Modeling Approach on Existing Competition of Intercity Land Public Transport in Malaysia: A Case Study on Bus Users in Kuala Lumpur - Penang Corridor

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Abstract

Based on the existing competition among intercity land public transport modes, the intercity bus is preferred to the train. But lately in Malaysia, bus is confronting more challenges. It is crucial to address this problem, since intercity bus transport plays an important role in the intercity transportation system in this country. This research aims to determine the influencing factors for intercity land transport mode competition in Malaysia based on the Stated Preference (SP) and binomial logit model. A paper based survey was designed in the form of Reveal Preference (RP) questions and Stated Preference (SP) questions. A total of 12,000 data set was analyzed to calculate bus preference probability by using SP technique and binary logit equation. SP questions designed in the form of two scenarios: intercity bus scenario and intercity train scenario. The intercity bus scenario represents the changes to intercity bus service values, meanwhile the intercity train scenario represents the changes to intercity train service values. It is really interesting finding that the bus users have a different perception on the value service changes of their current mode toward their mode’s competitor. This study considers providing a better understanding of higher intercity bus ridership against the train in Malaysia based on the four determined explanatory attributes.

Keywords: intercity land mode competition; stated preference; binomial logit; sensitivity

INTRODUCTION

The intercity land modes challenges in Malaysia will be an interesting issue to discuss. The challenges are related to fare, travel time, departure frequency and access time competition. A field survey has been conducted in order to collect some information on selected Origin-Destination (O-D) pairs for further modal competition analysis.

In intercity public mode service in Malaysia, many travelers rely on buses and trains. As seen in Table 1, fare and travel time attributes make the intercity bus the most popular transport mode option in this country. Intercity land public transport traveling costs are much cheaper than either flight fare or automobile fuel consumption costs within each corridor. From observation of the selected corridor, intercity bus travel time is shorter than intercity train (Table 1).

In relation with the concentration of development in the National Spatial Framework 2020, intercity travel to the north, south and east of Peninsular Malaysia were categorized into eight main corridors. The eight main intercity corridors are namely; Kuala Lumpur (KL) - Alor Setar, KL - Penang, KL - Ipoh, KL - JB, KL - Melaka, KL - Kuantan, KL - Kota Bharu and KL - Kuala Terengganu.
To analyze the intercity land transportation competition, thus, the selected corridors in Malaysia are possibly the north or the south corridors. The east corridors need to be excluded, since all of the intercity modes services only exist in the medium distance corridors, the KL - Penang corridor (medium distance) is selected as a study case area.

### Table 1: Fare and travel time competition in selected corridors

<table>
<thead>
<tr>
<th>O-D Pairs (From KL)</th>
<th>Bus</th>
<th>Rail</th>
<th>Air</th>
<th>Automobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penang</td>
<td>41.3</td>
<td>46.4</td>
<td>156</td>
<td>157</td>
</tr>
<tr>
<td>Ipoh</td>
<td>21.3</td>
<td>27.6</td>
<td>-</td>
<td>92</td>
</tr>
<tr>
<td>Kota Bharu</td>
<td>34</td>
<td>55</td>
<td>137</td>
<td>147</td>
</tr>
<tr>
<td>Kuala Terengganu</td>
<td>43</td>
<td>-</td>
<td>125</td>
<td>165.5</td>
</tr>
<tr>
<td>Kuantan</td>
<td>19.6</td>
<td>-</td>
<td>198</td>
<td>107</td>
</tr>
<tr>
<td>Johor Bahru</td>
<td>40.3</td>
<td>54.5</td>
<td>125.5</td>
<td>156</td>
</tr>
<tr>
<td>Melaka</td>
<td>12.6</td>
<td>-</td>
<td>-</td>
<td>64</td>
</tr>
<tr>
<td>Alor Setar</td>
<td>40.6</td>
<td>50.6</td>
<td>130</td>
<td>194.6</td>
</tr>
<tr>
<td>Average intercity mode fare (RM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penang</td>
<td>4.50-5.50</td>
<td>6.50-7.50</td>
<td>0.8</td>
<td>3.50-4.00</td>
</tr>
<tr>
<td>Ipoh</td>
<td>2.5</td>
<td>2.00-3.00</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Kota Bharu</td>
<td>8.00-8.50</td>
<td>12</td>
<td>1</td>
<td>4.50-5.00</td>
</tr>
<tr>
<td>Kuala Terengganu</td>
<td>8</td>
<td>-</td>
<td>0.9</td>
<td>4.5</td>
</tr>
<tr>
<td>Kuantan</td>
<td>3.5</td>
<td>-</td>
<td>0.7</td>
<td>2.5</td>
</tr>
<tr>
<td>Johor Bahru</td>
<td>4.50-5.50</td>
<td>6.50-7.50</td>
<td>0.9</td>
<td>3.50-4.00</td>
</tr>
<tr>
<td>Melaka</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Alor Setar</td>
<td>5.00-7.00</td>
<td>10</td>
<td>1.1</td>
<td>4</td>
</tr>
</tbody>
</table>

*1) Automobile refers to Car 2011, Fuel efficiency 12 km/liter, Fuel price 0.637 USD/liter (Model Car: Proton Saga 1600 cc, Automatic Transmission), 2) Toll fare and fuel consumption are included in automobile fare calculation, 3) Exchange Rate in 2011: 1 USD = RM 3.05, 4) Bus mode fare refers to average fare for 1st, 2nd and 3rd class, 5) Rail mode fare refers to average fare for 1st, 2nd and 3rd class of conventional rail. For Ipoh, ETS was included.

