Intercity Mode Choice Behaviour Post-Movement Control Order Associated with the Covid-19 Pandemic in Malaysia

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Abstract: The intercity travel behaviour has changed substantially post-Movement Control Order (MCO) associated with the Covid-19 pandemic due to higher level of risk perception and health concerns towards transmission of Covid-19. Consequently, the objective of this study was to develop a mode choice behaviour model for estimating the intercity travel demand post-MCO. Multinomial logistic regression analysis on 500 regular users of public transport demonstrated that a modal shift from public to private transport has occurred among younger age populations, and for those who has higher risk perception and value of a statistical life (VSL). The increase in travel fare will reduce the likelihood to travel intercity by bus and train. Meanwhile, female populations were still favoured to travel by train. These findings are crucial for transport policy maker and public transport service provider to seek alternative solutions to increase the confidence level of public transport users during the Covid-19 pandemic.

Keywords: Intercity travel, Mode choice behaviour, Covid-19, Movement Control Order, MCO, VSL

1. INTRODUCTION

Intercity public transport services such as intercity bus, intercity train and intercity flight provide efficient and equitable transport alternatives for Malaysians. However, the mode choice behaviour of intercity public transport services depends upon many factors, for instance, individual factors such as demographic and socioeconomic, travel mode factors such as cost, availability, regularity, punctuality, efficiency of the intercity public transport services and trip characteristics such as purpose, length, and group size.

The international economy is characterized by uncertainty caused by the outbreak of the 2019 novel coronavirus disease (2019-nCoV or Covid-19). In Malaysia, the execution of the Movement Control Order (MCO) beginning 18 March 2020 with the aim of breaking the chain of Covid-19 transmission has tremendously affected the mobility of communities as well as the intercity private and public transport services. The effect of MCO and the interruptions to intercity public transport services have impacted the passengers' quality of life in several ways, for example, passengers were restricted to travel more than 10 km from

home, in case of emergency, passengers were unable to travel due to cancellation or fewer discretionary trips in the absence of private vehicle ownership, increased cost of travels for alternatives in case of emergency travel, lack of spontaneity with fewer travel choices and feeling of a risk of infected with Covid-19 diseases when travelling on intercity public transport services.

Table 1 shows the phases of MCO in Malaysia. Generally, there are three phases of movement control in Malaysia - Movement Control Order (MCO), Conditional Movement Control Order (CMCO) and Recovery Movement Control Order (RMCO). During the MCO phase, interstate and intercity travels are totally prohibited where movement is only permitted within 10 km from home and exceptions will only be given with prior approval, which is stringent and rigorous. In the CMCO phase, interstate travel is still prohibited, however, intercity travel within the same state is possible provided that the origin and destination are categorized as green zones[1]. During the RMCO phase, restriction for interstate and intercity travels are allowed for green zones.

Table 1: Phases of movement control in Malaysia

MCO	CMCO	RMCO	
		10th June 2020 to 31st March 2021 (Whole country)	
18th March 2020 to 3rd May 2020 (Whole country)	4th May 2020 to 9th June 2020 (Whole country)	CMCO*	MCO*
		13th October 2020 to 12th January 2021 (Red Zones)	13th January 2021 to 31st March 2021 (Red Zones)

* Only for selected location declared as red zones.

Physical distancing will be essential to slow community transmission of Covid-19 until effective solutions to tackle the community transmission has been identified. Therefore, there was a massive reduction in intercity travel using public transport (Halid, 2020; Tan; 2020; Yahya, 2020). A modal shift from public to private vehicle for intercity travel was expected to increase as health concerns and preventive measure to reduce risk exposure of Covid-19. Thus, the objective of this study was to develop an intercity mode choice behaviour model that could be used to estimate intercity travel demand post-MCO. Five intercity transportation modes were identified and considered in the study: intercity bus, intercity train, intercity flight, private vehicles, and e-hailing services.

As indicated earlier, a modal shift from public to private vehicles for intercity travel was expected due to health concerns, thus private vehicle (including e-hailing services) choice was selected in the study as a control variable. The mode choice behaviour model developed would provide useful insights for transport policy maker as well as intercity public transport service provider in the planning and execution of their policies and services, respectively, towards a more sustainable transport development pathway post-MCO.

The rest of the paper is organized as follows. Section 2 provides the study design, whilst Section 3 presents empirical results. Section 4 contains discussion and conclusion of the study.

