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Estimating the Effects of Light Rail Transit (LRT) System on the Property Values in the Klang Valley, Malaysia: A Hedonic House Price Approach

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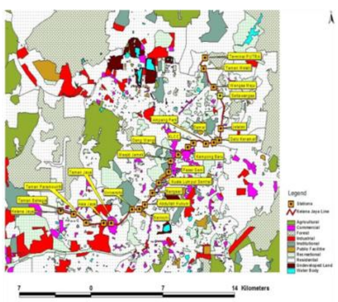
Graphical abstract



Abstract

This study investigates the increased value of land in the form of house prices as a result of improved accessibility owing to the construction of Light Rail Transit (LRT) systems. Kelana Jaya Line LRT system is chosen as the case study in this research. Hedonic house price modelling is employed to estimate the effects of the LRT system on the prices of the house that are located within the radius of two kilometres from the Kelana Jaya LRT stations. Selling prices, structural attributes, land use and socio-economic attributes were collected from the database of Department of Valuation and Services of Malaysia, selected maps and reports. Fifty-five factors that are likely to influence a house price were identified and used to estimate the overall effects of the LRT system on it. However, only significant variables were included in the final deliberation and these were identified by using correlation analysis and modified step-wise procedures. The outcome of this study shows a positive relationship between the existence of the LRT system and house prices. In other words, properties that are located within close proximity to the LRT station are valued more than properties that are located further away.

Keywords: Light rail transit systems (LRT); property values; hedonic price model; Klang Valley

Abstrak

Kajian ini menyiasat peningkatan nilai tanah dalam bentuk harga rumah hasil daripada peningkatan ketersampaian menerusi pembinaan sistem Transit Aliran Ringan (TAR). Sistem TAR laluan Kelana Jaya dipilih sebagai kajian kes dalam penyelidikan ini. Model harga rumah hedonik digunakan untuk menganggarkan kesan sistem TAR pada harga rumah yang terletak dalam lingkungan dua kilometer dari stesen TAR Kelana Jaya. Harga jualan, ciri-ciri fizikal rumah, lokasi dan sosio-ekonomi dikumpul daripada pangkalan data Jabatan Penilaian dan Perkhidmatan Malaysia, peta terpilih dan laporan. Lima puluh lima faktor yang mungkin mempengaruhi harga rumah telah dikenal pasti dan digunakan bagi menganggarkan kesan keseluruhan sistem TAR di atasnya. Walau bagaimanapun, hanya pemboleh ubah yang signifikan secara statistik telah dimasukkan dalam perbincangan akhir dan ini telah dikenal pasti dengan menggunakan analisis korelasi dan prosedur 'step-wise' yang telah diubah suai. Hasil kajian ini menunjukkan terdapat hubungan positif antara kewujudan sistem TAR dan harga rumah. Dalam erti kata lain, hartanah yang terletak dalam jarak yang hampir dengan stesen TAR mempunyai nilai yang lebih tinggi berbanding hartanah yang terletak jauh.

Kata kunci: Sistem transit aliran ringan (TAR); nilai hartanah; model harga hedonik; Lembah Klang

■1.0 INTRODUCTION

Rail transit systems, namely heavy and light transit systems are a public good and have been seen as serving a number of purposes and producing a number of public benefits, particularly to those areas that have been served by high service quality rail transit systems. These public benefits can be categorised into two; direct and indirect benefits.

The direct benefits of rail transit systems are defined in terms of improved regional mobility, consumer savings, vehicle cost savings, energy conservation, improved mobility for non-drivers and disadvantaged groups, congestion reduction, roadway cost savings, increased traffic safety, and pollution emission reductions (see, for example, Litman, 2003, 2004a, 2004b, 2007, 2012; Banister and Banister, 1995; Knowles, 1996; Pucher, 2004).

Alongside these direct benefits, the provision of high service quality of public transportation such as rail transit systems has also potentially influenced local land use and increased local property values (indirect benefits), particularly those that are directly perceived by the person who is purchasing or renting a property. The question is how a rail transit system could possibly affect land use and property values.

The concept of accessibility is the key to understanding how transportation and land use, and transportation and land value relate to each other. As widely recognised, public transportation such as rail transit systems significantly promotes spatial interaction between activities or land uses, particularly in larger and denser metropolitan areas. This spatial interaction is measured by accessibility, which reflects both the attractiveness of potential destinations and the ease of reaching them (Dalvi, 1978; Giuliano, 2004; Hanson, 2004; Smith and Gihring, 2011).

According to Giuliano (2004) the discussion on accessibility should include the element of attractiveness of a place as an origin (what opportunities are there to reach other destinations) and as a destination (how easy it is to get there from all other origins). Yet, the pattern of land uses is also important because it determines the opportunities or activities that are within the range of a given place. The potential for interaction between any two places increases as the cost of movement between them either in terms of money or time decreases. In addition, the structure and capacity of the transportation network could also affect the level of accessibility within a given area (Parsons, Brinckerhoff, Quade and Douglas, Inc., 1998).

This level of accessibility relies heavily upon high service quality of urban transit systems. This service quality refers to how transit system is directly perceived by users and it includes the availability and coverage of a geographic area, frequency, travel speed, reliability, integration, price structure and payment options, comfort and security, ease of reaching transit stations and making stops, universal design, affordability, information, aesthetics and amenity (Litman, 2012).

Since there is an increase in accessibility from one place to another (such as travel time saving and reduced transport costs), land uses and property values will respond accordingly in those places that have become more accessible. As Cevero and Kang (2010: 102) highlighted, 'a large body of literature confirms that the urban real-estate responds positively to transportation improvements, mainly in the form of higher property values and, zoning permitting, land use intensification'.

However, in the case of the transportation-land use relationship Parsons, Brinckerhoff, Quade and Douglas, Inc., (1998) argue that improving accessibility does not guarantee that land use changes will follow. The type, amount, and timing of land use changes will also depend upon the state of the regional economy, the current level of accessibility, the types of development permitted by land use regulations, the availability of services such as sewer and water, the desirability of the area for development, and other factors.

Land use changes can also vary because travelers have many options about the ways they can change their behavior in response to the change in the transportation network or the cost of travel. They can adjust the timing, route, or mode of trips as well as change the locations where they live, work, or shop.

Yet, as shown in the literature review (see, for example, Renne, 2005; Lin and Gau, 2006; Loo *et al*., 2010; Olaru *et al*., 2011; Cevero and Kang, 2011; Sung and Oh, 2011; Victoria Transport Policy Institute, 2011) improvement in accessibility due to the existence of public transportation such as rail transit systems together with the provision of high service quality has potentially played a significant role in influencing land uses and stimulating Transit-oriented development (TOD[2]), in particular, for those areas that are located within close proximity to rail transit stations.

In more developed countries such as the United Kingdom and United States, their rail transit systems have created compact, mixed-use and walkable urban villages around stations (Litman, 2007; Renne, 2005; Victoria Transport Policy Institute, 2011). As a result, residents around these areas tend to own fewer cars and drive less than if they were to live in more automobile-independent neighbourhoods.