### KL – PENANG CORRIDOR, A BRIEF DESCRIPTION

Referring to Jabatan Perancangan Bandar dan Desa Semenanjung Malaysia (2005) [1], the population of Malaysia is likely to increase in several national conurbations such as Pulau Pinang to 75% by year 2020. The population distribution in Pulau Pinang has been increasing for ten years of continuous observation, from 1,313,449 (2000) to 1,561,383 (2010). In Kuala Lumpur (including Putrajaya), the average annual population increment was 2.2%, and it increased from 1,379,310 (2000) to 1,747,034 (2010). In 2010, population density in Wilayah Persekutuan Kuala Lumpur is 6,696 per square km. Meanwhile, in Pulau Pinang it is 1,451 persons per square km (Department of Statistics, 2010) [2]. High density of population, concentration of development and the attraction of KL and its conurbations may influence the intercity movement in these origin and destination pairs. The Malaysian average monthly transport expenditure per household was increasing from RM 314/month (2004/2005) to RM 327/month (2009/2010) and the average of monthly gross household income in 2009 was RM 4,025 (Department of Statistics, 2011) [3]. It has been increasing by 4.4% from the year 2004-2009.

### RESEARCH METHODOLOGY

#### Data collection

The data used in this research is a combination of primary and secondary data. The secondary data was obtained from government agencies such as the Ministry of Transport (MOT), Suruhanjaya Pengangkutan Awam Darat (SPAD), Keretapi Tanah Melayu Berhad (KTMB), and Malaysia Airport Holdings Berhad (MAHB) and used in the modal competition analysis.
Meanwhile, the primary data was collected through a field survey since secondary data was not available.

**Survey and participants**

A field survey was conducted in three months at several intercity bus terminals and train stations in Kuala Lumpur and Penang as O-D pairs. Intercity bus terminals observation included: bus terminal of Bukit Jalil, Puduraya bus terminal, bus terminal of Shah Alam in Kuala Lumpur, and Butterworth in Penang. In addition, a field survey has been conducted at intercity train stations, in Kuala Lumpur and Penang.

A field survey with an interview session is suggested as a preferred data collection method in order to provide a more reliable and complete answer data set (Sivakumar et al. 2006) [4]. A field survey strategy eases the mode choice based sampling and random sample (Yang and Sung, 2010) [5]. The field survey conducted in this study uses a combination of 5 minute on-site interviews and 15 minutes on-site questionnaire sessions in terminals.

Regarding the number of respondents required, Ahern and Tapley (2008) [6] stated that the ideal number of respondents required per-design treatment is between 30 and 50 individuals. According to Field (2009) [7], to test the overall fit of the model in linear regression, the minimum sample size needed is equals to 50 + 8 k (k = number of predictors). A number of 242 intercity bus users were the respondents of this questionnaire-based study. A total of 12,100 data set of stated preference data (consisting of 6,050 train data set and 6,050 bus data set), have been analyzed for the KL-Penang corridor.

**Questionnaire design**

A paper based survey has been developed in order to gather information of intercity public transport user’s characteristics. The questionnaire was developed based on a disaggregate model due to their ability to enable more realistic models. The questions given in the survey form consist of three sections respectively: travel characteristics, passenger characteristics, and intercity land public transport services (Table 2). The questions are designed in the form of Reveal Preference (RP) questions and Stated Preference (SP) questions. In the RP data collection, the questions were developed to see how the actual respondent’s behavior related to their socioeconomics and travel characteristics based on their current trip.

<table>
<thead>
<tr>
<th>Part of questionnaire</th>
<th>Type of data</th>
<th>Questionnaire content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Travel characteristics part</td>
<td>RP data</td>
<td>Respondents age, marital status, gender, monthly income, monthly expenditure for transportation (transport budget), expenditure for intercity transport (intercity budget), intercity travel frequency, intercity bus fare (one way), intercity travel trip purpose, feeder transport service mode (access and egress), feeder transport travel time to terminal (access and egress), feeder transport waiting time (access and egress), feeder transport fare (access and egress), intercity bus mode choice reason, passenger perception of distance effect, Intercity bus competitor, intercity bus travel time (hour), intercity mode waiting time, passenger occupation</td>
</tr>
<tr>
<td>2. Passenger characteristic part (Respondents socio-economic part)</td>
<td>SP data</td>
<td>Scenarios of intercity land mode (bus and train) travel time changes, scenarios of intercity land mode (bus and train) travel cost changes, scenarios of intercity land mode (bus and train) travel frequency changes, scenarios of intercity public transport access time changes (to access bus and train station)</td>
</tr>
<tr>
<td>3. Intercity land public transport service part (Scenarios of two modes)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the SP data collection, the SP questions were designed to describe the users’ response if the services of intercity land transport mode were to be changed. SP questions were designed in the form of two scenarios: intercity bus scenario and intercity train scenario. The intercity bus
scenario represents the changes to intercity bus service values when the intercity train values remain constant. The intercity train scenario represents the changes to intercity train service values when the intercity bus values remain constant. The intercity mode preference was evaluated by using the four attributes for both scenarios.

