

PERPUSTAKAAN UMP



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ANALYSIS THI

ED INTERSECTION

BY USING SIDRA

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## **ABSTRACT**

This paper presents assessment of qualitative road service at signalized intersection and the implication to their performance especially the delay in terms the number of vehicles and level of service at the intersection. Improvement of the level of service at each intersection usually results in an improvement of the overall operating performance of the highway. An analysis procedure that provides for the determination of level of service at intersection is therefore an important tool for designers, operation personnel and policy makers. Factors that affect the level of services at signalized intersection include the flow and distribution of traffic, headway, saturation flow, the geometric characteristics, and the signalization system. Determining the traffic volume and traffic distribution is vital in this assessment in order to figure out the delays and level of services. According to Arahah Teknik Jalan 8/86, delay is the main factor of classifying a particular signalized intersection. Moreover, excessive delay that causes long queue length not only indicates the amount of lost travel time and fuel consumption, it is also a measure of the frustration and discomfort of vehicle users. Based on the result of the study, appropriate decision and optimization can be made regard to nature and degree of improvement possible or justified, if there is any. In a nutshell, cost and time can be reduced whereas safety can be increased if a signalized intersection is operating at a high level of effectiveness and efficiency.

## ABSTRAK

Laporan ini menunjukkan pengajian kualiti perkhidmatan jalan di persimpangan jalan di persimpangan berlampu isyarat dan implikasi terhadap prestasi jalan terutamanya kelengahan dari segi bilangan kenderaan dan tahap perkhidmatan di persimpangan. Peningkatan tahap perkhidmatan di setiap persimpangan biasanya mengakibatkan peningkatan prestasi operasi keseluruhan lebuhraya.. Langkah-langkah analisis yang memberi penentuan tahap perkhidmatan merupakan alat penting untuk pereka bentuk, operasi peribadi dan pengubah polisi. Faktor-faktor yang mempengaruhi tahap perkhidmatan pada persimpangan berlampu isyarat termasuk aliran dan pengagihan trafik, headway, aliran tepu, geometri jalan dan system lampu isyarat. Penentuan jumlah trafik dan pengagihan trafik adalah penting dalam kajian ini kerana digunakan untuk menentukan kelengahan dan baris gilir. Mengikut Arahan Teknik Jalan 8/86, kelengahan adalah factor utama bagi mengklasifikasikan tahap perkhidmatan sesebuah persimpangan lampu isyarat. Tambahan pula, kelengahan berlebihan akan mengakibatkan pemanjangan baris gilir dan ini menunjukkan kehilangan masa dan petrol. Langkah-langkah peningkatan tahap perkhidmatan boleh dibentuk berdasarkan keputusan kajian ini. Kesimpulannya, kos dan masa boleh dikurangkan dan keselamatan boleh dipertingkatkan sekiranya sesebuah persimpangan lampu isyarat berfungsi pada tahap perkhidmatan yang tinggi.

## TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	TITLE PAGE	i
	DECLARATION	ii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENTS	viii
	LIST OF FIGURES	xii
	LIST OF TABLES	xv
	LIST OF APPENDICES	
1.	INTRODUCTION	
1.1	Background of Study	1
1.2	Problem Statement	2
1.3	Aim and Objective of the Study	4
1.4	Scope of the Study	5
1.5	Important of the Study	6

## **4. RESULTS AND ANALYSIS**

4.1	Introduction	36
4.2	Surroundings and Approaches of Signalized Intersection	37
4.2.1	Existing Condition	38
4.2.2	Traffic Volume Data	38
4.2.3	Raw Data for Morning Session	39
4.2.4	Raw Data for Evening Session	44
4.3	Existing Traffic Pattern	49
4.4	Volume and Distribution of Flow	50
4.4.1	Morning Peak (7.45 a.m. - 8.45 a.m.)	51
4.4.2	Evening Peak (5.30 p.m. - 6.30 p.m.)	52
4.5	Forecast of Future Traffic	56
4.6	Trip Generation and Attraction	57
4.7	Traffic Distribution	59
4.8	Projection for future 2 years	61
4.9	Output from SIDRA	62
4.9.1	Queue	62
4.9.1.1	Queue Results for AM Peak	63
4.9.1.2	Queue Results for PM Peak	65
4.9.2	Level of Service	67

