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PRICE MODEL FOR TRANSIT-ORIENTED DEVELOPMENTS IN KUALA LUMPUR, MALAYSIA

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ABSTRACT

The idea of Transit Oriented Development (TOD) was to foster urban development around railway networks and has been strategically built and applied since the late 19th and early 20th centuries. Previous studies reported positive, negative, or irrelevant impact of TOD on prices of surrounding real estate. The study aims to evaluate the impact of TOD on property prices in Kuala Lumpur. It utilizes secondary data obtained from the National Property Information Centre (NAPIC), Malaysia, after data cleaning, Nine Thousand Five Hundred and Forty-Nine (9549) Housing Transactions between the periods 2009 and 2018 were used. The research design was quantitative, and the Hedonic Price Model (log-log model) was used for data analysis. The model revealed a multiple correlation coefficient (R) of 0.891 and an adjusted R2 value of 0.794, indicating that 79.4% of the house price variation is explained by the model. The F value of 996.921, which is statistically significant, indicates that the predictors significantly combine to predict the price of TOD areas in Kuala Lumpur. The coefficient for LnTrainsta is 0.056, indicating that there was a positive relationship between residential house prices and TOD in Kuala Lumpur; this explains that house prices increase by 5.6% for every 100 meter closer to the rail transit station.

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1. Introduction

The strategy for transportation and urban planning for Transit-Oriented Development (TOD) at present has attracted the attention of not just scholars but also policymakers and professionals (Bertolini, et al., 2012; Griffiths, & Curtis, 2017). The initial idea behind TOD was to create urban development around rail networks, with the concept having been strategically built and applied since the late 19^{th} and early 20^{th} centuries. TOD is now assumed to be the most dominant criterion for urban planning growth (Papa & Bertolini, 2015), and has gained acceptability in global policy (Ibraeva et al., 2020; Liu et al., 2020). Its emergence in Asia, Europe, and North America justifies this assertion (Kumar et al., 2020; Li et al., 2019; Singh et al., 2017; Su et al., 2021). Public infrastructural development, as a key development strategy, utilizes TOD as a vital factor for its growth (Liu, et al.,2022; Nyunt & Wongchavalidkul, 2020).

Local authorities around the globe continue their quest in search of solutions to traffic congestion, increasing transit ridership as well and rejuvenating urban neighborhoods that most utilize transit-oriented development (TOD) as a strategy (Cervero et al., 2002; Griffiths, & Curtis, 2017; Papa, & Bertolini, 2015). TOD, however, does not only entail public infrastructural development and service provisions, but also the integration of land uses and transport linkages to the network of activities (Bertolini et al., 2012; Jacobson, & Forsyth, 2008; Tsumita, et al., 2023). At the country level, both China and Malaysia made concerted efforts to develop national TOD guidelines to enhance and ensure TOD development (Ahamad, 2014; Liu et al., 2020; Din et al., 2023).

Previous studies confirmed that properties located close to TOD neighborhoods sell at higher prices (Debrezion et al., 2011). Other studies reported a negative or zero impact of TOD on house prices (Atkinson-Palombo, 2010; Bowes & Ihlanfeldt, 2001; Kahn, 2007). This may be due to negative externalities associated with the adjacency to transit stations. Transit capitalization studies usually put into effect a research design that assumes, independent of other factors, that station proximity has a price effect. Based on such studies, it produces a single premium finding applied to the entire study area.

TOD is considered a planning strategy that integrates land use with public transportation, taking into account development in the vicinity of transit stations (Yen, et al., 2023). The idea of the introduction of TOD was to achieve sustainable communities within the TOD transit stations. TOD is, therefore, a mixture of various development forms which include residential, retail, offices, public facilities, parks, open space, entertainment, cultural buildings, etc. (Abdullah, et al., 2023). Researchers propose that the fundamental tenets of TOD encompass factors such as connectivity, walkability, safety, proximity, mixed-use, comfort, density, transit, cycling, compactness, active engagement and amenities (Mathur & Gatdula, 2023).

