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Socio-economic and Travel Characteristics of transit users at Transit-oriented Development (TOD) Stations

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Abstract

The level of motorization has been increasing at an alarming rate in Malaysia over the years. Increase in population, economic growth, affordability to purchase vehicles, low fuel price, attractive vehicles financing system are some factors causing growth in motorization. As a result, Klang Valley and its conurbation is overwhelmed by traffic jams, where people tend to travel by their own cars. To provide a productive solution for these massive issues, it is important to identify the factors influencing the transit users to choose the LRT services as their mode of transport. Some of the factors are related with socio economic and travel characteristics. The objective of this study is to identify the factors affecting to select the LRT services as the transportation mode for their travel activities in the aspects of demographic and travel pattern of the transit users. A survey was conducted to 3 stations in Kelana Jaya line and 3 stations in Ampang Line. The questionnaires were distributed to the passengers who access to/from the selected TOD stations. The questionnaire survey covers area such as location of origin and destination, types of activities at origin and destination, and mode of transport used to reach the TOD stations. From this study, the willingness travel distance, important types of activities at origin and destination point, and major mode of transport to access to/from TOD stations were identified. The findings were made in comparison to the literature and the output was presented in appropriate digital mapping images. Recommendations are to realize the acceptable travel distance and mode of transport choice as well as the major land uses activities for the improvement of TOD stations in Kuala Lumpur.

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1. Introduction

Urban mobility is an essential component of the urban transportation system in enhancing the economic structure of an urban area. It is undeniable that economic growth of an urban area strongly depends on the functioning of the urban transportation system. Over the years, in big cities and towns, the mobility of people has been greatly affected because of a significant upsurge in the number of private vehicles on roads. Extreme traffic congestion, increase in air pollution, fuel consumption and decrease level of road safety are the common and frequent repercussion of increase in private vehicles use. Hence, encouraging the use of public transport would be critical in reducing such congestion.

Public transportation is an important transportation mode used by transportation planners to solve various transportation problems, particularly traffic congestion in urban areas. The use of public transport can be seen in almost all the major cities in the world. Transit provides mobility and accessibility to the employment, community facilities, medical care, and recreational activities. The role of public transportation in providing a form of public good (White, 1995) and as a provision of mobility for the young, elderly, handicapped and poor (Isaac, 1995) is important to include in the planning considerations of any human settlements. Thus, transit becomes more important as cities grow.

In Malaysia, new initiatives and multiple efforts have been taken by the government authorities to improve the public transportation system under the National Key Result Areas (NKRA) especially in Kuala Lumpur in an attempt to shift from the use of private to public transportation. The ongoing construction of Mass Rapid Transit (MRT), Bus Rapid Transit (BRT) and the extension of Light Rail Transit (LRT) in Klang Valley are some of the major public transportation projects which are undertaken to address the growing travel demand of the population.

To justify such large investments in public transportation, it is important to be able to understand the potential of transit usage. The people's movement by transit closely related with their social-economic and travel characteristics. Socio-economic characteristics consist of gender, ethnicity, age, marital status, income, employability status, vehicle ownership, and the number of households. Meanwhile, travel characteristics referred to the location of origin point before reaching transit station, type of activity at the origin point and destination, and mode of transport to access transit station. The success of the public transport use largely depends on how attractive the system is to the transit users especially in terms of the location of the stations, infrastructure at the station, the characteristics of the land use and pedestrian infrastructure surrounding the station. Therefore, this study will focus more on the socio-economic and travel characteristics of transit users at TOD stations. The study on the relationship between socio-economic and travel characteristics of transit users of rail-based public transport is very important to grasp current and future travel trends as well as to enhancing the quality of public transport service in the future.

2. Literature Review

Various studies have been undertaken previously on public transport demands. Socio-demographic variables were found to be most significant in many of them. Satiennam et al. (2011) and Thamizh Arasan and Vedagiri (2011) have found a higher probability to shift to public transport among females. Likewise, the study of Alvinsyah, Soehodho and Nainggolan (2005) concluded that men have a stronger preference for driving and are less likely to shift to public transport. . Morikawa et al. (2003) also found that male travelers prefer to use cars or motorcycles more than females in Japanese cities except Nagoya. In Malaysia, females were discovered to be more likely to use public transport (Rahmat and Ismail, 2007). Chang and Wu (2005) concluded that among the elderly, more men than women drive their own private vehicle in Taiwan.

Age is found to be significant as well. A positive relationship between age and the likelihood to use public transport was established by Abuhamoud, Rahmat and Ismail (2011). Nurdden, Rahmat and Ismail (2007) reported that senior citizens were more willing to shift to public transport if the minimum legal driving age is increased and the quality of public transport services is improved. Morikawa et al. (2003) also found a high preference for private vehicle dependency among those aged 18 years old and above, while the older population (65 years old and above) in Nagoya,

Japan prefer to travel by bus. Nolan (2001) also found that younger households had higher expenditure on transport, both private and public. Besides gender and age, other factors that have been evaluated in previous studies are education, income, household size, as well as car ownership. The use of cars is found to be positively related to household size, income and car ownership (Abuhamoud, Rahmat and Ismail, 2011).

Travel characteristics of transit users also influence on TOD stations ridership. Travel is undertaken to engage in an activity at some other locations (Kurani and Lee-Gooselin, 1997) since the activity cannot be completed in the place of origin. The activities can be varied due to the individual's needs and intentions. Therefore, each individual may reach a different decision to undertake a variety of activities to various destinations. Public-Private Infrastructure Advisory Facility (PPIF) have stated several reasons why origin and destination of people that use the transit affect the use of feeder bus (The World Bank, 2013). 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. Similarly, Limtanakool et.al (2006) have found that travel time, access distance to transit station, trip characteristics and purpose influenced the mode choices.

3. Intra-urban rail system in Klang Valley

The Klang Valley's rail-based transit system consists of three Light Rail Transit (LRT) systems which are Ampang line LRT, Sri Petaling line LRT and Kelana Jaya line LRT, two commuter rail lines (along with shuttle services) operated as KTM Komuter, one monorail line known as KL Monorail, and an airport rail link to Kuala Lumpur International Airport (KLIA) and klia2, which consists of an KLIA Ekspres and a KLIA Transit service. The new rail-based public transport network, 51km Sungai Buloh - Kajang line MRT, is integrated to the Klang Valley Mass Rapid Transit (KVMRT) project in 2017, together with the existing LRT, Monorail, KTM Komuter, KLIA Ekspres and KLIA Transit systems, to form the backbone of seamless connectivity in the Greater Kuala Lumpur / Klang Valley region.

The two LRT lines which is Kelana Jaya and Ampang line were selected in this study. The Kelana Jaya line, running from Gombak to Kelana Jaya and the Ampang line running from Sentul Timur to Ampang and Bandar Kinrara. The LRT Kelana Jaya line is the first fully automated and driverless rail system in the Valley area and forms a part of the Greater KL/Klang Valley Integrated Transit System. Servicing 37 stations, the line has 46.4 km of grade-separated tracks running mostly on underground and elevated guideways. Meanwhile, the Ampang and Sri Petaling line LRT which a combined network comprises 45.1 kilometres of track (28.0 miles) with 36 stations, and is the first to use the standard gauge track and semi-automated trains in Klang Valley.

Ridership on the Ampang and Kelana Jaya Line has steadily increased with the passage of time. In 2017, the Ampang line carried 59.46 million passengers, with over 160,000 passengers per day. Meanwhile, Kelana Jaya line carried 83.59 million passengers in 2017, with over 230,000 passengers per day. ("Transport in Kuala Lumpur" n.d.).

Table 1 revealed that the land use characteristics and major landmarks within a one-kilometre radius of the selected TOD stations. Sentul TOD station has the highest density level, followed by Wangsa Maju, Pandan Jaya and Kerinchi, Bukit Jalil and Taman Paramount. In terms of diversity, Sentul TOD station has the highest level of land use diversity (calculated using Simpson's index of diversity) followed by Kerinchi, Wangsa Maju, Pandan Jaya, Bukit Jalil and Taman Paramount. High density and diversity surrounding Sentul TOD station have influenced by the high residential developments. Medium density and high diversity around Kerinchi and Wangsa Maju TOD stations have contributed by high commercial developments for Kerinchi, and medium-to-high residential and commercial developments coupled with institutional (college) for Wangsa Maju. In addition, the low density and diversity of Bukit Jalil and Taman Paramount TOD stations, on the other hand, have contributed by institutional (stadium, college and school) for Bukit Jalil and low residential developments for Taman Paramount. Thus, the urban rail stations with a variation of land use characteristics have been chosen in order to study their socio-economic and travel characteristics pattern of TOD stations in Kuala Lumpur.

Table 1. Land use characteristics and major landmarks of the selected TOD stations

Station	Land use characteristics			Major landmarks
	Population density	Simpson's index of diversity	Level of land use density and diversity	
Ampang line				
Sentul	755.28	0.66	High density, High diversity,	High residential developments
Pandan Jaya	603.17	0.50	Medium density, Medium diversity,	Institutional (college and school), medium residential and commercial developments
Bukit Jalil	322.10	0.36	Low density, Low diversity,	Institutional (Stadium, College and school)
Kelana Jaya line				
Kerinchi	539.36	0.63	Medium density, High diversity,	High commercial developments
Wangsa Maju	675.19	0.55	Medium density, High diversity,	Medium-to-high residential and commercial developments, Institutional (college)
Taman Paramount	136.86	0.25	Low density, Low diversity,	Low residential developments

Note: The land use characteristics were calculated within a one-kilometre radius of the selected LRT stations.

