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Traffic performance analysis of unsignalized intersection using the Traffic Conflict Parameter technique

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Abstract
The unsignaled intersection of Jalan H Djole – Jalan Pasar Lama in Bekasi City is a densely populated commercial area with high economic activity. The lack of facilities and infrastructure that causes traffic jams at the intersection also raises the potential for conflict. This study aims to analyze the level of service, the type of conflict, and the traffic conflict complexity at an unsignaledintersection. The field survey method obtains primary data on the conflict approach and traffic volume. The analysis showed that the highest traffic volume was 3,810 passenger cars unit/hour with aDS value of 1.06 and LOS F. The number of conflicts that occurred during one hour of observation at peak hours was 420. Most of the conflicts that arose were straight-right, turned movements of 138.

Keywords:
Conflict Approach;
Traffic Conflict;
Traffic Volume;
Unsignalized Intersection;

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INTRODUCTION

The increasing population growthmultiplies mobility in Bekasi City also. Theexpanding means of transportation will cause traffic jams if facilities and infrastructure are not improved [1][2]. The problem seems normal in cities of developing countries, including Indonesia[3]. It generally can be found at signaled andunsignaled crossings [4]. Driver attitudes, traffic composition, and roadside activity levels differ from those in developed countries. Typically, the traffic in cities in developing countries is heterogeneous, consisting of motorized and non- motorized ones [5].

The complexity of high traffic conditionscan trigger engineering problems, such as congestion and accidents [6]. These two problems almost occur in various road networks with varying seriousness and frequency. Considering the stochastic features of demands on both primary and minor roads at unsignaled intersections on a plot [7]. Unruly motoristmovement behavior can trigger disaster for road users, especially at unsignaled intersections [8]. In the crossing area, the complexity becomesmore significant because the movement of traffic flows is constrained by differences in direction and traffic flow [9]. Figure 1 shows the example condition.

Figure 1. Traffic Conditions at Unsignaled Intersections

The existing condition shows that the traffic flow at the intersection of Jalan Pasar Lama – H. Djole is continuous and has cutting motions. Therefore, traffic conflicts can be triggered by the travel behavior of road users [10].

METHOD

The analytical method used is quantitative, consisting of several stages, namely the preparation stage, which discusses the preliminary survey. The data collection stage elaborates on collecting data; the analysis stage discusses how to process and analyze data conducted by MKJI 1997 for urban roads and unsignaled intersections and the evaluation and stage refinement [11]. Researchers use primary and secondary data [12]. Bidirectional stop control is a widely used form of crossing operation. Service level calculations are usually based on the acceptance gap theory [13].

A direct survey at the research location is conducted to get the critical information, as shown in Figure 2 above, such as geometric, environmental, traffic, side barriers, and existing speed conditions and data [14]. Observations were carried out for three days, each using a heavy traffic approach at 6.30–8.30, 11.30–13.30, and 17.00-19.00. Conflict at the Unsignalized Intersections is depicted in Figure 3.

Figure 2. Research Location

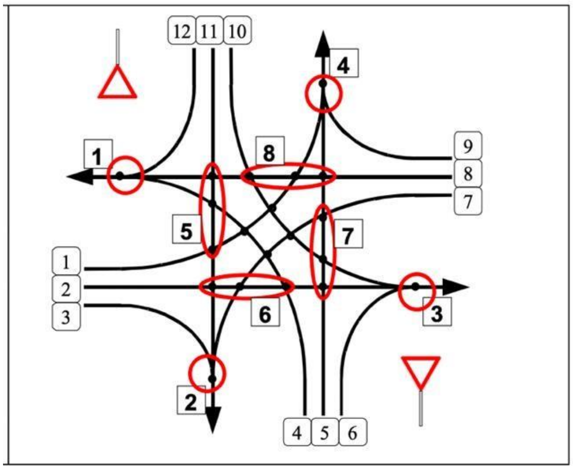


Figure 3. Conflict at the Unsignalized Intersections [15]

The conflict approach is analyzed by observing each leg of the intersection to find the dominant type of conflict. At the same time, the vehicles involved are divided into three types:light and heavy cars and motorcycles [16]. Now, look at the conflict group consisting of three movements in Figure 4. Here we have to apply a priority hierarchy that resembles conflict arrangements at the unsignaled intersection. Movement one has the highest priority, two is the middle one, and three must surrender to the other two movements [17].

