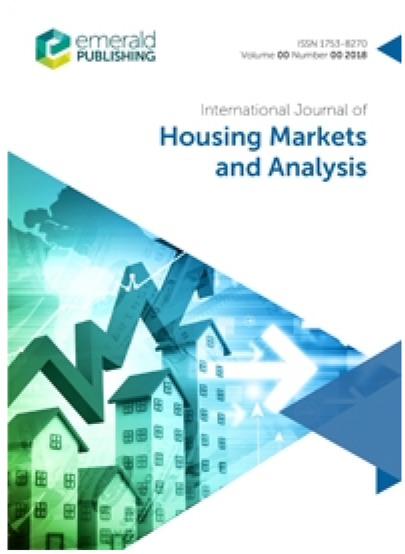

Impact of Light Rail Line on Residential Property Values – A Case of Sydney, Australia

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ABSTRACT

Purpose - The construction of new transportation infrastructure tends to affect the adjoining properties, economy, and environment. In particular, studies have investigated the change in the value of properties due to increased access to transportation facilities. In this current study, the impact of the recently completed light rail on residential property values in Sydney, Australia was examined.

Design/methodology/approach – Sales data of residential properties were extracted from the CoreLogic's RP database. The hedonic pricing model (HPM) was used to assess the effect of proximity to the light rail stops. Two models were developed for the announcement and construction phases of the light rail project.

Findings - It was found that during the announcement phase, properties located within the 400m radius from the station were 3.3% more expensive than those within the 400-800 radius. At the construction stage, the properties within the 0-400m radius from the stops sold at 3.1% more than those within the 400-800m radius. The study concludes that a positive relationship exists between the values of residential property and its proximity to the light rail stations.

Originality –Previous studies that aimed at examining the impact of light rails on residential properties values around universities are limited. Hence, this study provides a broad perspective on the impact of light rail on residential properties values~~ around a university~~.

Practical implications - These findings would be useful for policymakers to develop land value capture programs for infrastructure funding and to real estate professionals and investors for investment in future transit-oriented development.

Keywords: Light rail, property value, university, residential property, Sydney, Australia

Paper type Research paper

INTRODUCTION

The urban areas within nations play a significant role in economic development. As the number of people living in cities grows, the volume of carbon emissions increase (Shi, 2003; Jorgenson & Clark, 2010). Research shows that congestion within cities increases the volume of greenhouse emissions from fossil-powered vehicles (Zheng *et al.*, 2015). Across the globe, stakeholders are implementing strategies [such as mass transportation, emission charge, and incentives to encourage the purchase of electric cars] to improve air quality and reduce congestion in the cities (Steffen *et al.*, 2015; Zheng *et al.*, 2020). The construction of light rail systems for mass transportation is beneficial to the people, community, environment, and economy. Light rail systems are vital for the growth and long-term survival of cities.

The relationship between transportation and land use is significant. A common way to measure the relationship is to examine how property values vary with distance to a transportation facility (Ryan, 1999). The findings of previous studies into the impact of railway stations on the values of residential properties have been inconsistent. For instance, some studies indicate the rail stations have no (Wagner *et al.*, 2017) or negative impact on property values (Camins-Esakov & Vandegrift, 2018). In contrast, other investigations suggest that the proximity to rail stations has a positive impact on property values (Hess & Almeida, 2007; Pan *et al.*, 2014). These inconsistencies have been attributed to (i) ownership (low and high-income) and characteristics (single-family and multi-family) of the residential properties (Duncan, 2008; Forouhar & Hasankhani, 2018). These inconsistencies necessitate the need for fresh insights into the impact of railway stations on the values of residential properties.

An understanding of the attributes that influence property values can be used to inform investment and policy decisions. In the context of Australia, the existence of previous studies

(Mulley & Tsai, 2016; Chen *et al.*, 2019) which focused on the impact of railway lines on the value of residential properties is acknowledged. However, little is known about the impact of the recently completed Central Business District (CBD) and South East (SE) light rail line on the values of residential properties around a university, i.e. the University of New South Wales (UNSW), Sydney, Australia. Due to the gap in the existing knowledge, this study seeks to investigate how the CBD and SE Light Rail (CSELR) influence the value of residential properties located around the UNSW transit stops. The aim of the study is achieved by addressing two objectives: (i) ~~to examine~~examining the influence of the new light rail on residential property values around UNSW during the announcement (December 2012 – February 2015) and construction (March 2015 – March 2020) of the light rail; and (ii) ~~to assess~~assessing the effect of distance to the new light rail on residential property values around UNSW. The outcome of the present study provides insights into the economic benefits associated with the development of light railway systems within cities. This information can be used by stakeholders (such as government and developers) to develop strategies for the planning of land value capture for future infrastructure funding. It will also be of added value to consumers in real estate markets when deciding on where and when to buy or lease properties.

LITERATURE REVIEW

Accessibility and Nuisance Effects on Property Values

The findings of previous studies on the impact of transport infrastructure on the value of properties have been inconsistent. Previous studies show that the closeness to a railway station contributes to an increase in the value of properties (Debrezion *et al.*, 2007; Li, 2018; Pan, 2019). In contrast, Wagner *et al.* (2017) found that the proximity to railway stations has no impact, while Camins-Esakov and Vandegrift (2018) reported a negative impact on the values of properties. Literature suggests that the impact of transport infrastructure on the value of residential properties tend to vary from location to location. Considering all tho~~i~~se evidence, it seems that the presence of railway stations could be beneficial or detrimental to the value of residential properties. Furthermore, several studies have been conducted to understand the underlying reasons for these inconsistencies.

Researchers have used various tools and techniques to explain these~~is~~ inconsistent findings. Most authors have incorporated spatial data into developed models. In other cases, buildings have been classified based on characteristics, such as ownership. For instance, previous studies have shown that the proximity of train stations to properties in low-income neighbourhoods increases their values, however, it has a negative impact in high-income areas (Nelson, 1992; Forouhar & Hasankhani, 2018; Zhang *et al.*, 2021). Using geospatial data, Bowes and Ihlanfeldt (2001) showed that properties located within 0.25 miles of the MARTA (Metropolitan Atlanta Rapid Transit Authority) sold for 19 per cent less than outside of the three-mile radius. The existing literature on this subject is summarised and presented in ~~Table 1~~Appendix 1. Based on the evidence, scholars have attributed the observed inconsistencies to various reasons.

The factors suggested by scholars include the level of car ownership, noise population, and perceived level of security, among others. Forouhar and Hasankhani (2018) observed that train services tend to be utilised as the main means of transportation among low-income families. However, high-income earners can afford to own cars and pay for other associated costs, such as maintenance costs. Others (such as Bowes & Ihlanfeldt, 2001) stated that the presence of rail stations improves access to a locality. However, the perceived level of security and noise pollution tends to adversely affect the value of residential properties. From ~~Table 1~~Appendix 1, it is evident that most of the studies have focused on single-family homes in the US. Hence, there is a need to understand the impact of railway stations on the value of residential properties in other cities outside of the US.

Residential Property Values: Modelling and Prediction

Various tools have been used to model the relationship between the value of residential properties and their attributes. Research shows that these attributes contribute to the value of properties (Jenkins, 2000). according to Chen *et al.* (1998), t~~T~~hese attributes ~~according to Chen *et al.* (1998)~~ were classified into structural, neighbourhood, locational, fiscal or economic attributes. In contrast, Mohammad *et al.* (2013) categorised these attributes into internal, external, and economic (see Figure 1). The nomenclature of the property attributes classifications ~~have~~ has not been consistent in the literature (Chin & Chau, 2002). Taken together, the literature suggests that the attributes of properties have a significant impact on their value. Unearthing the relationship between attributes and property value is vital for optimising the returns on investment.