The impact of TOD on house prices has been studied in various cities of the world, Kuala Lumpur inclusive. Yusof et al., (2018) examined the impact of the Mass Rapid Transit (MRT) project on property prices in Kuala Lumpur. The study analyzed the transaction data of residential properties located within a 1-kilometer radius of the MRT stations, both before and after the completion of the MRT project. The results indicate a significant positive impact on property prices. Baharum et al., (2020) examined the impact of the Light Rail Transit (LRT) project on property prices in Kuala Lumpur, using transaction data on residential properties located within a 500-meter radius of the LRT stations, both before and after the completion of the LRT project. The results indicate that the LRT project had a significant positive impact on property prices, with properties closer to the LRT stations experiencing a higher increase in price compared to those located further away, and the impact varying with location. Also, (Sa'ari & Ahmad, 2019) examined the impact of the MRT system on property prices in Kuala Lumpur, Malaysia, and found a positive effect on property prices within the proximity of MRT stations. Similarly, (Kamaruzzaman et al., 2020) investigated the impact of the LRT system on property prices in Kuala Lumpur and found that properties near LRT stations experienced price premiums. Though there was little research conducted on this area in Malaysia, other regions and countries provided mixed results. These mixed results suggest that the relationship between TOD and property prices is complex and context-specific, depending on factors such as the type and quality of transit service, the characteristics of the surrounding neighborhood, and the local real estate market.

Further research is thus needed to better understand the relationship between TOD and property prices and to ensure effective policies and planning strategies that will maximize the benefits of TOD for both residents and property owners. Interestingly, all the TOD studies in Malaysia were conducted based on a single technology, which may be MRT, LRT, Monorail or KTM (Keretapi Tanah Melayu). This study intends to combine all the technologies in one single research to assess their impact. The results in Malaysia have found their impact to be positive, where house prices increase along with closeness to TOD transit stations. This study, however, intends to confirm or refute these existing results based on the available data and surrounding characteristics.

2. Material and methods

The study area of this research is Kuala Lumpur (KL), the official federal capital territory of Malaysia. This is the largest city in Malaysia which occupies a land area of 243 km^2 (94 sq. mi) and accommodates a population size of 1.98 million people as of 2020 (Department of Statistics Malaysia, 2021). However, it is important to note that population figures might have changed since then, due to ongoing demographic trends. The city has occupied a position amongst the fastest-growing cities in the region of Southeast Asia, in terms of both economic prosperity and population growth.

In 1992, following the promulgation of the Railways Act, after independence, the Malayan Railway Administration became Keretapi Tanah Melayu Berhad, which marks the foundation of rail transportation in Malaysia. The introduction of Komuter Keretapi Tanah Melayu (KTM) in 1995, which is a 175 km distance track with three different lines and 45 stations in operation at Kuala Lumpur, was the foundation for rail transportation in Malaysia. Star Line and Putra Line also commenced full operations between 1998 and 1999 respectively along a 27 km track in the suburbs of the city which was operated by Star. The Putra Line is a 29 km long automated self-driven system with 24 stations. There is also a monorail system, 8.6 km in length, within the central business district, which started operating in 2003. Light rail was also introduced in 1998. These transit rail stations, considering the pressure exerted on them due to the increase in both population and complexity in infrastructural development and vehicular traffic, call for TOD as a solution to solving these urban problems. Therefore, transit zones were identified in Kuala Lumpur by Hall 2011, where sixty-six (66) transit stations (TOD zones) were identified. These stations extend beyond Kuala Lumpur to include Selangor. Based on the study area considered for this research paper, twenty-six TOD stations were identified and adopted.

