Performance Analysis of Intersections along Jalan Abdul Rahman using Sidra Intersection 8.0

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Abstract: Signalized intersection is one of traffic facilities that usually provided to link several stretches in an urban road network. From time to time, the signalized phases might need to be revised to maintain reliability during operation due to traffic demand, especially in the developed area. Jalan Abdul Rahman, Muar has been chosen as a study location as it is one of the main entrances to Bandar Maharani Muar. This study was carried out to identify the peak hour and the level of service at the selected intersections. SIDRA Intersections 8.0 software was used to analyze the data to obtain current performance of intersection due to traffic vehicle flow. Study has found that the peak hour along Jalan Abdul Rahman is at 5.30 p.m. until 6.30 p.m. and the level of service at intersection of Jalan Abdul Rahman-Lebuh AMJ and Jalan Abdul Rahman-Jalan Sultan Ibrahim/Jalan Parit Haji Baki were verified as level of service C and F, respectively. These findings could help local authority to monitor the performance of these intersection so intervention can be done to control congestion along Jalan Abdul Rahman.

Keywords: Muar, Level of Service, SIDRA Intersection 8.0, Signalized Intersection

1. Introduction

Jalan Abdul Rahman, Muar is one of the main entrances to Muar Town from the South, and congestion might happen. It is because, as the main entrance to Muar Town, it will be busier, especially during peak hours. Due to traffic demand especially in the town area, most of the intersections are designed with signalized control. However, from time to time, the signalized phases might need to be revised to maintain reliability during operation. Many problems may occur due to improper provision of signal phases and cycle time at the intersection such as excessive delay and many more [1]. As a result, impatient road users might behave aggressively on the road which may lead to safety issues. For traffic engineering consistency, the junction zones throughout the route should be studied collectively [2].

The objectives of this study are as follows: (1) to identify several signalized intersections along with Jalan Abdul Rahman as the study location, (2) to determine peak hour at the study location based on commuter counting along a road segment, and (3) to analyse the level of service of selected intersections using SIDRA Intersection 8.0 software for the intersections along with Jalan Abdul Rahman.

2. Materials and Methods

This study focuses on Jalan Abdul Rahman, Muar. There were three main intersections along with Jalan Abdul Rahman for performance evaluation.
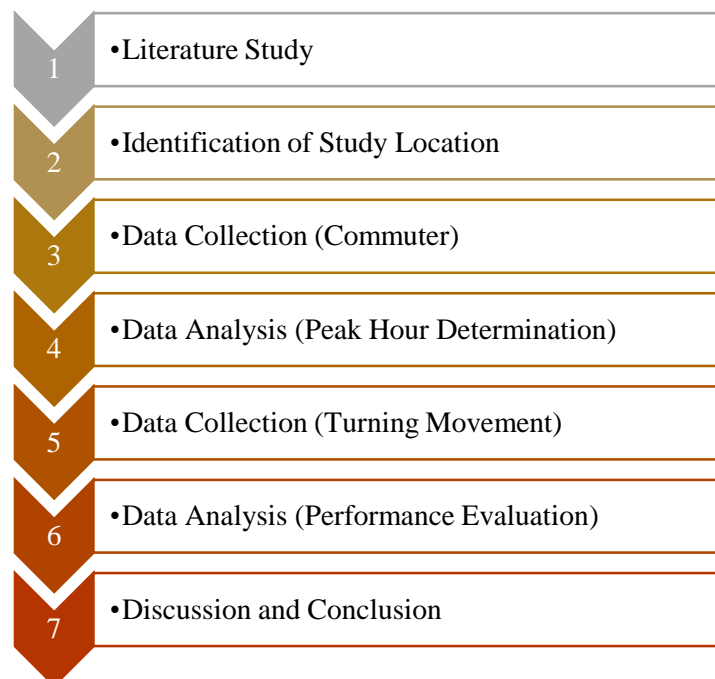
2.1 Materials

Data collection consists of two stages namely commuter and turning movement data collection. Commuter data was crucial in determining the pattern of daily traffic flow and in identifying peak hours. In this study, data collection was conducted on weekdays for 13 hours starting from 6.30 a.m. until 7.30 pm. Turning movement count or as known as intersection count was to count vehicles that were moving at every approach to an intersection [3]. In this study, the equipment that was used to collect data were counter for intersection of Jalan Abdul Rahman – Lebuh AMJ and CountCam 2 for intersection of Jalan Abdul Rahman – Jalan Sultan Ibrahim / Jalan Parit Haji Baki.

