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An Analysis of Travel Time in Multimodal Public Transport

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Abstract: Nowadays, with the growth of population, road expanding and approachability to the diverse commuting option Multimodal Trips which means using two or more transportation modes for a trip between two nodes ; are increasingly recognized as a consequential factor in solving traffic congestion problems. The import of this quantitative study is discussed about the time factor to encourage students to shift towards public transport, furthermore . The foremost purpose of this study is motivating people who use their own cars to shift toward public transportation in their inner-outer travel. The scheme of this quantitative study is to identify the importance of the Multimodal Trip as a success factor in the transportation world. The subject of the Multimodal Trip effect on the mode choice traveller and has been statically significant. There were significant interactions between time and cost, parking charge fees for Multimodal Trip. The data collected and demographic details are analysed like age, gender, educational level and travel behaviour in regard to the transportation mode. For a description of the survey data, SPSS is used and logit model is applied. The questionnaire designed based on social or economic preference, trip characteristics and probability of shifting from private vehicles to public transportation mode, and supporting reasons to improve public modes of transportation inside and outside the campus as multimodal trip. 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. The results show that the time made a significant contribution in motivating private vehicle users to switch public transport.

Key words: Multimodal Trip, public transport, sustainable transport system cost, UKM.

INTRODUCTION

Multimodal trips are trips comprising two or more vehicular modes, are a common travel phenomenon, which are thought to become more considerable in the future due to their expected association with sustainable urban transportation. Multimodal passenger transport modeling must deal with the concurrent choosing of routes, travel modes, and interchanging locations between public transport modes, access/egress locations from private to public transport modes and vice versa.

Research on multimodal trips has been performed by many authors, for instance, Lyons, Harman, Austin and Duff (2001). Which their study's objectives were based on the tries to provide the public with an opportunity to compare travel options across public and private transportation modes, and seeks to offer a one-stop-shop journey planning (Hafezi & Ismail 2011a). Reviewing abundant literature worldwide, it was revealed that this work has determined critical topics, findings and limitations (Hafezi & Ismail 2011b).

Li and Wachs (2000) and Hafezi et al. 2012 suggested a set of inter-modal performance indicators in which service input, service output and service consumption are measured respectively by total cost, revenue capacity, and unlinked passenger trips/miles based on economic principles and evaluation objectives. The concern of inter-modal performance can be considered as a proof of the importance of differences in multimodal transportation planning process (Hafezi & Ismail 2011c).

In the 1996 Pratt and Lomax studies about the Performance Measures for Multimodal Transportation Systems. They observed that Matching performance measures with objectives, Understanding the effects of improvements, Addressing people and goods, Using common denominators, Developing measures not governed by data concerns, Employing both multimodal and modes-specific measurements and remembering the audience are important in the measurement of the Multimodal Transportation Systems (Hafezi & Ismail 2011d; Ismail & Hafezi 2011).

Johnston (1994) highlighted the assessment of multimodal transportation systems for economic efficiency. The work indicated that the concern of multimodal transportation planning enhances planning efficiency. In the DOT's strategic plan 2006-2011, the policies, milestones, consequences as well as objectives of the U.S.

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Department of Transportation are emphasized, in which an instruction to emphasis on policy making considered being important in the suppliers' perspective of our progressing project is offered.

Modelling Attributes:

Despite the extensive body of literature on transportation performance measures, a few works have addressed the question of integrating the multi-modal service attributes.

Time:

Bates et al. 2001; Hollander (2006); Hollander and Steer Davies Gleave (2009) highlighted the stochastic nature of travel time variability, and defined reliability in travel time as a random variable. Similar categories were used by Noland and Polak (2002) to demonstrate travel time variability; differences in travel time from day-to-day, over the course of the day and even from vehicle to vehicle. In a work conducted by Bates et al. (2001), it is further added that on the demand side, besides the seasonal effects and weekday variations, the systematic variations i.e. The residual day-to-day variations are essentially random, whereas on the supply side randomness of variations is mainly due to incidents, such as vehicle breakdowns, signal failure, etc.

Reliability:

Rietveld et al. (2001), investigated reliability issue in a multimodal perspective, in the case of public transportation system in the Netherlands. This study drew explicit attention to one missing connection among elements of a chain. The data obtained from various one-modal resources, was needed to be combined. Customer assessment of unreliability was approximated by means of a stated preference approach. Generalizing obtained results to other countries was however, difficult because of the high density of bicycles in Netherland.

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.

Energy and Emission:

Ramseur and Parker (2009), GAO (2010) and Delucchi (2000) studies in the field of environmental externalities of motor-vehicle use in the US proposed that the marginal impacts are increasing with the ongoing pollution level. The perceivable impacts include human diseases, reduced visibility, and agricultural loss.

