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Outflow of traffic from the national capital Kuala Lumpur to the north, south and east coast highways using flow, speed and density relationships

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ABSTRACT

The functional relationships between flow (veh/km), density (veh/h) and speed (km/h) in traffic congestion have a long history of research. However, their findings and techniques persist to be relevant to this day. The analysis is pertinent, particularly in finding the best fit for the three major highways in Malaysia, namely the KL-Karak Highway, KL-Seremban Highway and KL-Ipoh Highway. The trans-logarithm function of density—speed model was compared to the classical models of Greenshields, Greenberg, Underwood and Drake et al. using data provided by the Transport Statistics Malaysia 2014. The results of regression analysis revealed that the Greenshields and Greenberg models were statistically significant. The trans-logarithm function was also tested and the results were nonetheless without exception. Its usefulness in addition to statistical significance related to the derived economic concepts of maximum speed and the related number of vehicles, flow and density and the limits of free speed were relevant in comparing the individual levels of traffic congestion between highways. For instance, KL-Karak Highway was least congested compared to KL-Seremban Highway and KL-Ipoh Highway. Their maximum speeds, based on three lanes carriage capacity of one direction, were 33.4 km/h for KL-Karak, 15.9 km/h for KL-Seremban, and 21.1 km/h for KL-Ipoh. Their corresponding flows were approximated at 1080.9 veh/h, 1555.4 veh/h, and 1436.6 veh/h.

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1. Introduction

Commuting traffics in the Federal Territory of Kuala Lumpur and the Klang Valley in general, are worsening every day despite efforts on speed-up fast lanes at the highway tolls. The Smart Tag and Touch-n-Go, in addition to several ordinary lines have been replicated but congestion continues to persist. Alternative models of transportation including light rail-transit, commuter and fast track lanes to help self-driven automobiles from congestion had already been implemented. On the supply side, these are the priority agendas of transport policy to ease traffic congestion. The problem of traffic congestion around the Klang Valley is escalating its impact to the other major cities in Malaysia. On the demand side, at least two reasons are relevant for this problem. First, the automobile industry is soaring every year with new and attractive models. The industry and its technology are past developing due to competition on the global business with the major producers in 2014 in China (23,722.8 thousands units), the United States of America (11, 660.7 thousands units), Japan (9774.6 thousands units), Germany (5907.5 thousands units) and South Korea (4524.9 thousands units) (OICA, 2015). Malaysia's total production was 596.6 thousands units. It was not in the list of big players for it is a small country. Increased urban population, higher per capita income and availability of credit for automobile purchases enable people to own cars (Almselati et al., 2011). Second, trade and economic activities in the country are booming and land transports like trailers, trucks carrying heavy shipments of timbers, petroleum and merchandised goods, and commercial vehicles are common scenarios on the highways.

This study will focuses on the traffic flow on the three major highways starting from Kuala Lumpur (KL) to the east coast, southern and northern states of the country, namely the KL-Karak Highway, KL-Seremban Highway and KL-Ipoh Highway known as part of North–South Expressway. The lengths of these specific surveyed highways were 19, 8.1, and 12.1 km, respectively (Ministry of Transport, Malaysia). With reference to statistics of one direction traffic flow for 2013, the average daily traffic for KL-Karak were 147.4 thousands, 206.1 thousands for KL-Seremban, and 253.2 thousands for KL-Ipoh. The growth rates for the five-year period of 2008–2013 were estimated at 1.3 percent, 2.2 percent and 9.5 percent, respectively. Evidently the KL-Ipoh Highways had illustrated a dramatic upsurge in the total number of traffics commuting to the northern regions over the last five years while traffics traveling to the east coast was the lowest. The east coast regions are less developed compared to the west coast areas by comparing the volume of traffics on the North–South Expressway.

The salient issue associated with traffic congestion is the problem of environmental degradation and the health deterioration of the society at large due to increased carbon dioxide emission. Carbon dioxide emission caused by traffic congestion is an external cost to the society which should be accounted by the automobile industry. In addition to the private cost, the social cost that the society bears in terms of the polluted air, environmental degradation, the worsening of health and productivity, will subsequently increase industrial cost. A higher cost normally leads to a reduction in the industry automobile that could ease traffic congestion.

The other pertinent issue associated with traffic congestion and directly felt by the commuters is the loss of time causing delay to reach the destination. Delay due to traffic congestion is unpredictable and the worse congestions occur following fatal accidents. The sharp increase in number of vehicles contributes to congestion problem and the probability of the automobile accidents. Several studies would be interested to know how much commuters are willing to pay for avoiding traffic congestion by internalizing the cost of congestion to the responsible commuters. The demand for a reduction in traffic congestion reflects the consumer's awareness for the improved condition of highway service.

The study is a part of the internalization of congestion cost survey using the contingent valuation methods (CVM) conducted in November–December 2014. The current investigation is deemed complementary to the results of the above survey and can be utilized inter alia with its findings. Specifically, the objective is to establish the functional relationship between traffic flow measured in vehicles per hour and the mean-speed measured in kilometers per hour to estimate the maximum speed (v_M) and maximum flow (q_M) for comparative analysis about their degree of congestion. An estimate of density measured in vehicles per km versus speed (km/h) using various functional forms that fit Malaysia traffic characteristics in relation to the theoretical traffic congestion models estimated earlier by pioneer researchers in this field. The classical traffic congestion models were applied to the Malaysian case hoping that useful parameters and specific concepts of interest derived from the analysis can be inferred. The trans-logarithm (interchangeably used as trans-log) models will be compared with these classical models in terms of their statistical robustness in explaining the current analysis of traffic data relating to the traffic congestion of the selected highways.

2. Literature review

Several investigations have been conducted in Malaysia pertaining to problem of traffic congestion primarily related to the issues that are pertinent to the ongoing problems encountered by the highway commuters. One of the congestion hypotheses is that commuters prefer private automobiles to the public transport, specifically buses. Thus any study on public transport service and consumer satisfaction may shed light on the issue (Hamzah and Azli Ayub, 2015; Ismail et al., 2012). Hamzah and Azli Ayub revealed that the value invested by the service providers instead of their quality and reputation was the major influence on consumer satisfaction. The public transport service can never be claimed efficient in terms of value of time punctuality due to traffic congestion. Mahirah et al. (2015) investigated highways users' willingness to pay to reduce traffic congestion. The value of willingness to pay was estimated in terms of the highway's toll ticket. Assessment of traffic noise had also been investigated as a result of traffic congestion (Aziz et al., 2012). The noise level was higher during the peak hours particularly towards the afternoon and the sound pressure levels (SPLs) had shown a significant correlation with the distance from the highway areas. With