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The Comparison of Mode Choice Sensitivity to the Reduction of Travel Time and Cost in Multimodal Trip

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Abstract: Nowadays, with the extension of travel distances and accessibility to the various commuting options, multimodal trip proposes as the most competent travelling strategy. However, with increasing in demand by using these options as well as metro, subway, buses, cycles and sidewalk, some problems arose. The import of this quantitative study is to sympathize with the significance of the multimodal as a novel factor in the transportation. In this study, we discussed about cost and time as two significant factors, which affect everybody's life. While improving these two factors have a meaningful effect on encouraging/discouraging private vehicle commuters to switch to public transport. The methodology of this study is an empirical research in which a survey was conducted among the students at The National University of Malaysia with a numeric sample. Hence, a case study based on areas around UKM campus is used to demonstrate the results. What were investigated in this study were the attributes of a reduction in either travel cost or time to promote people who use their own vehicles to shift toward public transportation. The results show that the two factors: time and cost made a significant contribution in motivating private vehicle users to switch public transport. However, the most important purpose of this study was determining the most effective factor (at least based on our condition) since it's not practically possible to have the travel time and cost reduction together.

Keywords: Multimodal trip, public transport, travel time, travel cost

INTRODUCTION

Multimodal movements are those in which two or more different transportation modes are linked end-to-end in order to move freight and/or people from the point of origin to point of destination. Multimodal public transport is a kind of multimodal transportation which has a same definition but the difference is multimodal public transport is used for inner-urban trips (short trips) and multimodal transport can be defined for inner-urban trips as well as long distance trips by ship, airplane, car, train, etc. An example would be to take the bike to the subway station, the subway and finally walk to the destination. Although it becomes more and more popular among users and transportation network planners, not many researches have been carried out yet about calculating optimal itineraries (Altef *et al*., 2013b; Ambak *et al*., 2011; Ismail *et al*., 2013).

Most literature on multimodal trips has been executed by many authors,stated that different factors can affect multimodal trips as well as:

Time: Noland and Polak (2002) in their study identified the differences between travel time variability and congestion, since a transportation system with high congestion may have very stable day-today travel times. Bates *et al*. (2001) iscovered that a generalized Poisson distribution can better explain the delay distribution for train travel times.

Reliability: Li *et al*. (2010) investigated the issue of reliability in terms of willingness to pay by reviewing empirical evidences from the Europe, the U.S. as well as by providing new evidences from Australia. This review focused on car, rail and bus, each by their single mode and revealed the importance of reliability in travelers' decision making (Altef *et al*. 2013a; Shokri *et al*., 2009a; Ismail *et al*., 2012).

Safety: Moen (2007) investigated the determinants of safety priorities in transport, from the view point of personality effects, worries, attitudes and willingness to pay. Several factors were found to be important to prioritize of safety. The three personality assets namely trust, seeking excitement and anxiety were measured along with optimism, worry, attitudes and willingness to pay (Shokri *et al*. 2010).

Energy and emission: Ramseur and Parker (2009) and Gao (2009) in his Environmental Externalities of Motor-vehicle Use in the US proposed that the marginal

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impacts are increasing with the ongoing pollution level. The perceivable impacts include human diseases, reduced visibility, agricultural loss.

Kanafani and Wang (2010) investigated multimodal transportation and their results are:

- Access
- Waiting
- In-vehicle travel

Stardling *et al*. (2000) investigated 68 items discouraging people from using public transport. Factor analysis has revealed eight factors:

- Inconvenience of route, scheduling and other service provision
- Unwanted arousal of the journey experience (e.g., Crowded public facilities)
- Feeling unsafe
- Needing autonomy and control
- Costs
- Self-image
- The preference for independence
- Disability and discomfort (Shokri *et al*. 2012a).

The present study focuses importance of change in cost and time travel and effect on the behaviour of the case study to make decisions to use by public transport instead of their personal cars. The methodology of this study is considered multimodal public transport by examination with real case study in The National University of Malaysia (UKM) which 151 students of the university attended in our survey. Its effects on current traffic condition, transportation mode choice and prediction of public transportation (Shokri *et al*. 2012b). Developing an appropriate model for evaluating other transportation mediums behaviour and their respective environmental impacts is another objective of this study. The linear and SPSS models used for data analysis have identified a wider approach in establishing a sustainable transport system with reduction in environmental deterioration; factors which favours public transportation usage (Shokri *et al*. 2009b).

