

# Living Environment Evaluation of Japanese Residential Area in Kitakyushu Japan

## Part 1: Survey Result and Statistical Analysis

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都市により、地域により、文化度、安全性、便利さなどの環境は異なる。住民たちはそれをどう評価するか。アジアの都市作りの指針を探求する。

### Abstract

Diversity is something that cannot be avoided in our lives and it lives in harmony with us. It has become common in a community that there appear diversification in culture, norms or policy, and even people's daily lifestyle. With those personal senses, diversification of value as well as the abundance of lifestyles, people's preferences, demands, perceptions and evaluations in relation with their living environment are also becoming more and more diversified. For that reason, it is necessary to clarify this diversity of urban residential lifestyles and make an evaluation of residential environment. In the beginning of 2013, questionnaire surveys and subjective evaluations of residential environment were performed in order to grasp the main factors of residential environment of some districts in Kitakyushu City, Japan. First in this paper, the regional residential environment characteristics and personal residential preference were analyzed. In the second part of this paper, the evaluation using GIS (Geographical Information System) database will be conducted to analyze the existence of public facilities and area land use. Finally, the results can be applied to the residential environment planning, development, and policy monitoring of the Asian cities.

**Keywords** Lifestyle diversification; residential environment; satisfaction evaluation; questionnaire; Kitakyushu

### Introduction

Everyone in this world was born with different and unique personality. It has become common that in one community there are many kinds of diversification, such as in culture, norms and policy, and even daily lifestyle. On the other hand, residential environment quality is one of the main factors for quality of life, as well as the main support for the economic activities, culture and society. With the diversification of personal senses of value as well as the abundance of lifestyles, people's preferences, demands, and perceptions of their living environment are also

becoming more and more diversified so it is hard to grasp. Considering the positive relationship between residence and lifestyle, this study tried to elucidate the concept of residential lifestyles, especially from the perspective of its interrelation between residential choice, residential preference, and residential satisfaction.

Despite an increasing number of studies that many researchers have performed to evaluate residential environment, and some evaluation models and index systems have been presented on the evaluation of residential areas, only a few have paid attention to

the identification of the components that influence the degree of residential satisfaction, and the literature on residential lifestyles is not rich, especially in Asian societies.

A review of the literature indicated that the concept of residential satisfaction has been used in several methods. Moore<sup>1)</sup> has proposed four levels of theoretical construction in organizing and integrating studies of residential environment, which are conceptual orientation, framework, model and theory. Amerigo<sup>2)</sup> presented a theoretical and psychological approach to the study of residential satisfaction, and gave general view of relationships between people and their residential environment. Smith<sup>3)</sup> investigated the physical elements that contribute to the quality of community and established a framework for understanding the relationship between quality of urban environment and its physical form or design. While Bonaiuto and Bonnes<sup>4)</sup> also identified clusters of residents who use the city in different ways and who differ in their perceptions and evaluations of neighborhood attributes. In Japan, Morita<sup>5)</sup> developed environmental indices according to the urban resident's evaluation based on qualitative questionnaire and quantitative data of different aspects of the environment in some area of Kitakyushu. In China, Ge and Hakao<sup>6)</sup> developed a living environment evaluation model based on residential preferences and compared two big cities in the Chanjiang delta region.

In this research, through the case study of Kitakyushu City in Japan, questionnaire surveys and subjective evaluations on residential environment were performed, in order to grasp the main factors influencing the residential environment of local cities, and establish the suitable evaluation index system. The regional residential environment characteristics and types of personal residential preference were also analyzed, so that their influence on residential environment evaluation could be grasped. The results can be applied to the residential environment planning, construction and monitoring of other local cities in Asia such as Indonesia, Thailand, and Viet-

nam, effectively and efficiently.

