Performance Analysis Of Simpang Empat Matang Seulimeng Roundabout, West Langsa District, Langsa City

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Abstract
In West Langsa District, Langsa City, you can find Gampong Matang Seulimeng. Langsa is now home to a sizable urban population. Obviously, this will lead to daily traffic congestion in Langsa City, which in turn will result in delays, long queues, and congestion at intersections and highways. Many cars, each with its own agenda, starting point and end destination, collide at the roundabout. There are many roads leading to the Simpang Matang Seulimeng Roundabout in Langsa City, including Jalan Prof. A Madjid Ibrahim and Jalan Jendral Sudirman. The research team in Matang Seulimeng wanted to know how well the roundabout at the intersection worked and what kind of side obstacles it encountered. The results of this study, which uses PKJI 2014, suggest a new approach to improve the functionality of roundabouts. The medium class score of 494 was obtained from the data of side obstacles. The saturation degree value is 0.37 (LOS B) on Jl Prof. A. Majid AB. The intersection, 0.53 (LOS B) on Jl. Jenderal Sudirman BC, 0.87 (LOS D) on Jl. Prof. A. Majid CD, and 0.53 (LOS B) on Jl. Jenderal Sudirman DA were determined through roundabout performance analysis. These values indicate stable traffic, unstable traffic, unstable traffic, and stable traffic, respectively.

Keywords: *Roundabout, Side Obstacle 2, Degree of Saturation, PKJI.*

Abstrak
Di Kecamatan Langsa Barat Kota Langsa Anda dapat menemukan Gampong Matang Seulimeng. Langsa sekarang menjadi rumah bagi populasi perkotaan yang cukup besar. Jelas, ini akan menyebabkan kemacetan lalu lintas harian di Kota Langsa, yang pada gilirannya akan menghasilkan penundaan, antrean panjang, dan kemacetan di persimpangan dan jalan raya. Banyak mobil, masing-masing dengan agenda, titik awal, dan tujuan akhir sendiri, bertabrakan di bundaran. Banyak jalan menuju Bundaran Simpang Matang Seulimeng di Kota Langsa, termasuk Jalan Prof. A Madjid Ibrahim dan Jalan Jendral Sudirman. Tim peneliti di Matang Seulimeng ingin mengetahui seberapa baik bundaran di persimpangan itu bekerja dan jenis hambatan samping yang ditemuinya. Hasil penelitian ini, yang menggunakan PKJI 2014, menyarankan pendekatan baru untuk meningkatkan fungsionalitas bundaran. Skor kelas sedang sebesar 494 diperoleh dari data hambatan samping. Nilai derajat saturasi sebesar 0,37 (LOS B) di Jl Prof. A. Majid AB. Persimpangan, 0,53 (LOS B) di Jl. Jenderal Sudirman BC, 0,87 (LOS D) di Jl. Prof. A. Majid CD, dan 0,53 (LOS B) di Jl. Jenderal Sudirman DA ditentukan melalui analisis kinerja bundaran. Nilai-nilai ini masing-masing menunjukkan lalu lintas stabil, lalu lintas tidak stabil, lalu lintas tidak stabil, dan lalu lintas stabil.

Kata Kunci: *Bundaran, Hambatan Samping, Derajat Kejenuhan, PKJI*

1. Introduction

Matang Seulimeng is a small town in the province of Aceh, Indonesia, specifically in the sub-district of West Langsa, Langsa City. Everyone knows that traffic in Aceh Province is bad, and Langsa City is one of the most populous cities in the province. Its population has been steadily increasing over the past four years, so you can expect traffic jams, long queues, and delays at intersections and roads every day. An important aspect of highway design is the layout of roundabouts. Conflicting interests, origins, and goals cause cars to collide at roundabouts.

Traffic congestion, especially at the Matang Seulimeng roundabout, is getting worse due to the increasing number of motorized vehicles in Langsa City. This congestion increases the likelihood of accidents, fuel waste, and air pollution. Congestion occurs when there is an imbalance between the population of an area and the number of roads accessible to them, because the population continues to grow faster than the number of available roads. (Mustikarani et al, 2016).

According to (Dharmawan, 2016) The safety level of roundabouts is often higher than conventional intersection control. The use of roundabouts has many benefits, one of which is to make drivers more careful and slow down the speed of vehicles when crossing roads. Several directions of traffic, including from Jalan Prof. A Madjid Ibrahim and Jalan Jendral Sudirman in Langsa City, are served by the Simpang Matang Seulimeng Roundabout. The Matang Seulimeng Roundabout has a width of nine meters. Traffic jams or sudden collisions between vehicles coming from different directions on Jalan Prof. A Madjid Ibrahim and Jalan Jendral Sudirman are both caused by the heavy traffic that passes through this roundabout.

