

Evaluation of Trigger Level at Equilibrium Conditions When Private Vehicles Equal to Public Transport Users

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Abstract—This research paper presents the evaluation of trigger level at equilibrium conditions when the number of users are equal for both private vehicles and public transport in order to investigate the impact arising from the new KTM Klang Commuter Station Park and Ride. Users always seek for a faster and more convenient method of transportation apart from driving themselves due to traffic congestions. The main focus of this research is the trigger level conditions that are involving people's decision on their mode of transport. The first stage of the trigger level is to investigate the possible of choices of decision on transport people make before embarking on their daily journey. The second stage of trigger level is route optimization since public transports route must be better in term of delays than those of private vehicles route. The last stage is to identify trigger levels of private vehicles and public transport user's equilibrium conditions when to park their private vehicles. Various factors such as the amount of time the users spend on finding affordable parking spaces downtown is taken into consideration. The study case is conducted at Klang Town where the authority is planning to construct a new Park and Ride at KTM Klang Commuter Station. The trigger level at equilibrium conditions when private vehicles equal to public transports users need to be evaluated in order to attract private users switch their mode of transport from private to public transportation to ensure traffic flow is smooth at Klang Town.

Keywords—Travel time, mode choice, trigger level, private vehicles, public transport

I. INTRODUCTION

Vehicles and transportation plays an important role due to increase in development rate of our country. As time goes by, a good transport is very important as people need to move from a place to another for many purposes such as for working, studying, shopping, and visiting. Ample accessibility and efficient transport systems can increase productivity, social opportunities, and provide economic benefits since they give multiple positive results such as better accessibility to markets, additional investments and employment. Traffic congestion however is not supportive to transport mobility. Traffic congestion causes slow movement of vehicles on the road. The most factor that contributes towards traffic congestion is due to increasing number of private

vehicles on the road. The smooth flow of traffic movement plays the most important roles towards users' satisfaction while they are commuting from origin to reach their destination. Congestion can be defined as slow movement of transports on the road when there are hindrances along the road that force the vehicle to move below the limits. In another words, traffic congestion is a condition on road networks due to increase in demand among users; and is characterized by longer trip times, slower speeds, and additional in vehicular queuing along the road.

Private vehicles can be defined as a classification of small vehicles that need car registration and driving licence. While public transport is a passenger transportation services, usually local in scope, that are available to any person who pays a prescribed fare. They operate on established schedules along designated routes or lines with specific stops and are designed to move relatively large numbers of people at one time (Rodrigue, 2009) [28]. Public transport (PT) is considered to be a sustainable, viable alternative to private car use (Holmgren, 2007) [18]. Users always seek a faster mode of transportation especially during peak hours to reach working place and school. Public transport is encouraged to be a prior transportation due to its nature as a sustainable transportation.

Modal split can be defined as the proportion of total person trips that uses each of various specified modes of transportation or the process of separating total person trips into the modes of travel used or a term that describes how many people use alternatives forms of transportation. It is frequently used to describe the percentage of people who use private automobiles, as opposed to the percentage who use public transportation (Rodrigue, 2009) [29]. Choice model is an attempt to model the decision process of an individual or segment in a particular context. In this research, the modal split in Klang Town is determined and the trigger that guides users shift their mode choice towards public transportation is established.

Travel time is the travel of a transit passenger on an origin-destination path, including his approach to a transit stop or station, travel on the line, a transfer between lines, and departure from a stop to his destination (Vuchic,

2005) [34]. The travel time for both private vehicles and public transport from origin towards KTM Klang is analyzed and the model for both transportation modes is formulated. Equilibrium is a condition of a system in which all competing influences are balanced, in a wide variety of contexts. In this research, equilibrium refers to balancing the travel time for both private vehicles and public transport. The non-equilibrium condition that occurs between private vehicles and public transport attracts users to choose the faster and most reachable transportation for daily commute. The tendency of traffic congestion to occur is when the number of private vehicles users exceeds the number of public transport users. Thus, when the performance of the travel time for both private vehicles and public transport are equal or almost reach the equilibrium conditions, the users ought to be attracted shifting their mode of transportation towards public transport. Public transport should be provided near to residential area; so it is easy to be reached by users and reduce their travel time to catch the public transport. The trigger level that attracts users the most is provided as a guideline for users to switch their modal choice from private vehicles to public transport which is more beneficial and economical.

The purpose of this research is to establish trigger level at equilibrium conditions when private vehicles equal to public transport users near the KTM Klang Commuter station.

