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Property Price Attributable to Subdivision Neighbourhood Designs: Hedonic Pricing Model Approach in Bangkok Metropolitan Region, Thailand

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ABSTRACT

The purpose of this paper is to determine whether the property price is caused by the subdivision neighbourhood designs in the Bangkok Metropolitan Region (BMR), Thailand. A total price model is developed during the analysis process. The model provides a greater understanding of the significance of the subdivision neighbourhood designs that are related to property pricing. This paper is based on data collection from 50 subdivisions across the BMR area. The hedonic pricing approach is used to develop the models. The semi-log models are developed on 1,182 samples of property sales located in eight zones of the BMR. The independent variables include general bundles of property characteristics and the subdivision neighbourhood design items. There are two major findings in this study. First, this study provides a suitable property price model for subdivision development in the BMR. The model presents the high level of R^2 at 0.948. The model confirms that all classical hedonic variables are statistically significant to the property price. Furthermore, the additional alternative variables for the subdivision neighbourhood design items can improve the level of variation explained by the model. Second, this study finds that the average property price attributable to the subdivision neighbourhood design is about 20.24 % of the total property price. The components of the subdivision neighbourhood design items consist of project characteristics, recreation features, social facilities, and transportation system design. The model should support knowledge of the design's impact on the property price for the Government or policy makers on making appropriate policies for urban and environmental management. The model provides a guideline for developers on appropriate property selling-prices for subdivision development in the BMR. The new understanding of the property price attributable to the subdivision neighbourhood designs support suitable decision making on new subdivision development in the BMR.

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1. Introduction

The Bangkok Metropolitan Region (BMR) is the area that consists of the Bangkok Metropolitan Area (BMA), the capital city of Thailand, and its five adjacent provinces, which are Nontha Buri, Pathum Thani, Samut Prakan, Nakhon Pathom, and Samut Sakhon (REIC, 2009). The BMR is the centre of various activities in Thailand, including political, commercial, agriculture, and industrial. Consequently, the BMR has the highest population density in Thailand (Calhoun, 2002; Sheng, 2002).

At present, the highly competitive situation for single-family housing in the BMR influents the developers who are more concerned about their product designs. The subdivision product includes land, houses, and their neighbourhood amenities. The quality and quantity of the subdivision neighbourhood designs are important for competitive strategies for developers. However, there is still a lack of information on property prices caused by neighbourhood designs, but this highly influences the developers' investment decision (Suttiwongpan et al., 2019). Therefore, appropriate knowledge for guidance on the neighbourhood designs is required for industry practices (Tochaiwat et al., 2018).

For the BMR, there are a small number of articles on the effects of the subdivision neighbourhood designs on property prices. Those articles present the experience of developers and designers, which indicate that the neighbourhood features can add value to property prices for single-family subdivision projects (Piputsitee & Kittikunaporn, 2006; Tangmatitham, 2010). There is still no academic research on the relevant topic in the BMR, but it can be found in a number of studies from various locations (Benefield, 2009; Hui et al., 2007; Jones et al., 2009; Kauko, 2003).

Due to lacking essential knowledge for the BMR, this study aims to determine the property price attributable to the neighbourhood designs on subdivision development. This study first develops a total property price model that includes all possible related variables, and then focuses on the influence of the subdivision neighbourhood designs to the property price. In addition, several studies confirmed strong evidence of using a hedonic pricing approach for developing a property price model. Thus, the hedonic pricing approach is applied to develop the models in this study. The most appropriate model comes from the empirical method on a semi-log function. The semi-log models are developed on 1,182 samples of property sold in eight zones of the BMR. Sets of dependent and independent variables are also collected from the primary source. The dependent variable is actually the property-selling price, while the independent variables include the general property characteristics bundles and the subdivision neighbourhood design items.

The model expects to provide a guideline for developers on setting an appropriate property selling-price for subdivision development in the BMR. This new knowledge of the property price attributable to the subdivision neighbourhood designs could give information to support more suitable decision making on new subdivision development in the BMR.

The structure of this paper is as follows: section 2 provides the literature review, including the study area background. Then, section 3 presents the data and methodology. Section 4 indicates the results and interpretation of the empirical models. Finally, conclusions are offered in section 5.

