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The influence of public facilities and environmental quality on residential satisfaction in Taiwan: Differences in neighborhood environment

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With reference to the residential survey data provided by the Directorate-General of Budget, Accounting, and Statistics of the Executive Yuan, this study investigates the influence of public facilities and environmental quality on residential satisfaction in the Greater Taipei area. First, in-house environment, convenience, sports and leisure, security, environmental quality and house defects are extracted through factor analysis. Second, factors affecting residential satisfaction are used to create two regression models. The results show that in-house environment, security, sports and leisure, and environmental quality have a significant effect on residential satisfaction. Finally, analysis models of random variance and covariance of single factors indicate that the average residential satisfaction levels of the various villages and towns are significantly different. However, after controlling for satisfaction with the individual variables including in-house environment, convenience, sports and leisure, security, and environment quality, the average residential satisfaction of villages and towns is not significantly different. This finding proves that the above variables indeed represent the important factors that influence overall residential satisfaction.

Key words: Public facilities, environmental quality, residential satisfaction.

INTRODUCTION

A house is an enclosed shelter where people live. In addition to a house, local public facilities are also necessary to create a good living environment. As time progresses, residents pay increasing attention to public facilities surrounding their houses because they realize that the construction of public facilities can increase their quality of life. Advancements in science and technology including electricity, nuclear energy and thermal power, among others, have improved residential living quality and increased convenience but have also led to a situation referred to as NIMBY (not in my backyard). For example, nuclear energy affects both nature and the ecological environment; therefore, local residents are often unwilling to allow the construction of nuclear power plants near their homes. This situation has caused various levels of the Taiwanese government to become interested in determining the influence of public facilities and environmental quality on residential satisfaction.

The World Health Organization (WHO) proposed four environmental quality principles: health, safety, convenience and amenity. Ha and Weber (1994) suggested seven quality dimensions including: environmental safety, planning/landscaping, housing policy, socio-cultural environment, public services, housing economics, and physical quality of housing, and these dimensions can serve as a reference for housing policy makers. Vera-Toscano and Ateca-Amestoy (2008) discussed the influence of four dimensions (individual and housing characteristics, neighborhood and location, individual views on neighborhood, and social network) on residential satisfaction. Their results indicated that individual and housing characteristics, neighborhood and location

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can affect residential satisfaction. In sum, studies on residential satisfaction are not limited to individual and housing characteristics. Further studies on the neighborhood environment are necessary to evaluate the development of residential satisfaction.

Previous studies on housing quality only focused on the relationship between housing types and price or the housing quality index. In addition, researchers often discuss housing selection behavior from customers' point of view and analyze differences in perception and customer preferences. There are few in-depth studies on the influence of the neighborhood environment and public facilities on residential satisfaction. From the viewpoint of the neighborhood environment, this paper aims to discuss the influence of the in-house environment, safety, environment quality, convenience and sports and leisure on overall residential satisfaction; in addition to housing characteristics, consideration is given to neighborhood environment. As such, public facilities and environmental quality serve as contributing factors in the analysis of residential satisfaction.

LITERATURE REVIEW

The neighborhood environment often refers to facilities for daily public use and service. Heimstra and Mcfarling (1987) divided the residential environment into the artificial environment and the physical environment, where the latter refers to landforms, air, soil, water quality, noise, and plant and animal ecology. This reveals the implications of the neighborhood environment on one's lifestyle because environmental quality is an important aspect of the concept of life quality. Perceived environmental quality reflects individual feelings on various aspects of welfare, and constitutes the perception of residential satisfaction (Van Poll, 1997; Van Praag and Ferrer-i-Carbonell, 2004). Hui et al. (2007) evaluated the residential quality of life in Hong Kong and indicated that residents were willing to improve their neighborhood environmental quality at higher costs.

Residential satisfaction can be defined as residents' pleasure and satisfaction in their places of residence. The psychological components include perception, affection and behavior, where both perception and affection represent variables such as residential environment quality and neighborhood attachment. Previous studies have indicated that residential environment has a positive direct impact on neighborhood attachment (Bonaiuto et al., 1999, 2003, 2006).

Ha and Weber (1994) used residential environment quality to measure people's satisfaction with their residential or surrounding environments. Lercher (2003) suggested that health and life quality often follow environmental quality and used satisfaction or pleasure as evaluative results. That study demonstrated that residential environment quality is positively correlated with residential satisfaction.

Residential quality satisfaction can be analyzed in terms of both the in-house and the out-of-house environments. Many previous studies have discussed the evaluation index of exterior environmental quality and suggested relevant impact indicators. The most common conventional indicators in Taiwan are proximity to junior high and elementary schools, to a business district, to neighborhood facilities, to one's workplace, to the public transportation system, to hospitals, and to civil services (Andriantiatsaholiniaina et al, 2004; Oh and Jeong, 2002).

