

EXPERIMENT ON BUS LANE APPLICATION IN YOGYAKARTA

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ABSTRACT

The growth of economy results in the growth of new business areas, which usually locate along streets with high traffic volume. However, these areas do not provide adequate parking facilities, so the visitors/customers often have to park their cars on trunk roads, which, in turn, reduces street effective width and leads to street capacity decrease. Public transport as the major transport service for middle to low class societies suffers from this situation in that buses have to share the lane with private cars which are growing bigger in number, resulting in lower public transport service quality. The application of bus lane is, therefore, expected to improve public transport service.

As a method for finding out the effect of bus lane application, the experiment compares the existing condition to the simulation of bus lane in which parking prohibition on trunk roads is included. The measurement covers street capacity, travel time, and speed.

The findings show that there is a flow increase of 4.73% from the condition before the application of bus lane. Bus travel time decreases as much as 6.69% while passenger car and motor bike travel time decreases 4.98% and 5.49% respectively. Bus speed increases 6.53%, but passenger cars and motor bikes speed decreases 4.59% and 5.49%.

INTRODUCTION

Economic improvement and technological advance in transportation field accelerate human mobility. This results in the increase of the needs for physical development - infrastructure and facilities-, which also influences the demand for new development areas to accommodate the needs. Almost all major cities are currently facing increasing pressures from different stakeholders to develop the existing areas for their business, commercial, trading, and industrial activities as well as for housings. Usually, these areas locate along streets of relatively high traffic volume.

The gap created by the development of road facilities and lack of parking facilities in areas of urban economic activities has triggered traffic problems. People using private cars absolutely need parking lots and when no parking lots are available they will use road trunk as an alternative. Street lanes are reduced and become narrower, and finally this leads to road capacity decrease. Speed slow down and traffic jam are indications for such a situation.

The use of public transport is an alternative to reduce traffic jam. However, without special priority, public transport becomes less attractive for users, or even may bring adverse effect: increasing traffic jam. With priority such as bus lane, it is hoped that passengers will arrive at their destination faster than when using private cars. Priority for public transport can be given during busy hours, i.e., when people go

to/home from offices. This will hopefully cause a shift from using private cars into using public transport.

RESEARCH METHOD

The research applies the following methods:

1. comparing road capacity before and after bus lane application
2. finding out speed and travel time increases which result from bus lane application.

Thus, the research is a field experiment on bus lane by observing and measuring the effect.

Bus lane and its use is defined as to give priority to buses by restricting other kinds of traffic sharing the same lane in order that buses can operate smoothly without any potential disturbances from other vehicles. The lane marking is normally used for a bus lane, thus it is not necessary separated with a physical barrier from other lanes. Generally, one lane for each direction is sufficient to provide buses free way for smooth operation. In areas of high bus density but lack of "lay bus" facility at the bus stops, a multi-lane must be provided to enable buses to pass another /others which are either running in low speed, or even stopping.

Oglesby and Hicks (1999) suggests that it needs a separate lane, called bus lane, to improve public transport facilities and services. This lane is usually a two-way lane in median area or along the street. This is applied on busy streets only. The major problems are high implementation cost and unwillingness of other road users to let that lane empty while they are stuck in traffic jam.

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Iskandar (1999) offers bus lane application as an alternative to improve the flow of big-size public transport in an efficient way. It has several advantages over railway, as the latter is not applicable for other kinds of vehicle. Bus lane is also flexible to operate.

Bus priority is applied when traffic jam caused by private cars reaches its peak level and when cars parked on road trunk and the effect of right turn disturb public transport movements. Under these conditions, the service speed is reduced so much that more buses need to be operated to maintain adequate service frequency. When additional buses are not available, the service frequency decreases and the users will choose other modes of transport that will actually worsen the jam. When bus priority application succeeds, it brings a satisfactory level of public transport service although traffic jam on other lanes may persist. Finally, this will attract users of private cars to using public transport.

