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An Investigation of Condominium Property Value Uplift around Light Rail Transit Stations Using a Hedonic Pricing Model

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Abstract. This paper aims to investigate the impact of proximity to the nearest light rail transit station on the value of condominium properties in Greater Kuala Lumpur, Malaysia. The paper utilizes a data set of 476 condominium sales occurring in Greater Kuala Lumpur between January 2017 and the second quarter of 2018. Using a hedonic pricing model, housing price was modelled as a function of proximity to the nearest light rail transit station and with regard to other structural and locational attributes. The results suggest that condominium units located within 800 m to the nearest light rail transit station can earn a premium of MYR 172,904 (US$43,226), or 30% of the city's average home value. The results of this study also indicate that in determining property values, proximity to the nearest light rail transit station is the second-most influential variable compared to other variables. This paper represents an original contribution to the literature in that there has been limited research on the impact of proximity to light rail transit stations on condominium prices in developing countries.

1. Introduction

Residential property is a multidimensional heterogeneous commodity. The value of a residential property can be attributed to a number of factors, including its accessibility to key employment centres, amenities, its structural characteristics, neighbourhood, environmental quality, the strength of the local economy, and market area demographics [1, 2]. In addition to these factors, the value of a residential property is influenced by accessibility to public transport. This is due to the fact that residential properties located near transit stations typically enjoy increased regional accessibility to employment centres, education institutions, and recreation amenities, more mobility options and reduced transportation costs [1].

Modern urban economic theory suggests that utility-maximising households choose a location in which to live so that attributes associated with housing (such as structural, locational, neighbourhood and environmental quality attributes) are purchased together as a bundle [2,3]. In this respect, accessibility to public transportation services (such as light rail transit) should be expected to positively influence households' preferences. Thus, it is expected that these preferences would be reflected in the value of residential properties, especially for those located within close proximity to stations.

The impact of urban rail transit systems (heavy or light rail) on residential property values has been investigated in many places over the past five decades. Although the results are mixed (and include positive, negative and non-significant results), most of this empirical research has found significant positive relationships between proximity to transit stations and residential property values. Using the Greater Kuala Lumpur Light Rail Transit system as a case study, the purpose of this paper was to investigate the impact of proximity to the nearest light rail transit station on the value of condominium properties.

The paper is structured as follows. Section 2 presents a review of the literature, followed by a description of the research method (Section 3). Section 4 discusses the results. Section 5 concludes with an explanation of the findings.

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2. Literature Review

An early investigation on the effect of rail transit on residential property values was carried out by Boyce, Allen, Mudge, Slater, and Isserman [4]. Using a hedonic pricing model in an attempt to estimate the effect of the Lindenwold High Speed Line on residential property values in Philadelphia, New Jersey in the United States (US), they found that for every minute's savings to the city centre via rail transit, property values experienced a premium of US$149 to US$200. Since then, many studies have been conducted to investigate land value uplift around improved public transport infrastructure in North America. For instance, a study carried out by Bajic [5] in Toronto, Canada found proximity to subway stations were capitalised into residential property values by $2,237. Other research has also indicated that proximity to transit stations has a positive and statistically significant effect on residential property values [6,7,8,9,10]. However, Hess and Almeida [9] found a less profound significant positive effect of rail transit on property values in Buffalo, New York in the United States.

More recent research by Atkinson-Palombo [11], Duncan [12, 13], Golub, Guhathakurta, and Sollapuram [14], Ko and Cao [15], Perk, Bovino, Catalá, Reader, and Ulloa [16], and Diao [17], have also found significant positive relationships between rail transit and residential property values. The effect of rail transit in the United Kingdom (UK) is generally seen as positive, but little emphasis has been put on quantifying exact amounts [18]. Meanwhile, studies carried out in other places have also found that rail transit has a significant positive effect on residential property values [19, 20, 21, 22, 23, 24]. While most studies found a significant positive effect on property values, a few studies have found that proximity to rail transit has a negative effect [25, 26, 27, 28]. Researchers attributed this negative effect to nuisance effects, including those relating to noise, safety, aesthetics and traffic, particularly for residential properties located too close to a transit station.