For CountCam 2, open the application and start to record the car's movement screen. First, activate CountCam 2. Connect to the CountCam 2 using a mobile device that has the CountCam App loaded. Click on the device and input the CountCam 2 password when the CountCam 2 network appears. Launch the app CountCam 2. As soon as you launch the program, record the screen as the car passes by [4]. The procedure is the same for commuters as it is for CountCam 2.

2.2 Methods

Figure 1 shows the flowchart of the overall methodology that is used in this research.

1 • Literature Study
2 • Identification of Study Location
3 • Data Collection (Commuter)
4 • Data Analysis (Peak Hour Determination)
5 • Data Collection (Turning Movement)
6 • Data Analysis (Performance Evaluation)
7 • Discussion and Conclusion

Figure 1: Flowchart of the Overall Methodology

Referring to **Figure 1**, this study was started with the literature study. Up to thirty journal papers were referred for this study. Then, identification of the study location was carried out. Two signalized intersections along Jalan Abdul Rahman, Bandar Maharani Muar were selected for performance evaluation, namely intersection of Jalan Abdul Rahman – Lebuh AMJ and Jalan Abdul Rahman – Jalan Sultan Ibrahim / Jalan Parit Haji Baki. Commuter volume data collection was conducted in order to determine peak hour. The data had been analyzed using Microsoft Excel to determine peak hour that later used for turning movement data collection. Beside field manual counting, recording device so-called Countcam2 was also used for data collection. Then, the data were analyzed using the SIDRA intersection 8.0 to evaluate the performance of selected intersections [5]. All findings had been critically discussed and concluded at the end of this study.

3. Results and Discussion

The objectives' outcomes presented and discussed, consist of a commuter volume and intersections analysis using SIDRA Intersection 8.0 software.

3.1 Commuter traffic flow

The type of the vehicles is divided into four classification which labeled as 1,2,3,4. **Table 1** shows the classification of vehicles in commuter count [6].

Table 1: Vehicles classification

Vehicle Classification			
1	2	3	4
Motorcycle	Passenger car	Four tiers, single unit	Buses, two axis, six tiers

The purpose of dividing the type of vehicles into a few classes is to make it easier to determine the type of vehicles that frequently pass through the road, especially during peak hours [7]. Therefore, which type of vehicles have often used the intersection of Jalan Abdul Rahman can be analyzed. **Figure 2** shows the vehicle composition at Jalan Abdul Rahman, Muar from 6.30 a.m. until 7.15 p.m.
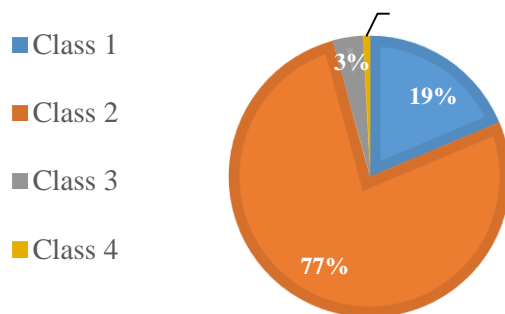

Figure 2: Vehicle composition

Referring to **Figure 2**, there are 77% of the users at Jalan Abdul Rahman are using vehicles class 2 which is a car followed by class 1 which motorcycles with 19%. and 3% from class 3 and 1 % from class 4. Therefore, most of the users at Jalan Abdul Rahman are using car and the least user of this road is heavy vehicles which are in class 4. The result of the observation data can be found in the appendix.