II. LITERATURE REVIEW

People demand much faster and easiest way to reach their destination without getting caught with traffic congestion in the middle of the road. Most current research reveals variation in travel time as an important issue due to its significant impacts on users' modal choice. According to Fosgerau and Engelson (2011), congestion leads to increased travel times. Travel times not only increases due to congestion; it may become more variable and unpredictable as congestion increase. This results hard in predicting the time taken to commute for work. Without hesitation, this affects additional costs to travellers and society as well [16]. In addition, the new Park and Ride under government's project near to KTM Klang Commuter Station is forecast to increase the number of private vehicles coming to the town and coincidentally making the traffic congestion worst. Thus, it is recommended to the users to change their mode choice by shifting from private vehicles to public transport as long as public transportation is also recommended to improve its current services.

Due to development in our country, people more concern about their value of time. It is not worth to put on such longer time on the road for their travel for working, or studying. This research will be conducted to find equilibrium conditions in term of travel time between private vehicles and public transport users in order to establish the model of travel time for each route which directed to KTM Klang station especially due to incoming government's Park and Ride project which is one of the attraction for private vehicles' users to come to downtown. A traffic equilibrium model of users by private vehicles and public transportations has been made

first by Michael (1977) [15]. He presents the remarkable features of the equilibrium model which consist the clear distinction between the flow of vehicles and flow of transit passengers and the means of modelling the interaction that occurs between both private cars and public transport which use the same road links of the networks. His study focuses only on presenting an extended equilibrium type model that considers the private car and one or more public transports mode. However, this research result in making a comparison between private and public transport users by modelling the travel time for the potentially selected roads at Klang Town. According to Michael (1977) the flow of vehicles by all modes on the road networks is presented in the framework of a road traffic equilibrium model if the public transport modes are servicing fixed itineraries, for example is the bus lines [15]. Meanwhile, this research focuses on finding the trigger level in order to switch mode choice of the users from private vehicles to public transport for Klang Town.

In order to help users undergo well decision making, the trigger level provide guidance for themselves to choose the most worthy transportation for their daily journey. Previous study is observed to find out the attractions which give higher probability to the users in switching their modal choice such as traffic problems, travel time and travel cost. As long as the performance of services for public transportation increases, users will be triggered to shift from private vehicles to public transport for their daily journey. According to Zhu et al., (2012) the number of people who choose bus mode goes up slowly when the parking fee of the destination is increased for the fixed bus frequency [39]. The number of bus mode users increases when the bus frequency increases for destination parking fee. The result also shows that the mode choice of travellers will not totally be affected with the parking fee of the destination if the bus frequency is lower. These can be concluded that with the increase of parking fee or increasing in bus frequency, the cost of bus mode is lower compared to the cost of private vehicles. Thus, some travellers who embark their private vehicles these whole time will be triggered and alternatively choose bus mode for their journey purposes.

The other research made by Masanobu and Shinya (2003) shows that time cost will change by travel time for a car, and by waiting time for rail [19]. Although this research is carried out for rail services, it is included in public transports category. The result from the research study also indicates that fixed cost of a car becomes large due to increasing of car usage while the time cost for rail is large because of a lower frequency. From the result, it can be concluded that modal shift to public transports by increasing the frequency will reducing private vehicles travel demand and reduce the roads congestion. Another analysis made by Zhu et al., (2012) shows almost the same result which is the number of the car mode decrease as the parking fee of the destination increases for a fixed bus frequency [39]. At the same time, the number of the private vehicles mode decreases with the increase of the bus frequency for a fixed parking fee. The analysis can be understood that users need to be triggered well to change their modal choice and can depict the users' preference properly before embarking for daily routines. Increasing

in bus frequency is very important to prevent users to keep waiting for such a long time for a bus to arrive and fetch them to their destination. The effect of travel time is significance and its influence a lot towards travelling mode choice of the users. Hensher et al., (2003) conclude that lower fares (price) would make important contributions to improve customer perceptions of PT quality, with speed coming a close one [17]. Andreassen (2005) agrees that both fare price levels and speed are critical in affecting customer satisfaction with PT [3]. Eboli and Mazulla (2008) found fare price and frequency to be the most important PT quality attributes for users [10]. Walker and Donovan (2009) found in their study of frequency improvements in 20 bus routes in Australian cities that patronage increased by 36% after 12 months, rising to just over 50% after 35 months, thus claiming evidence of persistent and sustained growth [34]. Perone and Volinski (2003) note in their study of free PT services offered in a medium-sized transit services in Austin, Texas, USA that the free fares encouraged a 75% increase of ridership [24].