## **5. CONCLUSION AND RECOMMENDATION**

5.1	Introduction	72
5.2	Findings	72
5.3	Recommendation	73
5.4	Conclusion	73

<b>REFERENCES</b>	74
<b>APPENDICES</b>	
<b>APPENDIX A - Traffic Volume Data</b>	76
<b>APPENDIX B - Detailed Output from Sidra Software</b>	91

## LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	Study Area (from Google Maps)	3
2.1	Fundamental Attributes of Flow at Signalized Intersections (Source: HCM 2000)	11
2.2	Delay Terms at a Signalized Intersection	14
3.1	Flow Chart of Carrying Out Study of Signalized Intersections	20
3.2	Satellite View of Selected Site	22
3.3	Map View of Selected Site	22
3.4	The Surroundings of Selected Site	23
3.5	Environment of Selected Site	23
3.6	Sample Screen Shot of Intersection Dialogue	29
3.7	Sample Screen Shot of the Geometry Dialogue (Lane and Movement Type)	30
3.8	Sample Screen Shot of the Volume Dialogue	31
3.9	Sample Screen Shot of the Movement Data Dialogue with Default Values	32
3.10	Sample Screen Shot of the Priorities Dialogue	33
3.11	Sample Screen Shot of the Phasing and Timing Dialogue	34
3.12	Sample of output from Sidra Software (Akcelik & Associates Pty. Ltd, 2010)	35
4.1	Selected Signalized Intersection and Surrounding Area at the Intersection	37
4.2	Histogram Graph of Traffic Volume at Jalan Sultan Ahmad Shah	40
4.3	Histogram Graph of Traffic Volume at Jalan Sultan	41

	Abdullah	
4.4	Histogram Graph of Traffic Volume at Jalan Tun Razak (east)	42
4.5	Histogram Graph of Traffic Volume at Jalan Tun Razak (west)	43
4.6	Histogram Graph of Traffic Volume at Jalan Sultan Ahmad Shah	45
4.7	Histogram Graph of Traffic Volume at Jalan Sultan Abdullah	46
4.8	Histogram Graph of Traffic Volume at Jalan Tun Razak (east)	47
4.9	Histogram Graph of Traffic Volume at Jalan Tun Razak (west)	49
4.10	Hourly Flow of Vehicle During Morning Peak Hour (7.45 a.m. - 8.45 a.m.) in pcu/hr	54
4.11	Hourly Flow of Vehicle During Evening Peak Hour (5.30 p.m. - 6.30 p.m.) in pcu/hr	55
4.12	Total Traffic Produced and Attracted by the New Hospital Development	59
4.13	Ingress Distribution Pattern for Morning and Evening Peak Hour	60
4.14	Egress Distribution Pattern for Morning and Evening Peak Hour	61
4.15	Queue length (vehicle) of an existing model for Morning Peak	64
4.16	Queue length (vehicle) of future model for Morning Peak	64
4.17	Queue length (vehicle) of an existing model for Evening Peak	66
4.18	Queue length (vehicle) of future model for Evening Peak	66
4.20	Level of Service based on Delay (HCM Method) of an existing model	68
4.21	Level of Service based on Delay	68



	(HCM Method) of future model	
4.23	Level of Service based on Delay (HCM Method) of an existing model	70
4.24	Level of Service based on Delay (HCM Method) of future model	70

