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Studies of Level of Service (LOS) at Signalized Intersection with Mix Traffic Flow

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Abstract

One of the signalized intersections with four approaches is the BPKP’s intersection at Banda Aceh. The intersection will be analyzed in the current condition and remodeled using the software SIDRA intersection 8.0. This Software can choose a predetermined minimum capacity for each little movement. Utilizing a video from a collected in the study area, the institute provided the information. Data from a video included vehicle volume, downstream distances, upstream distances, and negotiation distances, as well as transit time. in its current condition. The total flow of demand is 1060 pcu/h. degree of saturation is 1,406, and level of service is F. The remodel of this intersection is analyze the signalized intersection's traffic light cycle time. It is necessary to be able to handle the current that enters the intersection. Total flow of demand in remodel condition of BPKP's intersection at Banda Aceh is 1060 pcu/h, degree of saturation is 0,765, and level of service is C.

Keywords— *Signalized Intersection, BPKP’s intersection at Banda Aceh, software SIDRA intersection 8.0, degree of saturation*

1. INTRODUCTION

Nowadays transportation networks function successfully in part due to a number of criteria, including safety, efficiency, and dependability. Everyone, from customers to the business sector, depends on these elements. In many parts of the world, traffic congestion is on the rise and only getting worse, which is a serious threat to the quality of urban life [1].

At road intersections, the issue of traffic congestion in urban areas is significant. Driver behavior, traffic light capacity, and intersection design are common factors that affect traffic congestion. Given that traffic signals are one of the traffic controls used to minimize traffic congestion, a signalized intersection may be improved by having enough traffic capacity, and a suitable design [2].

The three legged and four legged signalized intersections are the two forms of signalized intersections that are most frequently found in urban areas situations [3]. Given a defined and consistent cycle time, a signalized intersection is a shared place that is used by drivers coming from many directions at one time. When the lane is near to end, vehicles must merge or change lanes, which is one of the situations in which they should be aware. A driver intends to go from one clearly defined lane to another when they change lanes [4].

The main issue with merging is that a lot of motorists drive more slowly than the posted speed limit. This is due to the fact that when motorists drive below the recommended speed limit, it may be difficult for motorists coming up behind them to maintain the speed restriction. In some other situations, motorists who are already familiar with the laws of the road refuse to wait any longer and suggest another lane that should be utilized for traveling in the opposite way. Traffic congestion will result as a result of the increased traffic flow, especially during peak hours [4].

In terms of vehicles/hour or pcu/hour, traffic flow is the number of traffic components flowing through the accessible upstream point at a given moment. The level of saturation that develops as a result of traffic passing through an intersection is indicated by the degree of saturation (DS) [5], by using the average travel time at signalized intersections to calculate the ratio of demand flow to capacity [6].

Design of the transportation network in Banda Aceh City, specifically in the neighborhoods of Jaya Baru, Lueng Bata, and Kuta Alam. Subdistricts and local roads have the lowest percentage of 8% and 9% of total highways 552,789 km, respectively, and 9% of local highways 56,65 km. Kuta Alam is the district with the majority of the longest city streets. 17% and 14% nations roads, 16% urban roads and 14% village roads at Meuraxa sub-districts, 13,55% urban roads and 1,62% village roads at Syiah Kuala sub-district, and 14% urban roads and 1,09% village roads at Ulee Kareng sub-district [7]. This resulted in a lack of coordination between centers of activity and existing sub-districts, which caused road networks to perform not well and cause delays during rush hour in some sub-districts, including Ulee Kareng, where the level of service (LOS) E-F (V/C ratio = 0,98) meant that the current was not stable and had stopped, and Banda Raya, Jaya Baru, Baiturrahman, and Lueng Bata, where the LOS D (V/C ratio = 0,8-0,9) [8]. One of the signalized intersections with four approaches is Simpang BPKP Banda Aceh. People here spend time at this crossroads with degree of saturation is 1,18 [9].

SIDRA, also known as Signalised (and Unsignalised) intersection Design and Research Aid, is a simulation program primarily used for road intersection analysis and design. It was created in 1984 [10]. SIDRA involves the use of a micro-analytical traffic evaluation tool that compares the options for intersections and networks intersections while using lane-by-lane and vehicle drive cycle models [11].