In details (Table 3), the scenarios of intercity bus service changes consist of eight sub-scenarios of bus travel time addition, eight sub-scenarios of bus travel cost addition, three sub-scenarios of bus frequency service reduction, and six sub-scenarios of feeder mode access time addition (to access intercity bus terminal). Similarly, scenarios of intercity train service changes consist of eight sub-scenarios of train travel time reduction, eight sub-scenarios of train travel cost reduction, three sub-scenarios of train frequency service addition, and six sub-scenarios of feeder mode access time reduction (to access the intercity train station). In this research, linear regression models have been developed by using these bus and train scenarios.

Table 3: Scenarios of intercity land public transport mode services.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Intercity land public transport mode</th>
<th>Scenario of service changes</th>
<th>Variation in service changes (sub scenarios)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>Intercity bus</td>
<td>If intercity bus travel time were longer than existing</td>
<td>(8 sub scenarios) 0%, 5%, 10%, 15%, 20%, 25%, 30%, 40%</td>
</tr>
<tr>
<td></td>
<td>Intercity train</td>
<td>If intercity train travel time were shorter than existing</td>
<td>(8 sub scenarios) 0%, 5%, 10%, 15%, 20%, 25%, 30%, 40%</td>
</tr>
<tr>
<td>Travel cost</td>
<td>Intercity bus</td>
<td>If intercity bus fare were increased than existing</td>
<td>(8 sub scenarios) 0%, 5%, 15%, 25%, 40%, 75%, 90%, 100%</td>
</tr>
<tr>
<td></td>
<td>Intercity train</td>
<td>If intercity train fare were decreased than existing</td>
<td>(8 sub scenarios) 0%, 5%, 15%, 25%, 40%, 75%, 90%, 95%</td>
</tr>
<tr>
<td>Frequency</td>
<td>Intercity bus</td>
<td>If intercity bus frequency were decreased than existing</td>
<td>(3 sub scenarios) 20%, 40%, 60%</td>
</tr>
<tr>
<td></td>
<td>Intercity train</td>
<td>If intercity train frequency were increased than existing</td>
<td>(3 sub scenarios) 100%, 200%, 300%</td>
</tr>
<tr>
<td>Access time</td>
<td>Intercity bus (to access intercity bus terminal)</td>
<td>If feeder mode access time to bus terminal were longer than existing</td>
<td>(6 sub scenarios) 5 minutes, 10 minutes, 15 minutes, 30 minutes, 45 minutes, 60 minutes</td>
</tr>
<tr>
<td></td>
<td>Intercity train (to access intercity train station)</td>
<td>If feeder mode access time to train station were longer than existing</td>
<td>(6 sub scenarios) 5 minutes, 10 minutes, 15 minutes, 30 minutes, 45 minutes, 60 minutes</td>
</tr>
</tbody>
</table>

Data preparation
The socioeconomic variables, travel characteristics and scenarios of intercity land public transport service changes were evaluated in this study. The type of socioeconomic data collected from the questionnaire was either ordinal or numerical data. The coding of socioeconomic data variables in the first part of the questionnaire was arranged as below (Table 4).

A choice technique has been applied in the SP data collection. The possibility of choosing either the intercity bus or train for both scenarios is arranged in four point variations from 1 to 4. This is used to produce a forced choice measure, where no indifferent option is available (Bertram, n. d.) [8]. The point variation had undergone appropriate transformation before doing the regression analysis. This transformation process is done to avoid the homoscedasticity assumption violations, and it can also be used to change a nonlinear model into a linear model. In this research, the point variation of the mode choice statement alternatives in the SP choices data have been transformed by using a linear model logit biner transformation. The score denotes as $P_{Bus}$ and the logit biner transformation is formed using equation (1). The transformation of mode choice statement is summarized in Table 5.
U_{Bus} - U_{Train} = \ln \frac{p_{Bus}}{(1-p_{Bus})} \quad (1)

Table 5: The transformation of mode choice statement

<table>
<thead>
<tr>
<th>Mode choice statement</th>
<th>Point variations</th>
<th>Score</th>
<th>Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surely Prefer Intercity Bus</td>
<td>1</td>
<td>0.8</td>
<td>1.386294361</td>
</tr>
<tr>
<td>Maybe Prefer Intercity Bus</td>
<td>2</td>
<td>0.6</td>
<td>0.405465108</td>
</tr>
<tr>
<td>Maybe Prefer Intercity train</td>
<td>3</td>
<td>0.4</td>
<td>-0.405465108</td>
</tr>
<tr>
<td>Surely Prefer Intercity train</td>
<td>4</td>
<td>0.2</td>
<td>-1.386294361</td>
</tr>
</tbody>
</table>

MODEL ANALYSIS AND VALIDATION

Reliability test and factor analysis
A reliability test has been used to measure the consistency of the questionnaire. Over the 22 questionnaire items designed, 17 of them are considered in exploring respondent characteristics. The reliability test result over 17 questionnaire items indicates that the overall reliability of the questionnaire is reliable (Cronbach’s α > 0.65). The 17 reliable questionnaire items are: alternative mode for intercity travelling, traveler perception on the distance to terminal, reason for taking bus intercity mode travel time, intercity mode fare, respondents age, marital status, gender, occupation, monthly income, for feeder mode, travel time for intercity bus feeder mode (access), total travel time of feeder mode (access), intercity bus feeder mode fare (access), travel time in intercity bus feeder mode (egress), total travel time of feeder mode (egress), intercity bus feeder mode fare (egress) and waiting time in the terminal/station.

