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Analysis of Road Performance to Overcome Congestion at Unsignalized Intersections (Case Study: Tanjung Buntung - Batam)

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ABSTRACT

Traffic jams and congestion at unsignalized intersections are common problems in many cities. This study aims to analyze road performance in overcoming congestion at unsignalized intersections using case studies in the Tanjung Buntung area, Batam. The research method used includes collecting traffic data such as geometric data, primary and secondary data, and data analysis using the 1997 Indonesian Highway Capacity Manual Method (MKJI). The analysis results show that this intersection experiences congestion during busy hours with high density. Alternatives that can overcome congestion at unsignalized intersections include widening the road and providing traffic signs on the side to give directions to motorists to avoid parking carelessly on the side of the intersection.

1. Introduction

The congestion case is familiar to developing countries. This transportation problem is extensive, and this case is not a case that can be quickly addressed [1]. Indonesia, a developing country, has the same problems, including congestion at uninterrupted intersections with the need for more traffic facilities. The intersection is a street whose commercial area is crowded with residents and economic activity every day [2]. The intersection is one of the accesses for residents to travel; it is expected that interchanges often occur in cases of congestion due to the existence of four lanes.

At the intersection of Tanjung-Buntung, there are very few traffic facilities. Therefore, there is a need for road performance that must be moved. This congestion is more noticeable due to the long and high population density. The increasing number of motorized equipment can also increase congestion on Tanjong bunting road. Researchers have defined congestion from a different perspective. The most common definition of congestion in a traffic flow state is when the travel demand exceeds the capacity of the road [3].

Most of the population must know this intersection; this intersection is the odd intersection where motor vehicles do not want to give in to each other and always want to win on their own, and the increase in residents' vehicles also causes congestion in traffic as a result of the increase in transportation tools of the population resulted in a buildup and volume that was getting bigger and exceeding the capacity of the road [4].

Based on the problems in this intersection, the author wants to conduct research by seeing the number of community users who often use this stump Tanjung interchange and its road conditions. Analyze the frequency of accidents at the intersection caused by negligent vehicle drivers. Heavy traffic without the support of good facilities and a lack of public awareness of traffic discipline will cause various violations and lack of discipline that lead to accidents [5].

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Figure 1. Intersection situation of Jl. Tanjung Buntung

This study aims to determine road performance at the Tanjung Buntung intersection and research objectives with the application of traffic management on Tanjung Buntung-Batam roads, among others, calculating the level of congestion ratio on Tanjung Buntung-Batam roads, providing surveyed road information, calculating noise levels in Jalan Tanjung Buntung-Batam Road, and Identifying traffic problems on Jalan Tanjung Buntung-Batam.

2. Literature Review

2.1 Road Performance Analysis

Road performance is a road's capability to serve every need of traffic flow by its function and can also be measured by the level of service standards on the road [6]. From that, the level of road service is used as road performance. According to the US-HCM, road performance or service level is a qualitative measure used in the United States that describes how traffic flow operates and is assessed by road users [7].

Performance analysis is a test that can produce something of quality [1]. The road is hoped to provide convenience to the community in a comfortable, safe, and efficient transportation service. The excellent road performance can be seen in the slow volume of traffic. Congestion can also be seen in vehicles driving very slowly or stationary [8].

The road performance parameter is the load capacity, defined as the maximum number of cars, motorcycles, people, or similar objects [9]. There is constant congestion due to the lack of road capacity rather than the volume of vehicles, so expanding the road capacity or widening the road becomes the most common solution. Many other cities are overcoming congestion by widening the road so drivers are more spacious.

A rough road can trigger an estimate of the workings of the road. Rough roads must always be considered to know the exact condition of road infrastructure. There are many indicators of poor road performance. For example, accidents that occur and the dissatisfaction of road users when passing through the road say that the performance on the road is poor [10]. Moreover, many indicators of road performance still need improvement. For example, traffic density and queue formation indicate that road performance is abysmal [11].

2.2 United Interchange

An intersection intersects or confluence on a plane between two or more lanes on a highway with their respective intersections. At each point, the intersection is not equipped or facilitated with lights as traffic signs. Behavior in interchange traffic is not good in giving way to lane discipline and rules. It is tough to

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describe a model of behavior because of the differences in behavior in each resident who crosses the road or intersection [12] [13].