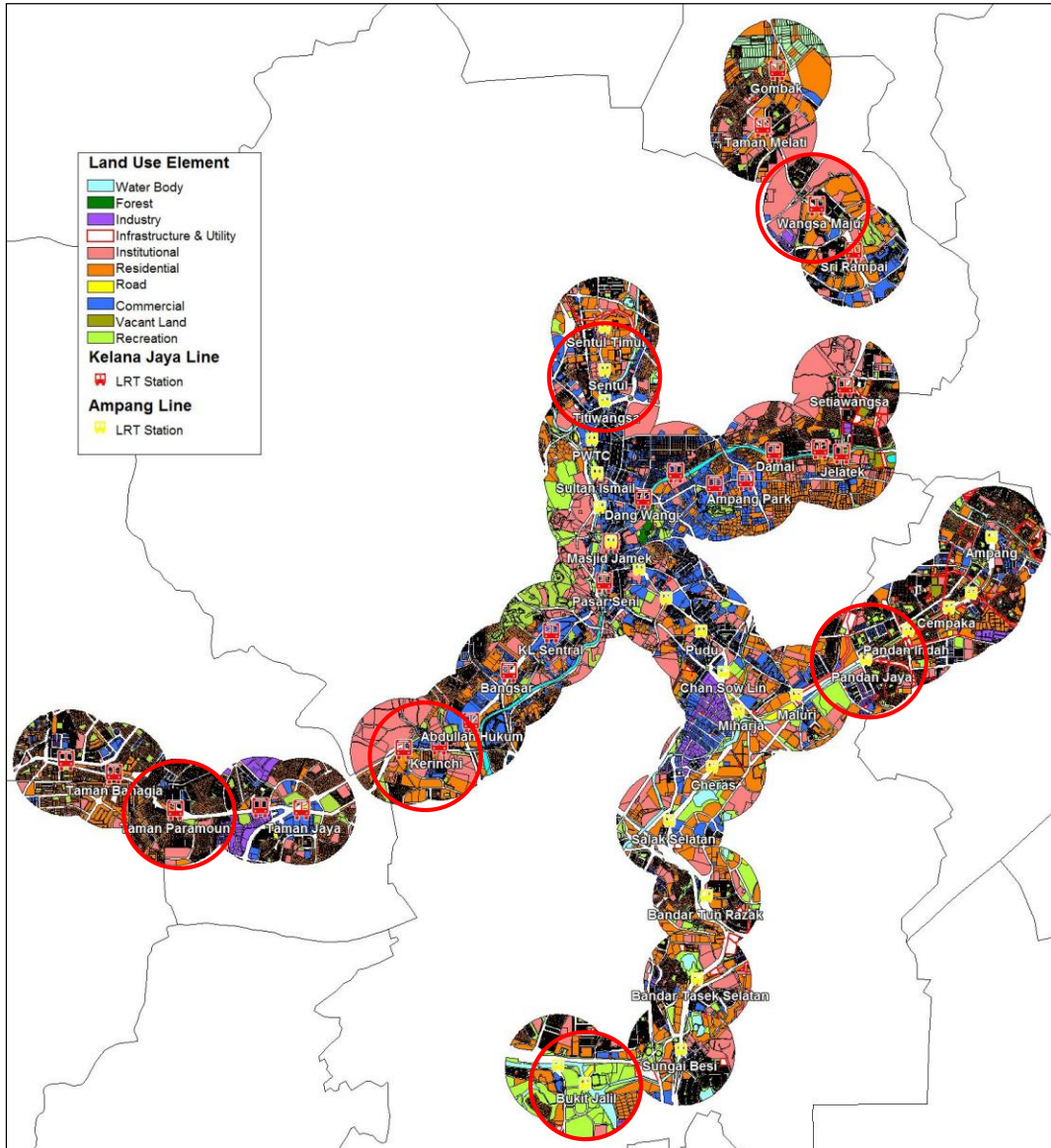


Fig. 1. LRT stations along Kelana Jaya and Ampang Line
Source: Kuala Lumpur city hall MapInfo digital mapping data 2010

4. Methodology

The questionnaire survey data of the six selected transit stations is important in order to identify socio-economic characteristics and travel characteristics. These two parts of major questions are placed together in a questionnaire survey form. Passenger characteristics questionnaire is carried out for two major groups; pedestrian-based passenger at the transit station and non-pedestrian-based passenger at transit stations. The target population consists of 2 groups which are pedestrian-based ridership and non-pedestrian based ridership. The pedestrian-based ridership is the passengers who walk to/from the transit station. Meanwhile, non-pedestrian based ridership are the passengers who use modes of transport other than walking to/from the transit station. Socio-economic characteristics consist of gender, ethnicity, age, marital status, income, employability status, vehicle ownership, and the number of households. Travel characteristics contain the location of origin point before reaching transit station, type of activity at the origin point, activity at the destination, and mode of transport to access transit station.

The population for passenger characteristics studies is referred to the total users of 3 stations in Kelana Jaya Line and 3 stations in Ampang Line. The population size of each train station is calculated based on the number of passenger volume pass through the automated ticketing machine from 7 a.m to 7 p.m for two consecutive days. The passenger volume recorded in Taman Paramount LRT station was 10,832 passengers, Kerinchi LRT station was 29,861 passengers, and 44,533 passengers at the Wangsa Maju LRT station. Meanwhile, the passenger volume recorded in Bukit Jalil LRT station was 14,795 passengers, 15,123 passengers at Pandan Jaya LRT station, and 9,885 passengers at Sentul LRT station. These numbers are considered as the population size of each train station.

The need for sampling in this research is based on the realization which in the passenger characteristics studies, a researcher has to deal with a very large transit user. An attempt to get the passenger characteristics data from all the transit users in all Kelana Jaya and Ampang line stations would be impossible. Thus, a sample population has been adopted in this research.

The number of respondents surveyed in Kerinchi LRT station was 321 respondents, Wangsa Maju LRT station was 276 respondents, and 290 respondents at Taman Paramount LRT station. Meanwhile, the number of respondents surveyed in Bukit Jalil LRT station was 375 respondents, Pandan Jaya LRT station was 377 respondents, and 370 respondents at Sentul LRT station. The number of sample size used for this study is based on suggestion and technique by (Raosoft, 2004; The Research Advisors, 2006).

The stratified sampling method was used by selecting two main strata which are pedestrian-based ridership (those who walk to the station) and non-pedestrian-based ridership (those who use other transportation). Then, the respondents are approached using the convenience sample. The questionnaire survey was conducted to get the passenger characteristics data with the respondents who access from/to LRT stations. Therefore to ensure the questionnaire survey that has prepared is reliable and well understood, a pilot survey was undertaken prior to the actual survey.

There are basically three methods of analysis conducted in this study; descriptive analysis, bivariavte analysis and digital mapping analysis by using GIS. The descriptive analysis method used to analyze data on passenger characteristics which consist of socio-economic characteristics and travel characteristics. Socio-economic characteristics referred to gender, ethnicity, age, marital status, income, employability status, vehicle ownership, and the number of households. Travel characteristics contain the location of origin and destination, activity at origin and destination, mode of transport before and after reaching LRT station. All these data are presented by suitable tabular data presentation and graphical data presentation in univariate and bivariate analysis. Crosstab is used to understand relationship of socio-economic and travel characteristics variables as well as to make general conclusion of the findings. GIS mapping technique will be used to analyze the origin and destination of the respondents within the selected radius of the transit station.

5. Socio-economic characteristics of passenger at TOD stations

The number of respondents is equally selected at three LRT stations along each line; Sentul, Pandan Jaya and Bukit Jalil LRT station along Ampang Line and Kerinchi, Wangsa Maju and Taman Paramount LRT station along Kelana Jaya Line. The socio-economic of transit users were analyzed using the selected six transit stations.

5.1. Gender

Table 2. Gender by transit station

	Station	Gender		Total
		Male	Female	
Ampang	Sentul	194	196	390
	Pandan Indah	117	275	392
	Bukit Jalil	184	217	401
Total		495	688	1183
Kelana Jaya	Kerinchi	143	178	321
	Wangsa Maju	124	152	276
	Taman Paramount	111	179	290
Total		378	509	887
Overall Total		873	1197	2070

Source: Questionnaire Survey, 2015

Based on the total 1183 people who have been interviewed at three LRT transit stations, Bukit Jalil LRT Station has a slightly high number of respondents (401 or 33.9%) followed by Pandan Jaya LRT Station 392 (33.14%) and Sentul LRT Station 390 (32.97%). The number of female respondents was higher (688 or 58.16%) than male (495 or 41.84%) counterparts and thus it illustrates a higher response rate by the female respondents than the male. The female respondents at Pandan Jaya and Bukit Jalil LRT Station were recorded to be the highest among the three selected transit stations.

Meanwhile, the female respondents totaling 178 (55.5%) at Kerinchi station were higher than male respondents 143 (44.5%). The number of female respondents and male respondents at Wangsa Maju transit station were 152 (55.1%) and 124 (44.9%) respectively. At Taman Paramount transit station, the number of female respondents represents 179 (61.7%) were also higher than the male respondents 111 (38.3%).

5.2. Ethnicity

Table 3. Ethnicity by transit station

	Station	Gender				Total
		Malay	Chinese	Indian	Others	
Ampang	Sentul	259	58	59	13	389
	Pandan Indah	319	43	22	6	390
	Bukit Jalil	181	118	53	46	398
Total		759	219	134	65	1177
Kelana Jaya	Kerinchi	175	89	56	1	321
	Wangsa Maju	152	82	37	5	276
	Taman Paramount	161	72	57	0	290
Total		488	243	150	6	887
Overall Total		1247	462	284	71	2064

Source: Questionnaire Survey, 2015

Ethnicity is divided into four major categories namely “Malay”, “Chinese”, “Indian” and “Others” representing the ethnic groups of the population at the selected study areas. The ethnic Malay represents the highest number of respondents comprising 64.49% (759 respondents) followed by Chinese 18.61% (219 respondents), Indian 11.38% (134 respondents) and others 5.52% (65 respondents).

