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The Influence of Public Facilities on the Transaction Price of Multi-Family Residential in Xitun District

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Authors' contributions

This work was carried out in collaboration between both authors. Authors HWY and HCH proposed the research framework of the study, managed the literature searches, carried out the calculation of the diversity scores of public facilities and hierarchical linear model analysis, managed the analyses of the study, wrote the protocol and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The ratio of public area in Taiwan's multi-family residential is gradually increasing, and the items of public facilities are becoming more and more diversified. Most researches only classify them, however, it is rarely discussed how the connotation and diversity of public facilities affect residential transaction prices? This study intends to classify the public facilities in 22 multi-families residential near the Zhongke Shopping Plaza in Xitun District, Taichung City and give them diversity scores. The study uses hierarchical linear model for analysis, residential price as the dependent variable, diversity of public facilities scores as the independent variable of group-level, and public area, private area, age and floor as independent variables of individual-level. The empirical results found that floor, public area, and private area have positive and significant influence on residential transaction prices; when controlling the influence of individual-level explanatory variables on residential transaction prices, the diversity of public facilities at the group-level has a positive effect on the average residential transaction price of residential buildings.

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Keywords: Multi-family residential; residential price; ratio of public area; hierarchical linear model.

1. INTRODUCTION

With the economic growth in Taiwan in recent years, consumers have paid more and more attention to residential safety and quality of life. Therefore, in order to pursue a high sales rate, builders have increased diversified leisure facilities, which has a positive influence on residential prices and increased incentives for buying houses [1]. In the past, researches mostly focused on some of the characteristics of public facilities, discussing the relationship between each public facility and residential price, and seldom discussed the overall public facilities, including the degree of influence on residential price under different combinations of conditions such as diversity of public facilities.

Therefore, this research hopes to classify and categorize the public facilities of various buildings, and to give scores to the diversity of public facilities to obtain clearer connotation of public facilities. The hierarchical linear model is used to clarify the connotation of various public facilities and the degree of influence of the diversity of public facilities on residential price, which can be used as the references for consumers when buying the house.

2. LITERATURE REVIEW

In the past, studies have explored the relationship between public facility and residential price in multi-family residential. Wang [2] found that the public area of multi-family residential has positive and significant influence on real estate price, that is, the public facilities of multi-family residential can increase the residential value. Wen and Lin [3] also mentioned that too many public facilities may cause high management cost, which will affect consumers' willingness to purchase the real estate. It can be seen that, in general, public facilities have positive influence on residential price.

Multi-family residential in the Klang Valley area of Malaysia divided public facilities into nine categories such as religious facility, commercial facility, open entertainment facility, architectural service facility, parking facility, safety facility, enclosed entertainment facility, educational facility and social facility in the early stages [4]; Weng [5] believed that leisure facilities of multi-family residential are spaces for residents to adjust their bodies and minds or socializing, and divided the functions and characteristics of shared spaces into seven categories; Au-Yong et al. [6] pointed out through related literature review that it need to maintain the necessary high-rise residential building facilities and services. The research divided high-rise residential public facilities into eleven categories; Li [7] discussed the suitability of public service spaces in multi-family residential and proposed that the public service spaces in multi-family residential communities in recent years can be classified into three categories: leisure space, sports space, and entertainment space.

In order to explore the influence of different types of public facility on residential price, this study refers to the above-mentioned related literatures, divided public facilities of multi-family residential into six categories, and assigns diversity scores. The hierarchical linear model (HLM) is used to clarify the connotation of public facilities and the influence of overall diversity on residential transaction price.

3. METHODOLOGY

3.1 Data Collection and Research Framework

The data source of this research is the cooperation with the construction manager company, and is taken from the real estate transaction registration data announced by the Ministry of the Interior in Taiwan from April 2012 to March 2019. The data range is the transaction data of 28 multi-families residential on the street profile near the Zhongke Shopping Plaza in Xitun District, Taichung City, with a total of 3282 transaction data. During the study, transaction cases with specific transaction status or transaction cases with incorrect information were deleted. The final database has 22 multi-families residential and 2500 valid samples.

