Study of potential implementations for motorcycle lanes in Padang city

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Abstract. Currently, two-wheeled vehicles or motorcycle dominate more than 80% of motorized vehicles in Indonesia. In addition to low prices, these motorized vehicles are fuel efficient, have easier and faster mobilization. However, the large number of motorcycles results in complicated traffic operations and reduced levels of safety. Lanes separation is the best engineering solution to overcome this problem. The purpose of this study was to review the potential application of motorcycle lanes in the city of Padang, a case study on the Raya Ampang and By Pass roads. Collecting the primary data were conducted by Video Image Processor. Each road was carried out recording for 1 day during peak hours in the morning, afternoon, and evening. Analysis of road performance is based on the Highway Capacity Manual of Indonesia (MKJI) 1997 with the degree of saturation (DS) parameter. Road performance analysis is reviewed by comparing the existing conditions and the conditions in which the inclusive motorcycle lanes are applied. The results of the study show that both the Raya Ampang and By Pass streets is feasible to provide an inclusive lane or shared lanes for motorcycles—with a lane width of 3 meters. With motorcycle lane application scenarios, on the Raya Ampang street for non-motorcycle lanes, there is a 10.7% increase in road performance, while for By Pass road, the increase in road performance is 31.5%.

1. Introduction
Motorcycle is the most favorite vehicle and as one of transportation mode in some countries in Asia, especially ASEAN countries [1-2]. Indonesia is the top three countries in trading motorcycle following China and India, respectively. In 2017, data indicated that total of motorcycles reached 113.000.000 units, which was equivalent to 81.6% of total number of vehicles in Indonesia [3]. Growth of motorcycle proportion in traffic flow of Indonesia increased from 25-45% in 1997 to 50-85% in 2011 [4]. The result of research in Padang in 2017 was that proportion of motorcycle volume was around 53-76% in traffic flow where the location of study on street with its type 4/2 D (4 lanes, 2 divided direction) and 4/2 UD (4 lanes, 2 undivided direction) [5]. It is predicted that it is going to develop in line with android application based on vehicle which is well known by its name online motorbike taxi. Various effects occur because of the growth of the total number of motorcycles, which most of them are negative. Among the effects are decreasing space mean speed [5-6], traffic congestion [7] and accident [7-9]. Some efforts are conducted to decrease the negative effects of the growth of motorcycle volume in traffic flow. The result of study proved that separation of lane is the best engineering solution to save motorcycle rider [1-2, 8, 10-12]. This research observes the potentiality in applying particular lane for motorcycle in Padang. The locations of study are Raya Ampang and By Pass km 8 street. The feasibility
of applying motorcycle lanes is assessed from existing road performance compared to performance after application in those locations.

2. Literature review

2.1. Definition and design of motorcycle lanes

According to Act number 22 Year 2009 regarding traffic and transportation in Indonesia, “motorcycle is a two-wheeled motor vehicle with or without accessories or a three-wheeled vehicle without accessories” [14]. Ministry of transportation ordinance of the Republic of Indonesia number 34 year 2014 regarding road signs defines that “Lane is a long part of road with or without road signs which has enough width in order that one vehicle can run, except motorcycle”[15]. Motorcycle lane sign is another sign which is marked by a picture of white motorcycle which is placed on the left of traffic. Motorcycle lane sign is placed on the same lane of other vehicles.

In Malaysia, there are two types of motorcycle lanes; they are exclusive motorcycle lanes and inclusive motorcycle lanes [5]. Exclusive motorcycle lanes are constructed specially to separate motorcycle and other vehicles, which is separated by fence or median. Meanwhile, inclusive motorcycle lane or shared lane [10] separates motorcycle with other vehicles which is bordered by road sign. Applying exclusive motorcycle lane in Indonesia has been done on some highways in Jakarta; Darmo street in Surabaya; Lingkar Utara street, Sleman, Yogyakarta; Bypass Sukarno-Hatta arteri street, Bandung.

Directorate General of Highways, 2004 made a rule that determination of the need of exclusive or inclusive motorcycle lane is decided if percentage of motorcycle volume > 40 than volume of total vehicles [12].

Lane widths of 2.0m, 2.5m, and 3.0m were recommended for motorcycle volumes ranging from 1000-1500, 1500-2000, and above 2000 per hour, respectively. A motorcyclist physically spans 0.8m wide, 2.0m in length. An area of 1.6m² represents the physical space occupied by static motorcyclist. The mean operating speed required by single motorcyclist is 1.3m [1].