Again, the ethnic Malays represent the highest users of the LRT stations than the other ethnic groups at all the selected three LRT transit stations. At Kerinchi transit station, 175 (54.5%) ethnic Malay was the users of this station followed by Chinese with 89 (27.7%), Indian with 56 (17.4%) and Others with only 1 (0.3%). The distribution of ethnic groups at the other two transit stations is same as that of Kerinchi transit station. The ethnic Malay users at Wangsa Maju station were 152 (55.1%) followed by Chinese with 82 (29.7%), Indian with 37 (13.4%) and Others only 5 (1.8%). Taman Paramount station has 161 (55.5%) Malay users followed by 72 (24.8%) Chinese and 57 (19.7%) Indian users.

5.3. Age group

Table 4. Age by transit station

Station		Age						Total	
		13-17	18-24	25-34	35-44	45-54	55-64		>65
Ampang	Sentul	69	146	107	38	16	9	5	390
	Pandan Jaya	32	318	20	8	5	4	4	391
	Bukit Jalil	48	181	79	44	27	17	6	402
Total		149	645	206	90	48	30	15	1183
Kelana Jaya	Kerinchi	50	67	109	31	38	23	3	321
	Wangsa Maju	39	122	68	26	14	5	2	276
	TamanParamount	5	118	125	36	6	0	0	290
Total		94	307	302	93	58	28	5	887
Overall Total		243	952	508	183	106	58	20	2070

Source: Questionnaire Survey, 2015

Table 4 shows the findings on the age group of the respondents at Sentul, Pandan Jaya, and Bukit Jalil LRT station. Most of the users were between 18 years old and 34 years old representing 146 (64.87%) from the total respondents. The findings also showed that the least number of users were among the older age group. At Pandan Jaya LRT station, most of the respondents were between 18 years old and 24 years old containing 318 (81.33%) users. At Bukit Jalil LRT station, most of the respondents were between 18 years old and 24 years old containing 181 (45.02%) users.

The findings on the different age category of the transit users show that the most of the users were between 25 years old and 34 years old at Kerinchi station comprising of 109 (34.0%) users. On the other hand, at Wangsa Maju station, the largest number of users were between 18 and 24 years old containing 122 (44.2%) users. The largest number of users at Taman Paramount station were between 25 and 34 years old comprising of 125 (43.1%) users.

5.4. Marital status

Table 5. Marital status by transit station

Station		MaritalStatus				Total
		Single	Married	Widowed	Divorced	
Ampang	Sentul	278	108	3	1	390
	Pandan Indah	368	21	0	0	389
	Bukit Jalil	291	107	0	3	401
Total		937	236	3	4	1180
Kelana Jaya	Kerinchi	183	127	9	2	321
	Wangsa Maju	182	86	8	0	276
	Taman Paramount	171	117	2	0	290
Total		536	330	19	2	887
Overall Total		1473	566	22	6	2067

Source: Questionnaire Survey, 2015

Table 5 shows the marital status of the respondents at three selected LRT Stations. Overall, the respondents can be categorized either single or married. 937 transit users (79.41%) were single and 236 (20%) married. The highest number of users at Pandan Indah station was “single” and the lowest were married. The number of “single” users at Kerinchi station were 183 which is equivalent to 57% of the total users at this station. The “married” users at this station were 127 (39.6%). At Wangsa Maju station, 182 (65.9%) respondents were “single”, 86 (31.2%) were married. The “single” users at Taman Paramount station were 171 (59%), “married” 117 (40.3%).

5.5. Monthly Income of the LRT Users

Table 6. Respondent’s monthly income by transit station

Sentul	Pandan Jaya	Bukit Jalil	Income per Month	Kerinchi	Wangsa Maju	Taman Paramount
186	320	240	Less than RM1000	96	142	6
105	28	56	RM1001 - RM2000	71	64	32
55	11	50	RM2001 - RM3000	109	42	149
21	6	25	RM3001 - RM4000	37	20	76
7	1	11	RM4001 - RM5000	8	5	16
5	4	4	RM5001 - RM6000	0	2	10
5	2	4	RM6001 - RM7000	0	0	1
1	0	4	RM7001 - RM8000	0	1	0
1	0	1	RM8001 - RM9000	0	0	0
0	0	2	RM9001 - RM10000	0	0	0
3	3	1	More than RM10000	0	0	0
389	375	398	Total	321	276	290

Source: Questionnaire Survey, 2015

Table 6 shows respondents’ monthly income ranges at three selected LRT stations along Ampang Line. The findings show that almost all the transit users belonged to the low-income group. The transit users whose income level ranging RM4000 and below at Sentul LRT station were 94.34% and Bukit Jalil LRT station 93.22%. About 85% of the total users at Pandan Jaya LRT were earning RM1000 and below. It indicates that the low-income group is the main users of LRT services at all the three selected transit stations.

At Kerinchi station, the highest income range of the users was between RM2001 and RM3000 comprising of 109 (34%) users. At Wangsa Maju station, the highest income range of the users was RM1000 and below comprising of 142 (51.4%) users. On the other hand, at Taman Paramount station, 149 users (51.4%) were earning income ranging between RM2001 and RM3000.

5.6. Employability status

Table 7. Employability status of respondents by transit station

Station	Employability status						Total	
	Student	Employed	Housewife	Unemployed	Retired	Others		
Ampang	Sentul	155	215	7	11	2	0	390
	Pandan Jaya	334	43	3	11	0	1	392
	Bukit Jalil	212	162	6	15	7	0	402
Total		701	420	16	37	9	1	1184
Kelana Jaya	Kerinchi	91	202	20	2	6	0	321
	Wangsa Maju	136	120	6	6	6	2	276
	Taman Paramount	13	276	1	0	0	0	290
Total		240	598	27	8	12	2	887
Overall Total		941	1018	43	45	21	3	2071

Source: Questionnaire Survey, 2015

Table 7 shows employability status of the respondents at three selected LRT stations. The “students” are among the highest LRT users totalling 59.21% (701) out of total respondent at the three transit stations. It is followed by “employed” respondents totalling 35.47% (420), “unemployed” respondents 3.13% (37), and “housewife” 1.35% (16), “retiree” 0.76% (9) and “others” 0.08% (1). The “students” account for the highest respondents at Pandan Jaya LRT station whereas “employed” respondents were among the highest number of transit users at Sentul LRT station.

According to the table above, the “employed” respondents were the highest number of respondents at the Kerinchi station totalling 202 (62.9%) followed by “students” 91 (28.3%), “housewife” 20 (6.2%), “retiree” 6 (1.9%) and “unemployed” 2 (0.6%). On the other hand, “students” were among the highest number of transit users at Wangsa Maju station totalling 136 (49.3%). It is followed by “employed” respondents totaling 120 (43.5%), “housewife”, “unemployed” and “retiree” constituting 6 (2.2%) users under each category. At Taman Paramount station, the majority of LRT users were “employed” totaling 276 (95.2%). It is followed by “students” totaling only 13 (4.5%) and “housewife” only 1 (0.3%) users.

5.7. Household Size

Table 8. Household size of the respondents by transit station

Station		Household size						Total
		One	Two	Three	Four	Five	Six and above	
Ampang	Sentul	19	29	59	92	90	97	386
	Pandan Jaya	12	19	28	64	71	193	387
	Bukit Jalil	28	38	80	90	76	90	402
Total		59	86	167	246	237	380	1175
Kelana Jaya	Kerinchi	20	21	71	105	76	28	321
	Wangsa Maju	5	32	52	74	48	63	274
	Taman Paramount	2	13	62	123	68	22	290
	Total	27	66	185	302	192	113	885
Overall Total		86	152	352	548	429	493	2060

Source: Questionnaire Survey, 2015

Table 8 shows that the respondents under household size six and above were 32.34% (380) followed by four 20.94% (246), five 20.17% (237), three 14.21% (167), two 7.32% (86), and one 5.02% (59). Overall, the findings show that the most of the transit users who were interviewed coming from bigger family size.

According to the table above, the result shows that most of the respondents were from households having four members in the household totalling 34.1% (320) followed by five 21.7% (192), three 20.9% (185), six and above 12.8% (113), two 7.5% (66), and one 3.1% (27).

5.8. Private vehicle ownership

Table 9. Private vehicles ownership by transit station

Station		Private vehicle ownership		Total
		No	Yes	
Ampang	Sentul	247	143	390
	Pandan Indah	332	60	392
	Bukit Jalil	273	127	400
Total		852	330	1182
Kelana Jaya	Kerinchi	165	155	320
	Wangsa Maju	109	167	276
	Taman Paramount	274	16	290
Total		548	338	886
Overall Total		1400	668	2068

Source: Questionnaire Survey, 2015

Table 9 indicates the vehicle ownership of the respondents at the selected three stations for both lines. The respondents who do not have private vehicles were more than those who do have private vehicles.

The results show that the vehicle ownership of the respondents at the three selected stations along Kelana Jaya Line. The number of respondents who do not own a private vehicle was more than those who do own private vehicles at Kerinchi and Taman Paramount LRT station. On the other hand, at Wangsa Maju station, the number of respondents who owned private vehicles were more than those who do not own it.

5.9. Private vehicles owned by respondents

Table 10. Private vehicles owned by respondents along Ampang Line

Type of private vehicle owned	Number of vehicles owned											
	Sentul				Pandan Jaya				Bukit Jalil			
	One	Two	Three	Four	One	Two	Three	Four	One	Two	Three	Four
Car	98	9	-	-	43	6	1	1	103	11	3	0
Motorcycle	66	5	1	-	18	1	-	-	38	5	1	-
Van	-	-	-	-	-	-	-	-	1	-	-	-
Bicycle	4	1	-	-	2	-	-	-	0	0	-	-
Other	-	-	-	-	-	-	-	-	1	-	-	-
Total (out of 184)	168	15	1	0	63	7	1	1	143	16	4	0

Source: Questionnaire Survey, 2015

Among those respondents who owned private vehicles at Sentul LRT station, most of them owned at least a car and a motorcycle representing 89.13% (164 respondents). Furthermore, those respondents who owned any private vehicle at Pandan Jaya LRT station, most of them owned at least a car and a motorcycle representing 84.72% (61 respondents) while respondents who owned any private vehicle at Bukit Jalil LRT station, most of them owned at least a car representing 63.19% (103 respondents) followed by motorcycles 23.31% (38 respondents).