Side obstacles and roundabout performance at the Matang Seulimeng intersection are the main problems at this roundabout. In this case, the volume of traffic is visible at all intersections throughout the day. The high level of conflict threatens traffic safety, which in turn increases vehicle density as more and more cars try to pass.

2. Material and Methods

The location of the research is on the Matang Seulimeng Roundabout which includes Jalan Prof. A Majid Ibrahim and Jalan Jendral Sudirman, West Langsa District, Langsa City, Aceh. The data collection time was carried out for 11 hours starting at 07.00 – 18.00 WIB. The research was conducted for 7 days, namely from Monday to Sunday.

2.1 Equipment

The equipment used is a roll meter to determine the size of the road dimensions, stationery for recording survey data, cameras for documentation needs and laptops for data processing.

2.2 Data Collection Methods

1. Information about traffic volume, including the exact number of motorcycles, large trucks, and small cars passing through the roundabout. It is done manually at 15-minute intervals for 12 hours. When collecting data for volume surveys, the traffic volume value is multiplied by the emp to get the unit of smp. There is an emp value of 0.5 for motorcyclists, 1.3 for large vehicles, and 1.0 for small vehicles. On Monday between 07.00 and 08.00 am, with 5556.4 smp/h, traffic volume survey data revealed that Jalan Prof. A Madjid Ibrahim AB experienced the largest volume. See Table 2.1 for a comprehensive view of the volume survey findings.

Table 2. 1 Traffic Volume Calculation (smp/hour)

Traffic Flow		LV		HV		MC		Non-Motorized Vehicles (MV)	
		1		1.3		0.5			
		kend/ hour	smp/ hour	kend/ hour	smp/ hour	kend/ hour	smp/ hour	kend/ hour	smp/ hour
A	RT	92	92	32	41.6	149	74.5	273	208.1
	ST	149	149	135	175.5	208	104	492	428.5
	LT	52	52	37	48.1	108	54	197	154.1
	UT	19	19	3	3.9	78	39	100	61.9
	Total	312	312	207	269.1	543	27.5	1062	852.6
B	RT	68	68	49	63.7	138	69	255	131.7
	ST	42	42	12	15.6	110	55	164	112.6

Traffic Flow		LV		HV		MC		Non-Motorized Vehicles (MV)	
		1		1.3		0.5			
		kend/ hour	smp/ hour	kend/ hour	smp/ hour	kend/ hour	smp/ hour	kend/ hour	smp/ hour
	LT	77	77	63	81.9	137	68.5	277	227.4
	UT	5	5	2	2.6	42	21	49	28.6
	Total	192	192	126	163.8	427	213.5	745	569.3
C	RT	48	48	47	61.1	134	67	229	176.1
	ST	141	141	133	172.9	212	106	486	419.9
	LT	55	55	12	15.6	146	73	213	143.6
	UT	37	37	3	3.9	69	34.5	109	75.4
	Total	281	281	195	253.5	561	280.5	1037	815
D	RT	53	53	32	41.6	146	73	231	167.6
	ST	32	32	41	53.3	101	50.5	174	135.8
	LT	79	79	52	67.6	162	81	293	227.6
	UT	19	19	2	2.6	49	24.5	70	70.6
	Total	183	183	127	162.5	70	204.5	780	550
Total								7236	5556.4

2. Information on side obstacles, documenting cases of side obstacles according to PKJI 2014 standards. In determining side obstacles, what needs to be considered is: people crossing the road, cars parked or stopped, vehicles entering or exiting the road area, and slow vehicles. Vehicles parked or stopped, vehicles coming or going, pedestrians, and slow vehicles all pass through the Pase Roundabout intertwined and are recorded in a predetermined manner. The side resistance data is then multiplied by the components that give it weight. If PED=0.5, PSV=1, EEV= 0.7, and SMV=0.4, then the weighting factor according to PKJI is 0.4. To determine the class of side resistance, the total number of side obstacles is multiplied by the weighting factor. Based on the frequency of side obstacle events along the observed route, the class is ranked from very low to very high.