## LIST OF TABLES

TABLE NO.	TITLE	PAGE
3.1	Input Data Needs for Each Analysis Lane Group	25
3.2	Traffic Volume Count Form	26
3.3	Equivalent Passenger Car Unit Adopted in Junction Analysis	27
4.1	Traffic Volume at Jalan Sultan Ahmad Shah	39
4.2	Traffic Volume at Jalan Sultan Abdullah	41
4.3	Traffic Volume at Jalan Tun Razak (east)	42
4.4	Traffic Volume at Jalan Tun Razak (west)	43
4.5	Traffic Volume at Jalan Sultan Ahmad Shah	44
4.6	Traffic Volume at Jalan Sultan Abdullah	46
4.7	Traffic Volume at Jalan Tun Razak (east)	47
4.8	Traffic Volume at Jalan Tun Razak (west)	48
4.9	Traffic Volumes Data for Jalan Sultan Abdullah	51
4.10	Traffic Volumes Data for Jalan Sultan Ahmad Shah	51
4.11	Traffic Volumes Data for Jalan Tun Razak (east)	51
4.12	Traffic Volumes Data for Jalan Tun Razak (west)	52
4.13	Traffic Volumes Data for Jalan Sultan Abdullah	52
4.14	Traffic Volumes Data for Jalan Sultan Ahmad Shah	52
4.15	Traffic Volumes Data for Jalan Tun Razak (east)	53
4.16	Traffic Volumes Data for Jalan Tun Razak (west)	53
4.17	The Generators Using Land Uses Medical-Dental Office Building	57
4.18	Trips Generated During AM and PM Peaks for the New Hospital Development	58
4.19	Ingress Trip Distribution for Morning and Evening Peak Hour	59
4.20	Egress Trip Distribution for Morning and Evening	60

	<b>Peak Hour</b>	
4.21	Largest 95% Back of Queue for any land used by movement (vehicles) for Morning Peak	64
4.22	Largest 95% Back of Queue for any land used by movement (vehicles) for Evening Peak	66
4.23	Level of Services of Existing and Future Model for Every Approach for Morning Peak	68
4.24	Level of Services of Existing and Future Model for Every Approach for Evening Peak	71

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background of Study**

Malaysia is moving towards becoming a developed country. With this fast pace of change so is the change in traffic conditions in this country. More and more citizens are using various types of vehicles in their everyday life, thus creating our very own typical travel behavior which is unique for this country as compared to other countries travel behavior. As a result, several problems arise especially in urban area such as congestion, delay, air pollution, noise and environment.

An intersection is very important in the road network, where traffic flows in different directions meet. Because of their influence each other, increasing volume of vehicles, and the loss of green time for beginning and clearance and so on, the volume of intersections is lower than that of their approach links. Intersections are locations that are most likely to experience traffic problems such as congestion, delay and safety.

Traffic signals are perhaps the most important traffic control devices for at grade intersection in urban traffic system. Proper installation of traffic signals can reduce the number of accidents and minimize delays to vehicles at intersections. Besides, traffic signals also can increase intersection volume. Since last three decades it is found that there is a significant increase in urbanization and consequent rapid growth of car ownership. Roadways of several major cities are unable to cater this increased traffic flow. Therefore, we more often come across with a situation in central areas that the traffic is congested with formation of long queues, causing delay, frustration and environmental issues for both the pedestrians and vehicle-users. Such traffic problems more often become the cause of accidents. The rapid increase in vehicle ownership in Kuantan in general, and Central Business District (CBD) area in particular has increased the traffic intensity that has created various serious problems such as congestion and formation of long queues ultimately causing heavy delays and increase in the number of accidents at various locations on roadways.

## **1.2 Problem Statement**

This study was conducted to analyze and evaluate the performance of signalized intersection based on measures of effectiveness (MOEs). The parameters are related with the queuing process at traffic signals, as well as delay, back of queue length and also fuel consumption. The focus of study is on delay and level of services only. Kuantan city is developing fast due the strategic location which located in Central Business District (CBD) area. The site study which is 4-arm signalized intersection is located nearest the new center of administration for Pahang government, InderaMahkota. This intersection consists of Jalan Sultan Abdullah, Jalan Sultan Ahmad Shah and also Jalan Tun Razak.