2. THE STUDY DESIGN

[1] Green zones are defined as area with zero community-transmitted Covid-19 cases, yellow zones are areas with 1 to 40 cases of community-transmitted Covid-19 cases while red zones are areas with more than 40 community-transmitted Covid-19 cases within the last 14 days. The Ministry of Health Malaysia divided the 13 states and 3 federal territories in Malaysia into 148 zones. (MOH, 2020).

Mode choice or the choice in selecting a transport mode when travelling plays a crucial role in transport planning. Understanding mode choice behaviour could help transport policy maker in formulating effective transport policies without under- or over-estimating demand and supply. Mode choice behaviour models are models used to predict the likelihood of a traveller choosing a given mode of transportation for any trip using the discrete choice modelling method (Chang and Yeh, 2017; Allard and Moura, 2018; Mattson et al., 2018; Van Acker et al., 2020). These models are very useful to estimate modal splits and to predict volumes of travel when estimated total trip volume is known. Generally, factors affecting mode choice behaviour can be differentiated into three major groups: (1) individual factors or traveller characteristics, (2) travel mode factors or characteristics of the different modes of transportation and (3) characteristics of the trip itself.

The traveller characteristics include demographic and socioeconomic factors of the traveller. Demographic factors are factors such as age, gender, marital status, education while socioeconomic factors include income, vehicle-ownership, ability to drive, preferences and attitudes. The characteristics of the different mode of transportation include cost, travel time, comfort and convenience, service frequency, need for transfer, and access for mode choice. Trip characteristics include trip purpose, trip length, and size of party.

Intercity travel means travelling from one city to another city. Usually, intercity travels are categorized as long-distance journey as compared to intracity travels. In Malaysia, both private and public transport are common modes of transportation for intercity travels. However, intercity public transport services play an essential role in providing mobility for the efficient movement of Malaysians especially for vulnerable road users such as children, young adults, and senior citizens as these groups usually are not fit to drive. Intercity bus services and intercity train services are common modes of public transportation in Peninsula Malaysia while domestic air services and waterways served as common mode of public transportation in Borneo Malaysia.

Previous studies demonstrated that cost and time are two of the most important factors that affect the intercity mode choice (Kumar et al., 2004; Andrade et al., 2006; Zhang et al., 2012; Aparicio, 2016; Ranjbari et al., 2017). However, other characteristics such as service frequency, waiting time and overall quality (Cascetta and Carteni; 2014; Chen and Li, 2017; Ranjbari et al., 2017; Lannoo et al., 2018); access, egress, and transfer times (Zhang et al., 2012) were also found significantly correlated with the intercity mode choice. In addition, demographic factors such as age, gender, education, and profession (Kumar et al., 2004; Aparicio, 2016) and socioeconomic factors, such as income (Kumar et al., 2004; Arbués et al., 2016; Hess et al., 2018; Llorca et al., 2018) were also important contributing factors to intercity mode choice. Arbués et al. (2016) indicated that low-income individuals are more likely to use bus and train for intercity travels while Llorca et al. (2018) showed that high-income individuals are more likely to travel intercity using airplanes.

Meanwhile, trip characteristics play an important role in influencing the mode choice. Previous studies showed that transit is a closer substitute for the private vehicle for commuter or business trips than for leisure travel (Storchmann, 2001; Ranjbari et al., 2017; Hess et al., 2018). Business travellers may be motivated differently from those traveling for personal reasons. On the other hand, the size of the travel party was recognized as one of the important factors that affect the mode choice. As the size of the travel party increases, the private vehicle becomes more cost-effective compared to public transport. However, the size of party is commonly ignored in mode choice studies (Miller, 2004).

In this study, some of the factors under the category of travel mode factors and trip characteristics were not included in the survey as this study focus more on the effect of Covid-19 pandemic and MCO on intercity travels. Therefore, the questionnaire was designed

based on the hypothesis that the intercity public transport services will only recover when the Covid-19 is under control and the demand increases. Thus, the perception of travellers towards an improvement in travel safety of the intercity public transport services was surveyed using the willingness-to-pay (WTP) and willingness-to-accept (WTA) approach to obtain useful information from the passengers' perspective.

In general, WTA is a monetary measure of a small risk increase, and WTP is a monetary measure of a small risk reduction. Both WTA and WTP emphasise the importance of individual preferences towards changes in the level of risk (Ng et al., 2013). In this study, WTP denotes the maximum amount of money an individual is willing to pay to obtain protection to reduce the risk exposure to Covid-19 when travelling via the intercity public transport services, and WTA denotes the minimum amount of money that an individual willing to accept to relinquish their protection and increase the risk exposure to Covid-19. It was hypothesized that population with higher WTP or WTA were more health concerns and has higher perception on risk exposure, therefore, it was expected that this group will shift to private mode for intercity travel post-MCO. The WTP or WTA could be used to estimate the value of a statistical life (VSL) provided the risk exposure to Covid-19 is known.