The main purpose of this research is to explore the impact of the diversity of public facilities on residential prices and uses hierarchical linear model (HLM) to analyze. The group-level variable is the diversity of public facilities in residential buildings; the individual-level variables are floor, age, public area, and private area. Fig. 1 is the research framework of this study.

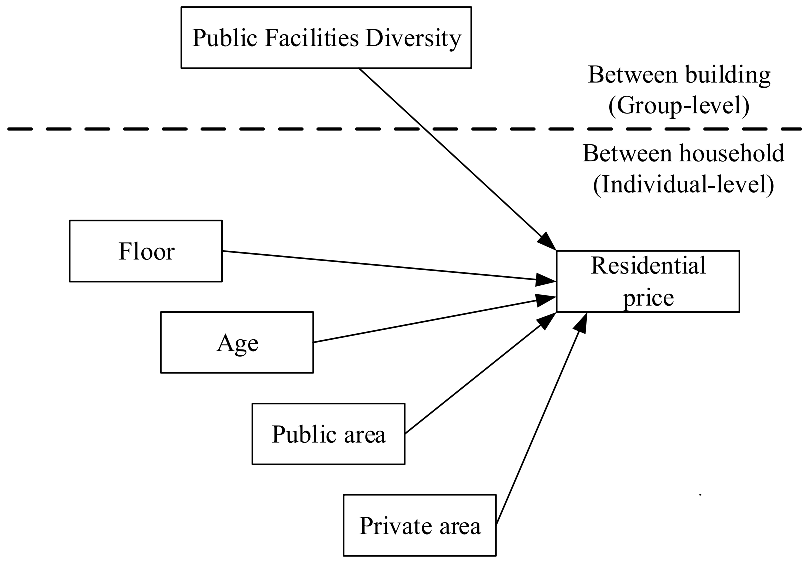

Fig. 1. Research framework of hierarchical linear model

3.1.1 Dependent variable

This research divides the residential building characteristics and residential unit characteristics of multi-family residential into group level variables and individual level variables, and uses the residential price as the dependent variable. The residential price referred to in this article is the transaction price of the residential unit minus the parking space price. Since the data spans different years, the residential prices will be adjusted through the residential transaction index.

3.1.2 Independent variable

The scope of this study is the street profile near Zhongke Shopping Plaza in Xitun District, Taichung City. The surrounding environment and quality of life in this area are similar. Therefore, this study excludes regional and neighborhood factors, takes the characteristics of the residential building itself as independent variables, and subdivides them into group level variables and individual level variables to explore the influence of those variables on the price of residential units. The independent variables adopted in this study are as follows:

3.1.2.1 Floor

Real estate has product heterogeneity. The floor of the building is different, and the ventilation, lighting, and surrounding landscape are also different. In addition, the lower floors are more susceptible to external noise and have sunlight exposure. Therefore, residential price is usually proportional to floor. This study expects that floor will have a positive and significant influence on residential price. In this study, the floor refers to the floor of the residential unit in the residential building.

3.1.2.2 Age

In the past related studies on the influencing factors of residential price, Ma and Lin [8], Shih [9], Cai [10], Cai [11], and Mao [12] have all studied the relationship between residential price and age. The results show that age is a significant factor affecting residential price, so this study expects that age has a negative and significant influence on residential price at the time of transaction.

3.1.2.3 Public area

The public area of multi-family residential does not include the area of parking spaces, and is a space shared by residents [13]. The purpose of the installation is mostly to improve the comfort of the residents; the larger the public area, the more shared facilities that can be enjoyed by residents [13]. Therefore, this study expects that public area has a positive and significant influence on the residential price.

3.1.2.4 Private area

The private area includes the area of the main building and the auxiliary building. In the real estate transaction, the private area is the most important component [13]. It is the main living space of the household [13]. This study expects that private area has a positive and significant influence on residential price.

3.1.2.5 Public facilities diversity

Public facilities diversity is the independent variable of the group level. For the calculation of diversity score, please refer to section 3.2.