2. METHODOLOGY

The user sets the preset minimum capacity for each little movement in the SIDRA Intersection (analytical model). There is no decrease in capacity or important movement delay as a result of this. Capacity and delay models uses gap acceptance, although the gap acceptance parameters could be sensitive to traffic. The method used in the research can be split down to three sections: (1) observations of the real traffic characteristics at a signalized intersection; (2) intersection modeling; and (3) evaluation of the impact of skewness on delays. The results of this research's Parts 2 and 3 were built around the use of the SIDRA Intersection program [12].

2.1 Data Collection

The information came from an institution [13]. The turning movement counts for peak hour are the most crucial information for determining how well an intersection uses its capacity [14]. Data from a video using cctv at the study area included vehicle volume, downstream, upstream, and negotiation distances, as well as transit time. The origin to destination during a peak hour after 3x24 hours (3 days) is the base for volume data [15]. MC (motorcycle), LV (light vehicle), and HV (heavy vehicle) are based on the data. This information is categorized using the vehicle type and orientation, starting with P. Nyak Makam (PNM), T. Iskandar Beurawe (TIB), Prof. Ali Hasyimi (PAH), and T. Iskandar Tujuh (TIT). The data has been converted from vehicle units per hour to passenger car units per hour using that equivalent value. It is also possible to display the percentage of heavy vehicles based on the results of the calculation. The speed of the vehicle may be calculated using the distance traveled under the present conditions and the time recorded on the CCTV footage. The two data were compared to calculate speed. The negotiation, upstream, and downstream speeds of each approach are factored into the study's estimation of speed. The terms "upstream distance", "downstream distance", and "negotiation distance" refer to the distances between the middle blocks of two junctions on an intersection leg in the approach travel direction, the distance from the approach stopline to a point on the exit road according to the

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destination of each origin-destination movement, and the distance for each movement of each origin-destination movement through the intersection [12]. To measure distance, use a length meter. In this case study, travel time estimations for one-way highways are created based on negotiating distance, downstream distance, and upstream distance. Using videos captured using CCTV on each leg, the start travel time (t1) and the end travel time (t2) were determined.

2.2 Data Analysis

Data in geometry To determine the geometrical intersection's state based on the movement of each leg from origin to destination, BPKP's Intersection at Banda Aceh is used. The approach's leg name and median width, as well as the lane configuration's lane discipline, lane type, short lane, and lane length, are measured in terms of geometry. For each lane on each leg of the road, there are two separate types of movement data: exclusive lanes and shared lanes. Shared lanes are LT (left through), TR (through right), LR (left right), and LTR (left through); exclusive lanes are L (left), T (through), and R (right). Additional elements like a data queue space, vehicle length, and arrival type are needed in order to fulfill the requirements of movement data input in Software SIDRA intersection 8.0 plus.

3. RESULT AND DISCUSSIONS

Performance as determined by intersection analysis with SIDRA Intersection 8.0 software. This software determines the intersection performance by using the level of service (LOS) and degree of saturation (DS) at the intersection. The first step of evaluating the performance of an intersection is determining how many vehicles are there. Based on how each leg moves, the volume that has to be entered is allocated. Due to SIDRA's restrictions on the types of vehicles that can be submitted as traffic volume data, only the volume of light vehicles (LV) and heavy vehicles (HV) may be examined. Based on secondary data [13], the busiest time for traffic on Monday was between 16:30 and 16:45 WIB. Based on the characteristics of the number of cars, this volume, which is created at the intersection, is used as a data to evaluate the intersection's effectiveness. Space Mean Speed is measured in terms of the average travel time over a given distance or the average speed of cars that have been using the same section of road for a certain period of time. Speed data is collected after estimating distance and travel time. In its current state, Figure 1 shows the output phase sequence. Phase A indicates that all legs other than PNM's leg display red time, with the exception of each leg that makes a left turn. Phase B signifies that, except from the left turn on each leg, only the TIB's leg would display green time. Phase C shows that, except from the left turn on each leg, only the leg of PAH will display green time. Phase D signifies that, with the exception of the TIT leg, all other legs display red time.

