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THE EFFECT OF AIR QUALITY ON ENVIRONMENTAL HUE DUE TO THE LEVEL OF TRAFFIC CONGESTION AT INTERSECTION DINOYO AND SIMPANG SARDO, MALANG CITY

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ABSTRACT

The condition of traffic congestion that occurs on the Jln. Gajayana section where there are two adjacent intersections on the section. Both are the intersection of Jl. Gajayana – Jl. MT. Haryono – Jl. Mayjen Hariyono and the intersection three of Jl. Gajayana – Jl. Simpang Gajayana which occurred at both intersections affected the increase in air pollution due to exhaust emissions produced from traffic vehicles and affected the components of the environmental hue around the study site. Therefore, from the performance results of the Dinoyo intersection and the Sardo intersection of Malang city which refers to the 2023 Indonesia Road Capacity Guidelines, and the air quality is guided by the Regulation of the Minister of Environment and Forestry No. 14 of 2020, the degree of saturation for 3 days of observation is still more than 0.85 with the service level E due to the service level is still poor, so it is necessary to plan improvements at the Dinoyo intersection of the signalized intersection with geometric widening while in The unsignaled junction of the Sardo junction is planned with road geometry on each arm of the road. The largest delay value is 24.175 sec/smp so that the level of intersection service produced is at least D., while at the Sardo junction the degree of saturation for 3 days of observation is still more than 0.85 with service levels B and C. and the air quality is measured at 06.00 – 07.00 with a delay value of 39.765 sec/smp, then the particulate concentration obtained NO2 is the ISPU value of 21.170 (18 ppm), SO2 ISPU value: 47.866 (19 ppm), C0 ISPU value: 15.609 (1090 ppm). The results of the air quality analysis show that the CO air quality parameter has a great influence on the environmental profile and the decline in public health due to air pollution due to high gas emissions from high vehicle volumes. This requires efforts to reduce air pollution through traffic engineering so that the delay value is not high and the carrying capacity of the environment with Green Open Space.

KEYWORDS *Exhaust Gas Emissions, Junction Performance, Queue Length, Delays*

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INTRODUCTION

Malang City is one of the tourist destination cities in East Java because of its natural and climatic potential. Apart from being a tourist city, Malang City is also one of the educational cities in Indonesia. Malang City is also known as one of the cities of education, this causes the population in the city of Malang to increase every year. The development of these sectors indirectly has an impact on high transportation movements as well. This high level of land transportation has an impact on traffic congestion and travel time delays. This is due to many factors, including inadequate transportation services, the comparison of the number of motorized vehicles with unbalanced road capacity.

One of the locations of congestion points that occur in Malang City is on the Jln. Gajayana section which is the object of study, namely, there are two adjacent intersections on the section. Both are the intersection of Jl. Gajayana – Jl. MT. Haryono – Jl. Mayjen Hariyono and intersection three Jl. Gajayana – Jl. Simpang Gajayana – Jl. Gajayana. With the distance between the adjacent intersections between the Dinoyo intersection and the Sardo intersection, the flow of traffic vehicles often experiences traffic congestion caused by the high volume of traffic flow.

The congestion at this intersection is caused by high traffic volume, there are also several activities on the approach of the two intersections, such as trade, as one of the connecting roads to several shopping centers and campuses around the intersection, as one of the connecting roads between cities, as well as vehicles entering and exiting next to the road from the neighborhood around the intersection. The absence of APILL (Traffic Signaling Device) makes the traffic flow at one of these intersections, namely the Sardo intersection, increasingly irregular, this can cause traffic accidents for users of this road section. The congestion that occurs at these two adjacent intersections can certainly affect the level of air quality to be poor.

Based on these conditions, it is necessary to evaluate the performance of the intersection and find out the effect of performance on air quality at the Dinoyo intersection and the Sardo intersection. The purpose of this study is to analyze the performance of the intersection and its influence on air quality at the Dinoyo intersection and the Sardo intersection, Malang city.

RESEARCH METHOD

The research stages used in this study include preparing a research introduction by compiling a research background and identifying problems at the location that will be used as a study area, then formulating a problem by identifying the problems that have been carried out as input to make a problem formulation and the purpose of the research.