The survey of residential environment evaluation in all Kitakyushu City was initiated in the beginning of 2013. As the first step, eight residential areas from Kitakyushu City were selected as sample areas, and some rudimental research was performed. On the basis of the rudimental results, the overall research of the whole of Kitakyushu City were carried out to establish the suitable evaluation index system and evaluation model while considering the regional characteristics and personal residential preference. (Fig. 1)

## Questionnaire Outline

The questionnaire survey was carried in all 8 residential areas (elementary school areas) of Kitakyushu City between December 2012 and January 2013. Altogether 4450 residents from the 8 residential areas and 7 districts of Kitakyushu City were selected due to the high number of students and were sent a questionnaire with cooperation of school teachers. Table 1 shows the sample numbers and response percentages for each residential area. The response percentages differed significantly across residential areas, ranging from 3.6% to 27.2%, and the overall response percentage is 23.1%. (Fig. 2)

Table 1 shows the main contents of the questionnaire survey, which is divided into five parts with a total of 88 questions.

**Table 1 Questionnaire Contents**

Questionnaire Categories	Questionnaire Contents	Question Number
Housing Characteristic	Family characteristic, house location, house type, house size, construction year;	8
Lifestyle	Public transportation choices, house stay hours, weekend activities, park activities;	25
Environment Evaluation	Amenity, Safety, Health, and Convenience evaluation;	31
Residential Preference	Personal preferences concerning: Amenity, Safety, Health, and Convenience;	22
Future Improvement	Citizen needs, facilities development.	2

