Understanding important variables for mode preference; A Case study of intercity land mode

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Abstract. This study aims to describe factors that influenced the mode preference for intercity land movement in Malaysia. Bus and train as intercity land public transport service was observed during the construction of the ETS (Electric Train Service) project in Malaysia. This study adopted a qualitative research study using the Revealed Preferred data and crosstabs procedure. The reliability test has been used over 17 questionnaire items to measure the consistency of the questionnaire. The result indicated that the overall reliability of the questionnaire is reliable. To evaluate the adequacy of the sample size, the factor analysis had conducted. The Kaiser-Meyer-Olkin (KMO) and Bartlett's test value is significant, which measures verified the sampling adequacy for the sample analysis. This research highlighted that the variable of fare, travel time, mode accessibility, departure frequency, and mode availability are some important attributes that influenced bus user preference for intercity land movement. Learning a lesson from the KL-Ipoh corridor, the completion of the ETS double-tracking project is predicted to affect the bus mode's ridership in the KL - Penang corridor. This finding can be beneficial for setting future strategy on particular intercity modal goals.

1. Rail and road improvement in Malaysia

The rail is the minor mode in Malaysia. The rail system only covers a small share of the whole transport network in this country. The government has intended to develop rail transport to play a more significant role in intercity and urban transport (Malaysia Plans, 2010) [1]. The railway track is 1641 km counted as 80 percent singletrack. In November 2014, The double-track railway network was extended from 20 to 47 percent [2]. The main intercity rail line of KTMB from Johor Bharu in the south to Padang Besar on the Thai border in the north, are now being double-tracked and electrified [3]. Intercity train service under KTMB management has improved its performance in many aspects by reducing travel time and offering affordable services.

On the other hand, roads play a dominant role in Malaysia. Comprehensive planning for roads in the country began in the First Malaysia Plan (1966-1970). In 1966 the road network in Malaysia was 15,000 km. The road network had expanded to over 85,000 km after the year 2005 [4]. Road linkage in Malaysia
covers 210,658 kilometers, of which 79 percent is paved, and 1969 km are expressways [2]. The road and rail network’s improvement poses competition between different modes of transport in this country. The competition in intercity public land transport mode is an exciting topic to discuss in the next section — especially the competition between bus and train as the intercity public transport mode.

2. Methodology

2.1. Objective
This study's main objective is to understand the crucial variables that influenced intercity land public transport mode preference along KL - Penang Corridor by using Reveal Preference data and cross-tabulation Method. Some of the variables to be evaluated were the mode accessibility, fare, travel time, transport mode availability, and departure frequency.

2.2. The study area of KL - Penang Corridor
The population density development, and the attraction of KL and its conurbations may influence the intercity movement in these origin and destination pairs. The population of Malaysia is likely to increase in several national conurbations, such as Pulau Pinang and 75% by 2020 [5].

2.3. Data collection
Primary and secondary data had collected for this study. Primary data was collected from the field survey during the completion of the ETS project in 2012-2013. The secondary data were collected and compiled since 2010 to 2020 from government agencies such as the Malaysia Airport Holding Berhad (MAHB), Keretapi Tanah Melayu Berhad (KTMB), Ministry of Transport (MOT) and Suruhanjaya Pengangkutan Awam Darat (SPAD). Also, Jabatan Perancangan Bandar dan Desa Semenanjung Malaysia (JPBD) and Department of Statistics Malaysia.

2.4. Data validation
A paper-based survey was designed to gain bus users' perception of their preference for intercity land transport services in Malaysia. The questionnaire questions were developed in the form of Stated Preference data and Reveal Preference data [5]. Nevertheless, only the reveal preference data was performed using crosstabs procedure for achieving the purpose of this study.

The Reveal preference data contains the data of socioeconomic and travel characteristics. RP data variables analyzed are including age, marital status, gender, monthly incomes, intercity bus fare, transport budget and intercity travel budget, occupations, trip purpose, intercity travel frequency, intercity mode choice reason, feeder mode accessibility to intercity mode terminal and intercity bus mode alternatives.

A reliability test has been used to measure the consistency of the questionnaire. The reliability test result over 17 questionnaire items, indicates that the overall reliability of the questionnaire is reliable (Cronbach's $\alpha > 0.65$). Factor analysis had conducted to evaluate the adequacy of the sample size number. The Kaiser-Meyer-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 sphericity is $\chi^2 (378) = 3387.950, p < .001$. Therefore the sample size in this research paper is adequate for the factor analysis. Finally, a total of 242 questionnaire forms used.