The VSL is the marginal rate of substitution between income and risk reduction or risk increase. It indicates a trade of how much a person is willing to pay (WTP) to reduce risk or how much a person is willing to accept (WTA) to increase risk. VSL is commonly adopted to evaluate the effectiveness of government's policies designed to improve health and social welfare as well as to reduce risk factors that adversely affect the health and well-being of an individual or society. Previous research related to VSL includes studies by Kim (2003), Adler et al. (2014), Gentry et al. (2016), Niroomand and Jenkins (2016), Mon et al. (2019) and Fan et al. (2021). In this study, the trade-off was estimated in hypothetical scenario based on the individual's WTP or WTA in ticket purchasing for the decrease or increase risk of infected with Covid-19. The Covid-19 risk exposure were estimated based on the infection rate per 10,000 population within the location that the respondent resides. The Covid-19 risk exposures estimated as of 30th September 2020 were summarized as indicated in Table 2.

Table 2: Covid-19 risk exposure in Malaysia (as of 30th September 2021)

Risk	Location
1 in 10,000	Kelantan, Perak, Pulau Pinang, Terengganu
2 in 10,000	Johor, Kedah, Perlis
3 in 10,000	Federal Territory Labuan, Melaka, Pahang, Sarawak
4 in 10,000	Selangor
6 in 10,000	Sabah
10 in 10,000	Negeri Sembilan
14 in 10,000	Federal Territory Putrajaya
16 in 10,000	Federal Territory Kuala Lumpur

2.1 The Questionnaire Survey

In this study, a questionnaire was designed to obtain information about a range of factors regarded as likely to influence the intercity travel change behaviour. These data were collected from individuals throughout Malaysia using telephone interviews[2] from October to December of 2020. The interview was conducted by trained enumerators and used a random

[2] Telephone interview was chosen instead of face-to-face interview to reduce the risks of enumerators infected with Covid-19 when they meet up with strangers during the interview.

sampling of 500 individuals from various states and federal territories in Malaysia.

The questionnaire survey consisted of sixth parts. The first part involved an eligibility screening to determine the eligibility of the respondents to participate in the survey. In the eligibility screening, only respondents who fit into the following criteria were recruited: (1) travel intercity at least 10 times within 2019, (2) travel intercity using a public transport at least 50% of the times within 2019 and (3) travel intercity using a public transport at least once after the MCO ended, from 10th June 2020 to 13th October 2020. There was a 3-stage screening process during the telephone interview.

In the stage one screening, respondent was asked, "*Do you travel at least 10 times intercity during 2019? For example, you are staying in Kuala Lumpur, but you travel to other city in Malaysia such as Johor Bahru for work, business, vacation, going back to hometown or etc?*" If the respondent answer "*Yes*", the telephone interview proceeds, else, the telephone interview will end, and the respondent will be thanked for participating in the interview.

The stage two screening consists of two questions. The first question was frame as, "*Do you use public transport such as bus, train, or flight when you travel intercity during 2019?*" The telephone interview proceeds if the respondent answer "*Yes*". Otherwise, the telephone interview will end. The next question asked was, "*If you travelled 10 times intercity during 2019, how many times you use a public transport such as bus, train, or flight when you travel?*" If the respondent provides any answer less than 5 times, the telephone interview will end, and the respondent will be thanked for participating in the interview. Respondent who answers 5 times or more, will proceeds to the next screening stage.

During the stage three screening, respondent was asked, "*Do you use public transport such as bus, train, or flight when you travel intercity after MCO (from 10th June 2020 to 13th October 2020)?*" If the respondent answer "*No*", the telephone interview will end, and the respondent will be thanked for participating in the interview. Otherwise, the telephone interview continues where respondent must answer the next screening question, "*If you travelled 10 times intercity after MCO, how many times you use a public transport such as bus, train, or flight when you travel?"* If the respondent provides answer between 1 to 10 times, the telephone interview proceeds, otherwise, the respondent will be thanked for participating in the interview. A qualified respondent who has passed all the three stages of screening could proceed to the next section in the telephone interview. The screening procedure was summarized as indicated in Figure 1.

The second and third part of the questionnaire gathered the respondent's intercity travel pattern in 2019 (pre-MCO) and after MCO (post-MCO), respectively. The fourth part of the questionnaires compares the respondents' intercity travel behaviour before and after MCO. Several questions asked the respondents about their attitudes and behaviours towards the selection of transportation mode for intercity travel and method of ticket purchasing in case a public transport is used for the intercity travel. The fifth part consists of the stated preference questions related to WTA and WTP in terms of risk exposure to Covid-19. The last part of the questionnaires collected information on the respondents' demographic.