In investigating land value uplift around rail transit, previous studies have operationalized accessibility indirectly through measures of proximity to transit stations to capture this bid-rent surface as a proxy for underlying accessibility benefits. Most studies seem to employ catchment areas around transit stations using a radial distance of up to 800 m or a series of thresholds which is related to a walk time of between 5-10 minutes for residential property. This is because the impact area for residential property seems to be wider compared to commercial and industrial properties.

Findings from previous research on various modes of public transport, including bus, light rail, heavy rail and commuter rail, indicate that residential property near commuter and heavy rail exhibit greater high rates of uplift than residential properties near light rail [7, 17, 29, 30], owing to faster speeds, frequent trains and greater geographical coverage of commuter and heavy rail. Researchers have also quantified land value uplift near bus routes [16, 31, 32] and results have shown that there have been modest uplifts. Hess and Almeida [9] associate this modest effect to the lack of permanence of fixed infrastructure provided by bus routes.

Another important feature of previous studies on the topic of transit systems and their impact on property values involves the treatment of time. Most studies have investigated the effect of transit systems on property values immediately after a service began and the decades after, during which the full benefits of the service were recognised. Researchers have also studied the response of home buyers to the announcement of transit systems in the context of market anticipation of improved transport infrastructure [33, 34, 35]. Despite the vast majority of studies having investigated the effects of rail transit services on property values, there have also been studies investigating the relationship between rail transit and commercial office and industrial property values [14,15,35]. These have generally demonstrated significant positive relationships.

Previous studies also indicate that rail transit effects on property values vary across a neighbourhood. Research by Nelson [10] of Metropolitan Atlanta Rapid Transit Authority (MARTA) Blue Line in Atlanta, Georgia found that property values increased in low-income neighbourhoods, whilst a study

by Gatzlaff and Smith [26] in Miami, Florida found that only high-income neighbourhoods experienced increased property values as a consequence of the presence of a rail transit system. This reinforces the observation that the effect of transit systems on property values is highly context-specific [9]. In a more recent study, Forouhar [1] investigated the extent of property value impact of the Tehran Metro Rail system and concluded that there was an overall negative effect of the metro stations on the sales value of residential properties located in Tehran's affluent neighbourhoods. On the contrary, the effect is positive and high for properties located close to the southern stations in the poor and run-down neighbourhoods of the city. He attributed the negative effect in the northern neighbourhoods to contextual factors such as a lack of considerable demand for public transport, inappropriate land-use management, perceptions of crime and privacy, and nuisance effects.

In addition to this, previous studies have also revealed that rail transit stations with better facilities are shown to have a greater impact on the surrounding properties. For instance, a study carried out by Bowes and Ihlanfeldt [36] found that stations with parking facilities have a higher positive impact on property values than those without parking. They also found that stations located closer to the city centre produced a greater positive impact on property values. The literature has shown that most studies employ a hedonic pricing model to capture the effect of rail transit systems on property values. Furthermore, the literature has also shown that most studies use residential transaction prices or apartment rent prices as the dependent variable. In cases where residential transaction price data are not available due to confidentiality, asking prices are normally used [20, 37].

In summary, whilst most studies have found significant positive relationships between property values and rail transit systems, each study varied with respect to the magnitude of the positive effect. Consequently, drawing definitive conclusions from these studies is difficult. Therefore, investigating land value uplift around improved transport infrastructure requires an in-depth investigation that looks at the research context (such as local transport systems, market conditions and location factors), data and research methods.

3. Method

A. Case Study – the Kelana Jaya and Ampang-Sri Petaling Light Rail Transit Lines

This study is conducted in Greater Kuala Lumpur, the largest and most-densely populated urban centre in Malaysia. Located in the relative centre of Peninsular Malaysia, the Greater Kuala Lumpur region serves as the commercial and business centre for domestic, regional and international markets. Greater Kuala Lumpur has experienced a rapid population growth during the period from 1980-2010, during which the population grew to six times its previous size (from 1.9 million in 1980 to 7.4 million in 2010) [38, 39]. In terms of economic growth, Greater Kuala Lumpur has generated over 37% of total gross domestic product (GDP) and contributed about MYR 263 billion (US$84.8 billion) to gross national income (GNI) in 2010. This has made the Greater Kuala Lumpur region the hub of Malaysia's economic growth. As a result, total employment in this region between 1990 and 2010 has increased from 1.4 million to 3.3 million, which was largely due to the services sector (i.e. accounting for approximately 60% of all new jobs creation in the region) [39,40].