Table 11. Private vehicles owned by respondents at along Kelana Jaya Line

Type of private vehicle owned	Number of vehicles owned											
	Kerinchi				Wangsa Maju				Taman Paramount			
	One	Two	Three	Four	One	Two	Three	Four	One	Two	Three	Four
Car	102	12	-	-	57	20	5	-	202	41	7	-
Motorcycle	74	3	-	-	50	3	-	-	88	2	-	-
Van	2	-	-	-	3	-	-	-	-	-	-	-
Bicycle	2	-	-	-	5	-	-	-	1	-	-	-
Other	2	-	-	-	-	-	3	-	19	-	-	-
Total (out of 184)	182	15	0	0	115	23	8	0	310	43	7	0

Source: Questionnaire Survey, 2015

Based on Table 11, the respondents who owned private vehicle at Kerinchi LRT station are at least owed a car (102 respondents) and a motorcycle (74 respondents). Meanwhile, at Wangsa Maju LRT station, most of them also owned at least a car and a motorcycle with 57 respondents and 50 respondents respectively. However, among those respondents who owned any private vehicle at Taman Paramount LRT station, most of them owned at least a car and a motorcycle representing of 290 respondents.

In the summary Table 12, the Malay male age group between 13 years old to 34 years old give higher response rate to answer the given questionnaire and most of them are single. The 64.2% of the respondents earned RM1000 or below, the 26.3% earned RM1001 to RM3000, and 9.1% earned RM3001 or above. In terms of employability status, 59.2% of the respondents are a student, 35.5% are employed, and the remaining 5.4% for other categories. Most of the respondents live in a high number of households unit and do not own any private vehicle.

Table 12. Summary of trip maker characteristics at three selected LRT Stations along Ampang Line

Category	Variable	Sentul		Pandan Jaya		Bukit Jalil	
		f	%	f	%	f	%
Gender	Male	194	49.7%	117	29.8%	184	45.9%
	Female	196	50.3%	275	70.2%	217	54.1%
Ethnicity	Malay	259	66.6%	319	81.8%	181	45.5%
	Chinese	58	14.9%	43	11.0%	118	29.6%
	Indian	59	15.2%	22	5.6%	53	13.3%
	Other	13	3.3%	6	1.5%	46	11.6%
Age group	13 to 17 years old	69	17.7%	32	8.2%	48	11.9%
	18 to 24 years old	146	37.4%	318	81.3%	181	45.0%
	25 to 34 years old	107	27.4%	20	5.1%	79	19.7%
	35 to 44 years old	28	9.7%	8	2.0%	44	10.9%
	45 to 54 years old	16	4.1%	5	1.3%	27	6.7%
	55 to 64 years old	9	2.3%	4	1.0%	17	4.2%
Marital Status	65 years old and above	5	1.3%	4	1.0%	6	1.5%
	Single	278	71.3%	368	94.6%	291	72.6%
	Married	108	27.7%	21	5.4%	107	26.7%
	Widowed	3	0.8%	0	0.0%	0	0.0%
Income range per month	Divorced	1	0.3%	0	0.0%	3	0.7%
	Less than RM1000	186	47.8%	320	85.3%	240	60.3%
	RM1001 - RM2000	105	27.0%	28	7.5%	56	14.1%
	RM2001 - RM3000	55	14.1%	11	2.9%	50	12.6%
	RM3001 - RM4000	21	5.4%	6	1.6%	25	6.3%
	RM4001 - RM5000	7	1.8%	1	0.3%	11	2.8%
	RM5001 - RM6000	5	1.3%	4	1.1%	4	1.0%
	RM6001 - RM7000	5	1.3%	2	0.5%	4	1.0%
	RM7001 - RM8000	1	0.3%	0	0.0%	4	1.0%
	RM8001 - RM9000	1	0.3%	0	0.0%	1	0.3%
Employability status	RM9001 - RM10000	0	0.0%	0	0.0%	2	0.5%
	More than RM10000	3	0.8%	3	0.8%	1	0.3%
	Student	155	39.7%	334	85.2%	212	52.7%
	Employed	215	55.1%	43	11.0%	162	40.3%
	Housewife	7	1.8%	3	0.8%	6	1.5%
	Unemployed	11	2.8%	11	2.8%	15	3.7%
Number of households	Retired	2	0.5%	0	0.0%	7	1.7%
	Other	0	0.0%	1	0.3%	0	0.0%
	One	19	4.9%	12	3.1%	28	7.0%
	Two	29	7.5%	19	4.9%	38	9.5%
	Three	59	15.3%	28	7.2%	80	19.9%
	Four	92	23.8%	64	16.5%	90	22.4%
Private vehicle ownership	Five	90	23.3%	71	18.3%	76	18.9%
	Six and above	97	25.1%	193	49.9%	90	22.4%
	No	247	63.3%	332	84.7%	273	68.3%
	Yes	143	36.7%	60	15.3%	127	31.8%

Source: Questionnaire Survey, 2015

In the summary Table 13, the highest response rate to answer the given questionnaire females with 57.4%, Malay ethnic with 5.0% and those age group between 18 years old to 24 years old with 34.6%. Moreover, most of the respondents are single which has a percentage of 60.4%. Besides that, 33.8% of the respondents earned RM2001 to RM3000. In terms of employability status, 67.4% of the respondents are employed, 27.1% are students, and the remaining are other categories. Most of the respondents live with a four number of households unit with a percentage of 34.1% and most of the respondents do not own any private vehicle with 61.9%.

Table 13. Summary of trip maker characteristics at three selected LRT Stations along Kelana Jaya Line

Category	Variable	Kerinchi		Wangsa Maju		Taman Paramount	
		f	%	f	%	f	%
Gender	Male	143	44.5%	124	44.9%	111	38.3%
	Female	178	55.5%	152	55.1%	179	61.7%
Ethnicity	Malay	175	54.5%	152	55.1%	161	55.5%
	Chinese	89	27.7%	82	29.7%	72	24.8%
	Indian	56	17.4%	37	13.4%	57	19.7%
	Other	1	0.3%	5	1.8%	0	0.0%
Age group	13 to 17 years old	50	15.6%	39	14.1%	5	1.7%
	18 to 24 years old	67	20.9%	122	44.2%	118	40.7%
	25 to 34 years old	109	34.0%	68	24.6%	125	43.1%
	35 to 44 years old	31	9.7%	26	9.4%	36	12.4%
	45 to 54 years old	38	11.8%	14	5.1%	6	2.1%
	55 to 64 years old	23	7.2%	5	1.8%	0	0.0%
	65 years old and above	3	0.9%	2	0.7%	0	0.0%
Marital Status	Single	183	57.0%	182	65.9%	171	59.0%
	Married	127	39.6%	86	31.2%	117	40.3%
	Widowed	9	2.8%	8	2.9%	2	0.7%
	Divorced	2	0.6%	0	0.0%	0	0.0%
Income range per month	Less than RM1000	96	29.9%	142	51.4%	6	2.1%
	RM1001 - RM2000	71	22.1%	64	23.2%	32	11.0%
	RM2001 - RM3000	109	34.0%	42	15.2%	149	51.4%
	RM3001 - RM4000	37	11.5%	20	7.2%	76	26.2%
	RM4001 - RM5000	8	2.5%	5	1.8%	16	5.5%
	RM5001 - RM6000	0	0.0%	2	0.7%	10	3.4%
	RM6001 - RM7000	0	0.0%	0	0.0%	1	0.3%
	RM7001 - RM8000	0	0.0%	1	0.4%	0	0.0%
	RM8001 - RM9000	0	0.0%	0	0.0%	0	0.0%
	RM9001 - RM10000	0	0.0%	0	0.0%	0	0.0%
More than RM10000	0	0.0%	0	0.0%	0	0.0%	
Employability status	Student	91	28.3%	136	49.3%	13	4.5%
	Employed	202	62.9%	120	43.5%	276	95.2%
	Housewife	20	6.2%	6	2.2%	1	0.3%
	Unemployed	2	0.6%	6	2.2%	0	0.0%
	Retired	6	1.9%	6	2.2%	0	0.0%
Number of households	Other	0	0.0%	2	0.7%	0	0.0%
	One	20	6.2%	5	1.8%	2	0.7%
	Two	21	6.5%	32	11.7%	13	4.5%
	Three	71	22.1%	52	19.0%	62	21.4%
	Four	105	32.7%	74	27.0%	123	42.4%
	Five	76	23.7%	48	17.5%	68	23.4%
Private vehicle ownership	Six and above	28	8.7%	63	23.0%	22	7.6%
	No	155	48.4%	167	60.5%	16	5.5%
	Yes	165	51.6%	109	39.5%	274	94.5%

Source: Questionnaire Survey, 2015

6. Travel characteristics of the passengers at TOD stations

The origin-destination questionnaire survey was conducted at Sentul, Pandan Jaya, Bukit Jalil, Kerinchi, Wangsa Maju and Taman Paramount LRT stations to understand the accessibility parameter of the urban rail stations in Kuala Lumpur. This survey recorded the name of places the respondents come from before or after they reach the selected LRT stations. Sentul, Bandar Baru Sentul, Menara Orkid, SMK Methodist Sentul, Titiwangsa, PWTC, Flat Seri Perak, Sentul Timur, Flat Seri Negeri Sembilan, Apartment Mawar and UTC Sentul are among places recorded from the respondents at Sentul LRT station (refer to Figure 2). These places contributed 39.49% and located within a 1km radius of Sentul LRT station. The 23.87% of 39.87% located within 500m of the station. Titiwangsa, PWTC and other places, on the other hand, located more than 1km of the station contributed 21.29%. The remaining 39.22% of the respondents have not responded to this question.