3. Data analysis and discussion

3.1. Socioeconomics and travel characteristics
The RP data analysis has been conducted to evaluate bus user's behavior related to their socioeconomic and travel characteristics. In this study, 64.5% of the respondents were students. The majority of the respondents had a non-work traveling purpose (social visit and recreation purposes counted as 47.9%, followed by educational purpose counted as 44.2%). Most of the respondents travel once every month
Meanwhile, some others travel once every three months (26.0%), and once every semester (15.7%). The majority age of the respondents is below 26 years old (61.6%), and that they are mainly single (69.0%) and male (53.3%).

Referring to the Department of Statistics, the Malaysian average monthly gross household income in 2009 was RM 4025. It has been increasing by 4.4% from the year 2004-2009 [6]. This study found that the respondent's monthly income is less than RM 5,000. Over a total of 242 respondents, there were 138 respondents (57.0%), with the income range from RM 1,001 to 5,000. There were 87 respondents (36.0%) with an income of less than RM 1,000.

Referring to the Department of Statistics, the Malaysian average monthly transport expenditure per household was RM 327/month (2009/2010) [6]. In the corridor of KL-Penang, where the study conducted, the majority of the respondents have less than RM 150 for their monthly transport budget. Of the 242 total respondents, there were 30 respondents (12.4%) with a transport budget of less than RM 50/month, and there were 115 respondents (47.5%) with a transport budget of around RM 50.01-150. The majority of the respondents allocated less than RM 100 for their monthly intercity budget. In detail, over the 242 total respondents, there were 155 respondents (64.0%) with an intercity budget of less than RM 50/month, and there were 44 respondents (18.2%) with an intercity budget of around RM 50.01-100. Over the 242 total respondents, there were 107 respondents (44.2%) who spent less than RM 35 for one way intercity travel and another 97 respondents (40.1%) who spent around RM 35.01-45. Most of the respondents pay less than RM 46 for one way intercity travel.

3.2. Important attributes that influencing mode preference
The choice among modes of intercity transport depends on both intercity mode quality of service and the intracity transport systems [7]. The Fare system, travel time, intermodality, and frequency of railway are found to be crucial variables related to the quality of rail transport [8]. In the most study of intercity mode choice, parameters such as price, travel time, frequency, comfort, safety, and reliability usually identified as the influential variables [9,10,11].

The travel time, fare, departure frequency, feeder mode accessibility, mode availability, and safety are some attributes that confirmed eligible with the result of this study. In this study (Figure 1), respondents were choosing an intercity mode because of fare (30.2%) and travel time reasons (25.2%). About 13.2% of respondents were choosing an intercity mode because they consider the departure frequency. Safety seems to become the consideration for only 1.7% of the respondents, are figured as below. The variable of the intercity mode travel time and fare variables, the accessibility to intercity mode terminal, and the intercity mode frequency will be discussed further.

![Figure 1. Intercity mode choice reason and feeder mode accessibility to intercity mode terminal (KL-Penang Corridor)](image)

3.2.1. The intercity mode travel time and fare. The travel time used to be the major reason for travelers to choose a particular mode of intercity travel, that make the bus becomes the most favorable in terms of it [5,10,11]. In KL-Penang corridor, the average bus moving speed was around 98 kph over a distance of 369 km. There are usually only two stops for loading and unloading purposes. Total bus travel time becomes 5.50 hours.

Meanwhile, the maximum conventional train moving speed recorded only 70 kph over 388 km. There are 12 to 19 stops for picking up passengers along the route from KL to Penang, which lengthen its total
travel time to be 7.50 hours. Train travel time becomes much longer than the bus because it runs at a lower average speed (60 kph) than the bus (98 kph).

Until 2012, the conventional train still traveled on a single-track railway from KL to Penang. The delays often occur as they have to share the same track with another train coming from the opposite direction. This delay has lengthened the total train traveling time and affected the reliability of the train service. Figure 2 (left) describes that in intercity mode, the travel time from KL to Penang by train is much longer than by bus. Including feeder mode service time, the total intercity train travel time (8.55 hours) is still longer when compared to an intercity bus (6.80 hours).

Besides travel time, the fare is another crucial factor. In KL - Penang corridor, bus fare was varied depending on the service class. According to Figure 2 (right), it is clear that the intercity bus fare (RM 33, 2nd class) is cheaper than the intercity train fare (RM 40, 2nd class).