Regarding the baseline risks, all respondents were informed that 3 in 10,000 populations in Malaysia were suffered from Covid-19 disease as of 30th September 2020. They were also informed regarding their risk's exposure staying at their current location which varies between 1 to 16 in 10,000 populations depending on the location they reside. The statement was framed as, "*3 in 10,000 people in Malaysia suffered from Covid-19 diseases as of 30th September 2020 and x in 10,000 people in your community suffered from Covid-19 diseases as of 30th September 2020.*"

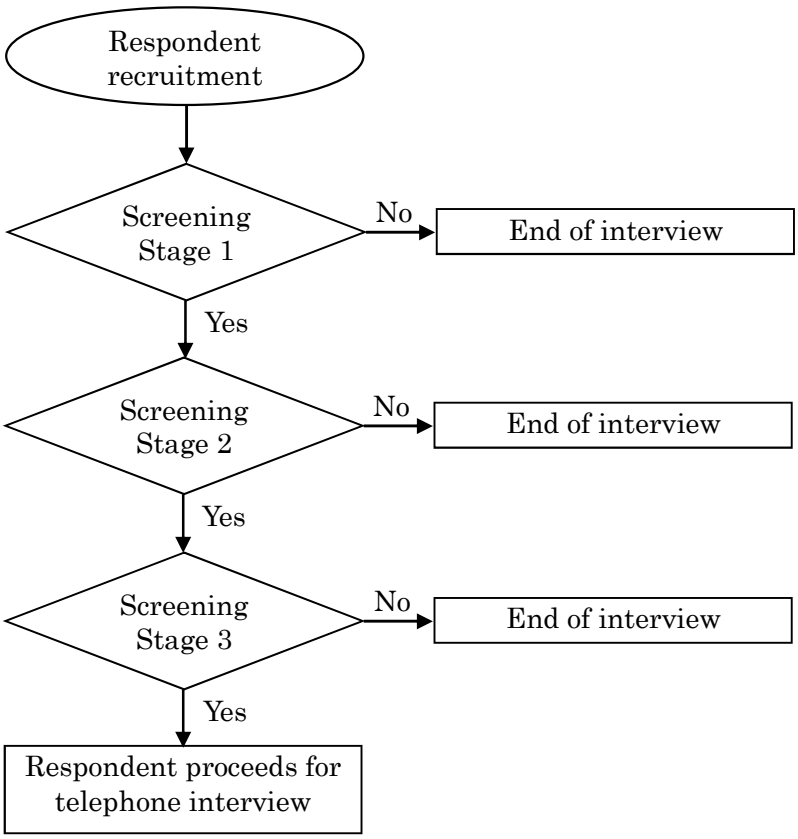

Figure 1: Screening procedure to recruit respondent

In the stated preference question, respondents were asked about saving certain amount of money for increasing their risk in Covid-19 infection when they purchase ticket over the counter for intercity travel. The WTA question was framed as, "*Imagine that now you need to travel to (the intercity location you frequently travel to) using (the public transport you mentioned). You can only purchase the travelling ticket over the counter. Purchasing ticket over the counter can increase your risk of infected with Covid-19 by 50%. Due to this, the public transport company has offered a discounted rate for you when you purchase the ticket over the counter. What is the price of ticket would you be willing to accept when you purchase ticket over the counter that can increased your risk of infected with Covid-19 by 50%?*

Meanwhile, the WTP question was framed as, "*Imagine that now you can only purchase the travelling ticket online. Purchasing ticket online can reduce your risk of infected with Covid-19 by 50%. However, purchasing ticket online is far more expensive. How much would you be willing to pay to purchase a ticket online so that you can decreased your risk of infected with Covid-19 by 50%?* Prior answering the stated preference questions, respondent was asked about the intercity location that they frequently travel to and the type of intercity public transport that they used when they travel. The two-way ticket price for travelling to the intercity location as mentioned by the respondent using a particular public transport was also surveyed.

2.2 Estimation Methodology

Mode choice behaviour models are often estimated using data collected from stated

preference (SP) surveys, which are also referred to as stated choice experiments. Several transportation studies utilized a SP survey to analyse transportation alternatives, for example Dehghani et al., 2002; Richardson, 2002; Kumar et al., 2004; Andrade et al., 2006; Richardson, 2006; Pinjari and Bhat, 2006; Mattson et al., 2010; Tuan, 2015 and Mattson et al., 2018. These studies analysed the data using a discrete choice modelling technique. Discrete choice modelling is popular in transportation and marketing research for understanding an individual's stated choice among alternatives. The multinomial logistic model has been traditionally used to model the choice among alternative modes in intercity travel demand modelling (Koppelman and Sethi, 2005).