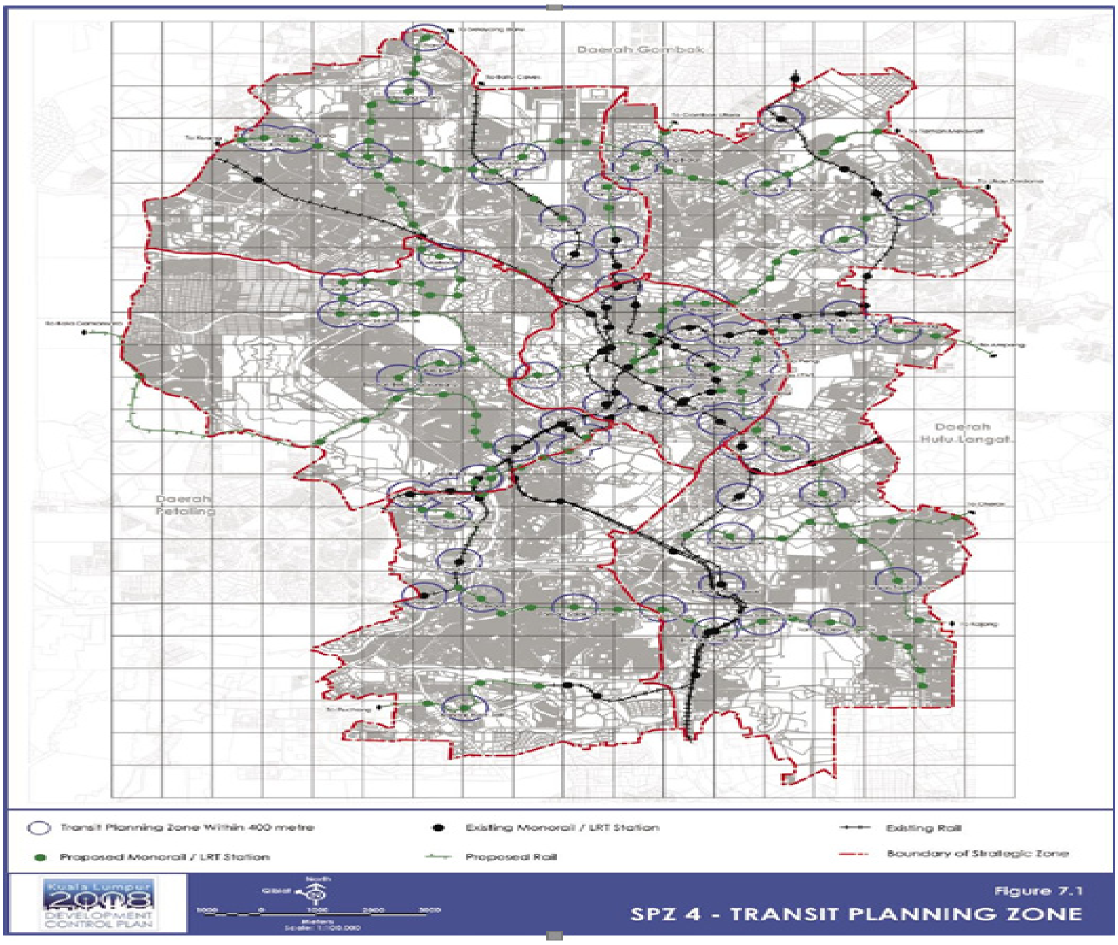

Fig. 1. Existing and proposed Transit Planning Zone/Stations in Kuala Lumpur (Hall, 2011).

2.1. Research Problem

The research problem at hand revolves around the uncertainties concerning potential residents in markets like Kuala Lumpur and whether properties in Transit-Oriented Developments (TODs) will command higher or lower property prices. It remains unclear whether these potential residents place value on purchasing properties that may necessitate changes in their current lifestyle, or whether the potential benefits in terms of site investment and accompanying economic advantages outweigh any drawbacks. While TODs offer several advantages, the presence of certain externalities, such as noise pollution, traffic congestion, crime and visual obstruction, might result in a negative impact (Dziauddin, 2022; Li & Huang, 2020).

Existing research in the field provides a mixed perspective on the relationship between TODs and house prices. Some studies, such as that by Duncan (2011), have found a positive impact between TODs and house prices. In contrast, other research, including studies by Atkinson-Palombo (2010), and Bowes & Ihlanfeldt (2001), suggests either a negative or negligible impact on house prices due to the negative externalities associated with proximity to transit stations.

TOD's influence on house prices has been explored in various cities globally, including Kuala Lumpur, utilizing different transit technologies, such as Mass Rapid Transit (MRT) (Yusof et al., 2018), Light Rail Transit (LRT) (Baharum, et al., 2020; Kamaruzzaman, et al., 2020) and Mass Rapid Transit (MRT) (Sa'ari & Ahmad, 2019). However, it's crucial to recognize that, despite demonstrating positive impacts, these studies come with specific contexts and limitations.

