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PROPOSED POLICIES FOR SHIFTING PRIVATE VEHICLES USERS TO PUBLIC TRANSPORTATION BY USING LOGIT MODEL

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Abstract

Many studies have been conducted to reduce carbon emission on the world. Large numbers of private vehicles help to increase greenhouse gas emissions, traffic congestion, physical inactivity, high temperature and air pollution. For these reasons, an urgent need to reduce carbon emission produced by private vehicles by switching to public transport. This study presents the effect of policies of reducing bus dwelling time, increasing parking fees and fuel cost private vehicles users. A survey was conducted at Kuala Lumpur city centre (KLCC) for respondents who uses private vehicles. Then, the data collected was analyzed by using logit model. The results showed that increasing fuel cost by 33%, 99.5% of respondents switch to public transports while increasing parking cost by 25%, 99.5% of respondents switch to public transport as well. Finally, 50% of respondents switch to public transport when decreasing bus dwelling time to 60%. These government policies contribute to reducing private vehicles by making private vehicles' users switch to public transport.

Keywords: Carbon emission, Logit model, Policies, Private vehicles, Public transport.

1. Introduction

Private cars are one of Malaysia's leading types of personal transport since they are more efficient than other accessible transports [1]. Statistics indicate that there were around 550,180 passenger vehicles registered in Malaysia by 2019, an improvement of about 3.2% relative to 2015 [2]. The world's oil production is largely used by passenger vehicles. The pollution in the atmosphere is also a big cause of it. This problem can be addressed by effective structures, renewable fuels, and reasonable transport networks [3]. The simplest solution is to promote the use of public transport (bus and rail). This approach can be solved by recognizing the need for a wide range of people using public transport.

Greenhouse Gas (GHG) emissions and global warming scientists commonly agree that burning fossil fuels and other human activities are the main cause for elevated amounts of GHGs in the atmosphere [4, 5]. Rising greenhouse gas emissions are expected to increase the pace of climate change, and scientists predict the average global surface temperature to rise from 1.6 to 6.3°F by 2100 [6]. Individual cities, states, and national governments around the world are pledging to cut emissions; however, reducing emissions is a process fraught with political and financial barriers which impede swift action. Also, emissions are continuously released while portions of which will remain in the atmosphere for centuries [7]. While car exhaust emissions pose significant problems with air pollution in many regions and lead to climate change at global level. Car use is also a major factor in other issues, including traffic jams, road injuries, noise pollution, urban severance and the depletion of rural areas from road construction. Forecasts of more growth in car ownership and usage have prompted policymakers to urge car users to turn to other modes of transport, especially busses [8].

Private transport has long been the preferred, most effective, convenient and time-efficient method to travel. Thus, most of the people in developing countries are driving, choosing their own vehicles to public transport. Growing numbers of private cars have raised road congestion, air pollution and traffic hazards [9]. For these reasons, immediate and meaningful cuts in GHG emissions are necessary and all levels of government should implement policies which aggressively promote these reductions.

Anwar and Yang [10] attempted a study based on a survey of public transports in order to devise ways of encouraging the use of public transportation. Once-an-hour direct bus service from home to university, and park-and-ride facilities were the two policies examined. Binary logistics models were proposed and compared the utility of travel modes between private cars and public buses. These models are also used in identification of encouragement factors of car users to switch from private vehicles to public transport. Relevant information on the choice of travel mode was collected by Stated Preference (SP) questionnaires [10].

Mohammed and Shakir [11] examined the students' perceptions and preferences in university campus on choosing the type of transportation. The study focused on providing alternatives transport mode to private vehicle users as a shifting preference of private vehicle users to other transportation mode. In order to develop a choice of transportation mode preferences, 456 questionnaires were conducted. While logit model and Statistical Package for the Social Sciences (SPSS) model were used to identify the factors that affect the determination of the choice of transportation mode. It was found that by reducing 70% of travel time, private vehicles users will be

reduced by 84%. In addition, reduction the travel cost will highly improving the public modes of utilization. The study revealed positive aspects is needed (travel time and travel cost reduction) to shift users from private to public modes [11].

Guzman et al. [12] evaluated the choice model by vehicle in response to a specific mobility strategy if mobility plans (MP) are implemented by mid and large size public and private organizations in the city of Bogotá (Colombia). After implementing different travel demand management instruments by using SP survey a modal was developed for employee trips. The results suggested that high parking rate in the organization's vicinity are likely to lead to high reduction of private vehicles versus high public transport, carpooling, bicycling, and walking demand. [12]

Abdulrazzaq et al. [13] developed a modal shift model from private vehicles to public transport and determine the factors that effects the performance of the mode of transportation. A survey with 384 respondents was carried out in order to develop a binary logit model for three alternative modes, car, bus, and train. The study found that significant factors are trip distances, a trip rate per day, trip time, gender, age, and occupation which influence the individual's choice of transportation. Travel time and distance travelled are the most important variables to encourage the use of public transport [13].

