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THE EFFECT OF SPEED LIMIT VIOLATION ON MOTORCYCLE CRASH RATE: CASE STUDY BANDUNG NATIONAL ROAD

Pengaruh Pelanggaran Batas Kecepatan Terhadap Tingkat Kecelakaan Sepeda Motor: Studi Kasus Jalan Nasional Kota Bandung

Aine Kusumawati
Faculty of Civil and Environmental Engineering
Bandung Institute of Technology
Jl. Ganesa No. 10 Bandung
West Java
aine@ftsl.itb.ac.id

Kardina N.S. Ayuningtyas
Faculty of Civil and Environmental Engineering
Bandung Institute of Technology
Jl. Ganesa No. 10 Bandung
West Java
kardina_nawassa@yahoo.com

Estiara Ellizar
Faculty of Civil and Environmental Engineering
Bandung Institute of Technology
Jl. Ganesa No. 10 Bandung
West Java
estiaraellizar@yahoo.com

Abstract

Speeding is one of the risk factors for road traffic crashes and deaths, especially for vulnerable road users. Research shows that increasing vehicle speed by 1 km/h can increase 4% -5% of fatal crashes. However, several other studies show that crashes are caused more by speed dispersion than by average speed vehicles in the traffic. This study aims to determine the effect of speed limit violations on the rate of a motorcycle crash on the national road in Bandung City. Although the proportion of motorcycles that violates the speed limit is quite high (40%), it turns out the result of this study indicates that the rate of motorcycle crash does not seem to be affected by the proportion of motorcycle in the traffic that violates the speed limit. Crashes involving motorcycles are more prevalent in the highest flow period than in the free flow conditions where the proportion of motorcycle that violates the speed limit is the highest.

Keywords: speeding, speed limit violation, crash rate, motorcycle crash

Abstrak

Mengendara dengan kecepatan tinggi merupakan salah satu faktor risiko penyebab kecelakaan lalu lintas dan kematian akibat kecelakaan lalu lintas, terutama pada kelompok pengguna jalan rentan. Penelitian menunjukkan bahwa peningkatan kecepatan kendaraan sebesar 1 km/jam dapat meningkatkan 4%-5% kecelakaan fatal. Namun beberapa penelitian lainnya menunjukkan bahwa kecelakaan lebih disebabkan oleh adanya variasi kecepatan di dalam arus dibanding kecepatan rata-rata kendaraan di dalam arus. Penelitian ini bertujuan untuk mengetahui pengaruh pelanggaran batas kecepatan terhadap tingkat kecelakaan sepeda motor di jalan nasional Kota Bandung. Walaupun proporsi sepeda motor yang melanggar batas kecepatan cukup tinggi (40%), ternyata hasil penelitian mengindikasikan bahwa tingkat kecelakaan sepeda motor tampaknya tidak dipengaruhi oleh proporsi sepeda motor di dalam arus yang melanggar batas kecepatan. Kecelakaan yang melibatkan sepeda motor justru lebih banyak terjadi pada kondisi arus tertinggi dalam satu hari dibanding pada kondisi arus lengang dimana proporsi sepeda motor yang melanggar batas kecepatan paling banyak.

Kata kunci: pelanggaran batas kecepatan, tingkat kecelakaan, kecelakaan sepeda motor

INTRODUCTION

One of the risk factors for road traffic crashes and the severity is driving at high speed (speeding). Speeding can cause the driver to lose control of his vehicle and can cause the driver not to be able to anticipate the danger in front of him. Speeding can also cause deaths, especially if it involves crashes with vulnerable road users such as pedestrians and

cyclists. Research shows that most pedestrians can survive if hit by a vehicle that runs at a speed of less than 30 km/hour (GRSP, 2008). An increase of speed by 1 km/h can increase 4% -5% of fatal crashes. A pedestrian has a death risk of 20% if hit by a car at speed below 50 km/h, but the risk increases to 60% if hit by a car at a speed of 80 km/h (WHO, 2017). Thus, limiting speed on the road plays an important role in realizing traffic safety.

West Java is the province with the largest population in Indonesia and has a fairly high vehicle growth rate (9%) in the last two years. Besides, West Java also ranked third for the number of deaths and traffic crashes in Indonesia in the last quarter (Korlantas, 2019). In the span of the last three years (2015-2017), the number of deaths from traffic crashes in West Java continued to increase from 15.33% in 2015 to 32.09% in 2017 (BPS, 2018). This shows the vulnerability of the traffic crash issue in West Java, especially with the growth rate of vehicles and a very high population.

In Bandung, most crashes involve motorcycles; in this case, motorcyclists experience the highest deaths on the road (68%), followed by pedestrians (23%) (Bandung Road Safety Annual Report, 2017). The factors that cause crashes are mostly the behaviour of vehicle drivers who violate traffic regulations, where 25% of injuries and traffic crash deaths are caused by vehicles travelling at high speed (Bandung Road Safety Annual Report, 2017).

One of the efforts that can be done to improve road traffic safety in Bandung is by limiting speed on roads in urban areas. Through this speed limitation, it is expected that the number of crashes and the severity of crash victims, especially for vulnerable road users, can be reduced. Thus, a study is needed to determine whether there is a relationship between violations of the speed limit and crash rate. This paper aims to determine the effect of violations of the speed limit on the motorcycle crash rate on the national road in Bandung. The results are expected to be a reference for stakeholders to determine steps to improve road traffic safety in Bandung.

