

**COMPARATIVE ANALYSIS OF LEVEL OF SERVICE (LOS) UNDER
VARYING LIGHTENING CONDITIONS**

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To my beloved mother and father

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ABSTRACT

Delay estimation at a traffic signal is required in assessing signal performance and operating conditions of an intersection. Delay indicates the amount of time spent at a traffic signal in waiting until the discharge of traffic. Previous studies have accounted for delay estimation (of a minor arm) under the day light conditions only. However, this study attempts to study the delay and subsequently level of service (LOS) in both natural light (day light) and artificial light (road light) condition. This study was carried out to perform comparative analysis of level-of-service (LOS) under varying lightening conditions at a signalized intersection located at Lebuhraya Skudai-Pontian (principal road) and Jalan Seri Pulai (collector road). Traffic Volume, Cycle Time, Intersection Geometric Elements and Headway Data were collected during off-peak periods of day light and road light. The collected data were further analyzed and chi-square test was conducted to differentiate the results of survey under varying lightening conditions. The results showed lighting conditions do not have distinctive differences in the level-of-service (LOS) and the effect of road light on level-of-service (LOS) is insignificant.

Key words: Traffic signal, road lighting, delay, level of service (LOS)

ABSTRAK

Anggaran kelewatan pada isyarat lalu lintas adalah diperlukan dalam menilai prestasi isyarat dan beroperasi dengan syarat satu persimpangan. Kelewatan menunjukkan jumlah masa yang dihabiskan pada isyarat lalu lintas di menunggu sehingga menunaikan lalu lintas. Kajian sebelum ini telah diambil kira untuk anggaran kelewatan (lengan kanak-kanak) di bawah keadaan cahaya hari sahaja. Walau bagaimanapun, kajian ini cuba mengkaji kelewatan dan kemudiannya tahap perkhidmatan (LOS) di kedua-dua cahaya semula jadi (hari cahaya) dan cahaya buatan (lampu jalan) keadaan. Kajian ini telah dijalankan untuk melaksanakan analisis perbandingan tahap perkhidmatan (LOS) di bawah yang berbeza-beza mencerahkan syarat-syarat di persimpangan signalized yang terletak di Lebuhraya Skudai-Pontian (jalan utama) dan Jalan Seri Pulai (pemungut jalan). Volum trafik, Masa Kitaran, Elements Intersection Geometric dan Data Headway dikumpulkan semasa tempoh puncak cahaya hari dan cahaya jalan. Data yang dikumpul terus dianalisis dan ujian khi-kuasa dua telah dijalankan untuk membezakan hasil kaji selidik di bawah mencerahkan syarat-syarat yang berbeza-beza. Hasil kajian menunjukkan keadaan pencahayaan tidak mempunyai perbezaan yang tersendiri dalam peringkat-perkhidmatan (LOS) dan kesan cahaya jalan raya pada tahap perkhidmatan (LOS) adalah kecil.

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LIST OF ABBREVIATIONS

| | | |
|-----|---|---|
| LOS | - | Level of service |
| PCE | - | Passenger car equivalents |
| PCU | - | Passenger car unit |
| HCM | - | Highway Capacity Manual |
| DOS | - | Degree of saturation |
| V/c | - | Flow rate of capacity ratio or volume to the capacity ratio |
| g/C | - | Rate of green effective to cycle time |

LIST OF SYMBOLS

| SYMBOLS | UNIT | ITEM |
|------------|---------|---|
| q | pcu | Flow |
| H | sec | Headway |
| S | pcu/hr | Saturation flow rate |
| L | sec | Loss time |
| C_o | sec | Optimum cycle time |
| c | pcu/hr | Capacity |
| d | sec/veh | Delay |
| O | sec/veh | Observed delay |
| E | sec/veh | Estimated delay |
| W | m | Lane width |
| l_{sl} | s/phase | Start-up lost time |
| Δ_i | sec | Incremental headway |
| T_n | sec | Green time required to move queue of “ n ” vehicles through a signalized intersection |
| T_3 | sec | Time for first 3 cars to clear the stop bar, including headway for each |
| T_{13} | sec | Time for first 13 cars to clear the stop bar, including headway for each |
| n | veh | Number of vehicles in queue |
| t_L | sec | Total lost time per phase |
| Y | - | Ratio of flow to saturation flow |

| | | |
|-------|---------|--|
| g_n | sec | Effective green time of the n th signal phase |
| Y_n | - | Calculated Y-value of the same signal phase |
| g | sec | Average effective green time |
| d | sec/veh | Average stopped delay per vehicle for the lane or lane group of interest |
| G | sec | Displayed green time |

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CHAPTER 1

INTERODUCTION

1.1 Introduction

The aim of this study is to compare the delay and level of service (LOS) of a signalized intersection located at Lebuhraya Skudai-Pontian (principal road) and Jalan Seri Pulai (collector road) under varying lightening conditions. The intersection has 3 stages that the vehicles move through it. For evaluating the quality of the intersection, the performance of it in day light and in road light conditions should be considered. Delay and level of service (LOS) which are some comparative indicators using to assess the performance of signalized intersection. Road lighting is one of the environmental conditions influencing on these indicators and respectively performance of signalized intersection. These comparative indicators are that so way conducted during the day light and road light conditions. Road lighting itself means whether in the night (artificial light), it has any impact on the delay and level of service (LOS).