Giannopoulos (1989) offers several methods of bus lane application as follows:

a. *with flow lane*

bus lane is made with flow (parallel with other traffic flow) and is placed on the left lane. It needs distinguished and understandable sign posts or a divider to help road users identify the lane.

b. *contra flow lane*

Bus lane is made contra flow (of opposite direction against other traffic flows) and is placed on the right lane. A contra flow lane has self enforcing quality as buses are big and can be seen easily by users of other vehicles. Still, it needs clear signs or divider to avoid accident.

c. *axial lane*

A two-way lane can be placed in the middle of a street and be given a physical divider to separate it

from other traffic flows and a crossing facility at each stoppage.

d. *Unilateral lane*

A two-way (unilateral) bus lane is placed on one side of the street and is given a physical divider from other traffic flow and a crossing facility at each stoppage.

The experiment adopts a with flow lane method by applying a bus lane on the left in line with other traffic flows. It is 3 meter wide and given a "BUS-LANE" signal to distinguish it from other lanes and to remind other vehicles not to enter /use it.

DATA COLLECTION

The experiment takes place on Kusumanegara street section, 350 meter long, with the following underlying considerations:

a. the street locates in the city center, is relatively of long section, i.e. 2400 meters and has high traffic volume. The number of public transports passing this street is also high: line 4, line 6, line 9, line 16, and line 17.

b. It accommodates many kinds of economic activities: shopping areas, offices, educational institutions, of which most of the clients use road trunk for parking.

c. It has two-way lanes of 3 m wide, side walks on both sides, and stable condition: good quality and even pavement.

The research observes two conditions for its data collection: before and after bus lane application. During bus lane application, it sets up parking prohibition on road trunk along the bus lane. The map of Jalan Kusumanegara and the observation area is presented in the figure 1 and figure 2.