In the telephone interview, respondents were asked about their choice of selecting a transport mode for intercity travel with five discrete outcomes, which are *using a bus*, *using a train*, *using a flight*, *using a private vehicle* and *using an e-hailing services,* post-MCO. The multinomial logistic regression (MLR) is an appropriate technique when the dependent variable is categorical, and the explanatory variables are continuous or categorical. It directly estimates the probability of selecting a transport mode subject to a set of factors. Among factors included are demographic factors such as age and gender, household income, household size, whether the respondent is the main income earner in the household, travelling cost, risk perception towards Covid-19, and the VSL.

The MLR analysis was performed using *"use a private vehicle or an e-hailing services"* as the reference category. MLR estimates the odds (logit) $Mode_{ik}$ of an observation i falling in a class k relative to a reference category, the equation can be written as follows.

$$Mode_{ik} = \hat{\beta}_{k0} + \hat{\beta}_{k1}x_{i1} + \hat{\beta}_{k2}x_{i2} + ... + \hat{\beta}_{kj}x_{ij} \tag{1}$$

where x_{ij} is the jth predictor for the ith case, $\hat{\beta}_{kj}$ is the jth coefficient for the kth unobserved variable, and j is the number of predictors. The corresponding probability of observation i will result in class k can be written as,

$$P_{ik} = \frac{Exp\left[Mode_{ik}\right]}{\sum_{j=1}^{k} Exp\left[Mode_{ij}\right]} \tag{2}$$

The VSL could be estimated using the following equation,

$$VSL = \frac{WTA}{\Delta Risk} = \frac{WTP}{\Delta Risk} \tag{3}$$

3. RESULTS

3.1 Participants demographics and characteristics

A total of 538 responses were obtained from the telephone interview. However, only 500 were included in the study after data cleaning. This study revealed that a modal shift from public to private vehicles for intercity travel has occurred post-MCO. The results shows that 34.8% of the regular public transport users for intercity bus, intercity train, and intercity flight pre-MCO has shifted to private vehicle or e-hailing services post-MCO as indicated in Table 3 and Figure 2.

Table 3: Intercity travel mode selection pre- and post-MCO

Mode of intercity travel	Pre-MCO (2019)	Post-MCO
Bus	52.6%	32.8%
Train	20.0%	11.2%
Flight	17.6%	11.4%
Private vehicle or e-hailing services	9.8%	44.6%
Total	100.0%	100.0%