2. Literature Review

This section provides a summary of the necessary existing information on related topics to the objective of this study. The first section presents literature on the subdivision neighbourhood design. Then, the relation between property selling-price and their design items are also reviewed for more understanding on the model development process. The last part of this section indicates a gap in the current situation that is significant for this study.

2.1 Neighbourhood Amenity Designs

The term neighbourhood has the meaning of the district or its local peoples or residents. A neighbourhood is the place that supports the social activity of the residents (Barton, 2000 p. 4; Choguill, 2008).

This broadly defines the "neighbourhood designs" as the design components of the community and residents for support, including project characteristics, recreation areas and social facilities, and the transportation system (Benefield, 2009; Warrick & Alexander, 1998). The appropriate neighbourhood design is important for sustainable subdivision development by increasing the level of social activities in the housing estate, which assists the creation of sustainability for development (Pasuthip & Panthasen, 2009).

Many previous studies on subdivision neighbourhood design have been done over the years. As started by Perry (2007) in a published monograph about neighbourhood unit design concept. The neighbourhood features include institutional, social, and physical designs, which provide neighbourhood residents opportunities to interact with those within their neighbourhood boundaries. This design concept focuses on the important neighbourhood centre, such as community school, which should be located at the centre of the community and could be accessed without crossing a main street. The density of residential units per neighbourhood area should be suitable for their social facilities, such as community centre, sport facilities, and playground. In addition, the design of the internal streets should consider both pedestrian safety and aesthetic purposes. Moreover, the neighbourhood should dedicate enough space for recreation in open space, such as parks, lakes and other community activity areas (Choguill, 2008; Lawhon, 2009; Perry, 2007).

Moreover, there are several publications that consider neighbourhood amenity designs. Those conclusive ideas demonstrate that there are four categories of neighbourhood amenity designs: *neighbourhood characteristics*, *recreation features*, *social facilities,* and *transportation system designs* (Asabere & Huffman, 2009; Blair et al., 2004; Foltête & Piombini, 2007; Warrick & Alexander, 1998). More details of some selective variables will be explained in Section 3.3.

The authors conducted this study in Bangkok, the capital city of Thailand, and there is a considerable number of shop-houses located here. The study was conducted in four districts of Bangkok, which were Bangkokyai, Parsricharoean, Bangkae, and Nongklam. The districts are located along Petchkasem Road on the boundary of the Bangkok Metropolitan Administration. These four districts were selected due to their variability in the types of enterprises present (Figure 1). They offer a mix of enterprises, such as commerce, service, and manufacturing. The study areas exist along the main arterial highway of Petchkasem Road within the industrial areas in Samutsakorn Province. The selected study area represents a cross-sectional profile of the city. This area is one of the centers of commercial activities in Bangkok. In the current study, shop-house enterprises were stratified based on their types of activities.

2.2 Hedonic Pricing Model Approach

The hedonic pricing model is a powerful and appropriate research tool to assess the values of the implicit values of the products (Jim & Chen, 2006; Sirmans et al., 2005). The hedonic regression model has been broadly used to model property value (sell or rent) (Baranzini & Schaerer, 2007; Chongyosying, 2005). The model approach regressed the property price by various characteristics (Cho et al., 2008; Gao & Asami, 2007; Jim & Chen, 2009; Limsombunchai et al., 2004). The simple pricing model can be presented as a linear relationship between the property price (dependent variable) and its characteristics (independents variables) (Randeniya et al., 2017). There is no specific function form for a hedonic pricing model. The model can be presented in many functional forms, such as simple linear, semi-logarithm, double-logarithm (log-log), and Box-Cox (Jim & Chen, 2006). The most suitable model is usually determined by empirical methods (Palmquist et al., 2005). However, hedonic pricing models have been usually presented by using a semi-logarithmic (semi-log) model. The dependent variable is usually estimated in the form of a natural logarithm (ln), while the independent variable is left as simple. Then the coefficient estimates present the percent change of the predictor for a unit change in the given dependent variable (Baranzini & Schaerer, 2007; Chongyosying, 2005; Sirmans et al., 2005).