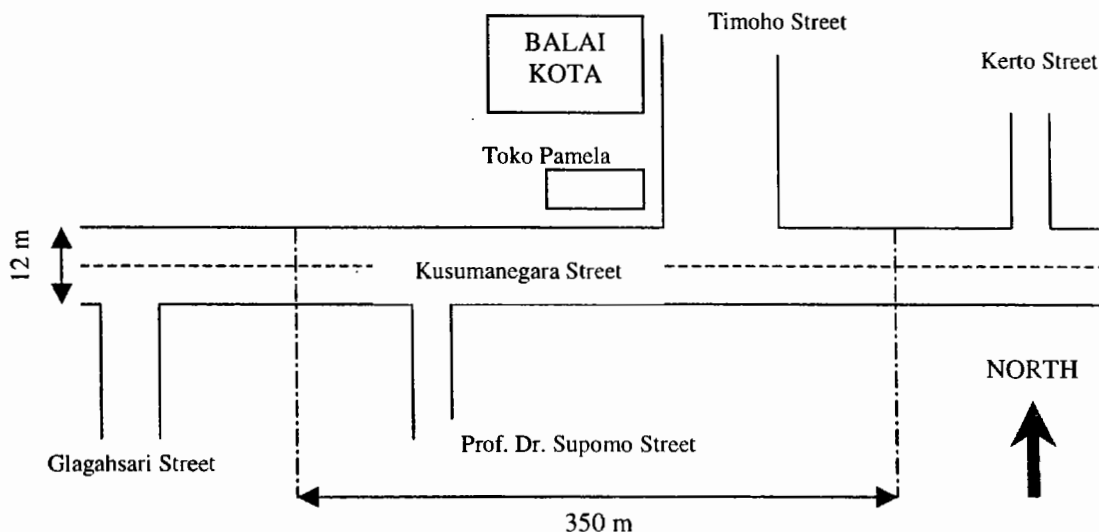


Figure 1. Site Location of Bus Lane Experiment

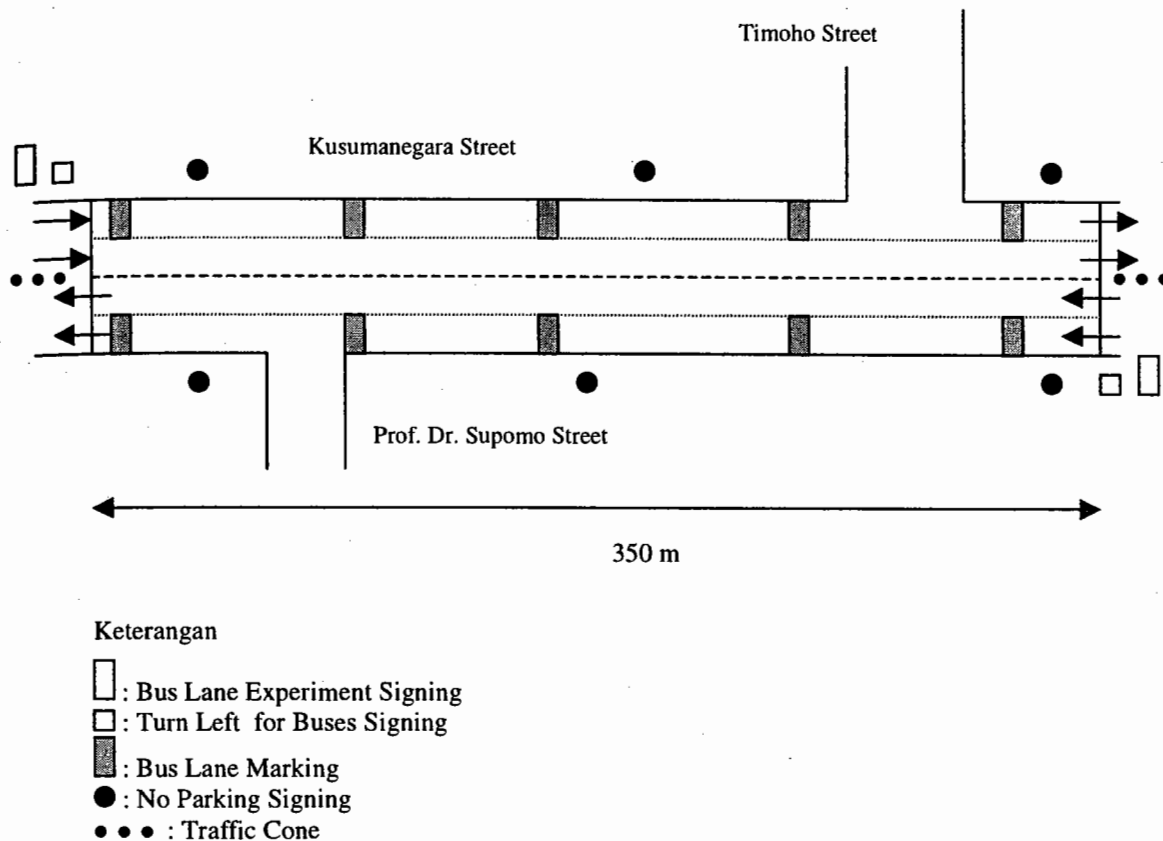


Figure 2. Marking and Signing for The Bus Lane Experiment

It takes four days for data collection: Thursdays and Fridays on 6, 7, 13, 14 September 2001. Data collection for each condition starts from 06.30 to 08.30 considering that these hours are the period when traffic is relatively crowded while the impact on the society is expected to be minimum. During simulation, the lane is marked with signings and other traffic markings: preliminary signal, left bus lane signing, "no parking on road trunk" signing, "BUS LANE" signing, and broken lines on the left and right, and cones to mark the starting point of the observed area. The survey covers:

1. survey on travel time
 - a. bus travel time
 - b. passenger car and motor bike travel times
2. survey on traffic volume
3. survey on side obstruction

EXPERIMENT FINDINGS

The research obtains the data for analysis from the road section selected as the field experiment. Data are calculated based on road width. The reasons are, first, the difficulty for counting each traffic lane due to heterogeneity of its traffic and second, the difficulty of road users for using only one lane because of either their lack of discipline or slow moving vehicles such as pedicabs and bicycles which operate on the same lane, making it difficult for the driver not to use another lane when overtaking others.

Traffic flow

The research obtains the traffic flow by counting traffic volume per type of vehicle. According to the Manual of Indonesian Highway Capacity (MKJI) 1997, unmotorised vehicles are not included into traffic flow component. Instead, they are regarded as side obstructions.