Generally, in the case study network three major parameters are considered including: access, waiting and in-vehicle travel as shown in Figure 1.

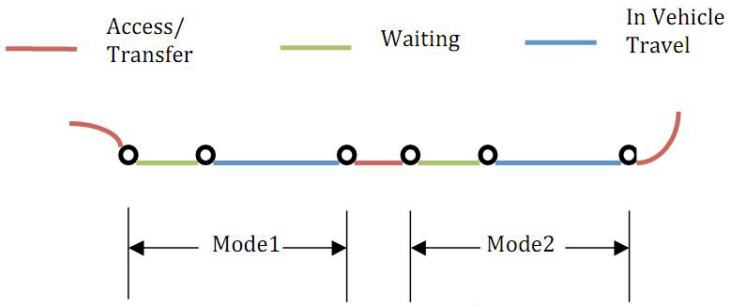

Fig. 1: The schematic of case study network.

Access:

The notation of access is usually mode specific. As mentioned above it is possible to consider that each mode is providing access to the next, but as long as the present analysis is concerned, we keep the term "access" to represent the first link connection between a trip origin and the first mode to be used in the multimodal system. In urban transportation modeling it is customary to consider the access process as individual travel, such as walking or bicycling.

Waiting:

This refers to the duration between user's arrival to a transport terminal and the actual entry into the vehicle of the model in question.

In-Vehicle Travel:

This is the duration of time spent on the vehicle.

The present paper focuses on the behavior of the case study to motivate to travel more often 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). Its effects on current traffic condition, transportation mode choice and prediction of public transportation. Developing an appropriate model for evaluating other transportation mediums behavior 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 favors public transportation usage.

MATHERIALS AND METHODS

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 analyze 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 analyzed.

The structure of the models on car users' mode choice behavior 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 favorite 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 using SPSS and logit choice model. The questionnaire explained below identifies our research objectives and outline the designing of the research. The questionnaire makes it easy to give the critical information and for the interviewer to verify the answer and to organize a sound analysis and explanation as well. Questions are analyzed and prepared to handle missing data. It's expected to guarantee an excellent questionnaire design and the appearance of obvious and shared approach to the definition of related parameters. The questionnaire is expanding to directly address the objectives of the research.

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, program of study, gender, nationality and marital status. The second part is concerned about how international students of UKM commute to the campus either using personal cars or multimodal public transport. They were also answered these questions: Time taken to reach to the university in the morning and time of leaving the university, Time spent for commuting to UKM and The main reasons to commute to UKM. The third part related to students who use cars for commuting to UKM. This section included: Reasons for using own car, Cost of commuting to UKM and Factors discourage them to prevent using public transport. The next part asked questions from students who use public transport inside and outside campus which means a multimodal trip such as: Distance of living place for the public transport, Total time wasted in waiting for public transport, Time taken to commute to UKM and Satisfaction of using public transport and their facilities inside and outside campus. The last part of preference survey focused on Strategies to improve multimodal public transportation involved seven parts as follow: Reducing the travel time and cost, Supplying parking facility inside and outside university (near KTM, LRT, Monorail, near bus stations), Closeness to the nearest public transport facility (KTM, LTR, Monorail, Bus station), Increasing the frequency of KTM, LRT, and Bus, Taking parking charge inside UKM, Providing special facilities for walking and cycling inside campus, Improving the quality of public transport.

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 which is divided into two parts, first; outside campus (from residential areas to UKM) and second; inside the campus. So, it would be good that the government and the university apply special policies to improve the multimodal public transport.

The procedure used for the variables assesses the number of commonly used measures and also provides information on the relationships between the individual items in the scale such gender, nationality, age, mode of study and different mode of transportation as well as the residential location.

Reliability:

The reliability test of the measurement being used shows how reliable are the instruments that are being used to measure the concepts and constructs of the research. Reliability of measurement indicates that how stable and consistent the instrument is in order to analyze the concepts and construct involved in the researches.

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.

The following reliability status (as shown in the following tables) was obtained when the Cronbach's Alpha was applied to the research questions that are included in this study:

Validity:

Reliability does not guarantee that observations are correct. Validity refers to the degree to which a measurement provides a correct measure of a phenomenon. It is a concept quite different from reliability. Validity is difficult to determine. How can you know that you are getting the "truth" when all you can observe is some surface feature? In this research validity of data is measured by correlation our survey data with the model. The results show a significant value and the fitted model of our data basically should be looked like the ideal model which is illustrated in Figure 2.

