Bicycle lanes development plan in Mataram city

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Bicycle lanes development plan in Mataram city

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Abstract. Mataram City Government established a bicycle lane at Udayana Street as an alternative for all community to shift their motorized transport by bicycle as a daily transport and to support the NTB Cycling program from NTB Provincial Government. To accommodate changing mode of transportation from motorbikes or cars to bicycles, it is necessary to develop bicycle lanes in Mataram City. Vissim software used to forecast the impact of bicycles lane development at 9 provincial roads as the study area. From the analysis after implementation of bicycles lane development, there is a decrease in level of service based on Volume per Capacity Ratio. In addition, at signal intersection show an increase in queue length and vehicle delays. To minimize the impact of bicycles lane development, mitigation is carried out by rearranging the intersection cycle time. And the result is a reducing of CO, NOx and VOC emissions, fuel consumption, vehicle queue lengths and vehicle delays.

Keywords: Bicycle lanes planning; non motorized transport; vissim

1. Introduction

1.1. Background

Bicycles as an alternative to non-motorized transport have various advantages, including not creating air and noise pollution, being more economical in terms of price and not requiring fuel. Creating an integrated friendly environmental transportation system can reduce exhaust emissions produced by private vehicles, providing a good effect on public health. Economically, bicycle maintenance is much cheaper than other modes of transportation. These three aspects are the concept of sustainability which cannot be separated from one another , Jeffrey [1]. The provision of bicycle infrastructure has an important role, by building the right infrastructure people are tend to use bicycles more often, Ekblad [2]. In December 2019, the Mataram City Government established a bicycle lane as an alternative to the community in carrying out activities along Udayana Street. The formation of cycling communities in Mataram City shows the high enthusiasm of the community in changing their lifestyle, to maintain the urban air quality and awareness of the importance of health. To support the program of the NTB Provincial Government in NTB Cycling and also accommodate the changes of transportation mode of the community from using motorbikes or cars to bicycles, it is necessary to develop bicycle lanes in Mataram City.

1.1. Research purposes

In general, this study aims to determine how the impact of bicycle lanes planning on the performance of roads and intersections in the study areas, the impact of mitigation at the APILL intersection toward network performance after the application of the bicycle lanes and what is needed by motorized vehicle users to switch to using a bicycle.

2. Research methods

This research located at 9 provincial roads in Mataram City as seen in Table 1.

Table 1 Road section of the Research Location

No	Street Name	Lenght of Path
1	Langko	2,3 Km
2	Pejanggik	1,92 Km
3	Bung Hatta	0,96 Km
4	Bung Karno	1,09 Km
5	Sriwijaya	1,32 Km
6	Majapahit	2,05 Km
7	Majapahit 2	1,00 Km
8	Yos Sudarso	0,85 Km
9	Airlangga	1,58 Km

Performance data of the existing roads and intersections were obtained from the Traffic Counting and CTMC surveys, while to find out the origin of the trip, Home Interview survey was carried out. In addition, secondary data in the form of geometric road data, land use and road networks were collected as input data in the Visum and Vissim programs to conduct forecasting after the development of bicycle lanes was applied to the roads that were being the study area**.**

3. Results and discussion

The roads study area are under the authority of the provincial government, the street of Yos Sudarso, Langko, Pejanggik, Majapahit and Sriwijaya are the secondary arterial roads, while street of Airlangga, Bung Hatta and Bung Karno are the primary collector roads.

3.1. Eksisting roard sections performance

Table 2. Exsisting Road Section Performance

No	Name	Type	Capacity (smp/hour)	Volume (smp/hour)	VCR	LOS
1	St. Langko	3/1 UD	4293.77	2467	0.57	C
2	St. Pejanggik	3/1 UD	4293.77	2475	0.58	C

3	St.Bung Hatta	4/2 D	5239.93	986	0.19	A
4	St.Bung Karno	4/2 D	5239.93	1481	0.28	A
5	St.Sriwijaya	4/2 D	5239.93	1890	0.36	B
6	St.Majapahit	4/2 D	5239.93	2744	0.52	B
7	St.Majapahit 2	2/1 UD	3122.74	1994	0.64	C
8	St.Yos Sudarso	4/2 D	6245.49	3281	0.53	B
9	St.Airlangga	4/2 D	4756.75	1808	0.38	B

