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FEEDER MODE CHOICE SELECTION BEHAVIOURAL MODELLING: THE CASE OF KTM KOMUTER, KUALA LUMPUR

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Abstract

Transit oriented development propagates the use of feeder services such as buses, taxis and paratransit to support the main rail trunks (Taylor, 1982; Limtanakool et.al, 2006; Alshalalfah & Shalaby, 2007). This paper attempts at explaining the preferences of passengers of a Malaysian rail service towards feeder buses, factors influencing their choices and recommendations to encourage the KTM Komuter passengers to switch mode to feeder services instead of driving their private vehicles to and from stations. Using on-board intercept survey method, some results of 200 samples were analysed for the research. Findings showed that 76% of the passengers did not prefer to use the feeder. As such, the chi-square analysis did not find any socio-demographic factors such as gender, income, level of study, employment types, to be significant in explaining this mode switching behaviour. Some trip characteristics such as vehicle ownership, frequency and length of using the KTM Komuter service also did not significantly influence the passengers' preference in using the feeder bus service. Other factors were then examined, including stations' characteristics, users' access and egress behaviours, travel time and distance. Therefore, in order to encourage the KTM Komuter users in using the feeder bus service, several recommendations such as providing an efficient, reliable frequency and catchment areas of feeder bus services were made.

Keyword: Feeder bus, KTM Komuter, public transportation, multimodal transportation system, integrated public transportation.

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INTRODUCTION

This paper revolves around the assessment of preference for bus feeder services. Feeder service is important for any public transport system to work effectively because integration between several different modes of transportation can contribute to a more efficient and highly patronage public transport services. For instance, feeder bus services can pick passengers up in certain areas to transfer points where passengers make an onward journey through other public transport services such as other public buses, trains, trams, rapid transit or even paratransit such as taxis or walking. Feeder buses usually acts as a connector within a locality or regional area. Therefore, its importance as a networking link in promoting the integration of public transportation is crucial. In addition, it promotes a better development that encourages sustainable development such as the transit-oriented development.

Prior to National Key Results Area initiatives (NKRAs) development programme in the year 2013, Malaysian urban rail networks have limited support facilities including park and ride systems as well as feeder services (PEMANDU, 2011). KTM Komuter is a provider of services in the Klang Valley and its surrounding city region hinterlands. The hinterlands spread as far as Seremban district in Negeri Sembilan, a state located southern of Kuala Lumpur; as well as Tanjung Malim in southern Perak district, a state northern of Kuala Lumpur. By 2013, the heavy rail system started to receive a huge investment injection from the government so as to increase the patronage in view of achieiving a more favourable modal split of 40:60. However, until 2013, only seventeen of KTM Komuter's 53 stations were offering the feeder bus services.

Hence, the feeder bus was still not commonly used as a mode of transport to KTM Komuter stations, neither as access nor egress vehicle. Amongst the problems faced by the KTM Komuter passengers regarding the use of feeder bus service were the unreliability of the service especially in terms of frequency and routes, the lack of provision of feeder bus service at KTM Komuter stations and the lack of partnership between the KTM Komuter authority with feeder bus service providers. Therefore, finding and developing a simplistic model to provide behavioural variations in feeder bus selection as an access and egress mode is the aim of this research paper. The two objectives are then formulated to be: i) to assess the parameters that significantly explain the mode choice selection among rail users and ii) to recommend areas in which feeder services can be improved from the rail passengers' perspectives.

LITERATURE REVIEW

The Significance and Function of Feeder Bus in the Bus Service Industry

The function of feeder bus in the bus industry is more focused on door to door connection for instance using a feeder bus from the origin such as residential area to the transit point such as the rail-transit network (Chien & Schonfeld, 1998). In addition, Ceder and Yim (2003) stated that, "Advanced and attractive feeder/shuttle transit system that operates reliably and relatively rapidly, part of the passenger door-to door chain with smooth and synchronized transfers." Which means, a feeder bus services provide the users the ability to move from door to door which can be interpreted as from the door of one mode of transport to another mode of transport easily without the need to walk for because the transports are efficiently connected.