De Witte et al. (2006) found that free travel had less impact on French and Flemish students' ridership in Brussels, Belgium; their PT travel neither increased nor decreased [9]. It was found that the students' knowledge and perceptions of the city, its local areas and how to access them by different PT modes was important in affecting their choice of modal use.^[15] Free transfers in Haifa, Israel contributed to an increase in passenger trips by 7.7% (Sharaby and Shiftan, 2012) [31]. Thøgersen (2009) notes that it is imperative that attributes such access and frequency of the PT services are not prohibitively limiting to the use of public transit. While fare price can support and encourage intentions to use PT, other quality attributes will determine whether such intentions are implemented and maintained [32]. All studies reveal notable levels of success for PT pricing mechanisms in terms of increased ridership levels: 12% in the long term (Abrate et al., 2009); modal shift from cars representing 10-20% of ridership in an estimated ridership population in the tens of thousands (Dargay and Pekkarienen, 1997); growth from 27.7 to 65.9 million trips per year over the years from 1983 to 1995 (FitzRoy and Smith, 1998, 1999); 50% increase in ridership over 5 years in Madrid, Spain (Matas, 2004); and substantial ridership increases compared to the previously non-integrated systems across five integrated transport pricing systems in Germany (Pucher and Kurth, 1995) [1], [8], [13], [22], [26]. All these studies stress that the amount of impact afforded by pricing mechanisms is determined to a great degree by other attributes of PT service quality such access, frequency, and speed.

There are a lot of factors that affect users to switch their mode of transport. However, this research aims to evaluate the best factor that gives highest tendency towards users to switch their modal choice. In order to establish trigger level that can help users making decision before embarking daily journey, the four-step method planning model is referred in order to help establishing trigger level in advanced. The modal split of the users should be changed in several ways:

1. Trip making may increase or decrease (trip generation change);
2. Existing trips may be made from / to new origins / destinations, or at different times of the day (spatial temporal trip distribution change);
3. Existing trips made using different transport modes (mode split change);
4. Existing trips made via different routes (trip assignment change).

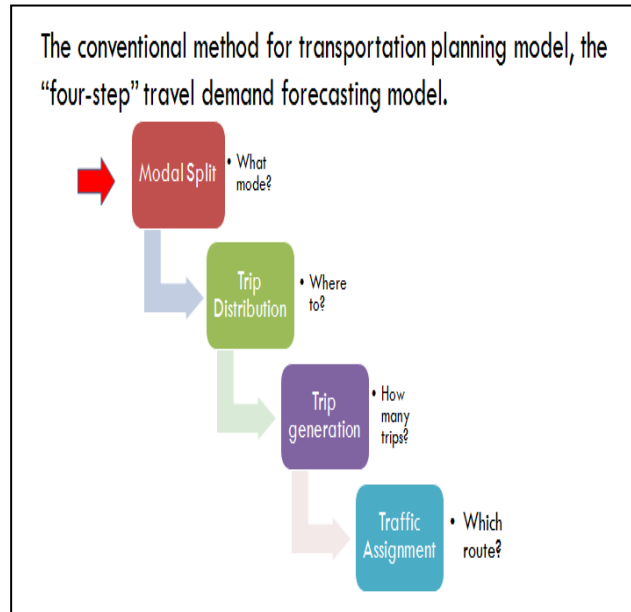


Fig. 1. The Four-Step travel demand forecasting model.

This research focuses on modal split; which is one of the four step travel demand forecasting model. Modal split is the most crucial step which users' decision making occur before embarking their daily journey whether to choose private vehicles or public transport. This situation seems to be small matter; however it offers unimaginable side effects if there is no guideline that can help users making the right decision for their journey purposes. Modal split will becomes the priority in this study to guide users making the right decision before embarking in their daily journey. The trigger level is formulated at equilibrium conditions among private vehicles and public transport users. The trigger level will guide users undergoing decision making wisely before having their trips from origin to reach their destination. The evaluation of trigger level will enhance the modal choice of the entire users before embarking on their daily journey and wisely shift to public transport from private vehicles.

III. METHODOLOGY

People demand a systematic and efficient transportations system because it gives direct impacts on economics and the life quality. Transportation system provides mobility for people and goods, deliver accessibility to various locations such as workplaces, school, recreational areas, malls and other places easier. The high efficiency of transportation system will

absolutely influences the economic activities and growth patterns of an area.

However, the effectiveness of transportation system is affected by the traffic movement on the road. The slow movement of traffic on the road due to congestion gives bad impacts towards economy development and people's activities. In addition, people's health may be affected when they undergone stress and fatigue due to congestion on road. The slow movement on the road at Klang Town is caused by excessive number of private vehicles which are originating in or destined for the traffic analysis zone. Thus, in order to help this issue, the trigger level is established to lure users switch their mode of transport from private vehicles to public transport. The data for this research study is taken by:

A. Origin-Destination Survey

The Origin-Destination Survey is conducted at KTM Klang Commuter Station. Klang Town is the best Traffic Analysis Zone because of its attractions due to KTM Klang Commuter Station and new Park and Ride Station which is still under government's planning. The origins and destinations (O-D Survey) of trips including some other characteristics such as trip purpose and mode travel can be defined in three ways:

1. Home interviews (for internal travel),
2. Roadside interviews at cordon station (for external-internal and through trips),
3. On-board survey on transit vehicles.