From Table 2, the roads which have the best service levels are Bung Hatta and Bung Karno Street with rank A Level of Service or free traffic flow conditions with high speed and low traffic volume. Next are street of Sriwijaya, Yos Sudarso, Airlangga and Majapahit with rank B service level or steady flow, but the operating speed is starting to be limited by traffic conditions. Meanwhile, street of Langko, Pejanggik and Majapahit 2 (the crossroad Seruni to Ampenan) shows the C rank level of service or the flow is stable but the speed and movement of the vehicle is controlled. To do forecasting, model validation is carried out to prove whether the model that will be used to forecast travel in the plan year can be used or not. The validation model used is Chi square test. The decision is accepted (Ho is accepted) based on the calculation. While is obtained from the Z-test table. From Table 3 it can be concluded that the model can be used because it is in accordance with the existing conditions with a 95% confidence level. After the validation test is carried out, the model can be used as an application for forecasting.

Table 3. Validation model test

No	Name	Type	Survey Volume (smp/hour)	Model Volume (smp/hour)	
1	St. Langko	3/1 UD	2467	2467	0.00
2	St. Pejanggik	3/1 UD	2475	2475	0.00
3	St.Bung Hatta	4/2 D	986	986	0.00
4	St. Bung Karno	4/2 D	1481	1481	0.00
5	St.Sriwijaya	4/2 D	1890	1890	0.00
6	St.Majapahit	4/2 D	2744	2744	0.00
7	St.Majapahit 2	2/1 UD	1994	1994	0.00
8	St.Yos Sudarso	4/2 D	3281	3281	0.00
9	St.Airlangga	4/2 D	1808	1808	0.00
				Chi Hitung	0.00
				Chi Tabel	3.33
				Conclution	Ho Accepted

After distributing the survey form to 400 respondents who live in the 11 predefined zones, 276 data on vehicle users in each zone that definitely changed modes by bicycle were obtained, the origin of the respondents' travel destinations are shown in Table 4.

Table 4. Matrix Origin Destination (O/D Matrix)

OD	1	2	3	4	5	6	7	8	9	10	11	Total
1	0	0	3	5	4	0	0	0	1	9	7	29
2	0	0	0	0	5	1	2	0	0	14	8	30
3	0	0	0	3	4	0	0	0	0	5	27	39
4	0	0	0	0	7	1	0	0	0	4	16	28

5	0	0	0	0	0	2	4	5	0	7	14	32
6	0	0	0	0	4	0	5	1	0	2	13	25
7	0	0	0	0	2	2	0	1	0	3	23	31
8	2	0	0	0	1	2	5	0	0	3	4	17
9	0	0	0	0	0	0	3	2	0	11	1	17
10	0	0	0	0	0	0	0	0	0	0	24	24
11	0	0	0	0	0	0	0	0	0	4	0	4
Total	2	0	3	8	27	8	19	9	1	62	137	276

Desire line map made from the matrix of the origin destination, as a results of the home interview survey from the people activity. Based on the data obtained, most of the respondents in all zones carried out many activities to zone 11, namely Mataram 3, where the area is the center of office and school activities. The second highest activity attraction or destination area is in zone 10, namely Selaparang 3, which is in Dasan Agung Village with the center of activity being dominated by offices and schools.

Figure 1. Desire Line of Potential Bicycle user

3.2. *Intersection performance with traffic signaling devices (APILL) existing*

From Table 5, it can be seen that the performance at each APILL intersection is in the form of queues, delays, spent fuel consumption, and the amount of pollution produced. It can be seen in the table that the higher traffic delay value at the intersection, the higher fuel consumption is spent and the higher pollution produced.

Table 5. Intersection Performance APILL Existing

No	Node	Emissions CO (gram)	Emissions NOx (gram)	Existing		Queue (m)	Delay (s)
				Emissions VOC (gram)	Fuel Consumption (US Gallon)		
1	BI Intersection	1415.69	275.44	328.10	20.25	42.43	68.91
2	Gubernur Intersection	607.45	118.19	140.78	8.69	37.86	49.67
3	Air Mancur Intersection	1464.05	284.85	339.31	20.94	53.95	80.46

4	Aston Intersection	819.13	159.37	189.84	11.72	38.00	59.11
5	Bung Karno Intersection	459.68	89.44	106.54	6.58	14.56	24.82
6	Mc D Intersection	1545.28	300.65	358.13	22.11	47.60	69.10
7	Epicentrum Intersection	1508.54	293.51	349.62	21.58	89.79	90.12
8	Seruni Intersection	729.82	142.00	169.14	10.44	36.65	12.30
9	AMM Intersection	283.06	55.07	65.60	4.05	40.25	19.27
10	Airlangga Intersection	245.75	47.81	56.96	3.52	44.97	26.99

3.3. Existing Road Network Performance

On 9 provincial roads in one road network in Mataram City which is become the study area, the existing condition of the speed to travel the roads on the network is 24 km / hour. As shown in Table 6, the total distance traveled was 2,556.99 km and the total time required was 812445.20 seconds.