Moreover, the use of private vehicles such as motorcycles and cars which causes problems such as congestion or environmental pollution can be reduced, and at the same time does not require the people to exert extra energy to walk far as there is feeder bus service they can use to bring them to their nearest transit points (Kuah & Perl, 1988). However, the feeder bus system too has its own disadvantages such as in terms of feeder bus planning, if there is insufficient analysis on the feeder bus users or a particular planning for feeder bus system is not being carried out, the success of an efficient and reliable feeder bus system cannot be implemented.

The KTM Komuter Feeder Bus Service

The KTM Komuter is a rail service provider under the subsidiary of the Keretapi Tanah Melayu Berhad (KTMB), the oldest rail service provider in Malaysia. KTM Komuter was the first electric train introduced in Malaysia which started its services in 1995 (KTM Komuter, 2010).

Only some KTM Komuter stations have bus services offered as part of the supporting facilities namely;

- Bandar Tasik Selatan
- Batu Caves
- Batu Kentomen
- Kg Batu
- Klang
- KL Sentral
- Kuala Lumpur
- Labu
- Nilai
- Padang Jawa
- UKM
- Sungai Gadut
- Taman Wahyu
- Shah Alam
- Subang Jaya
- Seremban
- Serdang

Source: Keretapi Tanah Melayu Berhad (2013)

FACTORS INFLUENCING THE USE OF FEEDER BUS

Literature review has identified various factors influencing the use of feeder buses. The bulk of literature has focused on users' socio-demographic characteristics as determinants of mode choice behaviours. Conclusive research on public transport facilities provision and trip characteristics (access or egress behavior) that might influence passengers' choices has been however, lacking. Table 1 outlines the contemporary literature that have been conclusively modelled the behavioural choices of feeder bus services as an alternative access and egress mode to and from the stations.

Table 1 A Summary of Literature Review of Factors Influencing the Use of Feeder Bus

Variables	Authors	Contents
Gender	Zahabi, Miranda-Morena, Patterson & Barla (2012); Xie (2012); Besser & Denneberg (2005)	Agreed that gender as a part of socio-economic characteristics has its share in influencing the preferences of people to use the bus
Origin and destination	Public-Private Infrastructure Advisory Facility [PPIF], The World Bank (2013)	Have stated several reasons why the origin and destination of people that use the transit affect the use of feeder bus.
Distance	Martin & Shaheen (2011); Elhabiby, Fikry, Mahdi, Kandi (2013); Lomax & Schrank (2010); Bachok et. al. (2012)	Have agreed that the travel time from people's origins and destinations do have an influence on people's preferences in choosing public bus as mode of transport.
Vehicle ownership	Bar-Yosef, Martens & Benenson (2013)	The captive riders - students, low income people, disabled people - are neither capable of using their own private vehicles or could not afford to own their own vehicles depends on buses to travel to the point of not caring if the waiting time for the buses is long.
Education	Bouf (2007); Glaeser, Kahn, Rappaport (2008); Soltani & Ivaki (2011)	Level of education does influence preference of using bus service.

Occupation	Taylor et al. (2009); Chow et al, (2002); Gomez-Ibanez (1996); McLeod et al (1991); Kain (1964); Black (1995) Giuliano (2005).	Per capita income and employment levels are the leading economic characteristics related to ridership
Trip characteristics and origin/destination waiting facilities	Taylor (1982); Limtanakool et. al. (2006); Alshalalfah & Shalaby (2007)	Travel time, access distance to transit station, trip characteristics and purposes influenced the mode choices.

STUDY METHODOLOGY

Data Collection

The primary data used for this research are based on the on-board intercept surveys, observation and interviews while the secondary data are obtained from the websites of the KTM Komuter authority itself. For the on-board survey, a sample of 400 respondents had been approached from the total population of approximately 95,000 people which was the average number of people using the KTM Komuter service daily (KTM Komuter, 2010). However, after data input and cleaning, only 200 samples were deemed useful for analysis purpose.

Statistical Analysis

Both descriptive and inferential analyses have been carried out. Inferential analysis has been limited to cross-tabulation and chi-square test, prior to the attempt at developing a simplified model using linear regression analysis. Dependent variable (FEEDER PREFERENCE) has been tested against various (independent) socio-demographic factors, trip characteristics and rail stations' support facilities.

ANALYSIS AND FINDINGS

Descriptive Analysis (n = 200)

The survey of n = 200 samples consisted of 52.5% female (105) and 47.5% male (95). Most respondents have access to a vehicle, either a car or a motorcycle (Figure 1).