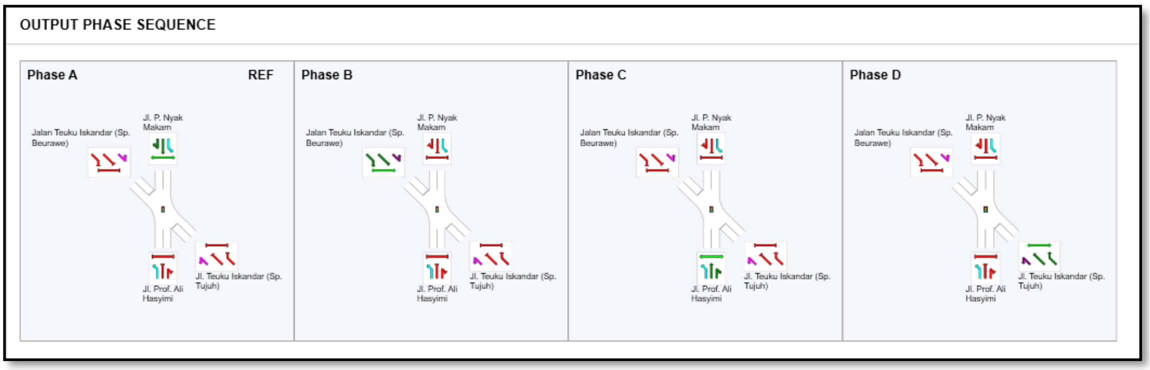

Figure 1 Output Phase Schedule

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Figure 2 shows a phase transition in an actual situation. At the BPKP's intersection in Banda Aceh, the signal timing was indicated with yellow time and all red being 3 sec and 2 sec for each leg. Phase timing for PNM (A) is 22 seconds, TIT (B) is 48 seconds, PAH (C) is 20 seconds, and TIB (D) is 17 seconds. Table 1 shown more details.

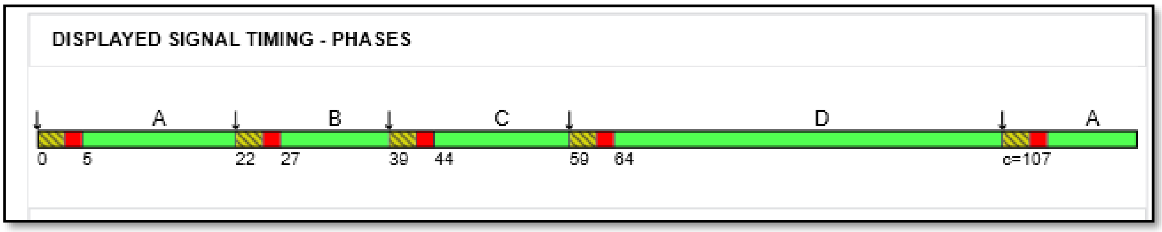

Figure 2 Timing of the displayed signal (Phases)

Table 1 Shows the Phase and Cycle Times at the Intersection of the BPKP in Banda Aceh in its Current State

Phase	SIDRA			
	Green Time (s)	Yellow Time (s)	All Red (s)	Phase Time (s)
Jl. P. Nyak Makam (PNM)	17	3	2	22
Jl. Teuku Iskandar (Sp. Tujuh) (TIT)	43	3	2	48
Jl. Prof. Ali Hasyimi (PAH)	15	3	2	20
Jl. Teuku Iskandar (Sp. Beurawe) (TIB)	12	3	2	17
Cycle Time				107

Table 2 Current Conditions of Performance Measure at PNM's Leg

Jl. P. Nyak Makam (PNM)	Total Demand Flows (pcu/h)	Performace (Current Condition)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 3,3 m	75	1795	0,042	A
Lane 2 = 3,3 m	104	136	0,843	C
Lane 3 = 3,3 m	131	157	0,885	C
Approach	310		0,885	C

By using SIDRA Intersection 8.0 software, performance is measured according on table 2, the leg of PNM has 310 pcu/h total demand flow. The level of service for the approach is C, and the degree of saturation is 0,885. Performance indicators for TIT's leg are shown in Table 3. There is 292 pcu/h of overall demand at the TIT leg, F level of service and 1,406 for the degree of saturation.

