Trigger Levels on Transport Mode Choice by Using Graphical Analysis

1NurFahriza, M.A and 2Adnan, Z.
1,2Faculty of Engineering Technology, University Malaysia Pahang, Lebuhraya Tun Razak, 26300, Kuantan, Pahang, Malaysia
1fahriza90@gmail.com, 2adnanz@ump.edu.my

Abstract - This paper presents the evaluation of trigger levels at the equilibrium condition which the users’ preferred mode choice is equal for both private vehicles and public transport. The research is conducted at Klang where the local authority is planning to construct a new Park and Ride at the Klang Commuter’s Station. This study selected travel time as an important factor in triggering the users’ mode choice in either selecting public transport or private vehicles for their daily journey. Therefore, the trigger levels’ condition said the users’ in deciding their mode of transport, as users often seek for a faster and more convenient method of transportation in getting themselves to reach their destination, especially during morning peak hour. The data is collected by means of The Bus Route in this study. The trigger levels are evaluated upon analyzing the data by using Graphical Analysis. The results show that almost equal of travel time was established between private and public transport. The outcome of this study may in turn be utilized to persuade users’ to change their mode choice from private to public transport.

Index terms - Public transport, private vehicles, trigger factors, trigger components, trigger levels, equilibrium condition, mode choice, decision-making

I. INTRODUCTION

Transportation plays a significant role in the economic growth and development of Malaysia. An efficient and accessible transport network is essential for a developing nation such as Malaysia as primarily the economic activities revolves around it. In this study, users’ mode choice will be briefly discussed in order to come out with the trigger levels that will attract users to select public transport as their preferred mode of transport (viz. bus) as compared to private transportation (viz. car). Therefore, the trigger levels evaluation must be assessed based on equilibrium condition that the travel time between bus and car is perfectly or almost equal to each other. The evaluation will allow users’ to make a more informed decision in selecting the preferred mode of transport. According to Stradling et al. (2000), the changes on users’ decisions should be investigated to assist policy makers in providing a framework that attract users to opt for public over private transport. The research reveals that travel decisions are driven by the interaction of opportunity, obligation, and inclination. In order to attract users to switch their mode of transport, it is advantageous to know the purpose of them using private vehicles, whether they would like to switch their daily mode of transport, whether they think additional facilities may help them reaching the public transport easier, which level will trigger their interest in switching mode of transport, and what behavioural change measures already proves their effectiveness [5].

II. LITERATURE REVIEW

Users’ mode choice should be changed from private vehicles to public transport in order to facilitate in mitigating the increase of harmful emissions to the environment. According to Newman and Kenworthy (1989) and Hayashi and Roy (1996), the dependency on private vehicles is recognized as a significant factor that contributes towards atmospheric pollutant emissions from the transport sector; whilst the use of public transport will aid the reduction of these emissions [5], [3]. The evaluation of trigger levels will assist users to consider less polluting means of transport to reach their
destination safely if the travel time between private and public transport is almost or perfectly equal to each other.

This study hypothesizes that travel time is the greatest factor rather than travel cost, accessibility, and mobility which trigger users to shift their mode choice towards public transport. This hypothesis is supported by the study performed by Andreassen (2005) whom opines that both fare price and speed are critical factors that affect customer satisfaction level with public transport [1]. On top of that, Eboli and Mazulla (2008) also found that fare price and frequency to be important factors considered by users in opting public transport [2]. Walker and Donovan (2009) established in their study that frequency improvements in 20 bus routes in Australian cities increased their patronage by 36% and 50% after 12 and 35 months, respectively [9]. Thogersen (2009) indicated that it is imperative that attributes such as access and frequency of the public transport services are not prohibitively limiting the use of public transit [6]. While fare price can support and encourage the intentions to use public transport, other quality attributes will determine whether such intentions are implemented and maintained.

Travel time should be lowered as to ensure users will be able to reach their workplace punctually during morning peak hour. This study focuses on users’ travel time, especially during morning peak hour. According to Small (1982), arriving not at the preferred arrival time (PAT) causes disutility amongst users. Walker (2009) established that waiting time is the most arduous component of the public transport travel time [10]. The increasing in waiting time at the bus stop is the factor that urge users to move away from public transport. According to a study by Infrastructure (2009) on the implementation of two modes namely trams and buses, the trams are practically even more frequent than buses [4]. Therefore, Walker (2009) conceived a concept of “frequent bus service” which by increasing the buses frequency can reduce the users waiting time for public transport [10].

There are many schemes were studied by the previous researchers to attract more users choose public transport as their main transportation to reach destination during morning peak hour. As many researchers agreed that travel time from origin to destination is the most important factor that need to be focused on, therefore an effective method for attracting users to choose public transport by equalizing the travel time for both private and public transport is established. Based on existing literature, it is also apparent that the evaluation of trigger levels at equilibrium condition is important to encourage users in Malaysia to switch their mode choice towards sustainable transportation system such as the Komuter, Monorail, LRT, and bus in order to reduce pollution and minimize the number of vehicles crowding on road and parking area.

III. METHODOLOGY

The Bus Route Survey was conducted during peak hours from 7 AM to 9 AM in the morning. It was carried out by observing the travel time for private vehicles (car) and public transport (bus). The base map of the study area was provided by capturing a screenshot of the google map. The nearest street, roadway, or residential area that is more accessible to the provision of the bus was located on the map.

