Influence of motorcycles lane to the traffic volume and travel speed in Denpasar, Indonesia

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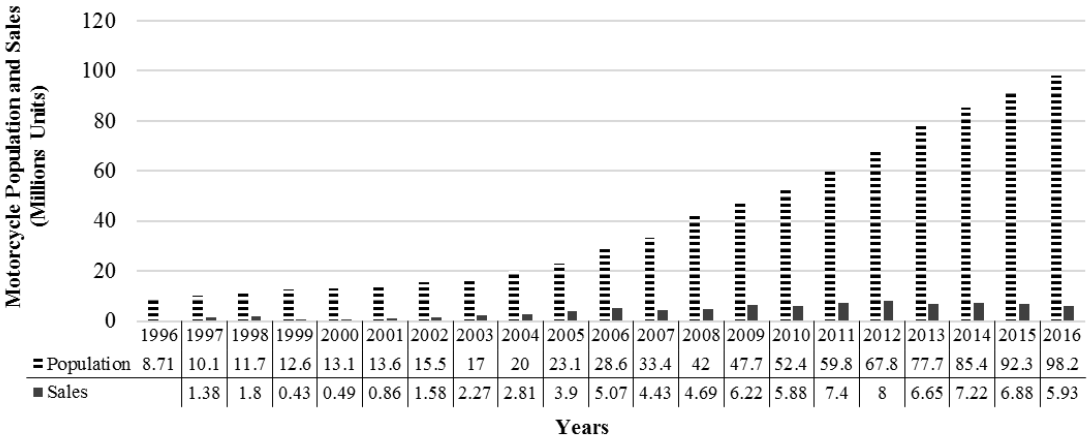
Abstract. The large number of motorcycles population was causing a decrease in road performance. In order to overcome these problems, motorcycles lane was build to make homogeneity movement of the motorcycle on the road. The purpose of this study is to analysis the influence of motorcycles lane to the traffic volume, travel speed and density. In this study, data was collected at three times segmentation times i.e. morning, noon and afternoon in four locations, there were Puputan road, Cok Agung Tresna road, Sudirman road heading south, and Sudirman road heading north in Denpasar. The data were collected are traffic volume and travel speed on motorcycles lane and non motorcycles lane. According to the paired t test of travel speed and traffic volume and density there was significant differences between motorcycle lane and without motorcycle lane.
Keywords: four-wheeled vehicle, motorcycles lane, traffic volume, traffic jammed, transportation mode

1. Introduction

Motorcycles as the most popular of transportation mode in Indonesia. Motorcycles have some advantages such as the relative easyly move by using narrow gap between other vehicles, so that the motorcycle made the main choice to travel, especially when traffic jammed occurs. Ownership of motorcycles increased year by year and dominated the movement of traffic on the road with motorcycle population reaching 98.20 million units or 80.5 percent of the overall traffic composition of vehicles in Indonesia [1]. The motorcycle population is shown in Figure 1.

The high composition motorcycle's ownership and changes riding behavior of motorcycle travel from short distance to long distance caused an impact to the traffic condition. The major impact of the problem is decrease of road capacity and increase the number of accidents. Issue of the Government Regulation no 22 in year 2009 is the regulating to force the movement of motorcycles should be on the left lane of the road [2] in order to reduce traffic conflicts with four-wheeled vehicles that generally have higher speeds.

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	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Population	8.71	10.1	11.7	12.6	13.1	13.6	15.5	17	20	23.1	28.6	33.4	42	47.7	52.4	59.8	67.8	77.7	85.4	92.3	98.2
Sales		1.38	1.8	0.43	0.49	0.86	1.58	2.27	2.81	3.9	5.07	4.43	4.69	6.22	5.88	7.4	8	6.65	7.22	6.88	5.93

Figure 1. Population and sales of motorcycles.

The concept of homogeneity of traffic movement by separate road's lane for motorcycles is one alternative solution to reduce the traffic conflict [3]. Therefore, to force the motorcycle to be on the left lanes, it is necessary to provide motorcycle lane.