2. Methodology

This section describes the methodology used in this study for data collection, the theoretical considerations in developing the models and making the estimates, and the conceptual and analytical framework of the study. The initial focus is to determine the mode choice variables and formulate the strategy for data collection, followed by selection of the study area, developing the sampling procedures and, finally, the data collection itself. Subsequently, to analyze the data, models will be constructed, and estimations will be made within the specifications and statistical considerations stated. The model development is discussed in two sections: Binary Logit Model and Multinomial Logit Model.

2.1. Determination of Mode Choice Variables

One of the crucial factors in public transport planning is mode choice behavior, as it has a significant effect on the design of system structure of urban transport and is also the basis for urban public transport planning and management policymaking. Therefore, data collection was done according to by Revealed Preferences (RP): socioeconomic, mode attributes and trip characteristics; and Stated Preferences (SP): attitudinal and hypothetical choices.

2.2. Selection of the study area and sample size

City center of Kuala Lumpur witnesses heavy private vehicle movement beside the availability of public transport, in addition to the high intensity of those selected areas with walking people. Therefore, KLCC has been chosen to be the study area where the population of Kuala Lumpur city is more than 250,000 and more than 5,000 visitors per day are roaming the city.

Shan [14] reported that 250,000 population size and above will require a sample size of 384 respondents at confidence of 95% and margin of error of 5% [14]. Therefore, based on the information from Department of Statistics Malaysia, the selected sample size for this study will be 384 respondents [15].

2.3. Survey Design

Private vehicles' commuters were surveyed by using questionnaire which developed based on Ben-Akiva and Lerman; Horowitz [16, 17]. The respondents were asked about their current travel situation with a set of questions in two categories: SP and RP methods were adopted due to their successful previous use by Boyle; Kroes and Sheldon [18, 19]. The framework in Fig. 1 shows the cognitive operation of study design and data collection.

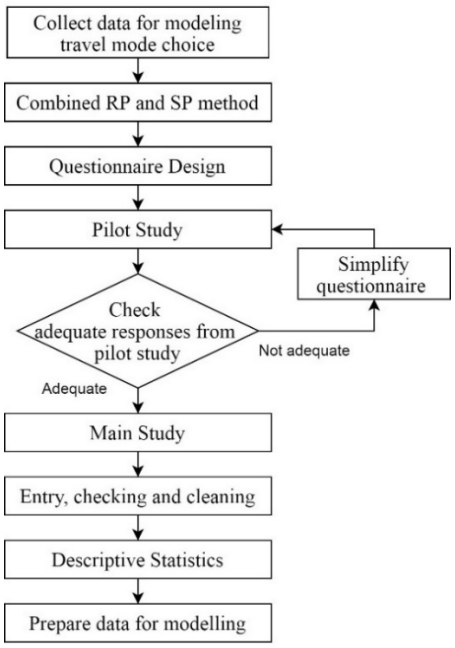

Fig. 1. Survey design and data collection process.

2.4. Logit Modelling

Logistic regression is a type of regression with binomial sensitive / dependent variables. It is important for predicting the possibility of an occurrence happening as a result of other variables. It is a simplified linear model that uses the logit as a connecting function [20]. Logistic regression is commonly used in the medical and social sciences. Some logistic regression terms found in many other implementation fields include the logistic algorithm, the logit model, and the maximum entropy classifier.

This conceptual structure is generally referred to as a single-layer "perceptron" or a single-layer artificial neural network. A single-layer neural network measures a constant performance instead of a phase function. The derivative of *pi* with respect to *X* is determined from the general form [21]:

$$y = \frac{1}{1+ e^{-f(x)}} \tag{1}$$

When $f(X)$ is the analytic function in X. With this option, a single-layer network is the same as the logistic regression model. This functionality has a continuous derivative that enables it to be used for back spreading.

3. Data Analysis and Results

This section illustrates the analytical results used for data collection, analysis, evaluation, and interpretation for transitional shifting (private car users to public transport) of car users that work the city centre of Kuala Lumpur. Constituent variances with respect to their proportional percentages were defined in Microsoft Excel program and SPSS. Descriptive details have been presented and analyzed for workers that used their own cars to preform to work.