Türkoğlu (1997) analyzed residential environmental satisfaction using multiple regression and predicted satisfaction in terms of housing and neighborhood characteristics. Kellekci and Berkoz (2006) used factor analysis to evaluate the relationship between residential satisfaction and environmental quality and indicated that housing accessibility, maintainability of the residential environment, quality of the leisure environment, structural safety of the residential environment and good neighborhood relationships have significant and direct effects on residential satisfaction.

In studies employing the hedonic price model, ordinary least squares (OLS) is often used as the evaluation tool, but this method ignores the hierarchical characteristics of housing, that is, spatial dependence and heterogeneity. The current study uses hierarchical linear modeling (HLM) as the evaluation tool. In previous research, OLS was often used to evaluate the hedonic price model, but this method neglected the data characteristics of different hierarchies. For example, regional characteristics (overall characteristics) and housing characteristics (individual) were regarded as a single level, resulting in greater parametric deviation and incorrect conclusions. Hierarchical Linear Modeling (HLM) is a statistical technique that applies regression theory to multilevel data analysis. HLM has been used as an analytical method in studies on education, which adopted a hierarchy concept (Raudenbush, 1993).

Many recent studies have applied HLM to the relationship between environmental quality and housing price. Van Poll (1997) reviewed past empirical and theoretical studies on the topic and proposed a hierarchical multi-attribute model of urban residential quality. The study suggested that overall residential satisfaction stems from satisfaction with the neighborhood, housing and neighbors, where neighborhood satisfaction is a key factor in community satisfaction; and housing satisfaction includes satisfaction with housing price, facilities, maintenance and size. Further, neighborhood satisfaction consists of seven aspects: noise, smell, air/water/soil pollution, garbage, security threat, crowding and lack of public faculties.

In contrast, Brown and Uyar (2004), Goodman and Thibodeau (1998) and Uyar and Brown, (2007) investigated housing prices using HLM. Uyar and Brown (2007) indicated that the hedonic price model is often used to analyze housing prices but the cross-level effect and the hierarchical characteristics of the housing market are rarely considered. Therefore, they adopted HLM to discuss the influence of housing characteristics, neighborhood affluence and academic achievements on housing price. Their results indicated that neighborhood affluence and academic achievements could affect housing prices.

In terms of the issues that affect residential environment satisfaction, Heimstra and Mcfarling (1987) suggested the cross-correlation of the environment factor and the behavioral factor from the point of view of environmental behavior, and the results indicated that better spatial quality leads to higher residential satisfaction. Some other previous studies have argued that policy decisions are motivated by the search for better residential satisfaction during relocations, and that when housing and neighborhood environments exhibit good quality, the relocation tendency is lower (Michalos, 1996; Stinner and Loon, 1992; Varady, 1983).

In sum, residential satisfaction and neighborhood environment are closely correlated. In addition to housing characteristics, the potential effects of the exterior environment should be considered, especially in terms of the influence of public facilities and environmental quality on residential satisfaction, to better estimate the substantial correlation between satisfaction and derivative demands.

METHODOLOGY

Empirical modeling

This paper adopts the regression method to estimate the influence of public facilities and neighborhood environment on overall residential satisfaction and housing characteristics. In-house facilities or equipment and other variables serve as control variables. The empirical model is as follows:

$$\mathrm{Sat} = \alpha_0 + \alpha_1 \mathrm{Inhouse} + \alpha_2 \mathrm{Safe} + \alpha_3 \mathrm{Envi} + \alpha_4 \mathrm{Conv} + \alpha_5 \mathrm{Leis} + \varepsilon \qquad (1)$$

In Equation 1, satisfaction with in-house environment (*Inhouse*), residential safety (*Safe*), environment quality (*Envi*), convenience (*Conv*), sports and leisure (*Leis*), and other variables are added together. The variable coefficients are expected to have positive values. ε , is the error term, and a normal distribution is assumed. Next, considering housing characteristics, in-house facilities or equipment and management costs, the equation becomes:

$$\begin{aligned}\mathrm{Sat} = {} & \alpha_0 + \alpha_1 \mathrm{Inhouse} + \alpha_2 \mathrm{Safe} + \alpha_3 \mathrm{Envi} + \alpha_4 \mathrm{Conv} + \alpha_5 \mathrm{Leis} + \alpha_6 \mathrm{Room} + \alpha_7 \mathrm{Age} \\ & + \alpha_8 \mathrm{Livroom} + \alpha_9 \mathrm{Dfloor} + \alpha_{10} \mathrm{Build} + \alpha_{11} \mathrm{Stru} + \alpha_{12} \mathrm{TV} + \alpha_{13} \mathrm{Internet} + \alpha_{14} \mathrm{Airc} \\ & + \alpha_{15} \mathrm{Saeq} + \alpha_{16} \mathrm{Eleva} + \alpha_{17} \mathrm{Mgmt} + \theta \end{aligned} \qquad (2)$$

Where θ is the error term and normal distribution is is assumed.