In the case of the effects of rail transit systems upon land values (the main purpose of this paper), emphasis has taken into account the research on locational externalities that are generated by the rail transit systems, which in turn affect the residential and commercial land. It is expected that the existence of a rail transit system should be able to capitalise land values in the form of property values (residential and commercial properties). Banister and Berechman (2000) argues that the improvements in accessibility for those areas that have been served by the rail transit systems can potentially trigger several major positive locational externalities, in particular for properties located within close proximity to railway stations. They argued further that these positive locational externalities should be viewed as additional benefits to the primary accessibility improvement benefits.

As mentioned above, this positive effect, however, is not expected to be automatic. Instead this can be achieved through high service quality of rail transit system that could bring benefits to the local land use. The desired effect will not be realised if the system is deployed in the wrong areas or delivered in an unsatisfactory way.

One question that needs to be asked however is, how are property values affected by rail transit systems? Transit systems can be reached by accessing their transit stations. Therefore, the ability to access transit stations conveniently and quickly should be capitalised in property values. In other words, higher property values are expected in places with superior access to stations. Yet, in the case of residential property it has been found that house prices have the potential to decrease for properties that are located too close to a rail station due to traffic congestion and noise pollution effects, whilst properties radiating out from the station and within easy walking and driving distance should increase in price (Hess and Almeida, 2007).

The purpose of this paper therefore is to report the results of a study that estimated the value for improved accessibility, encompassing the locational externalities that are generated by the LRT system, which in turn affect the land values in the form of house prices. The paper begins by reviewing the literature with respect to the effects of rail transit systems on property values. The empirical evidence from the previous studies forms a base that in turn can be used in estimating the effects of the LRT system on house prices. Section 3 of the paper discusses some background of the LRT system in the Klang Valley. Section 4 discusses the research methodology such as the study area, data and data sources and the identifications of the effects of the Kelana Jaya LRT Line on house prices. Section 5 deals with the results of the estimation. Finally, the process of estimating and principal findings are reviewed and discussed.

2.0 EXISTING RESEARCH

A number of existing studies have sought to estimate the effects of heavy and light rail transit systems, mainly in terms of locational externalities that are generated by the rail transit systems upon land values. The evidence from empirical researches both in the UK and North America suggest inconsistent results and varying magnitude on the effects of heavy and light rail transit systems on property values. This is due to the unique research methods, unique local transport systems and land use environments (Hess and Almeida, 2007).

Twenty-three of the thirty-three studies considering heavy and light rail transit systems suggest a positive relationship between property values and rail transit systems access. Early research highlights this relationship – for example Boyce *et al*., 1972; Lerman *et al*., 1978; Bajic, 1983; Dvett *et al*., 1979; Damm *et al*., 1980; Voith, 1991; Nelson, 1992; Al-Mosaind *et al*., 1993; Gatzlaff and Smith, 1993; Benjamin and Sirmans, 1994), and in more recent studies by Chen *et al*. (1997), Workman and Broad (1997), Dueker and Bianco (1999), Knapp *et al*. (1999), Chesterton (2000), FTA (2000), Weinberger (2000), Cervero (2002), Cervero and Duncan (2001, 2002), Garrett and Castelazo (2004), Du and Mulley (2006) and Hess and Almeida (2007).

However, some of the studies were dismissive of the effect. Eleven of the thirty-five both heavy and light rail transit systems studies suggest that there is no relationship between property values and rail transit systems access (see for example, Dewess, 1976; Nelson and McClesky, 1990; VNI Rainbow Appraisal Service, Inc., 1992; Cevero and Landis, 1993; Armstrong, 1994; Landis *et al*., 1995; Landis and Loutzenheiser, 1995; Forrest *et al*., 1996; Ryan, 1997; Henneberry, 1998). For example, in Atlanta, studies discovered that rail transit systems had virtually no effect on property values and a study of Miami's Metrorail system came to the same conclusion (Gatzlaff and Smith, 1993). Over the past decade, Portland's Metropolitan Area Express (MAX) rail transit system has also received attention. In two studies that were conducted, only very modest and localised effects on land values were identified (Al-Mosaind *et al*., 1993).

Preliminary results of a study on Toronto rail transit carried out by Dewess (1976) have shown virtually no effect on property values. However, a study on the same rail transit system carried out by Bajic (1984) revealed that the city's rail corridors have experienced intense development and that residential property values are significantly higher near a rail line than elsewhere. Moreover, in the study of Pennsylvania's commuter rail system, Voith (1991) concluded that houses served by a commuter rail system had a 4 per cent to 10 per cent premium over those that were not served by a commuter rail system. Nonetheless, he found that travel time to the CBD was significant in estimating property values. In the UK, estimating the effect of rail transit systems on property values commenced in the 1990s. For instance, a study conducted by Centre for Urban and Regional Development Studies (CURDS) (1990) on the effect of Tyne and Wear Metro on house prices concluded that there was no effect. However, a recent study conducted by Du and Mulley (2006) on the same basis found that housing units in some of the areas that are located within close proximity to railway stations increased in value.

Several explanations are available for these inconsistencies resulting from the effects of heavy and light rail transit systems on property values (see for example Knight and Trygg, 1977; Landis *et al*., 1995; Ryan, 1999; Giuliano, 2004). An early explanation was given by Knight and Trygg (1977). They concluded that the determinants of property value in an urban area relate to land value controls and economic growth rather than transportation investment. Ryan (1999) noted that many had supported the conclusions developed by Knight and Trygg. However, the inability to replicate the variables introduced by Knight and Trygg led to weak evidence in supporting earlier ideas of Knight and Trygg.

Alternatively, Landis *et al*. (1995) suggested different arguments to support research discrepancies, for example, new transportation facilities that could influence property values. However, the effect of new technology on accessibility levels will gradually decline over time. Even though new transportation technology is introduced, which benefits adjacent properties, they remain under-priced. Hence, the relationship between property value and transportation is still uncertain, but travel cost is still a strong factor to be observed (Ryan, 1999).

Yet another explanation as to why empirical evidence (particularly from the 1980s and 1990s) differs from theoretical expectations is provided by Ryan (1999). Ryan argued empirical evidence is different compared to theoretical expectations. She advocated that the distance of a property to the transportation as a variable has proved to be more accurate compared to other variables. The value of the properties where they are located will be bid up if there is apparent time saving. A relationship between access and property values is to be expected when the measure of access captures the essence of travel time saving. Inaccuracy in measuring changes in the travel time leads to inaccurate changes in the property value. Thus, studies should aim to answer whether transportation really improves the travel time for a specific segment of travellers. Ryan argues that all of the benefits are internalised through the transport time dimension and that there is no reason to investigate further into the effect on the property value.

