The Analysis on the Performances of Signalised Intersection at Taman Tas

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ABSTRACT

Malaysia is one of the developing countries in the world. Currently, Malaysia is taking into a massive fast track development so is the change in traffic conditions in this country. The operating characteristics of this system are functionally dependent upon the amount of types of users that require services. This is especially true at that point where elements of the system come together that is the intersection. The Malaysian citizens like to have their own transport and creating typical travel behaviour compare with other countries. When traffic volumes increase or change their nature, it is usually the intersection that first proves itself incapable of serving the added or altered demand. Consequently, congestion will increase during peak hours and causes delays. Therefore, signalised intersections are an important part of road system in Malaysia. The signalised intersection at Taman Tas has come to an alert for traffic engineers to come in and analysed the cause of delay and find a solution of ease the delays during the peak hour traffic. Hence, this study is made in order to analyse on the performances of the signalised intersection in terms of Level of Service and delays. After the study is made and the results of the Level of Service are obtained, an alternative solution is proposed in the data analysis to reconstruct the existing signalised intersection.

ABSTRAK

Malaysia merupakan salah satu negara yang sedang membangun standing dengan negara yang maju di dunia. Malaysia kini berada pada tahap kemajuan pada masa sekarang sama juga dengan keadaan trafik yang mengakibat kesesakan jalan raya di negara ini. Sistem ini beroperasi mengikut bilangan dan jenis pengguna jalan yang sangat memerlukan kemudahan jalan raya seperti persimpangan trafik. Semua pengguna jalan raya di Malaysia memilih untuk memiliki kenderaan sendiri dan mempunyai sifat-sifat tersendiri ketika memandu di jalan raya berbanding dengan pengguna jalan raya di negara lain. Apabila kenderaan telah meningkat secara mendadak di negara ini, persimpangan trafik merupakan sistem yang dapat mengawal bilangan kenderaan yang melalui setiap persimpangan. Kesesakan jalan raya selalunya berlaku pada masa waktu bekerja pada waktu pagi dan masa balik dari kerja pada waktu petang. Oleh sebab itu, persimpangan trafik merupakan kemudahan jalan raya yang sangat penting di Malaysia. Akan tetapi, persimpangan trafik di Taman Tas Kuantan adalah berada pada tahap yang membimbangkan semua pihak iaitu pengguna jalan raya. Bilangan kenderaan yang melalui persimpangan tersebut telah menyebabkan kesesakan yang sangat membimbangkan. Oleh sebab itu, kertas kerja ini adalah untuk menyelidik keadan LoS di persimpangan tersebut. Selepas mendapat keputusan LoS tersebut, maka proses penyelesian akan diberi dalam kaji selidik ini untuk meningkatkan LoS di persimpangan tersebut.

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INTRODUCTION

1.1 Background of Study

Malaysia is one of the developing countries in the world. Currently, Malaysia is taking into a massive fast track development so is the change in traffic conditions in this country. The operating characteristics of this system are functionally dependent upon the amount and types of users that require service. This is especially true at that point where elements of the system come together that is the intersection. The Malaysian citizens like to have their own transports and creating typical travel behaviour compare with other countries. When traffic volumes increase or change their nature, that is increase in the number of heavy vehicles like big trucks and buses, it is usually the intersection that first proves itself incapable of serving the added or altered demand. Consequently, delay will increase during peak hours traffic. That is theoretically and practically logical because the intersection is a concentrated conflict point which generally functions at a lower capacity and level of service than any of the road segment it serves (Arahan Teknik Jalan 11, 1987). Therefore, signalised intersections are an important part of road system in Malaysia. Efficient traffic networks enable all sorts of people to reach their destination faster, and ensure a good and safe transportation road system. Their capacity controls the volume of traffic within the network system (Arahan Teknik Jalan 11, 1987). It acts as a bottleneck to the satisfactory operation of the adjacent highway system. Thus, a detailed

study on the performance of the signalised intersection can be conducted to assess the effectiveness of an intersection based on local traffic condition.

Kuantan is the state capital of Pahang, the largest state in Peninsular Malaysia. It is situated at the east coast of Malaysia near the mouth of the Kuantan River and faces the South China Sea. Kuantan-Gambang by-pass is the road connecting Gambang to Kuantan and vice versa. The increasing numbers of road users coming to kuantan from various places like Kuala Lumpur, Temerloh, Karak, Bentong, Terengganu, Segamat, and Johor have contributed in the arising of transportation activity.

