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Residential environmental evaluation of local cities considering regional characteristic and personal residential preference—a case study of Saga City, Japan

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Abstract: Questionnaire surveys and subjective evaluations on residential environment were performed in order to grasp the main factors of residential environment of small local cities. The suitable evaluation index system was established, and the regional residential environment characteristics and personal residential preference types were 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 local cities.

Keywords: residential environment evaluation; local city; regional characteristics; personal residential preference

1 Background

Satisfied residential environment is the rudimentary condition of the quality of life, as well as the significant support of economic, cultural and social activities. The improvement of residential environment quality is one of the main targets of the city policy and urban planning. With the economic and social development, as well as the rapidly growing demands on the quality of life, the research and management of residential environment are becoming more and more important, in which the evaluation of residential environment turns out to be the first significant step.

Many researches have been performed to evaluate residential environment, and some evaluation models and index systems have been presented(Naito, 1995). However, most of these researches are carried out in large central cities, such as in Tokyo, Kitakyushyu, Koube and so on(Asami, 2001; Yoshimoto, 2000). In small local cities, however, such kinds of researches are not enough so far. In local cities, owing to the apparently different properties in natural, geographic, political, economic and cultural conditions, as well as the variance in personal life style and residential preference, the evaluation index system and model are surely distinct from those of big central cities. As a result, it is essential to improve the research on residential environment evaluation in local cities and establish suitable index system and evaluation model, instead of applying the big city model directly. Furthermore, many local cities are facing with the increasingly serious problems of losing activity and attractions. Making full use of their natural and regional advantages to establish an attractive residential environment could be one of the valuable and feasible solutions. Because of this, the researches on suitable evaluation method and index system considering regional characteristics are of great necessity and importance.

On the other hand, residential environment evaluation is related to not only objective factors, but also subjective factors, which are quite complicated because of individual subjective characteristics, such as life style, personal preference and so on. Thus, not only the index and method, but also the personal residential preference types, and their influence on evaluation are worth being studied as well.

In this research, through the case-study of Saga 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 small local cities, and accordingly to establish the suitable evaluation index system. Then, 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 local cities effectively and efficiently.

2 Flow chart of the research

The research on residential environment evaluation in Saga City was started from the beginning of 1999. As the first step, three residential areas from Saga City and two areas around the city were picked out as the sample areas, and some rudimental researches were performed (Yoshimoto, 2000). On the basis of the rudimental results, the overall researches all around Saga City were carried out to establish the suitable evaluation index system and evaluation model while considering the regional characteristics and personal residential preference. Furthermore, because of the research have been lasting for 3 years, the temporal change of residential environment evaluation were also analyzed. The flow chart of the research is shown in Fig. 1.

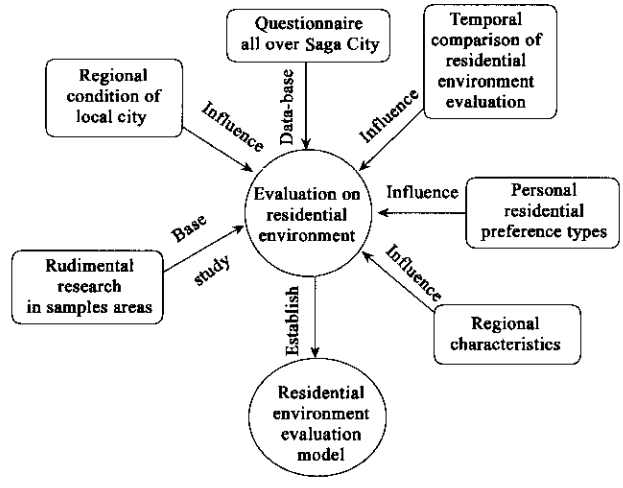

Fig. 1 Research flow chart

3 Questionnaire survey

The questionnaire survey was carried out all over the 19 residential areas (elementary school areas) of Saga City in the November of 2001.

3.1 Sample and response

Altogether 3802 residents from the 19 residential areas of Saga City were randomly selected and sent a questionnaire. Table 1 shows the sample numbers and response percentages for each residential area. The response percentages differed significantly across residential areas, ranging from 32.0% to 74.5%, and the overall response percentage is 49.5%.

Table 1 Samples and response percentage

Household number	63353
Sample number	3802
Sample percentage, %	6.0
Response number	1882
Response percentage, %	49.5

3.2 Questionnaires

The questionnaire form contained four parts (85 questions) is shown in Table 2.