Due to the growing urban population and increasing private vehicle ownership, traffic congestion has become one of the main issues in Greater Kuala Lumpur. Although the Greater Kuala Lumpur region enjoys a huge network of highways and ring roads, the city centre is still plagued by traffic congestion and is at times agonizing for residents, particularly during rush hours. To address this issue, many initiatives have been undertaken by local authorities. In this respect, Greater Kuala Lumpur's Light Rail Transit system was proposed in the early 1980s and the first line, known as STAR-LRT1 (later known as Ampang-Sri Petaling Line) started service in 1996. In 1998, the second line, known as PUTRA-LRT2 (later known as Kelana Jaya Line) began its service. The Ampang-Sri Petaling light rail transit line is broken up into two

destinations with its origin at the Sentul Timur Station. The first route ends in Sri Petaling in the south, while the second course ends in Ampang in the eastern suburbs of the city, travelling a distance of 15 km and 12.4 km respectively. Meanwhile, the Kelana Jaya light rail transit line operates an approximate 27 km course from north to south between Kelana Jaya and Gombak and has 24 stations. Since then, the network has been gradually expanded and the whole system is now 94.4 km long and carries approximately 600,000 passengers per day [41]. Fig. 1 shows the light rail transit system route and spatial distribution of observations within 1,200 m to the nearest light rail transit station.

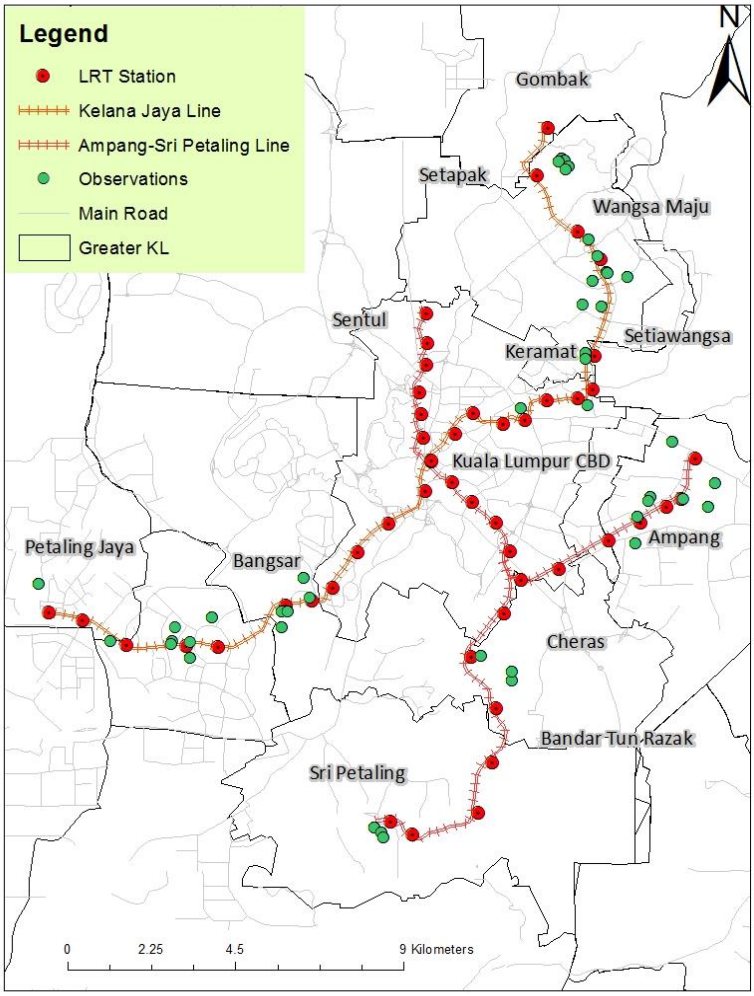


Figure 1. Map of study area and spatial distribution of observations within 1,200 m to the nearest light rail transit station
Source: Author's own work

B. Estimation method

This paper employs a hedonic pricing model to investigate the impact of proximity to the nearest light rail transit stations on surrounding condominium property values. Use of a hedonic pricing model makes it possible to infer the prices of attributes by using standard regression techniques. In this analysis, the selling price of the property was the dependent variable and the structural and locational attributes of the property were independent variables. The estimated coefficients for the variables can then be interpreted as the price per unit of the attribute with which it is associated. The traditional regression model can be stated as follows [3]:

$$Y = f\ (S, L, R) \qquad (1)$$

Where Y is the selling price of the condominium and S is a vector of the property's structural attributes. The locational attributes are represented by vector L. R is a vector that captures proximity to the nearest light rail transit stations.