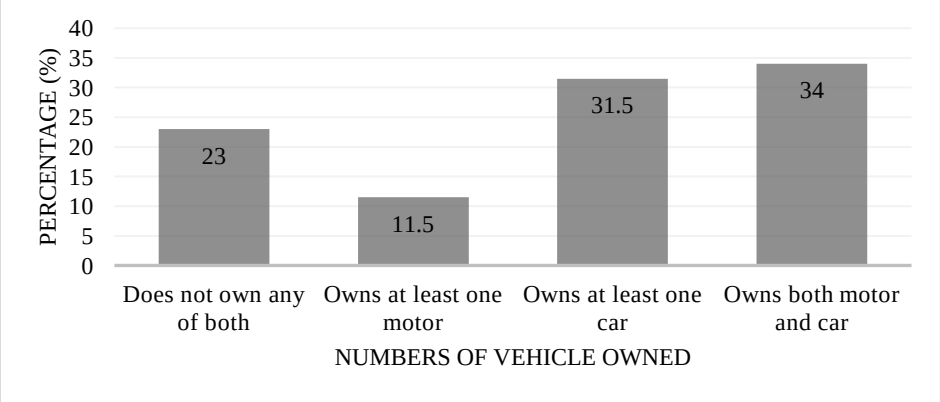

Figure 1 Respondents' Vehicle Ownership

Monthly income has been categorised to reflect the domestic definitions of income levels. Low income reflected those earning less than RM2,000, medium being between RM2,000 and RM4,000. Finally, high income represented those earning more than RM4,000. The lower income dominated the respondent income group at 82% (Figure 2).

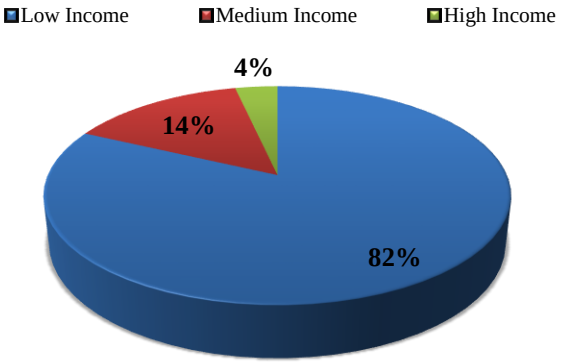

Figure 2 Respondents' Income Distribution

The majority (39.5%) of the respondents were College Diploma holders (Figure 3).

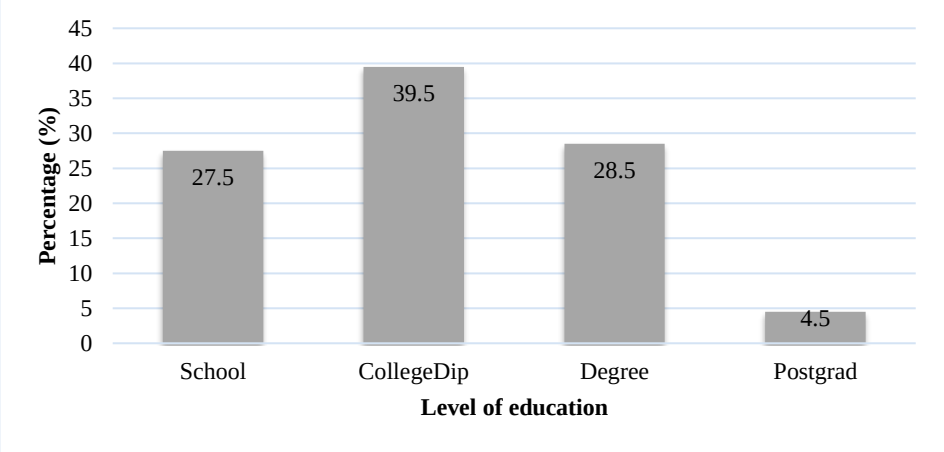

Figure 3 Respondents' Level of Education

Meanwhile, student community formed highest percentage (26%), providing a popular employment type. The routes that KTM Komuter ply through have been the educational and institutional catchment areas.

Trip characteristics of respondents are presented in the following figures. The highest percentage (49%) of the regularity of using the KTM Komuter service was less than 10 times a month (Figure 4). Meanwhile, most of the respondents (63%) had only used the KTM Komuter service between one to five years (Figure 5).