Table 2 Structure of questionnaire

Question content	Question number
Personal and household	19
Personal residential preference	12
Evaluation on residential quality	48
Intimate sense to the present residential area	6

4 Hierarchical multi-attribute index system and evaluation model for residential environment

4.1 Hierarchical multi-attribute index system

In 1999, three residential areas from Saga City and two areas around the city were picked up as the sample areas, and a questionnaire survey was performed as the rudimentary research. Considering the regional properties of Saga City, such as the properties of nature, geography, culture, economy, transportation, design factors and so on, as well as the variance in personal life style of local cities which are quite different from big cities, 45 items on residential environment qualities were set up as questions in the survey. After the Principle Component Analysis on these items, five components were abstracted, which were convenience, amenity, health, safety and community. WHO (World Heath 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 firstly presented in 1961, which are safety, health, convenience and amenity. From our rudimental research, the concept of "community" was added to the above four concepts as well. Accordingly, the hierarchical multi-attribute index system and evaluation model were established in four levels, described in Fig.2. 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.

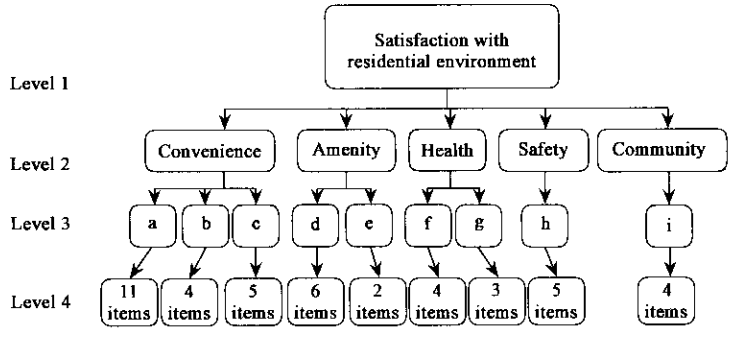

Fig.2 Hierarchical multi-attribute index system for residential environment evaluation
a: convenience with living facilities; b: convenience with access to working and studying; c: convenience with access to nearby cities; d: amenity with natural living environment; e: amenity with landscape; f: health with sanitary; g: health with no pollution; h: residential safety; i: residential community

According to this index system, "satisfaction with residential environment" (level-1) depends on satisfaction with "convenience", "amenity", "safety", "health" and "community" (level-2). Attributes of level-2 are assumed to depend on satisfaction with nine level 3 attributes. For example, "amenity" (level-2) is assumed to depend on "d" (amenity with natural environment) and "e" (amenity with landscape) (level-3). Furthermore, each of the nine attributes of level-3 is decomposed into some lower level attributes in level-4. For instance, "b" of level-3 (convenience with access to working and studying) is assumed to depend on 4 level-4 attributes, such as "distance to work", "convenience to the transportation access to work", "distance to school", "convenience to the transportation access to school". One more example for level-4 attribute is that: "d" of level 3 (amenity with natural environment) is assumed to depend on such 6 attributes of level-4 as "nearby green area", "water environment", "historical and cultural environment such as shrines, temples and historical remains", "parks", "playing gardens" and "residential condition such as room number, area and so on".

4.2 Evaluation results

On-site residents were asked to evaluate their present residential situation with respect to residential satisfaction on multi-attributes. Evaluations were given in terms of satisfaction degree elicited from "very much" (1 point) to "not at all" (5 points). Through the survey, residential environment situation evaluated by residents all over Saga City

can be grasped.

The mean scores and standard deviations of attributes of level-1 and level-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 2.34(0.81), which is close to the midpoint of the 5-point scale. The scores of convenience, amenity, health, safety and community are 2.83(1.02), 3.03(0.82), 2.91(0.92), 3.19(0.81) and 3.01(0.66) respectively.