Moreover, there is a gap in the literature concerning the existence of potential negative impacts or challenges related to TOD in Malaysia, such as displacement or other negative externalities, which might not have been thoroughly explored. Additionally, the existing studies tend to focus on a single transit technology, be it MRT, LRT, Monorail, or KTM. This research, in contrast, aims to encompass all available technologies within a comprehensive study.

Given the dynamic nature of TOD and property markets, further research and analyses are essential to attain a comprehensive understanding of the impact of TOD and MUC on property prices in Malaysia, a gap that this study aims to address.

2.2. Methodology

The purpose of the research is to develop a price model for TOD and MUC in Kuala Lumpur. For the research to be validated based on the study problem, it was determined that the property sales prices of the residential properties within the TOD neighborhood, as well as the MUCs in Kuala Lumpur are defined considering the various independent variables, hence the developed model.

To assess the price model, this study uses documented data obtained from the National Property Information Centre (NAPIC), Malaysia, the Bank Negara Malaysia Website, the Statistics Department of Malaysia, as well as other outside sources. To reflect on historical tendencies and trends that are related to the key issues of this study, major findings from previous research and studies were collected and presented. Multiple regression using the Hedonic Price Model, utilizing the log-log model option, was employed. The log-log linear model makes way for the logarithmic transformation determination for both sides of the equation and allows for the incorporation of dummy variables (Xiao & Webster, 2017). The dummy variables have proven to be more efficient than linear specification (Nguyen & Nguyen, 2020). To ensure normality and linearity, the log of each continuous variable was taken before analysis.

For measuring TOD around transit nodes, it is important to demarcate the "area of analysis" over which TOD can be measured. The concept of TOD is built around creating walkable neighborhoods (Calthorpe, 1993) and all the literature on TOD suggests that TOD should be developed within a typically comfortable walking distance (Guerra et al., 2013; Singh et al., 2017). There is no fixed rule as to what distance from the transit station should be used, except for the typically comfortable walking distance. This ranges from 250 m to 800 m, and even up to 2000m in the literature, varying from place to place depending on its geography and demography (Li & Huang, 2020). Therefore, a 2-kilometer radius was adopted for this study to accommodate for the different technology that is being utilized.

2.3. Data and variables

Variables are characteristics or attributes ascribed to things or people that vary in quality and quantity (Kaur, 2013). They are items that are measurable, though they can be manipulated and controlled. For this paper, the variables used are the house price, which is the dependent variable, and the independent variables, which include the house physical variables, the rail line variables, the rail accessibility variable, the neighborhood variables, the location variables as well and the time variables. Data for transacted property prices and other independent variables were obtained from the National Property Information Centre (NAPIC), Malaysia. Other variables were computed using ArcGIS and QGIS software. The natural logarithms of all continuous variables were taken, and time and TOD variables were represented as dummy variables. The data covers a range of ten years (2009-2018), with the variables presented in Table 1.

2.4. The HPM (Hedonic Price Model)

The average housing prices in regions and cities were unaccountable for in the housing mix. It was not known, therefore, whether the higher price recorded specifically represented the high price per square meter for the areas, or the houses in the areas appear larger or have some functions or attributes that make them more expensive. These problems were solved through a regression model, where the dependent variable was the price, whereas the independent variables were neighborhood elements, structural variables, as well as the attributes of each house. This produces what is referred to in the literature as a hedonic price model (Yao, & Stewart Fotheringham, 2016). Holistically, the hedonic price model is known to have good explanatory capabilities. To account for the variation in house prices in the data set, a hedonic price model is usually constructed (Zhang et al., 2018). This method is useful in assessing property prices in (TOD) neighborhoods as it can help to identify the specific characteristics of a property that contribute to its price.

To develop the HPM, which is also known as the ordinary least square (OLS). The formula below is used:

$$y_i = \beta_0 + \Sigma_k \ \beta_k x_{ik} + \varepsilon_i \quad (1)$$

The model represents the property price as a function of the property attributes or characteristics. Residential properties within the TOD zone are modeled as a composite of physical characteristics, neighborhood or TOD characteristics, location characteristics, rail line characteristics as well as time factors. This is presented in Equation 2 below.