The signalized intersection was located at the new federal and state government offices which is before this located at the center of Kuantan city. This intersection also located near to the residential area, commercial area and also educational area such as International Islamic University of Malaysia (IIUM InderaMahkota). The environment of the study are shown in Figure 1.1

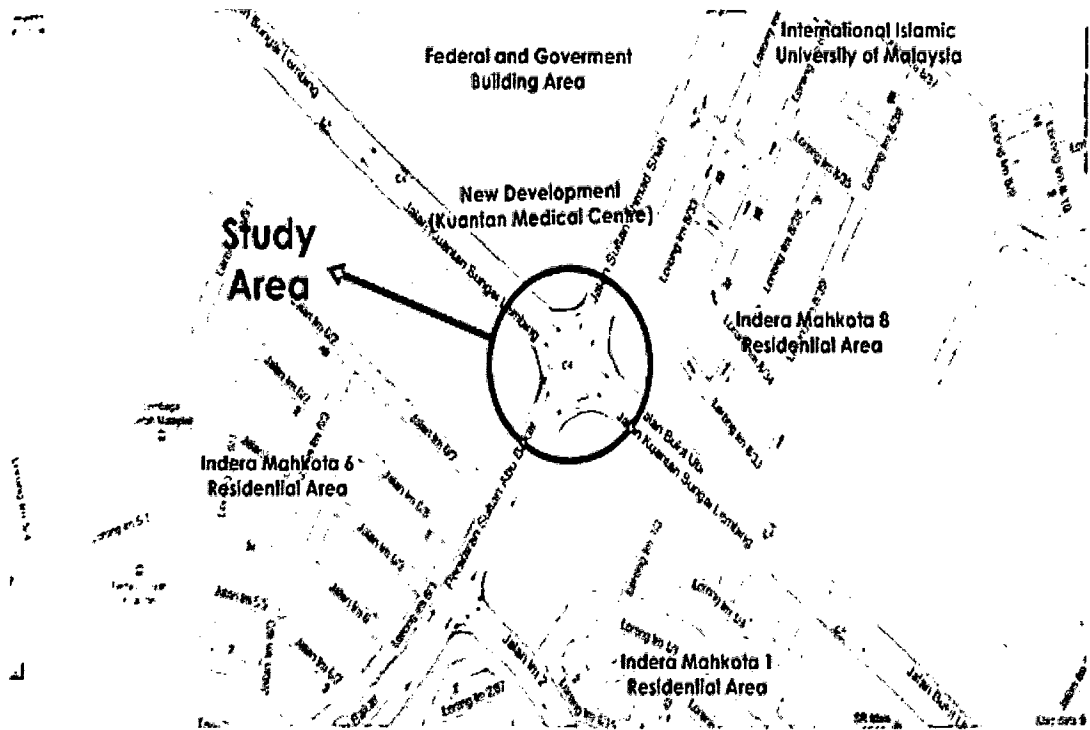


Figure 1.1 Study Area (from Google Maps)

Nowadays the condition of road and traffic of this intersection is become critical because of the volume of the vehicle also increase years to years. Severe congestion and accident can easily happen with such circumstances and this will lower the level of service on an intersection. Hence, a study about the delays and queue length enable us to categories the efficiency of the signalized intersections and better solutions can be provided in order to improve the safety and the effectiveness of the traffic control system.

After knowing the delays and queue for each arm and each lane, comparison can also be made by using Highway Capacity Manual 2011 (HCM 2011). As a result, suggestion of improving the traffic flow can be made so that can increase the LOS of the particular intersection. By efficient and effective signal control at intersections, continuous movement and smooth flow of traffic can be ensured. Therefore, by some modification of the intersection, those problems caused by improper design of intersection can be eliminated.

### **1.3 Aim and Objective of the study**

The main objectives of this study are:

- a) To analyses the performance of signalized intersection based measure of effectiveness: delay, queue, and level of service.
- b) To identify the effect of variation changes in parameters to the performance of signalized intersection.
- c) To propose alternatives to overcome the problems.

#### 1.4 Scope of the Study

For this study, four arm signalized intersection that connected between Jalan Sultan Abdullah, Jalan Tun Razak and also Jalan Sultan Ahmad Shah was selected as study location. Signalized intersection was chosen because this type of intersection is the most common type that will be used especially in urban area. Based on my observation, the volume of vehicle at this intersection will be increase because of the new developments such as new government building and commercial building located near to the intersection. Other than that the factor of number of vehicles that produced from the residential area and also from the education area which is from IIUM Kuantan campus. All this factors show that the intersection will be contribute to the congestion problems and long queue delay that can cause bad performance to the intersection.