Equation 2 includes the number of rooms (*Room*), and the coefficients are expected to be positive values. The coefficient of house age (Age) is expected to be negative, while the coefficient of number of living rooms (*Livroom*) is expected to be positive. Floor (*Dfloor*) is a dummy variable where the first floor is set as 1, and other floors are set as 0. Thus, the coefficient is expected to be positive. The total number of floors (*Build*) is a dummy variable, and the floors above the sixth floor are set as 1, while those below the sixth floor are set as 0; the coefficient is expected to be positive. The building structure (*Stru*) is also a dummy variable: a steel frame or reinforced concrete structure is set as 1 while other structures are set as 0; and the coefficient is expected to be positive. In-house equipment has five variables: TV, Internet, air-conditioning (Airc), safety equipment (*Saeq*) and elevators (*Eleva*); all are dummy variables.

The presence of equipment is set as 1 and 0 otherwise. Thus, the coefficients of all five variables are expected to be positive. Finally, management cost (*Mgmt*) is a dummy variable: the presence of a management cost is set as 1, and the lack of that cost is set as 0. This coefficient is also expected to be positive.

The hierarchical linear model is used to analyze whether residential satisfaction differs among various villages and towns with and without the inclusion of individual in-house environment, residential safety, environment quality, convenience and sports and leisure in the model. During the HLM analysis process, the null-model is used to verify whether the groups (villages and towns) differ, to estimate how many variations are caused by inter-group variations for comparison with other models, and to consider whether HLM or general regression analysis can be used (Kreft and Leeuw, 1998). This model is a one-way ANOVA with random effects, as follows:

$$Level1\ \ Sat_{ij} = \beta_{0j} + r_{ij}\ \ ,\ \ r_{ij} \sim \mathrm{N}(0, \sigma^2) \qquad (3)$$

$$Level2\ \ \beta_{0\mathrm{j}} = \gamma_{00} + u_{0j}\ \ ,\ \ u_{0j} \sim \mathrm{N}(0, \tau_{00}) \qquad (4)$$

Where *i* denotes the sample number of investigated households; *j* is the township number; Sat_{ij} is residential satisfaction with the i^{th} house in the j^{th} township; β_{0j} is the group mean of housing satisfaction in the j^{th} township; and σ^2 is the variable of r_{ij} (variation within the group). Further, γ_{00} is the grand mean of residential satisfaction for all townships; u_{0j} is the difference between the group mean and grand mean of residential satisfaction for all townships; and τ_{00} is the variable of u_{0j} (inter-group variation).

Equation 3 is a simple regression excluding all independent variables. β_{0j} denotes the group mean of residential satisfaction for all townships divided into the grand mean (γ_{00}) of residential satisfaction for all townships and the difference between the group mean and grand mean (u_{0j}) of residential satisfaction in all townships. Thus, the random variable u_{0j} includes information on the difference between the group mean of residential satisfaction for all townships. Then Equation 4 is substituted into Equation 3 to get the mixed model:

$$Sat_{ij} = \gamma_{00} + u_{0j} + r_{ij} \qquad (5)$$

Equation 5 can be regarded as an ANOVA to verify whether the group mean of residential satisfaction for each township differs, that is, to verify whether the difference (the within-group or the regional difference, r_{ij}) between residential satisfaction and the group mean of residential satisfaction for each township is greater than the difference (inter-group difference or inter-region difference,

μ_{0j}) between the group mean and the grand mean of residential satisfaction for each township. If the verification result of the inter-group variation (that is, the random component) is significant, then the group mean of residential satisfaction differs among the various townships. Thus, differences between townships should be considered.

However, if the verification result is insignificant, minor differences can be excluded. The data are regarded as single-level, and Equation 3 can be used to make estimates. When the group mean differs from the mean of residential satisfaction for individual townships, Equation 5 is used to allow the townships to have different regression equations.

In the null model, $Var(Sat_{ij}) = Var(u_{0j} + r_{ij}) = \tau_{00} + \sigma^2$:

Let $\rho = \tau_{00} / (\tau_{00} + \sigma^2)$, then ρ is called the intraclass correlation coefficient (ICC) or cluster effect (Raudenbush and Bryk, 2002). The coefficient can be used to describe the percentage of inter-group variation within the total variation, that is, the interpretation degree of the dependent variables using inter-group differences, and this can reveal any existing correlation between the dependent variables and the inter-group differences. For example, in this study, coefficients within group (ρ) represent the percentage of variation affecting residential satisfaction in all townships in terms of the total variation affecting residential satisfaction. It is then assumed that the intercept of Level 1 changes for all townships, but the slope of Level 1 does not change. If we assume that different townships have a different group mean of residential satisfaction and that the influence of in-house environment, safety, environment quality, convenience, and sports and leisure in the townships on overall residential satisfaction is identical, the one-way random effect ANCOVA can be used for verification. It is presented as follows:

$$Level1\ Sat_{ij} = \beta_{0j} + \beta_{1j} Inhouse_{ij} + \beta_{2j} Safe_{ij} + \beta_{3j} Envi_{ij} + \beta_{4j} Convi_{ij} + \beta_{5j} Leis_{ij} + r_{ij} \quad (6)$$

$$Level2\ \beta_{0j} = \gamma_{00} + u_{0j} \quad (7)$$

$$\beta_{1j} = \gamma_{10} \quad (8)$$

$$\beta_{2j} = \gamma_{20} \quad (9)$$

$$\beta_{3j} = \gamma_{30} \quad (10)$$

$$\beta_{4j} = \gamma_{40} \quad (11)$$

$$\beta_{5j} = \gamma_{50} \quad (12)$$

Variable definitions and descriptions

This study suggests that in-house environment, surrounding environment (safety, environmental quality, convenience, and sports and leisure), housing characteristics (number of rooms, house age, number of living rooms, number of floors and building structure), in-house equipment (TV, internet, air conditioning, safety equipment and elevators), and management costs are the predominant factors that affect residential satisfaction. Definitions of these variables are shown in Table 1.

DATA COLLECTION AND SAMPLE STATISTICS

This section details the empirical data collection, sample statistics, and factor analysis to verify the accuracy and validity of the measurement scale.

Data collection

The research data were sourced from the "2006 Resident Questionnaire of the Construction and Planning Agency, MOI," and the samples were sourced from the original data. This study investigated 25 administrative districts in Taiwan using stratified proportional sampling. The sampled population was 2005 door-plates of households in villages. Sampling data were provided by the MOI, and the total number of samples was 20,886. This study covered the Greater Taipei area including Taipei City and 32 townships in Taipei County.

The samples of cluster houses of leaseholders amounted to 425, and these were also used for empirical analysis. Further, real estate prices vary greatly across geographical locations, so observed values may include many outliers. To lessen their impact on statistics and inferences, townships with less than five samples were eliminated, the 5% of the data that included the highest and lowest prices were deleted, and DFFITS was used to delete sample outliers. As such, only 408 samples remained for analysis.

In the aforementioned 2006 Resident Questionnaire, satisfaction with the in-house environment pertained to the following variables: living area, ventilation, lighting, sound insulation, privacy, drainage pipelines, house arrangement, water leakages, and cracks. Satisfaction with residential safety included the following: drainage, water accumulation and flooding, fire concerns, frequency of surrounding traffic accidents and thefts, mixed residential and commercial use, community and neighborhood interaction, and community management and maintenance.

Satisfaction with environmental quality included: air pollution, noise interference, environmental sanitation, garbage collection and quality of potable water. Satisfaction with convenience included: external transportation, shopping, hospitals, junior high schools and elementary schools, post offices or financial institutions. Finally, satisfaction with sports and leisure pertained to: park land, sports venues, library or art districts, and landscape and community beautification. Satisfaction questions were answered on 5-point Likert scales where "5" denoted very satisfied, none and very convenient; "4" denoted satisfied, slight, and convenient; "3" denoted average, accepted and tolerable; "2" denoted dissatisfied, serious and inconvenient; and "1" denoted very dissatisfied, very serious and very inconvenient.

Sample statistics

From Table 2, we see that for in-house environment, the mean values for water leakages and cracks are 4.15 and 4.09, respectively, indicating satisfied and very satisfied responses. The mean values for sound insulation, pipelines and house arrangement are 3.16, 3.41 and 3.45, respectively, indicating average and satisfied responses. As for home safety, the mean values for drainage, water accumulation and flooding, fire concerns and frequency of nearby traffic accidents are 4.37, 4.33 and 4.28, respectively, indicating satisfied and very satisfied. The mean values for community and neighborhood interaction and community management and maintenance are 3.60 and 3.56, respectively, indicating average and satisfied responses.

For environmental quality, the mean values for garbage collection and air pollution are 3.76 and 3.71, respectively, indicating average and satisfied responses. The mean values of environmental sanitation and noise interference are 3.49 and 3.46, indicating average and satisfied responses. For convenience, the mean values of external transportation and the presence of post offices and of financial institutions are both 4.11, indicating satisfied and very satisfied. The mean value of hospitals is 3.93, indicating

Table 1. Research variables and definitions.