Table 2. 2 Criteria For Side Resistance Classes

KHS	Sum of event frequency values (on both sides road) multiplied by weight	Special features
Very Low (SR)	<100	Residential areas, availableneighborhood roads(frontage road)
Low (R)	100-299	In residential areas, there are several public transportation (transportation city)
Medium (S)	300-499	industrial areas, there are severalshops along the side of the road
Height (T)	500-899	Commercial area, there is activityhigh side of the road
Very High (ST)	≥900	Commercial area, there is activityRoadside Market

On Monday, there were 494.7 incidents with moderate side obstacles, made it the most problematic day at the study site. The following table displays the results of the survey on which side obstacles:

Table 2. 3 Side Obtacles Monday (smp/hour)

Jalan Sudirman BC					
Day/Date : Monday, 29/7/2024					
Time	PED	PSV	SMV	EEV	Total
	0.5	1	0.7	0.4	
07.00 - 08.00	9	11	28.7	13.2	61.9
08.00 - 09.00	9	10	24.5	12.4	55.9
09.00 - 10.00	8.5	21	12.6	15.6	57.7
10.00 - 11.00	3	9	15.4	15.6	43
11.00 - 12.00	2.5	3	8.4	11.2	25.1
12.00 - 13.00	11	15	19.6	7.6	53.2
13.00 - 14.00	9.5	3	14.7	14.8	42
14.00 - 15.00	0.5	2	8.4	10.8	21.7
15.00 - 16.00	0.5	9	9.8	10.4	29.7

3. The physical shape of the road is measured with a roller meter; this information is known as road geometry data. The road widths of 14 m, 7 m, 3.5 m, and 2.5 m were determined by geometric surveys. See this image for a better idea .

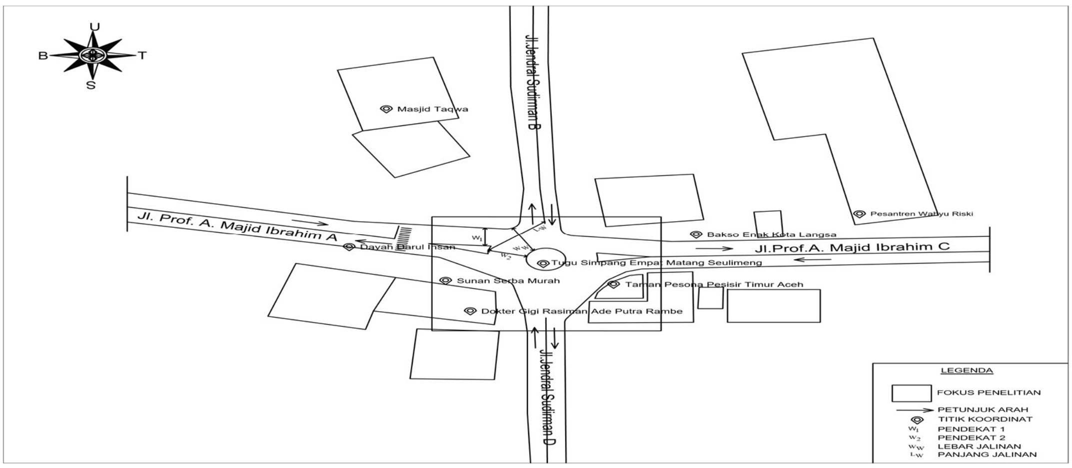

Figure 2. 1 Sketch Of The Research Location

2.3 Data Analysis

When analyzing the data collected, keep in mind that PKJI (2014) is an authority at the level of roundabout services. This procedure generates data on the following variables: peak hour volume, side obstacle class, type of roundabout capacity, degree of saturation, and potential delays and queues.

2.3.1 Traffic Flow

Drivers, cars, and highways are all involved in a unique dynamic known as traffic flow. Traffic flow on each road section will always be different because no two traffic flows are identical, even in identical situations. The formula for traffic speed is:

$$Qsmp = emp \times LV + emp \times HV + emp \times MC \quad (1)$$

Where:
Q = Volume of motor vehicles (smp/hour)
Emp = Passenger Car Equivalent
MC = Notation for motorcycles.
LV = Notation for light vehicles.
HV = Notation for heavy vehicles.

2.3.2 Roundabout Intertwining Ratio

As a percentage, the current that leaves the braided segment to the current that enters it is known as the loop braid ratio. To get the loop braid ratio, one uses the formula:

$$PW = QW/QTOT \quad (2)$$

Where:

QW = On going Flow (smp/hour)

QTOT = Total current (smp/hour)

PW = Braid ratio

2.3.3 Braided Section

Under certain circumstances (geometric, separation of directions, traffic composition, environment), the largest traffic flow that can pass through a road section stably is called the capacity of the road section. The capacity of the road section can be expressedas:

$$C=C0\times FCS\times FRSU \quad (3)$$

Where:

C0 = is the basic capacity of the braid, in (smp/hour).
FCS = city size correction factor
FRSU = correction factor of road environment type, side obstacles, and ratio of non-motorizedvehicles.