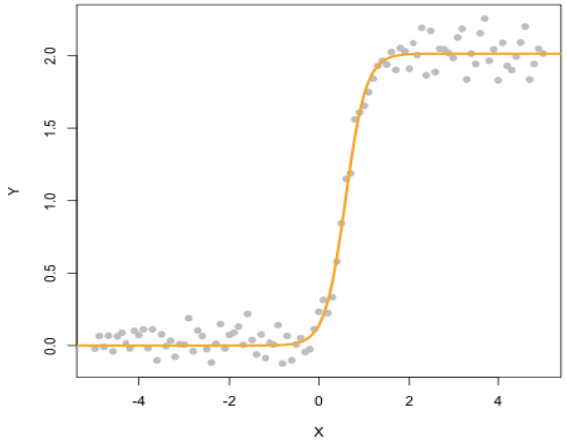

Fig. 2: Ideal models (logit) S-shape.

Case Study:

In the present study the stated preference surveys were conducted randomly among 151 international students of UKM. The survey questionnaires with the help of research assistants listed and distributed to the selected respondents and they were asked to fill the form and return to the researcher. In some cases the respondents asked to be interviewed by the researcher and then filled up the questionnaires during the interviews.

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 Figure 3.

Results:

In this part, the discussion will be on the analytical steps used for collecting data analysis, evaluation, and interpretation of the transportation mode shift (from private to public). This switch will lead to the result of motivating the international students inside and outside the campus. Constituent variables based on the percentage of their proportion are defined with the help of SPSS software model and Logit choice model. This study and all its collected and analysed descriptive details are focused on University Kebangsaan Malaysia (UKM) and its international students. We chose university Kebangsan Malaysia (UKM) as a case study 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. The data collected among 151 UKM international students and different places chosen in

order to set the interviews such as: main library, bus stations inside the campus, bus station near the KTM station, PhD students' office.

According our survey and regarding Figure 4, 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. 3: Map of Routs to UKM.

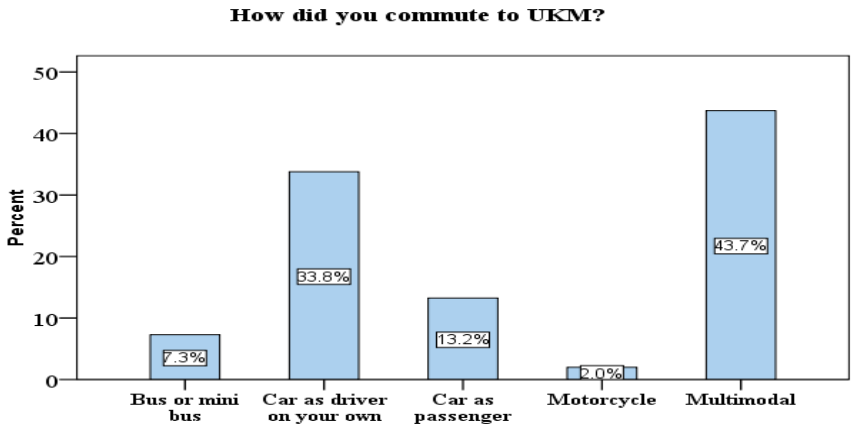

Fig. 4: Vehicle type.

Base on table below 90.5% students how use private vehicles for commuting to UKM has between 12 RM to above 24 RM to go and back to UKM. 71.6% of them do not use public transport because of unfrequented public transport (because most of the time the KTM which is the only train has station near UKM has lots of delay.

From Table 1 and 2 one can see that 90.5% of private car users pay 12 RM to above 24 RM for commuting to UKM, they claim that they have to pay this high cost to get rid of unfrequented public transport (71.6%) which is the biggest problem for them. 44.6% of international students of UKM use their own vehicles for the lack of public transport or improper of it.

Table 1: Summary of survey on international students' private vehicle user.

Cost when use private vehicles for commuting to UKM	Less than 6RM	0%
	6-12 RM	9.5%
	12-18 RM	28.4%
	18-24 RM	44.6%
	Above 24 RM	17.5%
Factors discourage to use public transport for commuting to UK M	Unfrequented public transport	71.6%
	Takes too long time to reach to distant	13.5%
	Uncomfortable	14.9%

Table 2: Summary of survey of public transport outside the campus.

Cost when use public transport for commuting to UKM	Less than 3 RM	15.2%
	3-6 RM	27.8%
	6-9 RM	36.7%
	9-12 RM	20.3%

Students who use different mode of public transport to commute to UKM must pay fees between 1 to 9 RM and of course this fee are less than the fees which international students who commute to UKM with their private vehicles. Students how uses public transport claim about the cost of transportation specially how use more than one mode of public transport to reach their destinations. We suggested to whom used private vehicles if we reduce the fees of public transport do you motivate to shift from private cars to public modes?