There are a number of studies on property price on various factors. Regarding the *neighbourhood characteristics*, Mohamed (2006) indicates the effect that higher-density development could have on residential privacy, followed by, Bosworth (2007) who supported this idea that the lower-density development is quieter, and then the higher-density development is negative to the property price. Several studies indicate the significant of the land-use diversity index (LUDI) to the property price (Baranzini & Schaerer, 2007; Geoghegan et al., 1997; Poudyal et al., 2009). The LUDI is the indicator to measure the variety of the land-use in the vicinity of the properties. The results from those studies conclude that LUDI can impact both positively and negatively on the property price. In addition, Song and Knaap (2004) analyzed the impact of the prices on single-family properties when mixed land uses are included in neighbourhoods. The study finds that the property prices increase with their proximity to or with increasing amount of community parks or neighbourhood commercial land uses, while the prices tended to decrease with proximity to multifamily residential units.

In cases of studies related to *recreation features*, Henry's (1999) contribution of landscape design quality to the property price. The result indicates that the selling price is 6 % - 7 % higher if the quality of the landscape is mark as excellent rather than good. In addition, the variations in the premium depend on the different property locations. Roberts (2007) presents details of the property prices in Aberdeen, Scotland, UK. The hedonic price model is developed from a relationship between the sale price to the urban park and open space. The results show that the distance from the boundary of a park and the perimeter of the open space to the property affects the property price premium. The price premium ranges between 0.44 % - 19.97 % depending on the type of residence and park. The premium will decrease if the residential area is in close proximity to the park area due to the effects of uncontrolled activities. Additionally, several studies from Baranzini and Schaerer (2007), Kong et al. (2007), and Cho et al. (2008) indicate that the size, location, configuration, and other design features of open spaces, such as community park, lake, sport field, and other recreation area create a positive impact to the property price.

In the case of *social facilities,* Hui et al. (2007) investigated the neighbouring and environmental characteristics of a residential property price in Hong Kong. The neighbourhood amenity independent variables including accessibility, clubhouse, and greenbelt area. The results show a positive impact for most of the variables, but only greenbelts are not significant to the property price. Benefield (2009) introduces the modelling of common neighbourhood amenity as a package using the hedonic pricing approach. The results indicate that tennis courts, clubhouses, boating facilities, and golf courses significantly impact the property price ranging from 8.3 % - 10.0 %.

Moreover, for *transportation system designs*, Matthews et al. (2007) evaluates the effect of street layout and interaction of accessibility to the property price. The study indicates that a more gridiron-like street pattern reduces the property value. In addition, this study introduces the connectivity index (CI) to represent the accessibility by a ratio of total street intersections to total street segments, thus the higher the CI trends to increase the property price. While, several studies support the idea that a cu-del-sac street pattern effects the positive impact to the property price due to the reasons of safety, liveable, and sense of the community form the design pattern (Asabere & Huffman, 2009; Bally, 2010; Ben-Joseph, 1995; Song & Knaap, 2003; Southworth & Ben-Joseph, 2004). Moreover, the width of the street and pavement on both main roads and sub roads are also significant to the property price (Ben-Joseph, 2003; Clifton et al., 2008), while increasing the development cost and reducing the saleable area (Cannaday & Colwell, 1990; Johnson, 2008).

For the BMR, there are a small number of property price model studies using the hedonic pricing approach. Calhoun (2002) and Buranathanung et al. (2004) developed a property price model using the log-linear form. The dependent variable data is assessed by the Government Housing Bank (GHB) for mortgage evaluation processes. The independent variables mostly focus on the structure characteristics and their location. However, the price of properties from the mortgage evaluation process have been usually lower than the asking or selling price. Furthermore, the models need to be updated every five years.

2.3 Summary

The information above presents strong evidence to identify if there is no appropriate study on single-family property selling-price attributable to the neighbourhood designs of subdivision development in the BMR. Therefore, this study firstly applies the hedonic pricing approach to develop the total property price model. The models include a set of independent variables, including general property characteristics and their neighbourhood designs. The most suitable model from the empirical processing is used to examine the property price attributable to the neighbourhood designs. The model should support knowledge of the design impact on the property price for policy makers on making appropriate policies for urban and environmental management. Moreover, the models expect to provide guidelines for the developers on setting appropriate property selling-prices for subdivision development in the BMR. This new understanding of the property price premium attributable to neighbourhood designs could indicate support for more suitable decision making on new subdivision development in the BMR.