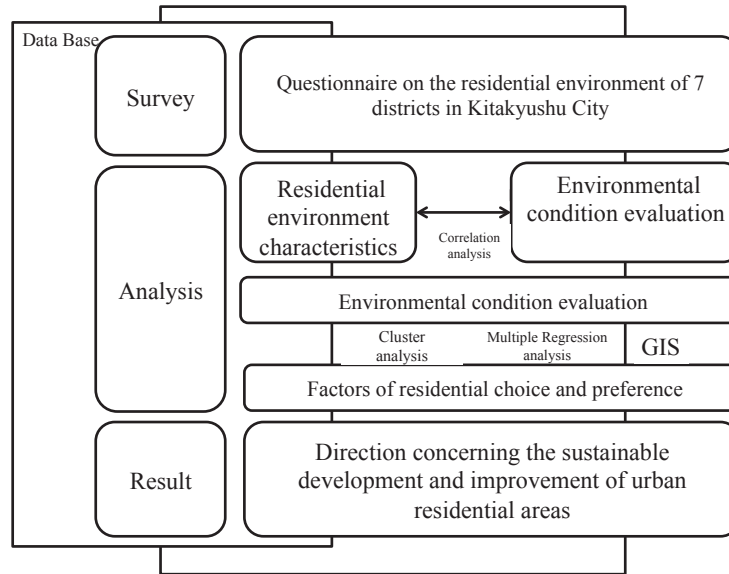


Fig. 1 Research Flow Chart

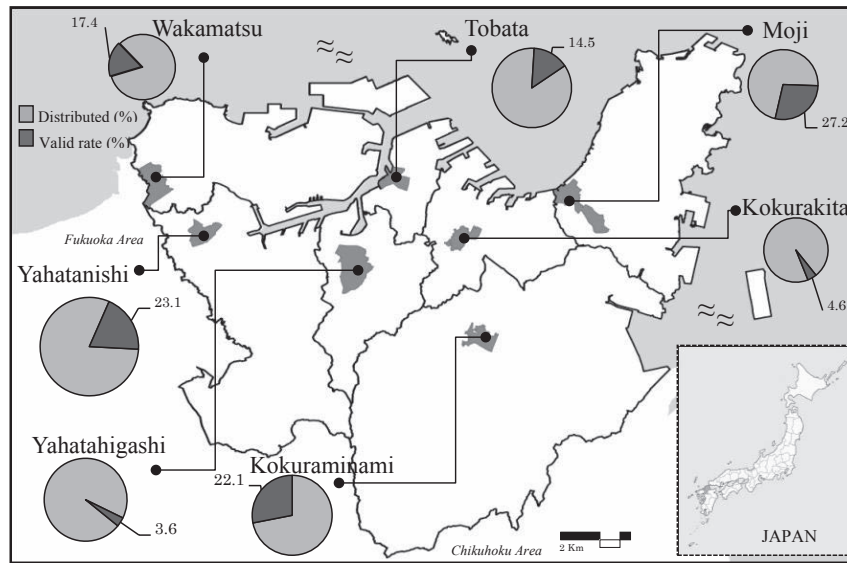


Fig. 2 Location and feedback number of investigated area in Kitakyushu

## Index System and Evaluation Model for Residential Environment

### (a) Hierarchical multi-attribute index system

At the beginning of 2013, 8 residential areas from 7 different districts in Kitakyushu City were selected

as sample areas, and a questionnaire survey was performed as the rudimentary research. Considering the regional properties of Kitakyushu City, such as the properties of nature, geography, culture, economy, transportation, and design factors, as well as the vari-

ance in personal life style of local cities which are quite different from big cities, 31 items on residential environment qualities were set up as questions in the survey. After the Principle Component Analysis on these items, 4 components were abstracted, which were convenience, amenity, health, and safety.

WHO (World Health Organization) defined health as “a complete state of physical, mental, and social well-being” and in accordance four concepts of residential environment to satisfy the basic living requirements of human beings were first presented in 1961, which are safety, health, convenience and amenity. Then the hierarchical multi-attribute index system and evaluation model were established in 4 levels, described in Fig. 3. The attributes of each level were designed on the basis of the principle component analysis finished by the rudimental research, as well as considering the residential concepts present by WHO.

According to this index system, “satisfaction with residential environment” (stage 1) depends on satisfaction with “convenience,” “amenity,” “safety,” “health” and “community” (stage 2). Attributes of stage 2 are assumed to depend on satisfaction with nine stage 3 attributes. For example, “amenity” (stage 2) is assumed to depend on “A1” (amenity with natural environment), “A2” (amenity of open space), and “A3” (amenity of neighborhood) which is included in stage 3. Furthermore, each of the 12 attributes of stage 3 is decomposed into some lower level attributes in stage 4. For instance, “C2” of stage 3 (convenience of daily life) is assumed to depend on 2 attributes of stage 4, such as “convenience for accessing bus,” and “convenience for accessing train.”

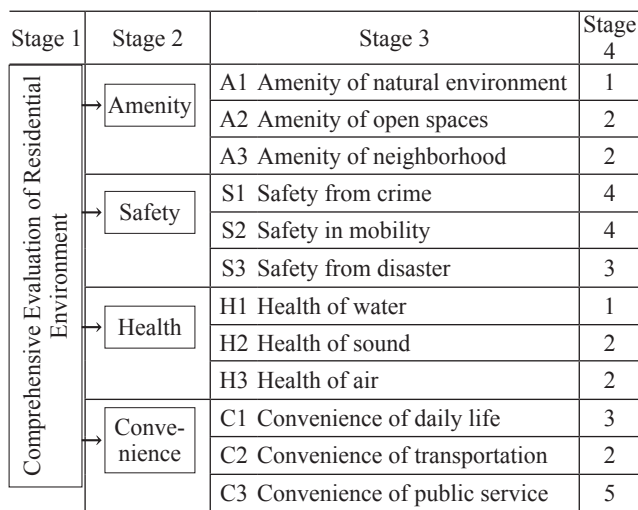
**(b) Evaluation results**

Table 2 shows the personal attributes and residential conditions of the 7 districts respectively. The family member of the survey subject is mostly 4- 5 persons per house and the age range is mainly from the 30s to 40s. House type are dominated by multiple apartment overall but in some district detached house

number is higher. Other residential conditions such as floor space and years of residence are also shown in Table 2 below.