LITERATURE REVIEW

Various studies have indicated that increasing speed limit will cause an increasing number of crashes and an increase in the severity of the crashes (Garber and Graham, 1990; Baum et al., 1991; Godwin, 1992; Chang et al., 1993; Rock, 1995, Farmer et al., 1999; Ossiander and Cummings, 2002; Vernon et al., 2004; Wong et al., 2005). However, crashes are not only related to absolute speed but also with speed variations, where the number of crashes will decrease when the speed of the vehicle in the traffic flow is uniform (Solomon, 1964; Lave, 1985; Garber and Gadiraju, 1989; Rock, 1995; Aljanahi et al., 1999; Oh et al., 2001).

Based on the speed data on the freeway, Oh et al. (2001) found that variations in speed were the most significant indicator of crashes potential. Solomon (1964) examined 600 miles of rural roads and measured vehicle speeds of 10,000 drivers and found the relationship of the U-shaped curve between speed variance and frequency of crashes. The lowest crash rate occurs when the speed variance is at the average speed and increases with an increase in speed variance away from the average speed. Rodriguez (1990) states that there are indications that variations in speed are positively associated with the crash fatality rate.

On main roads and arterial roads, Garber and Gadiraju (1989) found that variations in speed in road segments were greater when the difference between design speed and the speed limit was greater. But the study conducted by Pei et al. (2012) found that speed

variations were not significantly related to the incidence of crashes. They argue that their results contradict ordinary findings because the calculation of speed variations cannot accurately represent the speed difference in traffic flow with various types of vehicles.

The relationship between speed and speed limit has also been widely studied. In general, the results show that lowering the speed limit will cause the vehicle's average speed to decrease, and vice versa (Rock, 1995; Aljanahi et al., 1999; Ossiander dan Cummings, 2002). Speed variations will be greater at higher speed limits because, statistically, a data set with a high average will have a high variance (Rock, 1995). However, there is no clear effect of the speed limit on speed variations. Ossiander dan Cummings (2002) found that variations in crashes were not affected by increasing speed limits. Godwin (1992) states that high-speed limits are associated with lower speed variations. Levy and Asch (1989) show that there is a positive correlation between high speed and speed variations.

METHODOLOGY AND DATA COLLECTION

The study area in this study was Jalan Soekarno Hatta for the Buah Batu - Kiaracondong section. The road is a 6/2 D (six-lane two-way divided) national road segment located in Bandung. The research was conducted by collecting vehicle speed and flow data for 24 hours on a workday. The data was obtained from traffic recordings through cameras belonging to Area Traffic Control System (ATCS) at Bandung Department of Transportation on March 27-28, 2019, starting at 06.00 (March 27, 2019) until 06.00 (March 28, 2019). The recording was then used to carry out a traffic count survey and the average speed per 5-minute period for 24 hours.

