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Research Paper

Study of Intersection RoundaboutPlanning (Case Study Ir.H. Juanda Road - Kadrie Oening Road - A. Wahab Syahranie Road - Lettenan General Suprapto Road) Samarinda City

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Abstract
The signalized intersection at the intersection of Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road will be carried out planning and roundabout analysis to find out the more effective use between the Signalized Intersection or Roundabout at the intersection.The method used in the work consists of three stages, namely signalized intersection analysis, roundabout planning and roundabout analysis. The method used in the analysis of signalized intersections and roundabout analysis is the 1997 MKJI (Indonesian Road Capacity Manual) method and the method used in roundabout planning is Engineering Guidelines Number 20 of 2004 B on roundabout planning.From the results of the calculation of the analysis at the intersection, it can be seen that the degree of saturation of the signalized intersection is lower than the degree of saturation of the roundabout, so it can be seen that at the intersection of Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road the use of a signalized intersection (Traffic Light) is still more effective than the use of a Roundabout at the intersection.
Keywords:*Intersection RoundaboutPlanning*

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I. INTRODUCTION

Land transportation is the most dominant form of transportation compared to other systems. Therefore, the issues faced by many major cities in Indonesia are related to traffic congestion caused by the daily accumulation of vehicles. In other words, transportation is crucial for the development of various societal activities. The greater the activities, the larger the impact caused by transportation (Morlok, 1991), such as congestion.

The intersection of Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road is one of the intersections in Samarinda city facing traffic problems. During peak hours, particularly in the morning, afternoon, and evening, traffic issues often arise as this intersection serves as a hub for the central traffic of Samarinda. The high volume of traffic passing through this intersection leads to significant vehicle convergence.

The transportation process can improve if a good transportation network is available. To create an effective land transportation network, various facilities and infrastructures are needed to keep pace with the evolving traffic flow. One traffic management model commonly used in several cities in Indonesia today is the roundabout. The roundabout is a type of intersection control generally used as a meeting point for several road segments and has a higher level of safety compared to other types of intersection controls.

Formulation of the problem namely : **(**1) How to identify the performance of the Signalized Intersection (Traffic Light) or existing at the intersection of Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road using the MKJI (Manual Kapasitas Jalan Indonesia) 1997 Signalized Intersection method ?; (2)How to plan or design a roundabout in accordance with Technical Guidelines Number 20 of 2004 B concerning roundabout planning?; (3)How to evaluate the performance of a roundabout resulting from planning or designing a roundabout using the MKJI (Manual Kapasitas Jalan

Indonesia) 1997, Network Section method?; and (4)What are the results of identifying the performance of Signalized Intersections (Traffic Lights) and also evaluating the results of the roundabout planning using the MKJI (Manual Kapasitas Jalan Indonesia) 1997 method to determine the more effective use of Signalized Intersections or Roundabouts at intersections?

The aim of the research are:(1) to identify the performance of signalized or existing intersections at the intersection of Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road; (2) to planning or designing roundabouts in accordance with Technical Guidelines Number 20 of 2004 B concerning roundabout planning; (3) to evaluate the performance of the roundabout resulting from the planning or design of the roundabout using the MKJI (Manual Kapasitas Jalan Indonesia) 1997 Network Section method, and (4) as a comparison in the use of signalized intersections or roundabouts which are more effective at intersections.

II. BASIC THEORY

2.1. Definition of Transportation

Transportation is a process of moving or moving people, goods or services from one place to another by requiring facilities and infrastructure to support the movement. According to Morlok (1991), there are five main elements of transportation, namely : (1) humans, who need transportation; (2) goods, which humans need; (3) vehicles, as a means of transportation; (4) roads, as a means of transportation, and (5) organization, as a transportation manager.

2.2. Crossroads

Intersectionsareanimportantpartofurbanroads,becausemostoftheefficiency,operationalcostsand traffic capacity in the planning of continuous traffic andtrafficthatintersectsoneormoreintersectionarms(approaches) and also includes turning movements. Thistraffic movement is controlled in various ways dependingontheintersectionroad.Themainpurposeofintersectionplanning is to reduce the possibility of collisions betweenmotor vehicles, pedestrians, comfort and tranquility forroadserswhousetheintersection(MuhamadFikriTamam, BudiArief, AndiRahmah,2016).

2.3. SignalizedIntersection

Asignalizedintersectionisanintersectionconsisting of several arms and equipped with traffic lightsignalsettings.BasedonMKJI1997,thepurposeofusingtrafficlightsignalsatintersectionsincludes: (1) toavoidintersectioncongestionduetotrafficflowconflicts, so that it is guaranteed that a certaincapacitycanbemaintained,evenduringpeakhourtrafficconditions; (2) toprovideanopportunityforvehiclesand/orpedestrians from (small) intersections to cross themainroad; and (3) to reduce the number of traffic accidents due tocollisionsbetweenvehiclesfromoppositedirections.

2.4. Roundabout

Roundaboutisonetypeofintersection controlthatis generally used in urban and rural areas. Traffic that isprioritized is traffic that is already in the roundabout, sothatvehiclesthatwillentertheroundaboutmustfirstgiveopportunityto trafficthatisalreadyin theroundabout.