At the data collection stage, it is carried out through primary surveys and secondary surveys. Primary surveys include road geometric data, traffic volume data, cycle times, air quality data. Meanwhile, the secondary survey is in the form of collecting data on the population of Malang city. Furthermore, the data was analyzed using the 2023 Indonesia Road Capacity Guidelines (PKJI). The results that will be obtained from this case study are to determine the influence of

intersection performance and air quality at the Dinoyo intersection and Sardo intersection. The relationship between intersection performance and air quality was analyzed using a regression equation with variable x being the value of traffic delay and variable y being the value of air pollutant concentration, namely NO2, CO and SO2. The calculation stages can be seen in the *following flowchart*.

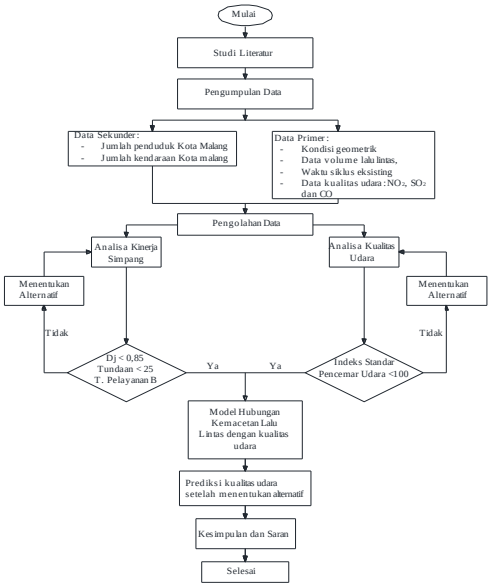

Figure 1 Diagram Chart Process.

RESULT AND DISCUSSION

Performance of Simpang Dinoyo and Simpang Sardo

The following is the result of the calculation of the performance of the intersection at the Dinoyo intersection and the Sardo intersection during existing conditions.

Dinoyo Junction

Table 1 Existing Conditions March 23, 2024

Saturday, 23 March 2024				
Proximity Code	**DJ**	**AP (m)**	**Delay Det/smp**	**THE**
Morning Peak Hours 06.15 – 07.15				
S	0,945	72,070		
B	0,790	70,441	47,263	And
T	0,911	62,655		
Peak Hours 14.45 – 15.45				
S	0,937	73,332		
B	0,795	71,001	46,790	And
T	0,906	62,240		
Afternoon Peak Hours 17.00 – 18.00				
S	0,931	74,041	46,281	And

B	0,628	55,245		
T	0,961	76,163		

Table 2 Existing Conditions March 24, 2024

Sunday, 24 March 2024				
Proximity Code	**DJ**	**PA (m)**	**Delay Det/smp**	**THE**
Morning Peak Hours 06.15 – 07.15				
S	0,886	62,291		
B	0,711	62,235	44,474	And
T	0,911	65,508		
Peak Hours 14.45 – 15.45				
S	0,861	66,255		
B	0,620	51,861	42,320	And
T	0,8630	60,764		
Afternoon Peak Hours 17.00 – 18.00				
S	0,862	69,985		
B	0,575	55,311	41,045	And
T	0,865	70,841		

Table 3 Existing Conditions March 25, 2024

Monday, 25 March 2024				
Proximity Code	**DJ**	**PA (m)**	**Delay Det/smp**	**THE**
Morning Peak Hours 06.15 – 07.15				
S	0,885	68,020		
B	0,729	64,458	43,585	And
T	0,867	60,221		
Peak Hours 14.45 – 15.45				
S	0,884	68,020		
B	0,794	64,458	44,255	And
T	0,872	60,645		
Afternoon Peak Hours 17.00 – 18.00				
S	0,862	71,935		
B	0,665	67,103	41,215	And
T	0,866	70,842		

Based on the three tables above, the performance of the intersection in the existing condition at the Dinoyo intersection obtained a degree of saturation for 3 days of observation is still more than 0.85 with the service level E. Due to the poor service level, it is necessary to plan an improvement so that the level of intersection service produced is in accordance with the Regulation of the Minister of Transportation No. 96 Th. 2015, which is at least D.