Residential property price = (physical characteristic, neighborhood characteristics, rail accessibility characteristics, location characteristics, rail line characteristics, time) (2)

The model is estimated using the Hedonic Price Model, where the log-log functional form is adopted. The log-log model supports logarithmic transformation, both to the left and right sides of the equation (Nguyen & Nguyen, 2020). Though only the continuous variables were transformed, the TOD variables, the time, and some physical variables are considered dummy variables. This is shown in Table 1. To ensure the normality and linearity of all continuous variables, their logs are taken before they are put into the equation for analysis. This is done using Equation 3 below.

$$lnP_i = \beta_0 + \Sigma_k \ \beta_k x_{ik} + \Sigma_l \ \beta_l x_{il} + \Sigma_m \ \beta_m x_{im} + \Sigma_n \ \beta_n x_{in} + \Sigma_p \ \beta_p x_{ip} + \Sigma_p \ \beta_q x_{iq} + \varepsilon_i \quad (3)$$

Where: lnP_i is the residential property price vector (dependent variable), $x_{ik}\, x_{il}\, x_{im}\, x_{in}\, x_{ip}\, x_{iq}$ are vectors for the continuous logarithmic transformed residential physical variable, rail accessibility variable, location variable, rail line variable, as well as the neighborhood (dummy) and time dummy at location *I*, and **ε** - the error at location *i*.

3. Results

From Table 1, the variable with the highest mean value of 16.050 is Levels, thus indicating a better performance; it is followed by LnPrice, 12.999, LnBRT, 9.367, LnCBD 8.551, LnGasPipe 8.510, LnMonorail, 8.367, LnRecreati 8.342, LnMRT, 8.258, until the variable with the least value - Y2018, with a mean of 0.050. In the case of standard deviation, the variable with the lowest value of 0.217 is Y2018, showing more consistency than all other variables based on the data spread.

Table 2 shows the model table with the multiple correlation coefficient of 0.898 and the adjusted R squared value of 0.805; this indicates that 80.5% of the variance in the price was predicted from the independent variables.

Table 3 shows the Analysis of Variance (ANOVA) and the significance of the model. The model is significant at 0.05 level and 0.01 level which is at 95 percent and 99 percent levels. The significance associated with the F value is (0.000), which is less than 0.05 and 0.01, meaning that the group of independent variables shows a statistically significant relationship with the dependent variable. Also, the F value is 983.528, which is statistically significant. Therefore, the groups of independent variables reliably combine to predict the housing price in the TOD area of Kuala Lumpur.

Table 1

Variables and Descriptive Statistics of the Model

	Description	units	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable						
LnPrice	Transaction House Prices	Malaysia Ringgits (RM)	10.308953	17.097743	12.99857360	0.783625927
Structural Variable						
LnArea	The Building Area	Meter Square	3.610918	10.179451	4.80956076	0.497339653
LnBArea	The Plot Area	Meter Square	3.610918	7.303271	4.75903725	0.396022433
LnAge	Year of Transaction	Number	0.693147	4.077537	2.48137481	0.794907528