A factor analysis has been conducted in order to evaluate adequacy of the sample size number. Based on the result in the Reproduced Correlations table, the percentage of non redundant residuals with absolute values > 0.05 was less than 50%. There are 103 (27.0%) non redundant residuals with absolute values greater than 0.05. The Kaiser-Meyee-Olkin (KMO) and Bartlett's test value is significant, p < .001. The KMO measure verified the sampling adequacy for this sample analysis, KMO = .614 (‘mediocre’). Bartlett's test of Bartlett's test of sphericity is \(\chi^2 (378) = 3387.950, p < .001\). Therefore, the sample size in this research paper is adequate for the factor analysis.

Regression analysis
The regression analysis was used to obtain the utility function of bus preference. Checking assumptions for regression data analysis, known as generalization, allows the model sample conclusions to be true over the wider population. According to Berry (1993) and Groebner et al. (2008), in Field (2009)[7], there are several generalization assumptions used in regression analysis, such as there should be no constraint on the variability of the outcome, none zero variance, no perfect multicollinearity, predictors are uncorrelated with external variables, homoscedasticity or residual at each level of the predictors should have the same variance, independent errors, meaning that for any two observations, residual terms should be uncorrelated (independent), normally distributed errors, all values of the outcome variable are independent, and the value of the outcome variable for each increment predictor’s lie along the straight line.

Checking a model’s goodness of fit and the statistical significance of the estimated parameters in a regression model has done firstly by checking pattern of residuals, the \(R^2\) to see the model’s goodness of fit. Secondly, it is done by checking statistical significance result of t-tests for individual parameters and F-test for the overall fit.

This model was uses adjusted \(R^2\) to cross-validate the model. Adjusted \(R^2\) is same with \(R^2\) (or very close to \(R^2\)) indicates that the cross-validity of the model is very good (Field, 2009) [7]. Adjusted \(R^2\) indicates the loss of predictive power of shrinkage. This shrinkage means if the
model derived from the population rather than a sample it would account less variance approximately 0.5% in the outcome.

According to Field (2009) [7], checking multicollinearity is also necessary since it may become a problem when the intercorrelation of predictor variables is high \((r > 0.9)\). There is no collinearity within data if the variance inflation factor (VIF) value is well below 10 and tolerance is well above 0.2. However, if the result shows the VIF is very close to 1, it will confirm that collinearity is not a problem in the model.

To check the statistical significance for statistical model validations, the hypotheses below are used:

1. T-test, to check if there is a linear relationship between the explanatory variables and the outcome. Hypothesis of T-test (for individual significance) at 5% significance level \((\alpha)\) is as following:
   - \(H_0: X_1, X_2, X_3, \text{ or } X_4 \) not influenced bus preference utility
   - \(H_A: X_1, X_2, X_3, \text{ or } X_4 \) influenced bus preference utility
   - \(H_0 \) will be rejected if the test statistic for each variable falls in the rejection region \((p\)-values < 0.05).

2. F-test, it is testing the hypothesis test between whole parameters variable is equal 0 with not all parameters variable is equal 0. F-statistic estimates the statistical significance of the regression equation. F-statistic estimates the statistical significance of the regression equation. F-statistic accounts for the degrees of freedom and involves both the predictors and sample size number in the model. A model with a high \(R^2\) may still not be statistically significant if the sample size is not large compared with the number of predictors in the model. To test the overall significance, a T-test is performed at a 5% significance level \((\alpha)\).

Utility function

Utility function is measured by measuring the effect of attribute component related to the mode. The assumption of the utility function is linear in parameters.

\[
Y = A + B X_1 + B X_2 + B X_3 + B X_4 \tag{2}
\]

The dependent variable in the regression model was the intercity mode utility as the effect of the intercity mode service value changes. The independent variables in this model were the mode service value differences. The mode service value which was evaluated consists of travel time, fare, frequency and access time. Therefore, equation (2) above can be explained as equation (3):

\[
Y = U_{Bus} - U_{Train} = b_0 + b_1 (X_1_{Bus} - X_1_{Train}) + b_2 (X_2_{Bus} - X_2_{Train}) + b_3 (X_3_{Bus} - X_3_{Train}) + b_4 (X_4_{Bus} - X_4_{Train}) \tag{3}
\]

Where: \(A, b_0 = \) intercept; \(B, b_1, b_2, b_3, b_4 = \) model parameter; \(X_1 = \) intercity mode travel time difference, and \(X_1 = X_1_{Bus} - X_1_{Train}\), \(X_2 = \) intercity mode fare difference, and \(X_2 = X_2_{Bus} - X_2_{Train}\), \(X_3 = \) intercity mode frequency difference, and \(X_3 = X_3_{Bus} - X_3_{Train}\), \(X_4 = \) feeder mode access time difference to intercity land public transport mode terminal, and \(X_4 = X_4_{Bus} - X_4_{Train}\).

