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The Vehicle Speed Distribution on Heterogeneous Traffic: Space Mean Speed Analysis of Light Vehicles and Motorcycles in Makassar - Indonesia

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Abstract: This paper attempts to analyze the space mean speed characteristic of the light vehicles and motorcycles under heterogeneous traffic situation in Makassar, Indonesia. The present study conducts traffic survey at the four one-way urban roads in the city. The survey measures the vehicle speeds in morning peak hour using video camera. The speed distribution characteristic of the light vehicles and motorcycles are analyzed in following the normal distribution model. The parameters values of the distributions have been calculated using a simulation approach. The results show that the vehicle speed distributions follow the normal distribution. The statistical test results such F-test and t-test indicate that there are similarity and difference of the speed distributions, among thirty minutes interval in the morning peak period. We expect that the distribution models are useful in the development of traffic simulation model for vehicle emission and traffic noise prediction in further studies.

Keywords: Distribution, Light Vehicle, Motorcycle, Speed, Heterogeneous Traffic

1. INTRODUCTION

In the last decade, the motor vehicles growth in developing countries such Indonesia has increased rapidly. Previous studies show that the fraction of motorcycle as one component of total transportation mode on urban roadways is more than 80% in Hanoi, Vietnam (Minh et al., 2005), and more than 70% in Makassar, Indonesia (Hustim et al., 2011). Further, the proportion of motorcycle to overall traffic in many cities in Indonesia has achieved 50% until 80% (Putranto et al., 2011).

This condition lead to several cities in the countries are facing traffic congestion problem in a critical level. In this situation the motor vehicles such passenger cars and motorcycles have made maneuvers and behaviors that are insufficient for the condition. For example, passenger cars and motorcycle have been conducting zigzag maneuvers, creeps up slowly to the front of queue when the signal are red, impedes traffic flow by disturbing the star of other vehicle behind, etc. (Chandra et al, 2003; Zakaria et al. 2011, Hustim et al., 2011). Also the vehicles have inconsistency or indiscipline to use their lane (Aly et al, 2011, 2012; and Hustim et al., 2011). Therefore, the motor vehicles behavior has changed from homogeneous situations to heterogeneous conditions. The last traffic behavior type has reduced the vehicle speeds and the other modes, also made more congested (Zakaria et al. 2011). In addition impact, the motor vehicle pollutants, vehicle emission and traffic noise, have increased on the urban roads the cities in recently years (Aly et al, 2012; and Hustim et al., 2012).

Concerning the heterogeneous traffic condition in the developing countries, some previous researches have been conducted. For instances, Chandra et al (2003) have studied

the effect of lane width on roadway capacity under mixed traffic condition in India. Minh et al. (2005) have studied that the speed distribution on urban roadway in Hanoi has followed the normal distribution. Minh et al. (2005) also have grasped the speed characteristics of motorcycle such as speed, flow, and headway under the heterogeneous condition in the city. Through a comparison between the characteristics and the homogenous traffic condition in the city, they have resulted that the empirical speed on different traffic composition and road characteristics exposed different speed level. Meanwhile, the average headway for all observed road locations has the same mean headway. However, the study did not evaluate effect of interval time variations of the speed distribution. Zakaria et al. (2011) have attempted to focus on this phenomenon for an urban roadway in Makassar, Indonesia. Unfortunately, their study only covers one type urban roadway, six lanes 2 way divided roadway type, and only for the motorcycle speeds. In addition, Minh et al (2010) and Chandra et al (2003) have developed a motorcycle unit (MCU) as instead of passenger car unit (PCU) as representative unit of traffic for motorcycle-dominated traffic in Vietnam and India, respectively. Putranto et al (2011) have evaluated the performance of motorcycle lane in Jakarta and Sragen, Indonesia, where the exclusiveness of motorcycle lane did not significant effect to V/C ratio. Furthermore, Hustim et al (2012) have predicted road traffic noise in Makassar City in evaluating the environmental impact of the heterogeneous traffic condition, as well as, for the quantity emission of the traffic in the city (Aly, et al, 2012).

In order to contribute on the research filed of the heterogeneous traffic behavior in Indonesia, particularly in to continue and complete the last previous study, this study attempts to analyze the motor vehicle (i.e. passenger cars and motorcycles) speed characteristics on the one-way urban roads in Makassar, Indonesia. The study assesses the goodness of fit of the speed distribution of both vehicle types in following the normal distribution using a simulation approach. Further, the study also carries out F-test and t-test in evaluating the mean and variance differences of the space mean speed of the vehicles among some interval time at the morning peak period. The study results are very useful on the prediction model development of road vehicle emission and its optimizing, and the traffic noise level under the traffic behavior condition in further studies..

2. THE STUDY METHODS

2.1 Data Collection and Preparation

This study carried out a traffic survey at the four primary one-directional urban roads, i.e. Jl. Lempangan, Jl. Saddang, Jl. Sulawesi, and Jl. Ratulangi, in Makassar, Indonesia, in April 26th, 2012. The survey collected speed data of the light vehicles and motorcycles using video recording method. In this regard, the travel times of light vehicles and motorcycles when passed two imaginary or measurement points respectively, with distance 40 meters at the roads were recorded. A digital video recorder was set up at a high place or building that available on the roadside nearby the study site. The video recorded traffic movements during twelve hours of the day, from 07:00 a.m. until 18:00 a.m. In addition, the survey also measured roadway geometric and its characteristics such as lane width, weather condition, and pavement condition. Table 1 presents the geometric characteristics of the urban roads.