Unsignalized intersections are interchanges that have minimal signalling devices for traffic lights. Interchanges are no more common in residential areas or urban or rural environments where traffic flow is low [14]. Potential problems at unsignalized intersections are higher than signalized intersections because of the lack of signs at Potential problems at unsignalized intersections are higher than signalized intersections because of the lack of signs at intersections, resulting in long traffic jams at the intersection.

Accidents found at interchanges are estimated at 0.60 accidents/million vehicles. This case can occur due to a driver's need for more attention when crossing an intersection and only wanting to be concerned with himself so that he reaches the desired destination. Every driver is selfish and does not want to give in; there are also cases of accidents at these intersections. Drivers also do not want to wait for gaps but insist on placing their vehicles on the roads they will enter [15].

The application of street lights at the intersection is also very minimal, even though lighting at night is needed so that drivers can see the road at the intersection. Street lighting is also essential for residents to see the road well at night. As a result, the lack of lighting can lead to accidents because some people use motorbikes with the lights on their motorbikes turned off, so it is difficult for other drivers to see, and accidents can occur if they accidentally hit a motorbike without these lights. Injury due to traffic accidents is a significant case for the international community [16].

2.3 Traffic Jams

City development is often followed by transportation problems; traffic congestion is one of the problems that often occurs in transportation. The congestion occurs due to the volume of vehicles passing on the road exceeding / not comparable to the capacity at the intersection. At the time of congestion buildup, residents prefer to use private vehicles instead of having to take public transportation [4].

Traffic congestion also occurs due to the high volume and capacity of traffic on transportation that passes at the intersection caused by a mix of regional and local traffic. When traffic jams become routine, they not only result in inefficient use of resources but also affect activities in the environment and other economic activities [17].

Traffic jam is a problem that often occurs at intersections, especially at intersections in urban areas. Congestion is a condition where the flow of traffic crossing a measured road section exceeds the capacity of the planned road, and the free transport speed of the sections on the road approaches or exceeds 0 km/hour and causes congestion. Evaluation of saturation on measured road sections where congestion occurs at 0.5 during congestion occurs [18]

The state of congestion can also affect accidents, in the form of minor accidents or significant accidents, to the point of taking their toll. It must be considered for the safety of residents who cross the road to stay safe when driving during traffic jams. In a minor accident, for example, a motor vehicle accidentally nudged the car so that the body of another driver's car was scratched (beret). Traffic accidents are a considerable problem because they can take their toll [19].

3. Method

Data is one of the main forces for constructing research [20]. The method used for this analysis is quantitative. This method has several stages, namely the preparatory stage, which discusses the preliminary survey; the stage discusses collecting all data; the analysis stage, which discusses how to manage and analyze data based on the 1997 MKJI to build non-signalized deposits. problem observed is

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regarding efforts to overcome congestion at unsignalized intersections. The research location is at the Tanjung Buntung intersection road near the Golden Prown.

Figure 2 Research Location

Data is one of the main strengths in compiling research and scientific modelling. This research is categorized as literature research using primary and secondary data. Primary data is data that will be observed. Primary data is the number of vehicles on the road and road geometric data, using location maps and population data as secondary data [10] [21] [22] [23] [24] [25]. The research data that will be used as primary data is the number of vehicles that cross the Tanjung Buntung road, including when traffic jams are high. The secondary data taken in this study is the high and low data of vehicles that cross or go through the road. The type of research conducted in this research is quantitative, namely the act of collecting and evaluating numerical data that can be used to develop statistics and identify patterns in research.

The research will be carried out during rush hours, namely in the morning, afternoon, and evening, for 3 consecutive days Monday (22 May 2023), Thursday (25 May 2023), and Friday (26 May 2023). The research was conducted for 2 hours; the time used for the survey was 07.30-09.30, 12.30-14.30, 17.00-19.00. With the consideration that each period has peak hours.

4. Result and Discussion

4.1 Performance analysis of unsignalized intersections

The performance analysis at the unsignalized intersection at the Tanjung Buntung intersection has a four-lane intersection that must be observed and analyzed for the data to be used. The data to be recaptured are primarily in the form of geometric, environmental, and traffic data based on direct observations and surveys in the field. As well as secondary data obtained from related agencies.