Simpang Sardo

Table 4 Existing Conditions of Simpang Sardo

Saturday, 23 March 2024				
Peak Hours	DJ	PA (m)	T (IT/SMP)	THE
06.30 – 07.30	0,95	71,3	17,1	C
14.45 – 15.45	0,46	22,4	9,6	B
17.00 – 18.00	0,93	68,9	16,5	C
Sunday, 24 March 2024				
Peak Hours	**DJ**	**PA (m)**	**T (IT/SMP)**	**THE**
06.15 – 07.15	0,88	62,0	15,2	C
14.45 – 15.45	0,42	19,6	9,2	B
16.00 – 17.00	0,87	59,9	15,0	C
Monday, 25 March 2024				
Peak Hours	**DJ**	**PA (m)**	**T (IT/SMP)**	**THE**
06.30 – 07.30	0,87	60,3	13,2	B
11.45 – 12.45	0,48	23,7	9,7	B
17.00 – 18.00	0,99	79,2	18,9	C

Based on the table above, the performance of the existing condition intersection at the Sardo intersection obtained a degree of saturation for 3 days of observation is still more than 0.85 with service levels B and C.

Air Quality

Sources of air pollution can occur due to human activities such as transportation, industry, power plants, combustion, factory exhaust gases that produce harmful gases. Air pollution can have a negative impact on living things, humans, animals and plants. The following is a summary of the air quality at the Dinoyo intersection and Sardo intersection during the 3 days of observation:

Table 5 Air Quality Recapitulation March 23, 2024

Measurement Time	**Delay**	**Particulate CONCENTRATION**								
		NO2			SO2			CO		
	det/smp	ppm	(µg/m3)	ISPU Values	ppm	(µg/m3)	ISPU Values	ppm	(µg/m3)	ISPU Values
06.00 - 07.00	39,765	18	33,873	21,170	19	49,781	47,866	1090	1248,714	15,609
07.00 - 08.00	33,192	16	30,109	18,818	17	44,541	42,828	917	1050,523	13,132
08.00 - 09.00	29,476	13	24,464	15,290	14	36,681	35,270	805	922,215	11,528
09.00 - 10.00	29,099	12	22,582	14,114	11	28,821	27,712	742	850,042	10,626
10.00 - 11.00	28,919	15	28,227	17,642	16	41,921	40,309	900	1031,048	12,888
11.00 - 12.00	28,629	13	24,464	15,290	14	36,681	35,270	812	930,235	11,628
12.00 - 13.00	28,571	12	22,582	14,114	13	34,061	32,751	834	955,438	11,943
13.00 - 14.00	28,448	12	22,582	14,114	13	34,061	32,751	847	970,331	12,129
14.00 - 15.00	30,484	16	30,109	18,818	17	44,541	42,828	955	1094,057	13,676

15.00 - 16.00	40,912	17	31,991	19,994	18	47,161	45,347	1031	1181,123	14,764
16.00 - 17.00	31,243	16	30,109	18,818	15	39,301	37,789	990	1134,153	14,177
17.00 - 18.00	41,229	15	28,227	17,642	14	36,681	35,270	961	1100,930	13,762

Table 6 Air Quality Recapitulation March 24, 2024

Measurement Time	Delay	Particulate CONCENTRATION								
		NO2			SO2			CO		
	det/smp	ppm	(µg/m3)	ISPU Values	ppm	(µg/m3)	ISPU Values	ppm	(µg/m3)	ISPU Values
06.00 - 07.00	41,562	20	37,636	23,523	16	41,921	40,309	900	1031,048	12,888
07.00 - 08.00	32,680	18	33,873	21,170	15	39,301	37,789	852	976,059	12,201
08.00 - 09.00	29,010	15	28,227	17,642	16	41,921	40,309	846	969,185	12,115
09.00 - 10.00	28,532	14	26,345	16,466	13	34,061	32,751	739	846,605	10,583
10.00 - 11.00	28,629	17	31,991	19,994	12	31,441	30,231	750	859,207	10,740
11.00 - 12.00	28,285	15	28,227	17,642	11	28,821	27,712	706	808,800	10,110
12.00 - 13.00	28,320	14	26,345	16,466	12	31,441	30,231	680	779,014	9,738
13.00 - 14.00	28,273	14	26,345	16,466	11	28,821	27,712	642	735,481	9,194
14.00 - 15.00	30,476	18	33,873	21,170	13	34,061	32,751	729	835,149	10,439
15.00 - 16.00	40,868	19	35,754	22,346	15	39,301	37,789	828	948,564	11,857
16.00 - 17.00	30,693	18	33,873	21,170	17	44,541	42,828	874	1001,262	12,516
17.00 - 18.00	41,045	17	31,991	19,994	12	31,441	30,231	834	955,438	11,943