Motorcycles lanes are divided into two types of inclusive motorcycles lanes and exclusive motorcycles lanes (Figure 2). Inclusive motorcycles lane is a special lane used for motorcyclists, which serves to separate motorcycles with other vehicles using traffic signs and road markings. Meanwhile, exclusive motorcycles lane is a special lane used for motorcycle, which separate the motorcycle with other vehicles by using a road separator or curb. Both exclusive or inclusive motorcycles lane are expected to reduce the number of accidents involving motorcycles because it is physically separate from other types of vehicles .

Motorcycle lanes are required when the number of motorcycles is greater than 600 motorcycles/ hour/ lane [4]. This number is obtained from determining the headway between motorcycles when driving on urban roads is at least 6 seconds. If converted into hours, then get 600 motorcycles. Providing motorcycles lanes is to reduce accidents. If the amount of accidents is greater than 40 accidents/km/year or the accident rate 100, then it has to have motorcycle lane [5].

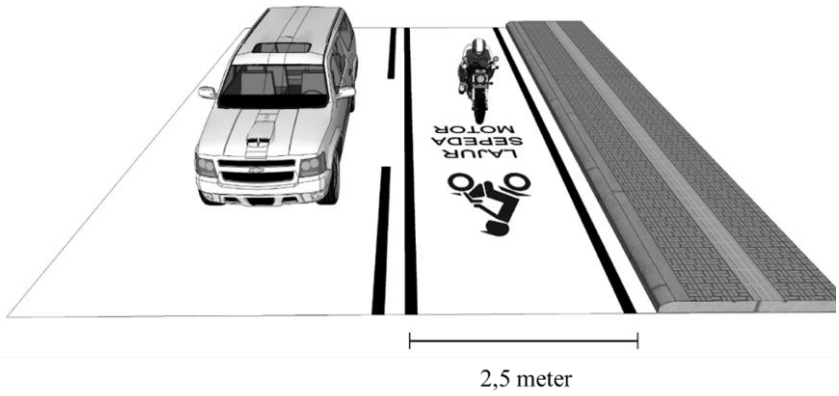


Figure 2. Motorcycles lane.

The placement of motorcycles lanes must meets with same criteria, i.e. motorcycles lanes are priority lane than other vehicles lane on the road, motorcycles lanes in urban arterial roads or suburban arteries which have urbanized travel characteristics. Motorcycles lanes in the urban arterial road are on the left side and should be separated from the lane of four-wheeled vehicles by using road marking or curb separator. This study to analyzes the difference of traffic volume, travel speed and

traffic density between a roads with motorcycles lane and without motorcycles lane facilities. It can be seen whether the motorcycles lanes affect the traffic volume and travel speed and traffic density on two different condition with the same criteria.

2. Research Method

2.1. Methods of Collecting Data

Traffic volume and travel speed data collection was conducted in mid July 2016 in four places, there were Puputan Niti Mandala Renon Road (Road with motorcycle lane), Cok Agung Tresna Road (road without motorcycle lane) and Sudirman Road way to south (road with motorcycle lane) and Sudirman Road way to the north (road without motorcycle lane) in Denpasar City. Data were collected during morning, noon and afternoon sessions. Each sessions was taking for two hours of data with intervals of five minutes. The data was taken by the surveyor by using traffic counter eqquipment to collect traffic volume data and speed gun eqquipment to collect travel speed data. Motorcycles lanes on Puputan road and Sudirman road which have width 2.5 meter were divided into 2 lanes in one direction. In addition, there are 2 lanes for other types of vehicles with a width of 3.5 meters. The data collection surveys is shown in Figure 3 and the roads survey condition is shown in Table 1.

Table 1. The roads survey condition.