In general, a typical traffic conflict [18] is likely to occur, especially at the intersection approach; the data taken are:

1. Straight in the same direction
   It is caused by the first vehicle moving in a straight line slowly. The position is in a potential situation of a front and rear collision. The observations on the second vehicle are pressing the brakes and changing direction to the left or right.
2. Turn right in the same direction.
   It is caused by the first vehicle moving slowly, which causes the second vehicle behind to be carried into a front-rear collision hazard situation. Observation on the second vehicle is to apply the brakes and change the course to the left or the right.
3. Turn right straight
   It is caused by the first vehicle moving in a straight line cutting off the direction of the second vehicle that is going to turn right. The first vehicle, which wants to turn right, cuts off from the second one, which is moving straight. These conditions can bring both cars into a head-swipe or side-swipe hazard.Prevention to avoid a collision is one, or both must do braking. Another way is to brake and change course.

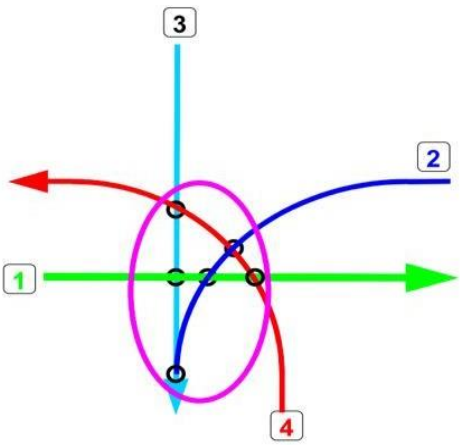


Figure 4. Conflicts Between Four Movements

4. Merging
   It is a conflict caused by the motions from two directions in the same direction, causing a collision. The movement of cars that are straight and coming from the right. As a result, vehicles moving into the intersection from the right must brake or change course to avoid a side-by-side collision.
5. Secondary conflict
   It happens due to a conflict between the first and second vehicles, which causes friction among others. A typical secondary conflict at the location is a straight-to-the-way conflict or a secondary conflict from the impact of a unidirectional right-turning conflict. It causes vehicle deceleration and has the potential to cause a rear-end collision.

RESULTS AND DISCUSSION

Based on the existing data, the calculation of the performance of unsignaled intersectionsand traffic conflicts is as follows.

Intersection Traffic Data

Traffic data collection is carried out on Monday, Friday, and Saturday, each for two hours in the morning, afternoon, and evening. For example, the following table shows that the highest traffic data is on Friday from 17.00 - 18.00.

Figure 5 shows a graph of the total traffic volume under observation for three days. Figure 5 shows that the movement of vehicles on weekdays is relatively the same as the most significant total vehicle on Friday afternoons. However, the trend on holidays increases again, with the number of means of transport less than on weekdays. Table 1 shows the survey data on Friday at each intersection.

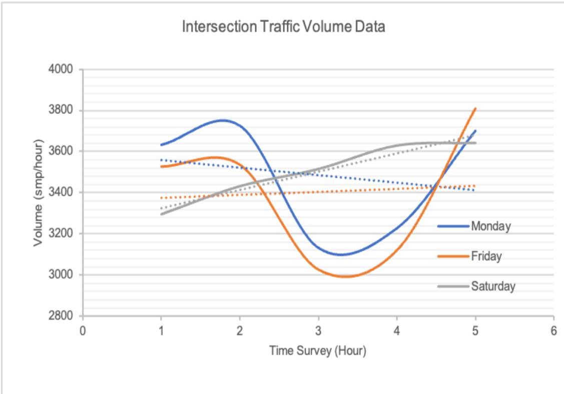


Figure 5. Intersection Traffic Volume Data During Observation

Table 1. Survey Results with Highest Traffic Data

Direction		Friday Afternoon (17.00 - 18.00)						
		LV	LV (emp : 1)	HV	HV (emp:1.3)	MC	MC (emp:0.5)	UM
		vehicle/hour	pcu/hour	vehicle/hour	pcu/hour	vehicle/hour	pcu/hour	vehicle/hour
Jalan H. Djole to Narogong (Leg D)	LT	123	123	8	10.4	351	175.5	6
	ST	102	102	4	5.2	378	189	4
	RT	95	95	5	6.5	317	158.5	5
Jalan Prapatan to Cipendawa (Leg A)	LT	175	175	14	18.2	563	281.5	6
	ST	113	113	12	15.6	401	200.5	3
	RT	75	75	7	9.1	326	163	6
Jalan H. Djole to Vida Bekasi (Leg B)	LT	132	132	6	7.8	632	316	4
	ST	108	108	8	10.4	473	236.5	4
	RT	96	96	12	15.6	254	127	3
Jalan Ps. Lama to Ps. Bantar Gebang (Leg C)	LT	132	132	13	16.9	359	179.5	7
	ST	109	109	13	16.9	257	128.5	8
	RT	125	125	8	10.4	253	126.5	4
		1385	**1385**	**110**	**143**	**4564**	**2282**	**60**
Total Vehicles				**6119**				**vehicle/hour**
Total Vehicles				**3810**				**pcu/hour**