2.2. Road performance

Analysis of road performance is based on MKJI 1997 [16] with degree of saturation parameter. Degree of saturation (DS) is defined as ratio of traffic flow Q (pcu/hour) on capacity C (pcu/hour), which is used as the main factor in determining level of road performance. DS score shows whether the road has a capacity problem or not.

Capacity is defined as the maximum traffic flow on a section of road under fluent traffic conditions per hour. To estimate road capacity in the city area, the formula is: [16]

\[ C = C_0 \times F_{CW} \times F_{SF} \times F_{SP} \times F_{CS} \]  

Where:
- \( C_0 \): basic capacity,
- \( F_{CW} \): lane width adjustment factor,
- \( F_{SF} \): side friction adjustment factor,
- \( F_{SP} \): separation of directions adjustment factor, and
- \( F_{CS} \): city size adjustment factor.

According to [16], the basic capacity is determined as a table 1. and adjustment factor as tables in [16].

| Roads type                               | Basic capacity (pcu/hour) | Note               |
|------------------------------------------|---------------------------|--------------------|
| Four lanes divided or one way street     | 1650                      | per lane           |
| Four lanes undivided                     | 1500                      | per lane           |
| Two lanes undivided                      | 2900                      | total of 2 directions |
3. Methodology

3.1. Data collection
To analyze road performance, some primary data were collected by doing a survey. The survey is a road geometric survey by measuring the road using tape-measure.

Collecting the data of traffic volume and side barrier were conducted by Video Image Processor. Collecting the data on By Pass street was conducted on Wednesday, March 20th 2019 and on Raya Ampang street on was conducted on Monday, March 25th 2019. Data of traffic volume were taken in peak hours; they are the peak hour from 6:30 a.m. to 8:30 a.m., the peak hour from 11:30 a.m. to 1:30 p.m., and the peak hour from 4:30 p.m. to 6:30 p.m.

3.2. Data processing
Data of recorded video were read by using software Avidemux. The observation result showed traffic volume and side barrier. Data of traffic volume were recapitulated per 15 minutes and classified as a motorcycle (MC), light vehicle (LV) and heavy vehicle (HV). The volume of classified vehicles is equivalent to passenger cars unit (pcu). Volume of peak hour (1 hour) was determined based on the highest volume. Based on types of the road, volume of peak hour on Raya Ampang street was taken from two directions. Meanwhile, volume on By Pass street was taken from each direction (North and South) and volume of peak season was the highest volume from one of them. Flow chart of data processing is shown in figure 1.

![Flow chart of data processing](image)

**Figure 1.** Flow chart of data processing.

4. Results and discussion

4.1. The existing conditions
The geometric data of Raya Ampang and By Pass street and their cross sections are shown in figure 2 and figure 3.

![Cross section of Raya Ampang street](image)

**Figure 2.** Cross section of Raya Ampang street.
Raya Ampang street is a 4-lane 2-way undivided road type with a width of 7 m pavement for travelled way and shoulder width on the left and right sides of 1 m. On this road side frictions are medium.

![Cross section of By Pass street.](image)

By Pass street is a 4-lane 2-way divided road type with a width of 8.3m pavement for travelled way and shoulder width on the left and right sides of 2 m. On this road side frictions are low.

Data processing result of traffic flow volume on Raya Ampang street is that volume of peak hour is 6623 vehicles/hour (2936 pcu/hour) from 6:45 a.m. to 7:45 a.m. The highest volume of motorcycle occurs at the same time that is 4920 vehicles/hour (1230 pcu/hour) with its percentage 74.3%. Based on this percentage, it is concluded that the Raya Ampang road requires a special lane for motorcycle. On By Pass street, volume of peak hour is 3961 vehicles/hour (1837.5 pcu/hour) from 7:00 a.m. to 8:00 a.m. toward north direction. The highest volume of motorcycle (MC) is 2842 vehicles/hour (710.5 pcu/hour) with its percentage 71.8. The By Pass street need a special lane for motorcycle too. Result of analysis of road performance and the need for special lane for motorcycle on Raya Ampang street are summarized in table 2, and on By Pass street in table 3.

| Time        | Volume (veh/hr) | Total volume veh/hr | % MC | C pcu/hr | DS | Suggestion               |
|-------------|-----------------|---------------------|------|----------|----|--------------------------|
| 6.45-7.45 a.m | 4920 1690 13 | 6623 (2936)         | 74.3 | 5224.6   | 0.56 | Need of motorcycle lane |

Table 2. Raya Ampang street performance analysis.

| Time        | Volume (veh/hr) | Total volume veh/hr | % MC | C pcu/hr | DS | Suggestion               |
|-------------|-----------------|---------------------|------|----------|----|--------------------------|
| 7:00-8:00 a.m | 2842 1690 13 | 3961 (1837.5)       | 71.8 | 3417     | 0.54 | Need of motorcycle lane |

Table 3. By Pass street performance analysis.