Table 7 Air Quality Recapitulation March 25, 2024

Measurement Time	Delay	Particulate CONCENTRATION								
		NO2			SO2			CO		
	det/smp	ppm	(µg/m3)	ISPU Values	ppm	(µg/m3)	ISPU Values	ppm	(µg/m3)	ISPU Values
06.00 - 07.00	41,253	22	41,400	25,875	17	44,541	42,828	910	1042,504	13,031
07.00 - 08.00	31,939	19	35,754	22,346	14	36,681	35,270	872	998,971	12,487
08.00 - 09.00	29,296	16	30,109	18,818	15	39,301	37,789	866	992,097	12,401
09.00 - 10.00	29,296	15	28,227	17,642	12	31,441	30,231	749	858,061	10,726
10.00 - 11.00	29,225	18	33,873	21,170	13	34,061	32,751	760	870,663	10,883
11.00 - 12.00	28,996	16	30,109	18,818	12	31,441	30,231	736	843,168	10,540
12.00 - 13.00	28,839	15	28,227	17,642	13	34,061	32,751	690	790,470	9,881
13.00 - 14.00	28,721	15	28,227	17,642	10	26,201	25,193	672	769,849	9,623
14.00 - 15.00	30,874	19	35,754	22,346	14	36,681	35,270	749	858,061	10,726
15.00 - 16.00	43,847	20	37,636	23,523	16	41,921	40,309	848	971,476	12,143
16.00 - 17.00	24,244	19	35,754	22,346	18	47,161	45,347	864	989,806	12,373
17.00 - 18.00	41,215	18	33,873	21,170	15	39,301	37,789	854	978,350	12,229

Based on the results of the calculations in the three tables above, it was concluded that the air quality at the Dinoyo intersection and the Sardo intersection

for 3 days of observation was still below the air quality standard based on the 2020 ISPU standard, with the good category.

Alternative Recommendations for Improvement and Air Quality Conditions

From the evaluation that has been carried out, the results of the intersection performance that exceed the predetermined conditions are obtained. Therefore, it is necessary to carry out improvement planning with the aim of improving the performance of the intersection at the Dinoyo intersection and the Sardo intersection, which is adjusted to the conditions of each intersection, where the Dinoyo intersection is a signaled intersection and the Sardo intersection is a non-signaled intersection. Then the best alternative will be selected from the three alternatives that have been planned.

The alternative selection method is to compare the advantages and disadvantages of each alternative. The results of the comparison can be seen in the following table.

a. Dinoyo Junction

Alternative recommendations used at the Dinoyo intersection are summarized in the following table:

Table 8 Advantages and Disadvantages of Dinoyo Simpang Alternative

It	Alternative	Excess	Deficiency
1	**Signal timing optimization**	Can be applied directly in the field	Service level rating not qualified
2	**Geometric widening of the road**	The average towing value is eligible in accordance with PM Transportation No. 96 of 2015, namely primary collector roads, service level at least B	To implement this alternative directly in the field, a permit is required. One of the drawbacks is the condition at this intersection. Environmental conditions in commercial areas make road widening impossible due to land limitations.
3	**One-way entrance road planning for arms**	The saturation degree value is qualified, which is less than 0.85 and the service level is B and C	If this alternative is applied to the Dinoyo intersection, it is less effective, considering that the Dinoyo intersection is one of the public transportation routes in Malang City. The one-way entrance road planning for the South arm (Jalan Gajayana) was once implemented but was reopened to two-way because residents opposed the policy. The average delay value does not meet the requirements of PM Transportation No. 96 of 2015, namely primary collector roads, with a service level of at least B