Unsignalized Intersection Analysis

The calculation for the analysis of the four-arm unsignaled crossing on H Djole - Pasar Lama is carried out using standard tables described in the 1997 Indonesian Road Capacity Manual (MKJI), known as USIG-I and II Forms. The type of intersection analyzed is 422, a hub with four arms with several lanes on the main road, while a minor road is two lanes. Table 2 shows the calculation of the intersection volume using the 1997 MKJI method.

Table 2. Capacity Adjustment Factor

Type	Basic Capacity Co Pcu/hour	Capacity Adjustment Factor (F): Approach With Adjustment Factor F_W	Main Street Median Adjustment Factor F_M	City Size Adjustment Factor F_{CS}	Environmental Adjustment Factor F_{RSU}	Left Turn Adjustment Factor F_{LT}	Right Turn Adjustment Factor F_{RT}	Minor Road Flow Ration Adjustment Factor F_{MI}	Capacity (C) Pcu/hour
1	2900	0.958	1	1.05	0.92	1.5	1	0.89	3583

Degree of Saturation

The formula:

DS = QTOT / C

= 1.06

Intersection Delay

D = DG + DT1

D = 22.31 sec/pcu

Queue Probability (QP%)

Figure 6 shows the probability of queuing the upper and lower limits while the Upper Limit QP_A is 90 % and the Lower Limit QP_B is 45 %.

Intersection Service Level

The analysis results with the 1997 MKJI show that Pasar Lama - H. Djole has a degree of saturation of 1.06 > the target of the study of ≤ 0,75. Therefore, it is at the Level of Service class F.

Traffic Conflict Analysis

The severity of a conflict measures how serious a traffic conflict is regarding a typical vehicle manoeuvre to avoid a collision. There are five levels of traffic conflict [20]. Mild level 1 is a condition where braking control or lane change is for collision prevention but moving for a long time. Severe grade 2 is when braking or changing direction to avoid a collision takes less time to carry than a minor conflict. Intense level 3indicates slowing down quickly, changing lanes, or stopping to avoid crashes in near-collision situations. The deep level 4 is emergency brakingor hard dodging to prevent collision in very close but not collision situations. Lastly, deep level 5 is when a crash follows emergency action. Some ofthe conflicts that occurred are below.

From the results of observations for three days, traffic volume data can be obtained, as shown in Figure 7, Figure 8, and Figure 9. The frequency of traffic conflicts and the percentage of the number of conflicts at each traffic conflict point at the crossroads are shown at each conflict point, as shown in Table 3. Table 3 shows that 420 conflicts occurred during the peak hour of observation, which is on the 2nd-day for one hour. The most significant conflict happened at the D with 119 conflicts, while the type of conflict most occurred was the right turn straight with 138 conflicts. Furthermore, by comparing conflicts that occurred in 3 days of observation, it can be seen that the more traffic volume that passesthrough the intersection, the higher the level of conflict that arises. It can be seen in Figure 10.