3.1.2 Commuter data

Before taking data on the preferred study location, determination of peak hour is needed by using commuter data. In the previous chapter, commuter data and how to use it are already discussed. Therefore, in this chapter, the result of commuter data is shown below. **Figure 3** shows the time series of commuter traffic flow along Jalan Abdul Rahman starting from 6.30 a.m. until 7.00 p.m. The purpose is to determine the highest 15-minute volume of vehicles.
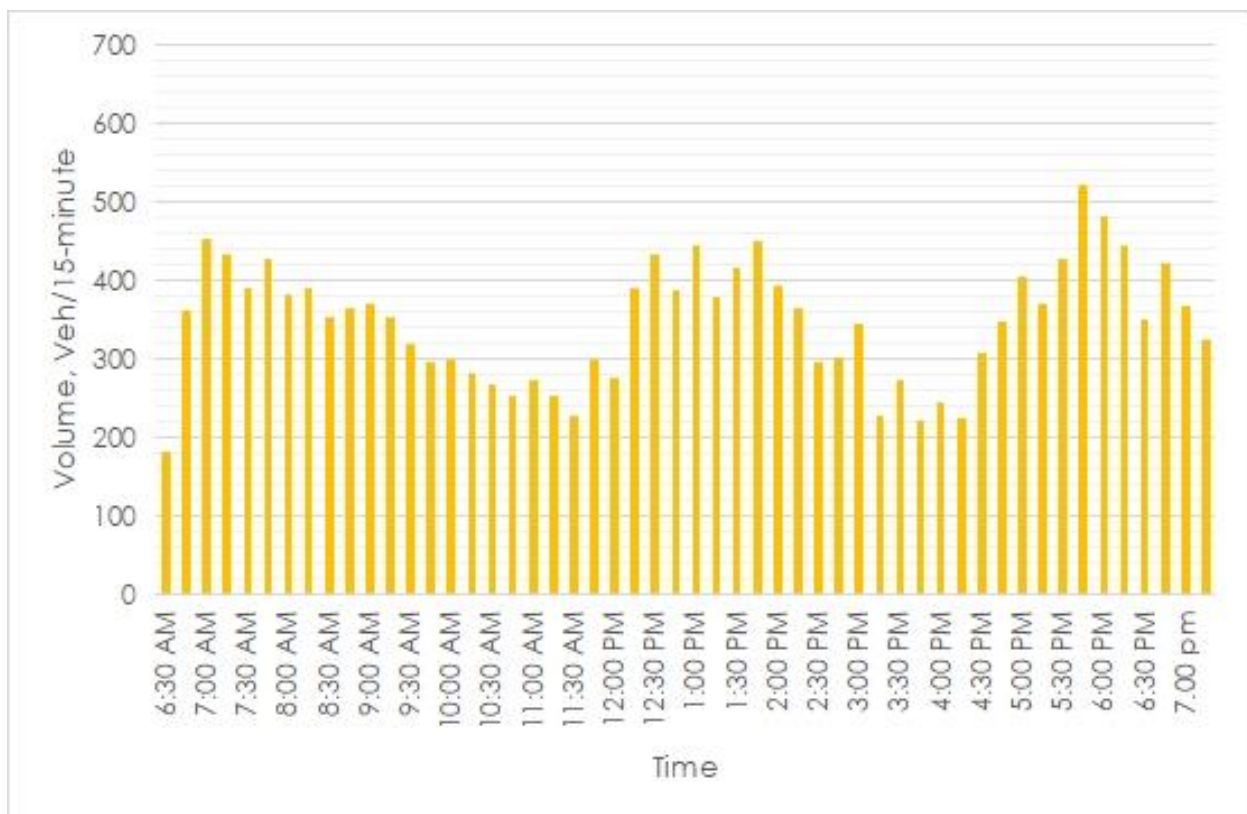
Figure 3: Time series of 15-minute volumes versus time

Referring to **Figure 3**, the peak hour and the highest 15-minute volume of the vehicle are from 5.30 to 6.30 p.m. and from 5.45 to 6.00 p.m., respectively. **Table 2** shows the flow rate of hourly volume during evening rush hour starting from 4.30 to 7.30 p.m. Referring to **Table 2**, the volume during peak hour is 1879 vehicles. While the volume of highest 15-minute is 523 vehicles.

Table 2: Hourly volume during evening rush hour

TIME		TOTAL
START	END	
4:30 PM	5.30 pm	1431
4:45 PM	5.45 pm	1552
5:00 PM	6.00 pm	1727
5:15 PM	6.15 pm	1805
5:30 PM	**6.30 pm**	**1879**
5:45 PM	6.45 pm	1800
6:00 PM	7.00 pm	1698
6:15 PM	7.15 pm	1585
6:30 PM	7.30 pm	1466