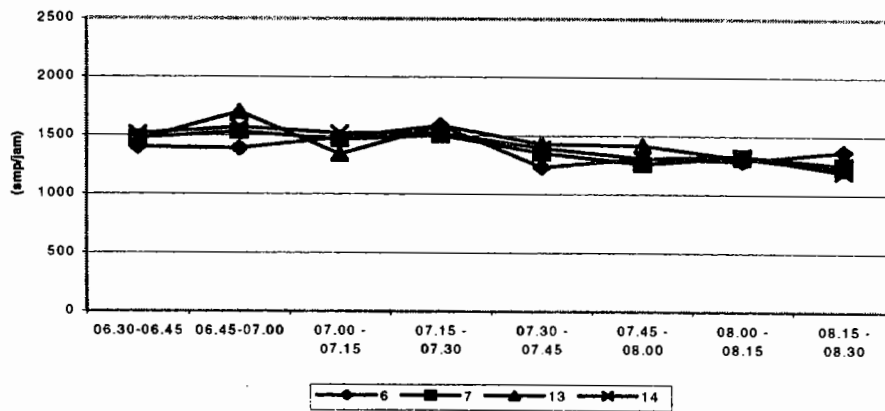


Figure 3. Traffic Flow in Every 15 Minutes.

The above presented curves indicate that maximum traffic flows for each day are as follows:

On September 6, the biggest flow is 1587 pcu/h at between 07.15 - 07.30

On September 7, the biggest flow is 1533 pcu/h at between 06.45 - 07.00

On September 13, the biggest flow is 1700 pcu/h at between 06.45 - 07.00

On September 14, the biggest flow is 1569 pcu/h at between 06.45 - 07.00

Traffic flow is getting constant with an average flow of 1350 pcu/h during the next hours and it happens on each day of observation.

The following table, which shows an increase of traffic flow, presents the comparison based on figure 3, i.e. the condition before and after bus lane application and maximum traffic flow.

Table 1. Maximum Traffic Flow Before and After Bus Lane Application.

Condition	Maximum flow on observation day	
	Thursday	Friday
Before (pcu/h)	1587	1533
After (pcu/h)	1700	1569
Difference (%)	7.12	2.34

Travel time

Travel time is the time taken by a vehicle to travel from one point to another on an observation area. Tables 2 and 3 present the result of travel time analysis under the conditions before and after bus lane application. Table 2 is for west direction flow and table 3 is for east direction flow.

Table 2. Travel Time of West Direction Flow

Condition	Vehicle types					
	Bus		Passenger car		Motor bike	
	Thursday	Friday	Thursday	Friday	Thursday	Friday
Before (second)	43.60	42.50	37.49	37.78	38.60	37.13
After (second)	41.44	39.68	39.22	40.00	38.58	37.72
Difference (%)	-5.21	-7.11	4.41	5.55	0.05	1.59

Table 3. Travel Time of East Direction Flow

Condition	Vehicle types					
	Bus		Passenger car		Motor bike	
	Thursday	Friday	Thursday	Friday	Thursday	Friday
Before (second)	42.38	41.42	38.14	38.30	35.10	35.98
After (second)	39.02	39.31	39.29	40.29	36.80	38.47
Difference (%)	-8.61	-5.37	2.39	4.94	4.62	6.47

Tables 2 and 3 indicate that bus travel time for west and east direction flows decreases 6.16% and 6.99% respectively; passenger car and motorbike travel time for west direction also decreases 4.98% and 0.76% while for east direction decreases 3.93% and 5.55%.

The tables also show a decrease of bus travel time to cover the starting point and finishing point of the observation area. For west direction flow, on Thursday, it decreases from 43.60 seconds into 41.44 seconds; on Friday, from 41.50 seconds into 39.68 seconds. For east direction flow, on Thursday, it decreases from 42.38 seconds to 39.02 seconds and on Friday, from 41.42 seconds to 39.31 seconds.

Passenger cars need additional travel time to cover the starting point and finishing point of the observation area. For west direction, on Thursday, travel time increases from 37.49 seconds into 39.22 seconds; on Friday, from 37.78 seconds into 40.00 seconds. For east direction, on Thursday, it increases from 38.14 seconds into 39.29 seconds and on Friday, from 38.30 seconds into 40.29 seconds.

West direction traffic shows travel time decreases on Thursday, from 35.60 seconds into 35.58 seconds. However, it needs additional travel on Friday, from 37.13 seconds into 37.72 seconds. Motorbike also takes additional travel time. For East direction flow, on Thursday, motorbike travel time increases from 35.10 seconds into 36.80 seconds and on Friday, from 35.98 seconds into 38.47 seconds.

Speed

The analysis calculates space mean speed (sms) from travel time data based on the type of vehicle in

every 15 minutes interval. It uses the following formula to calculate the space mean speed of each interval :

$$U_s = d.n / \sum t$$

In which:

U_s : vehicle space mean speed per interval (km/h)

d : travel distance (m)

n : sample number per interval

$\sum t$: total of vehicle travel time per interval (second).