To know the performance of the intersection, there have two measure of effectiveness for this intersection, queue length and level of services. These parameters are needed to be considered to analysis the signalized intersection. There are several data collection was conducted at the beginning. The three types of data collection will be taken at the site which is the geometric data, signal phasing data and traffic volume Data. Firstly, the geometric data for the signalized intersections (lane width and gradient) and the others related parameters such as type of turning lanes (exclusive turning lanes or shared lanes). Secondly, signal phasing data; signal phasing and cycles time (green time, inter-green time and red time) will be observed. Lastly, traffic volume data; the traffic volume of a signalized intersection was observed during morning session and also evening session. All the data will betaken during three days during weekdays.

The performance of the intersection was analyzing using Signalized and Unsignalized Intersection Design and Research Aid (SIDRA) software. All the parameters based from site location will be inserted to this software and later will be compared to Highway Capacity Manual (HCM). This software is one of micro-



analytical traffic evaluation tool that are usually use by traffic engineer. From output that produced by this software, the performance of the intersection can be análisis and evaluate in terms of queue and level of services (LOS). Hence, the solution or new alternatives way that can reduce the problem such as traffic congestion and long queue of delay can be proposed in future.

### **1.5 Important of the Study**

Signalized intersection in the study area is very important because the number of vehicles increase, by the increase in population and industrial growth and economy activity. With this study, various parties can see for themselves the extent to which the intersection of service levels to consider the best solutions to improve intersection level of service for the convenience of user

## **CHAPTER 2**

### **LITERATURE REVIEW**

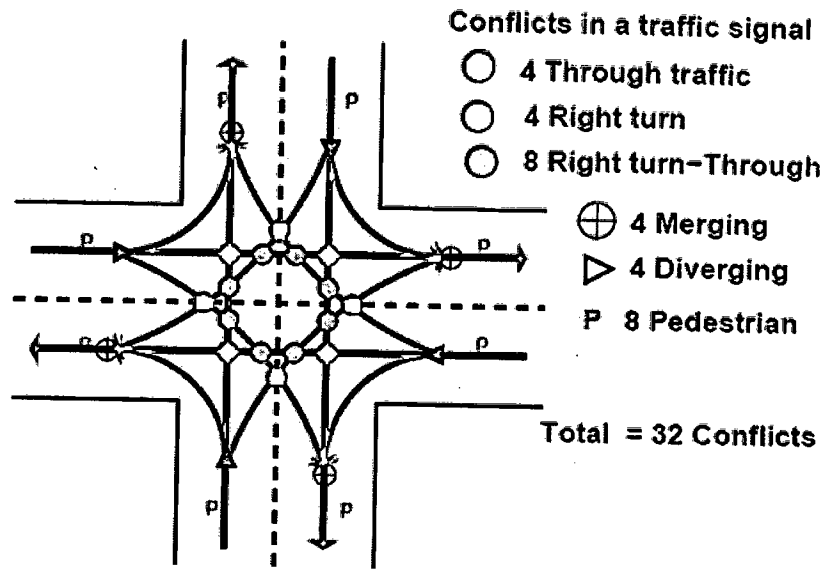
#### **2.1 Introduction**

All contents of this study from the problem statement, objectives and the scope of study were discussed in previously chapter. In order to get more understanding of this study, the literature reviews on several procedures and the discussion on the parameters are carries out in this chapter. This chapter discusses the literature review carried out for the study. Section 2.2 discusses the intersection studies especially about conflict at signalized intersection. Section 2.3 discusses about the traffic flow characteristics at signalized intersection. This section will discuss about some basic parameters of traffic flow at typical signalized. Traffic signal will be discussed in section 2.4 which is this section will be elaborated about the traffic signal control devices and modes of operation for traffic signalization. Section 2.5 discusses about the performance measures of a signalized intersection that can be evaluated by level of service, delay, and queue length. Finally, the applications of SIDRA software in conducting the analysis of an signalized intersection were discussed on last section in this chapter. In this section it was give a brief introduction about SIDRA software.