In order to prepare data for analysis activity, the recorded traffic situation were converted into media video files. Then, we replayed it in a computer and interpreted until entire necessary data were accomplished on the traffic laboratory. Considering the purpose of this research, we only covered two hours traffic condition, particularly in the morning peak

hour period of traffic condition, i.e. from 07:00 a.m. until 09:00 a.m. The speed data and its distribution are presented into each 30 minutes interval time using 120 data of each interval.

Table 1 Road Geometric Characteristics

Street Name	Road Geometric Characteristics			
	Number of Lane	Width of Lane (m)	Shoulder Width (m)	Side Friction
1. Lempangan	2	4.0	1.5	Quiet
2. Saddang	2	3.5	1.0	Crowded
3. Sulawesi	2	3.0	1.0	Crowded
4. Ratulangi	4	3.5	2.5	Un-crowded

2.2 The Simulation Program Development in Goodness of Fit of the Speed Distribution

This study develop a simulation program on Fortran Power Station, a computer programming language in order to assess the speed distribution in following a certain distribution shape or not. In this regard, we assumed that the space mean speed distribution of the motor vehicles is goodness of fit to normal distribution function as expressed below (Law and Kelton, 1991):

$$Y = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \quad (1)$$

where,

π : 3.1416
e : 2.7183
μ : mean
σ : standard deviation
x : score or value of event, in this case it is the vehicle speed, and
Y : ordinate on normal distribution curve, it is the vehicle frequency.

The simulation program as the calculation method to estimate the distribution model parameters in this research is procedure to find a set of numerals possibly regarded as the parameters, and the calculated values surely depend on the set of assumed initial values. Therefore, the calculation has to have some trial and error process to find the possible parameter values. The calculation method adopt the algorithm that used by Zakaria et al (2011). To ensure the goodness of fit between calculated distribution and observed distribution, *Kolmogorv-Smirnov* test was applied in order to assess the significant level of the goodness of fit.

2.3 The Tests of Space Mean Speed Dispersion of the Motor Vehicles

In order to grasp the dispersion of motorcycle speed among the interval time, we applied F-test and t-test for variance and mean tests, respectively. However, it is important to ensure firstly that the correct version of the tests is being used particularly in equal variance or non-equal variance. Thus, if the variances are not significantly different, the t-test with equal variances could be used. Otherwise, the t-test with equal variances could be applied. F-test and t-test utilize confidence level under 95%, so that a comparison between $F_{statiscal}$ and $F_{critical}$ values, as well as $t_{statiscal}$ and $t_{critical}$ values are tools respectively for assessment whether the variances and means of the vehicle and the motorcycle speeds in various interval times are equal or unequal.

3. THE RESULT AND DISCUSSION

3.1 The Survey Results

The results of motor vehicle speed survey based on space mean speed approach in the four urban roads are shown in Figure 1 and Table 2 for light vehicles, and Figure 2 and Table 3 for motorcycles. Figure 1 shows the frequency and cumulative frequency of motorcycle speed during time period 07:00 – 09:00 a.m., while Table 1 shows the statistical values of the speed sample, i.e. minimum speed, maximum speed, average speed and standard deviation of speed.

Table 2. Characteristics of the light vehicle speed sample

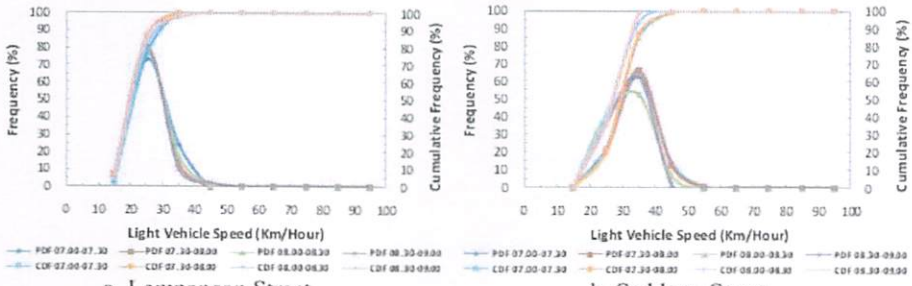
Street Name	Time Period	Statistical values of Observed Speed Sample				
		n (Units)	Min. (Km/Hr.)	Max. (Km/Hr.)	μ (Km/Hr.)	σ (Km/Hr.)
Lempangan	07:00 – 07:30	120	18.27	36.86	26.65	4.15
	07:30 – 08:00	120	14.08	38.43	25.43	4.15
	08:00 – 08:30	120	13.72	40.60	26.26	4.58
	08:30 – 09:00	120	12.04	47.16	25.83	5.20
Saddang	07:00 – 07:30	120	23.48	52.43	34.37	5.46
	07:30 – 08:00	120	23.95	52.43	34.65	5.21
	08:00 – 08:30	120	23.74	44.44	31.96	4.60
	08:30 – 09:00	120	23.38	41.06	31.14	3.52
Sulawesi	07:00 – 07:30	120	20.73	46.96	32.44	6.15
	07:30 – 08:00	120	17.12	58.70	32.46	7.11
	08:00 – 08:30	120	18.91	51.67	30.17	6.59
	08:30 – 09:00	120	15.93	49.32	29.41	5.94
Ratulangi	07:00 – 07:30	120	16.31	49.32	28.15	7.62
	07:30 – 08:00	120	16.00	49.09	29.18	9.04
	08:00 – 08:30	120	15.47	45.19	28.62	6.86
	08:30 – 09:00	120	14.44	78.83	30.56	8.24