Variables	Definitions
Residential satisfaction	Overall degree of satisfaction: very satisfied - 5, satisfied - 4, average - 3, dissatisfied - 2, and very dissatisfied - 1.
In-house environment	Average of the values of variables including: living area, ventilation, lighting and sunlight, sound insulation, privacy, drainage pipelines, house arrangement, water leakages, and cracks.
Safety of surrounding environment	
Safety	Average of the values of variables including: drainage, accumulated water, flooding, fire concerns, frequency of traffic accidents and theft, mixed residential and commercial use, community and neighborhood interaction, community management and maintenance.
Out-of-house environment	Average of the values of variables including: air pollution, noise interference, environmental sanitation, garbage collection, quality of potable water.
Convenience	Average of the values of variables including: external transportation, shopping, hospitals, junior high schools and elementary schools, financial institutions.
Sports and leisure	Average of the values of variables including: park land, sports venues, library or arts district, landscaping and community beautification.
Housing characteristics	
Number of rooms	Number of houses; a continuous variable.
Age	Age of the house in the year 2005.
Number of living rooms	Number of living rooms; a continuous variable.
Floors	Dummy variable; 1F is set as 1 and 0 otherwise.
Number of total floors	Dummy variable; 1F~5F is set as 0, and the floors higher than 5F are set as 1.
Structure	Dummy variable; reinforced concrete and steel frame or steel-framed reinforced concrete are set as 1; brick, reinforced brickwork and other structures are set as 0.
In-house equipment	Includes; TV, internet, air conditioning, safety equipments and elevators. Equipping with the above is set as 1 and 0 otherwise.
Management cost	Existing management cost is set as 1 and 0 otherwise.

average and satisfied responses. For sports and leisure, the mean value of park land and sports venues is 3.59 and 3.48, respectively, indicating average and satisfied responses. The mean value of landscape is lower at 3.20, indicating average and satisfied responses.

As shown in Table 3, the mean value of overall residential satisfaction (*Sat)* is 3.43. The mean value of satisfaction with in-house environment is 3.62; that of housing safety (*Safe*) is 4.04; that of environment quality (*Envi*) is 3.58; that of convenience (*Conv*) is 4.06; that of sports and leisure (*Leis*) is 3.34; and that of the number of rooms is 2.66 while the standard deviation is 0.93. The mean value of house age is 22.35 years, and the standard derivation is 10.38. The mean value of number of living rooms is 1.28.

Housing on the first floor (*Dfloor*) accounts for 20.8%, while housing on other floors accounts for 79.2%. Buildings (*Build*) higher than six floors account for 39.1% while buildings of one to five floors account for 60.9%. Reinforced concrete structures (*Stru*) account for 92.2% while brick or reinforced-brick structures and other structures account for 7.8%. Houses equipped with televisions account for 88%; those with Internet hookups account for 64%; those with air conditioners (*Airc*) account for 78%; those with safety equipment account for 19%; and those with elevators (*Eleva*) account for 33%. Finally, houses with an existing management cost

Table 2. Attribute statistics for neighborhood environment.

S.N.	Neighborhood environment	Mean value	Standard deviation
Satisfaction with in-house environment			
1.	Living area	3.60	0.861
2.	Ventilation	3.63	0.888
3.	Lighting	3.59	0.938
4.	Sound insulation	3.16	1.093
5.	Privacy	3.52	0.883
6.	Drainage pipelines	3.41	0.959
7.	House arrangement	3.45	0.923
8.	Water leakages	4.15	1.014
9.	Cracks	4.09	1.010
Safety			
10.	Drainage, water accumulation and flooding	4.37	0.946
11.	Fire concerns	4.33	0.958
12.	Frequency of nearby traffic accidents	4.28	0.921
13.	Frequency of thefts	4.09	1.101
14.	Mixed residential and commercial use	4.06	1.026
15.	Community and neighborhood interaction	3.60	0.900
16.	Community management and maintenance	3.56	0.966
Environment quality			
17.	Air pollution	3.71	1.136
18.	Noise interference	3.46	1.148
19.	Environmental sanitation	3.49	0.913
20.	Garbage collection	3.76	0.831
21.	Quality of potable water	3.52	0.883
Convenience			
22.	External transportation	4.11	0.780
23.	Shopping	4.08	0.807
24.	Hospitals	3.93	0.873
25.	Junior high and elementary schools	4.07	0.770
26.	Post offices or financial institutions	4.11	0.771
Sports and leisure			
27.	Park land	3.59	1.013
28.	Sports venues	3.48	0.998
29.	Library or arts districts	3.22	0.991
30.	Landscaping	3.20	0.965
31.	Community beautification	3.22	0.966

account for 36% of all responses.

