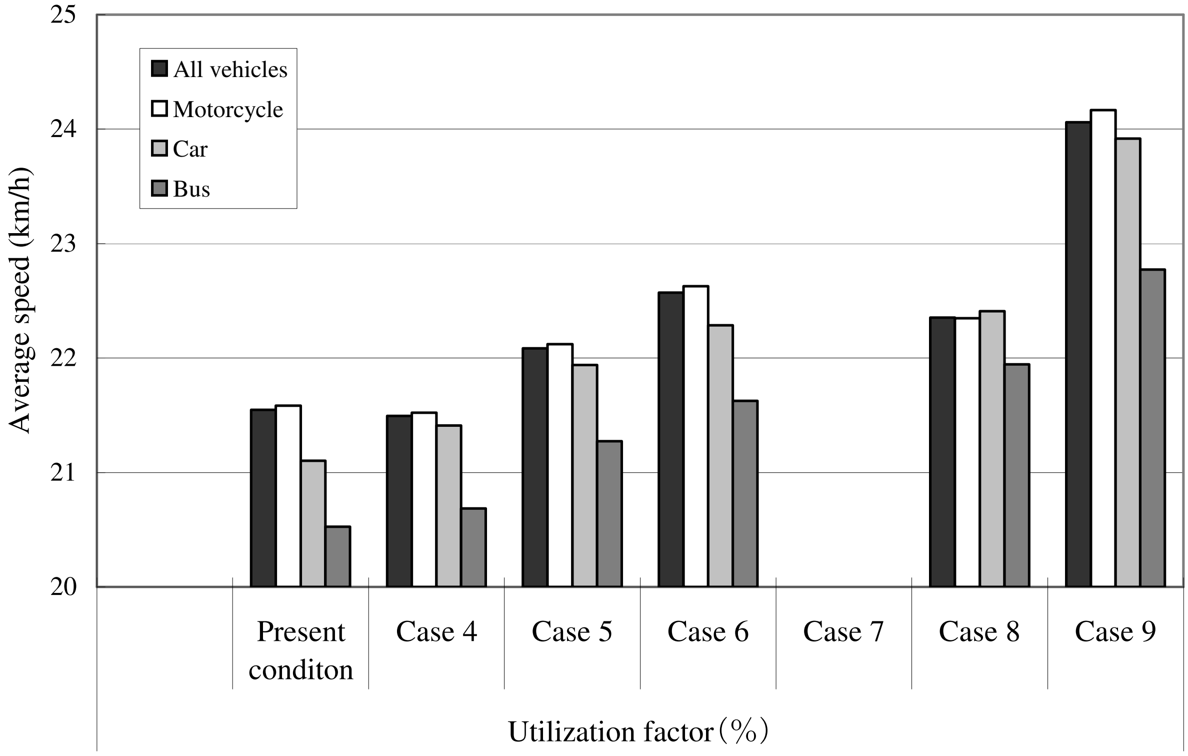

Figure 13 – Scenario 2: Average speed results

Table 11 – Scenario 2: Differences in average speed (%)

	Case 4	*Case 5*	*Case 6*	*Case 7*	*Case 8*	*Case 9*
All vehicles	-0.25	2.49	4.75	-	3.73	11.65
Motorcycle	-0.28	2.49	4.83	-	3.54	11.96
Car	1.47	3.97	5.61	-	6.20	13.34
Bus	0.77	3.63	5.36	-	6.90	10.94

In cases 4 and 6, the simulated volume was lower then the input parameter. It is, therefore, reasonable to assume that, in case the full input volume was simulated, the average speed would be much lower due to the increase of the vehicle density.

7. CONCLUSION

The study was able to analyze some traffic problems through micro simulation technique. It was observed that the presence of high number of motorcycles in the network interferes the flow of other vehicles, reducing their average speed drastically.

Furthermore, the assumptions representing the possible future trends for the traffic in Vietnam have shown that, if the number of cars increases, which is very likely to happen in their strong economic development process, the traffic problems, like congestion and low speed, will increase. Moreover, the simulation analyses have shown that the increase of the public transport share would increase the average speed, by over 10%, and make the transport system more efficient. Therefore, it is important to develop mitigating measures, mainly aimed at the control of individual vehicles, despite its increasing trend due to the economic growth. However, individual vehicle control is useless if an efficient public transport system is not available.

The study is a basic attempt to understand the behavior of motorcycles. A further research, which would consider the changing traffic patterns in a day, is necessary – morning, noon, evening – to understand the whole transportation situation. This understanding would allow the recommendation of appropriate measures. Similarly, efforts should also be directed at the behavior of motorcycle in an intersection and rotary.

This paper dealt with the running speed of vehicles, and the realization and analysis of the mixed traffic of which majority being motorcycle were simulated, though the movement of motorcycle may not be as complete as expected.

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