Many researchers have studied the effect of road lightening on motorways. (Al-Kaisy& F. L. Hall, 2000) testified that generally there is a slight decline in the capacity of one of motorways in Canada during road light condition. Any research, which indicates the relationships between day light and road light conditions; particularly at a

signalized intersection, was not found. In our study, based on logical attitudes towards understanding these relationships, due to varying lightening condition it is expected that there must be a variation in headways and saturation flows. In terms of delay and level of service (LOS), which will be found subsequently in the bearer intersection, the relationships can be established.

1.2 Statement of the problem

The varying lightening conditions during day light (natural light) and road light (artificial light) affect on the delay and consequently, the level of service (LOS) at traffic signal. Therefore, the relationship between the lightening conditions at the different time in day and its effect on delay needs to be further investigated.

1.3 Hypotheses

The hypothesis of this study is there will be differences in delay and consequently, in level of service (LOS) under day light and road light conditions at the study intersection.

1.4 Aims and objectives

The aim of study is to compare and analyze the level of service (LOS) under varying lightening conditions. In order to achieve the aim the following objectives are desired:

- To determine delay under varying conditions of lightening- daylight and road lighting conditions.
- To determine level of service (LOS) under daylight and road light conditions.
- To compare the delay and level of service (LOS) for both road lightening conditions.

1.5 Scope and limitation of the project

In this study, the microscopic level of observations and analysis are conducted.

This study is limited to:

- The urban area
- The study intersection
- The prevailing road condition
- The prevailing environmental condition
- The day light (natural light) and road light (artificial light)
- The off peak periods only

The area of this study is a signalized intersection at Jalan Seri Pulai and Lebuhraya Skudai-Pontian as it has shown in the Figure below.

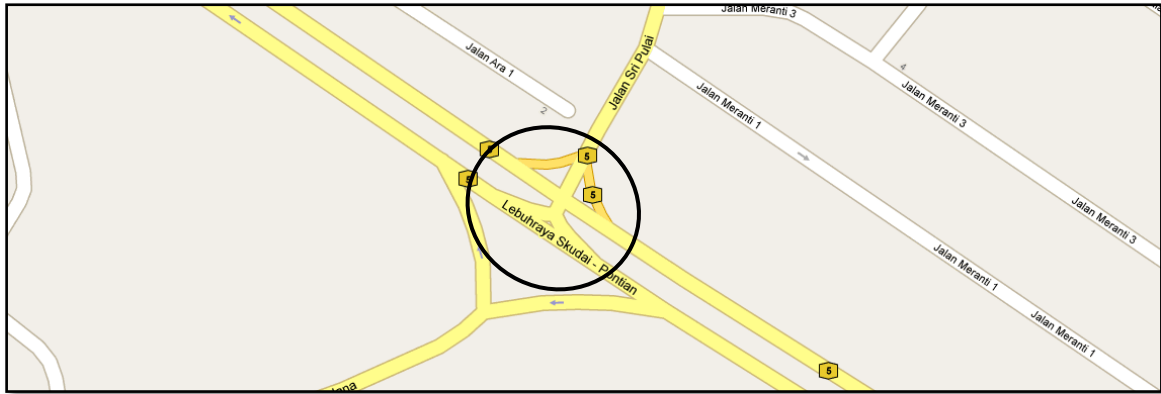


Figure 1.1: Study area

1.6 Importance of the study

There is no previous studies have been able to establish the relationship between day light and road light conditions, consider the delay and level of service (LOS). The outcome of this study shows that whether the performance of the intersection is similar the road light condition. The same effect on level of service (LOS) would depict that there is no variation due to varying lightening conditions. Furthermore, it would suggest several solutions to solve these problems. For example, improving the geometrics of the intersection, operating the signal based on new signal timings which signal timing is different during the day and finally changing power of the light that is related to the electric engineer and out of scope of traffic engineering.

1.7 General outline of research methodology

Methodology of study describes the steps to conduct this study in order to achieve its aims and objectives. This study starts with the identification of the current

issue (problem statement) concerning the traffic. After the problem statement has been identified, the objectives and scope of study are determined. Subsequently, based on the objectives of study, literature review is collected from variance data sources. Study method is formulated based on requirement and scope of the study. This study continued with site collection data. Demand flow was collected through equipments studies also cycle time, actual green length, and saturation headway collected. Moreover, after all data analyzed, the actual delay and estimated delays compared and evaluated. Finally, the comment and conclusion made based on the result and analysis obtained.

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