Table 6. Existing Road Network Performance

Network Speed (km/hour)	Total Distance (km)	Total time (Second)
24.00	2556.99	812445.20

3.4. The impact of bicycle lanes application on intersection performance

Table 7. The Road Section performance after the application of bicycle lanes

No	Name	Type	Capacity (smp/hour)	Volume (smp/hour)	VCR	LOS
1	St. Langko	3/1 UD	3844.88	2451	0.64	C
2	St.Pejanggik	3/1 UD	3844.88	2432	0.63	C
3	St.Bung Hatta	4/2 D	4367.28	963	0.22	A
4	St.Bung Karno	4/2 D	4367.28	1458	0.33	A
5	St.Sriwijaya	4/2 D	4367.28	1844	0.42	B
6	St.Majapahit	4/2 D	4367.28	2701	0.62	C
7	St.Majapahit 2	2/1 UD	2691.41	1951	0.72	C
8	St.Yos Sudarso	4/2 D	5382.83	3265	0.61	C
9	St.Airlangga	4/2 D	4490.18	1756	0.39	B

At the comparison before and after the bicycle lane operates there are some changes in the level of road service, especially on roads that have high side obstacles. For example, street of Majapahit and Yos Sudarso, which were originally in the rank B Level of Service, after the bicycle lane was implemented the service level became C.

3.5. Impact of Bicycle Path Application on Intersection Performance

Table 8. Intersection performance after Bicycle Lanes Application

No	Node	Emissions CO (gram)	Emissions NOx (gram)	Oprations Emissions VOC (gram)	Fuel Consumption (US Gallon)	Queue (m)	Delay (s)
1	BI Intersection	1419.66	276.21	329.02	20.31	41.52	68.60
2	Gubernur Intersection	612.58	119.19	141.97	8.76	37.75	56.21
3	Air Mancur Intersection	1360.86	264.77	315.39	19.47	55.63	70.13
4	Aston Intersection	740.20	144.02	171.55	10.59	38.46	57.66
5	Bung Karno Intersection	537.06	104.49	124.47	7.68	20.07	31.47
6	McD Intersection	1660.66	350.72	360.41	23.73	42.96	62.69
7	Epicentrum Intersection	1501.14	292.07	347.90	21.48	100.97	105.44
8	Seruni Intersection	742.70	144.50	172.13	10.63	39.42	14.47
9	AMM Intersection	280.59	54.59	65.03	4.01	51.75	20.21
10	Airlangga Intersection	239.68	46.63	55.55	3.43	46.32	29.67

The implementation of bicycle lanes has effect the performance of intersections as illustrated in Table 8, there is an increase in queue length at 7 intersections, namely the Air Mancur Pajang, the Aston, Bung Karno, the Epicentrum, the Seruni, AMM and Airlangga Intersections. Increased time delays also occurred at 6 intersections, whice are the Governor's intersection, Bung Karno intersection, Epicentrum intersection, Seruni intersection, AMM intersection and Airlangga intersection.

3.6. The Impact on Road Network Performance

If bicycle lanes are implemented on the study area, there will be an increase in speed on the network and a decrease in the total distance as shown in Table 9. The total travel time has also decreased; originally the travel time on the network was 812445.20 seconds, after the implementation of the bicycle lanes it became 780266.10 second. Meanwhile, the speed on the network, which was originally 24 km / hour, has increased to 24.25 km / hour.

Table 9. Performance of the Road Network after the Application of Bicycle Paths

Network speed (km/hour)	Total distance (km)	Total time (detik)
24.25	2506.36	780226.10

3.7. Mitigation of intersection with APILL

After mitigation measures againts the impact of operating the bicycle lanes, there is an improvement in the overall performance indicator of the intersection as in Figure 2, namely the total amount of CO for all intersections produced was reduced from the conditions during operation 9095.13 grams to 8978.82 grams, the total number of NOx, VOCs, vehicle fuel consumption, total queue and total vehicle delay in all intersections reduced from 1797.19 grams to 1746.95 grams for NOx, 2183.42 grams to 2080.94 grams for VOCs, 130.09 US gallons to 128.44 US gallons for vehicle fuel consumption, 474.85 meters to 444.65 meters of total queue, and 500.75 seconds to 500.44 seconds of total vehicle delay.