4.3 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 Saga City. 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 β as follows:

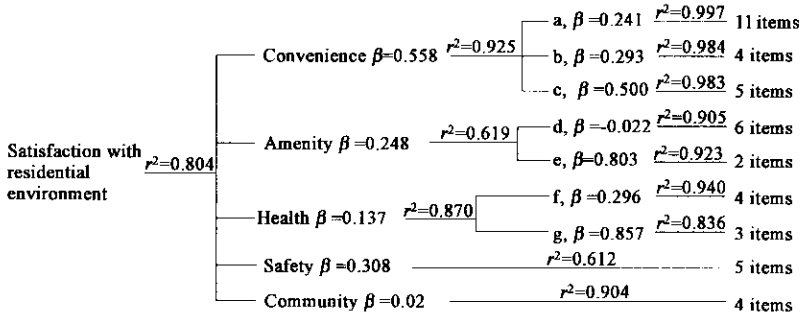

Table 3 Evaluation result on residential environment quality

Area	Level 1	Level 2				
	Satisfaction with residential environment	Convenience	Amenity	Health	Satety	Community
Junyu	2.49 (0.91)	2.63 (0.79)	3.22 (0.83)	2.87 (0.94)	3.27 (0.86)	3.04 (0.63)
Kanko	2.26 (0.74)	2.36 (0.78)	3.01 (0.78)	2.84 (1.01)	3.21 (0.70)	3.03 (0.65)
Nisshin	2.27 (0.83)	2.88 (0.80)	3.14 (0.80)	2.49 (0.90)	3.10 (0.88)	2.88 (0.76)
Kose	2.34 (0.86)	3.04 (0.74)	3.18 (0.69)	3.05 (0.86)	3.23 (0.71)	2.98 (0.40)
Honjo	2.38 (0.81)	2.85 (0.76)	3.03 (0.97	2.85 (0.99)	3.19 (0.88)	2.92 (0.73)
Kouno	2.25 (0.71)	2.51 (0.81)	2.99 (0.78)	2.98 (0.96)	3.16 (0.72)	2.91 (0.66)
Kaisei	2.25 (0.66)	2.77 (0.83)	2.97 (0.82)	3.15 (0.81)	3.22 (0.67)	3.08 (0.62)
Takagise	2.18 (0.64)	2.53 (0.73)	3.03 (0.74)	3.00 (0.82)	3.12 (0.79)	2.94 (0.57)
Nishiyoka	2.38 (0.78)	3.16 (0.68)	3.07 (0.57)	2.80 (0.70)	3.34 (0.75)	3.00 (0.47)
Akamatsu	2.24 (0.93)	2.72 (0.94)	2.84 (1.03)	2.62 (0.93)	3.27 (0.90)	3.26 (0.74)
Kubozumi	2.86 (0.95)	3.72 (0.94)	3.11 (0.88)	3.21 (0.94)	3.47 (0.89)	2.98 (0.74)
Nabeshima	2.14 (0.69)	3.00 (0.64)	2.71 (0.89)	2.63 (0.88)	3.06 (0.97)	3.03 (0.71)
Kitakawaoe	2.33 (0.81)	2.88 (0.79)	3.15 (0.80)	2.95 (0.90)	3.06 (0.85)	3.04 (0.77)
Hyogo	2.40 (0.97)	3.05 (2.54)	2.91 (0.72)	2.90 (0.91)	3.22 (0.77)	3.13 (0.76)
Kinryu	2.52 (0.82)	3.02 (0.69)	3.06 (0.65)	3.00 (0.94)	3.16 (0.83)	3.05 (0.64)
Shinei	2.11 (0.77)	2.50 (0.66)	2.93 (0.88)	2.76 (0.87)	2.87 (0.93)	2.91 (0.69)
Fuyo	2.50 (0.92)	3.45 (0.77)	3.07 (0.64)	2.76 (0.82)	3.14 (0.65)	3.14 (0.57)
Kase	2.47 (0.76)	3.05 (0.81)	2.94 (1.04)	3.11 (0.91)	3.20 (0.82)	2.98 (0.60)
Wakakusu	2.25 (0.70)	2.67 (0.82)	3.07 (0.87)	3.16 (0.87)	3.18 (0.78)	3.04 (0.63)
Total samples	2.34 (0.81)	2.83 (1.02)	3.03 (0.82)	2.91 (0.92)	3.19 (0.81)	3.01 (0.66)

The regression equation of level 1 is:

Santisfaction = 0.558 Convenience + 0.248 Amenity + 0.137 Health + 0.308 Safety + 0.02 Community, and equations of level 2 are:

Convenience = 0.241a + 0.293b + 0.500c; Amenity = − 0.022d + 0.923e; Health = 0.296f + 0.857g.