The explanation given by Ryan seems to be realistic because as has been noted earlier, the main objective of introducing rail transit systems was simply to improve accessibility to the CBD. Hence for many households, the only way to improve accessibility to the CBD is by being located closer to the rail transit service; households need to purchase a house in the associated area if they wish to enjoy the advantage of the rail transit service. Capitalising the price of houses could be expected if the rail transit service has truly improved accessibility to the CBD. This is due to the argument that for those households who really appreciate the improvement of accessibility to the CBD, they will bid-up for such service.

Giuliano (2004) offers an explanation for the inconsistency and varying evidence of the effects of rail transit systems on property values. She believes that the first few studies of the effects of heavy rail transit systems on property values were too premature since it would take decades before the land market could respond to the availability of rail transit systems in the area.

However, it is important to note that if the methods that have been employed to estimate the effects are an appropriate method, together with the quality of data, the positive relationship between rail transit systems and property values can be identified.

■3.0 BACKGROUND INFORMATION ON RAIL TRANSIT SYSTEMS IN THE KLANG VALLEY

The Klang Valley region consists of five administrative units which include the Federal Territory of Kuala Lumpur (the capital and financial as well as commercial centre of Malaysia), and four other districts of the state of Selangor; Klang, Petaling, Hulu Langat and Gombak. Being situated between the northern and southern regions has made the Klang Valley the core of the larger planning entity of the Peninsular Malaysia (see Figures 1 and 2). The Klang Valley region encompasses an area of 2,843.42 square kilometres or 1,097 square miles and, as of the year 2010, it had a population of about 6.0 million (about 21.4 per cent of the total population of Malaysia). With 2,000 residents per square kilometre, the Klang Valley comprises the densest urbanised area in Malaysia.

The Klang Valley region has been the most rapidly growing region in Malaysia for the past few decades. The early growth of this region concentrated primarily in the Federal Territory of Kuala Lumpur. Kuala Lumpur is the major financial and commercial centre of Malaysia and it encompasses an area of 243 square kilometres and had a population of about 1.58 million in 2010 (about 26.48 per cent and 5.67 per cent of the total population of the Klang Valley and Malaysia, respectively).

Figure 1 The location of the Klang Valley in Peninsular Malaysia
*Source***:** The Federal Territory Development and the Klang Valley Planning Division (2004)

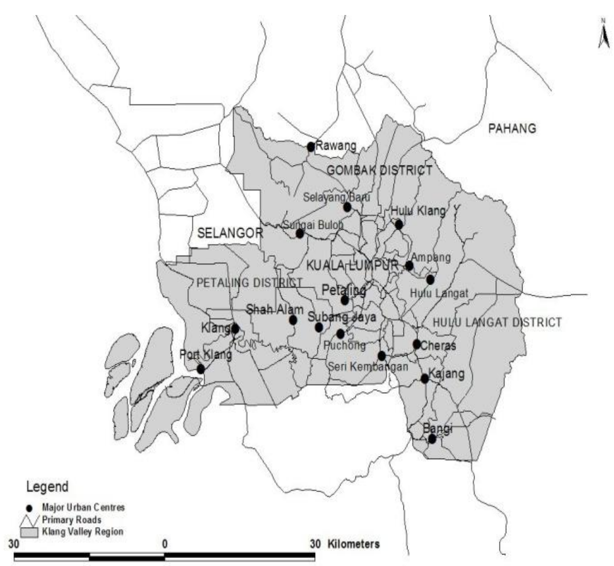


Figure 2 The Klang Valley and its conurbation

Source: The Federal Territory Development and the Klang Valley Planning Devision (2004)

Economic growth and rapid urbanisation have brought about steady increases in car ownership and congestion levels in the Klang Valley. A study conducted by Mohammad and Kiggundu (2007) found that between 1997 and 2005, the average motor-vehicles speed in the CBD of Kuala Lumpur hovered around 16-28 km/h, with the worst congestion during morning and evening peak hours. In terms of traffic fatalities, it was recorded that there were about 4.3 accident fatality cases for every 10, 000 registered vehicles (Marjan *et al*., 2007).

Realising that this problem needed to be addressed, the construction of heavy rail transit systems in the Klang Valley started in the 1991. The first line began operating in 1995, connecting Kuala Lumpur and Port Klang in the Klang Valley and Seremban (in the state of Negeri Sembilan) and Kuala Lumpur. An additional line to Rawang and Kuala Kubu Bahru was constructed and opened in 2000 and 2007 respectively. The KTM commuter system, with 175 kilometres of total length of network has fourty-five stations. It should be noted that several prominent shopping complexes and recreational centres became more accessible after the opening of the KTM commuter service. In addition, the KTM commuter system has improved accessibility for commuters from suburban areas who work in Kuala Lumpur City Centre, as they can travel without being caught in the traffic congestion.

In the case of the LRT system, the construction of this system in the Klang Valley started in 1994 and it involved several phases. The first phase of the LRT system in the Klang Valley was under Sistem Transit Aliran Ringan (STAR), stretching for twelve kilometres over thirteen stations between Ampang and Jalan Sultan Ismail, linking the northern and southern suburbs of Kuala Lumpur. This section began operating in April 1997. However, the section between Ampang and Plaza Rakyat began operating during the first quarter of 1996. The second section of the STAR LRT system project was completed on 30 June 1998 – extending southwards to the Commonwealth Games complex in Bukit Jalil.

The second phase of the LRT system in the Klang Valley was under Projek Usahasama Transit Ringan Automatik (PUTRA). The PUTRA LRT line covers the eastern and western suburbs of Kuala Lumpur. The line services some of Kuala Lumpur's most affluent and heavily populated areas. The total alignment of the line, which starts from the depot in Subang and ends at Terminal Putra in Gombak is twenty-nine kilometres in length. In 2004, the operation of this service was taken over by Rangkaian Pengangkutan Integrasi Deras Sdn Bhd (RapidKL). Since then, the name of PUTRA LRT has been changed to Kelana Jaya Line LRT system.

According to Md Nor *et al*. (2011), presently Kelana Jaya Line and Ampang Line LRT system carries some 350,000 passengers daily (180,000 passengers on Kelana Jaya Line and 170,000 on Ampang Line) and a monorail system with a daily patronage of 100,000 passengers.

In order to raise public transport modal share from the current 13 per cent to 25 per cent by 2015 for the morning peak period, the Malaysian government in 2010 announced to reinvest with large amount of investment (nearly US$12 billion) in public transportation that is by constructing Mass Rapid Transit (MRT) in the Klang Valley. The MRT is seen as a system that will operate at higher speeds and carries more passengers than the existing LRT system.

Although the main objectives of implementing rail transit systems in the Klang Valley were to improve accessibility, increase regional mobility, conserve energy, reduce congestion, save roadway cost, increase traffic safety, and reduce pollution emission, the Klang Valley rail transit system planners also hoped a modern era rail transit systems would also bring indirect benefits such as to guide future population and employment growth in the region, influence local land use and increase property values for those areas served by the system. Furthermore, by providing one of the largest incremental additions to regional accessibility, rail transit systems was expected to strengthen the Klang Valley's urban centres while guiding suburban growth along radial corridors.