Insert Figure 1 Here

There is a growing number of research~~es~~ that models and predicts residential property values using its attributes. Information gleaned from the literature indicates that the features influencing property values include the number of bedrooms, bathrooms, parking space, proximity of green parks, and academic performance of students in state schools, among others (Crompton, 2001; Abidoye & Chan, 2017; Fleishman *et al.*, 2017). ~~Table 2~~Table 1 provides a concise overview of the variables incorporated into models for the prediction of property value. Lines of evidence have shown that these features are useful for modelling and predicting residential property values (Nguyen & Cripps, 2001; Abidoye, 2017). The impact of these attributes tends to vary from one location to another. Hence, the need to understand the critical ~~features~~ attributes that contribute~~s~~ to property values in each location.

Insert ~~Table 2~~Table 1 Here

University Impact on Residential Property Values

The presence of UNSW within the study area necessitates the review of studies on the effect of education facilities on the value of residential properties. Much of the research has focused on the impact of school quality, measured in terms of students' academic performance, on the value of properties. For instance, studies have shown that school quality has a positive impact on residential property values (Chin & Foong, 2006; Wen *et al.*, 2014). However, little is known about the effect of school proximity on property values. Hence, there is a need to understand the impact of the presence of a university on the value of residential properties, using UNSW as a representative case.

Numerous studies have attempted to explain the impact of different levels of schools on the value of residential properties. For instance, Owusu-Edusei *et al.* (2007) found that elementary and high schools had a great impact on the values of residential properties in South Carolina, US. Similarly, studies have reported that the presence of school is a significant contributory factor to the values of residential properties in South Korea, China, and the United Kingdom (Davidoff & Leigh, 2008; Hahn *et al.*, 2012; Wen *et al.*, 2014). Wen *et al.* (2014) showed that the strength of this relationship varies based on the class of the school, e.g. kindergarten schools, high schools, or college. Collectively, it is evident that the proximity and accessibility of all schools have a positive effect on the value of residential properties. These studies highlight the place of educational facilities on property value formation~~ in economic success~~.

RESEARCH METHODOLOGY

Several techniques have been used for modelling and ~~prediction~~ predicting ~~of~~ residential property values. The methods used in previous studies can be classified into two groups: quantitative and qualitative. The main advantage of quantitative methods lies in the possibility of objectively verifying and validating the developed model. Despite the existence of several quantitative methods (see ~~Table 1~~Appendix 1), the suitability of a particular approach is dependent on the objectives of the study. In this study, the HPM is used to model and explain the strength of the relationship between the value of a residential property and its attributes. HPM utilises the regression analysis to deconstruct the value of a residential building and estimates the contributory significance of each available characteristic (Selim, 2009). Yacim and Boshoff (2014) point out that the main weakness of HPM is the non-inclusion of the spatial information about residential properties. A better approach would be the inclusion of a dummy variable, which represents the distance between a property and the railway station, in the HPM. Geographic Information System (GIS) is a useful tool for evaluating the impact of distance on the value of real estate properties (Anselin, 1998). For this study, the dummy variables were included in the HPM model to evaluate the impact of distance to a railway station on property value.

The variables included in the quantitative models, i.e. HPM, were informed by the outcome of an initial review of the literature. As stated earlier, dummy variables were used to investigate the impact of the proximity of light rail stops on residential property values. In this research, HPM was applied to data collected from two time periods ((i) the announcement of the new train line and (ii) the completion of the new train station). The variables included in the developed HPM are shown in ~~Table 3~~Table 2.

The HPM developed in this study can be specified as a multiple regression as shown in Equation 1.

$$PRICE = \beta_0 + \beta_1 \times BDRM + \beta_2 \times BTHR + \beta_3 \times PRKG + \beta_4 \times AGE$$

$$+\beta_5 \times AREA + \beta_6 \times LOTSZ + \beta_7 \times PTYPE + \beta_8 \times D400 + \beta_9 \times D800 + \varepsilon \quad (1)$$

Where β_0 is the regression constant, β_1 .... B_9 are the regression coefficients (described and listed in Table 2) and ε is the random error.

Insert Table 2 Here

Study Area

The new CSELR in Sydney, Australia comprises ~~of~~ the L2 (Randwick Line) and the L3 (Kingsford Line). The CSELR is 12 kilometres and it has 19 stops. The development phase of the CSELR project spanned between December 2012 and

March 2020. The government of New South Wales declared and announced the intention to procure the project in December 2012. Planning permission was granted in 2014. Subsequently, the construction phase commenced in March 2015 and the project was completed in early 2020. The Randwick Line was opened and operational on December 14, 2019, while the Kingsford Line continued testing through the first quarter of 2020 and opened for passengers on April 3, 2020.

Two light rail stations served the UNSW community – one via L2 on High Street and one via L3 on Anzac Parade. The impact of these two stops on the value of residential properties is the main focus of the current study. The residential properties were grouped into two classes, i.e. those within the 0-400m radius and those located within the 401-800m radius. This is a common metric used in similar previous studies (see, for instance, Weinberger, 2001; Hess & Almeida, 2007; Pan, 2013). Also, Zhong and Li (2016) mentioned that some residents are willing to walk about 800 m to a transit stop in America. Figure 2 shows the location of the two rail stations in proximity to the UNSW's Kensington campus.

Insert Figure 2 Here

Data Collection

The secondary data used for the study was retrieved from CoreLogic's RP database (https://www.corelogic.com.au/). The descriptive statistics for the variables included in the HPMs are presented in ~~Table 4~~Table 3 ('N' indicates the number of observations per model). The selection criteria for the variables are (i) the outcome of the literature review (~~Table 2~~Table 1) and (ii) the availability of data on the RP database. Upon completion of data cleaning, a total of 702 (286+416) complete observations were available for the development of the quantitative models. The data was collected for residential properties sold and bought within the study area between December 2012 and March 2020 when the new rail line was completed. To have consistent property values consummated between 2012 and 2020, the effect of inflation was considered. Therefore, the Consumer Price Index (CPI) retrieved from the Australian Bureau of Statistics (ABS) was applied to the data. The dataset was divided into the light rail announcement (T1) and construction (T2) phases. The post-construction phase was not considered in the study due to the outbreak of the COVID-19 pandemic. This is because global events, such as recession and pandemics, tend to disrupt the housing markets (Lai et al., 2006). This disruption informed the authors' decision not to include post-construction data into the developed HPM. The descriptive statistics and HPM were then generated using the Statistical Package for the Social Sciences (SPSS). ~~Table 4~~Table 3 ~~is~~ presents the descriptive statistics showing an increasing value in the average sales price of residential properties when the T1 and T2 periods are compared.

Insert ~~Table 4~~Table 3 Here

Results and Discussion

The output of the developed models is summarised in ~~Table 5~~Table 4. Lin and Mohan (2011) posit that ~~the closer the~~an r^2 value ~~is~~ closer to 1 demonstrates higher confidence of correlation between the dependent and independent variables. The models for T1 and T2 have r^2 values of .808 and .867, and adjusted r^2 values of 0.801 and .864, respectively. This metric indicates that the models can explain over 80 per cent variance (80.8% for T1 and 86.7% for T2) in the values of residential properties. From these values, both models demonstrate the goodness-of-fit of the HPM (Abidoye, 2017).