RESULTS

Characteristics of Traffic Flow

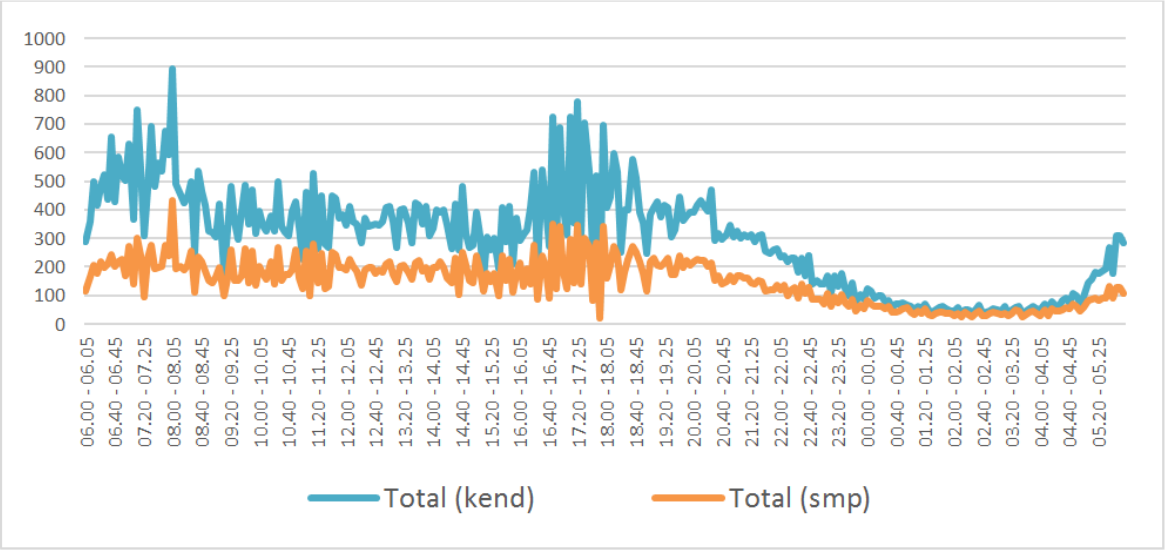


Figure 1. 5-minute flow variation in the Buah Batu - Kiaracondong segment

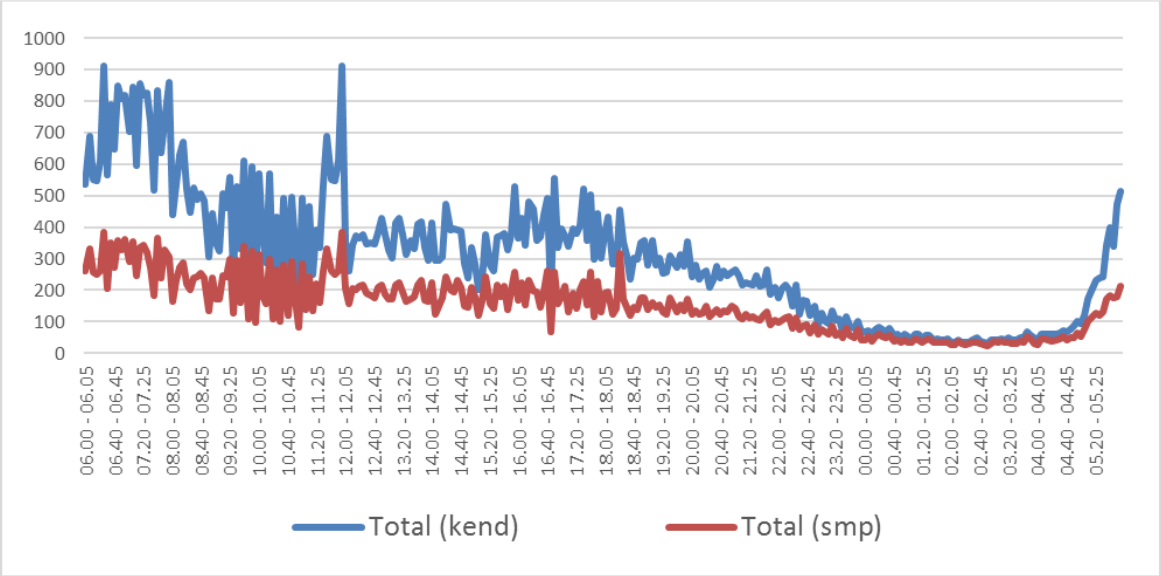
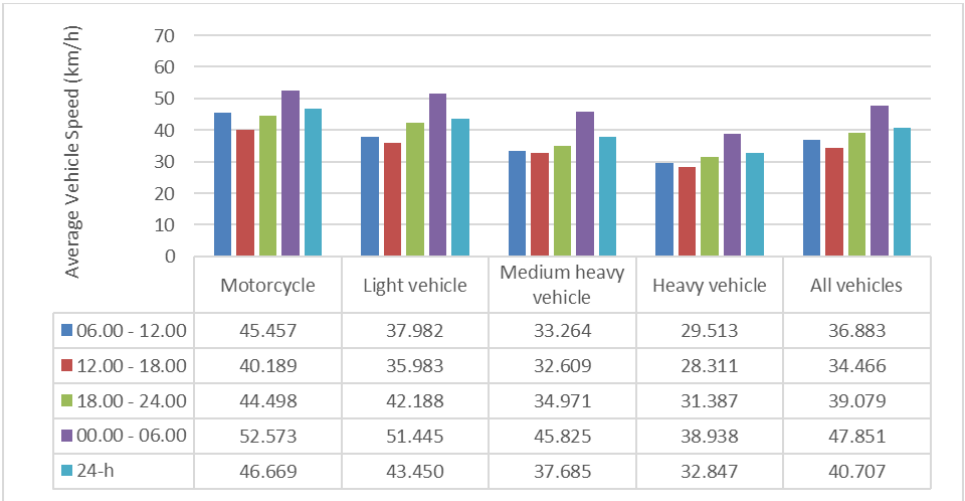


Figure 2. 5-minute flow variation in the Kiaracondong - Buah Batu segment

The results of the 5-minute flow survey for 24 hours on a workday are shown in Figure 1 (Buah Batu - Kiaracondong segment / Kiaracondong direction) and Figure 2 (Kiaracondong - Buah Batu segment / Buah Batu direction). AADT for Buah Batu - Kiaracondong segment is 83,731 vehicles/day or 42,863 pcu/day, while for Kiara Condong - Batu Buah segment is 88,119 vehicles/day or 43,950 pcu/day. The traffic flow is dominated by motorcycles (69%), with the same composition for both directions.