Taman Tas is a small residential area. It is located at 15 kilometers from Kuantan. Basically, Taman Tas consists of facilities like shop-houses, mini-supermarket, petrol station, food stalls, banks, school, bus stop, and taxi stand. The road connecting to this residential area is Kuantan-Gambang by-pass. At Taman Tas, there is a three-legged signalised intersection or T-Junction. This junction is very busy during peak hour traffic. The traffic delay that occurs at the Taman Tas intersection varies significantly when the traffic demands increases every year. The main factor contribute to the delay is that the population in that area is growing significantly.

1.2 Study Objectives

- To analyse the performances of a signalised intersection based on local traffic conditions in terms of LoS.
- To provide a satisfactory operating performance prior to the actual condition.

1.3 Problem Statement

Nowadays, the road connecting to Kuantan and Gambang and vice versa is very congested during peak hours. The road is categories as 2-way-2-lane road. Upon reaching the signalised intersection at Taman Tas, it becomes a multi-lane intersection. The condition of the traffic is measured by Level of Service. Generally, the Level of Service (LoS) is used to measure the efficiency of traffic flow through intersections, along routes, and in road network. The LoS on the existing road will become worsen by the increasing amount of vehicles passing through that signalised intersection.

The signalised intersection might not give any adequate or optimum signal timing when it is practically operating in real situation. Problems such as inadequate given limit with respect to the traffic volume can cause the traffic delay. Therefore, there is a need to begin to perform study on the existing intersection based on the LoS, and delays enable us to categories the efficiency of the signalised intersection in order to improve the performance of the existing signalised intersection.

1.4 Scope of Study

Generally, the scope for this study is to analyse the performances of the signalised intersection at Taman Tas intersection. Basically, this study would cover until the determination of LoS and delays of peak hour traffic. The parameters such as number of lanes, vehicles volume, saturation flow rate, saturation degree, cycle length, and level of service are included in this study. Signal control data such as signal phasing and cycle time will be observed throughout the collection of data on site.

In this study, traffic volume count will be done manually. Due to time constrained, the traffic volume count study is conducted on one Wednesday, 3rd March 2011, during the morning peak traffic hour from 7.00 a.m. to 9.00a.m and evening peak hour from 5.00 p.m. to 7.00 p.m. will be observed and analysed. The data is then used as input in the Microsoft Excel spreadsheets as a simple method to analyse the performances of the intersection controls.

1.5 Significant of Study

The results obtained from this study might be useful in finding solution to improve the LoS from the current condition for the years to come as well as to improve the traffic operation at Taman Tas intersection to ease the traffic delays. This will definitely benefit to all users passing through Taman Tas signalised intersection as well as the residents who live in the neighbourhood in Taman Tas and future growth of the population in Kuantan.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter contains literature reviews, which discuss about the signalised intersection, traffic signals, delays, analysis of signalised intersection, and level of service. Basically, the basic types of at-grade intersections, three-legged intersections, which consists of three approaches; four-legged or cross intersections, which consists of four approaches, and multi-legged intersections, which consists of five or more approaches according to Garber N. J. and Hoel L. A. (2002). Traffic signal controls most of the power-operated devices except signs either mechanically or electrically. However, this study will only improve the signalised intersection by taking into account the saturation flow rate, saturation degree, cycle length and LoS based on Malaysian Highway capacity Manual and JKR standard. The findings of this research have leads us to realise that there are some factors contributing to the saturation flow of our roads thus affecting the intersection capacity.

2.2 Traffic Signal

Garber N. J. and Hoel L. A. (2009) said that one of the effective ways of controlling traffic at intersections is the use of traffic signals. Basically, traffic signals can be used to eliminate many conflicts because different traffic streams can be assigned the use of the intersection at different times. Rogers M. (2008) explained that traffic signals work on the basis of allocating separate time periods to conflicting traffic movements at a highway intersection so that the available carriageway space is utilised as efficiency and safety as possible.

2.3 Types of Signal

There are few types of traffic signals used to control the inter-crossing movement at intersections. Those popular systems are pre-timed/fixed-time system, actuated system and traffic adjusted system. The types of traffic signals can be found in Arahan Teknik (Jalan) 13/87 of a guide to the design of traffic signals.