Insert ~~Table 5~~Table 4 Here

Tables 5~~6~~ and 6~~7~~ presents the regression results of the two models during the announcement and construction phase, respectively. The results provide insight into whether each independent variable is significant in contributing to property values during those periods. A p-value of less than .05 means the variable is significant at the 5 per cent significance level and less than .01 means highly significant at the 1 per cent significance level. The collinearity statistics column provides information on whether multicollinearity is present among the variables. To test for multicollinearity, as a general rule of thumb, a variance inflation factor (VIF) value of less than 10 is considered acceptable (Berenson *et al.*, 2012). The values of VIF shown in Tables 5~~6~~ and 6~~7~~ are less than 10. Hence, it is evident that there is no multicollinearity among the variables included in the models.

Insert Table ~~6~~5 Here

Insert Table ~~7~~ 6 Here

Property Characteristics

The characteristics of the properties (size of the property, number of bedrooms, number of parking spaces, and property type) are significant and have a positive correlation to the value of the residential properties. This finding is consistent with those of previous studies which indicate that structural variables are the most significant drivers of property values (Wilhelmsson, 2000; Abidoye & Chan, 2016; Chen *et al.*, 2019). This may be because structural attributes of properties are usually significant in the formation of property values (Wilhelmsson, 2000), and they could contribute above 60 per cent to the formation of residential property values (Wen *et al.*, 2005).

The number of bathrooms was found to be significant during T1 but not significant in T2. In T2 the number of bathrooms had a negative correlation to property value and for every increase in the number of bathrooms, there is a 1.7 per cent decrease in property value. The plausible reason might be that the home buyers were more concerned about other variables than the number of bathrooms during this period to secure properties close to the light rail stops. This result is similar to the findings of Abidoye and Chan (2018) and Nguyen and Cripps (2001) that reported that an additional number of bathrooms could reduce the price of residential properties. Property type was found to be highly significant in both T1 and T2. The positive correlation indicates that the average value of standalone houses is higher than those of flats/units. After all other variables are accounted for, the values of properties are predicted to be 49 per cent more than the value of units in T1 and 65 per cent more in T2. This corroborates Mulley and Tsai (2016) that found that units were valued lesser than houses within the same property market. This result could be explained by the fact that houses provide more space, privacy, and amenities when compared with units. These additional features make houses command a higher value.

In model T1, the age of property is not significant, but in T2, the age of property is significant at the 5 per cent significance level. One reason age is not significant in T1 could be that particular architectural styles of properties, such as federation style, may appreciate due to historical value. On the other hand, it has been established in the literature that the older a property, the lesser the value (Hui *et al.*, 2007), and this explains the negative correlation in T2.

The results for both the D400 and D800 are not significant during T1. The positive coefficients of those variables can be interpreted as properties in the two zones that enjoy value-added due to proximity to the stops. Properties located within the 0-400 m range of the stops are predicted to sell for 4.3 per cent premium, while those in the 401-800 m range sold at about 1 per cent premium. This suggests that during the announcement phase, properties located in direct proximity to the planned stops did not experience a negative influence on their values. This outcome is contrary to previous studies (such as Chen *et al.*, 1998; Bowes & Ihlanfeldt, 2001; Pan, 2013) who found that the railway stations had a negative effect on properties adjacent to the train stations. This outcome may be because T1 is before the construction and operation of the LRT so negative externalities were not yet present. Also, residential properties located within the 0-400 m radius of the two stops are close to the UNSW. The proximity to the university could explain the high value attached to properties located within the 0-400m radius. Previous studies have shown that the ease to access school facilities tends to have a positive influence on residential property values (Clark & Herrin, 2000; Chin & Foong, 2006). On the other hand, this result contradicts the findings of Yan *et al.* (2012) who reported that the positive influence is only experienced during the operation of light rails. However, there may be other explanatory variables for the negative impact e.g. the presence of surrounding industrial land use.

In T2, the D400 variable was highly significant at 1 per cent significance level and D800 was not significant at 1 and 5 per cent significance levels. Both variables are again positively associated as they were in T1. Properties within 0-400 m of the stops are expected to sell with a 6.7 per cent premium, while those within 401-800 m were expected to sell with a 3.6 per cent premium. This finding shows that properties closer to the light rail stops were valued higher than those located outside the 0-400 m radius. Since both T1 and T2 produced results that indicate higher property values closer to the LRT stops, this could mean properties directly adjacent to the stops were not affected by negative externalities. One possible reason for this could be linked to the fact that LRT technology does not produce noticeable negative externalities. The CSELR is powered by electricity and it produces less air pollution when compared with fossil powered variants. However, the overhead cables of the CSELR may affect the aesthetical views in the city. The results also suggest that the capitalisation effect of being located closer to UNSW may cancel out the negative externalities or is actually greater than that of the new transit system altogether.

Development Timeline

By comparing the results of T1 and T2, the development timeline of T2 appears to have a higher positive effect on residential property values. This is evident as both the minimum and maximum sale price of properties in T2 are higher than that of T1. Most of the variables also saw an increase in their coefficient from T1 to T2. With regards to distance, the coefficient for properties located within 0-400m of the stops saw an increase of 2.4 per cent in their values, while and properties within 400-800m saw an increase of 2.6 per cent in value. This can be interpreted as the impact of CSELR on property values improved from the announcement phase to the construction phase. The observed increase in value during the development timeline is in line with previous studies such as Yan *et al.* (2012), Chen *et al.* (2019) among others. There is a possibility that the values of residential properties would still increase when the new rail line becomes operational because would-be homeowners may not be willing to invest early as benefits of the transit system such as accessibility and travel cost savings cannot be actualised until the system is operational.

Proximity and timing are the variables of interest in this study. In terms of timing of value uplift, T2 outperformed T1. From the lens of proximity, it is evident that accessibility to rail stations led to increased property values. Overall, residential property values increased with proximity to LRT stops and did not appear to be affected by negative externalities. Residential property values were also positively affected during the announcement and construction phase but were only statistically significant during the construction phase.

Conclusions

The impact of LRT accessibility on the value of residential properties has been inconclusive in the existing literature. This present study aimed to address this gap in knowledge by examining the effect of a new light rail system on residential property values around UNSW in Sydney, Australia. Also, the effect of the rail system during the development timeline was evaluated. Using HPM, the study was able to address the objectives of the research. The results of this investigation have shown that residential property values increased during the announcement and construction phase of the railway project. Also, it was found that residential properties located within the 0-400m radius attract more value when compared with properties far away from the railway stops.

The current study provides insights into the impact of railway stations on the value of residential properties. Overall, evidence indicates that the proximity to railway stations contributes to an increase in the value of residential properties. Apart from providing jobs to the people, it is evident that new transport infrastructure, such as the LRT system, can add value to the community. Based on the evidence of value uplift, policymakers need to develop policies to optimise the capture of the value of investments in infrastructure projects. Also, stakeholders, such as real estate professionals and property investors, can use this information to objective inform property investment decisions.

The findings emanating from the study are subject to certain limitations. First, the variables included in the HPM model was not exhaustive. For instance, there was no information on green features, such as gardens, within the database. Second, the general state of the economy after the completion of the CSELR was not considered. Due to the outbreak of COVID-19, the data for the post-construction phase is not currently available. Despite these limitations, the study contributes to the existing knowledge on the impact of transport infrastructure on the value of residential properties. As more data become available, further research could explore the impact of CSELR on the value of properties at the post-construction phase.