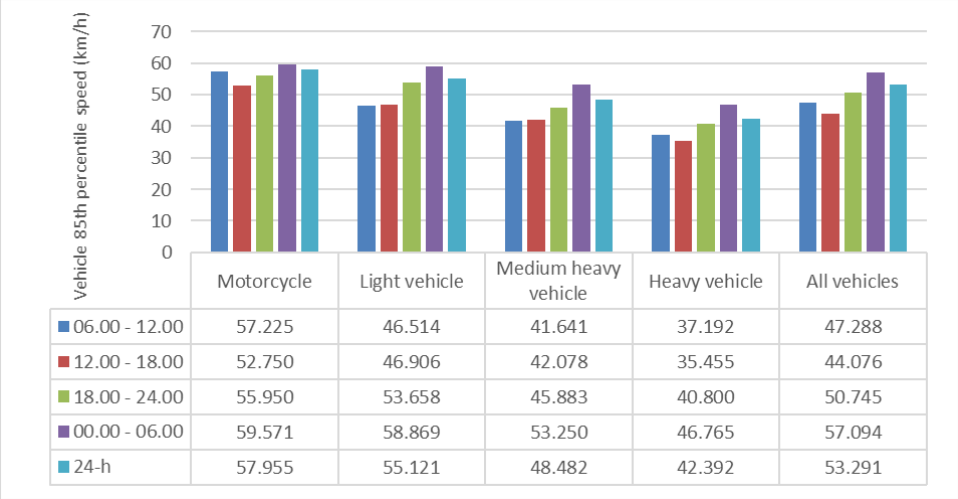
Speed Characteristics

The speed survey in the non-queueing condition resulted in 2230 speed data for the Buah Batu - Kiaracondong segment and 4385-speed data for the Kiaracondong - Buah Batu segment. The average speed and the 85th percentile speed for the two segments are shown in Figure 3 to Figure 6.



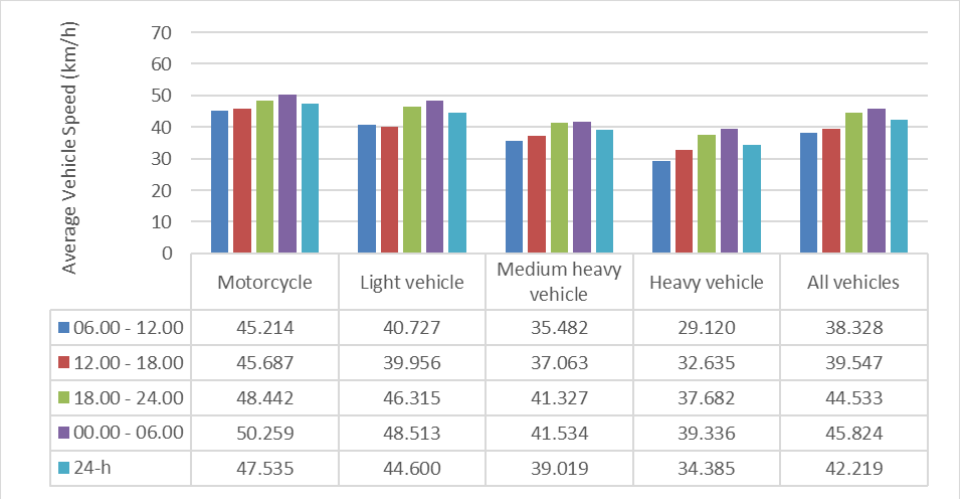
	Motorcycle	Light vehicle	Medium heavy vehicle	Heavy vehicle	All vehicles
06.00 - 12.00	45.457	37.982	33.264	29.513	36.883
12.00 - 18.00	40.189	35.983	32.609	28.311	34.466
18.00 - 24.00	44.498	42.188	34.971	31.387	39.079
00.00 - 06.00	52.573	51.445	45.825	38.938	47.851
24-h	46.669	43.450	37.685	32.847	40.707

Figure 3. The average speed of the Buah Batu - Kiaracondong segment



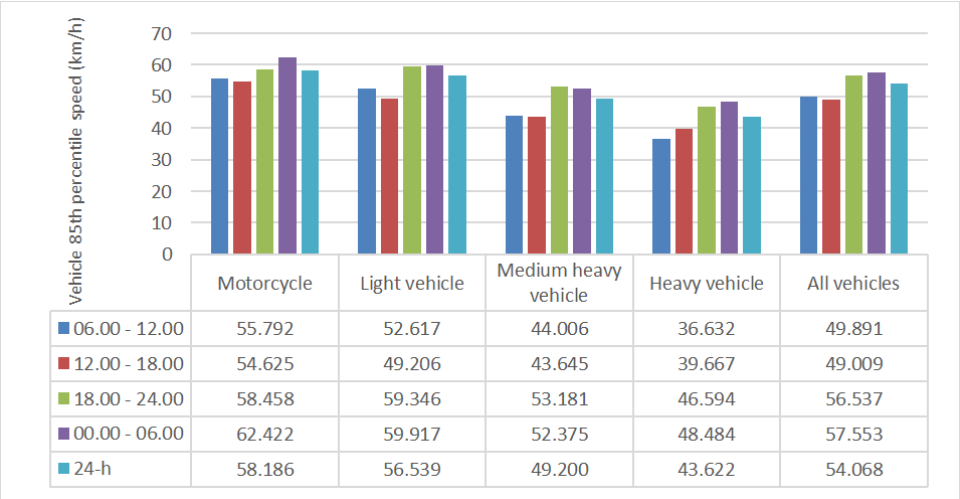
	Motorcycle	Light vehicle	Medium heavy vehicle	Heavy vehicle	All vehicles
06.00 - 12.00	57.225	46.514	41.641	37.192	47.288
12.00 - 18.00	52.750	46.906	42.078	35.455	44.076
18.00 - 24.00	55.950	53.658	45.883	40.800	50.745
00.00 - 06.00	59.571	58.869	53.250	46.765	57.094
24-h	57.955	55.121	48.482	42.392	53.291