■4.0 RESEARCH METHODOLOGY AND DATA SOURCES

To estimate the effects of the LRT system upon the house prices in the Klang Valley, the cross-sectional method was identified to be an appropriate method for this study. The selling price for each of the individual houses located within two kilometres of the LRT station was collected after the construction of the LRT system had been completed.

4.1 Data Sources

The literature has shown that hedonic data can be obtained from two sources; primary data and secondary data sources. In the context of this study most of the data were collected from secondary data sources. The secondary data were collected during fieldwork in the Klang Valley. The fieldwork consisted of several phases, spreading over a period of five months from July to September 2006 and July to August 2007. In the first fieldwork, data on several categories were collected from various agencies in Malaysia. However, after completing the first fieldwork, the researcher identified several other relevant data that are still needed for this study. Thus, the second fieldwork needed to be carried out in order to fill the gaps. As noted earlier, the second fieldwork was completed in August 2007. Several categories of data have been identified with regards to this study.

These data can be grouped into five categories; the selling price of individual houses and their structural attributes, locational attributes, socio-economic attributes, property market and transportation access variables. House price transactions for 2004/05 were chosen to be the sample for this study. This marks a period after several years of rail transit systems operated in the Klang Valley. In total, 2338 units of housing selling prices were collected. However, after going through several steps to clean the sample dataset by eliminating the unsuitable data and updating the unavailable data, the study was left with 1,580 observations. This cross-sectional data refers to the residential property located within two kilometres (straight-line-distance) of LRT stations. Figure 3 shows the twenty-nine-kilometres of the Kelana Jaya Line LRT system route with twenty-three stations whilst Figure 4 shows a two kilometre radius buffer surrounding the Kelana Jaya Line stations. However, due to the Kelana Jaya Line LRT system stations being located close to each other, this means that the two kilometre buffer areas around the stations overlap as shown in Figure 3. The selling price of an individual house and its structural attributes were collected from the Department of Valuation and Property Services, Malaysia.

The data on the base map, land parcel, locational attributes (type of land use) and socio-economic were obtained from the Centre of Spatial Analysis, Science University of Malaysia, Kuala Lumpur City Hall, Department of Agriculture of Malaysia and Department of Statistics of Malaysia. Land use or locational attributes data were collected for two different periods of time; 2004 and 2005. The purpose of dividing these data was based on different time periods because we needed to see the land use change during these two periods of time. Thus, we would be able to measure how these attributes could affect the house prices in the study area. The data was believed to be of high quality and reliability as these come from the centre involved in the GIS application of the Klang Valley project for the Prime Minister's Department of Malaysia.

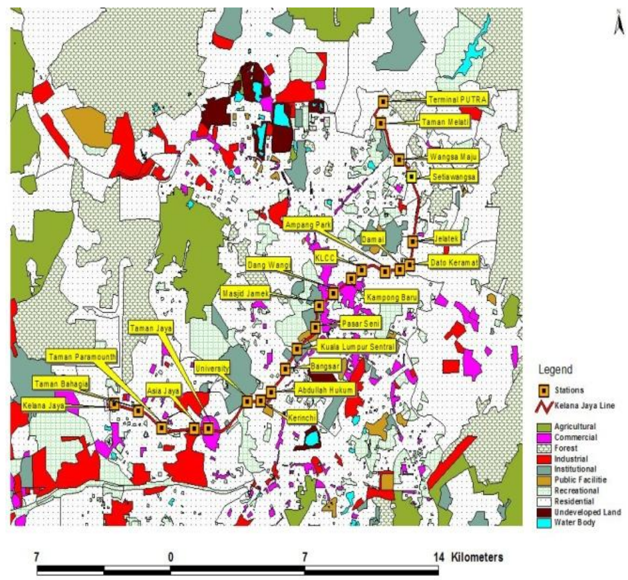


Figure 3 Case study: the Kelana Jaya Line LRT system

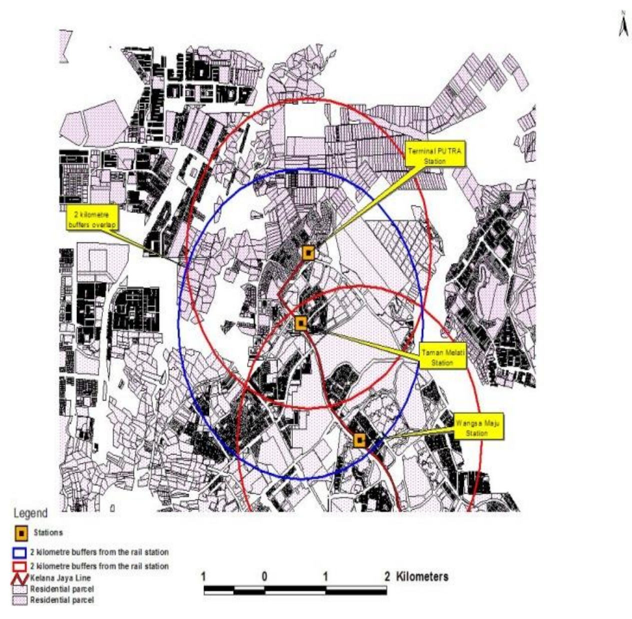


Figure 4 Two kilometre radius buffer areas surrounding stations

In order to measure the distance to an LRT station and other amenities from a given house, the geographical information systems (GIS), and in particular, network analysis was used in this study. GIS was used to organise and manage large spatial datasets (that is, units of houses) and of course their structural and locational attributes too, and most importantly GIS was used to position each observation and locational attribute accurately on a local map by using the geographical coordinates. Moreover, the combination between GIS and spatial analysis has been particularly useful in this study in which the distance and proximity were measured accurately by measuring the distance from one point to another using network distance such as the distances from the observations to the nearest station and other locational attributes.

4.2 Property Value Estimation

In order to measure the locational externalities generated by rail transit systems upon residential property values, this paper uses a standard hedonic pricing model where the house price is a function of structure, locational and neighbourhood variables. The general form of a hedonic pricing model can be presented as:

$$P(Z) = f(R, S, L, N) + \varepsilon \quad (1)$$

where,
P = a vector of observed house prices;
R = a vector of focus variables
S, L and N = the vectors of structural variables, locational variables and neighbourhood variables respectively;
ε = a vector of random error terms.

Typically, the specification of this function has been represented as:

$$P_i = \alpha X_i + \sum \beta_k S_{ki} + \sum \gamma_q L_{qi} + \varepsilon_i X_i \quad (2)$$

where,
$i = 1, \ldots, N$ is the subscript denoting each property;
P_i = the price of property i;
$k = 1, \ldots, K$ is the number of structural attributes;
$q = 1, \ldots, Q$ is the number of locational attributes;
α, β, γ and ε are the corresponding parameters;
X_i = a column vector that consists entirely of ones.

This has been termed the traditional hedonic specification and has been the basic model in the most of the studies (Can, 1992). Table 2 provides a list of the eighteen independent variables that was used to estimate the effects of the LRT system on house prices in this study, along with the definition, unit of measurement and data source for each variable.