Table 3 Current Conditions of Performance Measure at TIT's Leg

Jl. Teuku Iskandar (Sp. Tujuh) (TIT)	Total Demand Flows (pcu/h)	Performace (Current Condition)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 2,5 m	175	125	1,406	F

Lane 2 = 4 m	117	83	1,406	F
Approach	292		1,406	F

Table 4 shows measurements of performance obtained at PAH’s using the SIDRA Intersection 8.0 program. At this leg, the total demand flow is 239 pcu/h. Degree of saturation is 0,469, and level of service is A. Measures of performance for the TIB leg are shown in Table 5. The total flow of demand is 220 pcu/h. Degree of saturation is 0,762, and level of service is C. Figure 3, which shows the lane level of service at the BPKP intersection in Banda Aceh, may be seen for extra details.

Table 4 Current Conditions of Performance Measure at PAH's Leg

Jl. Prof. Ali Hasyimi (PAH)	Total Demand Flows (pcu/h)	Performace (Current Condition)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 3,5 m	153	1795	0,085	A
Lane 2 = 3 m	12	136	0,085	A
Lane 3 = 4,2 m	74	157	0,469	A
Approach	239		0,469	A

Table 5 Current Conditions of Performance Measure at TIB's Leg

Jl. Teuku Iskandar (Sp. Beurawe) (TIB)	Total Demand Flows (pcu/h)	Performace (Current Condition)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 3,2 m	103	173	0,596	A
Lane 2 = 3,2 m	117	153	0,762	C
Approach	220		0,762	C

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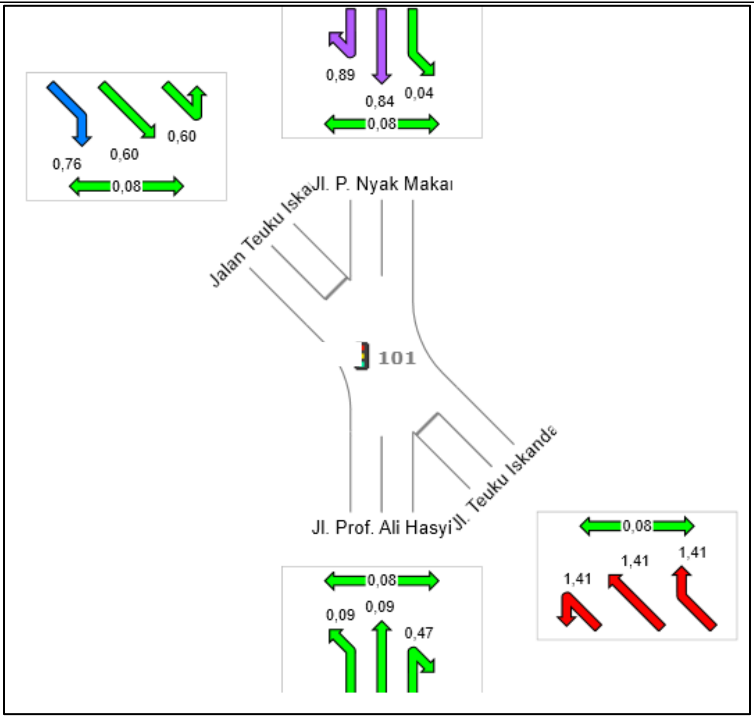

Figure 3 Show the level of service for each lane at the BPKP’s intersection Banda Aceh.

Table 6 displays performance data for the BPKP’s intersection in Banda Aceh as of the time of writing. The total flow of demand is 1060 pcu/h, degree of saturation 1,406, and level of service is F. The remodel of this intersection is necessary to improve the level of service so this intersection has level of service better than current condition.

Table 6 measures the performance of BPKP's Intersection at Banda Aceh in Current Situation

BPKP’s intersection Banda Aceh	
Performance	Current Conditions
Demand Flows (Total)	1060 pcu/h
Capacity	754 pcu/h
Degree of Saturation	1,406
Level of Service	LOS F

The remodel of this intersection is analyze the signalized intersection's traffic light cycle time. It is necessary to be able to handle the current that enters the intersection. The time allowed for each lane must be properly [16]. Figure 4 shows a phase transition in remodel condition. The signal timing was shown with yellow time and all red being 3 sec and 2 sec for each leg at that intersection. PNM (A) phase timing is 15 seconds, TIT (B) phase timing is 16 seconds, PAH phase timing is 13 seconds, and TIB phase timing is 11 seconds. Details are presented in Table 7.