Figure 4. 85th percentile speed of the Buah Batu - Kiaracondong segment



	Motorcycle	Light vehicle	Medium heavy vehicle	Heavy vehicle	All vehicles
06.00 - 12.00	45.214	40.727	35.482	29.120	38.328
12.00 - 18.00	45.687	39.956	37.063	32.635	39.547
18.00 - 24.00	48.442	46.315	41.327	37.682	44.533
00.00 - 06.00	50.259	48.513	41.534	39.336	45.824
24-h	47.535	44.600	39.019	34.385	42.219

Figure 5. The average speed of the Kiaracondong - Buah Batu segment



	Motorcycle	Light vehicle	Medium heavy vehicle	Heavy vehicle	All vehicles
06.00 - 12.00	55.792	52.617	44.006	36.632	49.891
12.00 - 18.00	54.625	49.206	43.645	39.667	49.009
18.00 - 24.00	58.458	59.346	53.181	46.594	56.537
00.00 - 06.00	62.422	59.917	52.375	48.484	57.553
24-h	58.186	56.539	49.200	43.622	54.068

Figure 6. 85th percentile speed of the Kiaracondong - Buah Batu segment

From Figure 3 and Figure 4, the average speed for the 24-hour period for the Buah Batu - Kiaracondong segment ranges from 32.847 km/h (heavy vehicles) to 46.669 km/h (motorcycles), with the average speed for all vehicles of 40.707 km/hour. Meanwhile, the 85th percentile speed ranges from 42.392 km/h (heavy vehicles) to 57.955 km/hour (motorcycles), with 85th percentile speed for all vehicles of 53.291 km/hour. The highest average speed occurred in the period of 00.00 - 06.00, while the lowest average speed occurred in the period of 12.00 - 18.00.

From Figure 5 and Figure 6, the average speed for the 24 hours for the Kiaracondong - Buah Batu segment ranges from 34,385 km/h (heavy vehicles) to 47,535 km/hour (motorcycles), with an average speed for all vehicles of 42,219 km/hour. Meanwhile, the 85th percentile speed ranges from 43.622 km/h (heavy vehicles) to 58.186 km/h (motorbikes), with 85th percentile speed for all vehicles at 54.068 km/hr. The highest average speed occurred in the period of 00.00 - 06.00, while the lowest average speed occurred in the period of 06.00 – 12.00.

Figure 7 to Figure 10 show the speed distribution of all vehicles and motorcycles in the Buah Batu - Kiaracondong segment (Figure 7 and Figure 9) and the Kiaracondong - Buah Batu segment (Figure 8 and Figure 10). From these figures, most vehicles run at a speed range of 40-45 km/hr, while the majority of motorcycles run at a speed range of 50-55 km/hr.

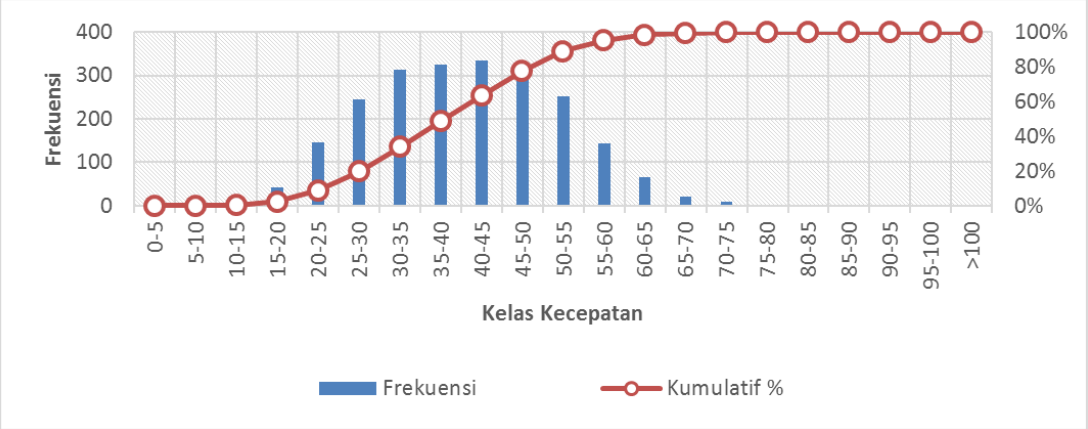


Figure 7. 24-hour vehicle speed distribution in the Buah Batu - Kiaracondong segment