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Table 1: Variables Used in Previous Studies

Authors \ Variables	Floor Area	Age of Property	Number of Bedrooms	Number of Bathrooms	Garage	Parking Spaces	View	Height/Number of Stories	Street Frontage	Lot Size	Basement	Air Conditioning	Fireplace	Corner Lot	Foundation Present	House or Unit	Building Quality	Distance to Stop/Station	Distance to School	Distance to Shopping	Distance to CBD	Park and Ride	Distance to Highway	Distance to Park	Distance to Medical Center	Income	College Education	Employment	Race	Crime	Density	Intersections	Neighbourhood Rating	Time
AlQuhtani and Anjomani (2019)																		X	X	X	X	X	X	X		X	X	X	X		X			
Chen *et al.* (2019)	X	X	X	X		X				X								X			X					X		X						
Hopkins (2018)	X	X	X	X														X			X			X		X		X					X	
Mulley *et al.* (2018)			X	X		X										X		X			X					X		X						
Li (2018)	X	X	X	X				X									X	X			X													
Mulley and Tsai (2016)			X	X		X										X		X	X	X	X		X			X		X						X
Wang (2016)	X	X					X			X	X						X																	
Xu *et al.* (2016)																																X		X
Zhong and Li (2016)	X	X	X	X						X								X		X		X	X	X						X				
Pan (2013)	X	X																X		X	X		X		X			X			X			X
Ibeas *et al.* (2012)	X		X	X	X											X	X	X			X							X			X			
Yan *et al.* (2012)	X	X	X					X				X	X				X	X																
Andersson *et al.* (2010)	X	X						X	X	X								X			X		X			X	X							
Duncan (2008)	X	X	X	X	X		X			X								X				X	X					X				X		
Hess and Almeida (2007)		X	X	X						X	X		X			X		X												X				
Bowes and Ihlanfeldt (2001)		X	X	X						X	X		X								X	X	X			X		X	X	X				
Chen *et al.* (1998)	X	X	X	X	X					X	X		X					X			X			X										
Nelson (1992)	X			X				X		X	X	X	X	X	X			X						X		X			X					
TOTAL	**12**	**12**	**12**	**12**	**3**	**3**	**2**	**4**	**1**	**9**	**5**	**2**	**5**	**1**	**1**	**4**	**4**	**15**	**2**	**4**	**11**	**4**	**7**	**5**	**1**	**8**	**2**	**9**	**3**	**3**	**3**	**2**	**1**	**3**

Table 2: Summary of Variables

Variable code	Definition/Measurement
Dependent variable	
PRICE	Price of property in AUD*
Independent variables	
BDRM	Number of bedrooms
BTHR	Number of bathrooms
PRKG	Number of parking spaces
AGE	Age of property in years
AREA	Area of property in meters squared
LOTSZ	Area of lot size in meters squared
PTYPE	Property type where 0=Unit and House=1
D400	Dummy: 1 = Property is located in 0-400 m to the stops and 0 = Property is located in 401-800 m to the stops
D800	Dummy: 1 = Property is located in 401-800 m to the stops and 0 = Property is located in 0-400 m to the stops

*AUD means Australian Dollars.

Table 3: Descriptive Statistics

Model	Variable	N	Minimum	Maximum	Mean	Std. Deviation
T1	PRICE	286	$315,000	$2,850,000	$972,659.35	$529,787.02
	AGE	286	1	114	46.9	33.993
	AREA	286	24	389	112.92	72.629
	BDRM	286	0	9	2.46	1.153
	BTHR	286	1	5	1.53	0.738
	PRKG	286	0	5	1.28	0.738
	LOT_SZ	286	100	6975	858.18	890.464
	P_TYPE	286	0	1	0.26	0.437
	D400	286	0	1	0.15	0.291
	D800	286	0	1	0.37	0.488
T2	PRICE	416	$388,000	$3,850,000	$1,428,598.57	$721,879.82
	AGE	416	1	119	53.97	36.769
	AREA	416	24	351	116.43	61.049
	BDRM	416	0	11	2.73	1.312
	BTHR	416	1	6	1.58	0.777
	PRKG	416	0	5	1.24	0.729
	LOT_SZ	416	100	6975	599.79	690.258
	P_TYPE	416	0	1	0.35	0.479
	D400	416	0	1	0.11	0.285
	D800	416	0	1	0.42	0.483

Table 4: The outputs of the two models

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
T1	0.899	0.808	0.801	$236,520.07
T2	0.931	0.867	0.864	$266,473.39

Table 5: Regression Results of T1 (Announcement Phase)

	Unstandardized		Standardized		Collinearity Statistics	
Variable	Coefficient	Std. Error	Coefficient	P-Value	Tolerance	VIF
(Constant)	299072.615	62114.426		0.000		
AGE	-2.737	609.503	0.000	0.996	0.457	2.187
AREA	1665.921	342.579	0.228	0.000***	0.317	3.154
BDRM	69979.407	21476.228	0.152	0.001***	0.32	3.125
BTHR	73740.179	30429.466	0.103	0.016**	0.389	2.568
PRKG	54604.633	21856.738	0.076	0.013**	0.755	1.325
LOT_SZ	-0.535	16.841	-0.001	0.975	0.873	1.146
P_TYPE	598145.437	60749.289	0.493	0.000***	0.279	3.587
D400	64979.197	45392.838	0.043	0.153	0.773	1.294
D800	22742.752	67041.932	0.010	0.735	0.824	1.214

* Significant at $p < 0.10$, ** Significant at $p < 0.05$, *** Significant at $p < 0.001$
Announcement phase is December 2012 – February 2015.

Table 6: Regression Results of T2 (Construction Phase)

	Unstandardized		Standardized		Collinearity Statistics	
Variable	Coefficient	Std. Error	Coefficient	P-Value	Tolerance	VIF
(Constant)	538918.940	55750.664		0.000		
AGE	-1489.234	607.064	-0.076	0.015**	0.352	2.842
AREA	2816.495	394.776	0.238	0.000***	0.302	3.313
BDRM	82793.058	19860.177	0.150	0.000***	0.258	3.87
BTHR	-15883.716	26759.403	-0.017	0.553	0.405	2.467
PRKG	103929.702	20881.198	0.105	0.000***	0.756	1.322
LOT_SZ	-19.360	20.237	-0.019	0.339	0.899	1.113
P_TYPE	981064.700	51472.085	0.651	0.000***	0.288	3.467
D400	154805.107	48003.912	0.067	0.001***	0.77	1.298
D800	120083.533	65190.065	0.036	0.066*	0.879	1.138

* Significant at $p < 0.10$, ** Significant at $p < 0.05$, *** Significant at $p < 0.001$
Construction phase is March 2015 – March 2020.