3.2 Data Analysis Method

3.2.1 Diversity index of public facilities in multi-family residential

In this study, based on the presence or absence of public facilities in each multi-family residential, the scores for the diversity of public facilities in 22 multi-families residential in the neighborhood of Zhongke Shopping Plaza in Xitun District, Taichung City are calculated.

3.2.1.1 Calculation of the raw score of each public facility item

This research first calculates the number of buildings with public facilities for each project, and then subtracts the total number of buildings from the number of buildings owned, which is the original score of each public facility item. When there are more buildings with the public facility item, the facility is less unique, and the score of the public facility is lower. The formula is as follows:

$$\text{RSPFI} = \text{TNB} - \text{NBOI} \tag{1}$$

RSPFI: the raw score of the public facility item
TNB: total number of buildings
NBOI: number of buildings owning the item

3.2.1.2 Total score calculation for all types of public facilities

After calculating the raw scores of each public facility item, add the raw scores of each type of public facility project to get the total score of that type of public facility. Then add the total scores of all types of public facilities to get the total score of all types of public facilities. The formula is as follows:

$$\Sigma\ \text{RSVTPF} = \text{TSVTPF} \tag{2}$$

$$\Sigma\ \text{TSVTPF} = \text{TSATPF} \tag{3}$$

RSVTPF: raw scores of various types of public facilities
TSVTPF: total score of various types of public facilities
TSATPF: total score of all types of public facilities

3.2.1.3 Calculation of the weight of each public facility type

After calculating the total score of each type of public facility, divide the total score of that type of public facility by the total score of all types of public facilities to obtain the weight of each type of public facility. The formula is as follows:

$$\text{WEPFT} = (\text{TSVTPF}) / (\text{TSATPF}) \tag{4}$$

WEPFT: weight of each public facility type

3.2.1.4 Weighted score calculation for each public facility item

After calculating the weight of each public facility type, the original score of each public facility item is divided by the total score of the category, and then multiplied by the weight of the public facility type to obtain the weighted score of the public facility item. The formula is as follows:

$$\text{WSEPFI} = \frac{RSPFI}{TSVTPF} \times (\text{WEPFT}) \tag{5}$$

WSEPFI: weighted score of each public facility item

3.2.1.5 Diversity score of public facilities of each building

The sum of the weighted scores of the public facilities in each building is the diversity score of the building.

$$\text{DS} = \Sigma\ \text{WSPFEB} \tag{6}$$

DS: diversity score
WSPFEB: Weighted scores of public facilities in each building

3.2.2 Hierarchical linear model

Hierarchical linear model (HLM) is a form of multi-level model, which deals with and analyzes the problem of nested data through the concept of regression analysis. In the process of data analysis, the general linear model (GLM) is only suitable for the discussion of the relationship between variables at a single level, and contains only one error term. If the data structure is nested and can be divided into individual-level and group-level, it must be analyzed through a hierarchical linear model [13,14].

Residential transaction prices may be affected by both the individual characteristics of the building and the overall factors of the residential building. Therefore, in this study, the influence of individual-level and group-level variables on residential prices will be explored through the five hierarchical linear models. The five hierarchical linear models are Zero Model, One-way Analysis of Covariance Model with Random Effects, Random Coefficients Regression Model, Context Model and Means as Outcomes Regression Model. The individual characteristics of the building are placed in level 1 to measure, and the overall factor of the residential building is placed in level 2 to measure. The full model in the hierarchical linear model is as follows:

Level 1:

$$Y_{ij} = \beta_{0j} + \beta_{1j}(x_{1ij}) + \beta_{2j}(x_{2ij}) + \beta_{3j}(x_{3ij}) + \beta_{4j}(x_{4ij}) + \varepsilon_{ij} \quad (7)$$

(i=1,2,3,4,……, ni ; j=1,2,3,4,……, 22)