3. Data and Methodology

3.1 Data collection

This study collects data from a primary field survey of 50 private subdivision projects in the BMR. The sample size will follow the requirements determined by Yamane's formula, where the minimum requirement is 400 sets at 95 % confidence (1973, p. 1089). The total sample size, after extraction of the outliers, are 1,182 sales from different locations in the BMR. The dependent variable in this study is the actual property-selling price. Meanwhile, the independent variables are the set of property characteristic variables and neighbourhood design variables. Table 1 provides the variable names and their general statistic figures.

The actual property-selling and all property design variables are directly collected from the developers or project sale representatives. Meanwhile, the set of neighbourhood design variables are gathered from the drawings and their design documents. All the design drawings and their documents received permission from the developers and/or the Department of Land, Ministry of Interior. However, the selling-price and all designs are confidential, thus the names of the developers, project names, and specific locations cannot be published.

3.2 Methodology

This study applies a hedonic price model to develop the property pricing model. This study adopts the semi-logarithm function to develop the model with a variable set of general characteristics, structural characteristics, project location, lot location, and neighbourhood design. According to He et al. (2010), the semi-log function is the key situation function in the Hedonic pricing model, thus it will be adopted for use in this study. The property price model is estimated using the ordinary least squares estimation (OLS) technique. The function is presented in Equation 1.

$$Ln(P) = \beta_0 + \beta_G X_G + \beta_S X_S + \beta_{PL} X_{PL} + \beta_{LL} X_{LL} + \beta_{NAD} X_{NAD} + \varepsilon \quad [1]$$

Where *Ln(P)* is the natural logarithm of the property price, X_G corresponds to the general characteristic vector of the property, X_S corresponds to the structural characteristic vector of the property, X_{PL} corresponds to the project location vector of the property, X_{LL} corresponds to the lot location vector of the property, X_{NAD} corresponds to the neighbourhood amenity design vector of the property, β_0 is the constant term of the model, β_G, β_S, β_{PL}, β_{LL} and β_{NAD} correspond to the regression coefficient vectors of each independent variable, and ε is an error term reflecting the unobservable.

This study develops three property price models using different sets of independent variables; *Model 1* is a traditional model used for confirming the essential classical hedonic variables of the general characteristics, structural characteristics, and location characteristics. The result from *Model 1* will be used to classify the appropriate variables for the next step. Then, *Model 2* is the first alternative model that includes the neighbourhood design variables into the property price modelling experiment process. All likelihood independent variables from the existing literature will be included in the model. Finally, *Model 3* is a second alternative model that applies a stepwise regression to the development of the most appropriate property price model. *Model 3* will be used to indicate the property price attributable to the subdivision neighbourhood designs for the BMR. Names, definitions, descriptive statistics, and a brief description of the selected variables will be provided in the next section.

3.3 Selection of Model Variables

Table 1 provides the variable legends along with the definitions and the descriptive statistics. However, to avoid unnecessary repetition, only variables requiring further explanation than that provided in Table 1 will be discussed in this section.

However, this study focuses on the subdivision neighbourhood designs, but the other non-subdivision neighbourhood designs (general characteristics, structural characteristics, project location, and lot location) are included for model completion purposes.