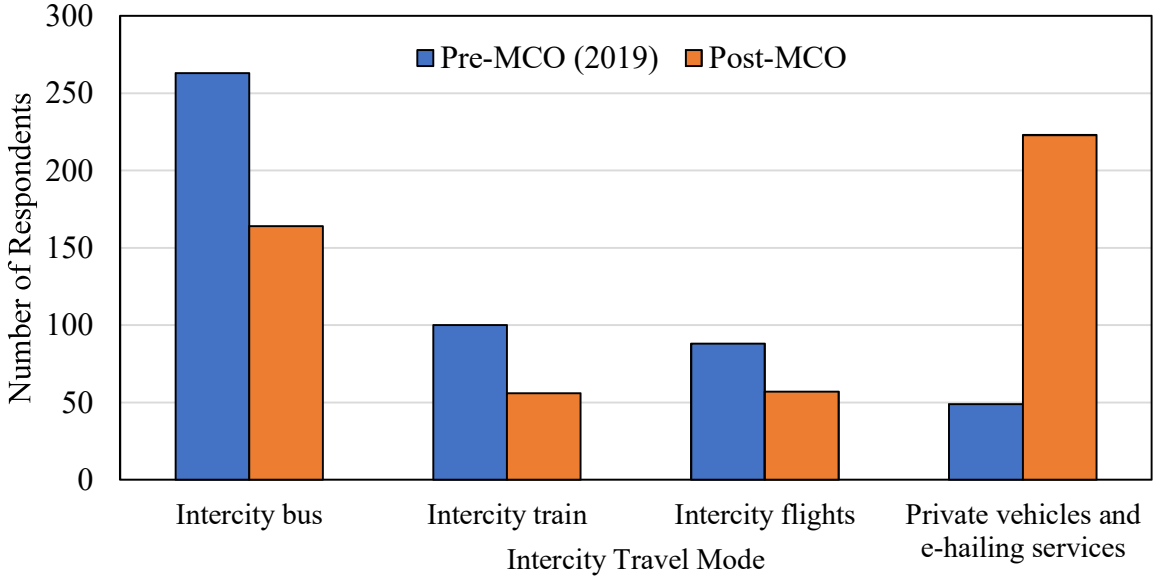

Figure 2: Comparison on intercity travel mode selection pre- and post-MCO

A total of 61.8% of respondents reported that their intercity travel behaviour using a public transport change post-MCO while the rest remain the same. Amongst the respondents who reported a travel behaviour change, 79.6% claimed that the change in intercity travel behaviour post-MCO was associated directly to Covid-19 pandemic, for examples, they were afraid of being infected with Covid-19 when they travel intercity using a public transport, they have self-awareness on the Covid-19 risk, prevention and transmission that could risk their life and their beloved family members. On the other hand, 20.4% of the respondents revealed that the change in intercity travel was not directly associated with the Covid-19 pandemic. These changes were mainly due to government policy on the restriction for interstate travel, less needs for intercity travel as working from home or studying online post-MCO, increase in travelling costs that reduces the likelihood for intercity travel (public transport ticket price for intercity travel was far more expensive and with less choice), income reduction and financial burden post-MCO.

A summary of respondents' demographic characteristics and variables used in the MLR was presented in Table 4. Most respondents were aged 23-30 years old (56.2%), female (52.6%), not the main income earner in the household (68.2%), having household income of less than RM 5,000 per month (51.2%), perceived the same risk of infected with Covid-19 in relation to the people staying in their community (35.8%). Other data used include household size (M = 4.55, SD = 2.09), intercity travel cost (M = 121.24, SD = 175.09) and natural log of VSL[3] (M = 12.21, SD = 1.46). The VSL value was computed using the WTP, hence, data for

[3] The VSL variable was transformed to a natural log prior to the MLR to reduce the heteroskedasticity and

WTP was also provided in Table 4.

Table 4: Descriptive statistics

Variables	Description	Number (Percentage)
Responses	Total number of responses	500
Mode	Transport mode selected for intercity travel	
	= 1 if bus	32.8%
	= 2 if train	11.2%
	= 3 if flight	11.4%
	= 4 if private vehicle or e-hailing services	44.6%
Age	Age group of respondents	
	= 1 if ≤ 22 years old	18.4%
	= 2 if 23-30 years old	56.2%
	= 3 if ≥ 31 years old	25.4%
Gender	Gender of respondents	
	= 1 if female	52.6%
	= 2 if male	47.4%
Earner	Main income earner in the household	
	= 1 if no	68.2%
	= 2 if yes	31.8%
HIncome	Household income	
	= 1 if < RM 5,000	51.2%
	= 2 if ≥ RM 5,000	48.8%
Risk	Risk perception towards infection of Covid-19	
	= 1 Lower	30.4%
	= 2 Same	35.8%
	= 3 Higher	33.8%
Size	Size of household	
	Minimum	1
	Maximum	17
	Mean	4.55
	Standard deviation	2.09
TCost	Intercity travel cost	
	Minimum	9.00
	Maximum	2000.00
	Mean	121.24
	Standard deviation	175.09
lnVSL	Natural log on value of a statistical life	
	Minimum	8.36
	Maximum	17.22
	Mean	12.21
	Standard deviation	1.46

improve the interpretation of the relative elasticity value of the estimates.

WTP	Willingness to pay	
	Minimum	13.00
	Maximum	2002.00
	Mean	149.50
	Standard deviation	206.95

3.2 Results for Multinomial Logistic Regression

Two MLR models were developed to describe the mode choice behaviour of respondents on their intercity travel post-MCO. The independent variables, such as age, gender, risk perception towards infection of Covid-19, main income earner, household income was categorical in the analysis. The size of household, natural log of VSL and intercity travel cost were continuous variables in the analysis.

The estimated coefficients (the log-odds) for the MLR models of mode choice for intercity travel, where the reference category was *using a private vehicle or e-haling services*, was presented in Table 5. The coefficient estimates were interpreted as follows: a positive significant coefficient indicated that the mode choice for intercity travel was similar to the compare category, whereas a negative coefficient indicated that the mode choice for intercity travel was similar to the reference category.