This classification scheme is very useful in order to develop forecasting models as well as policies and strategies for accommodating travel or additional of public transports because strategies for each classes of travel would be different. The trips classification can be divided into three classes as well which are internal, external-internal or internal-external, and through trips is useful for meso-scale and metropolitan-level as well as small-area studies such as Klang Town.

The reliability of an O-D Survey's results depends on its sampling scheme and sample size. This research study is conducted via 500 respondents by random selection. The respondents who are selected to fulfil the questionnaires are including different genders, races and ages. The sampling data is collected throughout the normal working day, from 7 AM in the morning and 7 PM in the evening. People who are waiting for their train at KTM Klang Commuter Station are asked to fulfil O-D Survey form to investigate which origin they come from and by which mode of transportation they used to come to KTM Klang Commuter Station. These two questions are the most important questions as to answer the objectives of this research study and to determine the trigger level in order to achieve equilibrium conditions for both private vehicles and public transport users.

IV. DISCUSSION

From the O-D Survey that has been conducted, the result indicates that most people come to take KTM Klang Commuter Station by their own private vehicles or

fetch by their family members. The higher number of people who come to KTM Klang Commuter Station by private vehicles is predicted to be increased due to incoming new Park and Ride which is still under government's planning.

Due to development in our country, the transportation planning should become the priority as well. The slow movement of vehicles due to traffic congestion should be well managed by the formulated trigger level. According to Lauren et al., (2013) the quality attributes of public transport that attract car users consist of four key points which are quality improvements, adjusting the planning and implementation process to enhance effectiveness public transport quality as well as satisfaction towards public transport users, reliability and frequency and the last is to provide evidence that access to private vehicle is a key hindrance for public transport services [27].

According to Hensher et al., (2003) that lower fares (price) would make important contributions to improved customer perceptions of public transport quality a speed coming a close second [17]. Andreassen (2005) agrees that both fare price levels and speed are critical in affecting customer satisfaction with public transport [3]. Meanwhile, Eboli and Mazulla (2008) found that fare price and frequency are the most important public transport quality attributes for users [10].

The trigger level is very significant in order to guide users in the decision-making process by preventing complexity and less predictable while making choice to switch their mode of transport from private vehicles towards public transport. According to Eriksson et al., (2008) a survey of car users' stated reasons for reduced car use for the work commute found that shorter travel time, increased frequency of service, and a lower fare would make public transport more attractive to the car users [11]. Meanwhile, Fiorio and Percoco (2007) found that price is more important than public transport speed in encouraging modal shift from private vehicles, an improvement in bus operations in Dublin, Ireland to increase speed and frequency resulted in a bus service that was about 6 min faster than if travelled by private vehicle (European Local Transport Information Service, 2010a) [12]. Such improvement is due to car mode share reduction from 34% to 22% as a result of the improvement. At this point, users' perception is more attractive towards public transport.

From observation and analyzing the data collection, there is lot of factors that can influence users' decision making; however the best factor which triggers users the most is by reducing the travel time from the origin towards their destination. The travel time can be reduced by either ways such as increase the bus frequency, increase the speed or improve the accessibility for the public transport service so users can reduce their waiting and walking time to reach the bus. According to the survey, the results for the study area shows that the number of private vehicles users are higher compare to public transport users although the roads near to KTM Klang are congested and slow traffic movement. The results shows that private vehicles are the most attractive transports at Klang Town compare to public transport. In

this research, it is proved that the satisfaction level of public transport due to longer of travel time in the study area needs to be improved so users are willingness to consider mode switch. According to Redman et al., (2013), encouraging modal shifts away from private vehicles to public transport should always have the ultimate aim of contributing to a transport system (possibly comprising a variety mode) that optimizes temporal, price, environmental, social, and affective benefits and costs [27]. The key point to attract private vehicles users is by reducing the travel time of the public transport which is destined towards KTM Klang Commuter Station.

V. CONCLUSION

This paper highlights trigger level that ought to be established at equilibrium conditions among private vehicles and public transports users. This trigger level will be able to lure users to switch their modal choice towards public transportation and manage the existing traffic congestion at Klang Town especially due to the incoming new Park and Ride at KTM Klang Commuter Station.

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