2.3.4 Degree of Saturation

One of the main factors used to determine the performance level of intersections and road sections is the degree of saturation, which is the ratio of traffic flow to capacity. The following equation is used to determine the saturation level of the intersection:

$$DS = Qsmp/C \quad (4)$$

Where:

DS = Degree of saturation.

Q = Total traffic flow, in (smp/hour).

Fsmp = Passenger car equivalence factor (emp).

2.3.5 Delay at the Rounbout

According to (Directorate General of Highways, 2014), guidance in the interweaving part can occur due to two causes, namely traffic delay (DT) due to the interaction of traffic traffic with movements in the intersection, and the second is Geometric Delay (DG) due to slowing and accelerating traffic. The average delay of the braided section isas follows:

$$D = DT + DG \quad (5)$$

Traffic Tundan can be defined as follows:

For DS ≤ 0.6

$$DT = 2+2{,}68982 \text{ X } DS - (I-DS) \text{ X } 2 \quad (6)$$

For DS ≥ 0.6

$$DT = 1/\,(0.59186 - 0.52525 \times DS) - (1\times DS) \times 2 \quad (7)$$

The Geometric Delay on the intersection of the road is determined as follows:

$$DG = (1-DS) \text{ x } 4 = DS \text{ x } 4 = 4 \quad (8)$$

The average roundabout delay is calculated as follows:

$$DTR = \sum (Qi \text{ x } DTi)/Qmasuk + DG \text{ ; } I = 1 \ldots n \quad (9)$$

Roundabout Delays (DRs) are calculated as follows:

$$DR = DTR + 4 \quad (10)$$

Where:

DR. = Average roundabout delay (det/smp)
I = Interwoven section I in a roundabout
N = Number of braided sections in the roundabout
Qi = Total current of field in the interwoven part I (smp/hour)
Dti = Average traffic delay in interwoven section I (det/smp)
Qin = Total current entering the roundabout (smp/hour)
DG = Geometric average delay on the braided section (det/smp)

3. Results and Discussion

1. Traffic Volume
   Data from the peak hours per day above, the peak hours on Monday, between 07.00 – 08.00 as many as 5,556 vehicles caused by many people traveling to school and work in the morning.
2. Roundabout Intertwining Ratio

Table 3. 1 Circular braid ratio data

Interwoven Parts	Q roundabout inflow	Inflow Qtot braided parts	Current weaving Qw	Weaving ratio Pw
	(smp/hour)	(smp/hour)	(smp/hour)	(smp/hour)
A	852	1436	1039	1,21
B	569	1581	1008	1,77
C	815	1497	1062	1,30
D	531	1424	916	1,72
Total	55374	5938	4052	6

3. Side Obstacles

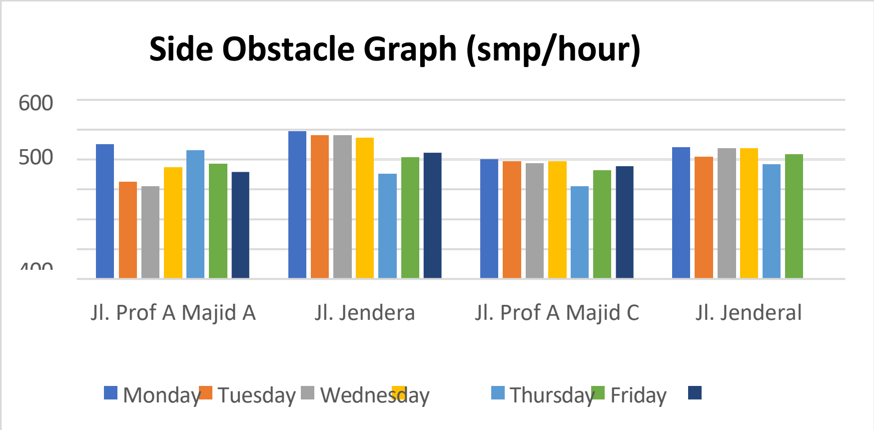

Figure 1. Data on the number of side obstacles at the Matang Seulimeng roundabout (smp/hour)

For Jalan Jenderal Sudirman BC is categorized as the highest among other roads because there are cake sellers who are quite crowded with buyers but there are no parking lots, crossers, and transportation that drops off passengers. So that buyers park their vehicles arbitrarily

