APPLICABILITY OF SIDRA FOR HETEROGENEOUS TRAFFIC

MOHAMED AHMED ABDELHADI ELSAYED

A report is submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Engineering (civil – Transportation and highway)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JUNE 2013

ACKNOWLEDGEMENT

I would like to express my sincere appreciation and thanks to my supervisor, Associate Professor Dr. Othman Che Puan, for his encouragement, guidance, critics and friendship. I am also very thankful him for his guidance, advices and motivation. Throughout this project he has been a great help to me in understanding this project. Without his continued support and interest, this final year project would not have been possible and went well.

Special thanks to Hardi for his assistance and guidance. A special thanks to my friends' Abubaker, Idres, Badreldin for their assistance during the collection of data and all my friend's Elwalid, Emad and Rami for their support, and encouragement for all days we have been together.

Last, but not least, deepest thanks to my family and parents for their continuous love, encouragements and full moral support throughout the advancement of this project.

ABSTRACT

Delay is an important factor in the optimization of traffic signals and the determination of the level of service of a signalized intersection. Various models have been developed to estimate delay to traffic at signalized intersections. All the models are based on homogeneous traffic conditions; these models may not estimate the delays satisfactorily under heterogeneous traffic conditions. The main objective of this study is to evaluate the applicability of Signalized Intersection Design Aid (SIDRA) Software which is widely used for estimating delay at signalized intersections in Malaysia. This is because SIDRA considers only two main types of vehicles, i.e. passenger car and heavy good vehicles. Traffic control delays for a range of traffic volumes and compositions were collected at a selected signalized intersection. The associated traffic volumes were used to evaluate the delay estimated by SIDRA software were compared with the corresponding delays measured at selected sites. The results show that the delay estimated by SIDRA software is higher than the observed delay. This implies that the analysis of delay for heterogeneous traffic cannot be based on existing homogeneous traffic delay models.

ABSTRAK

Kelewatan adalah faktor penting dalam mengoptimumkan isyarat lalu lintas dan menentukan tahap perkhidmatan isyarat persimpangan. Pelbagai model telah diwujudkan bagi menganggarkan kelewatan pada lalu lintas di persimpangan yang berlampu isyarat. Semua model dibuat berdasarkan keadaan lalu lintas homogen; model ini tidak boleh menganggarkan kelewatan yang memuaskan dalam keadaan lalu lintas heterogen. Objektif utama kajian ini adalah untuk menilai perisian "*Signalized Intersection Design Aid*" (SIDRA) yang digunakan secara meluas bagi menganggarkan kelewatan di persimpangan berlampu isyarat di Malaysia. Hal ini adalah kerana SIDRA hanya mempertimbangkan dua jenis kenderaan utama, iaitu kereta penumpang dan kenderaan yang baik berat. Kelewatan pada kawalan trafik untuk pelbagai jumlah lalu lintas dan jumlah dikumpulkan di persimpangan berlampu isyarat yang dipilih. Isi padu lalu lintas yang berkaitan digunakan untuk menganggarkan kelewatan menggunakan SIDRA. Hasilnya dibandingkan dengan nilai yang dicerap di lapangan. Hasil kajian menunjukkan kelewatan yang dianggarkan oleh perisian SIDRA adalah lebih tinggi berbanding kelewatan sebenar yaug dialami oleh pemandu. Hal ini menunjukkan bahawa analisis kelewatan bagi lalu lintas hetrogen tidak boleh dibuat berdasarkan model kelewatan lalu lintas homogeny sedia ada.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURE

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The traffic performance of a roadway network is greatly influenced by the traffic flow through intersections. Many types of traffic control are being used worldwide at intersections such as yield signs, stop signs, roundabouts and signals. Traffic signals are used to provide safe and efficient traffic flow through intersections, along routes and in street networks. They increase the traffic handling capacity of an intersection, reduce traffic delay and enhance safety, reduce certain types of accidents (most notably right-angle collisions), improve the orderly movement of traffic, interrupt extremely heavy flows to permit the crossing of minor movements that could not otherwise safely pass through an intersection and help in establishing a signal progression (Maryland Roads, 2003).