From the comparison table above, it can be concluded that the second alternative is the geometric change of the intersection which is a recommendation for the improvement of the intersection because the delay value meets the requirements and does not cause conflicts at the intersection. The NO2 concentration value was 22.8495 μg/m3, the CO value was 891.0973 μg/m3, and the SO2 concentration value was 33.746 μg/m3. With air quality categorized as good, the NO2, CO and SO2 air quality values are still below the standard quality standards based on ISPU, namely the ISPU value is still in the range of 1 - 50, with

the ISPU NO2 value is 14.281, the ISPU CO value is 11.139, and the ISPU SO2 value is 32.448.

b. Simpang Sardo

Alternative recommendations used at the Sardo intersection are summarized in the following table:

Table 9 Advantages and Disadvantages of Alternative Simpang Sardo

It	Alternative	Excess	Deficiency
1	**Geometric widening of the road**	It can be applied directly in the field. The average towing value meets the requirements in accordance with PM Transportation No. 96 of 2015, namely secondary collector roads, service level of at least C	To implement this alternative directly in the field, a permit is required. One of the drawbacks is the condition at this intersection. Environmental conditions in commercial areas make road widening impossible due to land limitations.
2	**Signalized Interchange Planning with 2 Phases**	The degree of saturation is qualified, which is less than 0.85.	If this alternative is applied to the Sardo intersection, it can cause the delay value of each intersection arm to increase due to the presence of APILL, thus causing more severe congestion. The average delay value has not met the requirements of PM Transportation No. 96 of 2015, namely secondary collector roads, service level of at least C
3	**Planning of 2-phase signalized intersections with geometric widening of roads**	The value of the degree of saturation is qualified, which is less than 0.85 and the service level is C and D	If this alternative is applied to the Sardo intersection, it will be less effective, considering the limited land at this intersection to carry out road widening, and if planned APILL will increase congestion.

From the comparison table above, it can be concluded that the second alternative is the geometric change of the intersection which is a recommendation for the improvement of the intersection because the delay value meets the requirements and does not cause conflicts at the intersection. The concentration value of NO_2 was 22.8495 μg/m^3, CO was 891.0973 μg/m^3, and the concentration value of$_{SO2}$ was 33.746 μg/m^3. With air quality categorized as good, namely air quality values NO_2, CO and SO2 are still below the standard quality standards based on ISPU, namely ISPU values are still in the range of 1 - 50, with ISPU NO_2 values of 14.281, ISPU CO values of 11.139, and ISPU SO2 values of 32.448.

CONCLUSION

Based on the results of the air quality analysis at the Simpang Dinoyo and Simpang Sardo intersections reveals that traffic congestion significantly affects air quality, especially the CO parameter, which impacts both environmental conditions and public health due to high vehicle emissions. At Dinoyo intersection, with a delay of 39.765 sec/smp, the air quality parameters were found to have ISPU values of 21.170 for NO2, 47.866 for SO2, and 15.609 for CO, indicating a notable decline

in air quality. As for traffic performance improvement alternatives, the most effective option for Dinoyo is geometric road widening (Alternative II), which successfully improved the intersection performance with a delay of 24.175 sec/smp and service levels from E to B and C. At Simpang Sardo, the optimal solution is also road widening (Alternative I), with a delay of 13.1 sec/smp and service level B during peak hours.

Predictions of air quality following these improvements show positive results. For Dinoyo intersection, after implementing Alternative II, the air quality is categorized as good, with NO2 at 22.8495 μg/m3, CO at 891.0973 μg/m3, and SO2 at 33.746 μg/m3, all remaining below ISPU standards. The ISPU values for NO2, CO, and SO2 fall within the acceptable range of 1-50. Similarly, for Simpang Sardo, after applying Alternative I, the air quality remains good, with NO2 at 29.7414 μg/m3, CO at 1109.0649 μg/m3, and SO2 at 41.653 μg/m3, all within the standard ISPU limits. This suggests that both intersection improvements lead to better traffic flow without significantly worsening air quality.

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