Table 1 Legend, definition, and descriptive statistic

Variable	Definition	Mean	Standard deviation	Range
Independent Variable				
P	Total price (million Baht)	5.39	4.05	1.45–32.00
ln(P)	Natural logarithm of price	15.34	0.52	1.49-17.28
General characteristics				
SY	Sale year up to 2010	1.07	2.51	0-18
B	1 if property is developed by branded company, 0 otherwise	0.46	0.50	0,1
Structural characteristics				
LS	Land lot size (m^2)	276.19	134.38	70.80-1,112.00
DA	Dwelling area (m^2)	181.88	71.57	70.00-577.00
DP	1 if dwelling is Duplex, 0 otherwise	0.06	0.24	0,1
TH	1 if dwelling is Townhouse, 0 otherwise	0.07	0.25	0,1
Project location				
BUF	1 if property is located in BUF, 0 otherwise	0.57	0.50	0,1
BSA	1 if property is in BSA, 0 otherwise	0.08	0.27	0,1
NB	1 if property is in NB, 0 otherwise	0.08	0.27	0,1
SP	1 if property is in NP, 0 otherwise	0.02	0.13	0,1
PT	1 if property is in PT, 0 otherwise	0.15	0.35	0,1
SP	1 if property is in SP, 0 otherwise	0.03	0.16	0,1
SS	1 if property is in SS, 0 otherwise	0.05	0.22	0,1
WRP	Width of road in front of subdivision project (m)	16.04	13.92	5.20-89.00
Lot location				
LC	1 if property lot is located at corner of block, 0 otherwise	0.22	0.41	0,1
LMR	1 if property lot is located on main road, 0 otherwise	0.28	0.45	0,1
LLV	1 if property lot is located on lake-view, 0 otherwise	0.02	0.14	0,1
LPV	1 if property lot is located on park-view, 0 otherwise	0.14	0.34	0,1
Subdivision neighbourhood design Neighbourhood characteristics				
LN	Number of property lots	237.05	217.64	41-1,198
LUDI	Land-use diversity index	0.76	0.08	0.54-1.00
PUA	Property unit per subdivision area (PU/m^2) × 1,000	2.94	1.23	
NDT	Number of dwelling types	1.31	0.50	1-3
DPR	Ratio of duplexes in subdivision development			0.00-1.00
THR	Ratio of townhouses in subdivision development			0.00-1.00
NDD	Number of dwelling designs in subdivision	5.13	2.57	1-11
NPA	Number of public art in subdivision	1.20	1.71	0-15
NCR	Number of cultural and religion symbols in subdivision	0.97	0.48	0-2
UEL	1 if subdivision designed by underground electricity line,	0.03	0.16	0,1

Variable	Definition	Mean	Standard deviation	Range
	0 otherwise			
Recreation features				
PA	Park area (m^2) / 1,000	4.20	4.82	0.10-23.29
PS	1 if park shape is rectangular, 0 otherwise	0.68	0.47	0,1
PD	1 if park is centralised design type, 0 otherwise	0.77	0.42	0,1
PSA	Number of properties within radius of 300 m. to nearest park	202.55	198.12	40-1,000
PaF	Ratio of park area located in front part of project	0.39	0.44	0.00-1.00
PaM	Ratio of park area located in middle part of project	0.52	0.46	0.00-1.00
LA	Lake area (m^2) / 1,000	0.63	2.00	0.00-10.92
LaF	Ratio of lake area located in front part of project	0.04	0.18	0.00-1.00
LaM	Ratio of lake area located in middle part of project	0.10	0.27	0.00-1.00
MTN	Number of mature trees per neighbourhood area (MT/m^2) $\times 100$	0.04	0.02	
RNP	Ratio of native plants	0.81	0.04	0.75-0.90
Social facilities				
CH	1 if neighbourhood has clubhouse, 0 otherwise	0.62	0.49	0,1
SP	1 if neighbourhood has swimming pool, 0 otherwise	0.56	0.50	0,1
TC	1 if neighbourhood has tennis court, 0 otherwise	0.12	0.32	0,1
FF	1 if neighbourhood has football field, 0 otherwise	0.06	0.23	0,1
PG	1 if neighbourhood has playground, 0 otherwise	0.63	0.48	0,1
WTP	1 if neighbourhood has wastewater treatment plant, 0 otherwise	0.09	0.29	0,1
Transportation system designs				
CI	Connectivity index	1.29	0.26	0.50-1.75
GCR	Ratio of road circulation design as grid	0.37	0.37	0.00-1.00
CCR	Ratio of road circulation design as cul-de-sac	0.26	0.25	0.00-0.88
WMR	Width of main road	13.55	3.20	6.00-16.00
WSR	Width of sub road	9.37	1.36	5.00-11.00
WWM	Width of pavement at main road	1.73	0.32	1.00-2.50
WWS	Width of pavement at sub road	1.43	0.22	1.00-2.00

The sale year (SY) considers the different times of each sale. A property that was sold in 2010 is recorded as 0, one in 2009 is recorded as 1, and one in 2008 is recorded as 2.