Table 2 shows that the light vehicle speeds data at Lempangan street vary from minimum speed 12 km/hour until maximum speed 47 km/hour during 07:00 - 09:00 a.m. period, or the averagely speeds are around 25 km/hour. In the Saddang street, the light vehicle speeds are approximately 23 km/hour, 52 km/hour, and 33 km/hour, for minimum, maximum, and averagely speeds, respectively. Difference phenomena happen at Sulawesi and Ratulangi streets. The average speeds at both streets are mostly similar, i.e. around 30 km/hour. As well as, the minimum and maximum speeds at both streets are 16 km/hour and 50 km/hour, respectively. In addition, the forst two streets have similar speed deviations, while Ratulangi street has the largest speed dispersion than the others.

Figure 1 shows that the light vehicle speed distributions during 07:00 – 09:00 a.m. follow the normal distribution curve. This phenomenon is in line as indicated by Zakaria et al. (2011) for motorcycle speed in divided urban roadway in Makassar. The speed distributions of the light vehicles at Lempangan and Ratulangi streets seem homogeneous in the time period, while the others three streets seem more heterogeneous among each 30 minutes interval during the time period. In addition, Ratulangi street has the most heterogeneous of its distribution shape.

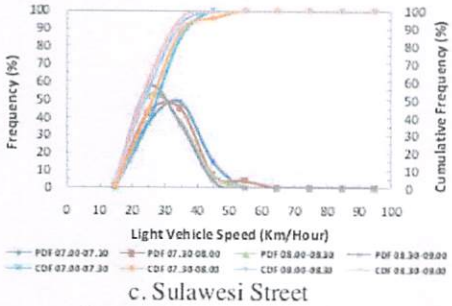
Table 3 shows that the motorcycle speeds data at Lempangan street are various from minimum speed 20 km/hour until maximum speed 65 km/hour during time period 07:00 a.m. until 09:00 a.m, as well as at Saddang street. The average speeds at both streets are mostly similar around 37 km/hour until 41 km/hour. Difference phenomena happen at Sulawesi and Ratulangi streets. The average speeds at both streets are around 45 km/hour and 56 km/hour, respectively. As well as, the minimum and maximum speeds at both streets are higher than

formerly both streets. However, the motorcycle speeds at Ratulangi street achieved more than 100 km/hour. In addition, the three streets except Ratulangi street have similar speed deviations, while Ratulangi street has speed dispersion larger than the others.

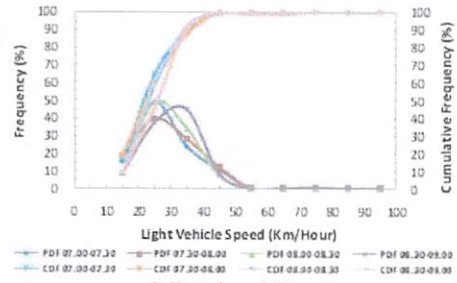


a. Lempangan Street

b. Saddang Street



c. Sulawesi Street



d. Ratulangi Street

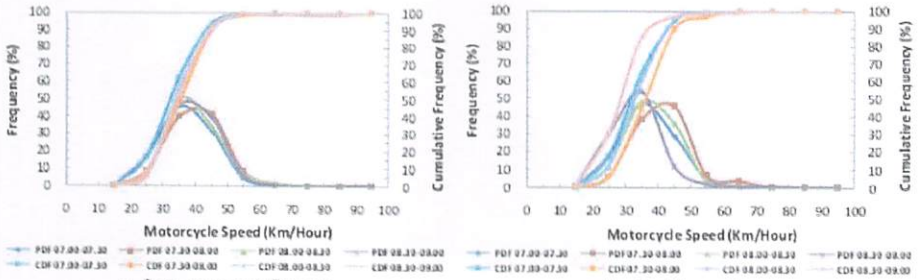
Figure 1. Frequency and cumulative frequency of the light vehicle speeds

Table 3. Characteristics of the motorcycle speed sample

Street Name	Time Period	Statistical values of Observed Speed Sample				
		n (Units)	Min. (Km/Hr.)	Max. (Km/Hr.)	μ (Km/Hr.)	σ (Km/Hr.)
Lempangan	07:00 – 07:30	120	20.51	65.45	37.66	7.97
	07:30 – 08:00	120	23.08	62.07	40.48	7.58
	08:00 – 08:30	120	25.13	61.54	39.83	7.41
	08:30 – 09:00	120	26.13	144.00	41.34	11.79
Saddang	07:00 – 07:30	120	22.64	68.79	37.43	7.48
	07:30 – 08:00	120	26.09	68.79	40.70	8.12
	08:00 – 08:30	120	23.79	62.43	37.74	7.06
	08:30 – 09:00	120	18.59	73.47	34.12	7.67
Sulawesi	07:00 – 07:30	120	31.76	83.08	47.63	8.36
	07:30 – 08:00	120	32.73	67.50	46.56	6.88
	08:00 – 08:30	120	24.00	56.84	40.25	6.51
	08:30 – 09:00	120	22.50	54.00	35.68	5.81
Ratulangi	07:00 – 07:30	120	32.32	97.83	56.48	16.42
	07:30 – 08:00	120	32.32	145.16	55.14	21.91
	08:00 – 08:30	120	31.47	125.87	55.85	18.34
	08:30 – 09:00	120	35.43	89.55	57.91	17.80