As shown by Rosen [3], the first stage of the estimation process using a hedonic pricing model consists of choosing the functional form which best represents the relationship under study. Unfortunately, there is no literature on the functional form of the hedonic pricing model [42]. Following the work of Brandt and Maennig [43] in their studies on housing, researchers commonly rely on semi-logarithmic functional forms, as non-linearity effects are allowed as well as intuitive interpretation of coefficients. Therefore, this paper uses semi-logarithmic functional forms for the analysis.

C. Data acquisition

Property data. This paper relies on selling prices of condominiums, which make up the second largest share of transactions involving residential properties in Greater Kuala Lumpur. This study included a total of 476 transactions from January 2017 to June 2018, located within 1200 m from the nearest light rail transit stations, together with their structural attributes (such as size of the condominium (*FLOORAREA*), number of bedrooms (*BEDROOMS*) and ownership status (*FREEHOLD*). Transaction data (along with the complete address of the property) were obtained from the Department of Valuation and Services, Malaysia (Kuala Lumpur, Gombak and Shah Alam branches). In addition, information on the available facilities in each condominium, such as gymnasiums (*GYMNASIUM*), swimming pools (*SWIMMING_POOL*), tennis courts (*TENNIS_COURT*), saunas (*SAUNA*) and jogging tracks (*JOGGING_TRACK*) were extracted from the website.

Locational data. Geographic information systems (GIS) were used to calculate the distance between properties and the nearest light rail transit station (*DIST_800M*, focus variable) and other locational attributes such as the nearest primary school (*DIST_SCHOOL1*), secondary school (*DIST_SCHOOL2*), shopping mall (*DIST_SHOPMALL*), central business district (*DIST_CBD*) and recreational area (*DIST_RECREATIONAL*). First, GIS was used to position each condominium accurately on a local map using geographic coordinates (latitude and longitude) obtained from Google Maps. The distance in metres was measured along the shortest possible straight line by using a near-distance function available in the ArcGIS 10.0 software package. The final variable selection for the model is presented in Tab. 1.

Tab. 2 shows the summary statistics of dependent and independent variables used in this paper. From the sample, condominium sale values range from MYR 160,000 (US$40,000) to MYR 2,500,000 (US$625,000). The mean condominium sales values in the sample is MYR 570,647 (US$142,662). In terms of floor size, the average residential property has a floor area of around 1,269 square feet. However, there are units with as low as 560 square feet to as large as 4,059 square feet.

Table 1. Operational definition of variables

Variable	Operational definition
INTERCEPT	Intercept
SALEPRICE	Sale price of property – dependent variable (Y)
DIST_800M	Dummy variable to the nearest light rail transit station
FLOORAREA	Size of floor (in square feet)
FREEHOLD	Dummy variable for freehold ownership status (1 if freehold, 0 otherwise)
GYMNASIUM	Dummy variable for gymnasium (1 if gymnasium, 0 otherwise)
SWIMMING_POOL	Dummy variable for swimming pool (1 if swimming pool, 0 otherwise)
TENNIS_COURT	Dummy variable for tennis court (1 if tennis court, 0 otherwise)
SAUNA	Dummy variable for sauna (1 if sauna, 0 otherwise)
JOGGING_TRACK	Dummy variable for jogging track (1 if jogging track, 0 otherwise)
DIST_SCHOOL1	Euclidian distance (in metre) to the nearest primary school
DIST_SCHOOL2	Euclidian distance (in metre) to the nearest secondary school
DIST_SHOPMALL	Euclidian distance (in metre) to the nearest shopping mall
DIST_CBD	Euclidian distance (in metre) to the nearest
DIST_RECREATIONAL	Euclidian distance (in metre) to the nearest recreational area

Source: Author's own work, 2018.