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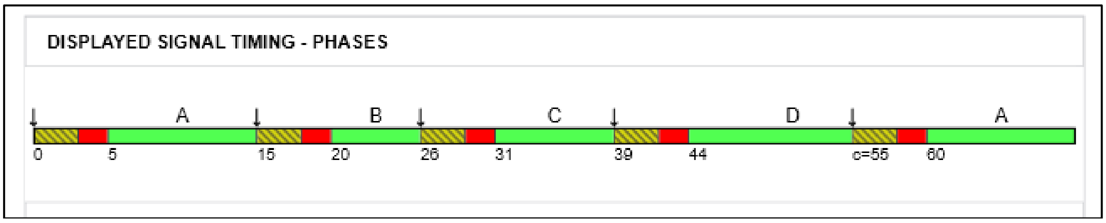

Figure 4 Timing of the displayed signal (Phases) in remodel condition

Table 7 shows the phase and cycle times at the intersection of the BPKP in Banda Aceh in remodel condition.

Phase	SIDRA			
	Green Time (s)	Yellow Time (s)	All Red (s)	Phase Time (s)
Jl. P. Nyak Makam (PNM)	10	3	2	15
Jl. Teuku Iskandar (Sp. Tujuh) (TIT)	11	3	2	16
Jl. Prof. Ali Hasyimi (PAH)	8	3	2	13
Jl. Teuku Iskandar (Sp. Beurawe) (TIB)	6	3	2	11
Cycle Time				55

Table 8 Remodel Conditions of Performance Measure at PNM's Leg

Jl. P. Nyak Makam (PNM)	Total Demand Flows (pcu/h)	Performace (Remodel)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 3,3 m	75	1772	0,042	A
Lane 2 = 3,3 m	104	184	0,565	A
Lane 3 = 3,3 m	131	201	0,651	B
Approach	310		0,651	B

Performance has been evaluated using the SIDRA Intersection 8.0 program in according to table 8. The PNM leg's total demand flow is 310 pcu/h. The approach's level of service is B, and level of service is 0,651. Table 9 displays the performance indicators for the TIT's leg. At the TIT's leg, level of service is C with degree of saturation is 0,765, there is a total demand of 292 pcu/h.

Table 9 Remodel Conditions of Performance Measure at TIT's Leg

Jl. Teuku Iskandar (Sp. Tujuh)	Total Demand Flows (pcu/h)	Performace (Remodel)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 2,5 m	174	228	0,765	C
Lane 2 = 4 m	118	155	0,765	C
Approach	292		0,765	C

The performance measurements collected at PAHs using the SIDRA Intersection 8.0 software are displayed in Table 10. The overall demand flow at this leg is 239 pcu/h. Level of service is A, and the degree of saturation is 0,394. Table 11 displays performance measures for the TIB's leg. 220 pcu/h is the entire flow of demand. Level of service is B, and the degree of saturation is 0,618. For further

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information, see to Figure 5, which depicts the degree of service for each lane at the BPKP intersection in Banda Aceh.

Table 10 Remodel Conditions of Performance Measure at PAH's Leg

Jl. Prof. Ali Hasyimi (PAH)	Total Demand Flows (pcu/h)	Performace (Remodel)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 3,5 m	151	1772	0,085	A
Lane 2 = 3 m	14	161	0,085	A
Lane 3 = 4,2 m	74	187	0,394	A
Approach	239		0,394	A

Table 11 Remodel Conditions of Performance Measure at TIB's Leg

Jl. Teuku Iskandar (Sp. Beurawe) (TIB)	Total Demand Flows (pcu/h)	Performace (Remodel)		
		Capacity (pcu/h)	Degree of Saturation	Level of Service
Lane 1 = 3,2 m	103	269	0,384	A
Lane 2 = 3,2 m	117	189	0,618	B
Approach	220		0,618	B