4. Geometric Parameters

Table 2. Calculation of Geometric Parameters of Matang Seulimeng Roundabout

Interwoven Parts	Entry Width		Average WE Entry Width	Braid width ww	WE / Ww	Length of Braid Lw	Ww Lw
	Proximity 1	Proximity 2					
A	13.21	19.63	23,03	10,7	0,46	8,13	1.32
B	7.34	10.42	12,55	12,44	0,99	8,01	1.55
C	6.4	14.01	13,42	15,68	1,17	7,8	2.01
D	8.83	17.3	17,48	16,19	0,93	7.98	2.03

5. Base Capacity

Table 3. Calculation of the Basic Capcity of the Matang Seulimeng Roundabout

Interwoven Parts	Factor-Ww	Factor WE/Ww	Pw Factor	Factor Ww/Lw	Base Capacity CO (smp/hour)
A	2941	1,32	0,42	1,61	2635
B	3578	1,99	0,12	1,45	1205
C	4834	2,26	0,08	1,28	1072
D	5039	1,89	0,09	1,28	1072

- City Size Adjustment Factor (FCS)

The city size adjustment factor is seen based on the number of residents that have been obtained from the Langsa City Central Statistics Agency (BPS) office, which totals 194,730 people in 2023.

- Variables that Can Be Adjusted to Side Obstacles, Non-Motorized Vehicles, an Road Environment Types (FRSU)

Table 3. Adjustment Factors of road environment type side obtacles and non-motorized vehicles

Environment type RE Road	SF Side Barrier Class	Non-motorized vehicle (PUM) ratio				
		0,00	0,05	0,15	0,20	≥0,25
Komersial	Low	0,98	0,93	0,88	0,78	0,74
	High/Medium/Low	1,00	0,95	0,90	0,80	0,75
	Low	0,95	0,90	0,86	0,76	0,71
	Tall	0,96	0,91	0,86	0,76	0,71
	Keep	0,97	0,92	0,87	0,77	0,73

6. Capasity

Table 4. Calculation of Matang Seulimeng Rounabout Capacity

Interwoven Parts	Base Capacity (CO) (smp/jam)	Adjustment factors		Capacity (C) (smp/hour)
		City Size (FCS)	Milieu Street (FRSU)	
A	2635	0,90	0,97	2300
B	1205	0,90	0,97	1052
C	1072	0,90	0,97	936
D	1141	0,90	0,97	936

7. Degree of Saturation

Table 5. Roundabout Intertwined Ratio Data

Interwoven Parts	Capacity (C)	Braided Section Current (Q)	Degree Saturation (DS)	Level Service (LOS)
A	2300	852	0,37	B
B	1052	569	0,54	B
C	936	815	0,87	D
D	996	531	0,53	B

8. Delays and Queue Opportunities

Table 6. Calculation of the Delay Value of the Matang Seulimeng Roundabout

Interwove nParts	Degree of Saturatio n(DS)	Dela y (DT)	Total Delay (DTTOT)	Averag eDelay (DTR)	Roundabo utDelay (DR)	QP% Max	QP% Min
A	0,37	1,73	473,96	0,13	4,13	2,07	7,7
B	0,54	2,53	1439,57			3,1	15,2
C	0,87	4,08	3325,2			5,1	52,6
D	0,53	2,48	1316,88			3,1	14,6

4. Conclusion

Since the side road barriers at the study site are still within simple limits, the findings of the calculations and analyses in the previous chapter show that the barriers do not have a significant impact on the level of roundabout services. By including the intermediate obstacle class, the total number of obstacles isS 494. Judging from the fact that the road service level remains at B, these findings suggest that medium-sized side road barriers do not significantly reduce road capacity. and for the results of the roundabout performance analysis. The results of the performance analysis of the Matang Seulimeng Roundabout were obtained that the value of the degree of saturation on Jalinan Jl. Prof. A. Majid AB was 0.37 (LOS = B) which means that traffic was stable, on the intersection of Jl. Jenderal Sudirman BC it was 0.53 (LOS = B) which meant that traffic was stable, on Jalinan Jl. Prof. A. Majid CD was 0.87 (L0S = D) which means that then it was still an unstable limit, and in the intertwined part of Jl. Jenderal Sudirman D is 0.53 (LOS = B) which means then stable. Based on PKJI 2014, the value of the degree of saturation on the intertwining of Jl. Prof. A. Majid AB, Jl. Jenderal Sudirman BC, and Jl. Jenderal Sudirman DA is still said to be feasible, and for the degree of saturation on the intertwining of Jl. Prof. A. Majid CD The condition of the traffic flow is unstable. Based on the 2014 PKJI, the saturation degree value is still said to be feasible except for Jalan Prof. A. Majid Ibrahim CD which is unstable.

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