Factor analysis

The 31 neighborhood environment quality factors were analyzed to extract common factors. The approximate Chi-squared value verified by Bartlett was 5553, and the results reached a 5% significance level. This demonstrates that correlation coefficients can be used in factor analysis to extract factors. Thus, factor analysis is suitable. Moreover, the Kaiser-Meyer-Olkin measure of sampling adequacy is 0.92, which exceeds the recommended value of 0.90, indicating that there are more common factors among the variables and that they are suitable for factor analysis. This paper also applies principle component analysis and varimax rotation. The number of factors or dimensions is determined by the eigenvalue, and only eigenvalues greater than 1 signify factors or dimensions. In addition, only items with a factor load greater than 0.4 can be selected as factor contents. The six dimensions of neighborhood environmental quality are selected and renamed as in-house

Table 3. Sample statistics.

Variable	Mean value	Standard deviation	Minimum value	Maximum value
Sat	3.43	0.776	1	5
Inhouse	3.62	0.691	1.89	5
Safe	4.04	0.672	2	5
Envi	3.58	0.786	1	5
Conv	4.06	0.685	2	5
Leis	3.34	0.838	1	5
Room	2.66	0.931	1	6
Age	22.35	10.376	1	87
Livroom	1.28	0.582	0	5
Dfloor	0.21	0.406	0	1
Build	0.39	0.489	0	1
Stru	0.92	0.269	0	1
TV	0.88	0.328	0	1
Internet	0.64	0.480	0	1
Airc	0.78	0.415	0	1
Saeq	0.19	0.393	0	1
Eleva	0.33	0.469	0	1
Mgmt	0.36	0.480	0	1

Note: n = 408.

environment, convenience, sports and leisure, safety, environmental quality and house defects. The amount of accumulative variance explained by these six neighborhood environment quality dimensions is 66.39% (Table 4).

Regarding respondent satisfaction with in-house and surrounding environmental quality, the highest explained variance was for in-house environment, with an explained variance of 34%, followed by convenience, sports and leisure, safety, environmental quality and house defects. This shows that respondents exhibit great concern for satisfaction with in-house environment and public facilities (convenience, sports and leisure). In-house environment, safety, environmental quality, convenience, and sports and leisure (the last two are public facilities) are all latent variables, meaning that the measurement scale should be verified prior to the analysis. Following the extraction of the six neighborhood environmental quality factors, calculations can be performed to discover the internal consistency of all dimensions (measuring scale). In terms of Cronbach's α, internal consistency coefficients of in-house environment, convenience, sports and leisure, safety, environment quality and house defects are 0.90, 0.91, 0.90, 0.79, 0.85 and 0.78, respectively (Table 5). All measurement scales are isomorphic, demonstrating the consistency and reliability of the scales.

When analyzing the validity of the measurement scales, r values of all items are calculated through correlation analysis. The significance level (p value) of r forms a two-dimensional matrix, and the p matrix is used to judge whether the items belong to the same dimension. The more significant the r values, the better the construct validity. Through correlation analysis, satisfaction with in-house environment and surrounding environment includes six factors, and 31 p values reach a significance level of 0.05, which demonstrates that convergent validity is high. The p values of the other dimensions reach a significance level of 0.05, and the construct validity of other measuring scales is optimal.

EMPIRICAL ANALYSIS

In Table 6, in-house environment, safety, environmental quality, convenience, and sports and leisure are included in model 1, leading to a significant F value. The model fitness is good, but $\bar{R}^2$ only explains 44.7% of the variance. Despite this, in-house value reaches a significance level of 0.05 and has a positive correlation with residential satisfaction. This means that as satisfaction with the variable (sound insulation, lighting etc.) increases, residential satisfaction also increases. Safety also reaches a significance level of 0.05, and shows positive correlation with residential satisfaction. Again, as satisfaction with the variable (low frequency of water accumulation, flooding, fire, traffic accidents) increases, residential satisfaction also increases.

In addition, both the environmental quality and sports and leisure factors reach a significance level of 0.05 and show positive correlation with residential satisfaction. As such, park land, sports venues, landscaping, clean environments, clean air and a lack of noise interference can all increase residential satisfaction. Finally, convenience has a positive correlation but fails to reach significance.

In model 2, housing features (number of rooms, house age, number of living rooms, floors, total floors and building structure), in-house facilities (TV, internet, air conditioning, safety equipment and elevators), and management costs are added, and the F value exhibits significance. As such, the model fitness is good. Further, $\bar{R}^2$ explains 45.2% of the total variation. The results show that the values for in-house environment, safety, environment quality, convenience and sports and leisure differ slightly from the values listed in model 1 and that each, reaches significance at the 5% level. Moreover, the number of living rooms and the availability of internet both reach significance at the 10% level and exhibit positive correlation. In terms of living rooms, an increased number of rooms lead to higher residential satisfaction, likely because living rooms are associated with entertaining. In terms of the internet, people see it as indispensable; as such, it helps to increase residential satisfaction. None of the other variables including TV, air conditioning, safety equipment, elevators or management costs are significant.

The purpose of the null model is to determine whether the group mean of residential satisfaction differs for each township, how many

Table 4. Dimensions of neighborhood environmental quality.