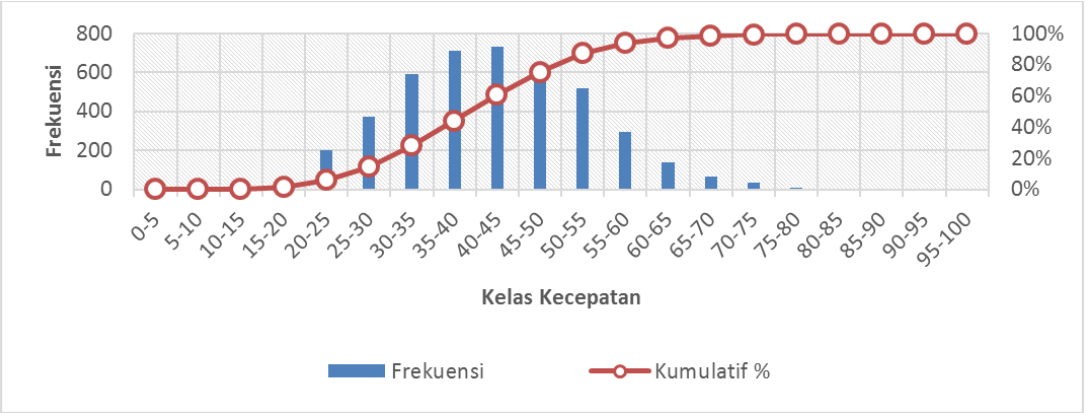


Figure 8. 24-hour vehicle speed distribution in the Kiaracondong - Buah Batu segment

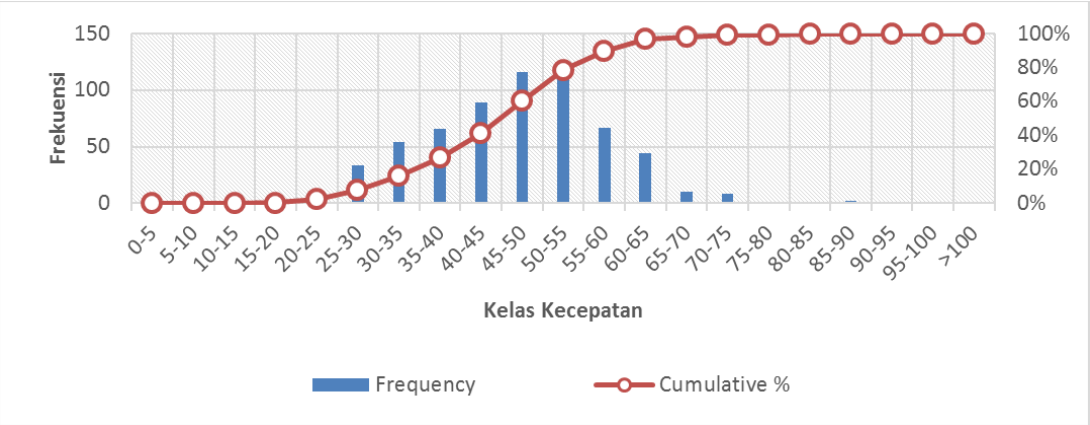


Figure 9. 24-hour motorcycle speed distribution in the Buah Batu - Kiaracondong segment

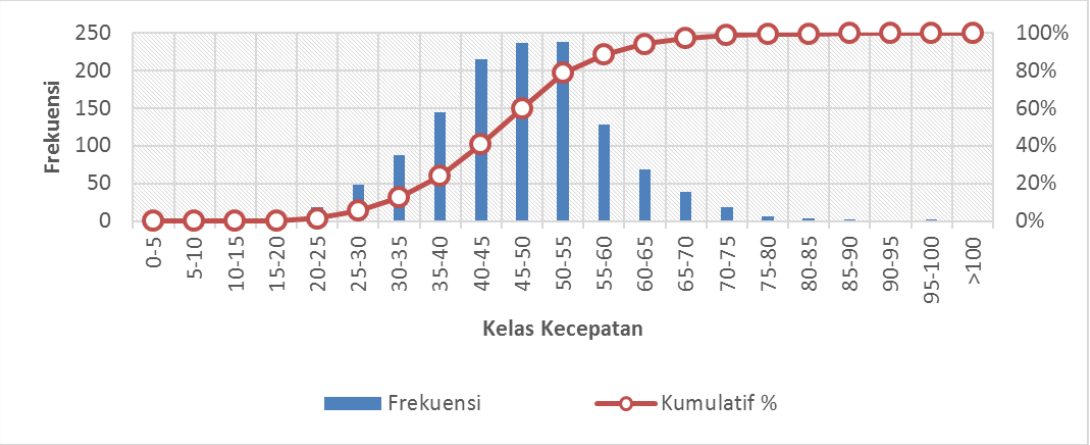
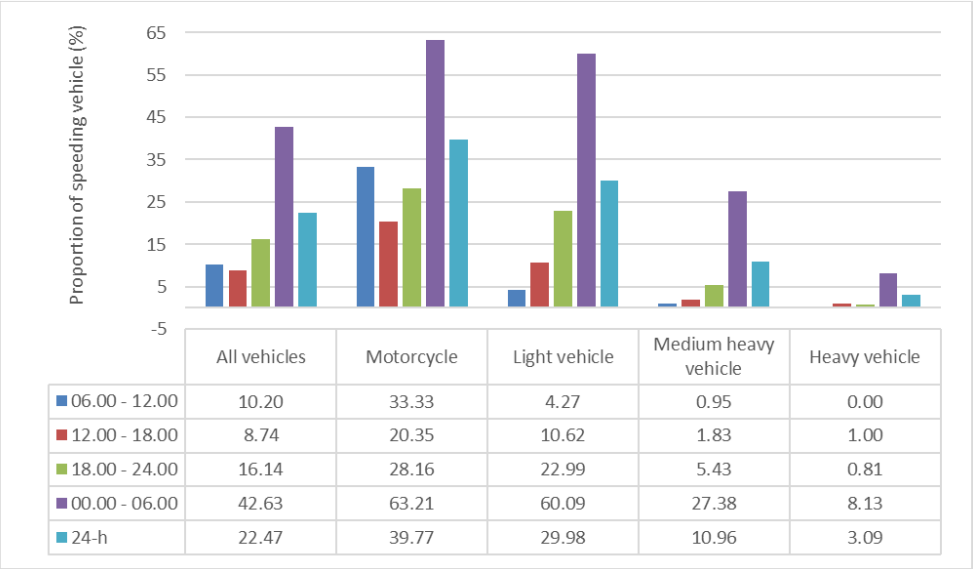