Table 5: The multinomial mode choice model estimates for intercity travel post-MCO

Independent variables	Model					
	A			B		
	Private versus Bus	Private versus Train	Private versus Flight	Private versus Bus	Private versus Train	Private versus Flight
Intercept	2.661**	2.735*	-1.977	2.919**	3.162**	-1.648
lnVSL	-0.243**	-0.229*	-0.130	-0.224**	-0.196	-0.100
TCost	-0.003*	-0.014**	0.011***	-0.003*	-0.014**	0.011***
Age (relative to ≥ 31 years old)						
≤22 years old	-0.726**	-2.261***	-1.562**	-0.232	-1.812**	-1.047
23 – 30 years old	-0.132	-1.179***	-0.616	0.147	-0.834*	-0.375
Gender (relative to male)						
Female	-0.486**	0.598**	-1.118**	-0.252	0.827**	-0.889*
Risk (relative to higher risk)						
Lower risk	0.504*	-0.301	1.169**	0.586**	-0.102	1.259**
Same risk	0.823*	-0.103	1.359**	0.882***	0.026	1.503**
Earner (relative to yes)						
No				-0.873**	-0.705*	-0.541
HIncome × Size						
< RM 5,000 × Size				-0.061	-0.322**	-0.264*
≥ RM 5,000 × Size				-0.045	-0.078	-0.064
	-2 log likelihood = 933.641			-2 log likelihood = 915.482		
	χ_{21}^2 = 272.153***			χ_{30}^2 = 300.252***		
Pseudo-R^2 (Nagelkerke)	0.460			0.495		

Note:
Private = private vehicle or e-hailing services, bus = intercity bus, train = intercity train, flight = intercity flight
* p < 0.1, ** p < 0.05, *** p < 0.001

As shown in Table 5, the overall goodness of fit as measured by pseudo-R-squared (Nagelkerke) were 46.0% and 49.5%, respectively for model A and model B which were considered satisfactory for qualitative regression model based on questionnaire survey data

(Boumtje *et al.*, 2005). The log-likelihood ratio test[4] was highly significant for all models (p-value <0.001), suggesting that the models explained a significant amount of the original variability (Field, 2017). The significance of each explanatory variable was tested separately to control for type 1 error.

3.2.1 Results on "Private versus Bus"

With respect to the choice of selecting intercity bus versus private vehicles or e-hailing services, lnVSL was negative and statistically significant in both models A and B, indicating that populations who had higher health concerns towards Covid-19 were more likely to travel intercity with private vehicles or e-hailing services post-MCO. The intercity travel cost variable was statistically significant and negative in both models, demonstrating that higher travelling cost will induce bus user to switch to private vehicles or e-hailing services. The coefficient's sign for younger population (less than or equal to 22 years old) was negative and significant in Model A, suggesting that younger population were more likely to use private vehicles or e-hailing services to travel intercity post-MCO as compared to populations greater than 31 years old. Compared to male, female populations were more likely to use private vehicles or e-hailing services to travel intercity. For populations who perceived lower or same risk of Covid-19 infection in relation to other people staying in their community, they were more likely to travel intercity by bus as compared to the populations who perceived higher risk of Covid-19 infection. Model B also shows that populations who are not the main income earner in a household were more likely to travel intercity by private vehicles or e-hailing services post-MCO.

3.2.2 Results for "Private versus Train"

Regarding mode choice behaviour between intercity train versus private vehicles or e-hailing services, the coefficient sign for lnVSL was also negative and statistically significant in Model A, implying that populations who had higher health concerns towards Covid-19 were more likely to use private vehicles or e-hailing services to travel intercity post-MCO. The coefficient sign for intercity travel cost was negative and significant in both models, showing that train users would likely to travel intercity using private vehicles or e-hailing services when travel cost increases post-MCO. Compared to elder populations, younger populations (those below 30 years old) were more likely to travel intercity by private vehicles or e-hailing services. On the other hand, female populations were more likely to travel intercity by train as the coefficient was positive and significant in both models. Similarly, populations who were not the main income earner in the household were more likely to travel intercity by private vehicles or e-hailing services post-MCO. Household income and size of household played an important role in the selection of intercity travel mode post-MCO. The interaction variables of household income and size of household shows that when size of household increases, populations with household income below RM 5,000 per month were more likely to travel intercity using private vehicles or e-hailing services.

3.2.3 Results for "Private versus Flight"

For the mode choice selection between intercity flights versus private vehicles or e-hailing

[4] The log likelihood measures how much unexplained variability is in the data. Hence, the difference in log likelihood implies how much new variance has been explained by the model.

services, lnVSL was not significant in both models A and B, suggesting that the used of intercity flight was not related to the health concerns. The intercity travel cost variable was statistically significant and positive, implying that traveling cost increase would leads to higher likelihood in the selection of intercity flights. The coefficient for female population was statistically significant and negative, suggesting that female populations were more likely to travel intercity by private vehicles or e-hailing services compared to male. Similarly, populations who perceived lower or same risk of Covid-19 infection in relation to other people staying in their community were more likely to travel intercity by flight. When the size of household increases, population in the lower household income category (less than RM 5,000) were more likely to use private vehicles or e-hailing services for intercity travel.

