Land Use and Transport Interaction

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ABSTRACT

Traffic congestion is one of the major problems in most cities around the world especially for developing country like Malaysia. One of the main causes of traffic congestion is the change in land use patterns where a new development will increase the amount of traffic generated. Increase in traffic volume can in turn influence future land use patterns. This relationship is called the land use transport interaction. This paper proposes a study on the travel corridor created by the building of the second Penang Bridge and the expected land use transport interaction due to the presence of the bridge. A review of previous studies regarding the impact of land use development on traffic and vice versa is made to establish the relevant parameters necessary for understanding the second Penang bridge travel patterns.

INTRODUCTION

The Sultan Abdul Halim Muad’zam Shah (SAHMS) Bridge is the second bridge in Penang which it connects Batu Kawan in South Seberang Perai on the mainland of Peninsular Malaysia and Batu Maung in south west district on Penang Island. It is the longest bridge in Malaysia and the longest in Southeast Asia with total length of the bridge is 24km (15 mi) and 16.9 km length over the water. The SAHMS Bridge is also the High Impact Project (HIP) launched under the Ninth Malaysia Plan (2006-2010). The construction of the SAHMS Bridge started in November 2008 and was completed in February 2014. The second Penang Bridge is aimed at easing the current traffic overload on the first Penang Bridge and to cater for future traffic demand. With the present vehicle population in Pulau Pinang standing at around 2.06 million in 2013[1] the construction of the SAHMS Bridge is very timely and appropriate. This bridge can cater up to 100,000 vehicles a day and is expected to reduce traffic congestion on the first bridge by about 20 to 30 per cent whilst providing an alternative route for road users heading to or coming from Penang Island. With the construction of the SAHMS Bridge, the land and economic development in Batu Kawan and Batu Maung is expected to be stimulated.

Changes in land use and increased economic activities can bring positive effects such as urbanization, industrialization, expanded infrastructure development and increasing income. However, it can also bring negative effects such as migration, pollution, high fuel consumption, traffic congestion and even accidents. Hokao and Mohamed [2] mentioned that the major causes of traffic congestion are due to ineffective implementation of land use, which the uncontrolled growth of land development will negatively affect the transport system. This is supported by G. F. Koorey et al. [3], who said that land use change, population growth or migration, economy boost, car use, vehicle ownership, induced traffic or road improvements, and availability of alternative transport modes are the factors that affect traffic growth and causes traffic congestion.

Traffic congestion can be defined as a condition where the road network is flooded with vehicles where vehicle speeds become slower, and the travel times become longer. It is also a situation where demand exceeds the capacity and the flow of traffic is below normal speeds [4,5] and stop-and-start traffic [6] is rampant. Meanwhile, land development can be defined as a change of land use that would impact the local socio-economy, population, travel pattern and help raise the standards of living.

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**Land Use Transport Interaction:**

Land use and transport is a two component in urban system that are inveterately interrelated and mutually influence [7,8]. This dynamic and complex relationship known as land use transport interaction. Land use pattern (land market and the location choice of household and firms) can be influence by the major change of travel pattern (the number of trip, destination and modes) and vice versa [9]. Meanwhile, according to [10], there are at least three reason for land use is relevance to transport that are the demand for transport can be generates by the activities and the interaction between them; the area of activities and interaction influenced by the availability of transport; and in the evaluation of transport strategies, the relation between transport and activities may be especially when trying to consider whether the transport system is providing the kinds of accessibilities that activities (i.e. people and businesses) require.

Wegener and Fürst [7] summarise the relationship between the land use system and transport system through the theory of the 'land-use transport feedback cycle' shows in Figure 1. It is explain that the distribution of land uses, such as residential, industrial or commercial, determines the locations of human activities such as living, working, shopping, education or leisure; the distribution of human activities requires spatial interactions or trips in the transport system to overcome the distance between the locations of activities; the distribution of infrastructure in the transport system creates opportunities for spatial interactions and can be measured as accessibility; and the distribution of accessibility in space co-determines location decisions and so results in changes of the land-use system.