Based on **Table 2** above, the highest volume of vehicle is around 5.30 p.m. until 6.30 p.m. with 1879 vehicles. At every facility, the worst traffic conditions often occur during peak hours [8]. Therefore, 5.30 p.m. until 6.30 p.m. is selected as study period for both locations of intersections.
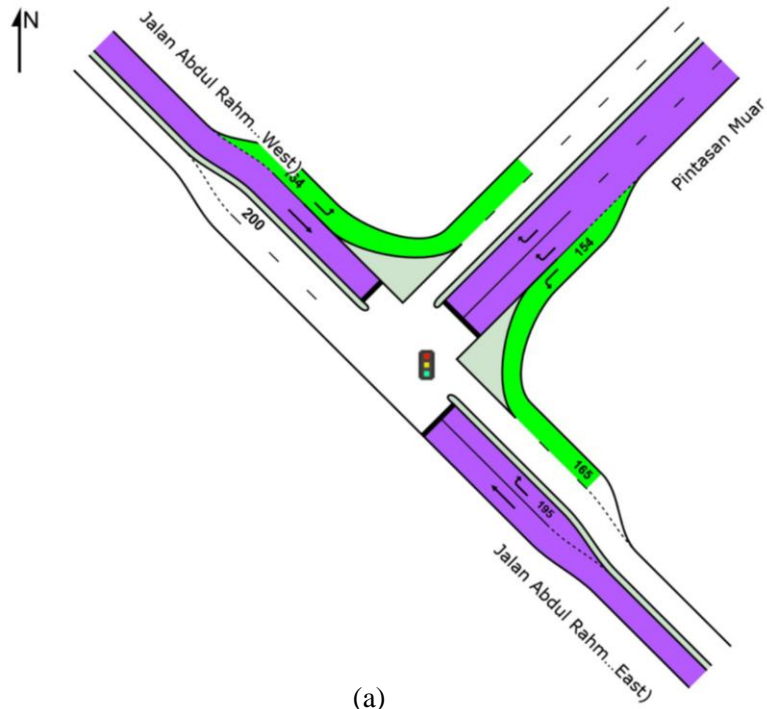
3.2 Turning movement data

There are 2 study locations along Jalan Abdul Rahman that were observed and analyzed, namely intersection of Jalan Abdul Rahman – Lebuh AMJ and intersection of Jalan Abdul Rahman – Jalan Sultan Ibrahim/Parit Haji Baki using Sidra Intersection 8.0.

3.2.1 Intersection of Jalan Abdul Rahman – Lebuh AMJ

Manual counting was used to collect the data at the intersection of Jalan Abdul Rahman - Lebuh AMJ. Based on the data, most of the users at this intersection are using cars. And it almost none to be found vehicles type 4 in this intersection during this hour. Observations at the green light have also been made. The average green light is stated on data where there are three phases. Phases one is 35.51 seconds, phases two is 31.16 seconds, and phases three is 33.46 seconds. The width of the road is also recorded in the data above. One of the reasons why the green light and width of the road is recorded is to know whether the width and time phasing of the intersection is suitable or not with the traffic flow during peak hour [9].

After collecting all the data, SIDRA Intersection 8.0 is used to analyze the flow peak and level of services in this intersection. Below is the data analysis from SIDRA Intersection 8.0 software.

	Approaches			Intersection
	Southeast	Northeast	Northwest	
LOS	D	C	C	C

(a)

Colour code based on Level of Service

| LOS A | LOS B | LOS C | LOS D | LOS E | LOS F |

	Approaches			Intersection
	Southeast	Northeast	Northwest	
Degree of Saturation	0.53	0.45	0.70	0.70

(b)
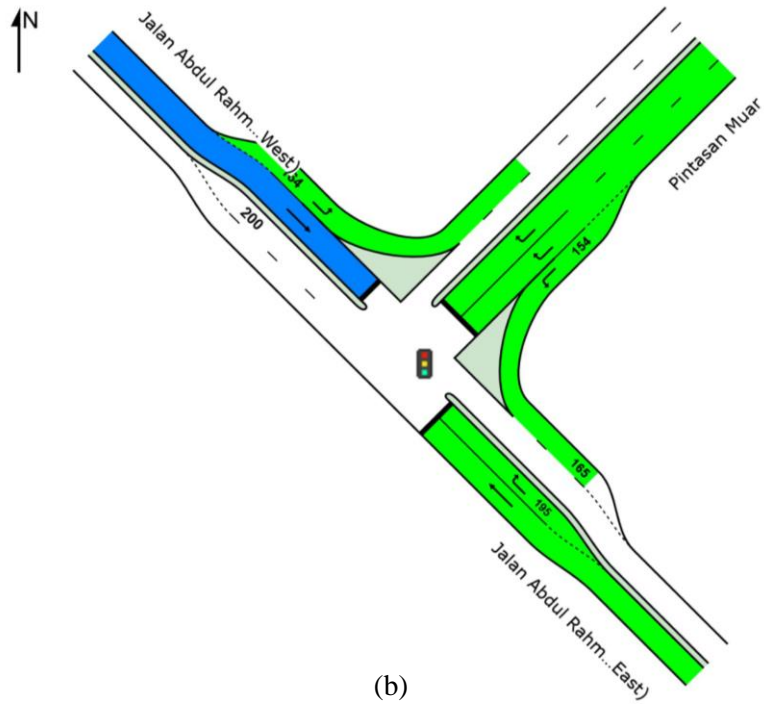
Colour code based on Degree of Saturation