In the bus scenario, bus service attributes \((X_1, X_2, X_3, \text{ and } X_4)\) will be changing but the train service attributes will remain constant. Therefore the bus utility will be changing while the train utility will remain constant. Contrary to this, in the train scenario, the train service attributes \((X_1, X_2, X_3, \text{ and } X_4)\) will be changing but the bus service attributes will remain constant. Therefore the train utility will be changing but bus utility will remain constant.

The calculations of model 1 (bus scenario) and model 2 (train scenario) are given in equations 4 and 5 as written below.

- Model 1 (Bus Scenario):
  \[
  Y_1 = U_{Bus} - U_{Train} = b_0 + b_1 (X_1_{Bus} - X_1_{Train}) + b_2 (X_2_{Bus} - X_2_{Train}) + b_3 (X_3_{Bus} - X_3_{Train}) + b_4 (X_4_{Bus} - X_4_{Train}) \tag{4}
  \]
Model 2 (Train Scenario):
\[ Y_2 = U_{Bus} - U_{Train} = b_0 + b_1 (X_1_{Bus} - X_1_{Train}) + b_2 (X_2_{Bus} - X_2_{Train}) + b_3 (X_3_{Bus} - X_3_{Train}) + b_4 (X_4_{Bus} - X_4_{Train}) \]  

(5)

Sensitivity analysis is the next stage of the analysis after obtaining the utility function for both scenarios. The aim of this sensitivity analysis is to measure the changes of probability for taking an intercity bus in consequence to the changes in certain intercity land mode attributes. The sensitivity graph model analysis only involved SP data with regards the significant value in the regression model result.

**Sensitivity analysis of bus preference equation**

In order to calculate bus preference probability and evaluate bus user perceptions of their current mode towards to the train as a bus competitor, a binary logit equation was applied. Referring to Yannis et al. (2005) [9], if \( U_{in} \) is alternative utility \( i \) for individual \( n \) and \( U_{jn} \) is alternative utility \( j \), thus \( P_{in} \) or the probability of choosing intercity mode \( i \) is written as follows:

\[
P_{in} = \frac{\exp U_{in}}{\exp U_{in} + \exp U_{jn}} \tag{6}
\]

Therefore, \( P_{in} \) can be used to represent bus preference probability using binary logit in equation (6) and can be written as equation (7) by eliminating \( \exp U_{Train} \):

\[
P_{Bus} = \frac{\exp U_{Bus}}{\exp U_{Train} + \exp U_{Bus}} \tag{7}
\]

\[
P_{Bus} = \frac{\exp (U_{Bus} - U_{Train})}{1 + \exp (U_{Bus} - U_{Train})}
\]

What remains is that \( P_{Bus} = \) Probability of choosing intercity bus, \( U_{Bus} = \) intercity bus utility as effect of its service value changes, \( U_{Train} = \) intercity train utility as effect of its service value changes.

**RESULT AND DISCUSSION**

The second part of the questionnaire consisted of SP data which has been analyzed to describe the user’s response if the intercity land transport service mode were changed. This part of the analysis was involving only the SP data as the explanatory variables. The intercity mode travel time difference, intercity mode fare difference, and feeder mode access times to intercity land public transport mode terminals were respectively found to be significant in both regression models.

**Stated preference data analysis result**

As can be seen from results of disaggregated analyses on bus utility in Table 2 and Table 3, it was proven that the travel time difference, fare difference, frequency and feeder mode access time difference, were significantly influenced (p-value < 0.05) the intercity mode preference. Based on stated preference data in both of model scenarios (bus and train attributes changes), the coefficients for intercity mode travel time difference, intercity fare difference, and access time to intercity public transport terminal are negatives. It means the increasing values of travel time difference, fare difference and access time difference attributes will decrease the intercity bus preference. Meanwhile, the increasing value of frequency attribute was found significantly to increase the intercity bus preference in both of model results (Table 6 and Table 7).
Table 6: Bus utility as effect on intercity bus attributes values changes*

<table>
<thead>
<tr>
<th>Model</th>
<th>Un standardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-3.4</td>
<td>.058</td>
<td>-59.930</td>
<td>-3.456</td>
</tr>
<tr>
<td>Travel Time Difference (min)</td>
<td>-.018</td>
<td>.000</td>
<td>-.702</td>
<td>-73.241</td>
</tr>
<tr>
<td>Fare difference (RM)</td>
<td>-.059</td>
<td>.001</td>
<td>-.627</td>
<td>-65.992</td>
</tr>
<tr>
<td>Frequency Difference (Departure/ day)</td>
<td>.107</td>
<td>.003</td>
<td>.383</td>
<td>41.924</td>
</tr>
<tr>
<td>Access Time Difference (min)</td>
<td>-.035</td>
<td>.001</td>
<td>-.580</td>
<td>-61.764</td>
</tr>
</tbody>
</table>

* R = .755; R Square = .570; Adjusted R Square = .570; df1 = 4, df2 = 6045; F_{0.05, 4, 6045} = 2.37; F_{708.809, .354} = 2002.904; Dependent variable: Bus utility as effect on intercity bus attributes values changes.