Figure 3 showed that respondents at Pandan Jaya LRT station connected to Apartment Bayu, Pandan Jaya and Kolej Polytech MARA located within the 500m radius of the station represent 36.49% whereby Maluri, Pandan Indah, and SMK Pandan Jaya located less than 1km of the station represents 8.92%. Chempaka, Pandan Perdana and others located more than 1km of the station represents 23.42%. However, 31.17% of the respondents have not responded to this question.

For Bukit Jalil station (refer to Figure 4), most of the respondents took a long trip to access the station. There is no record of the respondents accessed from/ to Bukit Jalil LRT station 500m or less. Majority of the respondents' origin-destination such as Bukit Jalil, SMK Bukit Jalil, Sri Petaling and TPM& APU College constitutes placed within 1km radius represents 28.33% out of total respondents. Another 27.46% of the respondents access the station more than 1km whereby 44.21% of the respondents, on the other hand, have not responded to this question.

Figure 5 shows the origin/ destination of the LRT users at Kerinchi LRT station. Most of the LRT users of this station were from Condo Fajaria 24.3%, followed by Kerinchi's areas 14.3 %, Plaza Pantai 9.1 %, Telekom Sdn. Bhd 6.3%, Wisma Goshen 5.7%, Tenaga Nasional Berhad (TNB) 5.3%, Menara Atlas 5.0%, and Pantai Business Center 4.0%. These origins/ destinations are located within walking distance radius of 500m to 1km from this station. Figure 6 shows the origin/ destination of the LRT users at Wangsa Maju station. The findings show that the users were coming from AEON 12.0% located within a 500m radius from this station, followed by from TARC 10.9%, located more than 1km than this station.

Figure 7 shows the origin/destination of the LRT users at Taman Paramount LRT station. As this station is surrounded by the residential areas, the origin/destination of the LRT users of this station was mostly within the 500m radius from this station. The findings show that 72.1% of the LRT users were accessed to/ from Flat Sri Aman, followed by Jalan 20/22 9.3%, Kampung Tunku 7.2% and the remaining were from/ to Jalan 20/14, Jalan 20/21, Jalan 21/1, Jalan 21/22, Jalan 21/27, Seksyen 14, Seksyen 20, Seksyen 21 and Seksyen 22. All these locations are located within 500m kilometre radius from Taman Paramount LRT station.

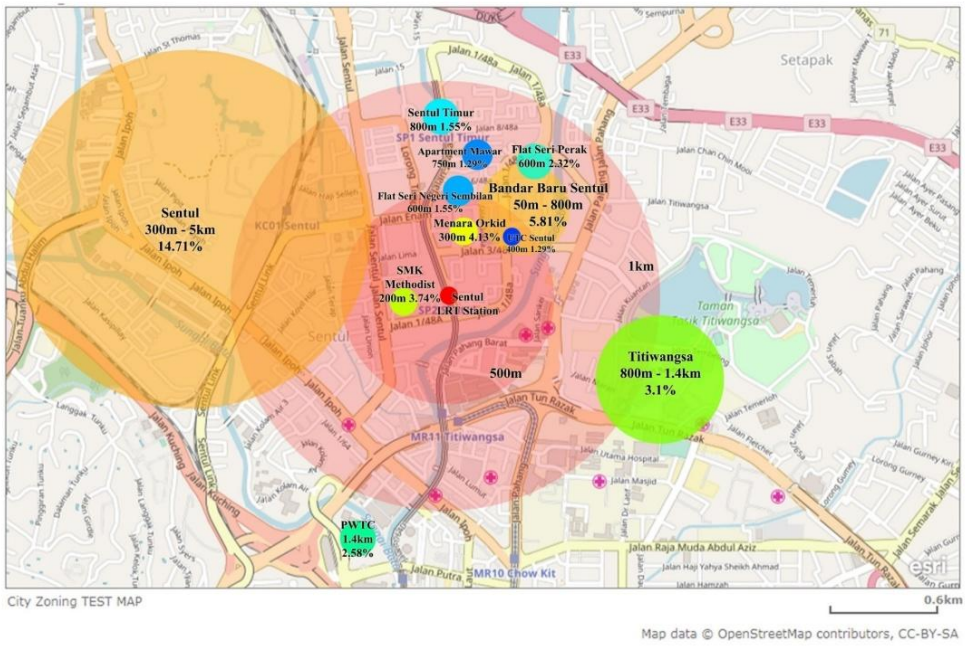


Fig. 2. The origins/ destinations of respondents at Sentul LRT station.

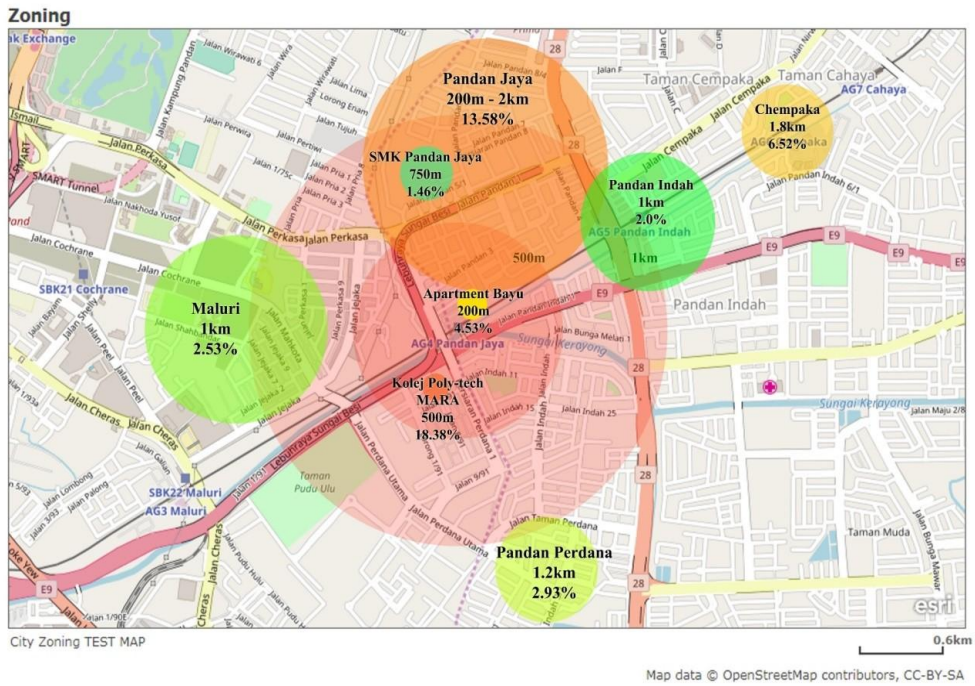


Fig. 3. The origins/ destinations of respondents at Pandan Jaya LRT station

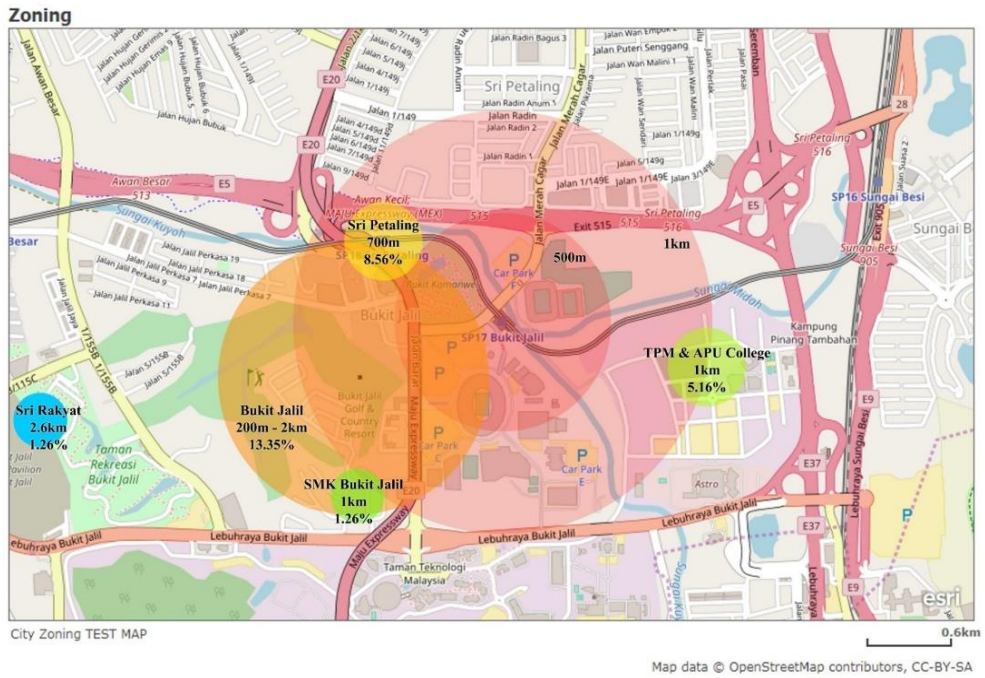


Fig. 4. The origins/ destinations of respondents at Bukit Jalil LRT station.