This importance of vehicle delay is reflected in the use of this parameter in both design and evaluation practices. For example, delay minimization is frequently used as a primary optimization criterion when determining the operating parameters of traffic signals at isolated and coordinated intersections. The Highway Capacity Manual 2000 (HCM) uses control delay as a criterion for determining the level of service provided to motorists by the traffic signals. This is because delay is a measure of performance that a driver can directly feel and react to. Moreover, both traffic professionals and the general public can easily comprehend its meaning.

The Signalized and Unsignalized Intersection Design and Research Aid (SIDRA) Software is an intersection based program developed by the Australian Road Research Board (ARRB) in Australia as an aid for capacity, timing and performance analysis of isolated intersections. SIDRA is a very powerful analytical program for signalized intersections (Bashar H. et. al (2007)). SIDRA software is used as an aid for design and evaluation of signalised intersection (fixed-time/pre-timed and actuated), roundabouts, two-way stop sign control, all-way stop sign control, and give-way (yield) sign-control.

1.2 Problem Statements

Unfortunately, the vast majority of the study has focused on developing models for estimating the mean delay and much less work has been done to quantify the variability of delay at a signalized approach. While knowing the variability of the delay has a number of useful applications, such as developing more accurate signal timing plans and providing a more complete and statistically significant comparison of different signal timing or roadway geometric improvements. Moreover, considering the variability of delay, more reliable signal control strategies may be generated resulting in improved LOS of signalized intersections (Y. Darma. et. al (2005)).

There is much traffic software that can be used for estimating delay at signalized intersections. However, traffic departments need to check the validity of these software’s before using them, especially developing countries which have very little work on the validity of these software. SIDRA software uses detailed analytical traffic models coupled with an iterative approximation method to provide estimates of capacity and performance statistics (delay, queue length, stop rate, etc). But the problem of this Sidra software is that the software deal with only two types of vehicles "heavy vehicles and passenger cars". Where in most developing countries represent motorcycles largest percentage of vehicles on the road.

In Malaysia, the influence of motorcycles should not be disregarded, traffic volume of motorcycles recorded in major cities or towns throughout Malaysia are very high and the percentage of motorcycles registered annually is approximately 41% (Highway Planning Unit, 2005).

Delays estimation at signalized intersections has been extensively studied in the literature and several methods for estimating vehicle delay at signalized intersections have been widely used. However, it seems that the exploration on the method for estimating the delay is still continuously conducted. This is may be due to the consideration of various variables which could affect the delays.

1.3 Aim and Objectives

In this study, there are three objectives to be achieved at the end, which are:

- To determine the delay based on field observation.
- To calculate the same value of the delay by using "***Sidra Software***".
- To determine the comparison between the two values and how to make modification to the resulting value of the program so that it can be used.

1.4 Importance of the study

The popularity of delay as an optimization and evaluation criterion is attributed to its direct relation to what motorists experience while attempting to cross an intersection. However, delay is also a parameter that is not easily determined; the difficulty in estimating vehicle delay at signalized intersections is also demonstrated by the variety of delay models for signalized intersections that have been proposed over the years.

Delay in the realm of signalized intersections is associated with the time lost to a vehicle and/or driver because of the operation of the signal and the geometric and traffic conditions present at the intersection (Click, 2003). The vast majority of the study has focused on developing models for estimating the mean delay and much less work has been done to quantify the variability of delay at a signalized approach. While knowing the variability of the delay has a number of useful applications, such as developing more accurate signal timing plans and providing a more complete and statistically significant comparison of different signal timing or roadway geometric improvements. As a performance measure, delay plays a critical role in evaluating levels of service at signalized and unsignalised intersections. Delay is also included, explicitly or implicitly, in the calculation of average speeds used to determine levels of service on arterial streets.