## 2.2 Intersection Studies

Intersection is a road junction where two or more roads either meet or cross at grade. It is designated for vehicles to turn to different directions to go to their destinations. The purpose is to control vehicles to their own directions. Traffic intersections are multifarious locations on any highway, because of the vehicles moving in different directions wanting to join the same space at the same time. Moreover, the pedestrians also find the same space for crossing. The vehicle users also have to make another decision at an intersection, a small error in judgment can cause severe accidents. It also reasons why the delay happens and it depends on the type of control and geometry. Overall traffic flow is influenced by the performance of the intersections. The capacity of the road also can be affected. Therefore, both from the accident and the capacity view, the study of intersections is very important especially to the traffic engineers.

Conflicts that happen at an intersection are not similar for different types of intersection. Consider a usual four arms-intersection as shown in the figure below. The numbers of conflicts for through movements are four, while competing right turn and through movements are 8. The conflicts between right turn traffics are 4, and between left turn and merging traffic are 4. The conflicts created by pedestrians will be 8 taking into account all the four approaches. Diverging traffic also produces about 4 conflicts. Therefore, a typical four legged intersection has about 32 different types of conflicts. This is shown in the figure below:



Conflicts at intersection

*Source: Signalized intersection Informational Guide (U.S. Department of Transportation)*

The purpose of the intersection control is to solve these conflicts at the intersection for more safety and effective movement of both vehicle users and pedestrians. Two methods of intersection controls are there: time sharing and space sharing. The type of intersection control that has to be implemented depends on the road geometry, traffic volume, and also the importance of the road.

### **2.3 Traffic Flow Characteristics at Signalized Intersection**

At any typical signalized intersection, we can observe a minimum of three signal lights are seen which are red, yellow and green. Some basic parameters of traffic flow at typical signalized intersection are presented in Figure 2.1. The figures implies at typical scenario of one-way approach with cycle of two phases to a signalized intersection (HCM 2000). The figure comprises of three portions. A time versus space graph of vehicles has been shown in first part. The diagram also indicates intervals for the signal cycle of the particular approach. From the diagram, the timing interval of interest, along with the labels with the symbols can be seen in second part. An ideal graphical representation of flow rate along the reference line is provided in the third part which is indicating the saturation flow.