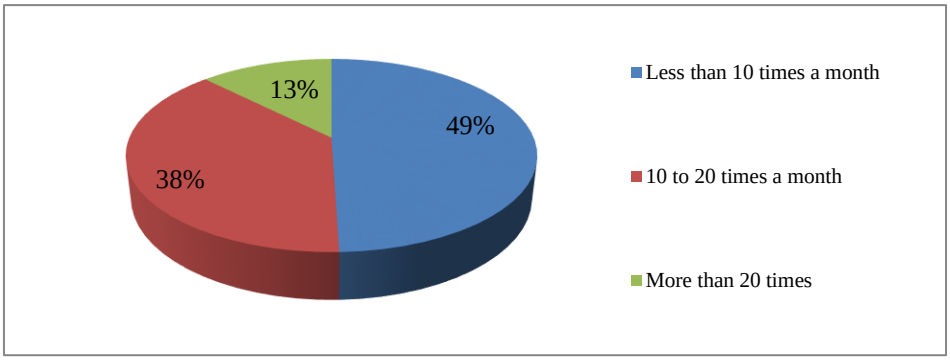

Figure 4 Annual Rail Trip Frequency

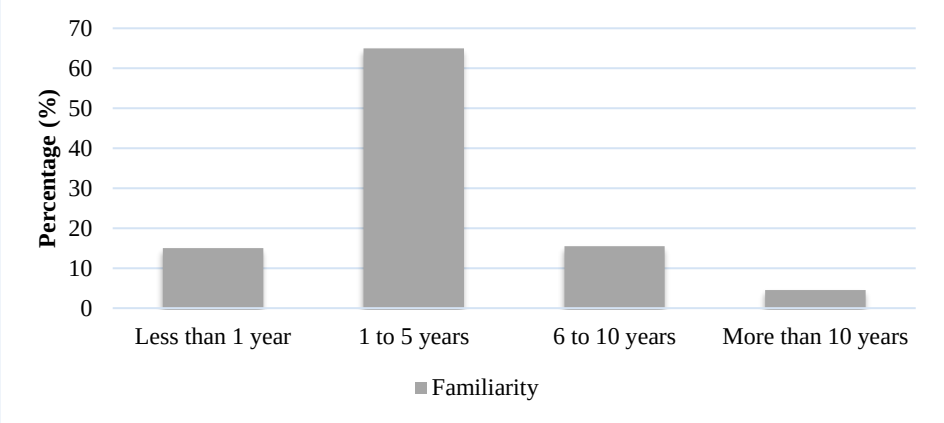

Figure 5 Length of Rail Usage

Origin station with the highest number of people coming from was KL Sentral at 12%. Similarly, people heading to KL Sentral as destination was also the highest (11.5%). Meanwhile, Klang (6.5%) was the second most popular destination.

The highest proportion (27%) of respondents has at least 10 minutes of rail travel time. Frequency of people travelling a shorter travel time was much higher than people travelling longer time. Stated preference revealed that feeder buses were not preferred as an access and egress mode (76% of respondents, Table 3).

Table 3 Feeder Service Preference by Respondents (N = 200)

	Frequency	Percent
No	152	76.5
Yes	48	23.5
Total	200	100.0

STATISTICAL ANALYSIS

Socio-demographic characteristics have been tested using chi-square test. These factors were gender, monthly household income, level of education and type of employment. Rail services usage variables such as frequency/regularity and familiarity were also tested. Neither the preference was determined by the frequency of usage in year nor was it influenced by the usage duration based on the year of the first ride. None of these factors were found significant in influencing feeder services selection.

Table 4 Chi-Square Test and Results for Selected Socio-Demographic and Trip Characteristics

Parameter	Pearson Chi-square Value	df	Asymptotic Significance (2-sided)	Significant at * 95%, **99% levels # insignificant
Gender	.196	1	.658	#
Monthly income	4.797	2	.091	#
Level of education	2.842	3	.417	#
Type of employment	.861	2	.650	#
Vehicle ownership	.509	3	.917	#
Usage frequency	2.452	2	.293	#
Usage familiarity	5.496	3	.139	#

One possible explanation could be the small sample size (n = 200), to be dispersed across multiple categories (column) of independent variables. Feeder preference was quite low (24%), due to various reasons which could only be explained by a more qualitative research, which is not within the ambit of this paper.