It shows that 80.4% of the variance in the assessment of "residential satisfaction" (level-1) can be explained by the five level-2 attributes. Satisfaction with "convenience" appeared to be the most important attribute (β = 0.558), then come the attributes of satisfaction with "safety", "amenity" and "health" (β = 0.308, β = 0.248, β = 0.137, respectively). The fifth attribute of satisfaction with "community" (β = 0.02) does not appear to affect residential satisfaction to an important extent in this questionnaire.

Three attributes a, b and c (level-3) can explain 92.5% of the variance in satisfaction with convenience. Convenience with "access to nearby cities" (β = 0.500) appears more important than that of "living facilities" (β = 0.241) and "access to working and studying" (β = 0.293).

The two level-3 attributes d and e appears to explain 61.9% of the variance in satisfaction with "amenity" (level-2), in which "landscape" (β = 0.803) seems to be much more important than "living natural environment" (β = − 0.022).

As to the satisfaction with health (level-2), the two attributes f and g (level-3) can explain about 87.0% of the variance, in which "no pollution" (β = 0.857) seems more important than "sanitary" (β = 0.296).

From the above analysis, it may also be noted that the model fitness (r^2) is quite high, indicating that the hierarchical multi-attributes index system established in this study can offer a promising and valuable theoretical framework for modeling residential environment quality. Our questionnaire ended with the question "Is there any other items not mentioned in the questionnaire that will affect the residential environment quality in your life?" Almost all of the answers consider no such items, which shows that the present model has captured most attributes of residential environment quality.

5 Influence of regional characteristics on residential environment evaluation

The distribution of 19 residential areas of Saga City is shown in Fig. 3, and there are 5 groups according to location distribution: north group, west group, east group, center group and south group.

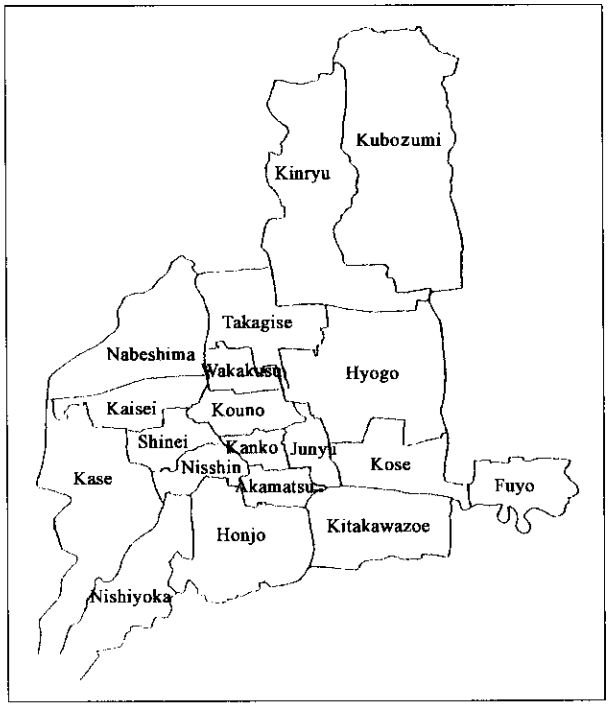

Fig.3 Distribution of 19 residential areas of Saga City

North group(Kubozumi and Kinryu) is located around the hill area and abundant of natural scenery and garden landscape. As a consequence, the evaluations on amenity attributes such as "green area", "clean air" are quite high. However, it is also shown that evaluations on such convenience attributes, as "public transportation" and "recreation facility" are comparatively low. As a whole, the assessment on residential satisfaction is lower than other groups. The low convenience can serve as the main reason for the assessment because the importance on convenience appears to exert greater influence on overall assessment than other attributes.

West group(Kaisei, Wakakusu, Nabeshima, and Takagise) is close to the industrial and commercial developed area, therefore the evaluation on convenience of daily life, such as attributes of "convenience of shopping", "financial institution" and so on, are quite high. On the contrary, for this group is adjacent to interchange and by-pass, transportation quantity here is quite large and accordingly the assessment on safety items such as "transportation safety" is quite low. However, the overall assessment on residential satisfaction is pretty high due to high assessment of convenience.

East group(Fuyo, Kose and Hyoko) is characterized as abundance of creak and water net. Due to carefully renovation towards water environment in Hyogo area, assessment on amenity and convenience are quite high herein. Yet, in Kose and Fuyo areas, the assessment results turned out contrary to that of the former area due to lack of renovation of the water environment. Assessment on safety bears quite low within this group.