While, brand (B) variable is a dummy variable to consider the influencing of the brand name of the property development firms in Thailand. The brand variable is recorded as 1 if the property is developed by a well-known listed company on the Stock Exchange of Thailand (SET) (SET, 2010), while recorded as 0 for the rest.

This study provides more explanation for the land-use diversity index (LUDI) and the connectivity index (CI). The LUDI variable in this study refers to the measurement of the land use variety in the subdivision. LUDI is the measurement of the land use variety in the subdivision, which is calculated by equation [2] below.

$$LUDI = -\sum_{k=1}^{K}(P_k)\ln(P_k) \qquad [2]$$

Where P_k is the proportion of the area dedicated to land use k in the subdivision. There are three types of saleable area, recreation area, and infrastructure area. A larger value of LUDI indicates more diverse land use.

Next, CI is a measurement to quantify the roadway connectivity. The CI of this study follows that of Ewing (1996), which is the ratio of the segment numbers to the intersection numbers. A higher CI number means that travelers have increased the route choice.

To conclude, the models will be developed under the recognized method. The variables and sample size will be selected by strong academic support. The results of this study will be presented in the next section.

4. Results and Discussion

The results will be divided into two sections for the total property price model and the specific property price attributable to the subdivision neighbourhood designs.

4.1 Total property price model

Table 2 presents the results of the study including the coefficient parameter estimations obtained for the OLS of all three models.

Table 2 Regression results

Variable	Coefficient					
	Model-1		Model-2		Model-3	
Interception	13.587	***	12.959	***	13.016	***
General characteristics						
SY	- 0.025	***	- 0.025	***	- 0.029	***
B	0.126	***	0.136	***	0.117	***
Structural characteristics						
LS	0.004	***	0.002	***	0.003	***
DA	0.001	***	0.001	***	0.001	***
DP	- 0.355	***	- 0.316	***	- 0.292	***
TH	- 0.658	***	- 0.647	***	- 0.588	**
Project location						
BUF	- 0.200	***	- 0.210	**	- 0.312	***
BSA	- 0.320	***	- 0.341	**	- 0.368	***
NB	- 0.313	***	- 0.312	*	- 0.345	**
SP	- 0.576	***	-0.529	*	- 0.575	**
PT	- 0.644	***	- 0.678	***	- 0.605	***
SP	- 0.430	***	- 0.423	**	- 0.502	***
SS	- 0.530	***	0.542	***	- 0.550	***
WRP	0.006	***	0.005	*	0.003	**
Lot location						
LC	0.051	***	0.046	***	0.066	***
LMR	- 0.020		0.033	***	0.065	***
LLV	0.025		0.023		0.079	***
LPV	0.009	**	0.020	**	0.093	**
Subdivision neighbourhood design variables						
Project characteristics						
NL			- 0.002	***	- 0.004	***
LUDI			1.457	***	0.576	**
PUA			- 0.005		- 0.078	***
NDT			- 0.325	***	- 0.188	***
RDP			-0.210		-0.115	*
RTH			-0.325	*	-0.232	**
NDD			0.0007		0.014	***
NPA			0.026	***	0.022	***
NCR			- 0.247		NA	
UEL			- 0.288	*	0.254	***
Recreation features						