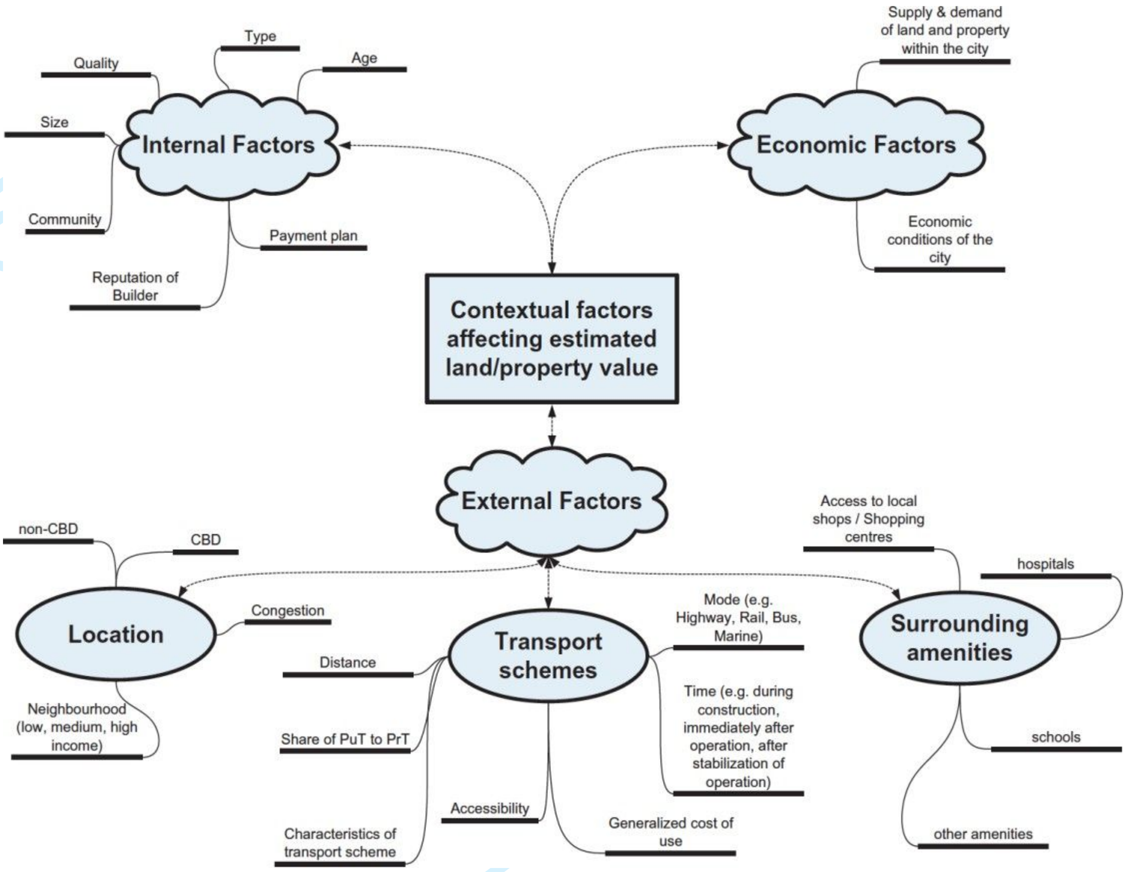

Figure 1: Factors Affecting Land/Property Values

Source: Mohammad *et al.* (2013)

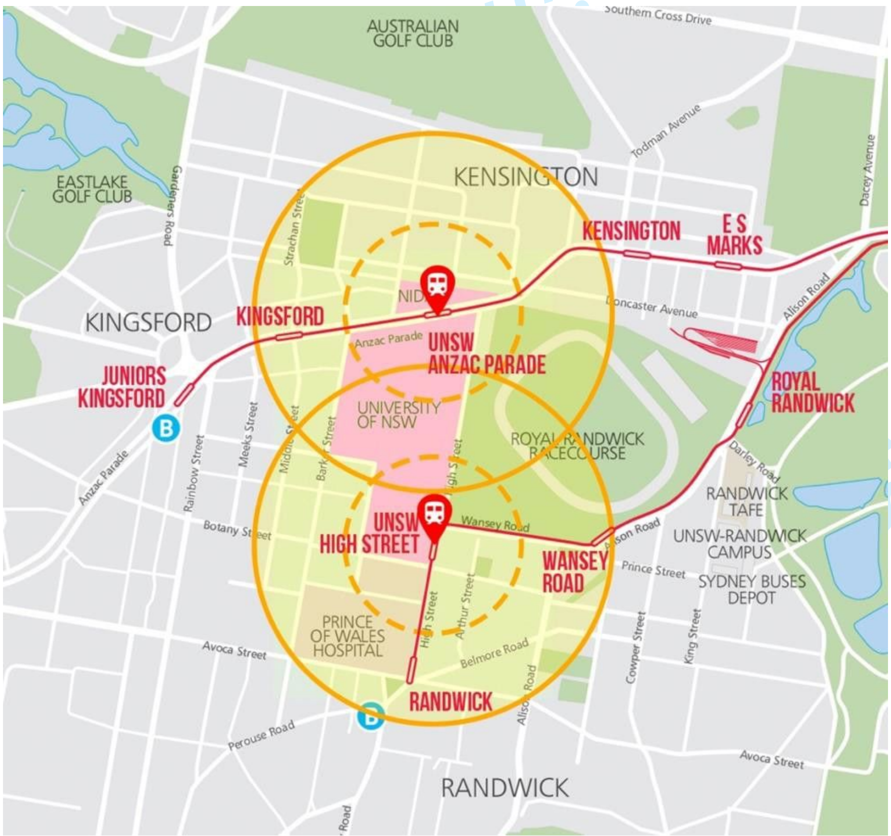

Figure 2: Map of Scope of Study

Source: https://transportnsw.info/

Appendix 1: Summary of Previous Studies

Authors	Location	Transit Type	Property Type	Method	Findings
Nelson (1992)	Atlanta, USA	Rail Transit	Single-Family	Empirical Model, Regression	Housing values increased in low-income areas but were negatively affected in higher-income neighbourhoods.
Chen *et al.* (1998)	Portland, USA	Light Rail	Single-Family	Hedonic Price Model	Housing values are impacted both negatively and positively, but the positive outweighs the negative
Bowes and Ihlanfeldt (2001)	Atlanta, USA	Rail Transit	Single-Family	Hedonic Price Model	Homes located in direct vicinity to stations were negatively affected and those located at an intermediate distance were positively affected
Debrezion *et al.* (2007)	Multiple Locations	Rail Transit	Residential	Meta-Analysis	Positive impact on property values. Commercial values benefited more at 1/4 or less to the station than residential values.
Hess and Almeida (2007)	Buffalo, USA	Light Rail	Single-Family	Hedonic Price Model	Housing premium existed within a 1/4 mile radius of a light rail station. Actual walking distance was statistically more significant than straight-line distance.
Duncan (2008)	San Diego, USA	Rail Transit	Single Family and Condominiums	Hedonic Price Model	The study observed a positive capitalization effect on both condominiums and single-family homes. The effect was higher on condominiums.
Andersson *et al.* (2010)	Taiwan	High-Speed Rail Line (HSR)	Multi-Family	Hedonic Price Model	HSR had a very minor effect on the residential property due to the infeasibility of HSR use for daily commuting.
Campbell (2011)	Houston, USA	Light Rail	Residential	Hedonic Price Model	Residential properties in the study were affected by both the nuisance effect and accessibility effect.
Ibeas *et al.* (2012)	Santander, Spain	Bus, Train	Residential	Hedonic Price Model (SEM)	Property asking prices increased when there were more train lines present in the area and decreased when distance in terms of time increased.
Yan *et al.* (2012)	Charlotte, USA	Light Rail	Single-Family	Hedonic Price Model	The study revealed a preference to live next to an Light Rail Transit (LRT) station improve once the line became operational

Appendix 1: Summary of Previous Studies (Cont.)