3.1. Socioeconomic and travel characteristics of the respondents

Table 1 demonstrates the demographic, socioeconomic and travel characteristics of the respondents, of which 75.7% were males and 24.3% females. In terms of education, 84.3% has been to university level and 15.7% secondary school degree. Their monthly income distribution was 5.7% earning less than RM1000/month, 22.9% RM1000-2000/month, 35.7% RM2000-3000/month, 18.6% earning RM 3000-4000/month and 17.1% got RM4000 and above.

Table 1. Profiles of respondents.

Category	Attribute	Percentage (%)
Gender	Male	75.7
	Female	24.3
Age	< 20 years	10.0
	2-40 years	84.3
	> 40 years	5.7
Ethnic	Malay	75.9
	Others	24.1
Level of education	High school	15.7
	College	84.3
Household size	1-3 persons	35.7
	4-6 persons	51.4
	More than 6 persons	12.9
Working time	Full time	80.0
	Part time	15.7
	Unemployed (student)	4.3
Monthly Income	RM 0-1000	5.7
	RM 1001-2000	22.9
	RM 2001-3000	35.7
	RM 3001-4000	18.6
	More than RM 4000	17.1
Distance to Work	< 10 km	35.7
	10 km – 20 km	44.3
	> 20 km	20.0
Working Days Per Week	≤ 3 days	4.3
	4 days	18.6
	5 days	60.0
	6 days	17.1
Time needed to perform work trip	< 10 minutes	21.4
	10-20 minutes	41.4
	20-30 minutes	20.0
	> 30 minutes	17.1
Cost of monthly fuel consumption	< RM200	10.0
	RM200 – RM400	40.1
	RM400 – RM600	32.9
	RM600 – RM800	11.4
	> RM800	5.6

The result illustrates that the percentage of male twice larger than female on workers in KLCC. Malay males were the most respondent of this survey. The age between 20-40 years was dominate for people ages with percentage 84.3%, also college education level was most of the respondents. Range of 4 to 6 person per household was the selected choice with full working time. More than half of the respondents have a RM 1001 to RM 3000 monthly income. While more than 80% of the respondents live less than 20 km from their works. The range of 5 working days with 10 to 20 minutes time for trip to work is the most range of respondents. Mostly 73% of the respondents spend between RM200-RM600 as fuel consumption in order to go to work.

3.2. Factors improving public transport and recommended policies

3.2.1. Factors encourage respondents to drive private vehicle to work

The key factors addressed for encouraging respondents to drive private vehicle to work were (reliable, comfortable, and convenient weather condition, satisfactory, flexibility, convenient for large families, and safe and prestige. Thirty eight percent of the respondents valued the comfortability overall. Figure 2 shows the values of all factors.

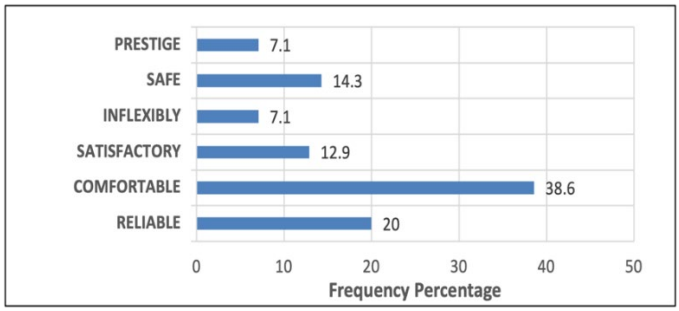

Fig. 2. Factors encourage respondents to drive private vehicle to work.

3.2.2. Factors discourage respondents to ride public transport

Figure 3 presents the major deterrents to drivers shifting to public transport (train/bus). The most discouraging factor was the "long travelling time" with 37.1% response. Other important factors were "uncomfortable" (18.6%) and "desirable routes" (17.1%), "Vehicles too crowded" with (14.3%) and other statement was not very important.

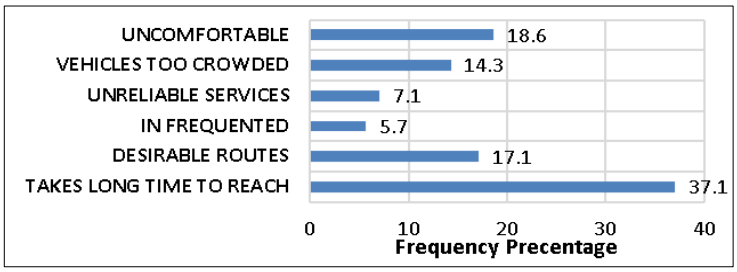

Fig. 3. Factors discourage respondents to ride public transport.