![Figure 2. The competition of intercity mode fare and travel time](image)

Based on Gross National Income (GNI) per capita, Malaysia classified into the upper middle income developing country. In developing countries like Malaysia, which has a minor rail transport infrastructure system, the road public transport mode is usually preferred. The cheaper travel cost comparing to the train leads the bus to become more affordable for the low income [9,12,13].

RP data analysis found that there is a relationship between intercity bus fare and transport budget. Figure 3 shows the distribution of the transport budget by intercity bus fare. Of the 30 respondents with a transport budget of less than RM 50/month, 50% spent less than RM 35 for intercity bus fare. Meanwhile, of the 115 respondents with a transport budget of around RM 50.01-150, 46.1% spent about RM 35.01-45 for intercity bus fare. The Pearson $\chi^2$ test of independence showed a significantly different result, Pearson $\chi^2 (20, N = 242) = 46.755, p = .001$. Symmetric measurement ($G = .166$) and directional measurement ($Somers'd = .112$). There is a statistically significant association between
respondents’ transport budget and the intercity bus fare they spend, \( p = .047 \). The willingness of respondents’ to spend the amount of intercity bus fare is related to their transport budget.

**Figure 3.** Distribution of transport budget by intercity bus fare

### 3.2.2. The accessibility to the intercity mode terminal.

The accessibility to the transport mode terminals is also a valuable factor in mode preference [5,13]. The feeder mode accessibility reflects the ease of taking the mode to reach an intercity terminal [13]. As previously mentioned, 21.5% of respondents had chosen an intercity mode because of the feeder mode accessibility reason (Figure 1). Figure 4 reconfirmed that feeder mode accessibility is an important variable (80.2%) to consider by the respondent.

**Figure 4.** Feeder mode accessibility to intercity mode terminal (KL-Penang Corridor)

To evaluate the accessibility in this study, KL Sentral train station was observed as an intercity train station, and meanwhile, the Puduraya bus terminal was observed as an intercity bus terminal. Both of these intercity mode terminals located in the center of Kuala Lumpur. KL train station is located inside the KL Sentral building. As the KL Sentral building is currently occupied as a primary transportation hub in KL, the ease of accessing the KL Sentral train station is higher than accessing the Puduraya bus terminal. The preliminary analysis found the access distance to the intercity bus terminal (6.90 km) and the intercity train station (4.60 km).

In fact, respondents’ perception of accessibility often relates to feeder mode availability. Availability for feeder mode often associates with the route possibilities or existence of particular mode in both origin and destination pairs. Thus, accessibility to the intercity mode terminal should be evaluated by the feeder mode access and egress times. Access time is the time needed to travel from an original point to the intercity public transport terminal. Meanwhile, egress time is required to move from the intercity public transport terminal to the destination point. The feeder mode service time is the total of the feeder mode access and egress time. According to Figure 5, the fractional value of access time needed by intercity buses was lower (80.9%) than by intercity trains (87.7%). Bus access time accounts for 11.8% of the total bus travel time. Meanwhile, train access time accounts for only 8.4% of the total train travel time, as describes in Figure 5.
Respondents often experience a long waiting time for public transport. This survey found that 73 respondents had experienced waiting times of around 11 to 20 minutes, 64 respondents experienced waiting times of approximately 21 to 30 minutes, and 63 respondents had experienced waiting times of less than 11 minutes. Fig. 6 describes the time variation of feeder access with respect to the time inside the mode and the waiting time for that mode. From 63 respondents who spent less time inside the feeder access mode than 11 minutes, 60.3% of them stated that they needed to wait for less than 11 minutes, 30.2% of them waited for around 11 to 20 minutes, and 9.5% of them waited about 21 to 30 minutes. Meanwhile, from 73 respondents who had experienced waiting around 11 to 20 minutes for the feeder access mode, 30.2% spent less than 11 minutes in the feeder access mode. According to the $\chi^2$ test of independence, the difference was statistically significant, Pearson $\chi^2 (10, N=242) = 41.300$, $p = .0001$. Symmetric measurement ($G = -.139,$) and directional measurement (Somers’$d = .189$). There is a statistically significant association between feeder access in mode travel time and feeder access mode waiting time, $p = .001$. The respondents’ patience with the length of waiting time is related to the length of feeder mode travel time.