Table 7: Bus utility as effect on intercity train attributes values changes*

<table>
<thead>
<tr>
<th>Model</th>
<th>Un standardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-3.64</td>
<td>.049</td>
<td>-73.920</td>
<td>-3.646</td>
</tr>
<tr>
<td>Travel Time Difference (min)</td>
<td>-.015</td>
<td>.000</td>
<td>-.808</td>
<td>-101.683</td>
</tr>
<tr>
<td>Fare difference (RM)</td>
<td>-.051</td>
<td>.001</td>
<td>-.637</td>
<td>-80.844</td>
</tr>
<tr>
<td>Frequency Difference (Departure/ day)</td>
<td>.144</td>
<td>.002</td>
<td>.452</td>
<td>59.682</td>
</tr>
<tr>
<td>Access Time Difference (min)</td>
<td>-.039</td>
<td>.000</td>
<td>-.655</td>
<td>-84.116</td>
</tr>
</tbody>
</table>

* R = .839; R Square = .705; Adjusted R Square = .704; df1 = 4, df2 = 6045; F_{0.05, 4, 6045} = 2.37; F_{882.411, .245} = 3603.804; Dependent variable: Bus utility as effect on intercity train attributes values change.

Regarding the regression analysis results on both scenarios (refer to equations 4 & 5 and Table 7 & 8), the final models can be written as shown below.

- Model 1 (Bus Scenario)

\[
\text{Bus utility as effect on intercity bus attributes changes} = -3.436 - 0.017 \times \text{Travel time difference} - 0.059 \times \text{Fare difference} + 0.106 \times \text{Frequency difference} - 0.034 \times \text{Access time to intercity mode station difference}.
\]

Thus;

\[
Y_1 = -3.436 - 0.017 X_{1Bus} - X_{1Train} - 0.059 X_{2Bus} - X_{2Train} + 0.106 X_{3Bus} - X_{3Train} - 0.034 X_{4Bus} - X_{4Train}
\]

- Model 2 (Train Scenario)

\[
\text{Bus utility as effect on intercity train attributes changes} = -3.646 - 0.015 \times \text{Travel time difference} - 0.051 \times \text{Fare difference} + 0.144 \times \text{Frequency difference} - 0.039 \times \text{Access time to intercity mode station difference}.
\]

Thus;

\[
Y_2 = -3.646 - 0.015 X_{1Bus} - X_{1Train} - 0.051 X_{2Bus} - X_{2Train} + 0.144 X_{3Bus} - X_{3Train} - 0.039 X_{4Bus} - X_{4Train}
\]

Sensitivity analysis result

The purpose of Sensitivity analysis is to determine the probability of intercity bus preference respectively on the bus and train service attributes changes using the four significant influencing parameters. The existing conditions of bus and train services are needed to be assumed in sensitivity analysis. The existing conditions are summarized in Table 8.
Table 8: Existing conditions of intercity land public transport modes for SP scenarios

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value (existing condition)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_{2\text{Bus}}$ = Intercity bus fare (2nd Class bus service)</td>
<td>RM 33</td>
</tr>
<tr>
<td>$X_{2\text{Train}}$ = Intercity train fare (2nd Class train service)</td>
<td>RM 40</td>
</tr>
<tr>
<td>$X_{2\text{Bus}} - X_{2\text{Train}}$ = Intercity mode fare difference</td>
<td>(-) RM 7.0</td>
</tr>
<tr>
<td>$X_{1\text{Bus}}$ = Intercity bus travel time</td>
<td>5.5 hours</td>
</tr>
<tr>
<td>$X_{1\text{Train}}$ = Intercity train travel time</td>
<td>7.5 hours</td>
</tr>
<tr>
<td>$X_{1\text{Bus}} - X_{1\text{Train}}$ = Intercity mode travel time difference</td>
<td>-120 minutes</td>
</tr>
<tr>
<td>$X_{1\text{Bus}}$ = Intercity bus departure frequency</td>
<td>23 buses/day</td>
</tr>
<tr>
<td>$X_{1\text{Train}}$ = Intercity train departure frequency</td>
<td>4 trains/day</td>
</tr>
<tr>
<td>$X_{1\text{Bus}} - X_{1\text{Train}}$ = Intercity mode frequency difference</td>
<td>19 departures/day</td>
</tr>
<tr>
<td>$X_{3\text{Bus}}$ = Access time to intercity bus terminal</td>
<td>45 minutes</td>
</tr>
<tr>
<td>$X_{3\text{Train}}$ = Access time to intercity train station</td>
<td>45 minutes</td>
</tr>
<tr>
<td>$X_{3\text{Bus}} - X_{3\text{Train}}$ = Feeder mode access difference to intercity land public transport mode terminal</td>
<td>0 minute</td>
</tr>
</tbody>
</table>

Sensitivity analysis on travel time attribute

The travel time attribute changes were evaluated using both scenarios of intercity train service and bus service for KL-Penang corridor. As for details, see Fig. 1, the graphs for sensitivity of bus preference toward the changes of travel time. The x-axis value in that figure is the difference between bus travel time and train travel time and the y-axis is bus preference probability.