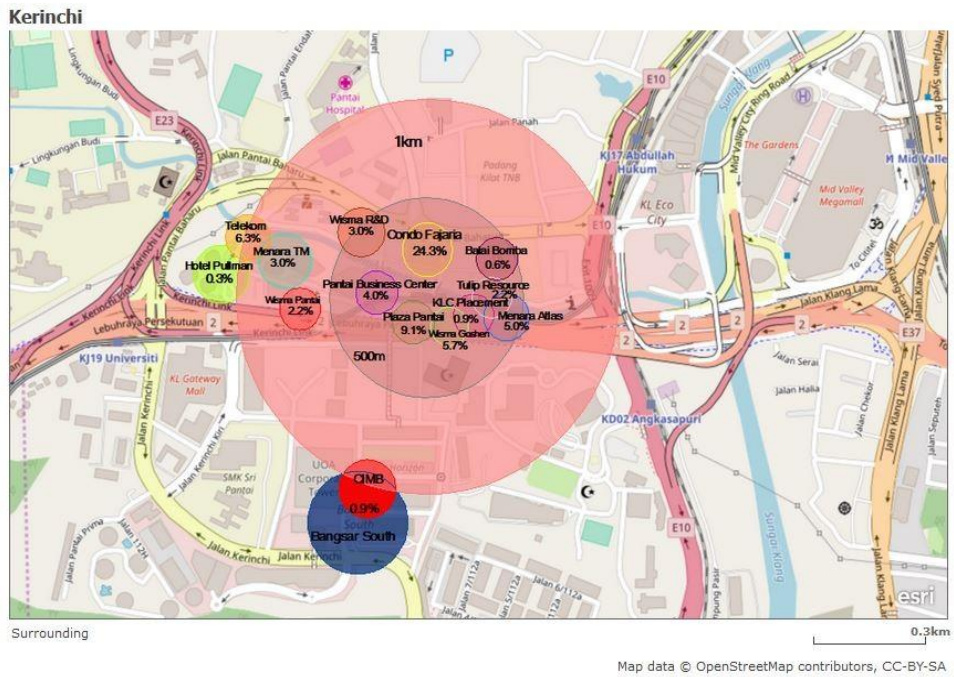


Fig. 5. The origins/ destinations of respondents at Kerinci LRT station.

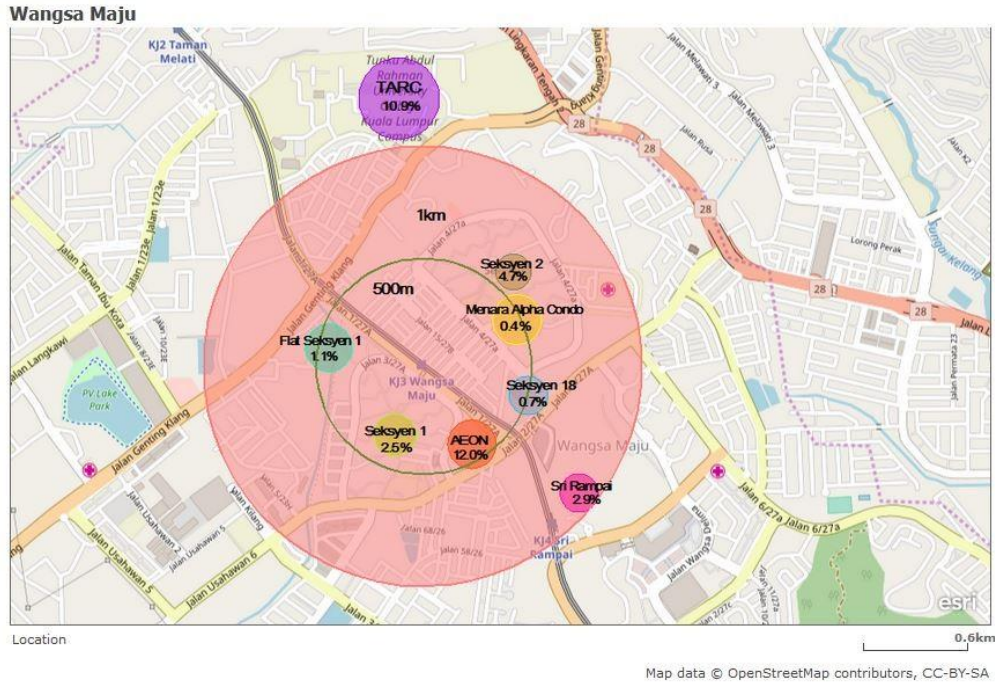


Fig. 6. The origins/ destinations of respondents at Wangsa Maju LRT station.

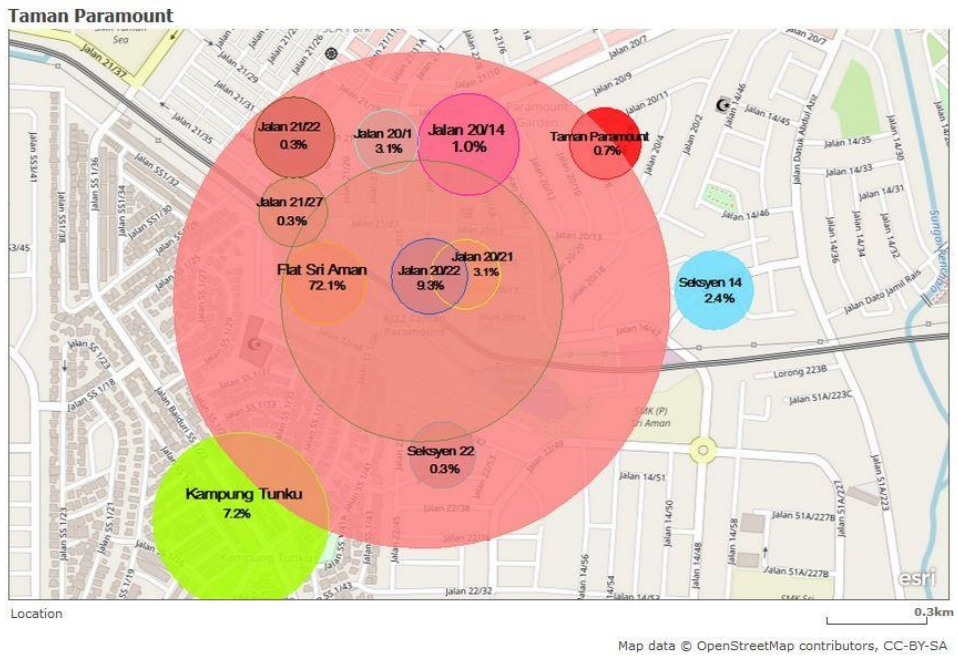


Fig. 7. The origins/ destinations of respondents at Taman Paramount LRT station

Table 14 shows the type of activities that the respondents involved at origin before arriving at the train station for both lines. Based on the result at the Ampang line, the main activities that the respondents involved were home 49.03% (580), education 30.09% (356) and work 13.36% (158). Meanwhile, the result at Kelana Jaya line shows that the activities that the respondents involved at origin were home 64.5% (572), work 17.2% (153), education 5.0% (44), business 4.2% (37), shopping and recreation 3.8% (34) each and others 1.5% (13). Thus, three major activities for Kelana Jaya and Ampang LRT stations are home, education and work. The rest have not contributed much to passenger ridership for Kelana Jaya and Ampang LRT stations.

Table 24. Type of activity at origin by transit station

Station		Activity at origin						Total	
		Home	Work	Business	Education	Shopping	Recreation		Other
Ampang	Sentul	230	53	8	78	11	3	7	390
	Pandan Indah	154	30	4	175	17	7	4	391
	Bukit Jalil	196	75	4	103	13	3	8	402
Total		580	158	16	356	41	13	19	1183
Kelana Jaya	Kerinchi	130	119	29	4	0	31	8	321
	Wangsa Maju	153	34	8	39	34	3	5	276
	Taman Paramount	289	0	0	1	0	0	0	290
Total		572	153	37	44	34	34	13	887
Overall Total		1152	311	53	44	75	47	32	2070

Source: Questionnaire Survey, 2015

Table 15 shows the type of activities at the destination that the respondents were involved with. For Ampang line, the major activities that the respondents involved at destination were home 42.69% (505), education 19.19% (227), work 16.74% (198), and shopping 10.65% (126). Based on the table above, the type of activities that the respondents involved were work 44.3% (393), home 17.9% (159), shopping 11.2% (99), education 10.4% (92), business 8.0% (71), recreation 4.6% (41) and others 3.6% (32). Thus, home and work are the dominant activities at the destination for Kelana Jaya and Ampang lines respondents.

Table 15. Type of activity at destination by transit station

Station		Activity at destination						Total	
		Home	Work	Business	Education	Shopping	Recreation		Other
Ampang	Sentul	143	129	13	42	44	5	14	390
	Pandan Indah	188	20	6	96	53	14	14	391
	Bukit Jalil	174	49	14	89	29	16	31	402
Total		505	198	33	227	126	35	59	1183
Kelana Jaya	Kerinchi	76	77	39	32	60	15	22	321
	Wangsa Maju	79	73	27	46	17	25	9	276
	Taman Paramount	4	243	5	14	22	1	1	290
Total		159	393	71	92	99	41	32	887
Overall Total		664	591	104	319	225	76	91	2070

Source: Questionnaire Survey, 2015

Most of the respondents at Sentul LRT station had stated that they walk to reach the LRT station. Table 16 shows that 71.79% (280) of the LRT users “walk” to this station. Most of the respondents at Pandan Jaya LRT Station also stated that they walk to reach the LRT station. Table 8.21 shows that 73.47% (288) “walk” to the station, followed by “bus” 9.18% (36), and “dropped off by friend/relative/” 7.65% (30), by “other rail transport” 2.81% (11), by “taxi”

1.79% (7), by “motorcycle and parked at the station” 1.53% (6). Again, none of the LRT users uses “bicycle” to reach this station. Meanwhile, the majority of the respondents at Bukit Jalil LRT station had used either “bus” or “walking” to reach this station.

However, almost all the LRT users of the selected three stations along Kelana Jaya line had stated that they ‘walk’ to reach the station before boarded trains at Kerinchi, Wangsa Maju, and Taman Paramount station.