[< 0.6]   [0.6 – 0.7]   [0.7 – 0.8]   [0.8 – 0.9]   [0.9 – 1.0]   [> 1.0]

	Approaches			Intersection
	Southeast	Northeast	Northwest	
Delay (Control)	39.6	30.6	24.7	30.8
LOS	D	C	C	C

(c)

Colour code based on Level of Service

| LOS A | LOS B | LOS C | LOS D | LOS E | LOS F |
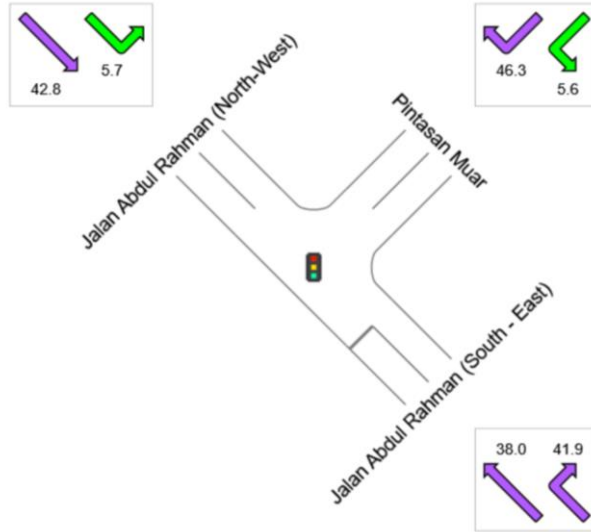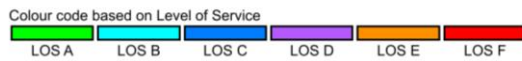
	Approaches			Intersection
	Southeast	Northeast	Northwest	
Queue Distance (Aver)	66	46	89	89

(d)

Colour code based on Queue Storage Ratio

| [< 0.6] | [0.6 – 0.7] | [0.7 – 0.8] | [0.8 – 0.9] | [0.9 – 1.0] | [> 1.0] |
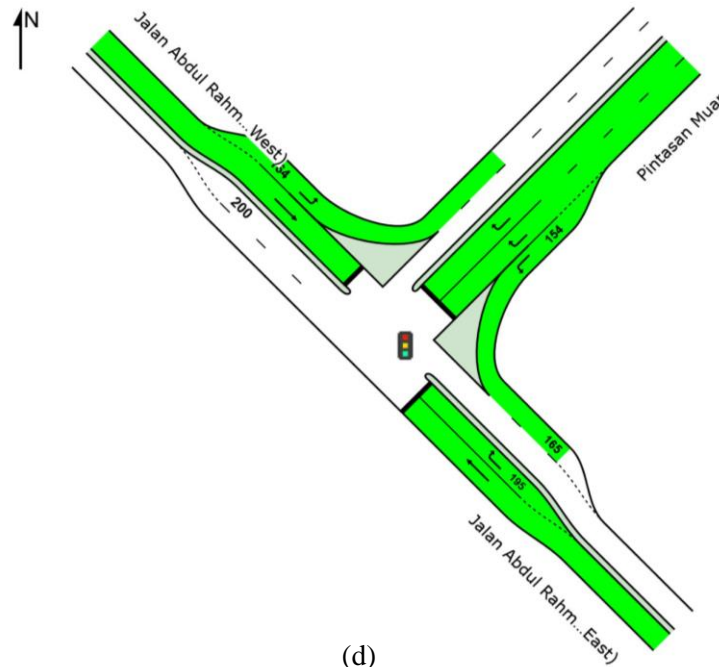
Figure 4: (a) Level of Service, (b) Degree of Saturation, (c) Delay control, (d) Queue average