Figure 10. 24-hour motorcycle speed distribution on the Kiaracondong - Buah Batu segment

The proportion of Speeding Violation

Given the Soekarno Hatta road, segment is a road that is located in an urban area, even though it is a National road (primary arterial), then according to Government Regulation No. 79 of 2013 about Road Traffic and Transportation Networks, the applicable speed limit is 50 km/h (Article 23 paragraph 4 (a)).

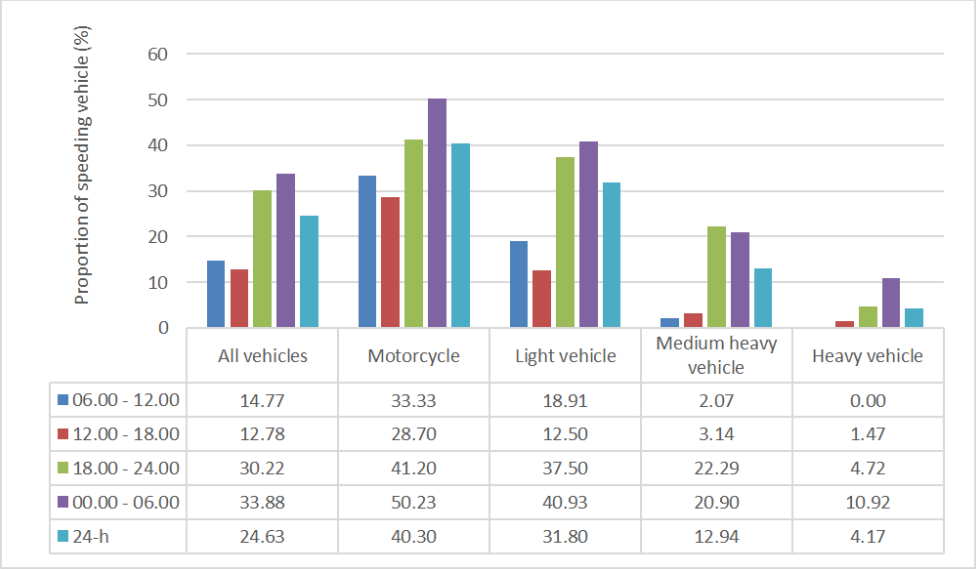
Figure 11 shows the proportion of vehicles that run exceeding the speed limit for the Buah Batu - Kiaracondong segment. The 24-hour observation resulted in 22.47% of vehicles exceeding the speed limit of 50 km/hour. Motorcycles are the highest proportion of vehicles (39.77%) that run exceeding the speed limit, while heavy vehicles are the lowest proportion of vehicles (3.09%) that run exceeding the speed limit. The period of 00.00 - 06.00 is the most vulnerable period for vehicles to speed; in this period the proportion of speeding motorcycles was 63.21%, and the proportion of speeding vehicles was 42.63%. The lowest level of speeding violation occurred in the period of 12.00 - 18.00 when there were only 8.74% of speeding vehicles.



	All vehicles	Motorcycle	Light vehicle	Medium heavy vehicle	Heavy vehicle
06.00 - 12.00	10.20	33.33	4.27	0.95	0.00
12.00 - 18.00	8.74	20.35	10.62	1.83	1.00
18.00 - 24.00	16.14	28.16	22.99	5.43	0.81
00.00 - 06.00	42.63	63.21	60.09	27.38	8.13
24-h	22.47	39.77	29.98	10.96	3.09

Figure 11. The proportion of speeding vehicles in the Buah Batu - Kiaracondong segment

Figure 12 shows the proportion of vehicles that run exceeding the speed limit on the Kiaracondong - Buah Batu segment. The 24-hour observation resulted in 24.63% of speeding vehicles exceeding the speed limit of 50 km/hour. Motorcycles are the highest proportion of vehicles (40.30%) that run exceeding the speed limit, while heavy vehicles are the lowest proportion of vehicles (4.17%) that run exceeding the speed limit. The period of 00.00 - 06.00 is the most vulnerable period for vehicles to speed; in this period, the proportion of speeding motorcycles was 50.23%, and the proportion of speeding vehicles was 33.88%. The lowest level of violation occurs in the period of 12.00 - 18.00, where there were only 12.78% of speeding vehicles.