Tables 4 and 5 present the results of space mean speed analysis in the conditions before and after bus lane application for both directions.

Tables 4 and 5 show that bus speed to cover the distance of observation increases 5.71% and 6.53% for west and east directions, respectively; passenger car and motor bike speed of west direction decreases 4.59% and 0.77% while of east direction is 3.91% and 5.49%.

Tables 4 and 5 also show an increase of bus mean speed. For west direction, on Thursday, it is from 29.24km/h into 30.46 km/h; on Friday, from 30.25 km/h into 31.76 km/h. For east direction, on Thursday, it increases from 29.73 km/h into 32.24 km/h; on Friday, from 30.65 km/h into 32.07 km/h.

Passenger cars experience a mean speed decrease. For west direction, on Thursday, it decreases from 33.79 km/h into 32.24 km/h and on Friday, from 33.10 km/h into 31.58 km/h. Speed decrease also happens in east direction traffic. On Thursday, it is from 35.93 km/h into 34.28 km/h and on Friday, from 35.06 km/h into 32.82 km/h.

Table 4. Speed of West Direction Traffic

Condition	Vehicle types					
	Bus		Passenger car		Motor bike	
	Thursday	Friday	Thursday	Friday	Thursday	Friday
Before (km/h)	29.24	29.61	33.79	33.10	32.65	33.99
After (km/h)	30.46	31.76	32.24	31.58	32.70	33.41
Difference (%)	4.17	7.26	-4.59	-4.59	0.15	-1.17

Table 5. Speed of East Direction Traffic

Condition	Vehicle types					
	Bus		Passenger car		Motor bike	
	Thursday	Friday	Thursday	Friday	Thursday	Friday
Before (km/h)	29.73	30.65	33.04	32.92	35.93	35.06
After (km/h)	32.24	32.07	32.10	31.28	34.28	32.82
Difference (%)	8.44	4.63	-2.84	-4.98	-4.59	-6.39

The above results also show that passenger cars and motor bikes travel time increases, or in other words their speed decreases, after bus lane application. The reason is because unmotorised vehicles such as pedicabs and bicycles are moved on the right lane, adding side obstruction to passenger cars and motor bikes. It suggests that, to overcome this problem the policy on bus lane application must be followed by an establishment/development of unmotorised vehicle lane, or in one package by prohibiting unmotorised vehicle to pass on streets with bus lane application.

Comparison of the conditions before and after bus lane application

The result of real time calculation (based on observation data) and that of theoretical calculation suggest that the number of buses of west and east direction before bus lane application is 2.93% and 0.18% higher than that after the application. After the application, the travel time can be shortened into 29.09% and 24.65%. Passenger cars travel time of west and east directions before bus lane application is already lower: 9.47% for west direction and 15.06% for east direction. However, with the application, it can be shortened into 9.00% and 7.53%.

Meanwhile, the calculation of space mean speed from the observation and from theoretical calculation suggest that before the application it is 2.32% lower for west direction but 0.21% higher for east direction. With the application, space mean speed can be accelerated into 22.42% and 19.81%. Before application, passenger cars space mean speed of west and east directions is 11.03% and 9.48% higher. After the application, however, the speed increases 11.36% and 11.97%. Before the application, motor bike speed is 10.60% higher for west direction and 17.83% higher for east direction. After the application, the speed improves into 8.18% and 6.81%. The small differences on public transport's flow, travel time and speed before and after application of bus lane are suspected due to the poor operation of public transport; i.e: no bus stop facilities.

CONCLUSION AND RECOMMENDATION

After bus lane application, bus flow increases 4.73% and bus travel time decreases 6.69%. However,

passenger cars and motorbikes flow and travel time decrease 4.98% and 5.55%. Public transport speed increases 6.53% but passenger cars speed decreases 4.59%. Motor bikes speed also decreases 4.49%.

In addition, it needs further research to find out the extent of the effect of bus lane application on speed increase and travel time decrease. The researchers should select the road section carefully by considering these conditions. It should have no intersection nor unmotorised vehicles; there should be no stopping for taking in/off passengers for public transport; it should have considerable length for observation area; and they should do the observations during peak hours in the morning, noon, and afternoon.

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