4.1.1 Geometric data at intersections

Tanjung Buntung intersection is a type 422 intersection, which is an intersection with 4 arms, 2 lanes on the minor road, and 2 lanes on the main road. The following is the geometric data at the Tanjung Buntung intersection:

Table 1. Existing geometric data

Description	Roads			
	Jl. Bengkong laut	Jl. Tanjung bunting	Jl. Golden prawn	Jl. Golden prawn

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	(B A rm)	(D A rm)	(A A rm)	(C A rm)
Road type	Major	Major	Major	Major
Lane width(m)	2,6	2,5	3,8	3,6
Road Widht(m)	2 x 2,6	2 x 2,5	2 x 3,8	2 x 3,6
Road Shoulder(m)	-	-	-	-
Median width(m)	-	-	-	-
Side walk width(m)	-	-	-	-

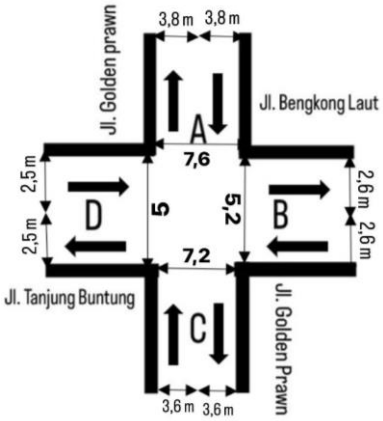

Figure 2. Illustration of unsignalized intersection of JL. Tanjung Buntung

Table 2. Intersection survey result Thursday, 25 Mei 2023 at 5 – 6 PM

Approach		LV Vech/hour	LV (emp : 1) Pcu/hour	HV Vech/hour	HV (emp : 1.3) Pcu/hour	MC Vech/hour	MC Pcu/hour	MC Vech/hour
Jalan Tanjung	LT	132	132	10	13	350	175	5
buntung	ST	142	142	5	6,5	382	191	4
(Arm D)	RT	120	120	6	7,8	322	161	6
Jalan Golden	LT	200	200	15	19,5	575	287.5	3
Prawn	ST	143	143	13	16,9	501	250.5	6
(Arm A)	RT	90	90	8	10,4	356	178	5
Jalan Bengkong	LT	145	145	5	6,5	656	328	4
Laut	ST	110	110	9	11,7	523	261.5	4
(Arm B)	RT	95	95	14	18,2	267	133.5	5
Jalan Golden	LT	134	134	12	15,6	409	204.5	6
Prawn	ST	105	105	13	16,9	278	139	7
(Arm C)	RT	123	123	10	13	246	123	5
		1539	1539	120	156	4865	2432	60
Total				6584				Vech/hour
Total				4127				Pcu/hour

4.1.2 The calculation results of the unsignalized intersection

Table 4. The Capacity of Intersections of Jl. Tanjung Bunting

Basic Capacity Co pcu/hour	Average Approach Width Fw	Capacity Adjustment Factor: Major Road Median FM	City Size Fcs	Side Barrier Factor FRSU	Left Turn Adjustment Factor FLT	Right Turn Adjustment Factor FRT	Mirror Road Adjustment Factor FMI	Capacity (C) pcu/hour
3000	1	1,5	1,25	0,90	1	1,0	0,90	3583

Table 5. Traffic behavior intersection of Jl. Tanjung Bunting

Traffic Flow (Q) pcu/hour	Degree of Saturation DS	Intersection Traffic Delays DT I	Major Road Traffic Delays DT MA	Mirror Road Traffic Delays DT MI	Intersection Geometric Delays (DG)	Intersection Delays (D)	Queue Opportunities (QP%)	Target

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4045.1	1,05	18,30	12,50	24,50	4	22,30	45-90%	DS≤0,75

The table above results in calculating the existing capacity at the Tanjung Buntung intersection. From the table above, it can be seen from the results of the data analysis using the 1997 Indonesian Road Capacity Manual (MKJI) Method at the Unsignalized Intersection of Jl. Tanjung Buntung has a degree of saturation of 1.05 which exceeds the research target of ≤ 0.75 and is at Service Level Class F. Therefore, an alternative solution is needed so that the density at the intersection of Jl. Tanjung Buntung can be overcome.

4.2 Analysis of Road Segment Performance

It is necessary to collect data on the performance of the road section at the Tanjung Buntung intersection to know the performance occurred at the Tanjung Buntung intersection. analyzing the performance of the road section at the Tanjung Buntung intersection, namely by observing and directly analyzing the area to get direct data that occurs at the intersection. Observations were made directly to the field to obtain road performance data on Tanjung Bunting Road.