A roundabout consists of a directional traffic lanesurrounding a central island, which may be raised or flat.Thistypeoftrafficcircleisdesignedtocreatearotationalmovementoftrafficflow,replacingintersectingmovement swith aseriesofintersection sections.

2.5. Analysis of Signalized Intersections Using the 1997 MKJI Method

Summary of the Calculation Procedure for signalized intersections is :

Step A: Input Data
- A-1: Geometric, traffic arrangements and environmental conditions
- A-2: Traffic flow conditions

Step B: Using Signal
- B-1: Signal phase
- B-2: Intergreen time and lost time

Step C: Signal Timing
- C-1: Approach type
- C-2: Effective approach width C-3: Basic saturation current C-4: Adjustment factors

C-5: Current/saturation-current ratio C-6: Cycle time and green time
Step D: Capacity
D-1: Capacity
D-2: Need for change
Step E: Traffic Behavior
E-1: Preparation E-2: Queue length
E-3: Vehicles stopped
E-4: Delays End of analysis

2.6. Roundabout Planning Technical Guidelines Number20of2004 B

A summary of how to plan a roundabout is asfollows:

1. Determine the number of roundabout lanesbytakingintoaccountthedailytrafficvolumeoftheintersection..
2. Determine:
   a. Planned vehicle
   b. Planspeed
3. Determinethediameterofthecircleandthetypeofcircle.
4. Determinethewidthofthecircularlaneaccording tothetypeofroundabout.
5. Planaroundisland.
6. Planordesigntheapproacharmby determining orcalculating:
   a. Entryand exitlanes.
   b. Entry radiusand exitradius.
   c. Planaseparationislandforeachapproacharm.

2.7. MKJI 1997 Method Roundabout Analysis

Summary of the Roundabout Calculation Procedure is:
Step A: Input Data
A-1: Geometric conditions
A-2: Traffic conditions
A-3: Environmental conditions
Step B: Capacity
B-1: Geometric parameters of the road section B-2: Basic capacity
B-3: City size adjustment factor
B-4: Adjustment factor for neighborhood type, side obstacles and non-motorized vehicles
B-5: Capacity
STEP C: Traffic Behavior
C-1: Degree of saturation C-2: Delay
C-3: Queuing probability End of analysis

III. RESEARCH METHOD

3.1. Research Location

Research activities were carried out in the area Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road, Samarinda City, Indonesia (Figure 1).

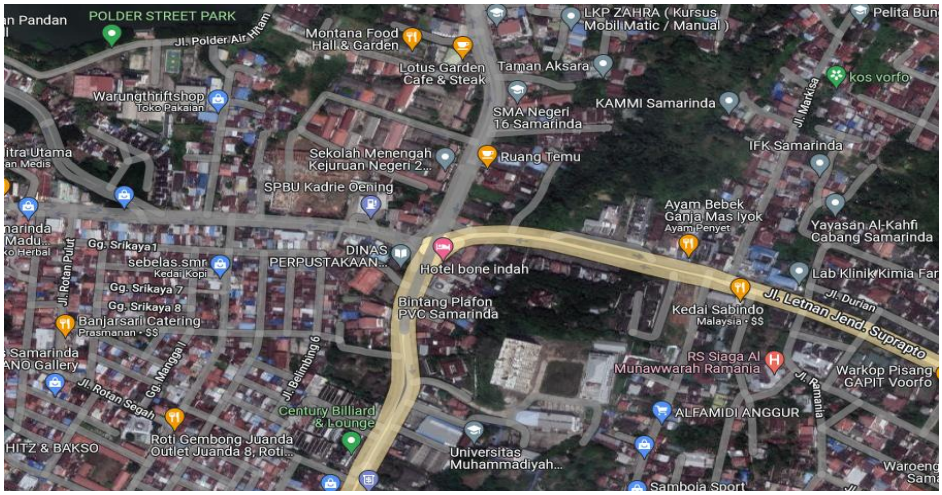

Figure 1 Research Location Map (Google Maps, 2023)