METHODOLOGY

In this part we state the methodological analysis and the opinion that is used in this research for collecting data and explanation, model development and evaluation as well as the analytical and conceptual structure of the research. The first focus is to make a decision the mode choice variables and to formulate strategies for data collection, selection of the research conditions, development of the sampling procedures, data analysis and explanation. SPSS module as well as a legit choice model will be used to analyse the data. Estimation will be completed within the conditions and statistical considerations confirmed will be clear from the model used. The model development and evaluation will be conferred and analysed.

The structure of the models is bast on the importance of reduction of travel cost and time on car users' mode choice behaviour and potential mode shift from car to multimodal public transportation .The process includes the determination of the model choice variables, data collection and specifying the choice mode models for transportation being considered-private car and multimodal transportation. Detailed description of international students of UKM determines in relation with estimated number of students and their respective favourite to the model choices.

Model choice activities and the switch from private to a multimodal public transportation mode are investigated through data collection and interpreted by SPSS/Microsoft Excel using the logit choice model. In this research, the general form of logit model that had been used to interpret and revise survey results was as following:

$$P(X) = \frac{1}{1+De^{\alpha(X)}} \quad (1)$$

The above equation was calibrated to determine fitting coefficients D and α. These coefficients were calculated by Microsoft Excel ANOVA test, based on the survey data obtained from questions related to the proportion of students board on bus with respect to a series of proposed travel time/cost reduction.

Questionnaire explained below identifies our research objectives and outline the designing of the research. Questions are analyzed and prepared to handle missing data. The questions presented in the questionnaires for each interview were divided into five sections covering various aspects. The first section included personal information such as: ages, place of living, the second part is concerned about how international students of UKM commute to the campus either using personal cars or multimodal public transport. The third part related to students who use cars for commuting to UKM. The next part asked questions from students who use public transport inside and outside campus which means a multimodal trip. The last part of preference survey focused on Strategies to improve multimodal public transportation

It is noticed that international students of UKM who are using public transportation for commuting to university used more two or more than two modes because of the location of campus.

RELIABILITY AND VALIDITY

Reliability and validity are two foremost and fundamental characteristics of any measurement

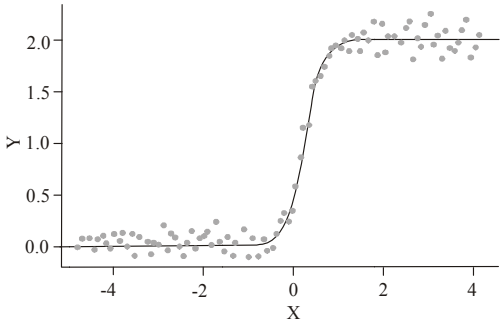

Fig. 1: I deal models (logit) S-shape

procedure. Joppem (2000) is defined reliability as the extent so that the results are consistent over time and accurately represents the entire studied population and the results of the study can be reproduced under a similar way, the research tool which is considered reliable. In order to test the reliability of the instrument used in this study, the popular method of applying Cronbach's Alpha is used. The reliability measurement of greater that 0.6 is deemed to be desirable for any concepts and constructs in the research.

However, it should be in mind that reliability and validity are two quite different concepts. Reliability itself does not guaranty the correctitude of observations. Validity is defined as an extent to which conducts a proper measurement of the phenomenon. In this study, data validity is determined from the correlation of our survey data and the model. The model which fitted on our results should be basically alike the ideal model which is considered to be used in this study and illustrated in Fig. 1.

CASE STUDY

In the present study the stated preference surveys were conducted randomly among 151 international students of UKM.

The survey is performed in University Kebangsaan Malaysia (UKM) because of the high car ownership and the availability of public transport. For this reason UKM is expected to be an excellent case study representing Universities in Malaysia. The train station is located on the northeast tip of the university's grounds, 1.5 km from the university's academics compound. Because of its location close to the University, the station typically receives a large number of passengers (mostly university student) on weekdays as well as weekends. Map of Routs to UKM is shown in Fig. 2.