Location	Criteria	Number of Lanes	Roads Classification [6]	Road Width	Remarks
Puputan Niti Mandala Renon Road	with motorcycle lane	3 lanes	Arterial Secondary	9 meters	Location 1
Cok Agung Tresna Road	without motorcycle lane	3 lanes	Arterial Secondary	9 meters	
Sudirman Road way to the south	with motorcycle lane	2 lanes	Local Primary	8 meters	Location 2
Sudirman Road way to the north	without motorcycle lane	2 lanes	Local Primary	8 meters	

2.2. Method of data analysis

Data analysis in this research was done by using paired sample t test. Paired sample t test is an analytical technique to compare one or more independent variables. This technique is used to test whether a particular value differs significantly or not with an average of two samples. The t test as a technique of testing the descriptive hypothesis has two criteria on each parameter analysis that is volume, speed and density.

Table 2. One-Sample Kolmogorov-Smirnov Test.

		Unstandardized Residual
N		228
Normal Parameters[a,b]	Mean	0E-7
	Std. Deviation	180,18704216
Most Extreme Differences	Absolute	0,273
	Positive	0,273
	Negative	-0,142
Kolmogorov-Smirnov Z		1,337
Asymp. Sig. (2-tailed)		0,556
a. Test distribution is Normal.		
b. Calculated from data.		

This research uses 5% significance level (0.05) based on research hypothesis that has been determined. Hypothesis using statistical test paired sample t test [7] was conducted to test the pairs of traffic parameters data as follows:

- If the value is significant <0.05 then H0 is accepted (no difference / significant)
- If the value is significant> 0.05 then H0 is rejected (there is a difference / not significant)

Prior to analysis t test of paired sample should be tested normality data, so it can get good value. Normality test aims to test whether the data used in the modelling has been distributed normal or not. To detect data normality, it can be done by One Sample Kolmogorov-Smirnov Test. If the significance value of the Kolmogorov-Smirnov One-Sample Test> 0.05 [10], then the assumption of normality is met as shown in Table 2.

The normality test results obtained significance value of the Kolmogorov-Smirnov One-Sample Test results of 0.556, then the assumption of normality for the data used in this study has been met.

3. Results and Discussion

The traffic volume data were processed by converting traffic volume data to passenger car unit (pcu/ hour) [8]. After that was divided into traffic volume per lane [9].

Table 3. Result of Paired T-test statistic test at Location 1.

Time Session	Parameter Analysis	Criteria	Sig (2 Tailed)	Level of significance	Explanation
Morning	Traffic Volume	Motorcycle Lane / Non- Motorcycle Lane	0.492	0.05	Not Significant
	Travel Speed	Motorcycle Lane / Non- Motorcycle Lane	0.284	0.05	Not Significant
	Traffic Density	Motorcycle Lane / Non- Motorcycle Lane	0.532	0.05	Not Significant
Day	Traffic Volume	Motorcycle Lane / Non- Motorcycle Lane	0.097	0.05	Not Significant
	Travel Speed	Motorcycle Lane / Non- Motorcycle Lane	0.086	0.05	Not Significant
	Traffic Density	Motorcycle Lane / Non- Motorcycle Lane	0.491	0.05	Not Significant
Noon	Traffic Volume	Motorcycle Lane / Non- Motorcycle Lane	0.037	0.05	Significant
	Travel Speed	Motorcycle Lane / Non- Motorcycle Lane	0.263	0.05	Not Significant
	Traffic Density	Motorcycle Lane / Non- Motorcycle Lane	0.411	0.05	Not Significant

From the results of data processing, it was found that the traffic volume on the road with motorcycle lane facilities is greater than in the road without motorcycle lane traffic in location 1 (Table 3). At Jalan Raya Puputan (with motorcycle lane), the traffic volume in the morning and afternoon session sessions is 722 pcu/ hour/lane and 560 pcu/hour/lane which higher than Jalan Cok Agung Tresna (without motorcycle lane) by 536 pcu/hour/lane and 457 pcu/hour/lane respectly. In the afternoon seassions the traffic volume on Jalan Cok Agung Tresna (without motorcycle lane) is 636 pcu/hour/lane was greater than the traffic volume on Jalan Raya Puputan (motorcycle lane) which is 586 pcu/hour/lane.