Center group(Shinei, Jyunyu, Kouno, Kanko, Nisshin and Akamatsu) has a long history of acting as the commercial and public center of Saga City. Thus the evaluation on "convenience of general life" is very high, while on safety attributes such as "transportation safety" and "community" are comparatively low. With the same reason that convenience seems to be the most important attribute, the overall evaluation of residential environment quality is apparently high in this group.

South group(Honjo, Kase, Kitakawazoe, and Nishiyoka) bears abundance of garden landscape, and close to the airport. The assessment on "convenience" and "health" are quite high, while those concerning "amenity" and "safety" are quite low. Especially in the attributes of amenity, although the assessment on such items regarding natural environment, for example "green area", "clean of the air" etc. are not low, evaluations on facilities of the "park" and "playing garden" are quite low. As to safety, owing to nearing to the south by-pass, the assessment is quite low. In all, about 60% of the residents show their satisfaction with residential environmental quality.

In conclusion, it is clear that the regional factors performed remarkable influence on residential environment evaluation. To grasp the regional characteristics can help to grasp the main point for the improvement of the residential environment effectively and efficiently.

6 Influence of personal residential preference on residential environment evaluation

6.1 Types of personal residential preference

In order to identify the personal residential preference, there are 12 choices presented for the residents about their preference when choosing the present dwelling, including residential environment factors (a)—(h), economic factor (i), social factor (j), historical factor (k), and others (l) ((a)convenience of shopping; (b)convenience to school and job; (c)natural landscape; (d)streetscape; (e)safety against disaster; (f)safety against crimes; (g) health and welfare service; (h) access in the city and to the around cities; (i)low cost; (j)near with parents or children; (k)without special consideration because of long time living and (l) others). Among these choices, we do not consider the community factors since the community condition is very difficult to be grasped and out of consideration when choosing dwelling. In addition, the factors of health are also not taken into consideration since they are the most fundamental requirement of human beings, and nowadays, the residential health condition is quite well and does not differ a lot around the whole city.

Firstly, in order to focus on residential environment itself, the principle component analysis was performed considering only residential environment factors. Analysis was performed by the software SPSS 11.0, by extraction method of principle component analysis, and rotation of Varimax with Kaiser Normalization. From the results shown in Table 4, five principle components have been extracted: 1st—amenity + safety; 2nd—convenience; 3rd—safety; 4th—convenience of access in and around cities; 5th—health and welfare service. According to these results, the main preferences of selecting dwellings are in the order of amenity + safety, convenience, safety, convenience of access, health and welfare service. The total variance shows that the above five principle components can explain the residential preference quite well, with the cumulative 81.9%, and the first and second factors served as

the 47.0%.

Analysis was conducted once again to analyze the influence of economic factor on residential environment, and the principle components changed in the sequence to: 1st: amenity + safety; 2nd: convenience(including daily and access convenience); 3rd: convenience of health and welfare service; 4th: economy and 5th: safety. Herein, note that the economic factor turns out to be the 4th main component influencing the residential environment quality evaluated by residents.

Table 4 Results of factor analysis

Variance	Component				
	1	2	3	4	5
Convenience of shopping	-0.106	0.875	-0.049	0.031	0.087
Convenience to school and work	0.335	0.730	0.076	0.140	-0.075
Natural landscape	0.765	-0.036	0.121	-0.060	-0.016
Streetscape	0.856	0.109	0.056	0.042	0.074
Safety against disaster	0.862	0.102	0.050	0.012	0.043
Safety against crimes	0.083	0.092	0.993	0.014	-0.012
Health and welfare service	0.067	0.070	-0.012	0.055	0.993
Access in the city and to the around cities	-0.013	0.122	0.086	0.989	-0.055
Percentage of variance of component, %	29.504	17.545	12.688	11.871	10.271
Cumulative percentage, %	29.504	47.049	59.737	71.608	81.879
Eigenvalue	2.360	1.404	1.015	0.950	0.822