Level 2:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Z_j) + \mu_{0j} \quad (8)$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(Z_j) + \mu_{1j} \quad (9)$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(Z_j) + \mu_{2j} \quad (10)$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}(Z_j) + \mu_{3j} \quad (11)$$

$$\beta_{4j} = \gamma_{40} + \gamma_{41}(Z_j) + \mu_{4j} \quad (12)$$

Mixed formula:

$$Y_{ij} = \gamma_{00} + \gamma_{01}(Z_j) + \gamma_{11}(Z_j) + \gamma_{21}(Z_j) + \gamma_{31}(Z_j) + \gamma_{41}(Z_j) + \gamma_{10}(x_{1ij}) + \gamma_{20}(x_{2ij}) + \gamma_{30}(x_{3ij}) + \gamma_{40}(x_{4ij}) + \mu_{0j} + \mu_{1j}(x_{1ij}) + \mu_{2j}(x_{2ij}) + \mu_{3j}(x_{3ij}) + \mu_{4j}(x_{4ij}) + \varepsilon_{ij} \quad (13)$$

Y_{ij} is residential price for the residential unit i in the residential building j (exclude parking space price); x_{1ij}, x_{2ij}, x_{3ij} and x_{4ij} are floor, age, public area and private area of the residential unit i in the residential building j respectively; β_{1j}, β_{2j}, β_{3j} and β_{4j} are the impact degree of floor, age, public area and private area of the residential building j on residential price respectively; β_{0j} is basic residential price for the residential building j; ε_{ij} is error term of residential price for the residential unit i of the residential building j; γ_{00} is the average residential price for all residential buildings; γ_{01} is the impact degree of public facilities diversity on the residential price; Z_j is public facilities diversity for residential building j; μ_{0j}, μ_{1j}, μ_{2j}, μ_{3j} and μ_{4j} are error terms affecting β_{0j}, β_{1j}, β_{2j}, β_{3j} and β_{4j} respectively; γ_{10}, γ_{20}, γ_{30} and γ_{40} are the impact degree of floor, age, public area and private area of individual-levels of residential units in each building on the residential price respectively; γ_{11}, γ_{21}, γ_{31} and γ_{41} are the impact degree of public facilities diversity on β_{1j}, β_{2j}, β_{3j} and β_{4j} respectively.

The Zero Model is that neither the individual-level nor the group-level of the above model has any independent variables that affect residential prices. This model is used to test whether the data set can be analyzed by hierarchical linear model; The One-way Analysis of Covariance Model with Random Effects is independent variables that affect residential prices placed in the individual-level, and no variables are placed in the group-level. The concept of this model is similar to a linear regression; The Random Coefficients Regression Model is to insert independent variables that affect residential prices in the individual-level, but the effect of the group is set to be random; The setting of the Context Model is to place independent variables that affect residential prices in the individual-level, and place overall variable that affect residential prices in the group-level, and set the effect as the random effect. The setting of the Means as Outcomes Regression Model is that no variables are placed in the individual-level, and the contextual variable that affects residential prices is placed in the group-level, and the model is set as the fixed effect.

4. RESEARCH FINDINGS AND DISCUSSION

4.1 Diversity Index of Public Facilities in Multi-Family Residential

4.1.1 Calculation of the raw score of each public facility and the total score of each type of public facility

This study assigns public facilities type and project code, and calculate the original score of each public facility and the total score of each type of public facilities as shown in Table 1.