Factors of neighborhood environmental quality		Content	Factor load
In-house environment	Eigenvalue: 10.55 explained variance: 34.04% accumulative explained variance: 34.04%	1. Ventilation	0.777
		2. Lighting	0.716
		3. Sound insulation	0.666
		4. Living area	0.665
		5. Privacy	0.665
		6. House arrangement	0.662
		7. Pipelines	0.651
		8. Community management and maintenance	0.416
		9. Community and neighborhood interaction	0.413
Convenience	Eigenvalue: 2.95 explained variance: 9.50% accumulative explained variance: 43.54%	1. Post office or financial institutions	0.789
		2. Shopping	0.776
		3. Junior high schools and elementary schools	0.774
		4. External transportation	0.767
		5. Hospitals	0.746
Sports and leisure	Eigenvalue: 2.44 explained variance: 7.88% accumulative explained variance: 51.42%	1. Sports venues	0.837
		2. Park land	0.772
		3. Landscape	0.737
		4. Library or arts district	0.704
		5. Community beautification	0.658
Safety	Eigenvalue: 1.95 explained variance: 6.28% accumulative explained variance: 57.69%	1. Frequency of nearby traffic accidents	0.677
		2. Frequency of fire concerns	0.639
		3. Mixed residential and commercial use	0.628
		4. Frequency of theft	0.600
		5. Drainage, water accumulation and flooding	0.523
Environment quality	Eigenvalue: 1.50 explained variance: 4.85% accumulative explained variance: 62.54%	1. Noise interference	0.665
		2. Environmental sanitization	0.665
		3. Air pollution	0.645
		4. Garbage collection	0.622
		5. Quality of potable water	0.583
House defects	eigenvalue: 1.20 explained variance: 3.85% accumulative explained variance: 66.39%	1. Water leaks	0.665
		2. Cracks	0.467

Table 5. Internal consistency coefficients.

Dimensions of neighborhood environmental quality	Coefficient	Number of items
In-house environment	0.90	9
Convenience	0.91	5
Sports and leisure	0.90	5
Safety	0.79	5
Environmental quality	0.85	5
House defects	0.78	2

variations of the grand mean of residential satisfaction are caused by inter-township variation, and whether the grand mean of residential satisfaction is different for each of the various townships after in-house environmental safety, environmental quality, convenience, and

Table 6. Residential satisfaction analysis results.

Independent variable	Model 1		Model 2	
	Coefficient	P value	Coefficient	P value
Intercept	0.092	0.669	- 0.167	0.549
In-house	0.282**	0.001	0.263**	0.001
Safe	0.131**	0.016	0.157**	0.005
Envi	0.244**	0.001	0.253**	0.001
Conv	0.076	0.116	0.044	0.376
Leis	0.180**	0.001	0.181**	0.001
Room			0.001	0.998
Age			0.004	0.219
Livroom			0.105*	0.052
Dfloor			0.045	0.536
Build			- 0.100	0.306
Stru			0.036	0.748
TV			- 0.052	0.564
Internet			0.113*	0.090
Airc			- 0.006	0.938
Saeq			0.124	0.186
Eleva			0.013	0.910
Mgmt			0.106	0.185
F	67.079**	0.001	20.760**	0.001
R^2	45.4%		47.4%	
$\bar{R}^2$	44.7%		45.2%	
n	408		408	

Notes: The dependent variable is overall residential satisfaction; the data presented in ( ) are the p-values; ** and * denote significance levels of 5% and 10%, respectively.

Table 7. Results of null model verification.

Fixed effect	Coefficient	Standard error	t value	P-value
γ_{00}	3.4214***	0.0546	62.640	0.000
Random effect	**Standard error**	**Variance components**	**Chi-square**	
τ_{00}	0.1752***	0.0307	43.5173	0.004
level-1 σ^2	0.7510	0.5634		
Deviance	939.2952			
Estimated number of parameters = 2				

Notes: * denotes p<0.1, ** denotes p<0.05, *** denotes p<0.01

sports and leisure are controlled. The results are shown in Table 7.

According to the fixed effect in Table 7, the estimated value γ_{00} of residential satisfaction is 3.4214 using the weighted least squares (WLS) method. Using the restricted maximum likelihood approach, the variation amount (τ_{00}) of the difference u_{oj} (inter-group variation) between the group mean and the grand mean of residential satisfaction is 0.0307. The Chi-Squared value is 43.5173, degrees of freedom is 22 (23 townships-1), and the significance level reaches 1%. Based on the foregoing, the group mean of residential satisfaction across the 23 townships has significant differences.

In terms of the inter-town variation (τ_{00}) and group variation (σ^2) of single-level effects, group correlation ρ can be computed as ICC $= \tau_{00} / (\tau_{00} + \sigma^2)$ = 0.0517. As such, 5.17% of the total

Table 8. Results of one-way ANCOVA.