Variable	Coefficient		
	Model-1	Model-2	Model-3
PA		0.010 ***	0.009 ***
PS		- 0.007	- 0.169 ***
PD		- 0.254 ***	- 0.097 ***
PSA		- 0.001 **	0.002 ***
PaF		0.333 ***	NA
PaM		0.101 ***	0.093 ***
LA		0.043 ***	0.110 ***
LaF		1.089 ***	NA
LaM		- 0.556 ***	NA
MTL		0.033 ***	0.019 ***
RNP		0.424 *	0.391 ***
Social facilities			
CH		0.220 ***	0.105 **
SP		0.271 ***	0.102 ***
TC		0.061	0.045 ***
FF		0.573 ***	NA
PG		0.222 ***	0.048 *
WTP		0.237 **	0.239 ***
Transportation design			
CI		0.248 ***	0.201 ***
GCR		- 0.536 ***	- 0.152 ***
CCR		0.054 *	0.023 **
WMR		0.026 ***	0.025 ***
WSR		- 0.119	0.010 *
WWM		0.018 **	0.019 ***
WWS		0.011 **	0.017 ***
R^2	0.870	0.950	0.948
Adjusted R^2	0.868	0.946	0.945
F-statistic	389.708	554.059	417.156
F-significant	0.000	0.000	0.000

Note: * Significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

The result in Table 2 indicates that all three models present high explanatory power: R^2 = 0.870 for *Model 1*, R^2 = 0.950 for *Model 2*, and R^2 = 0.948 for *Model 3*. The signs of all the independent variables are consistent with expectations. The comparison between the traditional model (*Model 1*) and the alternative models (*Model 2* and *Model 3*) shows that the R^2 of both alternative models are higher than the traditional model. Moreover, the R^2 of *Model 2* is slightly higher than that of *Model 3*, but some variables in *Model 2* are not significant at less than the 0.01 confidence level.

The results found that most of the coefficients of the non-subdivision neighbourhood designs are stable across the model. Meanwhile, some variables form the lot location category are not significant in Model 1 (*LMR* and *LLV*), while only LLV and DPT are not significant in Model 2, but all variables are significant in Model 3.

To conclude, the results strongly support all traditional variables being significant for the property price. The R^2 of Model 3 is slightly lower than the R^2 of Model 2, but all variables are significant. Thus, Model 3 is the most suitable model to predict the property price model for subdivision development in the BMR.

In Model 3, the coefficients of the classical variables show that the selling price rises by about 2.86 % annually; the price of the branded property increases by 12.41 % for similar structural and location characteristics. In addition, the property price increases by about 0.30 % and 0.10 % per 1 m^2 increase in lot size and dwelling area, respectively. The result indicates that there are significant differences in the type of dwelling: duplexes and townhouses decrease the selling price by 25.32% and 44.46%, respectively. Next, the price of properties located out of the BIC reduced by 26.80 % for BUF, 30.79 % for BSA, 29.18 % for NB, 43.73 % for NP, 45.39 % for PT, 39.47 % for SP, and 42.31 % for SS, compared to similar properties located in the BIC. In addition, the property price increased by 0.30% for every 1 m the WRP increased. Moreover, the property price increased by 6.82 %, 6.72 %, 8.22 %, and 9.75 % in cases where the lot is LC, LMR, LLV, and LPV, respectively. Nevertheless, the price reduced by 0.03 % for every 1 m away from the nearest park.

Finally, this study focuses on the effect of neighbourhood amenity design on property price, so the result of the neighbourhood amenity design variable bundles will be explained in the next section.

4.2 Property Price Attributable To Neighbourhood Amenity Design

According to Model 3, after the extraction of non-neighbourhood amenity design items, the average property price attributable to the neighbourhood amenity design is 1,130,086.16 Baht, which is about 20.24 % of the total property price. The clear explanation of the neighbourhood amenity designs effect the property price in the subdivision development for the BMR. The results are divided into four categories of neighbourhood amenity design, as in the following.

4.2.1 Project Characteristics

The coefficient in Table 3 indicates that there are five negative variables that affect the property price, which include six positive variables and one insignificant variable. A unit increase for NL drops the price by 0.36 %, while more diverse land-use (LUDI) also increases the property price. However, an increase in the PUA decreases the property price; but an increase in the NAU raises the price. Moreover, the variety of dwelling type also reduces the price, in addition a one-unit change of RDP and RTH drops the property price by 10.86 % and 20.71 %, respectively. The number of dwelling designs and public art are also significant and positive to the house price, while the number of cultural and religious symbols is not significant. Furthermore, the model indicates that the underground electrical design also added to the property price by 28.92 %. Finally, the property price in projects developed under the EIA regulation is also higher than the others by about 27.00 %.