An alternative to such analysis, is to combine or collapse the independent variable categories into smaller number, hence reducing the degree of freedom.

The Tables below, provide the cross tabulation of feeder services by the other variables to be analysed using chi-square test. Factors or parameters tested included categories of access and egress modes to and from station, distance (number) of station between origin and destination, availability of parking and feeder services at either origin or destination stations respectively, and whether respondents have driven and parked at the stations of origin or destination, respectively as well as collapsed travel time categories.

Table 5 Feeder Service Preference by Categories of Access Mode to Station

	Categories of access mode to stations		Total
Feeder preference	Private mode	Public mode	
No	74	78	152
Yes	4	44	48
Total	78	122	200

Table 6 Feeder Service Preference by Categories of Egress Mode from the Station

	Categories of access mode to stations		Total
Feeder preference	Private mode	Public mode	
No	72	80	152
Yes	9	39	48
Total	81	119	200

Table 7 Feeder Service Preference by Categories of Station Numbers between Origin and Destination Stations

	Station Distance		Total
Feeder preference	Below 10 stations	10 stations and above	
No	84	68	152
Yes	17	31	48
Total	101	99	200

Table 8 Feeder Service Preference by Origin Stations with Feeder Service

	Feeder Available		
Feeder preference	No	Yes	Total
No	106	46	152
Yes	32	16	48
Total	138	62	200

Table 9 Feeder Service Preference by Destination Stations with Feeder Service

	Feeder Available		
Feeder preference	No	Yes	Total
No	109	43	152
Yes	33	15	48
Total	142	58	200

Table 10 Feeder Service Preference by Origin Stations with Parking Facilities

	Parking Available		
Feeder preference	No	Yes	Total
No	20	132	152
Yes	5	43	48
Total	25	175	200

Table 11 Feeder Service Preference by Destination Stations with Parking Facilities

	Parking Available		
Feeder preference	No	Yes	Total
No	17	135	152
Yes	5	43	48
Total	22	178	200

Table 12 Feeder Service Preference by Having Driven to Origin or from Destination Stations

	Drove to or from stations		
Feeder preference	No	Yes	Total
No	117	35	152
Yes	41	7	48
Total	158	42	200

Table 13 Feeder Service Preference by Having Parked at Origin or Destination Stations

	Parked at either stations		
Feeder preference	No	Yes	Total
No	108	44	152
Yes	43	5	48
Total	151	49	200

Table 14 Feeder Service Preference by Travel Time Ranges

	Travel time categories		
Feeder preference	Below One Hour	One Hour or More	Total
No	142	10	152
Yes	42	6	48
Total	184	16	200

Tests have shown (Table 15) that feeder services preference was dependent on various factors including the type of mode used for access and egress to the stations of origin and destination respectively (significant at 99% C.L.).

Moreover, feeder preference was influenced by distance or number of stations between the origin and destination stations and whether respondents have parked their access or egress mode at either the origin or destination stations (significant at 95% C.L.).

However, feeder preference has also been influenced by availability of parking facilities and feeder services at either origin and destination stations or driven to and from stations of origin and destination, respectively. Similarly, feeder preference was not determined by travel time, or the duration of travelling exclusively by rail.

Table 15 Chi-Square Tests Analysis and Results for Selected Parameters

Parameter	Pearson Chi-square Value	df	Asymptotic Significance (2-sided)	Symmetric measures (Phi, Cramer's V, contingency efficient)	Approximate Significance	Significant at * 95%, **99% levels # insignificant
Type of access modes	24.967	1	.000	.353, .353, .333	.000	**
Type of egress modes	12.399	1	.000	.249, .249, .242	.000	**
Distance between Origin and Destination Stations	5.748	1	.017	.170, .170, .167	.017	*
Available parking at origin (O) station	.251	1	.617	.035, .035, .035	.617	#
Available feeder bus at origin (O) station	.161	1	.688	.028, .028, .028	.688	#
Available parking at destination (D) station	.022	1	.882	.010, .010, .010	.882	#
Available feeder bus at destination (D) station	.155	1	.694	.028, .028, .028	.694	#
Drove to or from OD stations	1.567	1	.211	-.089, .089, .088	.211	#
Parked at either OD stations	6.772	1	.009	-.184, .184, .181	.009	**
Travel time ranges	1.738	1	.187	.093, .093, .093	.187	#

Non significant testing was validated with a regression analysis, to develop a simple model of feeder preferences.