NeigbQual	Whether good, new, poor, very poor, fair	Number	2	4	3.66	0.541
ZLEVELS	The Level of the transacted property	Number	1	47	16.09	11.303
Tenure	Ownership freehold vs. leasehold	Dummy (0 or 1)	0	1	0.70	0.460
Condition	The state or condition of the property	Number	1	6	4.04	0.644
AreaClass	Area Classification	Number	1	5	3.61	0.930
Protype	Type of Property	Number	1	6	4.70	0.775
Locational Variable						
LnBrt	Proximity to Bus Rapid Transit	Meters	8.435105	9.922676	9.36663147	0.326195656
LnPark	Proximity to Park	Meters	-0.899714	7.003879	5.10412409	0.930426489
LnRecreati	Proximity to Recreation Center	Meters	4.973549	9.257133	8.34225176	0.618162907
LnElectrit	Proximity to Electric Facility	Meters	1.085109	8.341862	6.58120093	1.119203869
LnHealth	Proximity to Health Facility	Meters	2.190482	7.882058	6.77714418	0.846984719
LnServices	Proximity to Services	Meters	2.923246	8.100218	6.89070930	0.685754715
LnMall	Proximity to Mall	Meters	3.283084	8.654256	7.26675098	0.890451064
LnGaspipe	Proximity to gas pipeline	Meters	5.388687	9.361798	8.50955386	0.647289616
LnCBD	Proximity to Central Business District	Meters	5.460936	9.333745	8.55100194	0.630912816
Rail Transit Variable						
LnTrainSta	Proximity to Rail Transit Station	Meters	1.193922	7.600652	6.89907869	0.751219277
TOD Variable						
F_14Mile	Within ¼ Mile	Dummy (0 or 1)	0	1	0.13	0.340
F_12Mile	Within ½ Mile	Dummy (0 or 1)	0	1	0.15	0.356
F_1Mile	Within 1 Mile	Dummy (0 or 1)	0	1	0.40	0.490
Yearly Variable						
Y2009	Transacted in 2009	Dummy (0 or 1)	0	1	0.10	0.294
Y2010	Transacted in 2010	Dummy (0 or 1)	0	1	0.10	0.301
Y2011	Transacted in 2011	Dummy (0 or 1)	0	1	0.10	0.306
Y2012	Transacted in 2012	Dummy (0 or 1)	0	1	0.06	0.244
Y2013	Transacted in 2013	Dummy (0 or 1)	0	1	0.14	0.345
Y2014	Transacted in 2014	Dummy (0 or 1)	0	1	0.09	0.289
Y2015	Transacted in 2015	Dummy (0 or 1)	0	1	0.10	0.302
Y2016	Transacted in 2016	Dummy (0 or 1)	0	1	0.07	0.249
Y2017	Transacted in 2017	Dummy (0 or 1)	0	1	0.07	0.261
Y2018	Transacted in 2018	Dummy (0 or 1)	0	1	0.05	0.218
Rail Line Variable						
LnLRT	Proximity to LRT	Meters	3.615401	8.538941	7.36291680	0.692687871
LnMonorail	Proximity to Monorail	Meters	3.593364	9.201092	8.36666206	0.627900869
LnKMT	Proximity to KTM	Meters	1.182314	8.787382	7.74490679	0.678612894
LnMRT	Proximity to MRT	Meters	4.003131	9.244583	8.25765675	0.719022900

Source: own study.

Table 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.898[a]	0.806	0.805	0.34568902190

a. Predictors: (Constant), B_TINGKAT, Y2016, LnMonorail, Y2018, LnBArea, Y2012, LnBrt, Y2017, LnHealth, Y2014, Y2010, F_1Mile, Tenure, Condition, Y2009, AreaClass, NeigbQual, LnPark, Y2015, LnRecreati, F_14Mile, Y2011, Protype, LnServices, LnLRT, LnKMT, LnGaspipe, LnMall, LnAge, LnElectrit, Y2013, LnMRT, F_12Mile, LnCBD, LnArea, LnTrainSta

Source: own study.

Table 3

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4231.171	36	117.533	983.528	0.000[b]
	Residual	1017.192	8512	0.120		
	Total	5248.363	8548			

a. Dependent Variable: LnPrice

b. Predictors: (Constant), B_TINGKAT, Y2016, LnMonorail, Y2018, LnBArea, Y2012, LnBrt, Y2017, LnHealth, Y2014, Y2010, F_1Mile, Tenure, Condition, Y2009, AreaClass, NeigbQual, LnPark, Y2015, LnRecreati, F_14Mile, Y2011, Protype, LnServices, LnLRT, LnKMT, LnGaspipe, LnMall, LnAge, LnElectrit, Y2013, LnMRT, F_12Mile, LnCBD, LnArea, LnTrainSta

Source: own study.