Table 2. Descriptive statistics for explanatory variables

Variable	*N*	Mean	Standard deviation	Minimum	Maximum
SALEPRICE	476	570,647	253,160	160,000	2,500,000
DIST_800M	476	0.67	0.47	0	1
FLOORAREA	476	1,268.73	395.14	530	4059
FREEHOLD	476	0.54	0.49	0	1
GYMNASIUM	476	0.80	0.34	0	1
SWIMMING_POOL	476	0.86	0.34	0	1
TENNIS_COURT	476	0.18	0.34	0	1
SAUNA	476	0.29	0.46	0	1
JOGGING_TRACK	476	0.22	0.42	0	1
DIST_SCHOOL1	476	723.29	428.06	111.63	2,312.84
DIST_SCHOOL2	476	836.75	560.39	96.51	2,673.74
DIST_SHOPMALL	476	1,105.59	689.94	51.47	3,454.85
DIST_CBD	476	4,455.26	1,823.79	204.12	8,645.50
DIST_RECREATIONAL	476	2,097.45	1,485.94	140	5,393.05

Source: Author's own work, 2018.

D. Model specification

The semi-logarithmic specification employed in this paper can be written as follows:

$$LnY_i = \beta_0 + \beta_1 DIST_800M_i + \beta_2 FLOORAREA_i + \beta_3 FREEHOLD_i + \beta_4 GYMNASIUM_i + \beta_5 SWIMMING_POOL_i + \beta_6 TENNIS_COURT_i + \beta_7 SAUNA_i + \beta_8 JOGGING_TRACK_i + \beta_9 DIST_SCHOOL1_i + \beta_{10} DIST_SCHOOL2_i + \beta_{11} DIST_SHOPMALL_i + \beta_{12} DIST_CBD_i + \beta_{13} DIST_RECREATIONAL_i + \varepsilon_i \quad (2)$$

where Y_i is the sold price of a property in Malaysian Ringgit; *Ln* is the natural logarithm; DIST_*800M is* a dummy variable for a property located within 800 metres from the nearest light rail transit station; *FLOORAREA* is the floor area of the property in square feet; *FREEHOLD* is a dummy variable for property with freehold holding status; *GYMNASIUM*, *SWIMMING_POOL*, *TENNIS_COURT*, *SAUNA*, and *JOGGING_TRACK* are dummy variables for property with gymnasium, swimming pool, tennis court, sauna, and jogging track facilities respectively. Finally, *DIST_SCHOOL1*, *DIST_SCHOOL2*, *DIST_SHOPMALL*, *DIST_CBD*, and *DIST_RECREATIONAL* are proximity to the nearest primary school, secondary school, shopping mall, central business district, and recreational area, all of which were measured in metres.

In this paper, the correlations among the independent variables used for inclusion in the final models were detected using Pearson's correlation coefficient and variance inflation factors (VIFs). Orford [44] and Neter, Wasserman, and Kutner [45] suggested that a Pearson's correlation coefficient above 0.8 and a variance inflation factor above 10 indicate harmful collinearity. Thus, pairs of independent variables that produce a correlation coefficient higher than 0.8 and variance inflation factor of 10 or higher were eliminated from the final model.

4. Results and Discussion

Tab. 3 shows the semi-logarithmic specification estimations. The majority of estimated coefficients are significant at the 5% level, with the exception of freehold ownership status, sauna, and distance to the nearest primary school. The results also indicate a reasonably high adjusted R^2 of 0.70, a well-behaved VIF, and the signs of all coefficients are as expected, except for freehold ownership status. Since this is a semi-logarithmic specification form, the coefficients of the independent variables relate to their proportional (or when multiplied by 100, their percentage) effect on price. The estimated coefficient for a focus variable, namely, proximity within 800 m of the nearest light rail transit station, is positive and highly significant among locational attributes. Therefore, *ceteris paribus*, condominium units located within 800 m of the nearest light rail transit station experience a price premium of up to 30%. At the mean, this equates to MYR 172,904 (US$43,226). This finding provides strong evidence that accessibility improvements provided by light rail transit system is valued positively by home buyers.

Turning to structural attribute variables, the findings of this study provide unambiguous confirmation of previous researchers' results on the magnitude of impact of these variables on property values [46] [47] [48]. The estimated coefficient for property size measured by floor area is positive and very significant among all variables. *Ceteris paribus*, every square foot increase in floor area would add approximately 0.05% in value, which at the mean is a MYR 339 (US$85) increase in the market value of a surrounding property. Although freehold ownership status of property is expected to affect property values positively, the findings of this study indicate condominium units with freehold ownership status drop in value by roughly 0.2%, though the coefficient is not significant. The probable reason is that land tenure may not be the primary deciding factor when home buyers purchase property.