Authors	Location	Transit Type	Property Type	Method	Findings
Mohammad *et al.* (2013)	Multiple Locations	Rail Transit	Land/Property	Meta-Analysis	Results show large variation among studies and researchers report both negative and positive impacts on land and property values.
Pan (2013)	Houston, USA	Light Rail	Single Family Homes	Hedonic Price Model, OLS, MLR	The light rail had an overall positive effect, but properties within 1/4 mile distance still experienced negative effects.
Mulley and Tsai (2016)	Sydney, Australia	Bus Rapid Transit (BRT)	Single Family and Multi-family	Hedonic Price Model (Multilevel)	After the opening of the BRT, properties within 400 m of BRT stops were found to have a minor positive capitalisation effect than those outside the service area.
Wang (2016)	Seattle, USA	Light Rail	Single-Family	Hedonic Price Model	The LRT had a statistically significant positive effect on property values after construction, but not during or before construction.
Zhong and Li (2016)	Los Angeles, USA	Heavy Rail/Light Rail	Single Family and Multi-family	Hedonic Price Model, GWR	The study saw a positive impact on multi-family residential, but single-family homes were negatively impacted. Residents favour heavy rail over light rail.
Forouhar and Hasankhani (2018)	Tehran, Iran	Rail Transit	Apartments/flats	Trend Analysis, Difference in Differences	A large increase in housing premium in neighbourhoods with low income but had a negative impact on neighbourhoods with a higher income.
Li (2018)	China	Rail Transit	Apartments	Empirical Analysis	Overall positive impact on property values. Value uplift is highest between 300m to 1200m away from a station.
Camins-Esakov and Vandegrift (2018)	Bayonne, USA	Light Rail Extension	Single Family and Multi-family	Hedonic Price Model, Repeat Sales	No significant impact observed
Mulley *et al.* (2018)	Sydney, Australia	Light Rail	Single Family and Apartments	GWR	Property values increase ½ per cent for each 100m nearer to an LRT station, but value uplift decreases within 100m of a station.
AlQuhtani and Anjomani (2019)	Dallas, USA	Light Rail, Commuter Rail	Single-Family	Multiple Regression	Premium decreased where properties were located closer to the station. Areas with development and commercial activity had the strongest positive impact on housing values.
Chen *et al.* (2019)	Sydney, Australia	Metro Rail	Residential	Hedonic Price Model	The new metro rail had a negative effect on property prices during pre-construction and a positive effect during construction.
Zhang and Jiao (2019)	Zhengzhou, China	Urban Rail Transit (URT)	Gated Residential Apartments	Hedonic Price Model	The URT had a significant higher influencing strength during its early stages of planning and construction when compared with the operation periods

Impact of Light Rail Line on Residential Property Values – A Case of Sydney, Australia

ABSTRACT

Purpose - The construction of new transportation infrastructure tends to affect the adjoining properties, economy, and environment. In particular, studies have investigated the change in the value of properties due to increased access to transportation facilities. In this current study, the impact of the recently completed light rail on residential property values in Sydney, Australia was examined.

Design/methodology/approach – Sales data of residential properties were extracted from the CoreLogic's RP database. The hedonic pricing model (HPM) was used to assess the effect of proximity to the light rail stops. Two models were developed for the announcement and construction phases of the light rail project.

Findings - It was found that during the announcement phase, properties located within the 400m radius from the station were 3.3% more expensive than those within the 400-800 radius. At the construction stage, the properties within the 0-400m radius from the stops sold at 3.1% more than those within the 400-800m radius. The study concludes that a positive relationship exists between the values of residential property and its proximity to the light rail stations.

Originality –Previous studies that aimed at examining the impact of light rails on residential properties values around universities are limited. Hence, this study provides a broad perspective on the impact of light rail on residential properties values.

Practical implications - These findings would be useful for policymakers to develop land value capture programs for infrastructure funding and to real estate professionals and investors for investment in future transit-oriented development.

Keywords: Light rail, property value, university, residential property, Sydney, Australia

Paper type Research paper

INTRODUCTION

The urban areas within nations play a significant role in economic development. As the number of people living in cities grows, the volume of carbon emissions increase (Shi, 2003; Jorgenson & Clark, 2010). Research shows that congestion within cities increases the volume of greenhouse emissions from fossil-powered vehicles (Zheng *et al.*, 2015). Across the globe, stakeholders are implementing strategies [such as mass transportation, emission charge, and incentives to encourage the purchase of electric cars] to improve air quality and reduce congestion in the cities (Steffen *et al.*, 2015; Zheng *et al.*, 2020). The construction of light rail systems for mass transportation is beneficial to the people, community, environment, and economy. Light rail systems are vital for the growth and long-term survival of cities.

The relationship between transportation and land use is significant. A common way to measure the relationship is to examine how property values vary with distance to a transportation facility (Ryan, 1999). The findings of previous studies into the impact of railway stations on the values of residential properties have been inconsistent. For instance, some studies indicate the rail stations have no (Wagner *et al.*, 2017) or negative impact on property values (Camins-Esakov & Vandegrift, 2018). In contrast, other investigations suggest that the proximity to rail stations has a positive impact on property values (Hess & Almeida, 2007; Pan *et al.*, 2014). These inconsistencies have been attributed to (i) ownership (low and high-income) and characteristics (single-family and multi-family) of the residential properties (Duncan, 2008; Forouhar & Hasankhani, 2018). These inconsistencies necessitate the need for fresh insights into the impact of railway stations on the values of residential properties.

An understanding of the attributes that influence property values can be used to inform investment and policy decisions. In the context of Australia, the existence of previous studies

(Mulley & Tsai, 2016; Chen *et al.*, 2019) which focused on the impact of railway lines on the value of residential properties is acknowledged. However, little is known about the impact of the recently completed Central Business District (CBD) and South East (SE) light rail line on the values of residential properties around a university, i.e. the University of New South Wales (UNSW), Sydney, Australia. Due to the gap in the existing knowledge, this study seeks to investigate how the CBD and SE Light Rail (CSELR) influence the value of residential properties located around the UNSW transit stops. The aim of the study is achieved by addressing two objectives: (i) examining the influence of the new light rail on residential property values around UNSW during the announcement (December 2012 – February 2015) and construction (March 2015 – March 2020) of the light rail; and (ii) assessing the effect of distance to the new light rail on residential property values around UNSW. The outcome of the present study provides insights into the economic benefits associated with the development of light railway systems within cities. This information can be used by stakeholders (such as government and developers) to develop strategies for the planning of land value capture for future infrastructure funding. It will also be of added value to consumers in real estate markets when deciding on where and when to buy or lease properties.

LITERATURE REVIEW

Accessibility and Nuisance Effects on Property Values

The findings of previous studies on the impact of transport infrastructure on the value of properties have been inconsistent. Previous studies show that the closeness to a railway station contributes to an increase in the value of properties (Debrezion *et al.*, 2007; Li, 2018; Pan, 2019). In contrast, Wagner *et al.* (2017) found that the proximity to railway stations has no impact, while Camins-Esakov and Vandegrift (2018) reported a negative impact on the values of properties. Literature suggests that the impact of transport infrastructure on the value of residential properties tend to vary from location to location. Considering all those evidence, it seems that the presence of railway stations could be beneficial or detrimental to the value of residential properties. Furthermore, several studies have been conducted to understand the underlying reasons for these inconsistencies.

Researchers have used various tools and techniques to explain these inconsistent findings. Most authors have incorporated spatial data into developed models. In other cases, buildings have been classified based on characteristics, such as ownership. For instance, previous studies have shown that the proximity of train stations to properties in low-income neighbourhoods increases their values, however, it has a negative impact in high-income areas (Nelson, 1992; Forouhar & Hasankhani, 2018; Zhang *et al.*, 2021). Using geospatial data, Bowes and Ihlanfeldt (2001) showed that properties located within 0.25 miles of the MARTA (Metropolitan Atlanta Rapid Transit Authority) sold for 19 per cent less than outside of the three-mile radius. The existing literature on this subject is summarised and presented in Appendix 1. Based on the evidence, scholars have attributed the observed inconsistencies to various reasons.