Furthermore, the independent variables that influence residential property values were categorised into four distinct groups; focus variables, structural variables, locational variables and neighbourhood variables. The details of these data and how they were prepared are described below.

(1) *Focus Variables* (**R**); Two types of measures have been identified in order to measure the distance (in metre) from each observation to the nearest LRT station; straight-line-distance and network-distance. By using network-distance, the accessibility between each observation and a rail station is the shortest route on the road network connecting them. Straight-line-distance (STRDIST) was calculated within ArcView 3.2, and drawn using lines to connect each observation to the nearest LRT station. In the network-distance (NETDIST), the distance was measured along the street network by using a user-developed GIS programmed named Multiple Origins to Multiple Destinations, obtained from the Environmental Systems Research Institute (ESRI) support centre. The programme was written based on Avenue programming language of ArcView by Dan Paterson from the US and it was made accessible to the public. The network-distance measurement using this programme requires three layers of spatial data; points of origin (observations), points of destinations (LRT station) and the road network data. The distances between the origins and destinations measured were automatically saved in a *shapefile*. Figure 5a and 5b illustrates straight-line-distance and network-distance methods in measuring the distance for each observation to the nearest LRT station for three station areas.

(2) *Structural Variables* (**S**); Structural attributes are in short, those physical structures of a property and the land parcel within which it is located. Orford (1999) explained that structural attributes represent the shelter afforded by housing and the physical investment by the owner. Orford argued further that structural attributes are conceptually more tangible compared to locational attributes. Since the nature of structural attributes is more tangible, it is a much easier and straight forward process to measure the effects of structural attributes on house prices. Structural attributes of the house that were included in the analysis are the floor area of the property in square foot (FLRAREA), the number of bedrooms of the property (BEDS) and a set of dummy variables that illustrate the type of house which are further described as follows:

TYPTRRD is 1 if the property is terraced, 0 otherwise;

TYPSEMID is 1 if the property is semi-detached, 0 otherwise;

TYPDETCH is 1 if the property is detached, 0 otherwise;

TYPCONDO is 1 if the property is condominium, 0 otherwise.

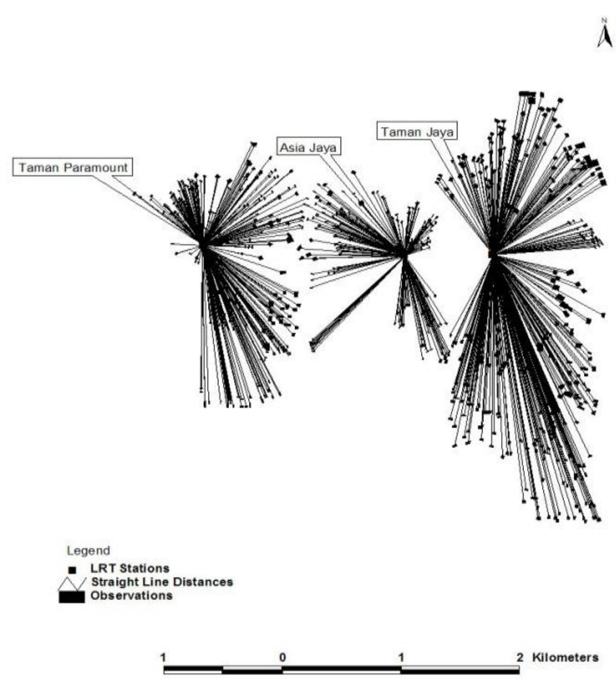


Figure 5a Straight-line-distance

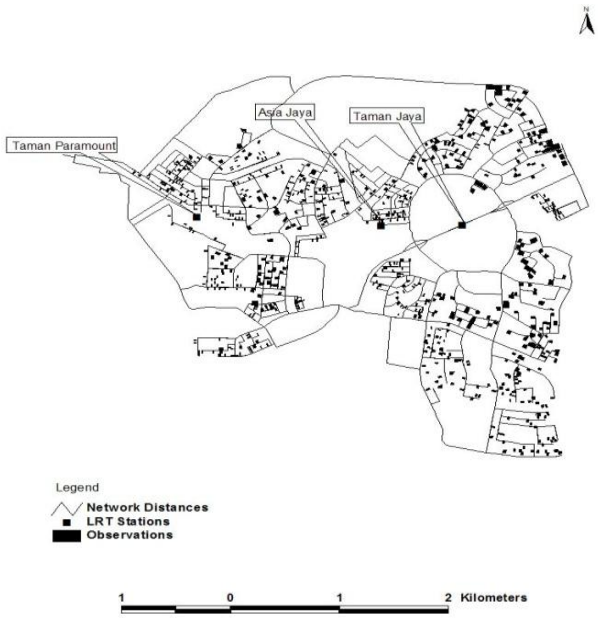


Figure 5b Network-distance

(1) *Locational Variables* (**L**); Locational attributes are in short, those attributes whose benefits are realised mainly in the form of externalities, and hence they are collectively shared by a large number of people and houses. Locational attributes can be categorised into two groups; fixed and relative locational attributes. Fixed locational attributes are those attributes that capture the location of a property with respect to the whole urban area, and pertain to some form of accessibility measure, typically accessible to the CBD. Relative locational attributes are those attributes that reflect the externalities of the local neighbourhood and are unique to an individual property such as environmental quality (Orford, 1999). In considering the decentralised mechanisms for the efficient provision of such attributes, their spatial attributes are found to be crucial. Locational attributes tend to be spatially concentrated in their impact on the quality of people's lives and the value of their property. In this study, CBD, COMMERCIAL, SECONDARYSCH, PRIMARYSCH, PARK, RECREATION, HOSPITAL, and INDUSTRY are the distances measured from the property to Kuala Lumpur city centre, commercial areas, secondary schools, primary schools, parks, recreational areas, hospitals and industrial areas respectively.

(2) *Neighbourhood Variables* (**E**); Neighbourhood attributes for socio-economic and racial composition were constructed from the census data. The proportion of the Malay ethnic group (MALAY) was calculated by dividing the number of population with the smallest administrative area that is Mukim.