**Table 2 Questionnaire Results on Residential Environment Condition**

Item/Category	YH	YN	KK	KM	TB	WM	MJ
Family Size	~3	■					
	4~5	■	■	■	■	■	■
	5~	■					
House Size	~50	■					
	50~100	■	■	■	■	■	
	100~150	■	■	■	■	■	■
	150~300	■	■	■	■	■	■
	300~	■					
House Type	Detached	■	■	■	■	■	■
	Multiple	■	■	■	■	■	■
Residence Year	~5	■	■	■	■	■	■
	5~10	■	■	■	■	■	■
	10~20	■	■	■	■	■	■
	20~	■					
Household Age	20s	■					
	30s	■	■	■	■	■	■
	40s	■	■	■	■	■	■
	50s~	■					



**Fig.3 Evaluation Method on Residential Environment**

On-site residents were asked to evaluate their present residential situation with respect to residential satisfaction on multi-attributes. Evaluations

**Table 3 Evaluation Results on Residential Environment**

Area		Stage 1		Stage 2		
		Comprehensive satisfaction	Amenity	Safety	Health	Convenience
Yahatahigashi	Mean	0.67	1.06	-0.12	0.97	1.45
	S.D.	0.92	1.00	1.14	0.95	0.79
Yahatanishi	Mean	0.52	0.82	-0.02	0.69	0.91
	S.D.	1.09	1.07	1.13	1.13	0.99
Kokurakita	Mean	0.98	1.04	0.02	0.96	1.26
	S.D.	0.80	0.92	1.11	1.01	0.85
Kokuraminami	Mean	0.71	1.09	-0.12	0.91	1.11
	S.D.	0.97	0.85	1.11	0.96	0.79
Tobata	Mean	0.32	0.35	-0.08	0.66	1.23
	S.D.	1.04	1.19	1.11	1.04	0.90
Wakamatsu	Mean	0.91	1.20	0.18	0.97	0.65
	S.D.	0.78	0.83	1.04	0.93	1.06
Moji	Mean	0.69	1.08	-0.11	1.05	1.14
	S.D.	1.02	1.00	1.14	0.85	0.85
Kitakyushu City (Total)	Mean	0.66	0.94	-0.03	0.86	1.03
	S.D.	0.99	1.02	1.11	1.00	0.94

were given in terms of satisfaction degree elicited from “very much” (2 score) to “not at all” (-2 score). Through the survey, residential environment situation evaluated by residents all over Kitakyushu City can be grasped.

The mean scores and standard deviations of attributes of stage 1 and stage 2 are presented in Table 3, which indicate the degree of satisfaction with various residential attributes. It can be seen that the overall evaluation of residential environmental quality in terms of “satisfaction with residential environment” revealed that residents were fairly satisfied with the quality of residential environment, with the average score (standard deviation) of 0.66 (0.99), which is close to the midpoint of the point scale (0.00). The scores of amenity, safety, health, and convenience are 0.94 (1.02), -0.03 (1.11), 0.86 (1.00), and 1.03 (0.94), respectively.

### (c) Hierarchical multi-attribute evaluation model

The relative importance of each residential attribute is assessed by means of multiple regression analysis to find the main factors influencing the residential environment evaluations of Kitakyushu. Evaluations of higher-level attributes were regressed on the

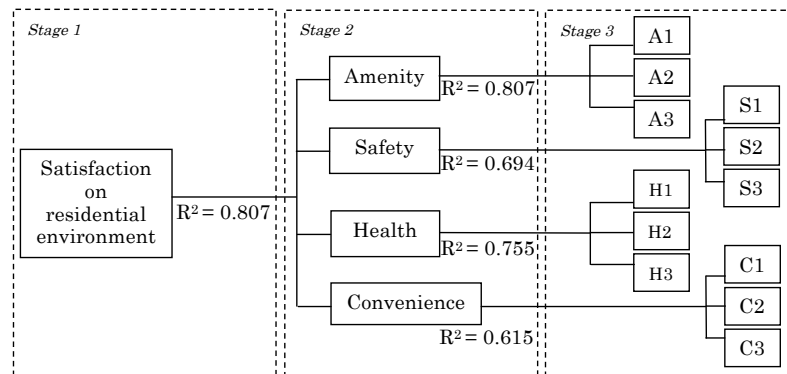
evaluations of the lower-level attributes. The relative importance of various residential attributes can be revealed in terms of coefficient  $b$  shown in Table 4.