5. Conclusion

The survey results obtained from the field from the results of data analysis that has been carried out indicate that several. The Tanjung Buntung intersection, which has four unsignalized roads, experienced a peak volume on Thursday, May 25 2023 of 4127 pcu/hour. The results of the analysis of the performance of the four intersections on the Tanjung Buntung road show a degree of saturation (DS) of 1.05, an intersection delay of 22.30 seconds/SMP, a queue probability of 40-90%, an F intersection service level, indicating that the Tanjung road needs this there is a flow which is limited by long queues and results in congestion which is a barrier for people to drive. Furthermore, install traffic signs that prohibit stopping around the intersection with a side friction regulation of 0.90 to 1; the prohibition must be on arms B and D. Provision of an alternative to being installed at the intersection is urgently needed because it can help ease the road on that road and can help prevent too long traffic jams at the intersection. It is hoped that the road sections that will be given alternatives can eliminate obstacles by installing traffic signs such as prohibitions on stopping or parking around the road, which can hinder community activities while traveling, and making traffic signs around intersections to make roads again.

Bibliography

[1] F. Firmansyah, A. I. Rifai and M. Taufik, "The Performance of Roundabouts with Traffic Signals:A Case Kadipaten Intersection,," *The Performance of Roundabouts with Traffic Signals:A Case Kadipaten Intersection,,* p. 823, 2022.

[2] M. Isradi, N. D. Nareswari, A. I. Rifai and A. Mufhidin, "Performance Analysis of Road Section and Unsignalized," *Performance Analysis of Road Section and Unsignalized,* p. 56, 2021.

[3] Yodo, T. Afrin and Nita, "A Survey of Road Traffic Congestion Measures towards a Sustainable and Resilient Transportation System," *A Survey of Road Traffic Congestion Measures towards a Sustainable and Resilient Transportation System,* p. 1, 2020.

[4] I. Andika, A. I. Rifai, M. Isradi and J. Prasetijo, "A Traffic Management System for Minimization of Intersection," *A Traffic Management System for Minimization of Intersection,* pp. 945-946, 2022.

Receieved 2 Juli 2023
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Published by Fakultas Teknik Sipil dan Perencanaan UIB

Civil Engineering and Architecture Journal Vol 1 No.3 (2023) E-ISSN
DOI 10.37253/leader.v1i3.8282

[5] D. Y. F. C. Hasibuan and M. Z. Muttaqin, "Analisis Kinerja Simpang Tak Bersinyal Persimpangan Pasar Sibuhuan, Kabupaten Padang Lawas, Sumatera Utara," *Analisis Kinerja Simpang Tak Bersinyal Persimpangan Pasar Sibuhuan, Kabupaten Padang Lawas, Sumatera Utara,* p. 53, 2021.

[6] W. E. G. Ginting and N. Widyaningsih, "The effect of one-way system implementation on traffic," *The effect of one-way system implementation on traffic,* pp. 657-658, 2022.

[7] A. I. Rifai, Y. A. Surgiarti, M. Isradi and A. Mufhidin, "Analysis of Road Performance and the impact of," *Analysis of Road Performance and the impact of,* p. 68, 2021.

[8] Wincent, A. I. Rifai and M. Isradi, "THE ROAD PERFORMANCE ANALYSIS IN JALAN AHMAD YANI," *THE ROAD PERFORMANCE ANALYSIS IN JALAN AHMAD YANI ,* p. 104, 2022.

[9] D. P. Moses, P. Sudharsanamurthy and K. Madhivadhani, "Study of Traffic Impact Assessment on Commercial," *Study of Traffic Impact Assessment on Commercial,* pp. 516-517, 2021.

[10] Vendhy, A. I. Rifai and M. Isradi, "THE ANALYSIS OF ROAD PERFORMANCE ON JALAN GAJAH MADA," *THE ANALYSIS OF ROAD PERFORMANCE ON JALAN GAJAH MADA,* p. 52, 2022.

[11] H. Sugari, A. K. Purnomo and R. Yudo, "Impact of Overloading Vehicle towards the Level of Service on Freeway Segment (Case Study: JORR KM 27 to KM 23)," *Impact of Overloading Vehicle towards the Level of Service on Freeway Segment (Case Study: JORR KM 27 to KM 23),* pp. 1-2, 2022.