3.2. Research Flow Chart

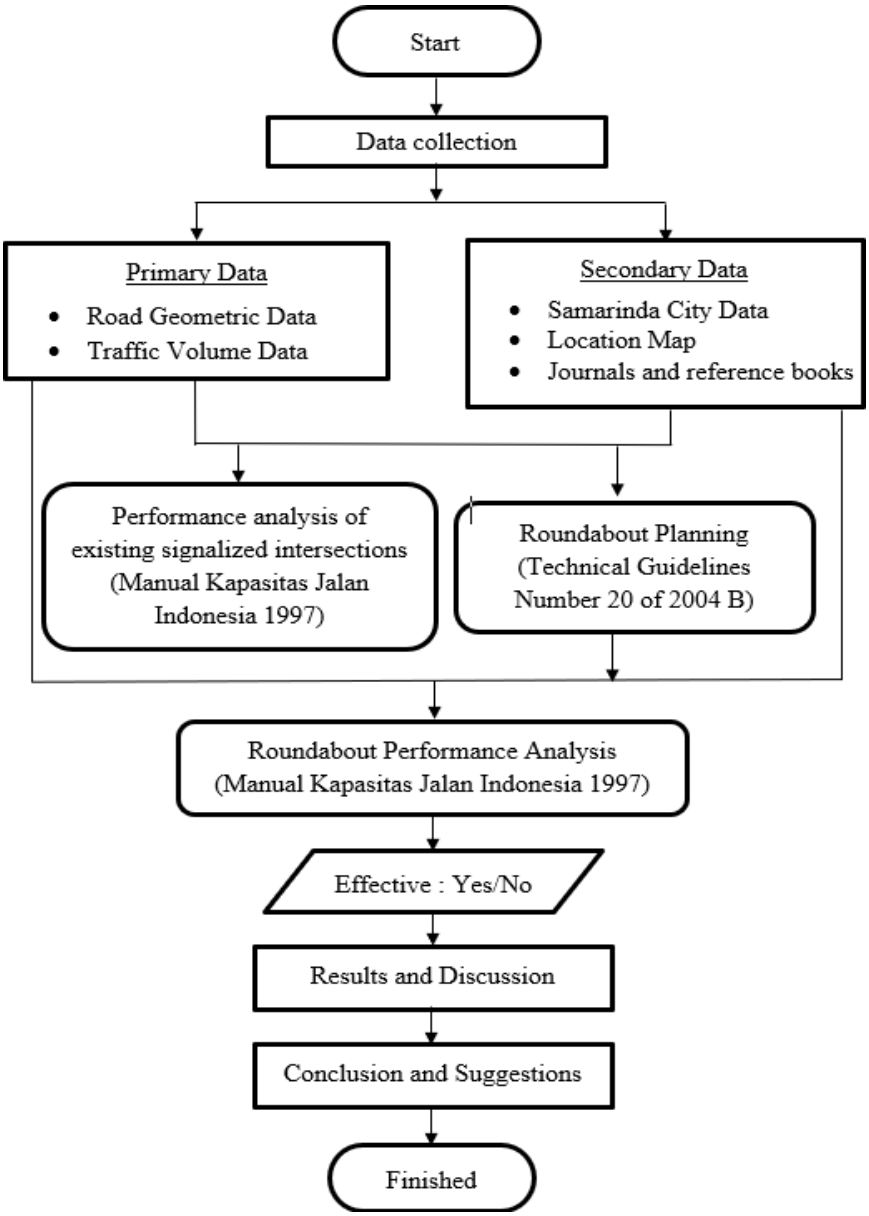

Figure 2 Research Flowchart

IV. RESULTS AND DISCUSSION

4.1. PopulationofSamarindaCity

SamarindaCityislocatedinEastKalimantanProvince where this city is also the center of governmentwithapopulationof834,824thousandpeople.TheareaofSamarinda City is 718,000 km^2 which is divided into tendistricts, namely: Palaran, SamarindaIlir, SamarindaKota, Sambutan, SamarindaSeberang, LoaJanan Ilir, SungaiKunjang, SamarindaUlu, SamarindaUtara and Sungai Pinang.

Where the area that will be the object reviewed inwriting this final assignment is located in Samarinda UluDistrictwhichisthecentralofficeandurbanarea.Preciselyatthe intersectionofIr.H.Juanda road-KadrieOening road -A.WahabSyahranie road -Lieutenant General. Suprapto road.

4.2. DataAnalysisorfSignalizedIntersectionsUsingthe1997 MKJIMethod

4.2.1 GeometricData

1. Ir.H.Juanda road
   Road Width : 27.5 meters, Median Width : 9.37 meters, Sidewalk Width : 0.9 meters,Number of Lanes : 2, NumberofLanes:2
2. Kadrie Oening road
   Road Width: 20 meters,Median Width: 1.5 meters,SidewalkWidth:None,Number of Lanes: 2, NumberofLanes:2
3. A. Wahab Syahranie road
   Road Width: 23.6 meters,Median Width: 9.37 meters, SidewalkWidth:None,Number of Lanes: 2,NumberofLanes:2
4. Lieutenant General Suprapto road
   RoadWidth:26.45 meters,Median Width: 0.5 meters,Sidewalk Width: 1.10 meters,NumberofLanes:2, NumberofLanes:2

4.2.2. Approach Codes

The following notations are used for the approach codes:

1. Ir. H. Juanda road faces South, approach code S (South).
2. Kadrie Oening road faces West, approach code B (West).
3. A. Wahab Syahranie road faces North, approach code U (North).
4. Lieutenant General Suprapto road faces East, approach code T (East).

Table 1 Signalized Intersection Geometrics

Approach Code	Road Environmenttype	Side Obstacles Highlow	Approach Width (M)			
			Approachwa (Meter)	Enter W Enter (Meter)	Turnleft Immediately Wltor	Go Out W Out (Meter)
North	COM	Low	7,00	7,00	5,78	7,88
East	COM	Low	9,82	9,82	-	8,76
South	COM	Low	9,36	9,36	-	9,23
West	COM	Low	9,26	9,26	-	7,33

4.2.3. Traffic Flow

The data used is traffic flow data on Monday, February 27, 2023. The data used is based on the busiest day in the survey results conducted at the intersection. The busiest flow was obtained during the morning peak hour at 07.00-08.00 with a total of 15,625 vehicles/hour. Data saturated flow of signalized intersections presented in Table 2.