4.2.2 Recreation Features

The park area is the most important item for the recreation feature design. The result from Model 3 indicates that an increase of 1,000 m^2 in park area can raise the property price by 0.92 %. In the same direction, the result indicates that a unit increase in PSA will lead to an increase of 0.18 % in the property price. Additionally, a park in the middle of the subdivision also increased the property price by 9.75 %, but a park in the front is not significant. On the other hand, a park with a rectangular shape and central park design does not support the property price. The price decreases by 15.55 % and 9.24 % for parks with rectangular shape and central park design, respectively. Moreover, the lake area is a voluntary design item for subdivision development (except for EIA-involved projects in the form of a flood management reservoir). The result indicates that every 1,000 m^2 increase in lake area increases the property price by 11.63 %, while the location of the lake both in front and middle areas are not significant. Finally, the model supports the importance of greenery features; both of mature trees and native plants, which also increase the property price.

4.2.3 Social Facilities

The social facilities normally increase the property price. The result from Model 3 confirms that idea, most mot social facility variables are significant and have a positive impact on the property price, and only the FF variable was not significant. The price of the property increased by 11.11 %, 10.71 %, 4.64 %, and 4.91 % for the existence of a clubhouse, swimming pool, playground, and tennis court in the subdivision development, respectively.

4.2.4 Transport System Design

The model indicates that a higher level of route choices (CI) will increase the property price by 22.26 %. However, a gridiron street ratio reduces the property price by 14.10 %, on the other hand, a cu-de-sac street plan lifted the property price by 2.31 %. Moreover, the wider the road and pavement generally increased the property price, and only the width of the sub road is not significant to the price. The model shows that a one-unit increase in the main road width, main road pavement width, and sub road pavement width could increase the property price by 2.53 %, 1.01 %, 1.90 %, and 1.72 %, respectively.

5. Conclusion

The aim of this study was firstly to develop a property-selling price for subdivision development in the BMR, and then to identify the specific property price influencing factors in neighbourhood amenity designs. The independent variables consist of classical variables on sale year, brand value, structural and location characteristic variables, and bundles of alternative neighbourhood amenity design variables. There are three semi-log hedonic price models developed in this study. However, this study prefers to use the result form Model 3 for further analysis, because the R^2 is high, slightly different from the R^2 of Model 2, and all variables are significant to the property price. The major findings of this study are as follows.

Firstly, this study confirms that the classical variables are significant to the price model. Meanwhile, the comparison of each R^2 value concludes that Model 2 and Model 3 are slightly different, while both are greater than the R^2 of Model 1. This situation confirms that the additional neighbourhood amenity design variables are necessary to improve the level of variables explainable by the model. Moreover, most of the selective alternative neighbourhood amenity design variables are significant to the property price. This situation confirms the importance of the different designs on the subdivision product. The knowledge supports information to encourage high quality neighbourhood amenity designs for the subdivision development industry for the BMR.

Secondly, this study found the ratio of property price that is influenced by the neighbourhood amenity design is about 20.24 %. This figure consists of project characteristics, recreation features, social facilities, and transportation system design. For project characteristics, the higher level of land-use diversity, number of dwelling designs, number of public art, underground electricity installation, and a project developed under the EIA-regulations have a statistically significant impact on the price. Meanwhile, the mix of dwelling types and the ratio of non-single detached houses can reduce the price. At the same time, the result finds that the larger the park and lake, along with a suitable location for the park, increase the price. Then, non-rectangular and decentralized park designs are appropriate designs to increase the property price. This study shows the strongly positive impact of all social facilities to the price. At the same time, higher level of travel choice, good proportion of traffic circulation, and wider road and pavement will support the property price.

To conclude, this study indicates that Model 3 can provide a guideline for developers on setting the appropriate property price for subdivision projects. Moreover, the proprty price attributable to neighbourhood amenity designs will be revealed to developers, designers, and other professionals, which relate to the subdivision development to understand the impact of the neighbourhood amenity design on the property price in the BMR. This study provides necessary information to support appropriate decision making on new subdivision development in the BMR.

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