	All vehicles	Motorcycle	Light vehicle	Medium heavy vehicle	Heavy vehicle
06.00 - 12.00	14.77	33.33	18.91	2.07	0.00
12.00 - 18.00	12.78	28.70	12.50	3.14	1.47
18.00 - 24.00	30.22	41.20	37.50	22.29	4.72
00.00 - 06.00	33.88	50.23	40.93	20.90	10.92
24-h	24.63	40.30	31.80	12.94	4.17

Figure 12. The proportion of speeding vehicles in the Kiaracondong - Buah Batu segment

In the Buah Batu - Kiaracondong segment, the proportion of vehicles that run exceeding more than 10% of the speed limit is 11.12% (all vehicles, 24 hours) and 21.43%

(motorcycles, 24 hours). In the period of 00.00 - 06.00, there are still 20.45% of vehicles that run exceeding more than 10% of the speed limit, with the proportion for motorcycles at 33.02%. The proportion of vehicles run exceeding more than 20%, 30%, and 40% of the speed limit is getting smaller. Only 4.66%, 1.66%, and 0.67% of vehicles (in the 24-hour period) run exceeding more than 20% (60 km/h), 30% (65 km/h), and 40% (70 km/h) of the speed limit. During these 24 hours, 10.55% of motorcycles run exceeding the speed of 60 km/h, and as many as 14.15% of motorcycles run exceeding the speed of 60 km/h in the period of 00.00 - 06.00.

In the Kiaracondong - Buah Batu segment, the proportion of vehicles that run exceeding more than 10% of the speed limit is 12.79% (all vehicles, 24 hours) and 21.63% (motorcycles, 24 hours). In the period of 00.00 - 06.00, there are still 19.01% of vehicles that run exceeding more than 10% of the speed limit, with the proportion for motorcycles at 28.37%. The proportion of vehicles run exceeding more than 20%, 30%, and 40% of the speed limit is getting smaller. Only 6,04%, 2,92%, and 1,37% of vehicles (in the 24-hour period) run exceeding more than 20% (60 km/h), 30% (65 km/h), and 40% (70 km/h) above the speed limit. During these 24 hours, 10.55% of motorcycles run exceeding the speed of 60 km/h, and as many as 18.60% of motorcycles run exceeding the speed of 60 km/h in the period of 00.00 - 06.00.

The Effect of Speed Limit Violations on Motorcycle Crash Rate

Table 3 shows the motorcycle crash rate for the Buah Batu - Kiaracondong segment and the Kiaracondong - Buah Batu segment (based on crash data of 2016-2018).

Table 1. Motorcycle crash rate

Buah Batu – Kiaracondong Segment				
Time period	**06.00 - 12.00**	**12.00 - 18.00**	**18.00 - 24.00**	**00.00 - 06.00**
Flow (vehicles/hour)	22.537	18.156	14.256	3.872
Total crashes	3	3	0	0
Crash rate (per 10,000 vehicles)	1,33	1,65	0	0
Kiaracondong – Buah Batu Segment				
Flow (vehicles/hour)	28.327	17.426	10.925	3.866
Total crashes	1	3	0	0
Crash rate (per 10,000 vehicles)	0,35	1,72	0	0

Based on the results of the previous analysis, motorcycles are the type of vehicle with the highest proportion of violations against speed limit, among other types of vehicles. However, although the highest proportion of speed limit violations by motorcycles occurs at 00.00 - 06.00, from Table 3, the highest rate of motorcycle crashes occurs in the period of 12.00 - 18.00 (in high flow condition and the lowest speed violation proportion). This shows that there seems to be no effect of violating the speed limit on the motorcycle crash rate.

DISCUSSION

The results of the analysis indicate that there is no effect of violations of motorcycle speed limits on motorcycle crash rates, even though motorcycles are the most dominant type of vehicle violating the speed limits and are also most often one involving in traffic crashes. Although the proportion of violations of speed limits by motorcycles most often occurs at dawn, at that time, there is no history of traffic crashes involving motorcycles. Traffic crashes are more prevalent in high flow conditions, where violations of the speed limit are low, but many conflicts occur with pedestrians and other vehicles.

The results of the analysis also show that even though many motorcycles violate the speed limit, only around 20% run exceeding more than 10% of the speed limit (55 km/h). This may be due to the characteristics of the road in the study area that are not too long and have many access roads even though they are national roads, making it difficult to drive vehicles at high speeds even when the flow is low. This motorcycle speed that is not too high, even though it is already above the applicable speed limit, might contribute to the results of this study that there is no apparent effect of violating the speed limit on the motorcycle crash rate. Also, the lack of availability of traffic crash data might be contributing to the difficulty in knowing the effect of violations of speed limits on crash rates.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis, it is concluded that there appeared to be no relationship between the proportion of vehicles that violate the speed limit and crash rates, especially on motorcycles. From the data that has been summarized, crashes occur more frequently in high flow conditions than in conditions where many vehicles violate the speed limit.

Nevertheless, the rate of violation of the speed limit still needs to be reduced. In this case, several recommendations are proposed, including the need to conduct socialization of speed limits on urban roads, the installation of more speed limit signs on urban roads, more intensive law enforcement for speed limit violators, and engineering measures to reduce vehicle speed on urban roads.

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