According our survey and regarding Fig. 3, 49% of international students of UKM attending in the interview use private cars and motorcycle and others (51%) not only use the bus or mini bus, but also use more than one public transport mode (multimodal trip). International students who use public transport for commuting to UKM must use multimodal trip i.e., To use more than one public mode of transportation is divided into two parts: inside the campus and outside campus.

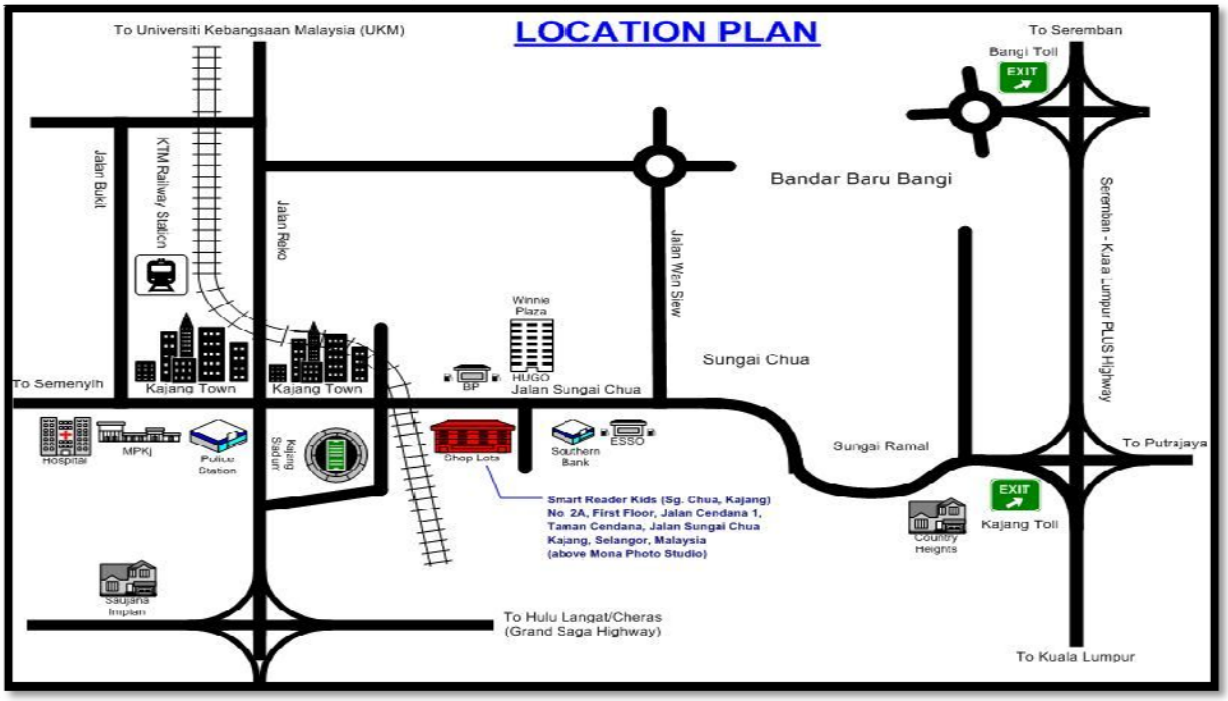

Fig. 2: Map of Routs to UKM

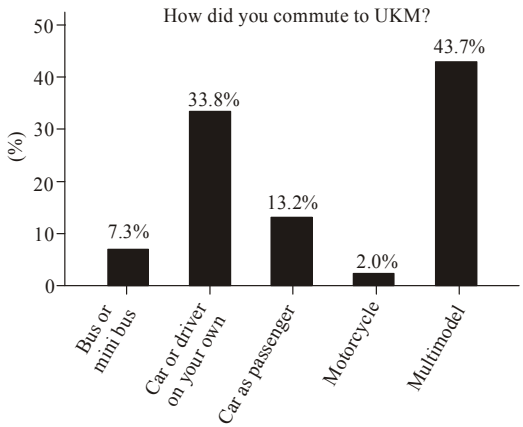

Fig. 3: Vehicle type

RESULTS ANALYSIS

The general view of in this study is the transportation mode choice and studying the sensitivity of motivation to switch from private to public transport to travel-time reduction and travel cost reduction. Since our findings were collected from questionnaires, a proper model was needed to modify our data and make them meaningful and predictable.