Figure 2 shows that the motorcycle speed distributions during 07:00 – 09:00 a.m. follow certain distribution shapes, i.e. normal distribution. This phenomenon is in line as indicated by Zakaria et al. (2011) for motorcycle speed in divided urban roadway in Makassar. The speed distributions of motorcycle at Lempangan and Ratulangi streets seem homogeneous in the

time period, while the others two streets seem more heterogeneous among each 30 minutes interval during the time period. In addition, only Ratulangi street has bi-peak distribution shape.



a. Lempangan Street b. Saddang Street

c. Sulawesi Street d. Ratulangi Street

Figure 2. Frequency and cumulative frequency of the motorcycle speeds

3.2 The Calculation Results of the Motor Vehicle Speed Distributions

The simulation of the goodness of fit of the light vehicle and motorcycle speed distribution in following the normal distribution curve has provided the calculation results of the distribution parameters, i.e. the average and standard deviation, as shown in Table 4 and Table 5, respectively. The tables also provide the indicator results of the goodness of fit test of the speed distributions. Further, the comparisons between both distributions, observation and calculation, visually are presented in Figure 3, Figure 4, Figure 5, and Figure 6 for Lempangan, Saddang, Sulawesi, and Ratulangi streets, respectively for the light vehicles, as well as in Figure 7, Figure 8, Figure 9, and Figure 10 for motorcycle at the four roads respectively.

The results show that the speed distributions of the light vehicles at the four urban roads have goodness of fit significantly in following the normal distribution regarding *Kolmogorov-Smirnov* test, significant at level 95% ($\alpha = 0.05$). Furthermore, Table 4 shows that the four urban roads have different values of the average and deviation speeds among each other. The largest average speed, i.e. around 29 km/hour, occurs in Saddang street, while the largest deviation speed around 8 km/hour occurs in Ratulangi street. Differently, the smallest of both parameters values, 20 km/hour and 4 km/hour respectively, occurs in Lempangan street only.

Table 5 shows that the motorcycle speed distributions at the formerly three streets have goodness of fit in following the normal distribution according to *Kolmogorov-Smirnov* test, significant at level 95% ($\alpha = 0.05$). However, the speed distribution tests at Ratulangi street was failed in following the normal distribution for one-peak distribution curve. Further, Table

5 shows that Lemapangan street and Saddang street, have similar values on their average and deviation speeds. Their values are around 34 km/hour and 7 km/hour, respectively. The comparison between Sulawesi street and Ratulangi street also is mostly similar. However, the average values at Ratulangi street (around 43 km/hour) are slightly larger than the values at Sulawesi street (around 38 km/hour). Moreover, the the speed distribution dispersion at Ratulangi street are larger actually, around 11 km/hour, than the deviation at Sulawesi street.

Table 4. Calculation results and goodness of fit test for light vehicles

Street Name	Time Period	Parameters Values		*Kolmogorov-Smirnov* Test		
		μ	σ	$KS^{*}_{critical}$	$KS_{Statistical}$	Result
Lempangan	07:00 – 07:30	22.192	3.966	0.0977	0.0088	Accept H_o
	07:30 – 08:00	20.745	3.866	0.0977	0.0066	Accept H_o
	08:00 – 08:30	21.454	3.963	0.0977	0.0104	Accept H_o
	08:30 – 09:00	20.419	3.818	0.0977	0.0250	Accept H_o
Saddang	07:00 – 07:30	29.245	5.452	0.124	0.0065	Accept H_o
	07:30 – 08:00	29.225	5.049	0.124	0.0081	Accept H_o
	08:00 – 08:30	26.173	5.569	0.124	0.0223	Accept H_o
	08:30 – 09:00	26.530	4.192	0.124	0.0044	Accept H_o
Sulawesi	07:00 – 07:30	27.274	7.279	0.124	0.0442	Accept H_o
	07:30 – 08:00	25.831	6.848	0.124	0.0474	Accept H_o
	08:00 – 08:30	23.851	5.714	0.124	0.0472	Accept H_o
	08:30 – 09:00	23.515	5.061	0.124	0.0309	Accept H_o
Ratulangi	07:00 – 07:30	21.633	7.479	0.124	0.0711	Reject H_o
	07:30 – 08:00	23. 635	8.871	0.124	0.0333	Reject H_o
	08:00 – 08:30	23.165	6.891	0.124	0.0289	Reject H_o
	08:30 – 09:00	25.756	7.078	0.124	0.0163	Reject H_o

H_o: Speed distribution goodness of fit to normal distribution * : $\alpha = 0.05$