2.3.1 Pre-timed/Fixed-time Signalised System

Arahan Teknik (Jalan) 13/87 stated that this type of signal directs traffic to stop and permits it to proceed in accordance with a single, pre-determined time schedule or a series of such schedules. Besides, Arahan Teknik (Jalan) 13/87 also said that the traffic signal is set to repeat a given sequence of signal indication regularly. In other word, this type of traffic signal is a system where the time frame of green period and the cycle time

is determined at the beginning stage during the installation of traffic light. Even though indication of each colour of signalised traffic is constant, it can vary due to different circumstances.

2.3.2 Traffic-actuated Signalised System

Arahan Teknik (Jalan) 13/87 mentioned that the operation of this type of signal is varied in accordance with the demands of traffic. According to Arahan Teknik (Jalan) 13/87, the green light period for one particular way is dependent on the traffic density on the particular route or direction. Besides, Arahan Teknik (Jalan) 13/87 explained that the sensor or other advanced devices will be installed at each arms of road that joined at the intersection area. Through this system, the indication of green light for one phase will be continued until there is traffic (detected by automatic sensor) from the following phase.

2.3.3 Traffic-adjusted System

Arahan Teknik (Jalan) 13/87 said that traffic-adjusted system is an advanced system that using the latest technology to control the network of a few signalised intersections at one centralised centre. This type of traffic system is more complicated and complex thus high-skilled technician or operator will be needed to run the system. Arahan Teknik (Jalan) 13/87 also explained that the controlling and detecting devices will be placed at the transportation network system so that the centralised control room can always obtain the real time information. The operation of the signalised intersection will be modified from time to time in order to suit the current traffic condition.

2.4 Traffic Signal Control

Arahan Teknik (Jalan) 13/87 stated that signal control is to provide a safe and efficient traffic flow through intersections, along routes and in road networks. Arahan Teknik (Jalan) 13/87 and Garber N. J. and Hoel L. A. (2009) described the primary purpose of traffic signal control is to assign the right of way for alternate roads or road of approaches in order to maximize capacity, minimize delay, reduce conflicts, and facilitate safety by ensuring the orderly and predictable movement of all traffic on the intersection. Garber N. J. and Hoel L. A. (2009) explained that the signal control may be achieved by using traffic signals, sign, or marking that regulate, guide, warn, and/or channel traffic.

2.5 Signal Display and Location

Arahan Teknik (Jalan) 13/87 explained the two fundamental principles that must be carefully considered to serve its intended purpose in directing and regulating traffic flow that is the conspicuity and clarity. Arahan Teknik (Jalan) 13/87 defined conspicuity as the signal must not only visible, but must be obvious to the eye and attract attention. Arahan Teknik (Jalan) 13/87 also defined clarity as the message or direction given can be easily understood. In other words, the signal must be seen in order for the driver to react and the required action must be obvious.

2.6 Signal Display Requirement

According to Arahan Teknik (Jalan) 13/87, For the driver to respond effectively to the traffic signal, these basic requirements have to be considered.

- The amount of light reaching the driver's eye.
- The position of the signal in the driver's field of view.
- The ratio of the signal in the driver's field of view.
- The ratio of the signal-to-background contrast.
- The amount of competing information sources (visual clutter or "noise").
- The degree to which the appearance of the signal is expected.
- The degree to which the precise location of the signal is known.
- The degree to which the message conform to the driver's knowledge and expectations.

2.7 Geometric Design of Signalised Intersections

Generally, Joe G. B. (2005) mentioned about the geometric design of signalised intersections that covers channelisation principles, number of intersection approaches, intersection angles, horizontal and vertical alignments, corner radius and curb ramp designs, detectable warnings, access control, sight distance, pedestrian facilities, and bicycle facilities. Besides that, Joe G. B. (2005) explained that the geometric design also includes making evident points of potential conflict in an intersection, particularly those involving vulnerable road users and offering the approaching road users a clear view of one another.

Joe G. B. (2005) also mentioned that the design influences roadway safety, shapes the expectations of road users, and defines how to proceed through an intersection. However, Joe G. B. (2005) proved that the design can facilitate desired vehicle and pedestrian actions by discouraging undesirable movements, defining appropriate paths for vehicles, encouraging safe speeds, helping separate points of conflict, facilitating the movement of high priority traffic flows, providing safe refuge, and offering way-finding clues for road users.

Joe G. B. (2005) stated that the primary goal of intersection design is to limit the severity of potential conflicts among road users. Besides, Joe G. B. (2005) also explained about the geometric design concept that the intersection channelisation that is used to reduce conflicts employ such techniques as raised, medians to traffic islands to discourage wrong-way turns and undesirable movements. Furthermore, Joe G. B. (2005) also described the alternative usage of channelisation techniques such as pavement marking to delineate desirable vehicle paths.