With a DS value of 0.5, the traffic conditions are stable flow, vehicle speed and movement controlled by traffic volume. Both roads require special lane for motorcycle. Based on the geometric condition of the road, the specific types of lanes applied are inclusive motorcycle lane or shared lane. Inclusive motorcycle lane or shared lane separate motorcycle with other vehicles which are bordered by road sign and marking, placed on the left of traffic.

4.2. The application of motorcycle lanes conditions

Raya Ampang and Bypass roads require a shared lane with 3 metre in width. Lane widths of 3.0m were recommended for motorcycle volumes above 2000 per hour [1]. Motorcycle lane is designed by using road shoulder and part of the road body as it is shown in figure 4 and figure 5.
Analysis of road performance with scenario of shared lane is shown in table 4.

|                  | $Q_{\text{non MC}}$ (pcu/hr) | C (pcu/hr) | DS  |
|------------------|-----------------------------|----------------|----|
| Raya Ampang      | 1705                        | 3481          | 0.50 |
| By Pass          | 1127                        | 3070          | 0.37 |

On Raya Ampang street, road performance increases 10.7% on non-motorcycle lane and DS score decreases from 0.56 to 0.50. The same thing, on By Pass street, there is an increase, 31.5% and the decrease of DS score from 0.54 to 0.37. Road performance improvement is quite significant so that traffic conditions are stable with moderate traffic volumes.

5. Conclusion
From the results of the analysis of the two road sections that are the locations of the research objects, Raya Ampang and Bypass road have the potential to apply motorcycle lanes. The right type of motorcycle lane applied is inclusive lane or shared lane, separates motorcycle with other vehicles which is bordered by road sign and marking. Motorcycle lane with 3 metre in width is designed by using road shoulder and part of the road body. Analysis of road performance with scenario of motorcycle lane implementation shows that there is an increase in performance on non-motorcycle lanes for both roads.

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References
[1] Hamid H, Sohadi R U R, Sadullah A F M and Ma’soem D M 2005 IATSS Research 29 1 50-6
[2] Le T Q and Nurhidayati Z A 2016 Procedia Engineering 142 292-8
[3] Central Bureau of Statistics 2018 Statistik Transportasi Darat https://www.bps.go.id/publication/2018
[4] Putranto L S, Suardika G P, Sunggiardi R, Munandar A S and Lutfi I 2011 Proc. of the Eastern Asia Soc. for Transportation Studies vol 8
[5] Kurniati T and Fajriati R 2019 MATEC Web of Conf. vol 276 03016
[6] Kusnandar E 2010 The effect of the proportion of motorcycle on the speed of traffic flow J. Puslitbang Jalan dan Jembatan (in bahasa)
[7] Lubis H A R S 2009 Proc. of the Eastern Asia Soc. for Transp. Studies vol 7
[8] Law T H and Sohadi U R R 2005 J. of the Eastern Asia Society for Transp. Studies 6 3372-85
[9] Khaidir N M, Manan M M A and Johari N M 2015 Proc. of Conf. of ASEAN Road Safety pp 80-5
[10] Mama S and Taneerananom P 2016 Engineering Journal 20 3 113-21
[11] Sulistio H 2018 The Open Transp. J 12 1-7
[12] Zukhruf F, Frazila R B dan Wibowo S S 2010 J. Transportasi 10 1 23-32
[13] Ibrahim M K A, Hamid H, Hua L T and Voon W S (2018) Accident Analysis and Prevention J. 111 63-70
[14] Anonymous 2009 Act of the Republic of Indonesia number 22 Year 2009 Traffic and Transportation
[15] Anonymous 2014 Ministry of Transportation Ordinance of the Republic of Indonesia number 34 year 2014 Road Markings
[16] Directorate General of Highways (Bina Marga) 1997 Indonesian Highway Capacity Manual Bandung Indonesia