Table 4

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	9.734	0.298		32.648	0.000		
	LnArea	0.356	0.014	0.227	25.425	0.000	0.286	3.493
	LnBArea	0.910	0.018	0.460	49.774	0.000	0.266	3.758
	LnAge	-0.128	0.007	-0.130	-19.340	0.000	0.507	1.972
	Tenure	0.128	0.009	0.075	13.926	0.000	0.784	1.276
	Condition	0.003	0.006	0.003	0.542	0.588	0.815	1.227
	NeigbQual	0.061	0.008	0.042	7.958	0.000	0.823	1.215
	LnBrt	-0.085	0.020	-0.035	-4.223	0.000	0.323	3.095
	LnPark	-0.002	0.004	-0.003	-.503	0.615	0.801	1.248
	LnRecreati	0.016	0.008	0.012	2.029	0.043	0.619	1.615
	LnElectrit	0.019	0.005	0.028	4.108	0.000	0.508	1.969
	LnHealth	0.030	0.005	0.033	6.554	0.000	0.903	1.108
	LnServices	0.025	0.007	0.022	3.482	0.001	0.554	1.805
	LnMall	-0.005	0.006	-0.006	-0.890	0.374	0.540	1.852
	LnGaspipe	-0.130	0.008	-0.108	-15.981	0.000	0.501	1.996
	LnCBD	-0.211	0.010	-0.170	-20.167	0.000	0.322	3.107
	LnTrainSta	0.056	0.014	0.054	4.049	0.000	0.128	7.808
	F_14Mile	0.171	0.032	0.074	5.287	0.000	0.116	8.620
	F_12Mile	0.057	0.022	0.026	2.572	0.010	0.228	4.384
	F_1Mile	-0.022	0.012	-0.014	-1.788	0.074	0.389	2.570
	Y2009	0.091	0.016	0.034	5.574	0.000	0.599	1.670
	Y2010	0.159	0.016	0.061	9.813	0.000	0.590	1.696

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Y2011	0.318	0.016	0.124	19.757	0.000	0.579	1.726
Y2012	0.418	0.019	0.130	22.505	0.000	0.679	1.474
Y2013	0.598	0.015	0.263	39.353	0.000	0.510	1.961
Y2014	0.697	0.017	0.257	41.072	0.000	0.581	1.721
Y2015	0.779	0.017	0.300	47.111	0.000	0.563	1.777
Y2016	0.762	0.019	0.242	40.915	0.000	0.653	1.530
Y2017	0.805	0.018	0.268	44.324	0.000	0.624	1.603
Y2018	0.813	0.020	0.226	39.670	0.000	0.704	1.420
LnLRT	0.020	0.007	0.018	2.858	0.004	0.593	1.686
LnMonorail	0.010	0.010	0.008	0.974	0.330	0.329	3.038
LnKMT	-0.019	0.008	-0.016	-2.380	0.017	0.486	2.059
LnMRT	-0.005	0.008	-0.005	-0.612	0.541	0.381	2.627
Protype	-0.115	0.006	-0.114	-19.946	0.000	0.698	1.433
AreaClass	-0.005	0.005	-0.006	-0.997	0.319	0.617	1.621
Levels	-0.002	0.000	-0.022	-3.187	0.001	0.457	2.189

a. Dependent Variable: LnPrice

Source: own study.

Table 4 displays the coefficient table; out of the thirty-six (36) independent variables, twenty-eight variables were found to be significant. These include LnArea, LnBArea, LnAge, LnBrt, LnElectrit, LnHealth, LnGaspipe, LnCBD, LnTrainsta, F_14Mile, Y2009, Y2010, Y2011, Y2012, Y2013, Y2014, Y2015, Y2016, Y2017, Y2018, NeigbQual Protype and Tenure, with significant values of 0.000, LnServices and F_12Mile with a significant value of 0.001, and LnLRT, F_12Mile, LnKMT, and LnRecreati, with a significant value of 0.004, 0.010, 0.017 and 0.043, respectively. The other remaining seven (7) variables, namely: Condition, AreaClass, LnPark, LnMall, F_1Mile, LnMonorail, and LnMRT, are not significant, with significant values of 0.588, 0.319, 0.615, 0.374, 0.074, 0.330, and 0.541, respectively. Though the latter set is not significant, it significantly contributes to this equation in predicting the property price.

3.1. Collinearity

There was no multicollinearity amongst most variables in Table 4 above as expressed by the values of the variance inflation factor (VIF) in the model which are below 5 in each case except for "F_14Mile" and "LnTrainsta", with the multicollinearity potential of 8.620 and 7.808 respectively; this might be because LnTrainsta and F_14Mile may be highly related variables. This slight multicollinearity is still within the limit of acceptability, hence the VIF is below 10. However, where the VIF exceeds 10, the predictor variable tends to be highly correlated resulting in a high level of multicollinearity, and becomes a matter of great concern (Midi et al., 2010). Multicollinearity primarily impacts calculations related to specific predictors and does not affect the model's overall predictive capacity or reliability (Hair et al., 2010).