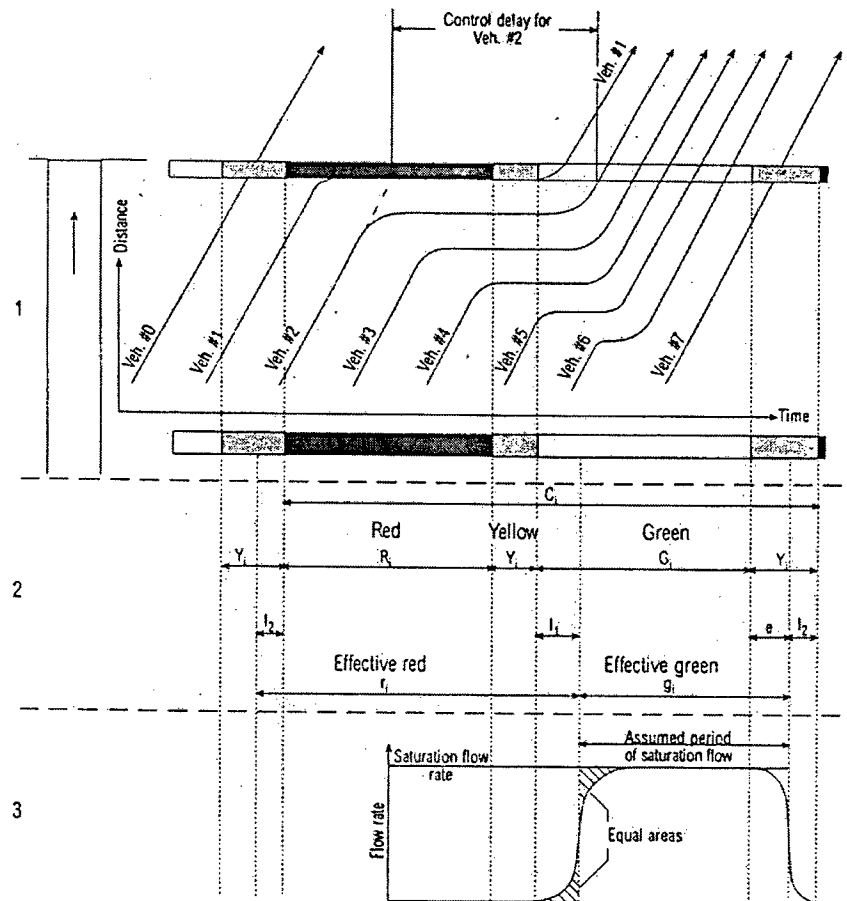


Figure 2.1: Fundamental Attributes of Flow at Signalized Intersections  
(Source: HCM 2000)

## 2.4 Traffic Signals at Signalized Intersection

Traffic signals are control devices that alternately direct traffic to stop and proceed at intersection using automatic red, yellow and green traffic lights. Typically traffic signals allocate the right-of-way among several conflicting traffic movement at intersections. The main purpose is to provide vehicular traffic as well as safety as of other users such as pedestrian. Moreover, traffic signals are usually designing to

minimize stopping time (delay) at the intersection. Traffic signals can be an effective tool for mitigating congestion on surface streets. Many countries have guidelines for the use of traffic signals. In Australia, an intersection generally may not be signalized unless it has a minimum of at least 600 veh/h over any four hours of an average day on major road and 200 veh/v or high pedestrian traffic on the minor road. Some expectation to this rule is if the intersection has a high accident rate or it is part of co-ordinated signal system (Ogden and Taylor, 1999).

In many countries, there are three modes of operation for traffic signalization: pretimed, semiactuated and fully actuated. With pretimed signalization, the cycle length, phases, green times, and change interval are determined. Different signal programs can be defined by day of the week or time of day based on anticipated traffic demand at the intersection. In fully actuated control, the signalization parameter change dynamically as traffic conditions at the interchange change. Sensors strategically placed at each intersection approach are required to monitor traffic demand. Semi actuated control is when only part of an intersection has actuated control (Transportation Research Board, 1995). This is appropriate when one street in the intersection bears the majority of the traffic through intersection. An example of this situation would be an intersection located along a major arterial providing access to a residential area or commercial parking lot.

Signalization can be done locally (i.e., at only one or a few intersection) or in co-ordination with other intersection in the area. If implemented properly, signal co-ordination can be significantly smooth traffic flow through an area, keep vehicles at a constant and ideal speed, and encourage the formation of platoons which reduce headways between vehicles, and result in more efficient use of existing capacity. Effective co-ordination requires surveillance technologies (e.g., sensors to monitor traffic condition, communication devices, and computer software and algorithms to optimize signal parameter

## **2.5 Performance of Signalized Intersection**

The performance measures of a signalized intersection can be evaluated by level of service, delay, and queue length. Each of these factors may be represented as values, which express totals or averages for the whole intersection or for individual approaches. These averages are generally expressed on a per vehicle basis. Delay, specifically the control delay is the parameter used in the signalized intersection methodology of the HCM 2000 and the primary measure used in the number of signalization optimization procedures. Performance measures are critical part of all intersection design methodologies.

### **2.5.1 Delay**

Delay in signalized intersections is related with the time lost to a vehicle and the users because of the process of the signal and the geometric and traffic conditions present at the intersection (Click, 2003). Whereas in the HCM 2000, delay is defined as the difference between the travel time actually experienced and the reference travel time that would result during ideal conditions; in the presence of traffic control, in the absence of geometric delay, in the absence of any incidents, and when there are no other vehicles on the road. There are several different types of delay that can be measured and each function has different purposes. The intersection capacity and LOS evaluation

procedures are created around the theory of average control delay per vehicle. Control delay is the segment of the total delay attributed to traffic signal operation for signalized intersections (TRB, 2000). Control delay can be categorized into acceleration