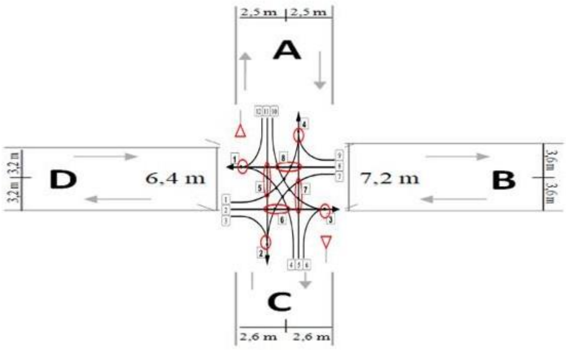


Figure 6. Conflicts that occur at the intersection

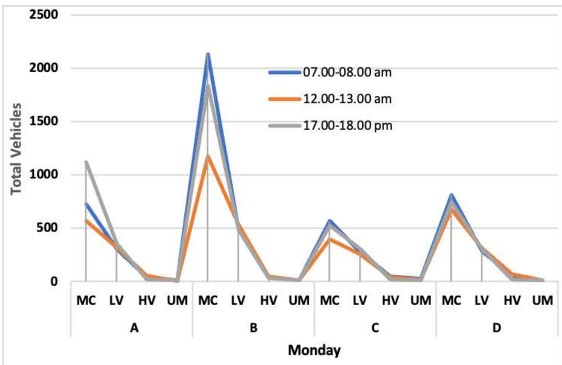


Figure 7. Number of vehicles on Monday

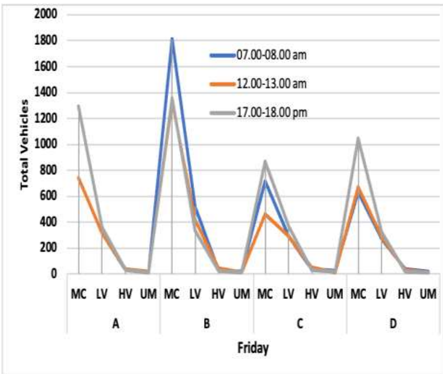


Figure 8. Number of vehicles on Friday

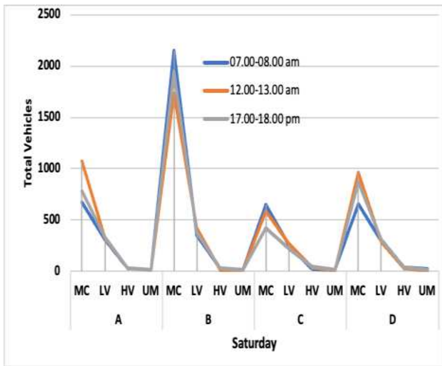
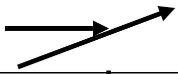
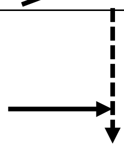


Figure 9. Number of vehicles on SaturdayTable

3. Traffic conflict data at the intersection

Type of Conflict	Conflict Point				Number	Type of Conflict (%)
	A	B	C	D		
	31	35	24	27	117	0.28
	43	22	17	41	123	0.29
	23	47	27	41	138	0.33
	14	11	7	10	42	0.10
Total	111	115	75	119	420	

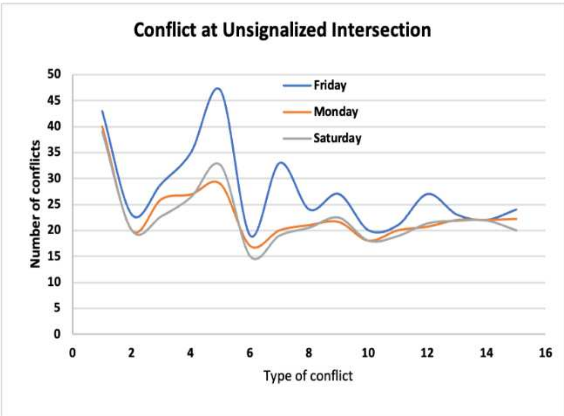


Figure 10. Graph of Conflicts Occurring at Unsignaled Intersections

CONCLUSION

The unsignaled intersection on H. Djole-Pasar Lama has a service level of F with a DS of 1.06, a D of 22.31 sec/passenger cars unit, and a QP of 45%-90%. Observations during peak hours showed 420 conflicts that occurred during one hour. Most of the conflicts occurred in the right-turn movement, with 138 conflicts. From the observations, this conflict was triggered by the behavior and the number of motorcycle riders trying to break through the movement at the estuary of the intersection.

SUGGESTIONS

There is a need for road engineering to improve the performance value of the intersection and reduce the number of conflicts. It can bedone by making a particular lane for turning around, prioritizing signs, and making a barrier between the road and the shops in the estuary of the intersection. There is similar research by adding survey time, especially on working days with the same period. It is intended to get the difference between one day and another so that the data can represent the whole

REFERENCES

[1] N. Widyaningsih and O. Daniel, "Analisis Karakteristik dan Perilaku Penyeberangan Orang Pada Fasilitas Penyeberangan Zebra Cross Dan Pelican Cross (Studi Kasus Ruas Jalan M. H. Thamrin)," *Pengembangan*

Rekayasa dan Teknologi, vol. 15, no. 1, p. 27, 2019, doi: 10.26623/jprt.v15i1.1486.

[2] M. Isradi, N. D. Nareswari, A. I. Rifai, A. Mufhidin, and J. Prasetijo, "Performance Analysis of Road Section and Unsignalized Intersections to Prevent Traffic Jams on Jl. H. Jole-Jl. Pasar Lama," *ADRI International Journal of Civil Engineering*, vol. 6, no. 1, pp. 56–67, 2021, doi: 10.29138/aijce.v6i1.21

[3] M. Isradi, H. Dwiatmoko, M. I. Setiawan, and D. Supriyatno, "Analysis of Capacity, Speed, and Degree of Saturation of Intersectionsand Roads," *Journal of Applied Science, Engineering, Technology, and Education*, vol. 2, no. 2, pp. 150–164, 2020, doi: 10.35877/454ri.asci22110.