The route or stations that are accessible by bus 5 km was marked on the map. The bus travel time during the morning peak hour trip was taken in order to determine the travel time for public transport. At the same time, a car was driven by using the same route as the bus to reach the destination (Klang Commuter’s Station) to evaluate the travel time taken for private transport. The travel time for both car and bus was repeatedly taken to get the travel time distribution of 30 samples. The travel time taken by car and bus were compared, and the trigger levels at the equilibrium conditions were evaluated.
Background analysis

Survey works

Bus Route Survey

Trigger Level Survey

Graphical Analysis

Correspondence Analysis

Identification of Equilibrium Condition

YES

Evaluation of Trigger Levels

NO

Discussion & Recommendation

Conclusion

Figure 1 The route heading to Klang Commuter’s Station with highest number of Klang Commuter’s users

Figure 2 The flow chart shows the step in evaluating trigger levels
Graphical Analysis

The trigger levels can be evaluated by using Graphical Analysis. The equilibrium condition was determined by choosing the perfectly equal travel time or the least different in travel time between bus and car.

IV. RESULT

The graph illustrates the comparison in travel time within 5 km (Figure 3a and Figure 3b) for bus and car from Zone 3 (Origin) to Zone 8 (Destination) at Klang Commuter’s Station. From the graph, the greatest difference in vehicle time (IVT) between bus and car is recorded as 38 minutes at Sample 3 and Sample 7. The result from the graph also indicates that the slightest difference of in vehicle time (IVT) between bus and car which is 1 minute as shown in Sample 8, 9, and 10. Meanwhile, the result at Sample 2, 6, and 24 shows that there is no difference between the in vehicle time (IVT) for bus and car. The average of in vehicle time (IVT) for bus and car are 15 and 12 minutes each. Therefore, the average of in vehicle time (IVT) difference between bus and car is 3 minutes. The differences in vehicle time between bus and car can be explained in such a way that IVT for both bus and car are affected by traffic conditions at the zones. The reason for the greatest difference in vehicle time between bus and car is due to slow traffic movement at certain areas in Zone 3. Users whom opt to take the bus are unable to reach their destination faster as compared to those whom are using cars as the bus has to stop and take passengers along its journey. In addition, road congestion always occurs during morning peak hour; however, it becomes worse if it is raining or the traffic light is not functioning. The result from the graph also indicates that there is slight or no difference in vehicle time (IVT) between bus and car. This is due to the traffic movement during the data collection for the samples is smooth, and the bus is able to catch up the same speed as car. In addition, as the number of users whom opt to take the bus to reach their destination is reduced, the number of bus stopping also minimized. As a conclusion, the in vehicle time (IVT) for bus and car is affected by both speed and the number of stops on the road.

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<th>Table 1 Trigger levels at distance 5 km</th>
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Graphical Analysis

The Trigger Levels were evaluated from the Graphical Analysis by demonstrating the perfectly equal of travel time between bus and car for a distance of 5 km. The Trigger Components that were considered during Graphical Analysis includes:

- **WL1_bus** = Walking time from home to the nearest bus stop
• $WT_{bus}$ = Waiting time for bus arrival at the bus stop and departure time
• $IVT_{bus}$ = In vehicle time from initial point to final point
• $WL2_{bus}$ = Walking time from final point to Klang Commuter’s Station

And
• $IVT_{car}$ = In vehicle time from origin to the Park and Ride
• $FPS_{car}$ = Finding parking space at the Park and Ride
• $WL2_{car}$ = Walking time from parking space to Klang Commuter’s Station

From the Figure 3a and Figure 3b of 5 Km distance, the Sample 15 and Sample 23 were selected as the equilibrium condition with the travel time for bus and car were 31 and 30 minutes each. Although the travel time between the transports mode were not perfectly equal, however, the travel time difference was the shortest viz. 1 minute.

It can be concluded that users’ mode choice would be shifted towards bus when the travel time for both of the transportation was perfectly equal or almost equal. The trigger levels for each component that contribute towards equilibrium condition among users’ mode choice can be described in Table 1.

**Distribution of Travel Time for Public Transport and Private Vehicles Within 5 Km**

![Figure 3(a) Distribution of travel time for public transport and private vehicles within 5 km](image-url)
Table 1 shows the trigger levels for a distance of 5 km from the origin (home) to the destination (Klang Commuter’s Station). In order to ensure that the users’ mode choice is at equilibrium condition, the trigger levels for walking time from home to the nearest bus stop (WL1bus) must be 2 minutes, the waiting time at the bus stop (WTbus) must be at most at 9 minutes, the sitting time in the vehicle from initial point to final point (IVTbus) must be 14 minutes, and the walking time from final point to the destination (WL2bus) should be 6 minutes. Meanwhile, for the car’s trigger levels, the driving time from home to the destination (IVTcar) must be 20 minutes, the finding for a parking space (FPScar) should be 5 minutes, and the walking time from parking space to the destination (WL2car) is supposed to be 5 minutes. Therefore, when these presented trigger levels are practiced in providing public transport services, the travel time for bus and car will be perfectly or almost equal, and consequently, users’ mode choice will be triggered in opting bus instead of car.

V. DISCUSSION

Figure 3(b) Distribution of travel time for public transport and private vehicles within 5 km
VII. CONCLUSION

The equilibrium condition can be achieved when the presented trigger levels are practiced. However, it is recommended to improve the facilities in order to attract users toward public transport namely by providing proper pedestrian walkways, good condition bus stop, and feeder transport to lift users from home to the bus stop. Therefore, with the improvement of facilities and the presented trigger levels, the public transport would seem to be a more attractive mode of transportation for users.

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