Table 16. Mode of transport used to reach LRT station by transit station

Station	Mode of transportation before arriving at the station								Total
	Walking	By motorcycle and parked	By taxi	Dropped off by friend/family/relative	By car and parked	By bus	By bicycle	By other rail transportation	
Sentul	280	17	7	35	22	15	0	14	390
Pandan Jaya	288	6	7	30	14	36	0	11	392
Bukit Jalil	101	20	40	72	44	104	1	20	402
Total	669	43	54	137	80	155	1	45	1184
Kerinchi	320	0	0	1	0	0	0	0	321
Wangsa Maju	272	1	0	1	1	1	0	0	276
Taman Paramount	290	0	0	0	0	0	0	0	290
Total	882	1	0	2	1	1	0	0	887
Overall Total	1551	44	54	139	81	156	1	45	2071

Source: Questionnaire Survey, 2015

Table 17 shows the most of the LRT users at Sentul and Pandan Jaya station would “walk” after reaching the final transit station to the respective destinations. Most of the LRT users at Bukit Jalil station would “walk” and use “bus” after reaching the final transit station to the respective destinations. At Kelana Jaya line, the result shows that most of the LRT users at Wangsa Maju and Taman Paramount station would “walk” after reaching the final transit station to the respective destinations. On the other hand, most of the LRT users at Kerinchi station would use “other rail transport” services after reaching the final transit station to the respective destinations.

Table 17. Mode of transport used from the final LRT station by transit station

	Mode of transportation after arriving at the station							Total
	Walking	By motorcycle and parked	By taxi	Picked by friend/family/relative	By car and parked	By bus	By other rail transportation	
Sentul	245	6	4	37	22	15	61	390
Pandan Jaya	295	2	11	50	6	25	3	392
Bukit Jalil	129	7	29	56	20	122	39	402
Total	669	15	44	143	48	162	103	1184
Kerinchi	70	3	35	40	11	37	125	321
Wangsa Maju	123	5	24	45	8	61	10	276
Taman Paramount	238	0	12	14	0	4	22	290
Total	431	8	71	99	19	102	157	887
Overall Total	1100	23	115	242	67	264	260	2071

Source: Questionnaire Survey, 2015

7. Socioeconomic and travel characteristics relationships of the passengers at TOD stations

There are important socioeconomic and travel characteristics relationships of the urban rail users in Kuala Lumpur based on respondents surveyed at the selected Kelana Jaya and Ampang rail stations. Figure 8 showed relationships between gender and mode of transport to access from/ to LRT stations. The figure showed that both female and male have a higher number of walking users to access LRT stations as compared to other modes of transport. Based on the gender, the female has a slightly higher number of walking users. For both genders, the number of other modes of transport users is almost identical but the male has a higher tendency to use motorcycles as compared to female.

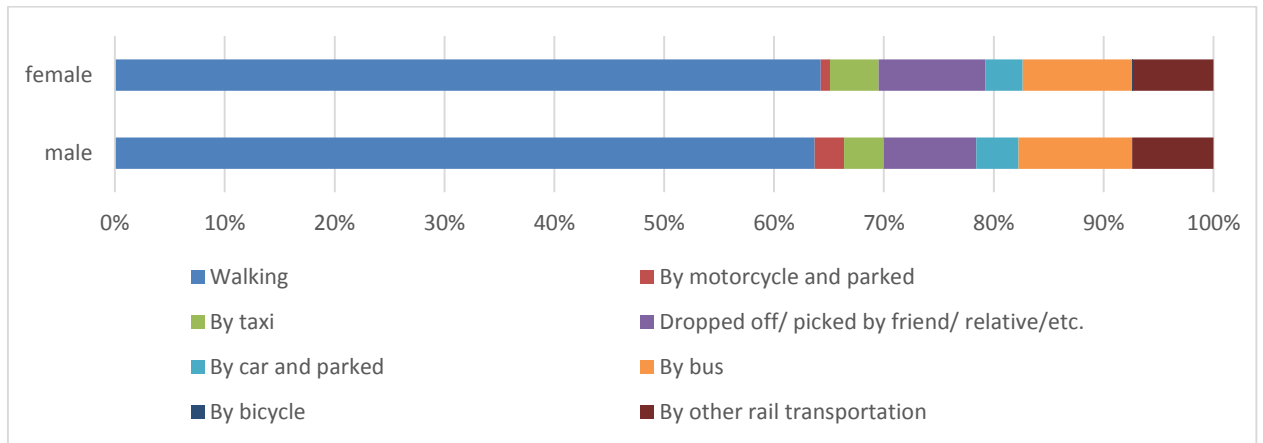


Fig. 8. The relationship between gender and mode of transport to access from/ to LRT stations

Figure 9 showed the relationship between employability status and mode of transport to access from/ to LRT stations. Based on the figure, more than 65% of the employed workers walk to/ from LRT stations and they have a higher tendency to take more than one train trip per direction. It contradicted the behaviour of the unemployed users in which every one of two persons does not walk to/ from LRT stations. The data also showed that the retired workers do not take more than one train trip per direction and housewives do not ride a motorcycle to access LRT stations but has a higher tendency to use a taxi instead.

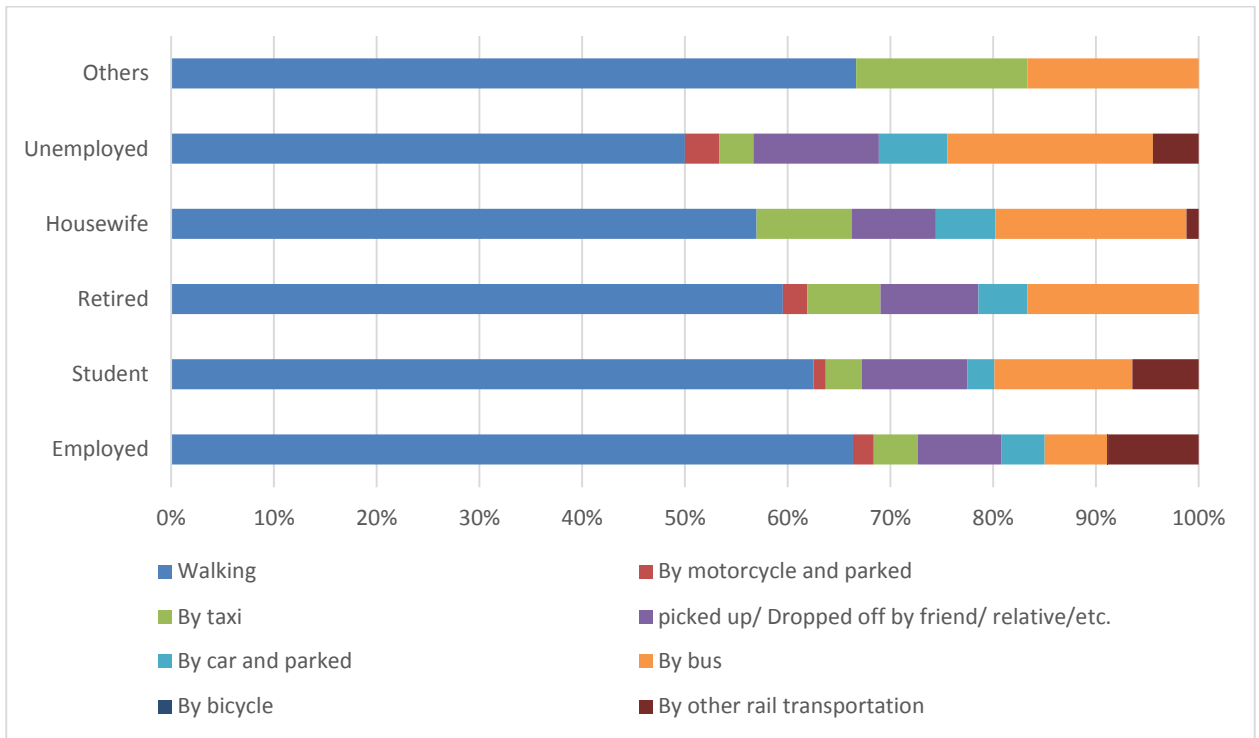


Fig. 9. The relationship between employability status and mode of transport to access from/ to LRT stations

Figure 10 showed the relationship between age groups and mode of transport to access from/ to LRT stations. Overall, it showed that the younger ages have a higher tendency to walk to/ from LRT stations and age between 18 to 34 are the most active users who walk to/ from LRT stations. Apparently, the older ages have a higher tendency to use the car to access LRT stations and users age 65 and above willing to take the bus to access LRT stations. The interesting part of this data is that while the older generation willing to use the bus, the younger generation are willing to walk to access to/ from LRT stations. There is less dependency on private automobiles to connect to places, indirectly it encourages a healthy lifestyle.