Based on analysis from SIDRA Intersection 8.0 software above, the traffic flow in the intersection of Jalan Abdul Rahman - Lebuh AMJ is moderate. Referring to **Figure 4 (a)**, the Level of Services (LOS) here is grade C, which means the traffic condition is moderate and the average speed for the car is 56.5 km/h which is good. Next, look at **Figure 4 (b)**, the degree saturation. The degree saturation in this intersection is quite good. The highest degree saturation is only 0.7 which is Jalan Abdul Rahman north-west to the south-east. The higher the degree of saturation, the higher the vehicle density, which can lead to congestion. But in this intersection, the degree of the saturation is not that high. So, it is still moderate and convenient for road users. Besides that, the average delay is also taken into consideration to determine the traffic flow and level of service. The longer the average delay, the longer the vehicles will stay in a system, and queue time also increases. Look at **Figure 4 (c)**, the average delay is 30.8 seconds. The average delay is not that high and still can be considered moderate. The intersection of Jalan Abdul Rahman-Lebuh AMJ has already passed the standard but in the future, it might become worst. The authorities need to think in advance for a better future so that the congestion does not happen on this road and still passes the standard that is already set for the convenience of the road users. As a recommendation, public transport needs to be upgraded to attract people to use it. Therefore, the saturation on this road is decreased and can maintain the level of services as a result.

3.2.2 Intersection of Jalan Abdul Rahman – Jalan Sultan Ibrahim / Jalan Parit Haji Baki

Next, analyze data at intersection of Jalan Abdul Rahman- Jalan Sultan Ibrahim / Jalan Parit haji Baki. In this intersection, the data are collected by using CountCam. The flow of traffic is recorded at peak hours between 5.30 p.m. and 6.30 p.m. The time for the green light and the width of the road is recorded as well. All the data were analyzed by using SIDRA Intersection 8.0 software to know whether the flow traffic in this intersection is good or not. Below is the result of data that can help to determine whether the traffic flow at Jalan Abdul Rahman - Jalan Sultan Ibrahim/ Jalan Parit haji Baki needs any improvement or not.

Based on analysis from SIDRA Intersection 8.0, the traffic flow, and Level of Services (LOS) at the intersection of Jalan Abdul Rahman - Jalan Sultan Ibrahim/ Jalan Parit Haji Baki can be determined. Based on the data in **Figure 5 (a)**, the Level of Services (LOS) for all the vehicles in this intersection is E which means the traffic flow is very heavy. Therefore, an improvement is needed for the convenience of road users. one of the reasons why this intersection is very heavy is because it is one of the main entrances to Muar Town and because of a lot of facilities nearby such as schools and restaurants. As indicated in **Table 3**, a standard Level of Service (LOS) from Malaysia's Public Works Department is used to assess the LOS of road service in junctions of Jalan Abdul Rahman and Muar. [10].

Table 3 Level of service by volume/capacity ratio

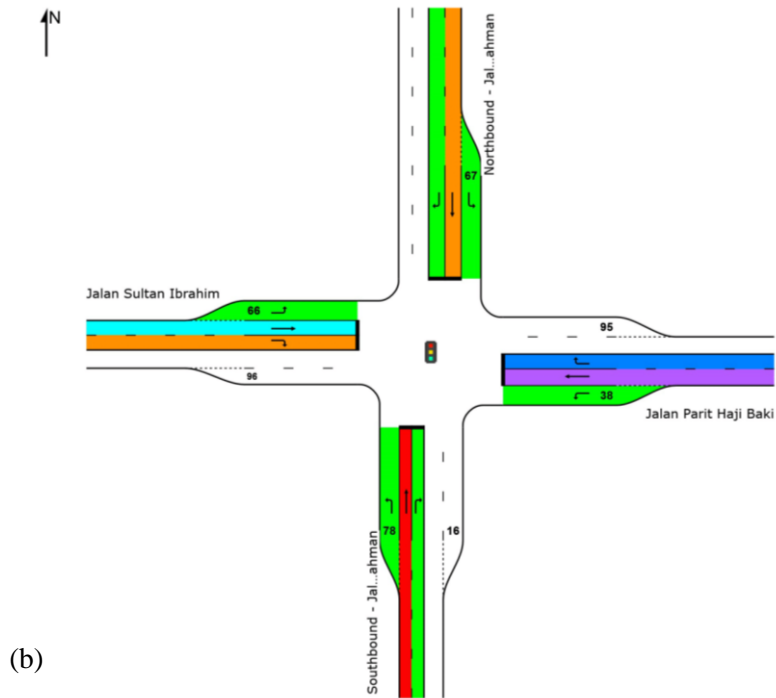| Volume/Capacity Ratio	Traffic Flow	Level of Service
0.0 – 0.2	Free flow	A
0.2 – 0.4	Free flow but close to stable flow	B
0.4 – 0.6	Stable flow	C
0.6 – 0.8	Stable flow but close to congested	D
0.8 – 1.0	Congested	E
More than 1.0	Very congested	F

According to Malaysia Standard, all roads must at least achieve LOS D to give convenience and comfort to the road users, especially car drivers. But unfortunately, the LOS in this intersection is E which can disturb the road users. The average speed for all the vehicles is only 34.7 km/h which is low.