3.2.3. Attitudes to using public transport

Figure 4 shows that 35.7% of the respondents found public transport to be indifferent, 24.3% inconvenient, 21.4% were convenient, 10% found it very inconvenient, and finally 8.6% of the respondents found it very convenient.

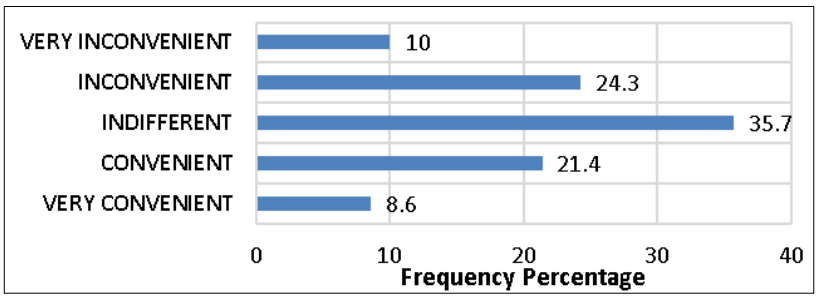

Fig. 4. Attitudes to using public transport.

3.2.4. Factors effecting respondents to shift from private vehicle to public transport

Figure 5 presents the major factors effecting drivers shifting to public transport. The most encouraging factor was the "quicker services" with 40% response. Other important factors were "routes more accessible" with 27.1%, "comfortable service" held 15.7% of the respondents' vote. While "fare inexpensive" held 14.3% of respondents' vote as well.

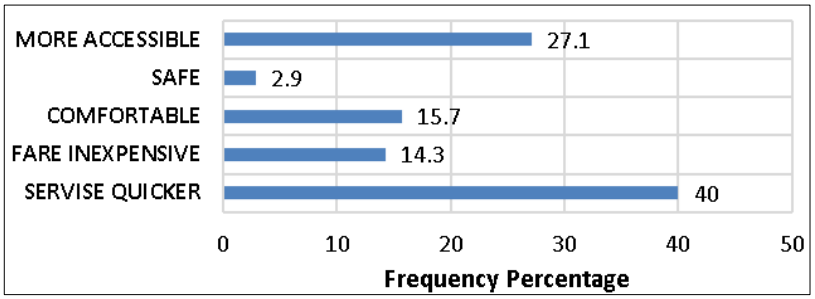

Fig. 5. Factors effecting Respondents to shift from private vehicle to public transport.

Figure above represents the major deterrents to drivers shifting to public transport. Which means that the most discouraging factor currently is the long travelling time with 40% response.

3.3. Model Shift Cases

3.3.1. Bus dwell time reduction

One of the suggestions to reduce carbon emission inside city center of Kuala Lumpur is bus time reduction that helps to reduce the travel time of journey for city center and the areas around the city centre.

As shown in Fig. 6, it can be noticed that the percentage of responders who tends to use public transportation will be increased when bus travel time is reduced. According to logit model, if the bus traveling time can be reduced by 60%, around 99% of the responders would take it instead. If the reduction were 45%, 88% would switch to public transport. While if the reduction were 30%, 20% would switch to public transport as well. Hafezi and Ismail [22] suggested that decreased dwell time results in shorter journey time, and buses arrive at the destination terminal close to their scheduling which results to encourage people to use public transportation for inter-city trips [22].

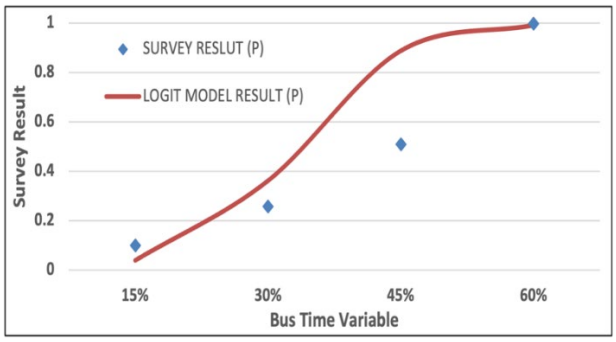

Fig. 6. Logit model for bus time reduction.

3.3.2. Increasing parking cost

Another suggestion that has been brought to this study was increasing parking fees per hour. Low parking fees is the one of the reasons that people remain to using private car in city center of Kuala Lumpur, so we propose the possibility of imposing fees on parking within the city centre.