The most important step after choosing a general adoption model is determining the proper values of model coefficients to calibrate the model based on a survey and its condition to have a most possible fitting to the model with data. Here is the significance of valid results upon a decent survey. Due to the fact that each case has its own conditions and without having an estimation of these terms choosing the appropriate model and determining the coefficients will be impossible.

Cost and time are always significant factors in students' communities' surveys while subsequently, they are influential factors have an impact on transportation mode choice. In addition, these two factors are noticeably touchy by commuters. However, in every planning, there are some possible options that influence the outcomes. Therefore, it is important to know how and how much anticipated outcomes are sensitive to any option. This concept can be extended to other studies as well as a transportation mode choice but in general, sensitivity of outcomes to the effective factors may vary from case to case and community by community.

Survey results of shifting to the public transportation due to a discounted travel cost and travel time gather at Table 1 as following.

However, these results would be more reliable in order to fitting of a model. Therefore, the general model was calibrated according to the survey results to obtain the fitted models. As I mentioned earlier the calibration

Table 1: Results of time/cost reduction

Travel time reduction	10%	30%	50%	70%	90%
Shift	5.4	14.9	45	78	96
Travel cost reduction	20	40	60	80	100
Shift	9.6	30	50	80	90

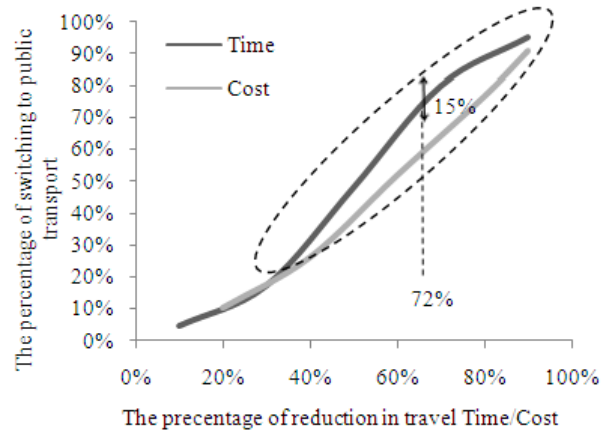

Fig. 4: Modelling results

would be through applying fitting coefficients derived from the Microsoft Excel ANOVA test. Revised modelling results due to employing any of the strategies (travel cost/time reduction) are calculated and plotted in Fig. 4. The illustration of both diagrams is considered to be in a same chart that so the return contrast of applying either travel time reduction or travel cost reduction would be more dominant.

As we can see in Fig. 3 the diagram of switching transportation mode due to travel time reduction is above the diagram of switching mode of transport due to travel cost reduction. Especially from the point that both diagrams suddenly ascend and enter to the highest slop rang, the difference in outcomes is obvious. The range that just talked about shows with orange dashes in Fig. 3. Based on modelling outcomes derived from our survey results, the difference of efficiency (switching transportation mode) between two diagrams reaches almost to 15% maximum (where 72% reduction in time/cost of travel is applied). However, this efficiency contrast may vary in various studies with different conditions that so it may consider insignificant and deniable in practical terms, while it statistically exists.

Reducing travel time would be included increasing the frequency and the accessibility of public transport. To achieve this, proving additional fleet, maximizing coverage area and improving connection between different modes of public transport are undeniable. However, providing all these upgrades needs injecting a large sum of money. Hence, it almost wouldn't be possible and implacable to reducing travel time while discounting the travel cost. Therefore, usually only one of these two strategies may be taken by planners. Of

course, they both can be implemented as well but in such this condition, the outcomes wouldn't be as efficient as anticipation since one of the most important points of any successful planning is affordability.

CONCLUSION

Travel time and cost reduction both will encourage commuters to switch to public transportation. Implementing these two together is practically impossible so usually we have to chose any of these factors. Therefore it is very important to pick the most effective one based on our situation since the results may vary due to the community attributes and category. Because It should be considered that time and cost have almost the same concept which is money. That so in the conditions that we would like to motivate more people to choose public transport a travel time reduction may be much more effective than a discount in the travel cost. Since the people who still prefer to use private transportation despite all considered obstacles which are mostly financial, may believe in a higher value of time for themselves.

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