There are two lines shows in the Fig. 1. The first line is the line of “bus scenario”. This line simulates a worse performance on bus travel time services, whereas the bus travel time is getting longer than existing. Another line is the “train scenario” line. It represents an improvement on train travel time services, whereas the train travel time is getting shorter than existing. Refer to the gap between these two lines, it can be said that bus user shifting because of bus travel time increment is more obvious rather than as the result of train travel time decrement.

This bus preference probability changing is interesting to discuss. The distance from KL to Penang is not much different when using the bus or train, but the bus travel time is shorter than the train because the average bus speed is higher (98 kph) than the train (60 kph). In
addition, bus stops are only for loading unloading passengers. For unloading passengers, the bus stops depend on demand. This is lower compared to the train (12-19 stops). From this result, it is implied that bus users would probably be attracted by the efforts of KTMB to cut the total travel time on the rail line. Shortening the total train travel time can be achieved by reducing the riding time, waiting time or stopping time. The effort to cut intercity train riding times by upgrading the rail track to support the speed (from 60 kph) of the new ETS (average on 90 kph) is still ongoing.

Efforts to shorten the waiting time are quite challenging since the train has a lower departure frequency and departing time reliability. Respondents usually prefer to arrive at an intercity mode terminal before the departure time. This makes respondents feel there is a longer waiting time than their actual waiting time. Indeed, the bus waiting time is usually shorter than the train, and the times of bus departures are more reliable than the train. KTMB currently only allows train users to wait on the platform 30 minutes before the departure time. This is considered a good strategy for eliminating the users' perception of a longer waiting time than their actual waiting time.

The effort to shorten train service stopping times (which been implemented on ETS) would probably attract intercity travelers, but something that the service provider should not forget is that offering passengers a train service with fewer stops will reduce passenger travel time but may require higher train frequency and higher operating costs. It would also cause the train fare to rise, which is not really favorable to the passengers. However, it seems that the provision of public services is constrained by the availability of money, knowledge, manpower and materials (Marsden and Bonsall, 2006) [10].

The result of those two lines models indicates a stronger effect of intercity bus travel time changes on the bus preference probability. Bus users may be worried about the longer travel time of their current intercity mode, for example while the road is congested. Therefore, the bus user response to the scenario is more obvious and shows them switching to the train. Eventually, the current phenomenon is a high demand for road infrastructure because of the low public transport modal share which contributes to traffic congestion. This is a big challenge for SPAD and the bus industry in the future.

Bus users have a different perception on the changing travel time attributes. There may be another consideration for a bus user to voluntarily move from their current mode to an intercity train if bus travel times were changed. Comfort can probably be a consideration. Many intercity travelers stated they preferred the intercity bus because of shorter travel time. In interview sections, bus users argued that they do not feel comfortable sitting in the train because of its long travel time. When there was no optional mode except for the train, bus users would prefer sleeping in a coach to deal with the train’s long travel time. Although it requires a higher travel cost, users can feel comfort during the journey.

Based on interviews with some other respondents, they argued that it is better to take the bus when a traveler needs to get to destination faster, but if the traveler prefers to enjoy the journey, it is better to take a train and get the sleeping coach. Moreover, they argued that the worse performance of buses was during the festive season when it is subjected to congested roads. From the analysis results, which are supported by respondent arguments, it is clearly proved that changes in travel time attributes would result in a strong effect on the bus preference in the future.

**Sensitivity analysis on fare attribute**

Fig. 2 shows the sensitivity of bus preference on fare attribute changes. The x-axis represents the fare difference between the intercity bus and train in USD and the y-axis represents bus preference probability. There are two regression lines in Fig. 2. First is “bus scenario” line and the second is “train scenario” line. The “bus fare changes” line shows trends of bus choice probability when the bus fare is getting expensive. The second line of “train scenario” shows a trend of bus choice probability when the train fare is getting cheaper.
It can be explained as the different perception on intercity bus users to value their intercity bus and train services changes. Refer to the gap between these two lines, intercity bus fare increasing will have a greater impact on bus choice probability rather than the train travel cost decreasing (bus competitor). It is interesting result to show that bus user is not as it easily to response (by switching to the train) as the fare of its competitor mode decreased.

From Fig. 2, it is implied that bus users would really be concerned about fare increments of their current mode, but they would expect a lot from a train fare reduction. In an economic perspective, there is supposed to be no difference to the money the respondents spent, whether using the intercity bus company or the intercity train company. But based on the sensitivity result, bus users have a different perception to the value of the intercity bus and train fare changes. It was an interesting result that setting an equal fare on intercity bus and train services provides no evidence that it would create a similar ridership attraction. There may be a reason for users’ different perspective this case, which is not included in the model. Probably it is related to the additional feeder transport mode costs needed to access an intercity mode terminal.

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**Sensitivity analysis on frequency attribute**

Fig. 3 shows the sensitivity of bus preferences to access time attribute changes. The x-axis represents the time difference between accessing the intercity bus terminal and the intercity train station in minutes. The y-axis is bus preference probability. There are two lines shown in Fig. 3. First is the line of “bus scenario”. Another line is the “train scenario” line.