The factors suggested by scholars include the level of car ownership, noise population, and perceived level of security, among others. Forouhar and Hasankhani (2018) observed that train services tend to be utilised as the main means of transportation among low-income families. However, high-income earners can afford to own cars and pay for other associated costs, such as maintenance costs. Others (such as Bowes & Ihlanfeldt, 2001) stated that the presence of rail stations improves access to a locality. However, the perceived level of security and noise pollution tends to adversely affect the value of residential properties. From Appendix 1, it is evident that most of the studies have focused on single-family homes in the US. Hence, there is a need to understand the impact of railway stations on the value of residential properties in other cities outside of the US.

Residential Property Values: Modelling and Prediction

Various tools have been used to model the relationship between the value of residential properties and their attributes. Research shows that these attributes contribute to the value of properties (Jenkins, 2000). according to Chen *et al.* (1998), these attributes were classified into structural, neighbourhood, locational, fiscal or economic attributes. In contrast, Mohammad *et al.* (2013) categorised these attributes into internal, external, and economic (see Figure 1). The nomenclature of the property attributes classifications has not been consistent in the literature (Chin & Chau, 2002). Taken together, the literature suggests that the attributes of properties have a significant impact on their value. Unearthing the relationship between attributes and property value is vital for optimising the returns on investment.

Insert Figure 1 Here

There is a growing number of research that models and predicts residential property values using its attributes. Information gleaned from the literature indicates that the features influencing property values include the number of bedrooms, bathrooms, parking space, proximity of green parks, and academic performance of students in state schools, among others (Crompton, 2001; Abidoye & Chan, 2017; Fleishman *et al.*, 2017). Table 1 provides a concise overview of the variables incorporated into models for the prediction of property value. Lines of evidence have shown that these features are useful for modelling and predicting residential property values (Nguyen & Cripps, 2001; Abidoye, 2017). The impact of these attributes tends to vary from one location to another. Hence, the need to understand the critical attributes that contribute to property values in each location.

Insert Table 1 Here

University Impact on Residential Property Values

The presence of UNSW within the study area necessitates the review of studies on the effect of education facilities on the value of residential properties. Much of the research has focused on the impact of school quality, measured in terms of students' academic performance, on the value of properties. For instance, studies have shown that school quality has a positive impact on residential property values (Chin & Foong, 2006; Wen *et al.*, 2014). However, little is known about the effect of school proximity on property values. Hence, there is a need to understand the impact of the presence of a university on the value of residential properties, using UNSW as a representative case.

Numerous studies have attempted to explain the impact of different levels of schools on the value of residential properties. For instance, Owusu-Edusei *et al.* (2007) found that elementary and high schools had a great impact on the values of residential properties in South Carolina, US. Similarly, studies have reported that the presence of school is a significant contributory factor to the values of residential properties in South Korea, China, and the United Kingdom (Davidoff & Leigh, 2008; Hahn *et al.*, 2012; Wen *et al.*, 2014). Wen *et al.* (2014) showed that the strength of this relationship varies based on the class of the school, e.g. kindergarten schools, high schools, or college. Collectively, it is evident that the proximity and accessibility of all schools have a positive effect on the value of residential properties. These studies highlight the place of educational facilities on property value formation.

RESEARCH METHODOLOGY

Several techniques have been used for modelling and predicting residential property values. The methods used in previous studies can be classified into two groups: quantitative and qualitative. The main advantage of quantitative methods lies in the possibility of objectively verifying and validating the developed model. Despite the existence of several quantitative methods (see Appendix 1), the suitability of a particular approach is dependent on the objectives of the study. In this study, the HPM is used to model and explain the strength of the relationship between the value of a residential property and its attributes. HPM utilises the regression analysis to deconstruct the value of a residential building and estimates the contributory significance of each available characteristic (Selim, 2009). Yacim and Boshoff (2014) point out that the main weakness of HPM is the non-inclusion of the spatial information about residential properties. A better approach would be the inclusion of a dummy variable, which represents the distance between a property and the railway station, in the HPM. Geographic Information System (GIS) is a useful tool for evaluating the impact of distance on the value of real estate properties (Anselin, 1998).

For this study, the dummy variables were included in the HPM model to evaluate the impact of distance to a railway station on property value.

The variables included in the quantitative models, i.e. HPM, were informed by the outcome of an initial review of the literature. As stated earlier, dummy variables were used to investigate the impact of the proximity of light rail stops on residential property values. In this research, HPM was applied to data collected from two time periods ((i) the announcement of the new train line and (ii) the completion of the new train station). The variables included in the developed HPM are shown in Table 2.

The HPM developed in this study can be specified as a multiple regression as shown in Equation 1.

$$PRICE = \beta_0 + \beta_1 \times BDRM + \beta_2 \times BTHR + \beta_3 \times PRKG + \beta_4 \times AGE + \beta_5 \times AREA + \beta_6 \times LOTSZ + \beta_7 \times PTYPE + \beta_8 \times D400 + \beta_9 \times D800 + \varepsilon \quad (1)$$

Where β_0 is the regression constant, β_1 .... B_9 are the regression coefficients (described and listed in Table 2) and ε is the random error.

Insert Table 2 Here

Study Area

The new CSELR in Sydney, Australia comprises the L2 (Randwick Line) and the L3 (Kingsford Line). The CSELR is 12 kilometres and it has 19 stops. The development phase of the CSELR project spanned between December 2012 and March 2020. The government of New South Wales declared and announced the intention to procure the project in December 2012. Planning permission was granted in 2014. Subsequently, the construction phase commenced in March 2015 and the project was completed in early 2020. The Randwick Line was opened and operational on December 14, 2019, while the Kingsford Line continued testing through the first quarter of 2020 and opened for passengers on April 3, 2020.

Two light rail stations served the UNSW community – one via L2 on High Street and one via L3 on Anzac Parade. The impact of these two stops on the value of residential properties is the main focus of the current study. The residential properties were grouped into two classes, i.e. those within the 0-400m radius and those located within the 401-800m radius. This is a common metric used in similar previous studies (see, for instance, Weinberger, 2001; Hess & Almeida, 2007; Pan, 2013). Also, Zhong and Li (2016) mentioned that some residents are willing to walk about 800 m to a transit stop in America. Figure 2 shows the location of the two rail stations in proximity to the UNSW's Kensington campus.

Insert Figure 2 Here

Data Collection

The secondary data used for the study was retrieved from CoreLogic's RP database (https://www.corelogic.com.au/). The descriptive statistics for the variables included in the HPMs are presented in Table 3 ('N' indicates the number of observations per model). The selection criteria for the variables are (i) the outcome of the literature review (Table 1) and (ii) the availability of data on the RP database. Upon completion of data cleaning, a total of 702 (286+416) complete observations were available for the development of the quantitative models. The data was collected for residential properties sold and bought within the study area between December 2012 and March 2020 when the new rail line was completed. To have consistent property values consummated between 2012 and 2020, the effect of inflation was considered. Therefore, the Consumer Price Index (CPI) retrieved from the Australian Bureau of Statistics (ABS) was applied to the data. The dataset was divided into the light rail announcement (T1) and construction (T2) phases. The post-construction phase was not considered in the study due to the outbreak of the COVID-19 pandemic. This is because global events, such as recession and pandemics, tend to disrupt the housing markets (Lai et al., 2006). This disruption informed the authors' decision not to include post-construction data into the developed HPM. The descriptive statistics and HPM were then generated using the Statistical Package for the Social Sciences (SPSS). Table 3 presents the descriptive statistics showing an increasing value in the average sales price of residential properties when the T1 and T2 periods are compared.

Insert Table 3 Here

Results and Discussion

The output of the developed models is summarised in Table 4. Lin and Mohan (2011) posit that an r^2 value closer to 1 demonstrates higher confidence of correlation between the dependent and independent variables. The models for T1 and T2 have r^2 values of .808 and .867, and adjusted r^2 values of 0.801 and .864, respectively. This metric indicates that the models can explain over 80 per cent variance (80.8% for T1 and 86.7% for T2) in the values of residential properties. From these values, both models demonstrate the goodness-of-fit of the HPM (Abidoye, 2017).