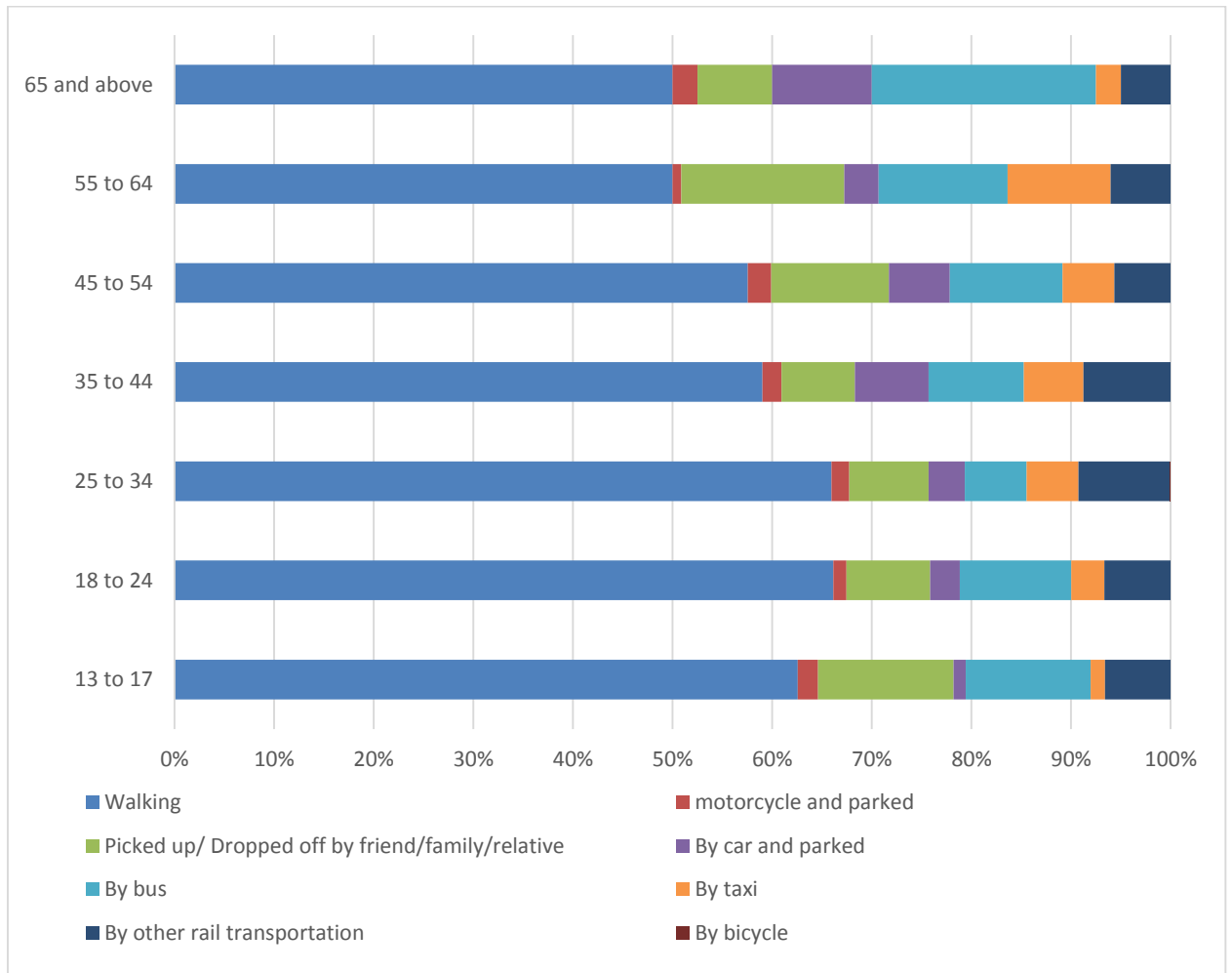


Fig. 10. The relationship between age groups and mode of transport to access from/ to LRT stations

Figure 11 showed the relationship between income groups and mode of transport to access from/ to LRT stations. It showed that most of the low incomes walk to/ from LRT stations except those who earned RM8001 to Rm9000. None of this high-income group was picked up/ dropped by friend/ family/ relative, unlike other high-income groups who have a higher tendency to get picked up/ dropped by friend/ family/ relative and they also use the car to access to/ from LRT stations.

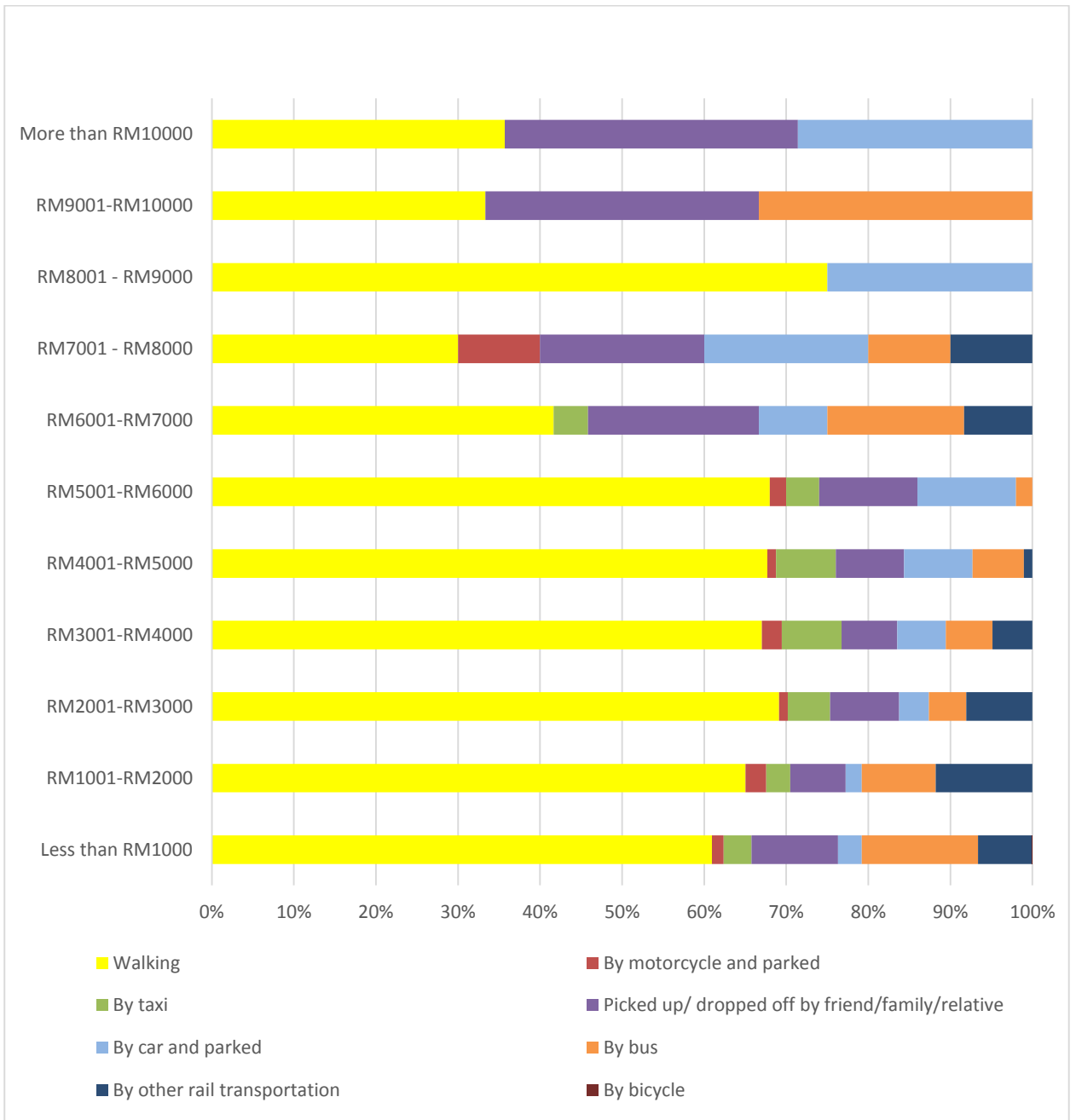


Fig. 11. The relationship between income groups and mode of transport to access from/ to LRT stations

Table 18 showed the relationship of those who walk to/ from LRT stations and origin-destination points. Overall, this data displayed that walking respondents for Kelana Jaya line are higher than the Ampang line represents 74.01% and 56.50% respectively. The table also showed that LRT stations which have a higher percentage of respondents who walk to/ from LRT stations have commuted less than 500 meters except for Wangsa Maju LRT station. It assumed that those who walk to/ from LRT stations derived within walking distance (less than 500 meters). The LRT station which has a lower percentage of walking users (Bukit Jalil LRT station) in vice versa, has no users derived within walking distance (less than 500 meters). It is believed that those who are not walk to/from LRT stations use automobiles to commute and they are derived from more than 500 meters from the LRT stations.

Table 18. The relationship of the walking LRT users and origin-destination points.

LRT station	% of walking respondents	Respondents origin and destination points			
		Less than 500 meters (%)	500 meters to 1km (%)	More than 1km (%)	Unavailable (%)
Taman Paramount	91.03	83.79	9.98	6.2	0.03
Pandan Jaya	74.36	36.49	8.92	23.42	31.17
Wangsa Maju	71.56	16.70	7.60	26.30	49.4
Sentul	67.31	23.87	15.62	21.29	39.22
Kerinchi	60.75	50.70	19.60	5.60	24.1
Bukit Jalil	28.61	-	28.33	27.46	44.21

8. Conclusion

Based on the findings, the study can be concluded that the social-economic and travel characteristics of transit users have influence on the TOD stations ridership. For the social-economic characteristics of Ampang line users, the selected TOD stations are dominated by single, male, students, age between 13-34 years old with income less than RM1000. They also come from high number of household sizes and usually do not own any private vehicles. While for Kelana Jaya line, the selected TOD stations are dominated by single, female, employed worker, age between 18-24 years old with income between RM2000 to RM3000. They are mostly come from small household size.

In term of travel characteristics, home, work, and education were found as the major activities at selected TOD stations for both lines. The major mode of transport to access TOD stations is walking except for Bukit Jalil and Kerinchi LRT station. Automobile users were found as the major mode of transport for Bukit Jalil LRT station while other rail transport users were found as the major mode of transport for Kerinchi LRT station.

The study has found that there is the relationship between socio-economic and travel characteristics at TOD stations for both lines. There is more than 65% of employed workers walk to/from LRT station and they are aged between 18 to 34 years old. On the other hand, the older age has a higher tendency to use car and bus to access the TOD stations. The lower income groups displayed as a dominant walking users to access the TOD stations. The higher percentage of walking respondents come within 500 meters or less of TOD station. Besides, the lower percentage of walking respondents access more than 1km away of TOD stations. The study recommend that the acceptable walking distance for TOD stations' users are within 500 meters and for the non-walking TOD stations' users can exceed more than 1 km.

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