Frequency difference in existing condition is 19 departure/day and bus choice probability is currently over 74%. Refer to the “train scenario” line, while the intercity train was getting as frequent as the bus, around 58% bus user would switched to the train. Interestingly, even if the intercity bus was getting as less frequent as the train, refer to the “train
scenario” line, around 52% bus user would switched to the train. This situation probably tells us based on bus user perception, they are keen on train frequency departure service improvement. Although so, there is still a strong reliability on their current mode departure service.

Government argue that an effective transportation movement will be achieved by a mass-transportation mode, rail based transportation would be an answer (Dewan Bandaraya Kuala Lumpur, 2011) [11], But the current investment on rail based infrastructure for example to expand the network or to enhance number of train departure is highly cost. In terms of the frequency departure service, it is quite hard to compete with the bus, since bus-train departure frequency difference is too large (19 departures/day). It seems that the provision of public services is constrained by the availability of money, materials, manpower and knowledge (Marsden and Bonsall, 2006)[10].

Fig. 3: Sensitivity of bus preference frequency attribute.
(Source: Primary data analysis.)

Sensitivity analysis on access time attribute

Fig. 4 shows the sensitivity of bus preference on access time attribute changes. The x-axis represents the time difference between accessing intercity bus terminal and intercity train station in minutes. The y-axis is bus preference probability. There are two regression lines in Fig. 4. The “bus scenario” line shows trends of bus choice probability when the access time to intercity bus terminal is getting longer. Similarly, the “train scenario” line also shows trends of bus choice probability when the access time to intercity train terminal is getting shorter.

Interestingly, based on the sensitivity graph analysis in Fig. 4, it was captured that the bus user would probably more responsive to the decrement on access time to intercity train station rather than to the bus terminal. It means the percentage of bus user who would shift to the train is higher when the access time to train station is getting shorter.

In intercity land public transport sector in Malaysia, the accessibility is currently a big issue. Feeder public service improvement, especially in KL, is being used to promote intercity land public transport usage. A transport hub to facilitate commuting to the North, South and East of Peninsular Malaysia is urgently required. Appropriate and adequate infrastructure has to be made available for direct and easy access to these terminals, in order for the final door to door travel time between origin and destination can be minimized. The Government has declared a vision for comprehensive and efficient transportation system networks with good inter and intra city linkages in Malaysia (Dewan Bandaraya Kuala Lumpur, 2011) [11]. The accessibility for feeder transport would be a big challenge for intercity bus in the future intercity land transport competition.
CONCLUSION

The findings of the field survey and analysis with respect to intercity land public transport mode are reported. A number of observations and conclusions can be drawn.

1. Bus users were introduced to two SP scenarios of intercity bus and intercity train, which consisted of 25 SP statements for each scenario. The four selected attributes were able to model the bus utility and to predict the bus preference probability. Based on SP data analysis in both of the regression model results, the coefficients for intercity mode travel time difference, intercity fare difference, and access time to intercity public transport terminal are consistently negative. This means that the increasing value of bus travel time, bus fare and access attributes will decrease the value of the intercity bus utility. Meanwhile, the frequency difference coefficient is consistently positive, which means that the increasing value of intercity mode frequency difference attributes will increase the value of the intercity bus utility.

2. The regression analysis result significantly proved that the cheaper travel cost comparing to the train leads the bus become more affordable for the low income. And in fact, higher bus frequency and access time to intercity mode terminal also proven as the significant factors to choose intercity bus. This finding highlights bus as a preferred intercity transportation rather than train in Malaysia, in terms of travel time, fare, frequency and access time to the intercity public transport terminal.

3. The perception of bus user toward their current mode and the competitor (intercity train) is different. Regarding the sensitivity analysis, bus users are less responsive to the decrement of intercity train travel time and fare. The sensitivity analysis on fare attributes shows that: setting the bus and the train on an equal fare provides no evidence of creating similar ridership attraction. In contrary, bus users are more responsive to the increments on train departure frequency and access time. The probability of bus shifting because of a decrease in bus departures is lower than the shift because of an increase in train departures. It is implied that bus users are concerned about decreases in the frequency of their current mode, although they are keen to see improvements to the frequency of train services. The infrastructure improvements, especially on the accessibility and linkages within these intercity land public transport networks, are urgently required. 

Feeder public service improvement is currently a big issue and is being used to promote intercity land public transport usage. The Government has declared a vision for comprehensive and efficient transportation system networks with good inter and intra city linkages in Malaysia (Dewan Bandaraya Kuala Lumpur, 2011) [11]. A transport hub to facilitate commuting to the North, South and East of Peninsular Malaysia is urgently required.
transport modes would favorable to promote the intercity land public transport modes in the future.

4. In short, the infrastructures and accessibility of intercity land transportation modes may become the reason for preferring the mode in Malaysia. Attributes of travel time, fare, frequency and access time can help to explain why the bus is preferred to the train. It is now well understood that the bus has become a predominant intercity transport mode in this country. To increase ridership of intercity trains, a certain level of service should be designed related to these four attributes. The study approaches on these four attributes of intercity land public transport sector in Malaysia hopefully can be a lesson to face intercity land public transport competition in the future.

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REFERENCES