Table 1. Calculation of raw score

Types of Public Facility	Symbol	Public Facility Item	Symbol	Calculating Original Score	Total Score
Water Related Facilities	A	Radiator	A1	22-22=0	36
		Water Meter Room	A2	22-3=19	
		Sewage Treatment Plant	A3	22-22=0	
		Water Supply Room	A4	22-22=0	
		Swimming Pool Machine Room	A5	22-5=17	
Electricity Related Facilities	B	Mechanical and Electrical Equipment Space	B1	22-18=4	57
		Power Distribution Room	B2	22-22=0	
		Generator Room	B3	22-22=0	
		Landscape Machine Room	B4	22-5=17	
		Telecom Room	B5	22-6=16	
		Relay Room	B6	22-22=0	
		Electric Instrument Room	B7	22-2=20	
		Elevator	B8	22-22=0	
		Elevator Machine Room	B9	22-22=0	
Safety and Fire Protection Facilities	C	Air-raid Shelter	C1	22-22=0	38
		Disaster Prevention Center	C2	22-14=8	
		Smoke Exhaust Room	C3	22-14=8	
		Emergency Elevator	C4	22-14=8	
		Firefighting Equipment Room	C5	22-22=0	
		Specially Safe Stairs	C6	22-14=8	
		Ventilation Duct	C7	22-16=6	
		Management Service Space	C8	22-22=0	
		Escape Ladder	C9	22-22=0	
Social Service Space	D	Lobby	D1	22-11=11	110
		Management Committee Space	D2	22-7=15	
		Environmental Resource Room	D3	22-5=17	
		Hall	D4	22-7=15	
		Social Plaza	D5	22-8=14	
		Staircase	D6	22-22=0	
		Veranda	D7	22-4=18	
		Porch	D8	22-2=20	
		Aisle	D9	22-22=0	
Sport Space	E	Fitness Center	E1	22-1=21	38
		Swimming Pool	E2	22-5=17	
Leisure and Entertainment Space	F	Roof type Open Space Along the Street	F1	22-4=18	140
		Roof type Square Open Space	F2	22-5=17	
		Audiovisual Room	F3	22-1=21	
		Recreation Room	F4	22-1=21	
		Roof Terrace	F5	22-1=21	
		Landscape Pool	F6	22-1=21	
		Rest Pavilion	F7	22-1=21	

4.1.2 Calculation of the weight of each public facility type

Table 2 shows the weight calculation of each public facility type.

4.1.3 Weighted score calculation for each public facility

The weighted scores of each public facility are calculated as shown in Table 3.

4.1.4 Calculation of the diversity score of public facilities in each building

This study calculates the diversity score of public facilities of each building as shown in Table 4.

The higher the score indicates that the type and quantity of public facilities is more abundant in the building.

After calculating the diversity score of public facilities, it is found that the public facilities diversity score of "Tai Zi Yun Shi Ji Special Zone A" is 0.5897, which is the highest in the research area; The public facilities diversity scores of " Li Jing Tian Di - Zhai Xing" and "Yu Jing Jiang Shan" are 0.0000, which are the lowest in the research range, which means that the types and number of public facilities are poorer than other buildings. After statistically sorting out the diversity scores of public facilities according to time, it is found that the diversity scores of public facilities are increasing year by year. It means that the types and quantities of public facilities will become more and more diversified and abundant due to the evolution of time.

4.2 Analysis Results of HLM

Table 5 shows the parameter estimation results of hierarchical linear model. The results of Model A show that the total average transaction price of residential units in residential buildings within the research area is 9.438 (NT million dollars). The average variance of residential transaction prices among residential buildings is 18.933, and the average variance of residential transaction prices among residential units in residential buildings is 3.543. The ICC is calculated to be 0.842 (ICC=18.933/ (3.543+18.933)), which means that all independent variables in the study can explain the residential price variable of 84.2%. After analysis by the Zero Model, it is shown that the average residential transaction price of each group (between residential buildings) is significantly different. The analysis results of Model B and Model C show that age, public area, and private area in the individual-level all have significant positive influence on residential transaction price, which means that if these variables increase by one unit each, the transaction price of residential houses will also increase, and after controlling for the influence of all variables in the individual-level on residential prices, the average residential transaction prices of each group (between residential buildings) still have significant differences.

Model D puts the variables of the diversity of public facilities in the group-level, and at the same time puts various independent variables that affect residential prices in the individual-level. The analysis results show that the diversity of public facilities has positive and significant influence on the residential transaction prices of residential buildings. The only variable in the individual-level is age which does not have significant impact on residential prices. After controlling the influence of all the variables in the individual-level and the group-level on residential prices, the average residential transaction prices of each group (between residential buildings) still have significant differences. The analysis results of the random effects of Model C and Model D show that the variations of private area and public area are not significant in Model C and the variation of private area is not significant in Model D. From the results of Model D, it can see that the degree of influence of floor, age and public area on the residential transaction prices among residential buildings are significantly different.