2.8 Traffic Control and Analysis at Intersections

Mannering, F. L. (2009) described that roadway intersections are a source of great concern to traffic engineers. Mannering, F. L. (2009) explained that intersections can be a major source vehicles delays as vehicles yield to avoid conflicts with other vehicles. Mannering, F. L. (2009) also explained that a poorly timed signal or one that is not justified can have a negative impact on the operation of the intersection by increasing vehicle delay, causing a disruption to traffic progression which is adversely impacting the through movement of traffic, and encouraging the use of routes not intended for through traffic such as routes through residential neighbourhood.

2.9 Signalised Intersection

Mannering, F. L. et al. (2009) defined an intersection as an at-grade crossing of two or more roadways. Joe G. B., (2005) mentioned that signalised intersection is a key component in improving the safety and efficiency of intersections. A proper design of the intersection would increase the level of service of a signalised intersection to a better level. Joe G. B., (2005) explained that traffic engineers need to consider a variety of elements when designing a system for signalisation at an intersection. Joe G. B., (2005) said that one factor is the type of control, either pre-timed signal that operates with a fixed cycle length or an actuated signal that varies the length of the green light based on traffic demand.

The development of a signal timing plan should address all user needs at a particular location, including transit vehicles, emergency vehicles, automobiles, and trucks. In general, the Arahan Teknik Jalan 13/87 recommends that the optimum cycle lengths/time for conventional, four-legged intersections is between 120 second to 140 second.

Another design element is signal phasing (Joe G. B., 2005). A signal phase is the interval of time allotted for green, yellow, and red in a traffic movement cycle (Joe G. B., 2005). Signal phasing is the sequence of individual phases in a cycle that defines the order in which road users have the right-of-way to move through the intersection (Joe G. B., 2005).

2.10 At-grade Intersection Characteristics

AASTHO (2001) introduced four basic elements that enter into design considerations of at-grade intersections which are the human factors, traffic considerations, physical elements, and economic factors. However, Jha M.K. et al. (2001) explained that those mainly affecting alignments are vehicle speeds, vertical alignments at the intersection that is the differences between an existing road and new road, angle of the intersection, geometric features like topography of the site and cross sections, design hourly turning movement with additional lane needed for turning volumes, and sight distances.

2.11 Capacity of Intersections

The term capacity of an intersection refers to the ability of a roadway to accommodate traffic (REAM, 2002). It is defined as the maximum number of vehicles that can pass over a given section of a lane or a roadway during a given time period under prevailing roadway and traffic conditions (REAM, 2002). Generally, major intersections, signalised intersections, or unsignalised intersections will determine the overall capacity and performance of the road network (Arahan Teknik Jalan 11/87, 1987). Significantly, channelisation and intersection control can control and lessen the volume of crossing or turning traffic at minor roads which will cause interruptions and capacity reductions (Arahan Teknik Jalan 11/87, 1987). The capacities of intersections are very important and to achieve balance, the intersection design should take into account the capacity of the approach roads (Arahan Teknik Jalan 11/87, 1987).

Generally, the capacities of signalized intersections are determined by a long list of determinants (Xiaoming et al., 2009). According to Xiaoming et al., (2009) mentioned that the determinants include not only deterministic factors like the geometric and signalized conditions, but also random effects such as differences in traffic composition, random driver behaviour, and the resulting random intersections between vehicles.

Arahan Teknik Jalan 13/87 suggested that traffic engineers must design the intersection so that the intersection will not be fully utilized till its full capacity. Thus, engineers must gather all the information from the capacity analysis so that they can design the intersections based on the given information. The engineers will upgrade the existing intersections by considering the long queue of the traffic volume during peak hours. The engineers must design the existing intersections capacity.

2.12 Analysis of Traffic at Signalised Intersections

2.12.1 Saturation Flow Rate

Garber N. J. and Hoel L. A. (2009) defined the saturation flow rate as the maximum flow rate on the approach or lane group that can go through the intersection under prevailing traffic and roadway conditions when 100 percent effective green is available. Garber N. J. and Hoel L. A. (2009) explained that the concept of saturation flow or saturation flow rate (s) is used to determine the capacity of a lane group. Garber N. J. and Hoel L. A. (2009) also mentioned that the saturation flow rate is given in units of veh/h of effective green time.