[4] T. Aswini and G. Asaithambi, “Capacity Analysis of Uncontrolled Intersections with and Without Pedestrian Cross Flow in Mixed Traffic Conditions,” Transportation in Developing Economies, vol. 8, 2022, doi: 10.1007/s40890-022-00159-2

[5] M. Azzam, S. A. Hassan and O. C. Puan, “Autonomous Vehicles in Mixed Traffic Conditions—A Bibliometric Analysis,” Sustainability, vol. 14, no. 17, 2022, doi: 10.3390/su141710743

[6] J. Prasetijo *et al.*, “Investigation of Road Crash Rate at FT050 , Jalan Batu Pahat – Kluang: Pre and Post Road Median Divider,” *International Journal of Road Safety*, vol. 1, no. 1, pp. 16–19, 2020.

[7] M. Khajehvand, A. A. Rassafi, and B. Mirbahaa, “Modeling traffic noise level near at-grade junctions: Roundabouts, T andcross intersections,” *Transportation Research Part D: Transport andEnvironment*, vol. 93, 2021, doi:10.1016/j.trd.2021.102752

[8] Yosritzal, Purnawan, M. Lovita, and D. Dissanayake, "Mitigation of Traffic Disaster by Analyzing Motorist's Movement Behavior Based on an Image Captured by a Drone," *E3S Web Conf.*, vol. 331, p. 06003, 2021, doi: 10.1051/e3sconf/202133106003.

[9] G. R. Miranti and H. R. Agah, “Analisis Konflik Lalu Lintas Pada Simpang TakBersinyal Studi Kasus : Simpang Jalan Raya Lenteng Agung Putaran Balik IISIP,” *Proc. 19th Int. Symp. FSTPT*, vol. 6, no. October, pp. 756–766, 2016.

[10] W. Li, L. Tan, and C. Lin, "Modeling driver behavior in the dilemma zone based on stochastic model predictive control," *PLoS One*, vol. 16, no. 2, February 2021, doi: 10.1371/journal.pone.0247453.

[11] M. Isradi and E. A. Pratama, "Performance Analysis of Unsignaled Intersection andRoad Section With MKJI Method 1997," *IJTI (International J. Transp. Infrastructure)*, vol. 4, no. 1, pp. 1–11, 2020, doi: 10.29138/ijti.v4i1.1160.

[12] Bina Marga, *Manual Kapasitas Jalan Indonesia*. 1997.

[13] W. Brilon and T. Miltner, "Capacity at Intersections without Traffic Signals,"*Transp. Res. Rec. J. Transp. Res. Board*, vol. 1920, no. 1, 2005, doi: 10.1177/0361198105192000104.

[14] A. I. Rifai, Y. A. Surgiarti, M. Isradi, A. Mufhidin, “Analysis of Road Performance and the impact of Development in Pasar Minggu, Jakarta (Case Study of Jalan Lenteng Agung - Tanjung Barat),” *ADRI International Journal of Civil Engineering*, vol. 6, no. 1, pp. 68–74, 2021, doi: 10.29138/aijce.v6i1.22

[15] M. Krbálek et al., “Statistical aspects of gap-acceptance theory for unsignalized intersection capacity, *Physica A: Statistical Mechanics and its Applications*, vol. 594, 2022, doi: 10.1016/j.physa.2022.127043

[16] A. Thankappan, Y. Tamut, and L. Vanajakshi, "Traffic stream modeling under heterogeneous traffic conditions," in *Proceedings of the Conference on Trafficand Transportation Studies, ICTTS*, 2010, vol. 383, DOI: 10.1061/41123(383)37.

[17] A. Kurek and E. Macioszek, “Impact of Parking Maneuvers on the Capacity of the Inlets of Intersections with Traffic Lights for Road Traffic Conditions in Poland,” *Sustainability*, vol. 14, no. 1, 2022, doi: 10.3390/su14010432

[18] C. Fu and T. Sayed, “Bayesian dynamic extreme value modeling for conflict-based real-time safety analysis,” Analytic Methods in Accident Research, vol. 34, 2022, doi: 10.1016/j.amar.2021.100204

[19] BPS-Jawa Barat, *Statistik Transportasi Provinsi Jawa Barat 2020*. Bandung, 2020.

[20] C. Fu and T. Sayed, “Random parameters Bayesian hierarchical modeling of traffic conflict extremes for crash estimation,” Accident Analysis & Prevention, vol. 157, 2021, doi: 10.1016/j.aap.2021.106159