There are several different types of delay that can be measured at an intersection, and each serves a different purpose to the transportation engineer. The signalized intersection capacity and LOS estimation procedures are built around the concept of average control delay per vehicle. Control delay is the portion of the total delay attributed to traffic signal operation for signalized intersections (TRB, 2000).

Control delay (overall delay) can be categorized into deceleration delay, stopped delay and acceleration delay. Stopped delay is easier to measure, while overall delay reflects better the efficiency of traffic signal operation (Olszewski, 1993). Typically, transportation professionals define stopped delay as the delay incurred when a vehicle is fully immobilized, while the delay incurred by a decelerating or accelerating vehicle is categorized as deceleration and acceleration delay, respectively.

Various components of vehicular delay at signalized intersection, including control delay used in the HCM, are shown in Figure 1.1. below (Quiroga and Bullock, 1999). In the 2000 version of the HCM, control delay is comprised of initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay, though in earlier versions it included only stopped delay.

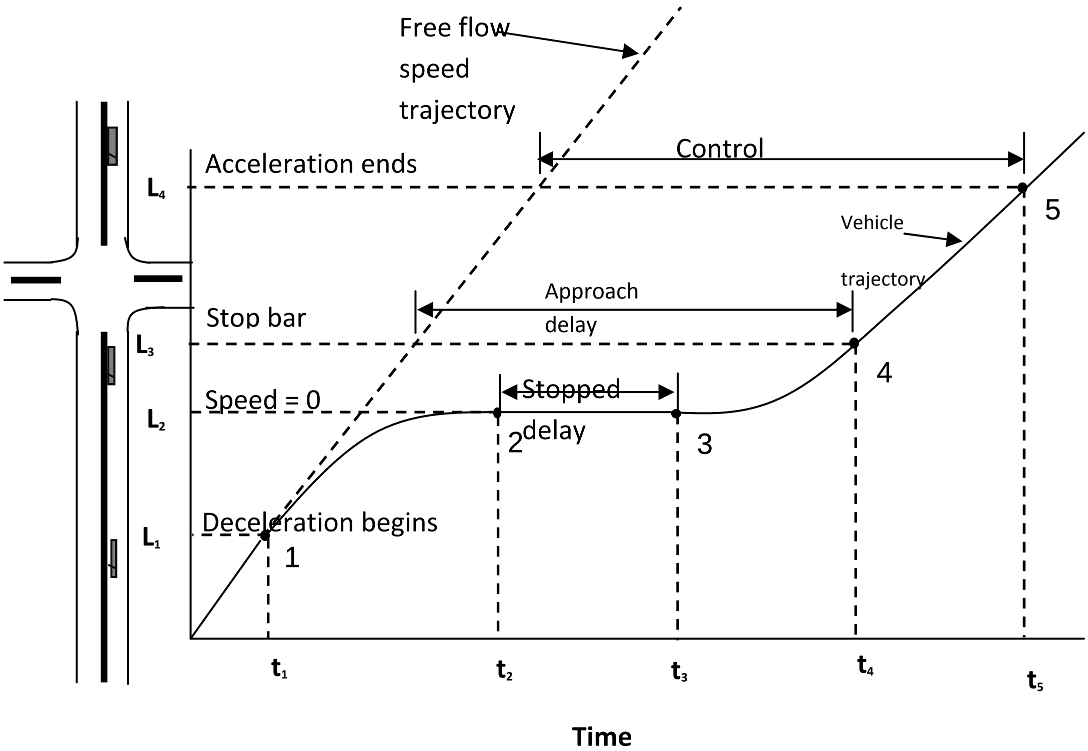

Figure 1.1: Delay Terms at a Signalized Intersection

1.5 Scope of Study

This study focus on control delay at signalised intersection, the analysis is based on an approaches delay. The Highway Capacity Manual, SIDRA software and the field measurements are used in the analysis, and the data had been collected from an intersection. There is one site study to be done which connect “Skudai-Pontion Hwy to Jalan Teratai” at a cross-section intersection in the In the adjacent part of the north-western area of Universiti Teknologi Malaysia, UTM.