3.2. The Model

According to the analysis for TOD in Kuala Lumpur, based on the HPM it is reported as follows:

$$LnP_i = 9.734 + 0.356LnArea + 0.910LnBArea - 0.128LnAge + 0.003Condition + 0.061NeighbQual + 0.128Tenure - 0.115Protype - 0.005Areaclass - 0.002Levels - 0.085LnBrt - 0.002LnPark + 0.016LnRecreati + 0.019LnElectrit + 0.030LnHealth + 0.025LnServices - 0.005LnMall - 0.130LnGaspipe - 0.211LnCBD + 0.056LnTrainSta + 0.171F\_14Mile + 0.057F\_12Mile - 0.022F\_1Mile + 0.020LnLRT + 0.010LnMonorail - 0.019LnKMT - 0.005LnMRT + 0.091Y2009 + 0.159Y2010 + 0.318Y2011 + 0.418Y2012 + 0.598Y2013 + 0.697Y2014 + 0.779Y2015 + 0.762Y2016 + 0.805Y2017 + 0.813Y2018 \quad (4)$$

The above model is considered to estimate the price model of TOD in Kuala Lumpur, Malaysia.

4. Discussion

The result of "LnTransita" is statistically significant, with a coefficient of 0.056 denoting a positive relationship, which means that the house prices increase by 5.6% for every 100m distance nearer to the TOD station. The finding in Malaysia is consistent with that of Sa'ari and Ahmad (2019) who examined the impact of the Mass Rapid Transit (MRT) system on property values in Kuala Lumpur, Malaysia, and found a positive effect on property prices in the vicinity of MRT stations. Similarly, Kamaruzzaman et al. (2020) investigated the impact of the Light Rail Transit (LRT) system on property values in Kuala Lumpur and found that properties near LRT stations experienced price premiums. The same outcome was confirmed by Li & Huang (2020) in a study in Wuhan, China, as well as in the Duncan (2011) study in San Diego. In contrast, the findings of Bowes & Ihlanfieldt (2001) reported a negative impact of TOD on property prices, particularly in areas with high levels of poverty or crime. The effect of TOD on property values could vary depending on the local housing market and other factors. In some research, the effect of TOD on property prices was only significant within a certain distance of transit stations, or the effect was stronger for certain types of properties (such as commercial or high-end residential).

5. Conclusions

In conclusion, the findings of this study indicate a positive impact of Transit Oriented Development (TOD) on property prices in Kuala Lumpur. This aligns with the results of previous studies carried out to date for Kuala Lumpur, and is different from the results in other parts of the world, which may be positive, negative, or even insignificant. These disparities may be attributed to variations in study locations, technological advancements and temporal effects.

This result shows that there is yet untapped potential regarding TOD in Malaysia that can be explored in the future. It is therefore important to note that the analysis in this study relied on point data, which limited the inclusion of other significant variables. Using polygon data, particularly for measuring variables like perimeter, road distances and intersections, data, or housing complexes rather than individual houses, as well as household income would provide a more comprehensive analysis of TOD variables and potentially influence the study's results. Additionally, the focus of this research was solely on Kuala Lumpur, whereas the expansion of the geographical scope to include the entire Klang Valley or the whole of Selangor could yield more robust and comprehensive outcomes.

The implications of these findings are valuable for individual residents, developers, investors, and policymakers involved in TOD projects. Understanding the market demand and potential returns for TOD properties is crucial for making informed investment and development decisions so that stakeholders can lay their planning strategies and investment approaches accordingly.

Overall, this study contributes to the existing knowledge on the relationship between TOD in Kuala Lumpur on the one hand, and property prices on the other, providing insight that can guide future research and provide useful information for decision-making processes in urban development and transit-oriented planning.

The positive impact of this research paper in Malaysia lies in facilitating access to various amenities, job opportunities and the potential for higher-density development, even though there are already hundreds of condominiums in Kuala Lumpur.

It is recommended, however, that more research be conducted in this area, including studies on affordability as a variable, as well as the inclusion of negative variables like noise, pollution crime, etc. This will open a new dimension to this research area and provide a high prospect for better-informed decision-making.

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