It shows that 80.7% of the variance in the assessment of “residential satisfaction” (stage 1) can be explained by the four stage 2 attributes. Satisfaction with “amenity” appeared to be the most important attribute ( $R^2=0.807$ ), then come the attributes of satisfaction with “health,” “safety” and “convenience” ( $R^2=0.755$ ,  $R^2=0.694$ ,  $R^2=0.615$ ). Three attributes A1, A2 and A3 (stage 3) can explain 70% of the variance in satisfaction with amenity.

Amenity of “neighbourhood” appears more important than amenity of “natural environment” and “open space.” The three stage 3 attributes H1, H2, and H3 appears to explain 75.5% of the variance in satisfaction with “health” (stage 2), in which health of “sound” seems to be much more important than “air” and “water.” As to the satisfaction with safety (stage 2), the three attributes S1, S2, and S3 (stage 3) can explain about 69.4% of the variance, in which safety of “disaster” seems more important than safety in “mobility” and “crime.”

From the above analysis, it may also be noted that the model fitness ( $R^2$ ) is quite high, which is indicat-

**Table 4 Multiple regression analysis result**



	Regression equation	R square
Comprehensive	$Y = 0.229A + 0.209S + 0.190H + 0.139C + 0.667$	$R^2 = 0.807$
Amenity	$Y = 0.439A3 + 0.224A1 + 0.235A2 + 0.410$	$R^2 = 0.700$
Safety	$Y = 0.451S3 + 0.383S2 + 0.204S1 - 0.108$	$R^2 = 0.694$
Health	$Y = 0.482H2 + 0.317H3 + 0.177H1 + 0.085$	$R^2 = 0.755$
Convenience	$Y = 0.420C2 + 0.262C3 + 0.337C1 - 0.025$	$R^2 = 0.615$

ing that the hierarchical multi-attributes index system established in this study can offer a promising and valuable theoretical framework for modelling residential environment quality. Our questionnaire ended with the question “Are there any other items not mentioned in the questionnaire that will affect the residential environment quality in your life?” Almost none of the answers included such items, which shows that the present model has captured most attributes of residential environment quality.

### Influence of Personal Residential Preference on Residential Environment Evaluation

#### (a) Types of residential preference

In order to identify the personal residential preference, there are 21 choices presented for the residents about their preference when choosing the present dwelling, including residential convenience factors (1)-(5), amenity and comfort factor (6)-(9), safety factor (10)-(15), community factor (16) and (17), economic factor (18), and other factor such as good design (19), good leisure (20), and special attachment (21).

First, in order to focus on residential environment itself, the principle component analysis was performed considering only residential environment factors. Analysis was performed by SPSS 16.0, by extraction method of Principle Component Analysis, and rotation of *Varimax* with *Kaiser Normalization*. From the results shown in table 5, five principle components have been extracted: 1st—Amenity + Safety; 2nd—Convenience related to children’s education and the economy; 3rd—Convenience of daily mobility; 4th—Community and other; 5th—Health. According to these results, the main preferences of selecting dwellings are in the order of amenity + safety, convenience, safety, health, community and economic. The total variance shows that the above five principle components can explain the residential preference quite well, with the cumulative 56.08%, and the first and second factors accounted for 38.29%. (Table 5)

#### (b) Patterns of residential preference

In order to analyze the personal preference residential type, the scatter plot of the distribution of component value of the 1st and 2nd factors (which can