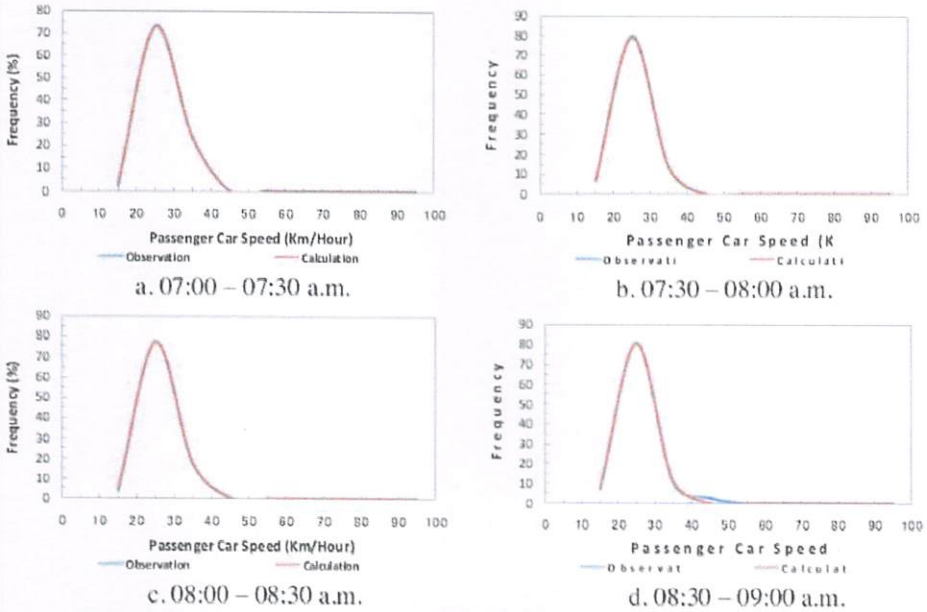
Table 5. Calculation results and goodness of fit test for motorcycles

Street Name	Time Period	Parameters Values		*Kolmogorov-Smirnov* Test		
		μ	σ	$KS^{*}_{critical}$	$KS_{Statistical}$	Result
1. Lempangan	07:00 – 07:30	32.260	7.793	0.124	0.015	Accept H_o
	07:30 – 08:00	35.385	7.620	0.124	0.030	Accept H_o
	08:00 – 08:30	33.418	6.600	0.124	0.054	Accept H_o
	08:30 – 09:00	34.351	6.327	0.124	0.040	Accept H_o
2. Saddang	07:00 – 07:30	31.776	7.455	0.124	0.016	Accept H_o
	07:30 – 08:00	35.827	6.827	0.124	0.030	Accept H_o
	08:00 – 08:30	33.186	7.026	0.124	0.007	Accept H_o
	08:30 – 09:00	27.924	6.423	0.124	0.029	Accept H_o
3. Sulawesi	07:00 – 07:30	41.669	6.499	0.124	0.033	Accept H_o
	07:30 – 08:00	41.538	6.236	0.124	0.084	Accept H_o
	08:00 – 08:30	34.607	5.891	0.124	0.039	Accept H_o
	08:30 – 09:00	30.844	5.148	0.124	0.014	Accept H_o
4. Ratulangi	07:00 – 07:30	44.366	12.108	0.124	0.171	Reject H_o
	07:30 – 08:00	43.763	9.705	0.124	0.153	Reject H_o
	08:00 – 08:30	44.506	9.829	0.124	0.223	Reject H_o
	08:30 – 09:00	44.406	14.841	0.124	0.241	Reject H_o

H_o: Speed distribution goodness of fit to normal distribution * : $\alpha = 0.05$

3.3 The Difference Test Results of the Light Vehicle Speed Distribution based on Time Period

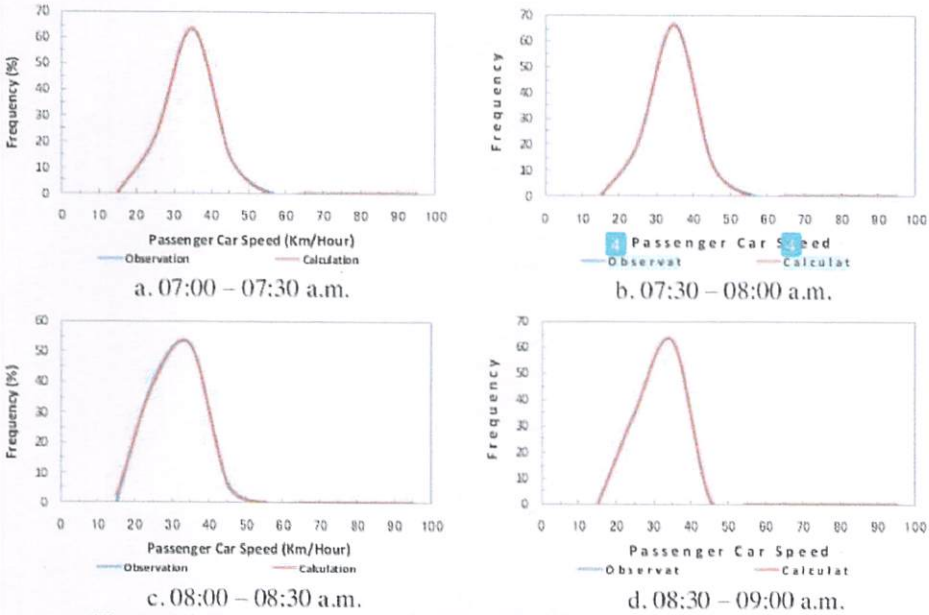
Regarding the difference test of the speed distributions among time period of each urban road, Table 6 until Table 13 provide the results of F-test and t-test for the light vehicles at the four urban roads, respectively.



a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.