![Fig. 1: The land-use transport feedback cycle [7].](image)

**Previous Studies:**

(i) **Impact of Land Use Development on Transport System:**

In Malaysia there are few studies that relate the prediction of traffic growth to land use development. Basically traffic engineers in Malaysia will refer to the guidelines of traffic impact assessment and Malaysia Trip Generation Manual 2010 (developed by Malaysia Highway Planning Unit, HPU) or United State Trip Generation (developed by the Institute of Transportation Engineer, ITE) for forecasting the amount of traffic for a future year based upon the population growth and additional traffic generated by the new development. According to Minhans et al. [11], the Malaysia trip generation manual are still in their early stage with limited number of survey sites and the ITE manual does not match with Malaysia travel pattern. Minhans et al. also stated that without a proper knowledge of developmental impact on the road network, the development will be seen in bad light with the occurrence of traffic congestion. Besides, a new development which supposedly improves the economy and living standards of the local community can also reduce the accessibility and mobility of commuters by impacting the Level of Service (LOS) of the road network. In their study, Minhans et al discovered that the development of new Tesco hypermarket which will be opened in the year 2015 will bring the worst traffic congestion with Level of Service (LOS) F for the 4 signalized intersection some 400m away from the Tesco hypermarket location in the year 2025 [11].

A recent study in Malang City, Indonesia analyzed the influence of mixed-land use development on the transport system [12]. The study revealed that the rapid urban land use change will result in higher trip generation and trip attraction and bring worse LOS in the study area. It was suggested that the reduction of the variety of mixed land uses will reduce the traffic congestion and automatically improve LOS (from F to C).

Masoumi [13] found that socio-economic factors such as age and household income that is generated from a land development has significant effects on transport system especially in mode choice. In their study, it was shown that the selection of residential is not so important in defining the urban travel pattern in contrast to the western countries. Shubho and Neema [8] found in their study that in 5 years, the traffic volume in Dhaka city increased on an average by 30.75% attributed to land use changes where the residential and commercial areas are increased. They also found that the result have an implication on increasing congestion and pollution.
(ii) Impact of Transport System on Land Use:

There have been numerous studies where the objective was to identify the impact of new transport system on land use change. Kubat et al. [14], investigated the impacts of the third proposed bridge on the land development of Istanbul, and their found that the proposed bridge will affect the urban sprawl and land use change. This result supported by Ayazli et al. [15], who said that in the prediction map for year 2030, the areas that are connected the proposed third bridge showed a 28.88% is forest areas and 71.43% is agricultural areas and open spaces will be transform to urban area. Kubat et al. and Ayazli et al. mentioned that the results would lead to population growth and bring the traffic problems that cannot be solved and would force the city to grow much bigger. A transport system can affect the household and employment location choice and the land prices. Roukouni [16] examined the impact of a new metro station in Thessaloniki, Greece on land use pattern around it. According to him, the new metro station will bring more customer to the enterprises at the neighbourhood and will increase the land value such as rents and property prices.

Summary:

It is important to understand the traffic conditions in the future because with it, the traffic engineer and planner can propose an alternative plan to reduce the negative effects. Besides, it is also important to predict the traffic growth that will be generated by new land use development in order to estimate the impacts on the transportation system [17]. In Malaysia, the study of traffic on bridges is still undeveloped. There is only one study done by Lee et al. at Penang Bridge [18] so far. The study only analysed the traffic congestion problem at a road merge without touching the issue of land use and transport system. The latest study done by Chenming et al. [19], and P. Zheng et al. [20], only reviewed the driving behaviour under certain conditions, car following behaviour, driving speed limits under different road conditions and wind intensities, and the average demand of the bridge traffic. A review of previous studies has prompted this study to be conducted in Malaysia. The study will consider the interaction of land use and transport system within the Sultan Abdul Halim Mu’adzam Shah Bridge area. In terms of land use effect on transport, the study will look into the changes of travel demand on Sultan Abdul Halim Mu’adzam Shah Bridge and will predict when the highest traffic volume will occur based on the land use changes in Batu Kawan and Batu Maung. In terms of the effect of transport on land use change, the study will identify the right percentage or proportion of mixed land use that can be used in study area to ensure a sustainable traffic patterns on the Sultan Abdul Halim Mu’adzam Shah Bridge and its surrounding areas.

REFERENCES