In the location 2, the traffic volume on the road with motorcycle lane facilities has a higher than on the roads without motorcycle Lane in the morning, afternoon and also afternoon sessions. The traffic volume on the road with motorcycle lane facilities is 25% larger than on the road without the motorcycle lane facilities. The largest traffic volume is on the road with the motorcycle lane facility in the morning session by of 1109 pcu/hour/lane. As for the largest traffic volume on the road without motorcycle lane is 885 pcu/ hour/lane.

Table 4. Result of Paired T-test statistic test at Location 2.

Time Session	Parameter Analysis	Criteria	Sig (2 Tailed)	Level of significance	Explanation
Morning	Traffic Volume	Motorcycle Lane Non- Motorcycle Lane	0.284	0.05	Not Significant
	Travel Speed	Motorcycle Lane Non- Motorcycle Lane	0.073	0.05	Not Significant
	Traffic Density	Motorcycle Lane Non- Motorcycle Lane	0.597	0.05	Not Significant
Day	Traffic Volume	Motorcycle Lane Non- Motorcycle Lane	0.335	0.05	Not Significant
	Travel Speed	Motorcycle Lane Non- Motorcycle Lane	0.181	0.05	Not Significant
	Traffic Density	Motorcycle Lane Non- Motorcycle Lane	0.662	0.05	Not Significant
Noon	Traffic Volume	Motorcycle Lane Non- Motorcycle Lane	0.293	0.05	Significant
	Travel Speed	Motorcycle Lane Non- Motorcycle Lane	0.064	0.05	Not Significant
	Traffic Density	Motorcycle Lane Non- Motorcycle Lane	0.520	0.05	Not Significant

Data processing speed at location 1 has the largest spread distribution of data, espesially the data on Cok Agung Tresna (without motorcycle lane) that have an average travel speed of 62 km/h during the afternoon session. Meanwhile on the Puputan road with the motorcycle lane facilities, the average travel speed is 55 km/h in morning and afternoon session.

Result of data processing of travel speed in location 2 has the largest data spread distribution data that is at the location of Sudirman road (north direction) that have an average speed of 50 km/hour in morning and afternoon seassion. Meanwhile on Sudirman Road (south direction) without motorcycle lane facilities th average speed is 37 km/h in the afternoon seassion.

From the test results it was obtained significance value for the difference of analysis parameters ie traffic volume, traffic speed and traffic density on the road with motorcycle lane and without motorcycle lane > 0.05 then H0 is rejected (there are differences/not significant). Result of data test at location 1 has got difference of data between two criterions of location at all time session and test parameter in the afternoon session there were traffic volume with a significance value of 0.037. This value shows that there is no significant difference in the traffic volume value between road with motorcycle lane and non-motorcycle lane at that time.

The results the analysis data was taken at location 2, it's obtained the significance value for the different parameters of analysis i.e. traffic volume, traffic speed and traffic density on road with motorcycle lane and without motorcycle lane location criteria >0,05 then H0 rejected (there is difference/not significant). The volume of traffic, travel speed and traffic density between motorcycle Lane and without Motorcycle Lane can be concluded differently as shown in Table 4.

4. Conclusion

The result of hypothesis test by Paired t test shows that traffic volume at location 1 shows that there is significant difference between traffic volume in morning and afternoon session time. Meanwhile in the afternoon there were no insignificant differences between with motorcycle lane and without motorcycle lane. For the analysis of travel speed and traffic density, there were significant differences at all time sessions. The result of hypothesis test by Paired t test shows that the traffic volume at location 2 shows that there are significant differences of traffic volume, travel speed and traffic density and at all time session. Based on the results of the research which was conducted, recommendations can be given that the presence of motorcycle lane could improve road performance significantly. Separation of movement between motorcycles and other types vehicles give more road space to other vehicles so that can increase the travel speed.

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