c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

Figure 3 Observed and calculated speed of light vehicle on Lempangan Street



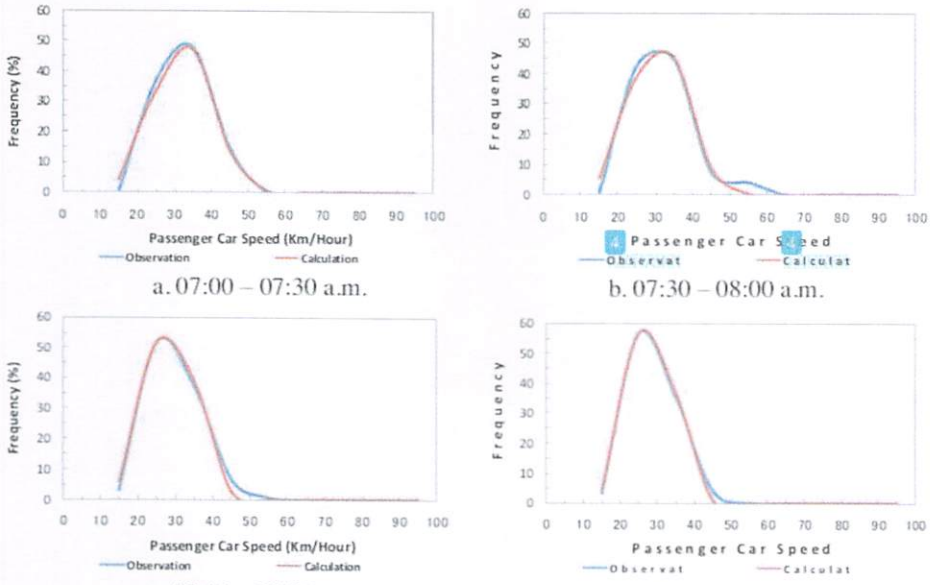
a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.

c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

Figure 4 Observed and calculated speed of light vehicle on Saddang Street.

Table 6 shows that most of the variances of the speed sample at Lempangan street are difference among the 30 minutes interval during 07:00 a.m. until 09:00 a.m. The speed variances are only similar between the speeds at 08:30-09:00 to 07:00-07:30 and 07:30-08:00.

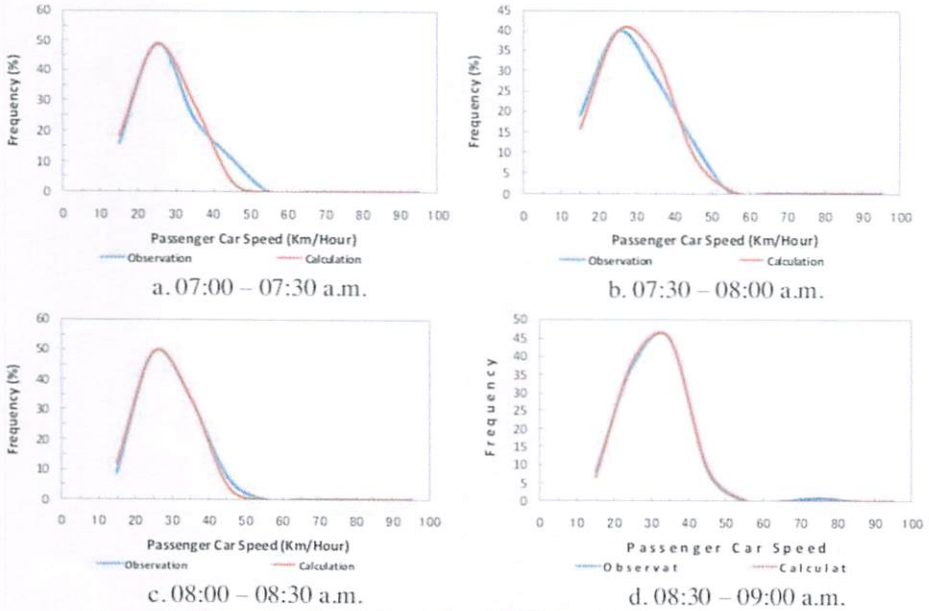
Under the difference and similar of the speed variances, Table 7 shows that all of the speed means are difference to each others.



a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.

c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

Figure 5 Observed and calculated speed of light vehicle on Sulawesi Street.



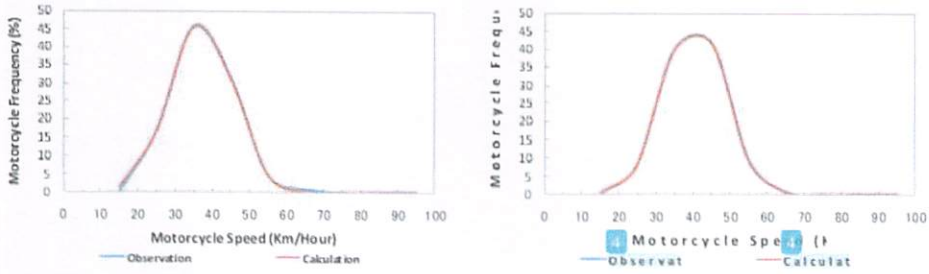
a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.

c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

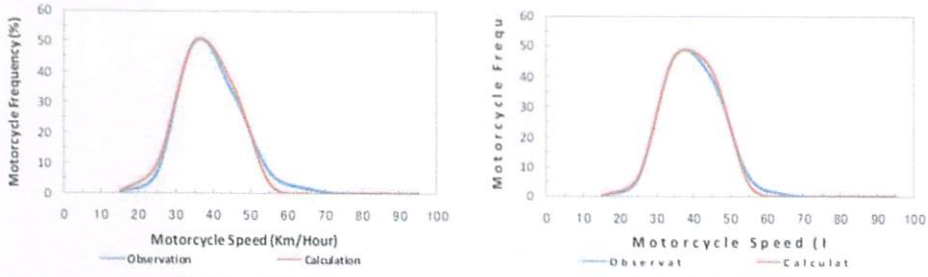
Figure 6 Observed and calculated speed of light vehicle on Ratulangi Street.