Table 2 Saturated Flow of Signalized Intersections

Time	Approach Code	Saturated current smp/hour green							
Monday 27/02/2023		Core Values smp/hour S_O	Adjustment Factor						Adjusted value smp/hour green S
			All types of approaches				P type only		
			City size F_{CS}	Side obstacles F_{SF}	Slope F_G	Parking F_P	Turn right F_{RT}	Turn left F_{LT}	
Morning	U	4728,000	0,940	0,950	1,000	1,000	1,098	1,000	4637,508
	T	5256,000	0,940	0,950	0,900	1,000	1,062	1,000	4488,089

	S	5538,000	0,940	0,950	1,000	1,000	1,189	1,000	5877,943
	B	4338,000	0,940	0,950	1,000	1,000	1,043	1,000	4038,486
Midday	U	4728,000	0,940	0,950	1,000	1,000	1,092	1,000	4609,044
	T	5256,000	0,940	0,950	0,900	1,000	1,051	1,000	4438,089
	S	5538,000	0,940	0,950	1,000	1,000	1,024	1,000	5953,056
	B	4338,000	0,940	0,950	1,000	1,000	1,092	1,000	4229,165
Afternoon	U	4728,000	0,940	0,950	1,000	1,000	1,097	1,000	4633,362
	T	5256,000	0,940	0,950	0,900	1,000	1,055	1,000	4456,614
	S	5538,000	0,940	0,950	1,000	1,000	1,193	1,000	5902,300
	B	4338,000	0,940	0,950	1,000	1,000	1,051	1,000	4070,286

Data capacity and degree of saturationpresented in Table 3.

Table 3 Capacity and Degree of Saturation of Signalized Intersections

Time Monday 02/27/2023	Approach Code	Capacity (smp/hour)	Degree of Saturation
Morning	U	629,912	0,645
	T	900,228	0,645
	S	273,106	0,645
	B	1224,484	0,645
Midday	U	615,567	0,439
	T	947,587	0,439
	S	77,145	0,439
	B	932,113	0,439
Afternoon	U	524,596	0,542
	T	1206,718	0,542
	S	89,646	0,542
	B	934,459	0,542

Data queue lenght presented in Table 4.

Table 4 Number of Vehicles Queuing and Length of Queue at Signalized Intersections

Time	Approach Code	Number of vehicles in queue (smp)				Queue
Monday 02/27/2023		NQ1	NQ2	Total NQ1+NQ2= NQ	NQ Max	Length QL meters
Morning	U	0,408	6,182	6,590	12,000	34,286
	T	0,408	8,565	8,973	14,000	28,513
	S	0,406	2,782	3,187	6,000	12,821
	B	0,408	10,991	11,399	18,000	38,877
Midday	U	0,000	2,992	2,992	6,000	17,143
	T	0,000	4,343	4,343	8,000	16,293
	S	0,000	0,404	0,404	0,500	1,068
	B	0,000	4,249	4,249	8,000	17,279
Afternoon	U	0,092	3,649	3,741	8,000	22,857
	T	0,092	7,593	7,685	13,000	26,477
	S	0,092	0,655	0,747	2,000	4,274
	B	0,092	6,054	6,146	11,000	23,758

Data vehicle stopped and delay presented in Table 5 dan 6.

Table 5 Stop Figures and Number of Vehicles Stopped at Signalized Intersections

Time Monday 02/27/2023	Approach Code	Stop NumberNS	Number of Vehicles Stopped Nsv
Morning	U	0,909	369,282
	T	0,866	502,855
	S	1,014	178,621
	B	0,809	638,788
Midday	U	0,828	224,087
	T	0,781	325,261
	S	0,893	30,287
	B	0,777	318,210
Afternoon	U	0,872	247,917
	T	0,779	509,322
	S	1,019	49,504
	B	0,804	407,295

Table 6 Signalized Intersection Delays

Time Monday 02/27/2023	Approach Code	Delay			
		Average traffic delay DT sec/smp	Geometric mean delay DG sec/smp	Average delay D= DT+DG sec/smp	Delay total DxQ smp/sec
Morning	U	25,992	3,842	29,834	12124,480
	T	25,294	3,657	28,951	16814,550
	S	29,010	3,995	33,005	5815,565
	B	24,863	3,422	28,285	22345,008
Midday	U	17,250	3,677	20,927	5660,626
	T	17,250	3,380	20,630	8590,404
	S	17,250	4,075	21,325	722,910
	B	17,250	3,580	20,830	8531,880
Afternoon	U	21,111	3,775	24,886	7077,685
	T	20,755	3,395	24,150	15798,853
	S	24,159	3,991	28,150	1368,105
	B	20,835	3,445	24,280	12300,160

4.3. Roundabout Planning Technical Guidelines Number 20 of 2004 B

The results of the Roundabout Planning based on Technical Guidelines Number 20 of 2004 B can be seen as follows:

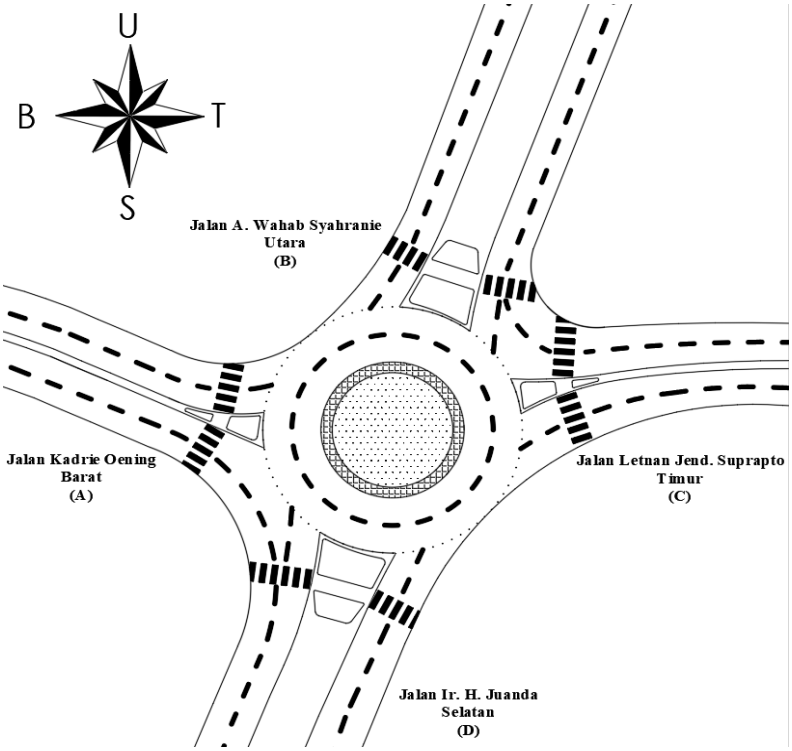

Figure 3 Results of Roundabout Planning

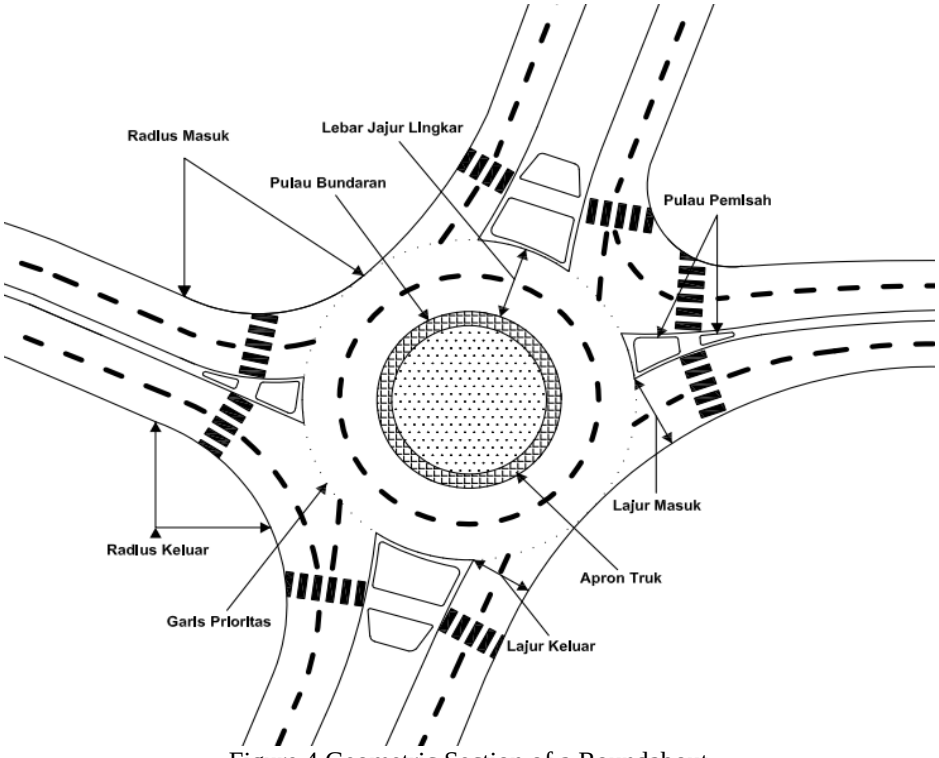

Figure 4 Geometric Section of a Roundabout

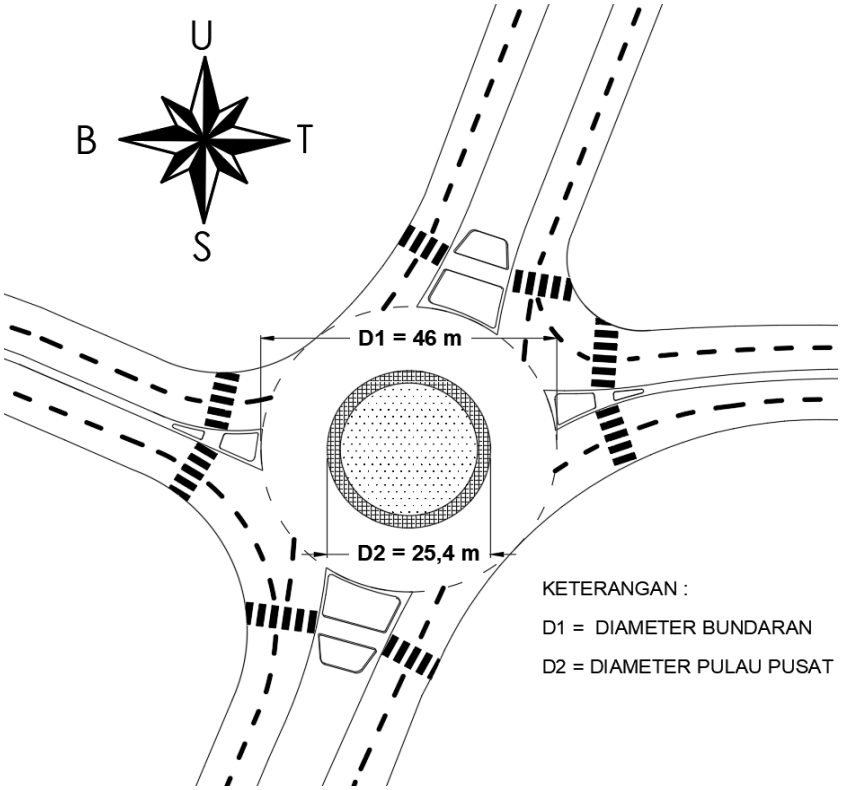

Figure 5 Diameter of the Roundabout and the Central Island of the Roundabout

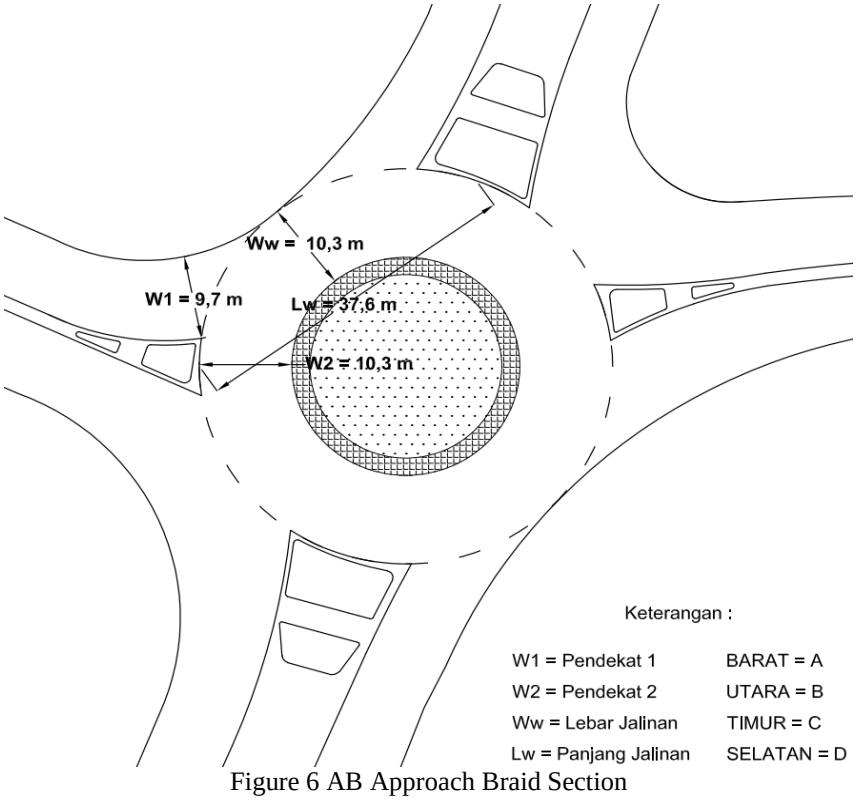

Figure 6 AB Approach Braid Section

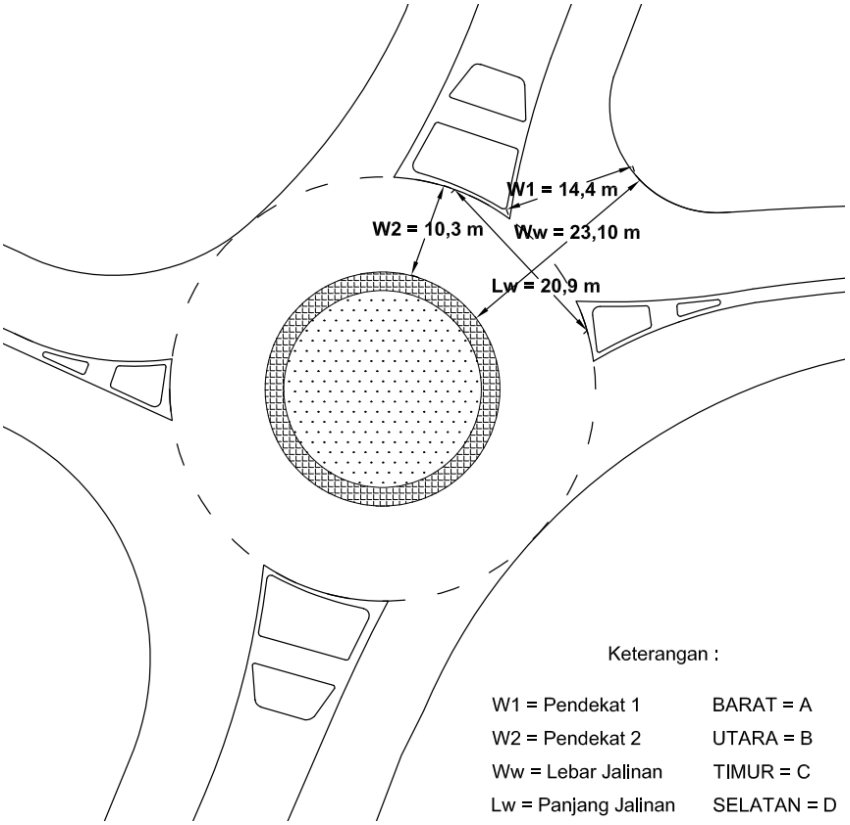

Figure 7 BC Approach Mesh Section

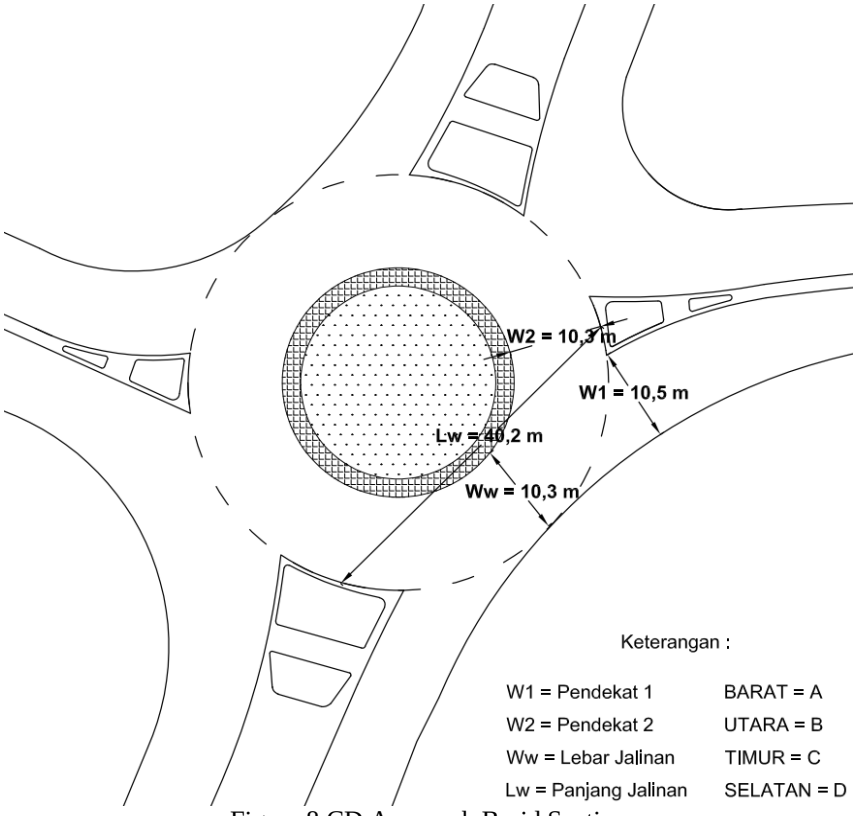

Figure 8 CD Approach Braid Section

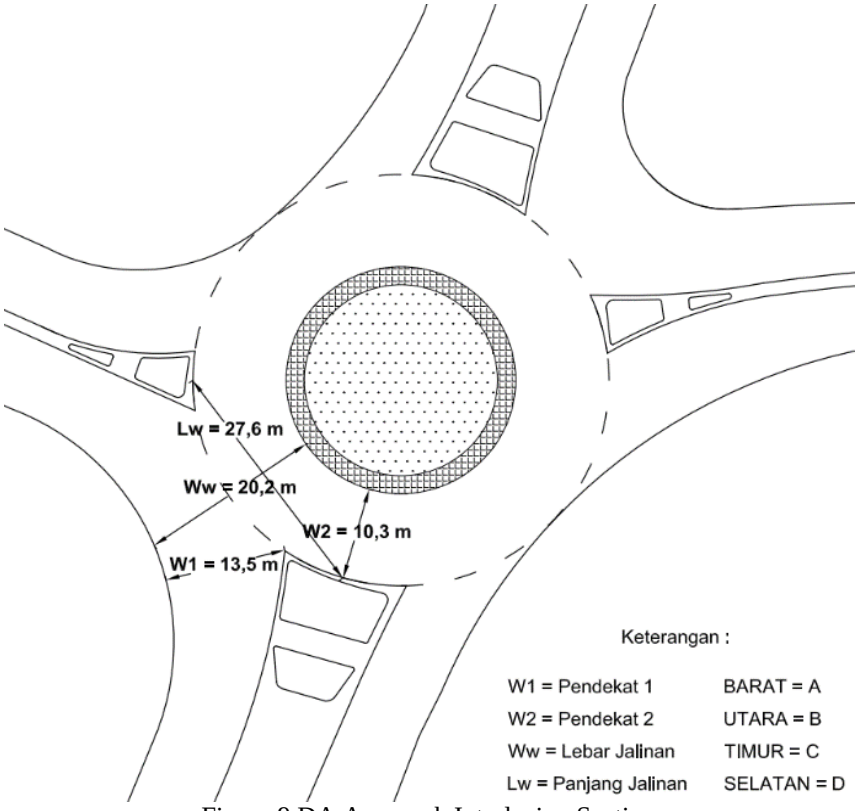

Figure 9 DA Approach Interlacing Section

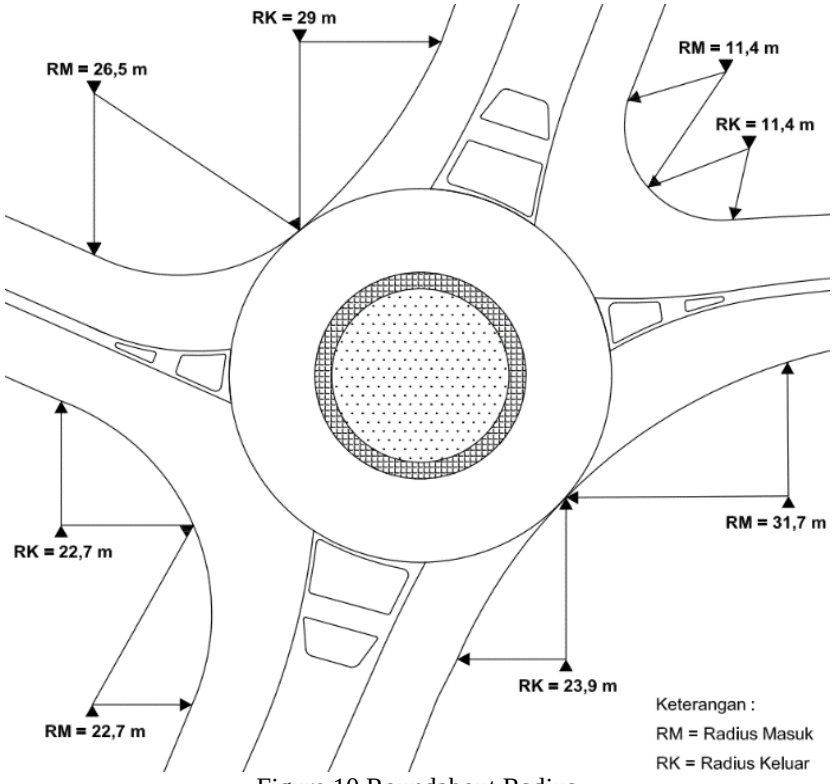

Figure 10 Roundabout Radius

4.3.1. MKJI 1997 Method Roundabout Analysis

The data used is traffic flow data on Monday, February 27, 2023, morning time period. The data used is based on the busiest time in the survey results and the results of the analysis of signalized intersections using the 1997 MKJI method above with the highest degree of saturation value.

For the approach code, the following notation is used :

1. Ir. H. Juanda road facing South (S), approach code D