Table 2. Weight calculation of public facility type

Symbol	Total Number of Items of the Type	Total Raw Scores of the Type	Total Score of All Types	Weight of the Type
A	5	36	419	36÷419=0.0859
B	9	57	419	57÷419=0.1361
C	9	38	419	38÷419=0.0907
D	9	110	419	110÷419=0.2625
E	2	38	419	38÷419=0.0907
F	7	140	419	140÷419=0.3341

Table 3. Weighted score of each public facility

Symbol	Items Raw Score	Types Total Score	Weighted Scores of Public Facilities Items
A1	0	36	0÷36×0.0859=0
A2	19	36	19÷36×0.0859=0.0453
A3	0	36	0÷36×0.0859=0
A4	0	36	0÷36×0.0859=0
A5	17	36	17÷36×0.0859=0.0406
B1	4	57	4÷57×0.1361=0.0096
B2	0	57	0÷57×0.1361=0
B3	0	57	0÷57×0.1361=0
B4	17	57	17÷57×0.1361=0.0406
B5	16	57	16÷57×0.1361=0.0382
B6	0	57	0÷57×0.1361=0
B7	20	57	20÷57×0.1361=0.0477
B8	0	57	0÷57×0.1361=0
B9	0	57	0÷57×0.1361=0
C1	0	38	0÷38×0.0907=0
C2	8	38	8÷38×0.0907=0.0191
C3	8	38	8÷38×0.0907=0.0191
C4	8	38	8÷38×0.0907=0.0191
C5	0	38	0÷38×0.0907=0
C6	8	38	8÷38×0.0907=0.0191
C7	6	38	6÷38×0.0907=0.0143
C8	0	38	0÷38×0.0907=0
C9	0	38	0÷38×0.0907=0
D1	11	110	11÷110×0.2625=0.0263
D2	15	110	15÷110×0.2625=0.0358
D3	17	110	17÷110×0.2625=0.0406
D4	15	110	15÷110×0.2625=0.0358
D5	14	110	14÷110×0.2625=0.0334
D6	0	110	0÷110×0.2625=0
D7	18	110	18÷110×0.2625=0.0429
D8	20	110	20÷110×0.2625=0.0477
D9	0	110	0÷110×0.2625=0
E1	21	38	21÷38×0.0907=0.0501
E2	17	38	17÷38×0.0907=0.0406
F1	18	140	18÷140×0.3341=0.0430
F2	17	140	17÷140×0.3341=0.0406
F3	21	140	21÷140×0.3341=0.0501
F4	21	140	21÷140×0.3341=0.0501
F5	21	140	21÷140×0.3341=0.0501
F6	21	140	21÷140×0.3341=0.0501
F7	21	140	21÷140×0.3341=0.0501

From the above analysis, it can be seen that when there are influencing variables in the individual-level, the diversity of public facilities in the group-level has significant positive impact on residential prices. However, the analysis results of Model E show that without any influencing variables in the individual-level, the diversity of public facilities in the group-level has not significant influence on residential prices.

Comparing the analysis results of each model with the Zero Model, the σ^2 of Model B is reduced to 1.070 and it can explain that the percentage of variance on the price of residential units in each residential building is 69.8% ((3.543-1.070)/(3.543)), the σ^2 of Model C is reduced to 0.558 and it can explain that the percentage of variance on the price of residential units in each residential building is 84.2%

((3.543-0.558)/(3.543)), the σ^2 of Model D is reduced to 0.558 and it can explain that the percentage of variance on the price of residential units in each residential building is 84.2% ((3.543-0.558)/(3.543)). Among the AIC values, the AIC value of Model D (5980.485) is the lowest, and the AIC value of Model A (10383.243) is the highest, and the AIC value of Model E (10377.271) is only slightly lower than Model A. Therefore, from the foregoing results, among all the models, model D has the best fit. The conditions setting of each model are different, so the influence of each variable on the residential transaction prices is also different. The comparison of analysis results is shown in Table 5.