Table 8 shows that all light vehicle speeds among the 30 interval minutes on

08:30-09:00 period to the others periods at Saddang street have similar variance each others. Meanwhile, the speeds on the others time periods have difference variance. As consequently, the t-tests under these conditions result mostly similar phenomenon of the variance tests, as shown in Table 9.

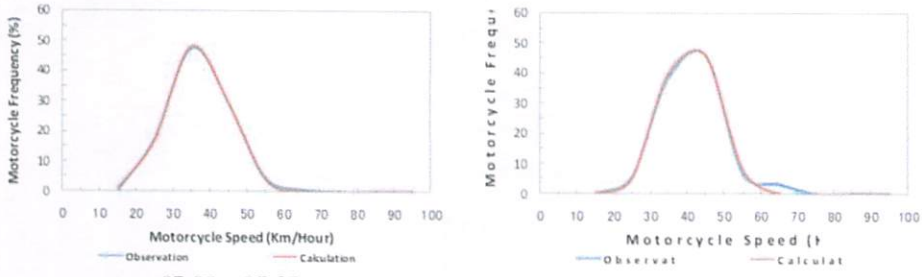


a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.

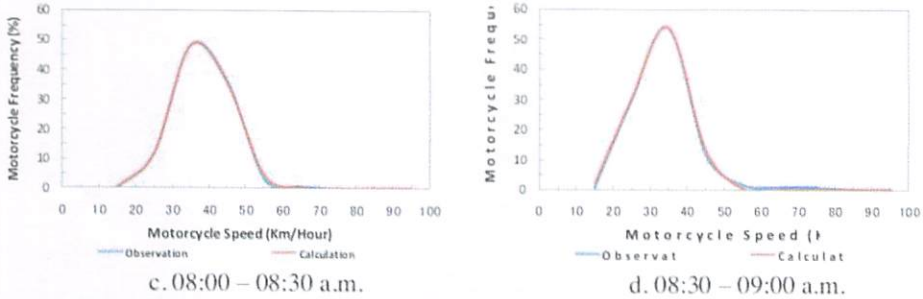


c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

Figure 7 Observed and calculated speed of the motorcycles on Lempangan Street

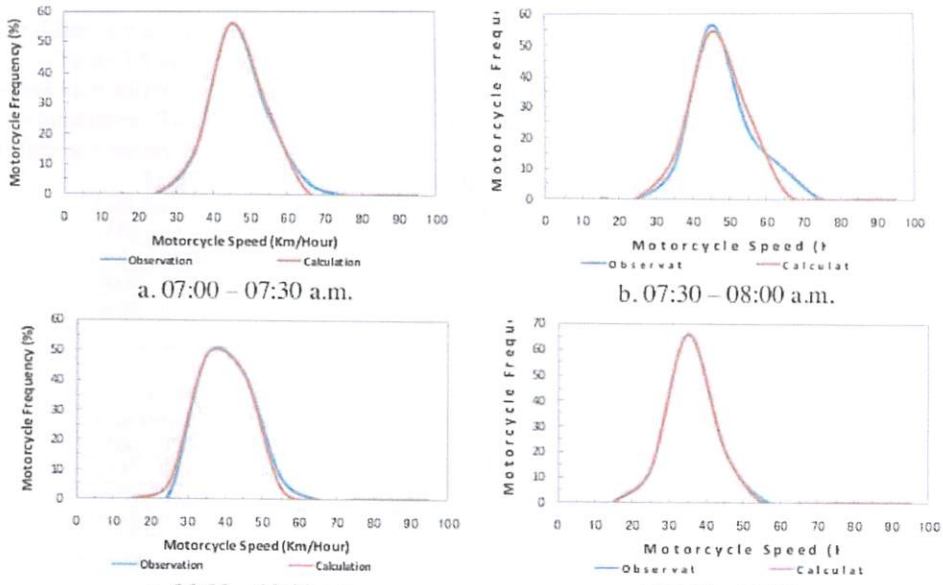


a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.



c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

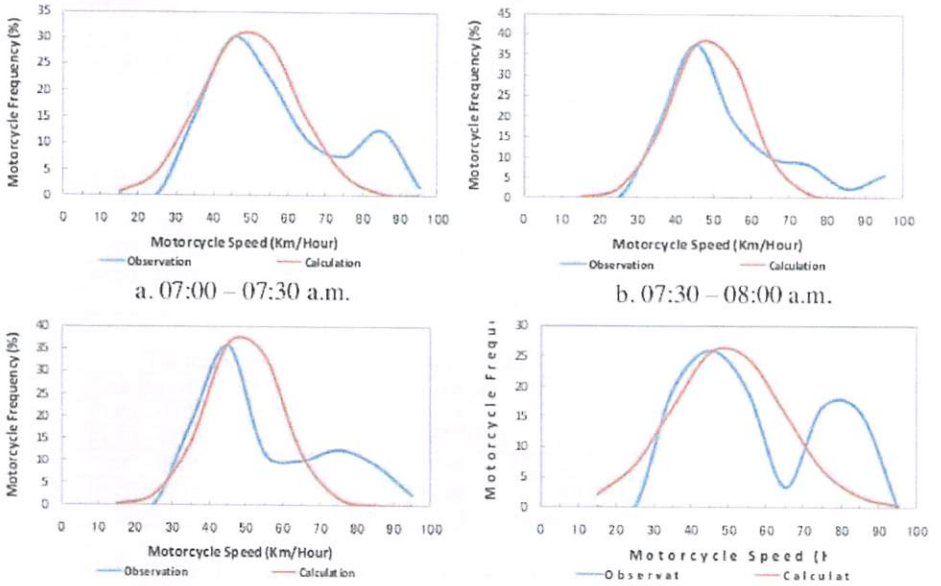
Figure 8 Observed and calculated speed of the motorcycles on Saddang Street.