Table 3. Results of the hedonic pricing model (n = 476)

Variable	Coefficient (β)	T value	Sig.	Variance inflation factor
INTERCEPT	12.239140	210.13	0.00	
DIST_800M	0.302996	9.84	0.00	2.38
FLOORAREA	0.000594	22.38	0.00	1.24
FREEHOLD	-0.002018	-0.07	0.94*	2.26
GYMNASIUM	0.140105	4.20	0.00	2.02
SWIMMING POOL	0.090535	2.43	0.02	1.84
TENNIS COURT	0.226241	6.27	0.00	2.14
SAUNA	0.029966	1.19	0.23*	1.47
JOGGING TRACK	0.071580	2.52	0.01	1.58
DIST_SCHOOL1	-0.000026	-0.60	0.55*	3.72
DIST_SCHOOL2	-0.000081	-2.59	0.01	3.46
DIST_SHOPMALL	-0.000046	-2.21	0.03	2.36
DIST_CBD	-0.000021	-3.34	0.00	1.54
DIST_RECREATIONAL	-0.000023	-2.43	0.02	2.26

Notes: Goodness of fit: Adjusted R^2=0.70. * denote non-significant at the 0.05 level.
Source: Author's own work, 2018.

The presence of a gymnasium facility is shown to affect property values positively – *ceteris paribus*, the presence of a gymnasium facility raises condominium values by some 14%. At the mean, this equates to a premium of MYR 79,950 (US$19,988). The availability of a swimming pool also positively affects property values where the estimated coefficient indicates that, *ceteris paribus*, condominium units with a swimming pool generate a 9% increase in price premium which, at the mean, equates to MYR 51,664 (US$12,915). As expected, the estimated coefficients for tennis court and jogging track are both positive and significant. Specifically, *ceteris paribus*, condominium units with a tennis court facility generate a price premium of 22.6% or MYR 129,104 (US$32,276) at the mean. A jogging track yields a 7.2% price premium and at the mean, this equates to MYR 40,847 (US$10,212). The estimated coefficient for a sauna is positive and indicates that, *ceteris paribus*, condominium units with a sauna facility would realize an approximate 3% (though statistically insignificant) price premium. This equates to MYR 17,100 (US$4,275) at the mean.

In terms of locational attribute variables, proximity to the nearest secondary school, shopping mall, central business district and recreational area are all significant, suggesting that there is a positive 'locational effect' on property values. *Ceteris paribus*, every 100 m closer to the nearest secondary school adds 0.81%, to the nearest shopping mall adds 0.46%, to the nearest central business district adds 0.21% and to the nearest recreational area adds 0.23% to property value. At the mean, this equates to a premium of MYR 4,622 (US$1,156), MYR 2,625 (US$656), MYR 1,198 (US$300), and MYR 1,312 (US$328) respectively. The only insignificant locational attribute was proximity to the nearest primary school. The probable explanation for this is that property buyers who are parents perhaps put less emphasis on proximity to primary schools due to the fact that major examinations occur at later stages of schooling.

5. Conclusion

This paper was an attempt to investigate the impact of proximity to the nearest light rail transit station on the value of condominium property in Greater Kuala Lumpur, Malaysia. In particular, this paper has attempted

to address major shortcomings of previous investigations, specifically, that previous studies on this topic have been carried out in the context of developed countries setting and landed properties.

The results presented in this paper generally confirm those of previous investigations in other places. Condominium units located within 800 m to the nearest light rail transit station can earn a premium of MYR 172,904 (US$43,226), or 30% of the city's average home value. The results of this study also indicate that proximity to the nearest light rail transit station is the second-most influential variable in determining property values. This paper therefore adds to the growing literature on the positive impact of light rail transit on property values and provides needed evidence on the interrelationship between transit access and property values in a 'car-loving country' such as Malaysia.

While the results are considered to be robust in investigating the impact of light rail transit on property values, data limitations prevented this paper from considering other variables such as floor level [49], building age [50], balcony [42] and noise level [43]. Consideration of these variables would therefore represent an interesting subject for future investigations.

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