4. DISCUSSIONS AND CONCLUSIONS

This survey was particularly designed to measure the effect of Covid-19 pandemic and the MCO on intercity travel, especially for regular public transport users in Malaysia. Therefore, travel mode factors such as cost, availability, regularity, punctuality, efficiency of intercity public transport services were not surveyed in the telephone interview. Instead, the risk perceptions and health concerns towards the infection of Covid-19 disease, measured in terms of risk and VSL, were surveyed. In the MLR analysis, all estimated coefficients possessed the expected signs and statistically significant. Therefore, the MLR models developed were acceptable for this study as McFadden (1979) suggested R-squared values between 0.2 to 0.4 for excellent fit in mode choice behaviour model.

In this study, it was hypothesized that population who were more health concerns will switch to private mode to reduce the risk of infected with Covid-19 when they travel intercity. The results supported this hypothesis showing that populations who has higher lnVSL were more likely to use private mode post-MCO instead of intercity bus and train. The mean VSL value computed using the WTP was RM 200,787 (lnVSL =12.21). Regarding the risk perception, populations who perceived that they have the same or lower risks of infected with the Covid-19 in relation to other people in their community were more likely to travel intercity by bus or by flight.

Generally, travel cost was a significant factor that explained the choice of transport for intercity travel. The increased in travel cost would induce a switch from intercity bus and train to private mode. However, a contradict result was obtained for intercity flight. Higher travelling cost will induce the use of intercity flight. This could be explained by the following points: (1) Certain origin and destination could only reach by flights instead of other mode of transportation. For instance, travelling from any states in Peninsular Malaysia to Borneo Malaysia or vice versa. (2) The Eastern region of Peninsular Malaysia (Pahang, Terengganu and Kelantan) has limited high mobility road network and slower rail network as compared to the Northern, Centre and Southern regions of Peninsular Malaysia. Thus, intercity flight would be a better option for intercity travel to the Eastern region of Peninsular Malaysia. (3) Intercity travel within Borneo Malaysia (Sabah, Sarawak and Federal Territory Labuan) highly depend upon flights as the topography of Borneo Malaysia is less suitable for road and rail network development. (4)

Younger populations were more likely to use private mode as compared to elder populations (greater than 31 years old) post-MCO. This is particularly true especially for younger age group below 23 years old. This could be attributed to majority of this age group were students that highly depend upon public transport when they travel intercity. However, the Covid-19 pandemic and MCO has forced education system in Malaysia to online mode.

Thus, this group might had reduced their intercity travel using public transport post-MCO as online mode does not required this group to travels.

Gender was a significant variable in predicting the intercity mode choice behaviour post-MCO. Female populations were more likely to travel with private mode in relation to male population in intercity travel by bus or flight post-MCO. However, an interesting finding in the analysis revealed that female populations were more confident with intercity train as compared to private mode post-MCO.

With respect to economic factors, personal income was not a significant predictor in this study to explain the mode choice behaviour model which is contradict to previous research (Kumar et al., 2004; Arbués et al., 2016; Hess et al., 2018; Llorca et al., 2018). However, another variable, the main income earner in a household was a significant predictor in this study. For populations who were not the main income earner in a household, they were more likely to travel intercity with private mode. Household income and household size also played a significant role in affecting the mode choice behaviour. Generally, when the household size increases, the tendency to travel intercity by private mode was greater as it is more economical to travel intercity with private vehicles than public transport. This result is consistent with previous research as indicated by Miller (2004), Al-Ahmadi (2006) and Miskeen et al. (2013).

The objective of this study was to develop a mode choice behaviour model that could be used to estimate the intercity travel demand using public transport in Malaysia post-MCO. The two models, Model A and Model B developed indicated that an increase in travel cost would contribute to the shift from intercity bus and intercity train to private mode. Younger age populations were more likely to use private mode as compared to populations greater than 31 years old post-MCO. This implies that a modal shift from public to private mode for intercity travel had occurred among younger age regular public transport users. Female populations were still favoured to travel intercity by train. Last but not least, the findings from this study would be useful for policy maker and public transport service provider to look into potential planning and execution of their policies and services, to develop a sustainable intercity transport policy during the Covid-19 pandemic in Malaysia.

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