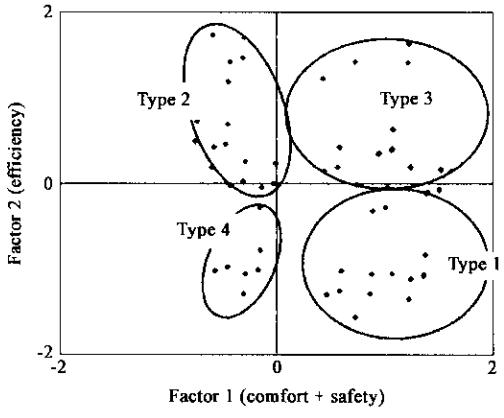

Fig.4 Scatter plot of component value of factor 1 and factor 2 and personal residential preference type

Type	Type characteristics	Number	Percentage, %
1	Amentity + safety type	171	14.40
2	Convenience type	820	69.30
3	Comprehensivbe type	66	5.60
4	Other type	127	10.70

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 explain about half contribution of the total factors) of each resident is plotted in Fig.4. The X-axis is the 1st factor (amenity + safety); Y-axis is the 2nd factor (amenity). Thus, 4 types can be identified, which are Type 1 (amenity and safety type); Type 2 (convenience type); Type 3 (comprehensive type) and Type 4 (other type).

6.2 Influence of personal preference on residential environment evaluation

In order to analyze the characteristics of each preference types, we calculated the satisfaction scores and importance scores of 4 types, shown in Table 5.

Type 1(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 average 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 on convenience is the lowest among all types, which may illustrate the difficulty in pursuing the satisfaction with amenity, safety and convenience simultaneously. Type 1 regards amenity and safety as their first preference, and this seems to have been realized, while the aspect of convenience is compromised.

Type 2(convenience type): This type is focused on convenience, and the evaluation on convenience importance is the highest. It is also shown that the satisfaction evaluation on convenience is quite high, much higher than the average. The importance evaluation on 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 that of type 1, type 2 choose the convenience as the most important factor on dwelling, and in consequence their requirement on amenity and safety are given up to some extent. Among all the residents, the percentage of this type is largest (69.3%).

Type 3(comprehensive type): The importance evaluation on amenity, health, and safety are highest among all types, and the importance evaluation on convenience is on average. In addition, their satisfaction with convenience, amenity, health and safety rank the first among all types, community ranks the second. It can be seen that their comprehensive wish on living condition are realized to the largest extent, which is also the target of residential environment plan and design. Although the number of this type is as the lowest as only 66 residents, the importance to analysis the residential environment property of this type is unquestionable.

Type 4(other type): The preference emphasized on other factors instead of amenity, safety and convenience. As Table 5, the evaluation on importance and satisfaction with 5 factors are all very low, while convenience is the second worst, and other four factors bear the worst. The totally satisfaction on residential environment is also the lowest. The reason may be related to their unclearness of residential preference. The

Table 5 Evaluation on residential satisfaction and importance of 4 types

	Evaluation on residential satisfaction with 4 types						Evaluation on residential important with 4 types				
	Convenience	Amenit	Health	Safety	Community	Total	Convenience	Amenit	Health	Safety	Community
Type 1	2.99	2.87	2.83	3.07	3.09	2.27	2.75	2.37	1.95	1.69	2.77
Type 2	2.65	3.05	2.89	3.15	2.95	2.28	2.62	2.43	2.01	1.73	2.92
Type 3	2.57	2.66	2.73	3.07	3.06	2.27	2.73	2.02	1.78	1.63	3.06
Type 4	2.87	3.18	3.01	3.29	3.12	2.43	2.74	2.43	2.09	1.64	3.01

residential environment condition of this type is also worth being studied, in order to improve their residential environment, as well as their residential awareness.

7 Temporal change of residential environment evaluation

Hoygo area is located in the eastern of Saga City and the whole area is plane, full of garden landscape, and creek nets. We compared the questionnaire results this time with the data obtained in 1999, shown in Fig. 5(a)—(e), concerning convenience, amenity, health, safety and community respectively. The temporal change of residential environment assessment in the same area can be seen clearly.

Convenience: Concerning the attributes of "convenience", the assessments of almost all the items appear lower (higher score means lower assessment) than that of two years ago. Especially the dissatisfactions with "shopping" and "road network" expressed by residents are getting increasingly intensified, illustrated in Fig.5(a).

Amenity: Concerning the "amenity" attribute, the assessments on natural and residential amenity seem to have decreased a lot compared with two years ago, especially the item of children's playing garden, park, and so on.