The presence of multicollinearity among parameter estimates was detected first by using Pearson's correlation analysis in SPSS. As mentioned previously, the correlation coefficients above 8.0 indicated serious multicollinearity – those independent variables that produce a correlation coefficient of 0.8 or higher were removed from the particular regression model. Table 3 provides descriptive statistics for the dependent and independent variables used in the analysis; mean, maximum, minimum and standard deviation

4.3 Analysis

The discussion in the preceding section presents the traditional hedonic specification that has been identified as the basic model in the many studies related to the house-price analysis. Based on the specification 2, a log-log specification is found to be the best functional form for hedonic specification in estimating the effect of the LRT system on house prices. A log-log specification is chosen for this study because it produces robust and reliable results in estimating the effect of the LRT system on house prices compared with two other specifications (linear and semi-log specification). In order to identify the difference between perceived-distance to a station and actual-distance to a station, the following hedonic house price model is constructed. The model for straight-line-distance can be stated as:

$$LnP_i = \alpha_0 + \alpha_1 LnSTRDISTi + \alpha_2 LnFLRAREA_i + \alpha_3 LnBEDS_i + \alpha_4 TYPTRRDi + \alpha_5 TYPSEMID_i + \alpha_6 TYPDETCH_i + \alpha_7 TYPCONDO_i + \alpha_8 LnCBD_i + \alpha_9 LnCOMMERCIAL_i + \alpha_{10} LnSECONDARYSCH_i + \alpha_{11} LnPRIMARYSCH_i + \alpha_{12} LnPARK_i + \alpha_{13} LnRECREATION_i + \alpha_{14} LnHOSPITAL_i + \alpha_{15} LnINDUSTRY_i + \alpha_{16} LnMALAY_i + \varepsilon_i \quad (3)$$

where i is the subscript denoting each property; P_i is the price of property i in Malaysia Ringgit (MYR); Ln is natural logarithm; STRDIST is the straight-line-distance from the property to an LRT station measured in metres; FLRAREA is the floor area of the property in square foot; BEDS is the number of bedrooms of the property; TYPxxx is a set of dummy variables that illustrate the type of house which are further described as follows:

TYPTRRD is 1 if the property is terraced, 0 otherwise;
TYPSEMID is 1 if the property is semi-detached, 0 otherwise;
TYPDETACH is 1 if the property is detached, 0 otherwise;
TYPCONDO is 1 if the property is condominium, 0 otherwise.

CBD, COMMERCIAL, SECONDARYSCH, PRIMARYSCH, PARK, RECREATION, HOSPITAL, and INDUSTRY are the network-distances from the property to Kuala Lumpur city centre, commercial areas, secondary schools, primary schools, parks, recreational areas, hospitals and industrial areas respectively. These variables are all measured in metres. Finally, MALAY is the percentage of the Malay ethnic at the Mukim level; α denotes a parameter to be estimated; and ε denotes the standard error of the estimation.
Similarly, the model for network-distance can be stated as:

$$LnP_i = \alpha_0 + \alpha_1 LnNETDIST_i + \alpha_2 LnFLRAREA_i + \alpha_3 LnBEDS_i + \alpha_4 TYPTRRDi + \alpha_5 TYPSEMID_i + \alpha_6 TYPDETCH_i + \alpha_7 TYPCONDO_i + \alpha_8 LnCBD_i + \alpha_9 LnCOMMERCIAL_i +$$

$\alpha_{10}LnSECONDARYSCH_i + \alpha_{11}LnPRIMARYSCH_i + \alpha_{12}LnPARK_i + \alpha_{13}LnRECREATION_i + \alpha_{14}LnHOSPITAL_i + \alpha_{15}LnINDUSTRY_i + \alpha_{16}LnMALAY_i + \varepsilon_i$ (4)

where the actual-distance to a station is given by NETDIST: the network-distance from the property to an LRT station measured in metres. The results from the hedonic house price models are presented in a standard format. This standard format is shown in Table 4. Note that the results from straight-line-distance and network-distance were separately displayed. As can be seen in Table 4, the results from the hedonic house price models include five attributes which represent the predictor, coefficient, standard error, t-value and VIF. The predictor is the variable that has been used to measure the house prices and it has included focused, structural, locational and socio-economic variables. The second column provides coefficients which represent the prices of each predictor used in the model. The standard errors of the coefficients are presented in the third column. The fourth column gives us the results of a t-value of the predictor. The greater t-value of the predictors implies that the greater its function in determining a house price. The multicollinearity level of the predictors used in the final model is shown in the final column, namely the variance inflation factor (VIF). Meanwhile, the adjusted R^2 for the number of variables in the model is shown below each model.

Table 2 Definition of variables and data sources

Vector	Predictor	Operational definition	Units	Data source
Dependent variable				
House price transactions (**P**)	*SELLING*	House price transactions	Malaysia Ringgits (MYR)	Department of Valuation and Property Services of Malaysia (DVPA)
Independent variables				Calculated using GIS
Focus variables (**R**)	*STRDIST*	Straight-line-distance	Metre	Calculated using GIS
	NETDIST	Network-distance	Metre	Calculated using GIS
Structural variables (**S**)	*TIMESAVINGS*	Travel time savings to CBD	Minutes	DVPA
	FLRAREA	Floor area	Square foot	DVPA
	BEDS	Number of bedrooms	Number	DVPA
	TYPTRRD	Terraced house	Dummy (0 or 1)	DVPA
	TYPSEMID	Semi-detached house	Dummy (0 or 1)	DVPA
	TYPDETCH	Detached house	Dummy (0 or 1)	DVPA
	TYPCONDO	Condominium	Dummy (0 or 1)	Calculated using GIS
Locational variables (**L**)	*CBD*	Proximity to CBD	Metre	Calculated using GIS
	PRIMARYSCH	Proximity to primary schools	Metre	Calculated using GIS
	SECONDARYSCH	Proximity to secondary schools	Metre	Calculated using GIS
	COMMERCIAL	Proximity to commercial areas	Metre	Calculated using GIS
	PARK	Proximity to parks	Metre	Calculated using GIS
	HOSPITAL	Proximity to hospitals	Metre	Calculated using GIS
	RECREATION	Proximity to recreational areas	Metre	Calculated using GIS
		Proximity to industrial areas	Metre	
Socio-economic variables (**N**)	*INDUSTRY* *MALAY*	Proportion of Malays	Proportion of Malays (for each Mukim)	Malaysia Census 2000

Table 3 Characteristics of dependent and independent variables

Vector	Predictor	Mean	Standard deviation	Minimum	Maximum
Dependent variable					
House price transactions (**P**)	*LOGSELLING*	12.49	0.59	10.82	14.43
Independent variables					
Focus variables (**R**)					
Structural variables (**S**)	*LOGSTRDIST*	6.73	0.64	4.33	7.64
	LOGNETDIST	7.15	0.65	4.33	8.08
	LOGTIMESAVINGS	2.15	1.14	-4.07	3.38
	LOGFLRAREA	6.17	0.68	4.79	8.54
	LOGBEDS	1.07	0.26	0.00	1.79
Locational variables (**L**)	*TYPTRRD*	0.46	0.49	0.00	1.00
	TYPSEMID	0.01	0.12	0.00	1.00
	TYPDETCH	0.12	0.32	0.00	1.00
	TYPCONDO	0.19	0.39	0.00	1.00
	LOGCBD	9.08	0.29	7.91	9.43
	LOGPRIMARYSCH	6.65	0.82	1.45	7.85
	LOGSECONDARYSCH	6.65	0.64	2.73	7.93
	LOGCOMMERCIAL	6.62	0.99	2.27	7.94
	LOGPARK	6.94	2.27	0.52	9.04
	LOGHOSPITAL	7.87	0.89	4.25	9.04
	LOGRECREATION	8.67	0.49	7.09	9.44
	LOGINDUSTRY	7.19	0.55	4.29	7.94
Socio-economic and ethnic variables (**N**)	*LOGMALAY*	3.73	0.24	3.46	4.49