**Table 5 Principal Component Analysis\***

Variance Factor	Component				
	1	2	3	4	5
1. Convenience of shopping	0.287	-0.059	<b>0.567</b>	0.016	0.318
2. Convenience of commuting	0.071	0.039	<b>0.82</b>	0.12	-0.016
3. Nearby the workplace	-0.042	0.218	<b>0.739</b>	0.04	-0.106
6. Beauty of nature	0.461	<b>0.597</b>	0.123	-0.211	-0.061
7. Beauty of city/town	<b>0.546</b>	<b>0.61</b>	0.044	-0.163	-0.119
8. Noise and air quality of outdoor	<b>0.74</b>	0.181	0.046	-0.024	-0.1
9. Sunshine and ventilation are good	<b>0.615</b>	0.036	0.122	0.201	0.038
10. Safety from disaster is high	<b>0.681</b>	0.143	0.153	0.027	0.108
11. Nearby the parent's house (independent)	0.103	0.161	-0.001	-0.029	<b>0.8</b>
12. Security of crimes is good	<b>0.722</b>	0.026	0.05	0.114	0.149
13. Safety of walking, bicycle, and car are high	<b>0.674</b>	0.102	0.147	0.164	0.305
15. Cleanliness is high	<b>0.636</b>	0.294	0.019	0.178	0.126
16. Social connection is good	0.285	<b>0.578</b>	0.039	0.14	0.212
17. Educational environment is good for children	<b>0.548</b>	0.22	0.028	0.138	-0.045
18. Economic reason (house price and rent)	0.182	-0.022	0.1	<b>0.726</b>	0.086
19. House design is good	0.171	0.209	0.077	<b>0.777</b>	-0.066
20. Good for leisure	0.062	<b>0.685</b>	0.184	0.33	0.181
21. There is inner attachment	-0.002	<b>0.591</b>	0.155	0.113	0.492

Extraction Method: Principal Component Analysis.  
Rotation Method: Varimax with Kaiser Normalization.

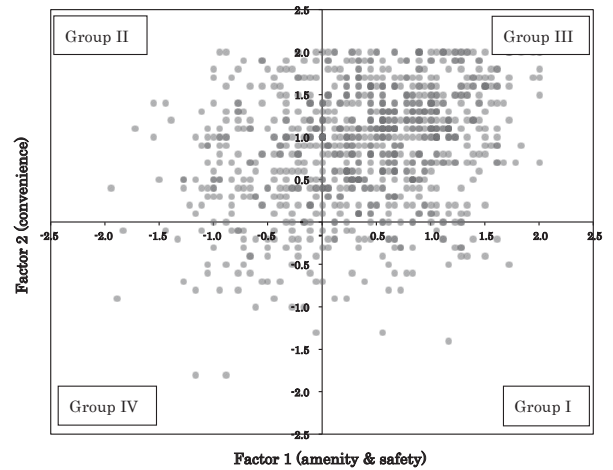
\*Factor with lower than 0.5 value were eliminated in the table

Principal Component	Initial Eigen-values	% of Variance	Cumulative %
1	6.28	29.93	29.93
2	1.76	8.37	38.29
3	1.43	6.79	45.09
4	1.27	6.03	51.13
5	1.04	4.96	56.08

explain about half of the contribution of the total factors) of each resident is plotted in figure 4, the X-axis is the 1st factor (amenity + safety); Y-axis is the 2nd factor (convenience). Thus, 4 group patterns can be identified, which are Group I (amenity and safety type); Group II (convenience type); Group III (comprehensive type: amenity+safety+convenience) and Group IV (other type). (Fig. 4, Table 6)

**(c) Analysis of group characteristic**

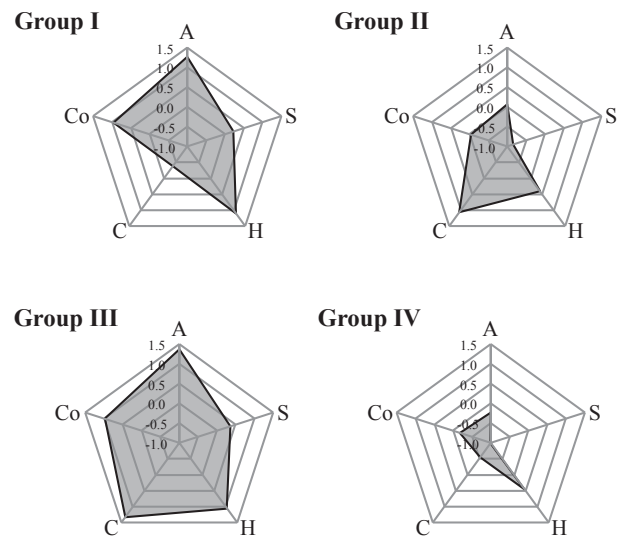
In order to understand the characteristics of each group, the satisfaction scores and importance (preference) scores from 4 types of group were analyzed, as shown in Tables 6 and 7. Each group characteristic is presented based on these two judgments (satisfaction type and preference type).