Table 4. Diversity score of public facilities of each building

Building Name	Public Facilities Diversity Score	Year of Construction
W Era	0.4417	2015
Tai Zi Yun Shi Ji Special Zone A	0.5897	2012
Tai Zi Yun Shi Ji Zone A	0.5706	2011
Hong Tai Shang Cheng	0.3938	2011
Tai Zi Yun Shi Ji Zone B	0.5229	2011
Tai Zi Yun Shi Ji Zone C	0.5229	2011
Xin Du Bai	0.3342	2007
Shi Ji Kai Yue	0.1624	2006
Zong Tai Ru Lai	0.1504	2006
Lan Hai Di Guo	0.1337	2006
Mei Li Jing Jie	0.1600	2006
Tian Han	0.1743	2005
Zong Tai Guan Kuo	0.2411	2005
Fu Yu Upstart Special Zone	0.1361	2005
Fu Yu Leader Special Zone	0.0836	2005
Tang An Ju	0.0597	1996
Zhong Ke Li Ren	0.0096	1992
Sheng Ming Zhi Quan	0.0096	1989
Dong Hai Luo Man Lan	0.0501	1989
Li Jing Tian Di - Zhai Xing	0.0000	1989
Yu Jing Jiang Shan	0.0000	1989
Li Jing Tian Di - Ying Xi	0.0358	1989

Table 5. Comparison of HLMs

Parameter estimates	Model A	Model B	Model C	Model D	Model E
Fixed effect					
γ_{00} (average residential transaction price for all residential buildings)	9.438 (p<0.001)	8.414 (p<0.001)	8.984 (p<0.001)	7.665 (p<0.001)	8.387 (p<0.001)
Context variable /explaining variable					
γ_{01} (public facilities diversity)				4.867 (p=0.039)	4.791 (p=0.322)
Intercept					
γ_{10} (floor)		0.057 (p<0.001)	0.054 (p=0.001)	0.054 (p=0.001)	
γ_{20} (age)		-0.001 (p=0.937)	-0.009 (p=0.923)	-0.002 (p=0.983)	
γ_{30} (public area)		0.388 (p<0.001)	0.267 (p=0.017)	0.201 (p=0.070)	

Parameter estimates	Model A	Model B	Model C	Model D	Model E
Fixed effect					
γ_{40} (private area)		0.133 (p<0.001)	0.167 (p=0.003)	0.193 (p=0.004)	
Random effect					
μ_{0j} variation τ_{00}	18.933 (p=0.001)	2.756 (p=0.002)	3.351 (p=0.018)	2.446 (p=0.029)	18.890 (p=0.002)
μ_{1j} variation τ_{11}			0.003 (p=0.012)	0.003 (p=0.013)	
μ_{2j} variation τ_{22}			0.166 (p=0.002)	0.167 (p=0.002)	
μ_{3j} variation τ_{33}			0.039 (p=0.105)	0.046 (p=0.086)	
μ_{4j} variation τ_{44}			0.002 (p=0.546)	0.001 (p=0.675)	
ε_{ij} variation σ^2	3.543	1.070	0.558	0.558	3.543
AIC	10383.243	7401.510	5988.331	5980.485	10377.271

5. CONCLUSION

The total average residential transaction price of residential buildings in this research area is NT 9.438 million dollars, that is, the basic value of residential building transaction prices in this area is NT 9.438 million dollars. When considering the fixed effect of variables at the individual level, for every additional unit of floor, public area, and private area, the transaction price of residential units can increase by NT 0.057 million dollars, NT 0.388 million dollars, and NT 0.133 million dollars, respectively. For residential transaction prices, these variables are all positive effects. After considering the random effects at the individual level, for every additional unit of floor, public area, and private area, the transaction price of residential units can increase by NT 0.054 million dollars, NT 0.267 million dollars, and NT 0.167 million dollars, respectively.