Regardless of the long waiting time, some respondents are still keen on using the feeder public transport mode (Figure 9). Commuter buses were recorded as an access mode to the intercity bus terminal (17.8%) and egress mode (19.8%). A taxi was also famous as the feeder mode (access 19.0% and egress 23.6%). Other respondents still prefer LRT or commuter trains as an access mode (18.2%).
Figure 7. Feeder mode accessibility (from/to) intercity bus terminal (KL-Penang)

About 82 respondents choose private cars, 19 respondents choose a motorcycle, 43 respondents choose a commuter bus, 44 respondents prefer the commuter train, 46 respondents choose taxi, and eight respondents choose the other as their transport access mode. It is interesting to report that respondents would likely use a similar transport mode for their egress mode, whether it was a private car, motorcycle, commuter bus, or taxi. For example (Figure 7), 82 respondents (33.9% over the total sample) who prefer private cars as an access mode also prefer private cars as their feeder transport egress mode.

Similarly, 43 respondents who preferred commuter bus as their access mode (17.8% over the total sample) choose a similar egress mode. Only the commuter trains a different trend because The commuter train did not exist as a feeder transport egress mode in Penang [5,14]. Therefore, the 44 respondents who preferred to take a commuter train as their feeder transport access mode would likely prefer a private car (31.8%), motorcycle (5.0%), commuter bus (5.0%), taxi (11.0%) and other modes (9.0%) for their feeder transport egress.

Figure 8. Distribution of feeder transport access mode by feeder transport egress mode

The $\chi^2$ test of independence allows us to understand whether the preference on private cars, motorcycle, commuter bus, commuter train, taxi, and other modes as an access mode would influence the preference of respondents' egress mode. It showed a significant difference. Pearson $\chi^2 (20, N = 242) = 739.968$ and $p = .0001$. Symmetric measurement based on the Cramer's V value = .874, $p = .0001$ and directional measurement of Goodman and Kruskal tau = .644, $p = .0001$. In short, availability for feeder mode associate with the route possibilities or existence of certain modes in both origin and destination pairs. There is sufficient evidence (Figure 7) to conclude that the preference for access mode has a strong association with the preference of egress mode.

3.2.3. The intercity mode frequency. Approximately 130 bus companies were operating more than 3,200 buses throughout Malaysia [5]. Many bus stations exist to collect the passenger directly, which will minimize the feeder mode access time or intercity mode transfer time. The demand for intercity travel
to the North, South, and East of Peninsular Malaysia was high. A total of 401 bus departures per day are calculated based on data obtained from Suruhanjaya Pengangkutan Awam Darat (SPAD) [15].

In KL–Penang corridor, the service frequency of intercity buses is the highest among the other intercity public transport modes. Compare to the train; the Intercity bus departures are much more frequent. SPAD noticed 15 bus companies registered their buses to operate along the KL–Penang corridor. Five bus companies registered their 23 coaches to depart from KL to Penang [15]. Seven bus companies registered to transit several 42 buses at KL for the destination of Penang. Three bus companies registered their 19 coaches to depart from Penang to KL. In total, 84 buses are moving within this corridor. Every day, around 1218 intercity bus passengers travel in this corridor. Meanwhile, around 791 passengers travel by train [5].

![Figure 9](image)

**Figure 9.** Availability of intercity mode (KL–Penang corridor)

About 23 buses were departing from KL to Penang every day. Within the 13 hours of the bus terminal service, bus service frequency is nearly one hour. Bus schedules are varied depending on bus company services. Based on bus user perception, there is strong reliability on bus frequency departure services compared to the train. From the origin of KL, the train has a lower frequency (4 departures/day) at a long service headway.

The availability of intercity mode is another crucial variable to influence user preference [13]. When the respondents asked for an alternative to the intercity bus, 11.2% of them said don’t have (Figure 8). The alternatives mode for the intercity bus is an intercity train (47.9%) or private vehicles. The private vehicles preferred were cars (28.9%) and motorcycle (6.6%). However, driving private vehicles for a long trip during intercity traveling was not so preferable for the travelers, since they should consider the fees, tolls, transit pass ownership, and the number of people who shared the trip with them [4].