REFERENCE

American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets.* Washington, D.C. 2004.

Akgungor, A. P. *A new delay parameter dependent on variable analysis periods at signalized intersections.* Part 1: Model development. Transport. Vilnius: Technika, Vol. 23, No. 1, 31-36 2008.

Arasan, V. T., and Jagadeesh, K. *Effect of heterogeneity of traffic on delay at signalized intersections. Journal of Transportation Engineering*, September/October, 397- 404 1995.

Arahan Teknik (Jalan) 11/87. *A Guide to the Design of At-Grade Intersection.* Jalan Kerja Malaysia (1987).

Bashar H. Al-Omari, Madhar M. Ta'amneh *Validating HCS and SIDRA Software for Estimating Delay at Signalized Intersections in Jordan,* Jordan Journal of Civil Engineering, Volume 1, No. 4, 2007.

Chu Cong MINH, Tran Hoai BINH, Tran Thanh MAI, Kazushi SANO. *The Delay Estimation under Heterogeneous Traffic Conditions*, Journal of the Eastern Asia Society for Transportation Studies, Vol.7, 2009.

Click, M., Variables Affecting the Stopped to Control Delay at Signalized Intersection, TRB 2003 Annual Meeting, 2003.

DIANA ANAK GARY GERISAH. *Passenger Car Equivalency of Motorcycle at the Roundabout.* Faculty of Civil Engineering Universiti Teknologi Malaysia 2011.

D.X. Cheng, et al. *Modification of Webster's Minimum Delay Cycle Length Equation Based on HCM 2000*. Transportation Research Board, Washington, D.C., 2003.

Hardi S. F. Effect of Skewness on Delay at signalised Intersection, Faculty of Civil Engineering Universiti Teknologi Malaysia 2013.

Hanna, J. T., & Webb L.T. *Characteristics of Intersection Accidents in Rural Municipalities*. Transportation Research Record, 601, TRB, Washington D.C. 1976.

Olszewski, P., *Overall Delay, Stopped Delay, and Stops at Signalized Intersections*, Journal of Transportation Engineering, Vol. 119, No. 6, pp. 835-852, 1993.

Transportation Research Board, National Research Council, *Highway Capacity Manual (CD-ROM), Version 1.0,* Washington, D.C., 2000.

Teply, S., *Accuracy of Delay Surveys at Signalized Intersections*, Transportation Research Record 1225, TRB, National Research Council, Washington, D. C., 1989.

Maryland Roads. 2003. Traffic Signs and Signals, http://www.Marylandroads.com.

McShane, W.R & Roess, R.P. *Traffic Engineering*. Third Edition United States Prentice-Hall, Inc., 2004

Olszewski, P. Overall delay, stopped delay and stop at signalized intersections. Journal of Transportation Engineering, Vol. 119, No. 6, 835- 842, 1993.

Park, B., Kamarajugadda, A. D. (2003) Estimating Confidence Interval for Highway Capacity Manual Delay Equation at Signalized Intersections. CD-ROM. Transportation Research Board of the National Academies, Washington, D.C.

Quiroga, C. A., and Bullock, D. (1999), Measured Control Delay at Signalized Intersections, Journal of Transportation Engineering Vol. 125 No. 4.

Transportation Research Board. Chapter 16: Signalized intersection. Highway Capacity Manual. National Research Council, Washington, D.C., U.S.A. (2000).

Webster, F. V. (1958) Traffic Signal Settings. Road Research Laboratory Technical Paper No. 39, HMSO, London, U.K.

Y. Darma, M. R. Karim, J. Mohamad, S.Abdullah (2005), Control Delay Variability At Signalized Intersection Based On Hcm Method, the Eastern Asia Society for Transportation Studies, Vol. 5, pp. 945 - 958, 2005.

Y.S. Kang. Delay, Stop and Queue *Estimation for Uniform and Random Traffic Arrivals at Fixed-Time Signalized Intersections.* Faculty of the Virginia Polytechnic Institute and State University, 2000.