Under the conditions of setting fixed effects and random effects, age does not have significant influence on the residential prices. When the individual-level is put into independent variables, the diversity of public facilities in the group-level will have significant positive impact on residential prices. The diversity of public facilities increases by one unit (a unit referred to here is 0.0001 points), and the average residential transaction price of each residential building can increase by NT 4.867 million dollars. However, if the diversity of public facilities is only included in the group-level, and there are not influencing variables included in the individual-level, the diversity of public facilities will not have significant impact on residential prices. That is to say, the diversity of public facilities can have positive and significant impact on residential prices through individual characteristics, but cannot directly have positive and significant impact on residential prices.

Therefore, this study explored the extent to which the public facilities of multi-family residential affect the transaction price of residential units. From the above results, the public area will have a positive and significant influence, and the degree of influence will vary under different circumstances; The diversity of public facilities needs to consider floor, age, public area, and private area at the same time, to have a positive and significant influence on the transaction price of residential units.

The limitation of this research is that the data source is taken from real-price login data, and the information of variable that can be obtained is limited. In addition to the variables used in this research, there may be other factors that affect residential prices. Due to the limited number of samples, it is impossible to construct full hierarchical linear model.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chen SM, Lin PH. A study of the correlation among community management services, residents' satisfaction towards the services and property values. Journal of Architecture. 2013;86:191-205. Chinese.

2. Wang YW. Discussion on the way of housing pricing method. Master's Thesis of Department of Land Economics, Chengchi University, Taiwan; 2018. Chinese.
3. Wen SL, Lin CY. A study on the relationship between facilities type and maintenance fee for collective housing community in Taipei. Proceedings of the Third Property Management Research Achievement Conference of Taiwan Property Management Association; 2009. Chinese.
4. Rashidah S, Che-Ani AI, Sairi A, Tawil NM. Classification of high-rise residential building facilities: A descriptive survey on 170 housing scheme in Klang Valley. MATEC Web of Conferences 66:00103. Malaysia; 2016.
5. Weng GC. A study on the utility & management of the "common space" of inner court amalgamated dwelling --Use the fourth and fifth conciliation in Taichung as an example. Master's Thesis of Department of Architecture, Tunghai University, Taiwan; 1993. Chinese.
6. Au-Yong CP, Ali AS, Chua SJL, Che-Ani AI. Maintenance interval towards different facilities and services in high-rise housing, Malaysia; 2019.
7. Li CY. A preliminary study on architecture programming strategies— base on researching suitability of public service space for congregate housing. Master's Thesis of Department of Civil Engineering, Taiwan University, Taiwan; 2015. Chinese.
8. Lin CC, Ma YC. An application of mass appraisal and the hedonic equation in the real estate market in Taiwan. Journal of Housing Studies. 2007;16(2):1-22. Chinese.
9. Shih FH. The impact of high density development on housing prices— an example of Taipei City. Master's Thesis of Department of Land Economics, Chengchi University, Taiwan; 2008. Chinese.
10. Cai CL. Attribute price of residential properties in Neihu district of Taipei City. Master's Thesis of Department of Civil Engineering, Taiwan University, Taiwan; 2008. Chinese.
11. Cai YC. A study on the factors which affect the real estate values: Pei-tuo, Shi-Tuo, Nan-tuo, Central, and East District in the Taichung City. Master's Thesis of Department of Finance, Chaoyang University of Technology, Taiwan; 2009. Chinese.
12. Mao LZ. Characteristic analysis of the housing price-taking urban area of Kaohsiung as an example. Journal of Commercial Modernization. 2010;5(3):31-48. Chinese.
13. Yang HW, Hsieh HC. Effect of private and common areas on transaction price for collective housing. Journal of Business & Economic Policy. 2020;7(1):43-51.
14. Wen FH, Qiu HJ. Methodology of multilevel modeling: The key issues and their solutions of hierarchical linear modeling. NTU Management Review. 2009;19(2):263-293. Chinese.

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