Table 16 Regression Model for Feeder Preference by Distance (Number of Stations) Between Origin and Destination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.041[a]	.002	-.003	.429

a. Predictors: (Constant), DISTANCEOD

Table 17 Regression Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.208	.064		18.956	.000
	DISTANCEOD	.003	.006	.041	.579	.563

a. Dependent Variable: FEE

Selection for regression analysis was based on the significant results for chi-square analysis. However, parameters of ratio data such as travel distance (p-value 0.563) and trip frequency (p-value 0.980) made by rail were not found to be significantly contributing to the development of models for feeder preferences.

Table 18 Regression Model for Feeder Preference by Trip Frequency

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.002[a]	.000	-.005	.429

a. Predictors: (Constant), REG2

Table 19 Regression Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.241	.048		26.036	.000
	REG2	-7.574E-5	.003	-.002	-.025	.980

FINDINGS

The empirical analysis indicates that not many passengers (23%) were using the feeder bus services. This was probably because most of the respondents were not regular commuters as most of them were only using the KTM Komuter services not more than 10 times annually. Moreover, more than half of the respondents were using the KTM Komuter service either for the first time and/or less than five years.

The statistical analysis has shown that out of seventeen independent variables tested, only four parameters were found by chi-square test to be significantly influencing mode choice behaviours, namely feeder bus as an access or egress mode for trunk rail service. Nevertheless, the chi-square results corresponded with some of the conclusion made by selected studies researched (Martin & Shaheen, 2011; Taylor, 1982; Limtanakool et. al, 2006; Alshalalfah & Shalaby, 2007). These results therefore can be interpreted in both ways: i) that feeder was not an attractive mode and ii) that returning to bus system was seen as inferior to the current rail system that passengers were enjoying. It can be said that lower demands for feeder bus service was due to the lower number of stations providing this service (seventeen out of 53 stations only). Hence, other variables needed to be examined so as to model the passengers' modal choices.

Regression analysis failed to confirm the strength of the two ratio parameters (number of stations between origin and destination, and travel frequency) in developing a model for mode choice behaviour in this research paper. As such, extended research should be focused on attaining more accurate and precise ratio data for tests including travel time (minutes) and travel distance (kilometre). Access and egress modes to stations, at this juncture were the two variables, worth investigating as the ultimate determinant for mode choice behavioural model for feeder services supporting trunk rail routes.

RECOMMENDATIONS

Based on the findings that there was a low demand, recommendations are focused on improving the availability and quality of feeder bus services. Thus, these recommendations have been forwarded to the KTM Komuter management team so as to increase passengers' patronage of feeder buses to their rail stations. They are:

i. KTM Komuter should provide feeder bus services at all KTM Komuter stations instead of providing the service at only the selected stations.
ii. KTM Komuter should establish partnership with feeder bus service providers such as RapidKL (now Prasarana) or Metrobus with the supervision of the Land Public Transport Commission (SPAD) and to provide suitable routes at places with large catchment areas such as residential and institution areas.

iii. KTM Komuter should also provide suitable supporting facilities for the feeder bus service such as comfortable and convenient waiting facilities, proper bus stops, route maps, integrated scheduling and ticketing between rail and feeder services.

iv. The Land Public Transport Commission (SPAD) should start providing special lanes for buses only so that the bus services are the prioritised traffic, since buses are usually stigmatised to be congested and unattractive relative to other road vehicles.

CONCLUSION

In brief, this empirical study has proven that buses received less proportionate demand as feeder vehicles. The lower demand could be attributable to buses being inferior to rail and that only seventeen out of 53 rail stations of KTM Komuter have been providing the feeder service. It was confirmed that access and egress modes to stations determined the mode choice. Additionally, the number of stations in between origin and destination as well as whether users' had parked at either origin or destination stations were significant in explaining this behaviour. Therefore, KTM Komuter and related agencies may adopt the recommendations made in this paper to encourage more people to use the feeder bus service. The paper's suggestion for feeder services improvements can also benefit other researchers, academicians, transport planners, public transport service providers of city region with characteristics similar to those of Klang Valley, Malaysia.

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