And the density is extremely high. The slow-moving may cause traffic congestion which will cause the level of service (LOS) to be downgraded. That is why the LOS in this intersection is E. Look at **Figure 5 (b)**, the degree saturation. The higher the degree of saturation, the higher the vehicle density, which means it can lead to congestion. The highest degree saturation is at a southbound - Jalan Abdul Rahman to Northbound - Jalan Abdul Rahman with 1.08. Other than that, the average delay in this intersection is 72.4 seconds. The longer the delay, the longer the time car will stay, and the time queue also increases. In a conclusion, based on the observation, the authorities need to act due to congestion that happens during peak hours at the intersection of Jalan Abdul Rahman- Jalan Sultan Ibrahim/Jalan Parit haji Baki for the convenience of road users. As a recommendation, the public transport needs to be upgraded to attract people to use it and carpool also one of the great ideas to decrease the saturation of vehicles in this area.
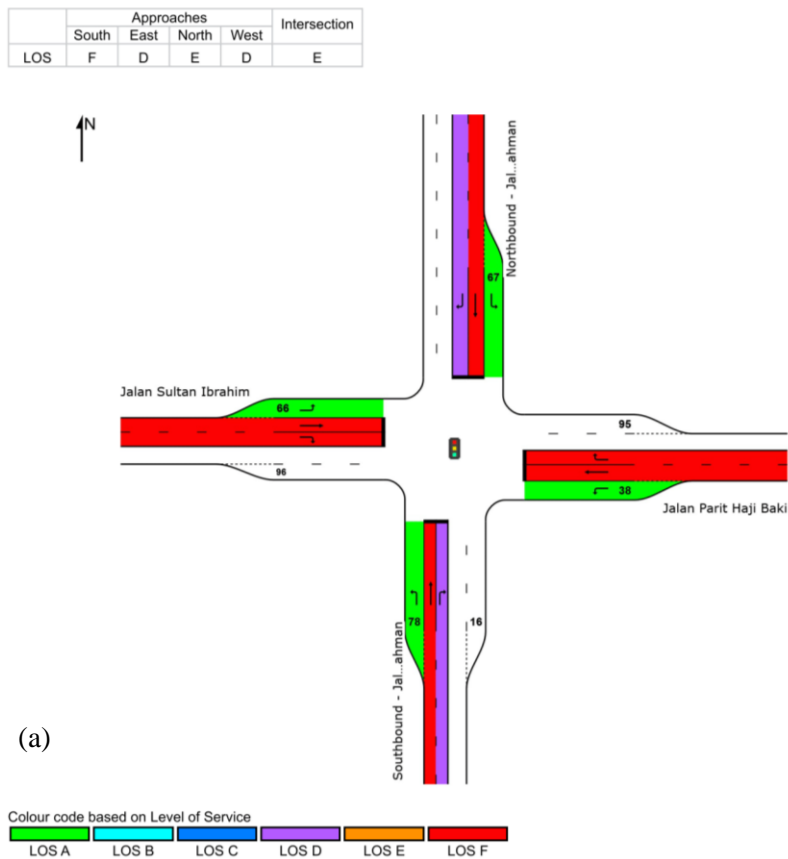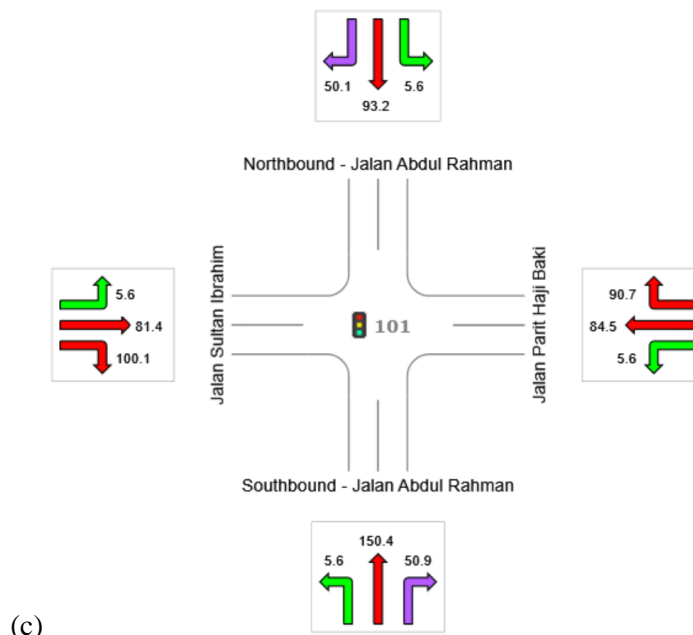