**Fig. 4 Scatter Plot of component value of factor 1 and 2**

**Table 6 Residential preference group**

Group pattern	Number	Percentage (%)
I	61	6.55
II	226	24.27
III	582	62.51
IV	62	6.66
Total	931	100



**Fig. 5 Group characteristic upon satisfaction type**

**Group I: Amenity and safety type**

The evaluation on satisfaction and importance of the amenity attribute are both quite high among all types, much higher than the comprehensive score of total samples. The same tendency can be noted in the case of the safety attribute, where importance evaluation is above average, and the satisfaction evaluation is the highest among the 4 types. On the other hand, the evaluation of convenience is the lowest among all types, which may illustrate the difficulty in pursuing the satisfaction with amenity, safety and convenience simultaneously. Families in group I regard amenity and safety as their first preference, and this seems to have been realized, while the aspect of convenience is compromised.

**Table 7 Evaluation on residential satisfaction by group**

Satisfaction type	I	II	III	IV
A) Amenity	1.26	0.06	1.37	-0.23
S) Safety	0.23	-0.85	0.36	-1.02
H) Health	1.10	0.41	1.06	0.45
C) Convenience	-0.38	1.07	1.33	-0.55
Co) Comprehensive	0.97	-0.04	0.98	-0.18

**Group II: Convenience type**

This type is focused on convenience, and the evaluation of convenience importance is the highest. It is also shown that the satisfaction evaluation of convenience is quite high, much higher than average. The importance of evaluation of amenity and safety are the lowest, and satisfaction with amenity and safety are also quite low among 4 types, much lower than the average.

Similar to group I, group II chooses convenience as the most important factor on dwelling, and in consequence their requirement on amenity and safety are given up to some extent.

**Group III: Comprehensive type**

The importance evaluation of amenity, health, and safety are highest among all types, and the importance evaluation of convenience is also high. In

addition, their satisfaction with convenience, amenity, health and safety rank the first among all types. It can be seen that their comprehensive wishes for living condition are realized to the largest extent, which is also the target of residential environment plan and design. Also the number of this group is the highest as 582 residents, among all the residents, the percentage of this group is largest (62.51%).

**Table 8 Evaluation on residential preferences by group**

Preferences type	I	II	III	IV
P1) Convenience of shopping	1.02	1.46	1.56	0.97
P2) Convenience of commuting	1.02	1.17	1.30	1.06
P3) Nearby the workplace	0.10	0.19	0.26	0.02
P4) Convenience of children going to school	1.49	1.59	1.64	1.06
P5) Access to neighbor city is good	0.52	0.77	0.90	0.42
P6) Beauty of nature	0.67	0.38	0.74	0.06
P7) Beauty of city	1.03	0.34	0.76	0.03
P8) Noise and air quality of outdoor	1.48	1.14	1.39	0.87
P9) Sunshine and ventilation are good	1.5	1.57	1.57	1.24
P10) Safety from disaster	1.23	1.20	1.34	0.73
P11) Nearby the parent's house (independent)	0.33	0.56	0.55	0.45
P12) Security from crimes	1.57	1.54	1.70	1.40
P13) Safety of walking, bicycle, and car	1.33	1.26	1.39	0.97
P14) Medical and welfare services is easy	0.87	1.08	1.06	0.44
P15) Cleanliness is high	1.21	1.19	1.29	1.03
P16) Social connection is good	0.49	0.12	0.48	0.24
P17) Education for children	1.43	1.15	1.43	0.98
P18) Economic reason	1.11	1.15	1.25	1.10
P19) House design	0.85	0.99	1.12	0.66
P20) Good for leisure	-0.28	-0.37	-0.12	-0.34
P21) There is inner (special) attachment	-0.51	-0.04	0.08	-0.56