4. Learning a lesson from KL- Ipoh corridor

The road infrastructure ensures fast and efficient movement on high-speed expressways and contributes significantly to Malaysia's economic development. The improvement of road capacity could also lead to the mode switches and changes in ridership. It learned from the North-South Expressway (NSE) road construction in 1996; the NSE contributed to causing mode shift along KL- Ipoh corridor. Before the NSE exist, the travel time on the road and rail were far too long when compared to taking a flight. Soon after the NSE opening, more intercity travelers chose the expressway route, instead of taking a flight. It simply because the door to door travel time does not differ very much, plus some other side benefits of using land transport. As an impact, Malaysian Airlines had to reduce the number of flights on this corridor, significantly because of dwindling patronage [16].

A previous study conducted can explain this situation. The travel time and cost had identified as the influential parameters on modes shifting between airplane and intercity bus in Lybia [10]. According to Ribeiro et. al., the improvements in infrastructure, when combined with other strategies such as road pricing, intelligent transport systems and technologies, congestion reduction, routing systems, transit systems, and information systems, could reduce around 10 to 15% of particular vehicle travel demand [5].
Similarly, the railway infrastructure improvement of the KL - Ipoh rail network in 2010 also caused mode shifting. Since 2010, the railway has been double-tracked and electrified. Two types of train served this corridor; the ETS train and the conventional train. The ETS speed is faster (90 kph) than the conventional train (60 kph) and only stops at three stations. As a result, a travel time of 2 hours 55 minutes by conventional train is now reduced to just 1.58 hours by the ETS (platinum) [17]. As people are keen on faster modes of transport, the train has a higher mode share in this corridor.

Further fact related to the departure services frequency and the fare policy impact, can be highlighted from Asian Development Bank Final Report, 2014 [18]. The report stated that since 2006 to 2012 commuter ridership has been flat due to occasional shortages of serviceable rolling stock. However, during the latter part of 2012 new EMU trains sets were received from China with regard to KTM intercity services. Thus, departure services frequency improved when 20 trains and 20 ETS trains are operated daily between KL - Ipoh corridor. KTMB introduced a 50% ticket price discount policy. Unfortunately, it was reported that all services fail to cover costs. KTMB intends to request a subsidy for additional services to be compensated for operating losses. However, it was confirmed that by introducing a 50% ticket price discount policy, KTMB had gained an increase in ridership of about 30% [18].

A lesson learned from KL- Ipoh corridor. The improvement of railway service (ETS) along KL- Ipoh Corridor brought significant impact on fare, travel time, and departure frequency; and contributed to the train utility changing. The changing on the train utility, in fact, contributes impact to air mode shifting and changing on bus mode ridership. Currently, the bus companies operate as private enterprises. Thus, the issue over their sustainability is a concern. Provision on the nation's land public transport industry should be formulated. Related to the fare policy, Government may consider to give the patronage to the bus company for example by subsidize policy. However, to face the ridership challenge, new scenario for these attributes should be considered for maintain the ridership for particular intercity modal. As the NSE contributed to causing mode shift along KL- Ipoh corridor, the ETS completion also indicates changing on the intercity mode ridership on the KL-Penang corridor.

Noted that the primary data was conducted in 2012. At the time, the double-tracking project had not been completed yet. Thus, the preference analysis was excluding ETS services utility. Since, the railway projects for the northern track Ipoh - Padang Besar- were completed in 2013, the conventional train (single-track rail mode) had replaced by the ETS (double-track rail mode). It eventually shortened the travel time between Kuala Lumpur to Penang (Butterworth) from 7.5 to 4 hours. The headway now is more frequent but the user needs to pay more.

In short, this analysis is to confirm that the fare, travel time, and departure frequency attributes are crucial factors that influence user in preferring the intercity mode. Thus, the intercity land mode will be more competitive and the ridership changing may occur in the KL- Penang corridors. Further research on the intercity model regarding these attributes is worthed to conduct.

5. Conclusion
The findings of the analysis and conclusions can be drawn as below.
1. The land transport development in Malaysia had existed and supported more excellent connectivity between the cities. It pursues competition between different modes of transport in this country.
2. The cheaper travel cost comparing to the train leads the bus to become more affordable for the low income. Also, the facts of higher bus frequency and better access time to intercity mode terminal were proven to influence the user to consider the intercity bus in the KL - Penang corridor.
3. The lesson learned from the ETS double-tracking project in Ipoh - KL Corridor; the fare, travel time, and departure frequency variable contributed clearly to cause mode shifting and ridership. Since these attributes are significantly influenced bus user preference in the KL- Penang corridors, ridership changing may occur. And these attributes important to consider for setting future strategy on particular intercity modal goals.
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