As shown in Fig. 7 the respondents were asked if an increase in parking cost would shift them to public transport. The present cost was assumed to be RM4/hour and 88% of respondents will shift if the cost remains RM4/hour. 99.5% of respondents would shift to public transport if the cost of parking fee will raise to RM5/hour. With RM3/hour parking cost, 20% of the responders will shift to public transportation as well. Finally, 7% of respondents have agreed to shift to public transport when parking fees reduced to RM2/hour. Increasing parking charges would cause a decrease in term of private vehicles travel into the city-centre which was in concur with other studies [3,7,23].

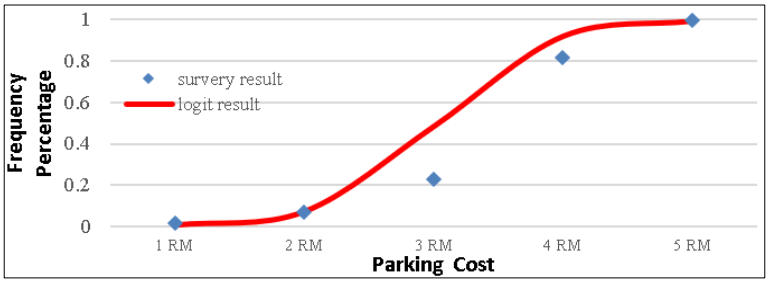

Fig. 7. Logit model for increasing parking fees.

3.3.3. Increasing fuel cost

Last suggestion was increasing fuel cost from current cost in order to force people to shift to public transport. Reduced price of fuel cost per liter (RM2.08) is the fuel cost in September 2019 due to subsidization in fuel cost from Malaysian government.

Figure 8 shows that higher percentage of responders accept to switch to public transport when fuel cost increased, the switching percentage still increased until reach to 99.5% when imposing RM2.5 per liter for fuel price. Shahid et al. [24] suggested measures to reduce CO_2 emission by diversification of fuel and developing public transportation systems which have the same target of shifting to public transport [24].

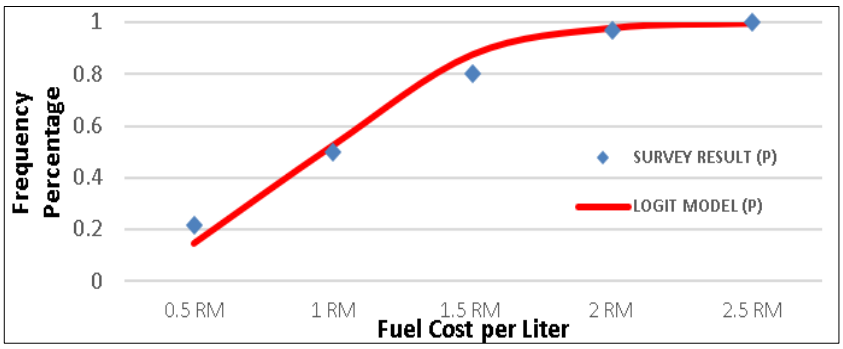

Fig. 8. Logit model for increasing fuel cost.

It can be shown that the difference among the factors that encourage people to shift to public transport. The survey illustrates that the main factor which effect shifting to public transport is increasing fuel cost due to high-shifting percentage when increasing fuel cost above RM2 per litre.

4. Conclusions

Income, travelling time and cost are the major factors that influence the transport choice made. The most important variables found likely to encourage the use of public transport were the increasing of fuel cost, faster travel by public transport and subsidized fares. Most of the workers in city center of Kuala Lumpur found the private vehicle more comfortable than the public transport and 37% of them found the service takes long time to reach the destination, while 19% found the buses not comfortable. 35.7% feel indifferent when they are using public transport, while around 25% of the private vehicle users feel inconvenient in public transportation.

The current survey showed that reduce carbon emission inside city centre of Kuala Lumpur can be done by shifting to public transport which can be made by following some policies. One of these policies is increasing fuel cost, reduce bus travel time, and increasing parking cost.

Nevertheless, Comfort of vehicle can be an important factor by private vehicle users, while 37% of respondent discourage using public transport due to long time ride. Therefore, it is possible to conclude that there are negative perceptions towards public transport in KLCC in term of long-time ride and comfortability of private vehicles.

Nomenclatures

$f(x)$	Analytic Function
MP	Mobility Plans
P	Logit Model
RM	Malaysian Ringgit
RP	Revealed Preferences
SP	Stated Preferences

Abbreviations

GHG	Greenhouse Gas
KLCC	Kuala Lumpur City Centre
SPSS	Statistical Package for the Social Sciences

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