[12] M. Waris, "Analisis Kinerja Simpang Tak Bersinyal Metode Pedoman Kapasitas Jalan Indonesia 2014," *Analisis Kinerja Simpang Tak Bersinyal Metode Pedoman Kapasitas Jalan Indonesia 2014,* p. 47, 2018.

[13] E. P. Kulo, S. Y. R. Rompis and J. A. Timboeleng, "ANALISA KINERJA SIMPANG TAK BERSINYAL DENGAN ANALISA GAP ACCEPTANCE DAN MKJI 1997," *ANALISA KINERJA SIMPANG TAK BERSINYAL DENGAN ANALISA GAP ACCEPTANCE DAN MKJI 1997,* p. 54, 2017.

[14] A. Y. Nurkafi, Y. C. SP, S. Winarto and A. I. Candra, "ANALISA KINERJA SIMPANG TAK BERSINYAL JALAN SIMPANG BRANGGAHAN NGADILUWIH KABUPATEN," *ANALISA KINERJA SIMPANG TAK BERSINYAL JALAN SIMPANG BRANGGAHAN NGADILUWIH KABUPATEN,* p. 166, 2019.

[15] N. Listiana and T. Sudibyo, "Analsis Kinerja Simpang Tak Bersinyal Jalan Raya Dramaga-Bubulak Bogor, Jawa Barat," *Analsis Kinerja Simpang Tak Bersinyal Jalan Raya Dramaga-Bubulak Bogor, Jawa Barat,* pp. 69-70, 2019.

[16] I. Pangesti, A. I. Rifai and J. Prasetijo, "The Horizontal Curved Geometric Planning Using the Autocad® Civil 3D Method on Tanah Merah Road, Banjarbaru City, South Kalimantan," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 265-287, 2022.

[17] E. O. Joice, A. I. Rifai and M. Taufik, "The Link Road Design of Jalan Plupuh Tanon And Jalan Gabugan Section 1, Sragen Indonesia," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 211-223, 2022.

[18] M. R. Aswad, A. Andriawan and A. Savitri, "ANALISIS KEMACETAN JALAN PADA SIMPANG TAK BERSINYAL (STUDI KASUS: SIMPANG LAKSAMANA BINTAN-BATAM)," *ANALISIS KEMACETAN JALAN PADA SIMPANG TAK BERSINYAL (STUDI KASUS: SIMPANG LAKSAMANA BINTAN-BATAM),* p. 540, 2022.

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Civil Engineering and Architecture Journal Vol 1 No.3 (2023) E-ISSN
DOI 10.37253/leader.v1i3.8282

[19] Y. Immanuel, A. I. Rifai and J. Prasetijo, "The Road Performance Analysis of the Tuah Madani Roundabout, Batam-Indonesia," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 27-36, 2022.

[20] R. Maro, A. I. Rifai and J. Prasetijo, "THE DRIVER PERCEPTION ANALYSIS OF ROUNDABOUT INTERSECTION: A CASE OF BASECAMP INTERSECTION BATAM," *THE DRIVER PERCEPTION ANALYSIS OF ROUNDABOUT INTERSECTION: A CASE OF BASECAMP INTERSECTION BATAM,* p. 41, 2022.

[21] A. H. Agniya, A. I. Rifai and M. Taufik, "The Geometric Design of New Jakarta-Cikampek Highway Access Using Autocad® Civil 3D: A Case of West Karawang Industrial Area," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 189-198, 2022.

[22] J. A. Ong, A. I. Rifai and S. Handayani, "Comparative Analysis of Conventional Taxi Performance with Application-Based Taxi in Batam," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 117-128, 2022.

[23] D. Pratama, A. I. Rifai and S. Handayani, "The Passenger Satisfaction Analysis of Commuter Line in the New-Normal Period," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 409-418, 2022.

[24] R. S. Nadillah, A. I. Rifai and S. Handayani, "The Efficiency Analysis of Motorcycle Versus Public Transportation: A Case of Cipinang-Tebet Area Route," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 164-176, 2022.

[25] A. Megarestya, A. I. Rifai and M. Isradi, "The Horizontal Curved Geometric Design with Autocad® Civil 3D on Jalan Muara Wahau, East Kalimantan," *Indonesian Journal of Multidisciplinary Science,* vol. 1, no. 1, pp. 237-250, 2022.

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