(a)

	Approaches				Intersection
	South	East	North	West	
Degree of Saturation	1.08	0.89	1.00	0.97	1.08

(b)

Colour code based on Degree of Saturation

[< 0.6]   [0.6 – 0.7]   [0.7 – 0.8]   [0.8 – 0.9]   [0.9 – 1.0]   [> 1.0]

	Approaches				Intersection
	South	East	North	West	
Delay (Control)	104.8	46.0	73.6	43.7	72.4
LOS	F	D	E	D	E

(c)

Colour code based on Level of Service

LOS A   LOS B   LOS C   LOS D   LOS E   LOS F

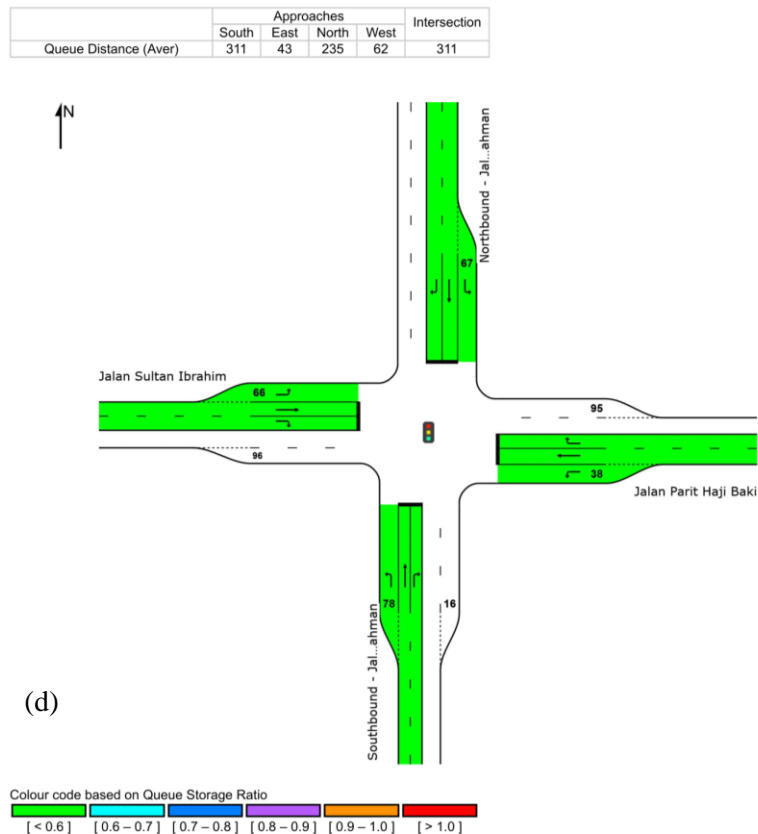|	Approaches				Intersection
	South	East	North	West	
Queue Distance (Aver)	311	43	235	62	311

Figure 5: (a) Level of Service, (b) Degree of Saturation, (c) Delay control, (d) Queue average

4. Conclusion

In conclusion, the objectives of this study were achieved. First, the objective of this study is to identify several signalized intersections along with Jalan Abdul Rahman as the study location. The objective is successfully done. The identification location study is stated and as a result, there is two preferred signalized intersection, which is Jalan Abdul Rahman - Lebuh AMJ and Jalan Abdul Rahman - Jalan Sultan Ibrahim / Jalan Parit haji Baki. Next, the objective to achieve is to determine peak hours at the study location based on commuter counting along the road segment. The data on determining the peak hour is already discussed in result and discussion section. Finally, the objective is to analyze the level of service of selected intersections using SIDRA Intersection 8.0 software. This objective also successfully complies. All the results are already discussed in result and discussion. For detailed and raw data can be referred to in the appendix. Intersections network analysis could be done in the future to observe the road segment level of service to comprehend the traffic pattern along with Jalan Abdul Rahman. Therefore, SIDRA Intersection with network analysis tool needs to be obtained to fulfil this suggestion.

Acknowledgement

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