2. Kadrie Oening road facing West (B), approach code A.
3. A. Wahab Syahranie road facing North (U), approach code B.
4. Lieutenant General Suprapto road facing East (T), approach code C.

The results of the analysis regarding capacity and Degree of Saturation are presented in Table 7 and 8.

Table 7. Basic Capacity and Roundabout Capacity

Time	Roundabout Section	Basic Capacity Co Smp/hour	Capacity C Smp/hour
Monday 02/27/2023 Morning	AB	4533,914	4048,785
	BC	3441,376	3073,149
	CD	4726,461	4220,730
	DA	4290,276	3831,216

Table 8 Degree of Saturation of Roundabout Weave

Time	Roundabout Section	Degree of Saturation DS
Monday 02/27/2023 Morning	AB	1,308
	BC	1,659
	CD	0,906
	DA	1,248

V. CONCLUSION AND SUGGESTION

5.1. Conclusion

Based on the results of research that has been conducted on the four-way intersection of Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road, the following conclusions were obtained :

1. Based on the results of the analysis calculations for Signalized Intersections (Traffic Light) using the 1997 MKJI method, the highest degree of saturation values were obtained at signalized intersections as follows :
   a. A. Wahab Syahranie road : North Approach (U), DS = 0.645 smp/hour
   b. Lieutenant General Suprapto road : East Approach (T), DS = 0.645 smp/hour
   c. Ir. H. Juanda road : South Approach (S), DS = 0.645 smp/hour
   d. Kadrie Oening road : Western Approach (B), DS = 0.645 smp/hour
2. From the results of the planning of the Roundabout Technical Guidelines Number 20 of 2004 B, where the planning was carried out based on the availability of land at the research location, the maximum diameter dimensions of the roundabout that can be planned are 46 m and the diameter of the central island of the roundabout is 25.4 m.
3. Based on the results of the analysis calculations of the MKJI 1997 Roundabout Network method from the results of the Roundabout planning of Technical Guidelines Number 20 of 2004 B, the saturation degree value obtained for the roundabout network is :
   a. A. Wahab Syahranie road : North Approach (BC), DS = 1,308 smp/hour
   b. Lieutenant General Suprapto road : East Approach (CD), DS = 1,659 smp/hour
   c. Ir. H. Juanda road : South Approach (DA), DS = 0.906 smp/hour
   d. Kadrie Oening road : West Approach (AB), DS = 1,248 smp/hour
4. From the results of the analysis calculations at the intersection, it can be seen that the saturation degree value of the signalized intersection is lower than the saturation degree value of the roundabout, so it can be seen that the use of signalized intersections (Traffic Light) is still more effective than the use of Roundabouts at the intersection of Ir. H. Juanda road - Kadrie Oening road - A. Wahab Syahranie road - Lieutenant General Suprapto road.

5.2. Suggestion

1. For similar research, peak hour determination is done by calculating traffic volume data every 15 minutes..
2. For further research at the same location, traffic analysis studies can use VISSIM software (software that can be used to simulate and model microscopic traffic flows, public transportation and pedestrians)..
3. For further research at the same location, work can be carried out with the alternative of building an Underpass from Kadrie Oening road to Lieutenant General Suprapto road or vice versa.

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