Permanent effect	Coefficient	Standard error	t-ratio	P-value
γ_{00}	3.4217***	0.0235	145.453	0.000
Inhouse γ_{10}	0.2854***	0.0489	5.833	0.000
Conv γ_{20}	0.0857	0.0608	1.408	0.160
Leis γ_{30}	0.1707***	0.0460	3.714	0.000
Safe γ_{40}	0.1025**	0.0397	2.582	0.011
Envi γ_{50}	0.2547***	0.0540	4.719	0.000
Random effect	**Standard error**	**Variation components**	**Chi-square**	
τ_{00}	0.0070	0.0000	17.0707	>.500
Level-1, σ^2	0.5760	0.3317		
Deviance	729.2841			
Estimated number of parameters=2				

Notes: * denotes p<0.1, ** denotes p<0.05, *** denotes

variation in residential satisfaction within all townships is caused by differences in township characteristics. According to suggestions from Cohen (1988), this level of correlation is low. In addition, traditional regression analysis is adopted to estimate the parameters of the null model; 22 dummy variables representing 23 townships are input into the regression model, the intercept is regarded as a fixed effect, and OLS is used to estimate the group mean of residential satisfaction for all townships.

Results of a one-way ANCOVA are shown in Table 8. For the fixed effect, only convenience fails to reach a significance level of 10%. The coefficient for safety reaches a significance level of 5%, and those of the remaining variables reach a significance level of 1%. For the random effect, the estimated τ_{00} is 0.000, which is not significant. After the individual variables are controlled, the intercept of Level 1 is non-random, and does not change due to the consideration of different townships. That is, the group mean of residential satisfaction does not vary across different townships when satisfaction with in-house environment, safety, environmental quality, convenience and sports and leisure is fixed.

Conclusions

This paper extracts 6 neighborhood environmental dimensions from 31 items through factor analysis. The dimensions include in-house environment, convenience, sports and leisure, safety, environmental quality and house defects. The accumulative variance explained by these six dimensions is 66.39%. Reliability coefficients of the factor dimension measurement scales vary from 0.78 to 0.91, indicating good internal consistency. Based on the factor analysis results, leaseholders stress neighborhood environmental quality and prioritize the in-house environment, convenience, sports and leisure, safety and environmental quality over house defects. This highlights that leaseholders are usually short-term and have options pertaining to renewals and relocation.

This study discusses the influence of public facilities and neighborhood environmental quality on residential satisfaction through a regression analysis approach. Variables of housing characteristics (number of rooms, house age, number of living rooms, floors, total floors and building structure), in-house equipment (TV, internet, air conditioners, safety equipment and elevators) and management costs are input into the second regression equation. The results in Model 1 show that in-house environment, safety, environmental quality and sports and leisure all reach a significance level of 5% and are positively correlated with overall residential satisfaction. Moreover, convenience is positively correlated with residential satisfaction, but fails to reach significance. In Model 2, variables pertaining to housing characteristics, in-house facilities or equipment and management costs are also included. Only the number of living rooms and the availability of the internet reach a significance level of 10%, and all other variables are insignificant. Analysis results from hierarchical linear modeling (HLM) indicate that the group mean of residential satisfaction exhibits significant differences across townships. After controlling for the individual satisfaction variables related to in-house environment, safety, environmental quality, convenience and sports and leisure, the group mean of residential satisfaction for all townships does not exhibit any difference. Therefore, the findings of this study indicate that the satisfaction variables are the important factors that affect overall residential satisfaction.

Most previous studies on residential satisfaction evaluated the housing characteristics and considered the external environment such as the neighborhood environment while ignoring macro-level and single level factors. This paper applies HLM to analyze residential satisfaction for all townships, a variable that has hierarchical characteristics. Therefore, HLM is a suitable tool for data processing and analysis in future studies.

The results show that public facilities and the neighborhood environment both have a significant influence on residential satisfaction. As the quality of life improves over time, housing policies often shift from “adequate housing for everyone” to “suitable housing for everyone.” As such, basic housing will not satisfy everyone. Improvement in the neighborhood environ-ment, public facilities and environmental quality helps to increase residential satisfaction. Therefore, government officials responsible for public facilities and environmental quality should work to increase residential satisfaction and reduce the adverse impacts of NIMBY, and they must also ensure that they do not force people to bear negative transaction costs.

This study investigates leaseholders within the greater Taipei area and discusses the influence of public facilities and neighborhood environment on residential satisfaction. Taipei is the capital of Taiwan, and it should spare no effort in the construction of public facilities. Future studies should investigate other areas in Taiwan to determine potential differences between urban and rural areas and between housing types and to provide the relevant authorities with suggestions on how to increase residential satisfaction. Through such research, residential satisfaction and housing quality will continue to grow in importance.

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