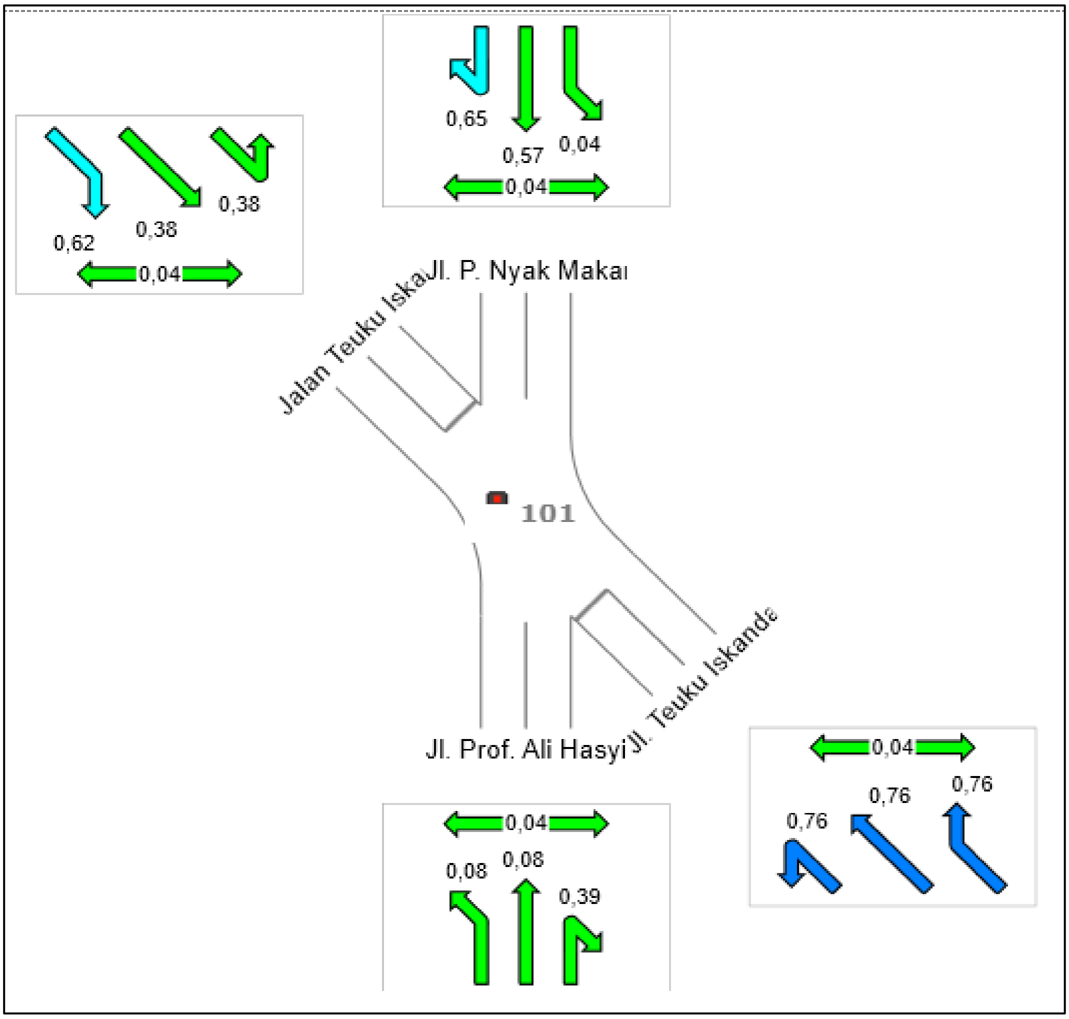

Figure 5 Show the level of service for each lane at the BPKP's intersection Banda Aceh.

Table 12 displays performance data for the BPKP's intersection in Banda Aceh as of the time of writing. The total flow of demand is 1060 pcu/h, degree of saturation 0,765, and level of service is C. The traffic light cycle time at this intersection is being analyzed as part of its remodel. The remodel of this intersection improve the level of service so better than current Condition.

Table 12 Measures the performance of BPKP's Intersection at Banda Aceh in Remodel Condition

BPKP's intersection Banda Aceh	
Performance	Remodel Condition
Demand Flows (Total)	1060 smp/jam
Capacity	1386 smp/jam
Degree of Saturation	0,765
Level of Service	LOS C

4. CONCLUSIONS

1. Overall flow of demand With a degree of saturation of 1,406 and level of service of F, the BPKP's Intersection at Banda Aceh is 1060 pcu/h in current condition.
2. The remodel of this intersection is analyze the signalized intersection's traffic light cycle time. It is necessary to be able to handle the current that enters the intersection.
3. Total flow of demand in remodel condition of BPKP's intersection at Banda Aceh is 1060 pcu/h, degree of saturation is 0,765, and level of service is C.

5. SARAN

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