Table 4 The traditional hedonic specification of Model 3 and Model 4

Vector	Predictor	Straight-line distance (Model 3)				Network distance (Model 4)			
		Coefficient	Standard error	t-value	VIF	Coefficient	Standard error	t-value	VIF
	Constant	35667.67	1.74	18.85		43739.2	1.76	18.89	
Focus variables	*STRDIST*	-10.56	4.95	-2.16	1.85				
	NETDIST					-6.61	3.03	-2.31	1.70
	TIMESAVINGS	2019.25	296.16	6.82	3.27	2046.17	296.15	6.87	3.30
Structural variables	*FLRAREA*	310.63	13.09	24.07	6.23	312.65	13.09	23.99	6.35
	BEDS	31485.34	3922.05	8.01	1.87	31594.29	3922.04	8.06	1.87
	TYPTRRD	71160.14	9509.88	7.44	4.33	72143.93	9509.88	7.61	4.29
	TYPSEMID	139696.87	22626.95	6.19	1.40	138713.09	22626.95	6.15	1.40
	TYPDETCH	173145.42	17052.20	10.16	6.02	170849.93	17052.20	10.02	6.03
	TYPCONDO	184622.86	10165.74	18.23	3.02	184950.79	10165.73	18.25	3.03
Locational variables	*CBD*	-17.96	1.52	-11.75	3.18	-18.61	1.55	-11.92	3.33
	PRIMARYSCH	26.25	3.94	6.75	1.93	26.57	3.93	6.79	1.93
	SECONDARYSCH	-11.11	4.66	-2.40	1.41	-11.11	4.66	-2.36	1.41
	COMMERCIAL	-10.13	3.28	-3.17	2.41	-9.54	3.28	-2.94	2.50
	PARK	-1.13	0.31	-3.33	1.24	-1.13	0.31	-3.36	1.24
	HOSPITAL	3.40	1.29	2.64	3.27	3.58	1.28	2.73	3.32
	RECREATION	-4.81	1.70	-2.84	5.87	-4.65	1.70	-2.76	5.80
	INDUSTRY	28.22	3.72	7.74	1.70	26.91	3.71	7.23	1.80
Socio-economic and ethnic variables	*MALAY*	3673.45	613.52	5.99	7.61	3520.07	605.85	5.83	7.37
		R^2 (adj.) = 78.2 per cent				R^2 (adj.) = 78.2 per cent			

5.0 RESULTS: HEDONIC PRICE MODELS

Table 4 presents the summary of the parameter estimates of Models 3 and 4 – the basic model for straight-line-distance and network-distance in estimating the effect of the LRT system on house prices. To reduce the complication of the interpretation process, continuous independent variables are deviated around their means. In other words, the models are estimated with respect to the average property size of 651.35 square feet. The results of both models show that most of predictor variables that have been used to estimate the LRT-house prices relationship produce correct signs (positive or negative) as theoretically expected, except for primary school and significance level of 0.01 and 0.05. In terms of the R^2 statistic, the model explains the variation of the house price within a two-kilometre radius from an LRT station in the Klang Valley reasonably well for both straight-line and network-distance model with 78.2 per cent. The result of hedonic model also shows that the parameter estimates of several independent variables are found to be slightly different between these two models.

(1) *Value of the LRT system*; An examination of Table 4 shows that the parameter estimates of focus variables are found to be statistically significant with the correct sign. Evidently, it can be seen that the house price decreases as we move further away from the LRT station – for every metre away from an LRT station, the value of a residential property decreases by MYR10.56 (straight-line-distance model) and by MYR6.61 (network-distance model). This implies that a residential property located anywhere within 1,000 metres of an LRT station would generally be valued at an average rate between MYR10,560 (straight-line-distance model) and MYR6,610 (network-distance model) more than a residential property located outside of this distance. As for the magnitude of effect, the LRT system has significantly contributed at -2.16 (t-value of straight-line-distance) and -2.31 (t-value of network-distance) in determining the house price in the study area. It is notable that the t-value of the parameter estimate of straight-line-distance measures is slightly higher than that of network-distance measures.

(2) *Value of structural attributes*; The result of the estimation indicates that the most influential factor in determining the house price is floor area. For every square-foot increase in the floor area, the house price increases by an average of around MYR310.63 for straight-line-distance model. Similarly, an increase around MYR312.65 is deduced for network-distance model. The greater magnitude of the effect of floor area was expected since floor areas are always associated with the size of the property – this is consistent with the most of the hedonic house price literature. In the case of number of bedrooms, a potential buyer has to pay on average MYR31,000 for one additional bedroom of a property for both models. As for property-type attribute, its role is only to indicate the price for different types of housing in the study area. As to be expected, the price for a detached or semi-detached house would be higher than a terraced house. After examining the results for both models, the conclusion that can be made is; there are significant differences in price between different types of housing. In other words, implicit prices of detached (MYR170,000), semi-detached (MYR139,000), condominium (MYR184,000) and terraced houses (MYR71,00) for both models should all have reflected some value-added by the attributes that they possess. In the case a condominium property, the explanation that could be given is; since a condominium property has various facilities such as swimming pool, sauna, club house, sport facilities, landscape and security, it can be expected that a condominium property has a positive effect on house price. The same thing can be expected from a detached property, since it stands exclusively on its own and normally it comes with a bigger plot of land with lower density – these attributes will definitely contribute to the positive effect on house price.