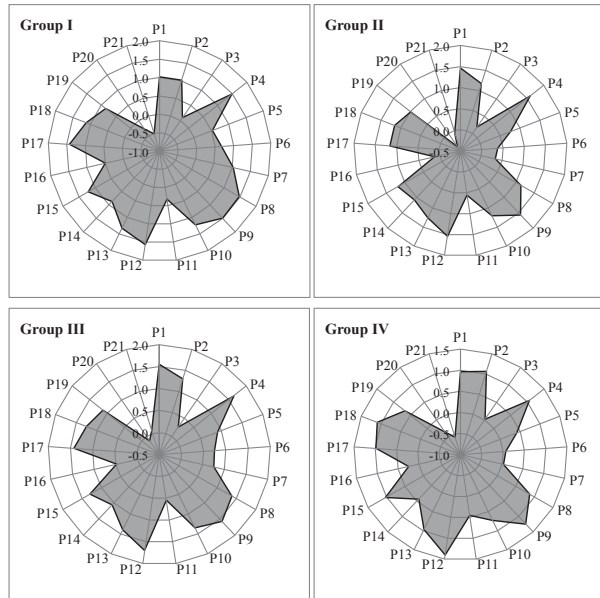


Fig. 6 Group characteristic upon preference type

#### Group IV: Other type

The preference emphasized other factors instead of amenity, safety and convenience. As we see in Table 7 and Table 8, the evaluation on satisfaction and importance with 4 satisfaction factors are all very low, while convenience is the lowest, and other 3 factors tend to be low. The comprehensive satisfaction in residential environment is also the second lowest. The reason may be related to their unclearness of residential preference. The residential environment condition of this type is also worth being studied, in order to improve their residential environment, as well as their residential awareness.

## Conclusions

The following conclusions can be drawn from the above research:

(1) The present residential environment situation evaluated by on-site residents can be grasped throughout Kitakyushu City, as well as the regional characteristics and the influence on residential environment evaluation, which can be served as the database for the urban planning and decision-making.

(2) Hierarchical multi-attribute index system of residential environment evaluation considering local city properties was developed, and the relative importance of each attribute was also studied according to multiple regression analysis. The study of model fitness shows that the evaluation system developed in this study has captured most attributes that underlie residential environment and can offer a promising and valuable theoretical framework for the evaluation of residential environmental quality.

(3) Four groups of personal residential preference types are identified and their influences on residential environment evaluation are also studied.

Further, the objective attributes of residential environment and lifestyle could also be analyzed by GIS in the next part of this paper.

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## References

- Moore, G.T. (1997) Toward environment-behavior theories of middle range. In *Advances in Environment, Behavior, and Design*. New York: Plenum Press, pp. 1-40.
- Amerigo, M. (2002) Psychological approach to the study of residential satisfaction. *J. Environ. Psychol.* 17, 47-57.
- Smith, T., Nelischer, M., Perkins, N., 1997. Quality of urban community: framework for understanding the relationship between quality and physical form. *Landscape Urban Plan.* 39, 229-241.
- Bonaiuto, M., Bones, M. (2002) Residential satisfaction in the urban environment within the UNESCO-MAB Rome Project. In *Residential Environment: Choice, Satisfaction, and Behavior*. Westport CT and London: Bergin & Garvey, pp. 101-134
- Morita, T., Noda, K. and Horiuchi, Y. (1985) A computation of environment indices according to evaluation by residents—for environmental management in Kitakyushu City. *City Planning Review*, Papers for the Annual Conference of the City Planning Institute of Japan, 20: 133-147.
- Ge, J. and Hakao, K. (2006) Research on residential lifestyle in Japanese cities from viewpoints of residential preferences, residential choice and residential satisfaction. *Landscape and Urban Planning*, 78(3), pp. 165-178.