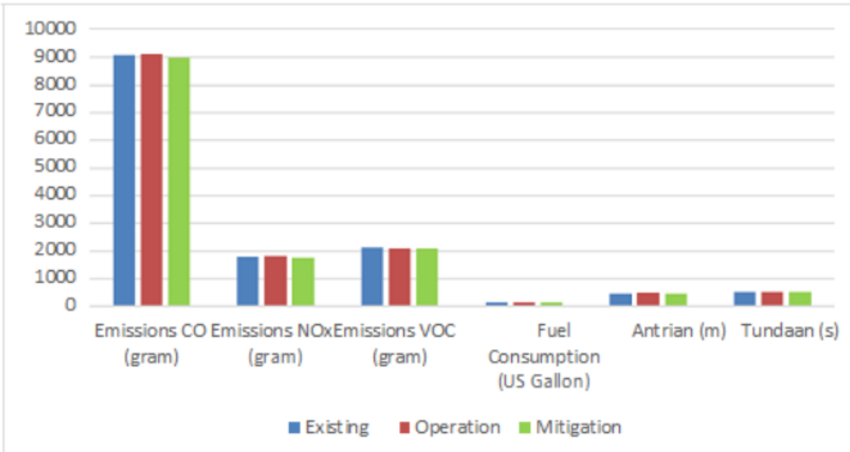
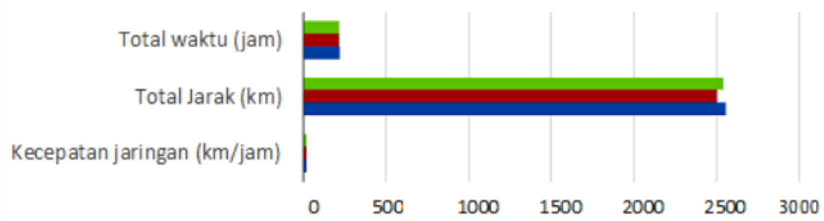


Figure 2**.** Intersection Service Level in Existing Condition, Bicycle Path Operation and Mitigation

3.8. Network performance with APILL cycle time change mitigation

The mitigation taken to maximize the performance of the transportation system, by change the traffic light cycle time. And the result is an increase in network speed and a reduction in time for all vehicles to travel in network system, but there is an additional mileage in the network system. Comparison of service levels in the network system before, after the implementation of the bicycle lanes and after mitigation at the APILL intersection can be seen in Figure 3.



	Kecepatan jaringan (km/jam)	Total Jarak (km)	Total waktu (jam)
Mitigasi	24.6	2538.9	216.49
Rencana	24.25	2506.36	216.73
Eksisting	24	2556.99	225.68

Figure 3. Network System Service Level in Existing Conditions, Bicycle lanes Operation and Mitigation.

4. Conclusion

- The impact of the bicycle lanes development plan policy on provincial roads which became the study area when the bicycle lane was operating was that there was a change in Level of Service (LOS) from B to C, namely on Majapahit street and Yos Sudarso street. At the APILL intersection where the bicycle lane passes, there was an increase in queue length at all intersections except McD intersection, BI intersection and Governor's junction where vehicle queues drop down to 4.6, 0.9 and 0.11 meters respectively. Whereas in the network system there was an increase in speed from 24 km / hour to 24.25 km / hour, a decrease in the total distance from 2556.99 km to 2506.36 km and a total travel time from 225.68 hours to 216.73 hours.
- Mitigation was carried out by resetting the intersection cycle time, at the BI, Governor, McD, Epicentrum, Seruni, AMM and Airlangga intersections. By resetting the APILL cycle at the 7 intersections, there was an increase in service as indicated by reduced CO, NOx and VOC emissions besides fuel consumption, vehicle queue lengths and vehicle delays were also reduced.

Recommendation

- Providing bicycle lanes with traffic signs, socializing the provision of safe parking facilities and changing clothes at the office, parking facilities in public areas and integrating bicycle routes with public transportation so that cyclists can travel longer.
- Regulate parking on roads that have bicycle lanes and provide traffic signs that regulate parking restrictions on bicycle lanes.
- Giving priority to cyclists in the crossing area by carrying out traffic management and engineering in the form of providing wider zebra crossings so that they can be used together with pedestrians, so that cyclists can cross safely and not cut off the flow of motorized vehicles that will turn left.

- Together with law enforcement officials, periodic monitoring and evaluation of the use of bicycle lanes.
- Issue local regulations that support the safety and security of bicycle users in road traffic

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