(3) *Value of locational attributes*; The results of the estimation have also confirmed the importance of locational attributes in determining house prices. Distance from the CBD is significant with the correct sign of the estimated parameter for both models. The model suggests that a rent gradient for the Klang Valley of around MYR17.96 per metre for the straight-line-distance model and MYR18.61 per metre for the network-distance model. This can be interpreted as a distance decay relationship between land rent and the distance from the CBD. For every metre away from the CBD (Kuala Lumpur city centre), the property value decreases around MYR17.96 and MYR18.61 for straight-line and network-distance respectively. The other locational attributes that also show significant contribution to the house price is the proximity to commercial areas. The interpretation that can be made is that for every metre away from the commercial areas, house price decreases at the rate of MYR10.15 (straight-line-distance model) and MYR9.54 (network-distance model). The parameter estimates for proximity to a secondary school also shows statistical significance with the anticipated sign. The implicit price for proximity to secondary schools suggests that for every metre away from secondary schools, house price would generally decrease by about MYR11 for both models. With regards to the proximity to primary schools, the result is statistically significant, however, with unexpected signs. The model suggests that for every metre away from primary schools, there is a degree of increment in housing value. It clearly shows that on average, for every metre away from primary schools, the house price experiences an increase by about MYR26 for both straight-line and network-distance models. This supports the study on the impact of school on house prices carried out by Cheshire and Sheppard (2004). The logical reason for the decreasing house value by being located too close to the primary schools is due to negative externalities such as noise and traffic congestion that can be associated with the existence of primary schools. The other possible reason is that house price would normally respond positively (increase) when located in the neighbourhood where the school is regarded to perform well in major examinations (in practice most of the major examinations take place in secondary schools). In other words, the quality of schools assessed by their performance in major examinations is found to be more important than just being located near to an ordinary school. Thus, it is reasonable to expect house prices to increase for every metre away from primary schools after considering the explanation that has been given above. Proximity to parks is also found to be statistically significant in determining house prices with the expected signs. The parameter estimates for proximity to parks is MYR1.13 per metre (rent gradient) for both models. Similarly, proximity to recreational areas is also found to be significant in determining house prices. For the proximity to recreational areas, the parameter estimates indicate that for every metre away from recreational areas, the house price reduces at the rate of MYR4 for both models. In terms of proximity to health centres that is hospitals, the parameter estimates suggest that house price increases by about MYR3 for straight-line and network-distance models of every metre away from this amenity. Continuing the observation of the study, the price-distance function for proximity to industrial areas shows positive signs. The estimated parameter indicates that there is an increase in house price at the rate of MYR28.22 (straight-line-distance model) and MYR26.91 (network-distance model) for every metre away from industrial areas. The rationale behind this observation is that being located adjacent to industrial areas suggests that residential property is prone to suffer from traffic congestion and air and noise pollution. Additionally, the norm of industry workers to populate surrounding areas close to factories for example, result in social problems and hence, brings the perceived value of properties in the area down. Therefore, it is very understandable at least in the context of this study (where house price increases for every metre away from industrial areas) since people tend to avoid negative externalities caused by the industry, the associated community and its activities.

(4) *Neighbourhood variables*; The only significant factor of socio-economic and ethnic attributes in determining house prices in this study is the percentage of Malay ethnic (Malay proportion). The model suggests that if a property is located in the areas with a higher percentage of Malay ethnics, it would result in an increase in housing price with an average of MYR3,600 (straight-line-distance model) and MYR3,500 (network-distance model). The contribution of the Malay ethnic towards higher house prices in these areas can be reasoned out by examining the history of these affected areas. Unlike today's well spread-out city of Kuala Lumpur or CBD of the Klang Valley, over 40 years ago these areas were considered to be suburban areas for the Klang Valley. Those days, these areas were considered to be affordable among the ethnic Malays while the actual downtown of the city centre was dominated by high-income dwellers. However, due to the rapid urbanisation in the Klang Valley these areas that were once considered as suburban areas have inevitably become an integral part of the city of Kuala Lumpur that are well connected by the roads and highways with no distinction of differences. These newly integrated demographically Malay dominated areas have quickly emerged as attractive housing estates among middle and high income Malays. The house price difference can easily be explained through the gain of premium value for the mentioned areas. Consequently, observation can be made today that the more affluent second and third generation of the Malays would have the preference to purchase a house in these Malay dominated areas since they are willing to pay a higher price in order to be located in these areas with perceived advantages of becoming an integral part of the city and belonging to a community of the same race that they are familiar with.

■6.0 CONCLUSIONS AND POLICY IMPLICATIONS

The study in the Klang Valley was carried out in order to provide empirical evidence for the estimation of the negative rent gradient with respect to the trade-off between the improvement of accessibility to the CBD and house prices. Hedonic house price models was employed – the role of hedonic house price models is to provide empirical evidence of a negative land rent gradient for a unit of house from an LRT station. In other words, it has been assumed that house prices would decrease for every metre further away from an LRT station.

The estimating of the effects of the LRT system on house prices using hedonic house price models in this study reveals a number of key findings. Firstly, the hedonic house price models estimate that houses located within two kilometres of an LRT station in the Klang Valley decrease in price as the distance from an LRT station increases for both straight-line-distance and network-distance models reasonably well with 78.2 per cent of adjusted R-square. In other words, there is strong evidence to suggest that a distance decay relationship between house prices and the LRT system strongly exists. Secondly, the results of both straight-line and network distance suggest that, throughout the system, a typical home located within two kilometres of a rail station can earn a premium of MYR7,000-11,000, or 2-5 per cent of the city's average home value in which can be considered as weak effect. Finally, the results also reveal that structural attributes of the house played a greater role in determining house prices in the study. As discussed above, the size of the floor area and the number of bedrooms have shown to contribute more greatly to the house price. This is of course in line with most of the hedonic house price analysis. This study thus finds support for the hypothesis that proximity to stations increases property values.

The following conclusions can be drawn from this finding. Firstly, the results of this study support the micro-economic theory of the bid-rent function and the trade-off between accessibility to the CBD, transportation and house prices. As extensively examined, the improvement of accessibility to the CBD through the introduction of the LRT system has increased house prices for those houses that have superior access to its station, however as mentioned above, the effect in the Klang Valley is weak. The weak effect found in this study may relate to the method that was used in this study; hedonic pricing method. Although this method is useful and widely employed to study the relationship between house prices and its determinant factors, it has been argued in the literature hedonic house price model is a global model which naturally has a tendency to assume that the relationship between house prices and housing attributes are stationary over space, and therefore may hide some very interesting and important local differences such as different types of houses and areas may respond differently in terms of prices towards structural and locational attributes. Therefore, several other local models such as geographically weighted regression (GWR), multilevel modeling and spatial expansion method need to be considered in estimating the effects of rail transit systems upon house prices. By employing these techniques, it allows local rather than global parameters to be estimated, and thus provides a way of accommodating the local geography of house prices-housing attributes relationships.

Secondly, the increase of house prices due to the presence of the LRT system found in this study has implications for the government's decision to introduce the LRT system or different types of rail transit systems in other places. In other words, the introduction of new transport infrastructures such as an LRT system to improve the accessibility of city centres for those living in residential areas could also bring indirect benefits to the local area because it can uplift land value for those areas that have been served by the system. Hence, it could increase government revenues through land value taxation. In addition, the research findings provided justification for the potential implementation of a Land Value Capture (LVC) policy. The strategies in a LVC policy that may be implemented involved at least in six respects such as property and sales taxes, real estate lease and sales revenues, fees on everything from parking to business licenses, join development, tax increment financing, special assessment districts and public-private partnership. But, a Land Value Capture (LVC) policy need to be carefully implemented where the premium associated with the rail transit systems on land values/house prices should be well estimated beforehand.

Thirdly, most locational attributes including the LRT variable that have been used in determining house prices in this study are local in their impact, with a distance decay effect in their extent and intensity. Fourthly, structural attributes of the houses still play a major role in determining house prices. Finally, as previously mentioned, the evidence from empirical research both in the UK and North America shows inconsistent results and varying magnitude of the effects of rail transit systems on property values. However, if the methods that have been employed to estimate the effects are an appropriate method, together with the quality of data, the positive relationship between rail transit systems and property values can be identified at least in the context of this research. These have proven to be true from the outcomes of this study – the increase in house prices results from an improvement in the transport system. In general, this study has achieved its aims to critically investigate the effects of the Kelana Jaya Line on house prices in the Klang Valley by employing the hedonic house price models.

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