a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.

c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

Figure 9 Observed and calculated speed of the motorcycles on Sulawesi Street.



a. 07:00 – 07:30 a.m. b. 07:30 – 08:00 a.m.

c. 08:00 – 08:30 a.m. d. 08:30 – 09:00 a.m.

Figure 10 Observed and calculated speed of the motorcycles on Ratulangi Street.

Table 10 shows that the light vehicle speeds at Sulawesi street mostly have difference variance among the interval time on the time period each other. Under the similar and the difference variance, Table 11 shows that most of the speed means between the time intervals

Table 17. t-test of motorcycle speed variance at Saddang street

Time Period	07:00 – 07:30	07:30 – 08:00	08:00 – 08:30	08:30 – 09:00	
07:00 – 07:30		0.0226	0.7021	0.0078	$t_{statistical}$ values
07:30 – 08:00	0.0053		0.0482	0.0000	
08:00 – 08:30	0.0053	0.0053		0.0019	
08:30 – 09:00	0.0053	0.0053	0.0053		
$t_{critical}$ values					

Table 16 shows that all motorcycle speeds among the 30 interval minutes at Saddang street have difference variance each others. However, some of them have similar speed mean under the difference variance condition, as shown in Table 17.

Table 18. F-test of motorcycle speed variance at Sulawesi street

Time Period	07:00 – 07:30	07:30 – 08:00	08:00 – 08:30	08:30 – 09:00	
07:00 – 07:30		0.0348	0.0067	0.0001	$F_{statistical}$ values
07:30 – 08:00	0.0580		0.5431	0.0646	
08:00 – 08:30	0.0580	0.0580		0.2140	
08:30 – 09:00	0.0580	0.0580	0.0580		
$F_{critical}$ values					

Table 19. t-test of motorcycle speed variance at Sulawesi street

Time Period	07:00 – 07:30	07:30 – 08:00	08:00 – 08:30	08:30 – 09:00	
07:00 – 07:30		0.3553	0.0000	0.0000	$t_{statistical}$ values
07:30 – 08:00	0.0053		0.0000	0.0000	
08:00 – 08:30	0.0053	0.0053		0.0000	
08:30 – 09:00	0.0053	0.0053	0.0053		
$t_{critical}$ values					

Table 18 shows that the motorcycle speeds in interval 07:00-07:30 at Sulawesi street have similar variance to the others time period. Meanwhile, the speed variance of the others time are difference to each other. Under the similar and the difference variance, Table 19 shows that only the speed means between time interval 07:00-07:30 and 07:30-08:00 are difference each other.

Table 20. F-test of motorcycle speed variance at Ratulangi street

Time Period	07:00 – 07:30	07:30 – 08:00	08:00 – 08:30	08:30 – 09:00	
07:00 – 07:30		0.0018	0.2272	0.3792	$F_{statistical}$ values
07:30 – 08:00	0.0580		0.0539	0.0242	
08:00 – 08:30	0.0580	0.0580		0.7421	
08:30 – 09:00	0.0580	0.0580	0.0580		
$F_{critical}$ values					

Table 21. t-test of motorcycle speed variance at Ratulangi street

Time Period	07:00 – 07:30	07:30 – 08:00	08:00 – 08:30	08:30 – 09:00	
07:00 – 07:30		0.8258	0.6868	0.6913	$t_{statistical}$ values
07:30 – 08:00	0.0053		0.8945	0.5823	
08:00 – 08:30	0.0053	0.0053		0.4417	
08:30 – 09:00	0.0053	0.0053	0.0053		
$t_{critical}$ values					

Table 20 shows that some of the motorcycle speeds during 07:00-09:00 at Ratulangi street have similar variance, while some of them have similar variance. However, Table 21 shows that all of the speed mean of each 30 minutes interval have difference means to each others during 07:00-09:00.

5. CONCLUSION

The behaviors of the light vehicle motorcycle speeds on the one-directional urban roads in Makassar, Indonesia have been elaborated in this paper. Analysis of mean and standard deviation values of the speed using statistical test (i.e. variance and mean tests) shows the similarly and the difference phenomena of the speeds among 30 minutes interval in morning peak period (07:00-09:00). Further, the study has developed a simulation approach based on generating a large set of random number in order to assess the light vehicle and motorcycle speed distribution model in following the normal distribution. Regarding the calculation results of parameters values and a *Kolmogorov-Smirnov* test, we could state that the motorcycle speed distribution at three roads followed normal distribution curve, while one road failed in the test. This result leads to the chance in revising the simulation in further studies. Briefly, we expect that the distribution model is useful for a micro simulation of motorcycle traffic in further studies such motorcycle emission and noise simulation model.

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