Based on the Figure 5 below demonstrates below, 9.5% of the international students using private vehicles will switch to public transportation mode if 20% commuting cost reduced, however 90.5% of the international students prefer to use their cars. At a reduced cost of 40%, 70% of the international students will prefer to stay in their own vehicles and 30% of them will shift to public mode outside the campus. By following these reductions in fees, 50% of international student agree to switch to public transportation modes with 60% reduction while 50% of them prefer to use their own cars. Almost 69% of the international students will prefer to use buses, metro and other public modes and despite of decreasing the fares up to 80% but 32% prefer to use their own cars. 90% of the car owners will switch over to public modes if the fare declines to 90% but international students (10%) stated comfortably is the most important thing in their life and they prefer to have their own vehicles.

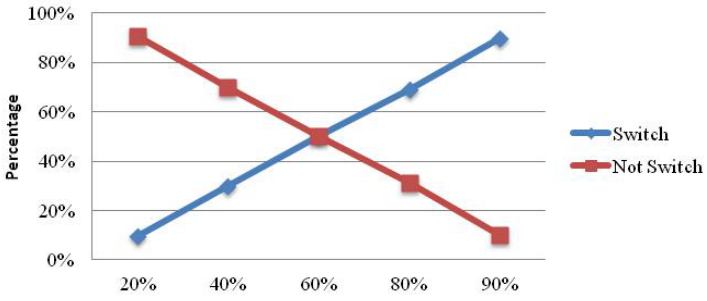

Fig. 5: Different percentages of switch and not switch.

Discussion:

It is clear that the main purpose of this paper is studying the transportation mode choice and how motivating the international students to shift to public transportation rather than private vehicles. Since all findings were derived from the collected data so a proper logical model was needed to modify the questionnaire results.

The first step in modeling is determining correct values of the chosen pattern coefficients to be calibrated and adopted based on current condition. Here is the point that our results from the survey get importance. Since, without having an estimation that what will happen one cannot determine which model is more fitted for the study and what the proper coefficients of our model are.

Cost means money, which most international students always care of this issue specially students who are self-sponsored in order to manage their life. So, a fare believable transportation cost will motivate lots of international students to switch to public modes. The cumulative format with model regression line plotted and it is shown in Figure 6 extracted from Table 4.8 and its equation is presented below. The value of α and D found out from MicrSoft Excel ANOVA that one can see in Table 3.

Table 3: An illustration Survey results and logic model results.

Improving travel cost	Survey results (P)	Results from logit model
20%	0.096	0.10
40%	0.30	0.26
60%	0.50	0.52
80%	0.80	0.77
100%	0.90	0.91

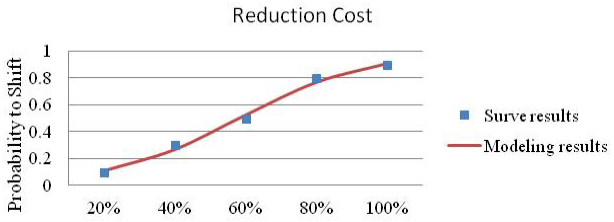

Fig. 6: Effect of cost reduction to shifting from private cars to public transport.

Table 4: 9 A demonstration ANOVA result.

Regression Statistics							
Multiple R							0.996073
R Square							0.992161
Adjusted R Square							0.989548
Standard Error							0.180349
Observations							5
ANOVA							
	df	SS	MS	F	Significance F		
Regression	1	12.34954	12.34954	379.684	0.000295		
Residual	3	0.097578	0.032526				
Total	4	12.44712					
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%
Intercept	3.235129	0.189152	17.10334	0.000435	2.633163	3.837095	2.633163
X Variable 1	-1.11129	0.057031	-19.4855	0.000295	-1.29278	-0.92979	-1.29278

Conclusion:

The growth rate of switching to public transportation among UKM student is shown in Figure4.30. As we can see there, the growth rate of reduction cost and percentages of switching are not same since where we impose 20% we will have 10% changes in transport mode. While if we improve reduction cost 50% there will be 42%, which is over three times more rather 20%. Therefore, in this range, reduces cost growth for 250% will cause 420% growth in shifting to public transportation and this is the most efficient range that the curve of our model also has the highest slope. On the other hand, for the charges above 50% as we can see the slope of the model curve is decreasing rapidly so the growth rate of switching is reduced as well. For example, in order to 200% increasing in 50% reduction cost to reach 100% (based on the model in 100%, the percentage of the shift to the public transportation will reach to 91%) will have only 58% increase in shifting transportation mode.

As I mentioned in the efficient range of the model where the curve has the highest slop 20% reduction cost addition will cause more than three-time growths in shifting transportation mode. While in the deficient range where the slope is decreased to zero 95% reduction cost rate increment will cause only 89% enlarging the change of chosen transportation mode.

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