Insert Table 4 Here

Tables 5 and 6 presents the regression results of the two models during the announcement and construction phase, respectively. The results provide insight into whether each independent variable is significant in contributing to property values during those periods. A p-value of less than .05 means the variable is significant at the 5 per cent significance level and less than .01 means highly significant at the 1 per cent significance level. The collinearity statistics column provides information on whether multicollinearity is present among the variables. To test for multicollinearity, as a general rule of thumb, a variance inflation factor (VIF) value of less than 10 is considered acceptable (Berenson *et al.*, 2012). The values of VIF shown in Tables 5 and 6 are less than 10. Hence, it is evident that there is no multicollinearity among the variables included in the models.

Insert Table 5 Here

Insert Table 6 Here

Property Characteristics

The characteristics of the properties (size of the property, number of bedrooms, number of parking spaces, and property type) are significant and have a positive correlation to the value of the residential properties. This finding is consistent with those of previous studies which indicate that structural variables are the most significant drivers of property values (Wilhelmsson, 2000; Abidoye & Chan, 2016; Chen *et al.*, 2019). This may be because structural attributes of properties are usually significant in the formation of property values (Wilhelmsson, 2000), and they could contribute above 60 per cent to the formation of residential property values (Wen *et al.*, 2005).

The number of bathrooms was found to be significant during T1 but not significant in T2. In T2 the number of bathrooms had a negative correlation to property value and for every increase in the number of bathrooms, there is a 1.7 per cent decrease in property value. The plausible reason might be that the home buyers were more concerned about other variables than the number of bathrooms during this period to secure properties close to the light rail stops. This result is similar to the findings of Abidoye and Chan (2018) and Nguyen and Cripps (2001) that reported that an additional number of bathrooms could reduce the price of residential properties.

Property type was found to be highly significant in both T1 and T2. The positive correlation indicates that the average value of standalone houses is higher than those of flats/units. After all other variables are accounted for, the values of properties are predicted to be 49 per cent more than the value of units in T1 and 65 per cent more in T2. This corroborates Mulley and Tsai (2016) that found that units were valued lesser than houses within the same property market. This result could be explained by the fact that houses provide more space, privacy, and amenities when compared with units. These additional features make houses command a higher value.

In model T1, the age of property is not significant, but in T2, the age of property is significant at the 5 per cent significance level. One reason age is not significant in T1 could be that particular architectural styles of properties, such as federation style, may appreciate due to historical value. On the other hand, it has been established in the literature that the older a property, the lesser the value (Hui *et al.*, 2007), and this explains the negative correlation in T2.

The results for both the D400 and D800 are not significant during T1. The positive coefficients of those variables can be interpreted as properties in the two zones that enjoy value-added due to proximity to the stops. Properties located within the 0-400 m range of the stops are predicted to sell for 4.3 per cent premium, while those in the 401-800 m range sold at about 1 per cent premium. This suggests that during the announcement phase, properties located in direct proximity to the planned stops did not experience a negative influence on their values. This outcome is contrary to previous studies (such as Chen *et al.*, 1998; Bowes & Ihlanfeldt, 2001; Pan, 2013) who found that the railway stations had a negative effect on properties adjacent to the train stations. This outcome may be because T1 is before the construction and operation of the LRT so negative externalities were not yet present. Also, residential properties located within the 0-400 m radius of the two stops are close to the UNSW. The proximity to the university could explain the high value attached to properties located within the 0-400m radius. Previous studies have shown that the ease to access school facilities tends to have a positive influence on residential property values (Clark & Herrin, 2000; Chin & Foong, 2006). On the other hand, this result contradicts the findings of Yan *et al.* (2012) who reported that the positive influence is only experienced during the operation of light rails. However, there may be other explanatory variables for the negative impact e.g. the presence of surrounding industrial land use.

In T2, the D400 variable was highly significant at 1 per cent significance level and D800 was not significant at 1 and 5 per cent significance levels. Both variables are again positively associated as they were in T1. Properties within 0-400 m of the stops are expected to sell with a 6.7 per cent premium, while those within 401-800 m were expected to sell with a 3.6 per cent premium. This finding shows that properties closer to the light rail stops were valued higher than those located outside the 0-400 m radius. Since both T1 and T2 produced results that indicate higher property values closer to the LRT stops, this could mean properties directly adjacent to the stops were not affected by negative externalities. One possible reason for this could be linked to the fact that LRT technology does not produce noticeable negative externalities. The CSELR is powered by electricity and it produces less air pollution when compared with fossil powered variants. However, the overhead cables of the CSELR may affect the aesthetical views in the city. The results also suggest that the capitalisation effect of being located closer to UNSW may cancel out the negative externalities or is actually greater than that of the new transit system altogether.

Development Timeline

By comparing the results of T1 and T2, the development timeline of T2 appears to have a higher positive effect on residential property values. This is evident as both the minimum and maximum sale price of properties in T2 are higher than that of T1. Most of the variables also saw an increase in their coefficient from T1 to T2. With regards to distance, the coefficient for properties located within 0-400m of the stops saw an increase of 2.4 per cent in their values, while and properties within 400-800m saw an increase of 2.6 per cent in value. This can be interpreted as the impact of CSELR on property values improved from the announcement phase to the construction phase. The observed increase in value during the development timeline is in line with previous studies such as Yan *et al.* (2012), Chen *et al.* (2019) among others. There is a possibility that the values of residential properties would still increase when the new rail line becomes operational because would-be homeowners may not be willing to invest early as benefits of the transit system such as accessibility and travel cost savings cannot be actualised until the system is operational.

Proximity and timing are the variables of interest in this study. In terms of timing of value uplift, T2 outperformed T1. From the lens of proximity, it is evident that accessibility to rail stations led to increased property values. Overall, residential property values increased with proximity to LRT stops and did not appear to be affected by negative externalities. Residential property values were also positively affected during the announcement and construction phase but were only statistically significant during the construction phase.

Conclusions

The impact of LRT accessibility on the value of residential properties has been inconclusive in the existing literature. This present study aimed to address this gap in knowledge by examining the effect of a new light rail system on residential property values around UNSW in Sydney, Australia. Also, the effect of the rail system during the development timeline was evaluated. Using HPM, the study was able to address the objectives of the research. The results of this investigation have shown that residential property values increased during the announcement and construction phase of the railway project. Also, it was found that residential properties located within the 0-400m radius attract more value when compared with properties far away from the railway stops.

The current study provides insights into the impact of railway stations on the value of residential properties. Overall, evidence indicates that the proximity to railway stations contributes to an increase in the value of residential properties. Apart from providing jobs to the people, it is evident that new transport infrastructure, such as the LRT system, can add value to the community. Based on the evidence of value uplift, policymakers need to develop policies to optimise the capture of the value of investments in infrastructure projects. Also, stakeholders, such as real estate professionals and property investors, can use this information to objective inform property investment decisions.

The findings emanating from the study are subject to certain limitations. First, the variables included in the HPM model was not exhaustive. For instance, there was no information on green features, such as gardens, within the database. Second, the general state of the economy after the completion of the CSELR was not considered. Due to the outbreak of COVID-19, the data for the post-construction phase is not currently available. Despite these limitations, the study contributes to the existing knowledge on the impact of transport infrastructure on the value of residential properties. As more data become available, further research could explore the impact of CSELR on the value of properties at the post-construction phase.

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