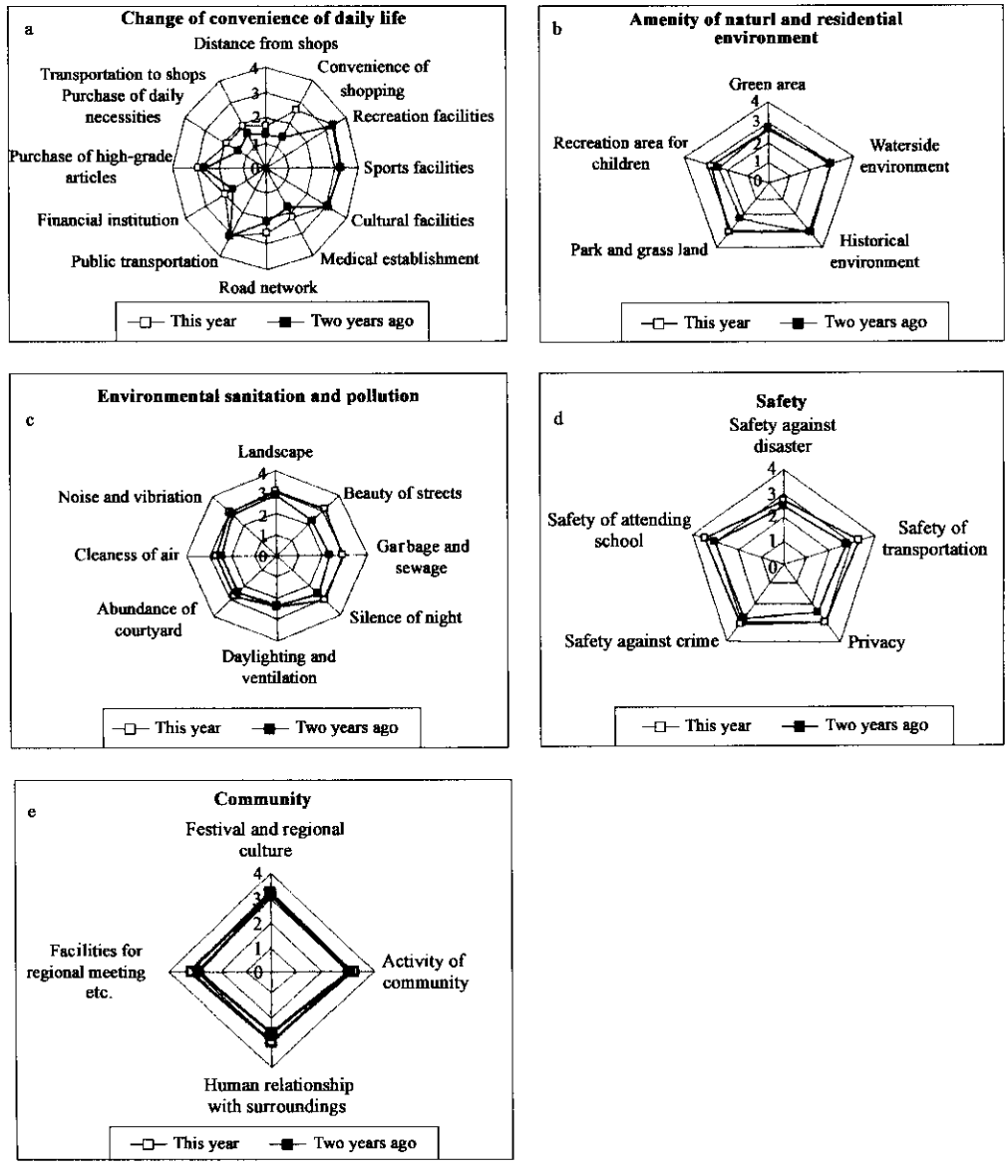

Fig.5 Change of evaluation on (a) convenience; (b) amenity; (c) health; (d) safety; (e) community

Health: As for the attribute of "health", similar to the attributes of convenience and amenity, almost all of the items bear low assessments than before, especially satisfaction on "garbage and sewage", "beauty of streets" and "silence of night", which appear to have decreased most compared with two years ago.

Safety: Regarding the attributes of "safety", all of the items appear to get lower assessment than two years ago. It seems that residents are increasingly worrying about the danger from road, transportation, accidents, etc. more than before.

Community: The assessment on "community" has decreased a little during these two years and maintains under the average level. It is illustrated that social activities within this community remains inadequate.

In general, the overall assessment on residential environment by residents turned out to have dropped during these two years, although with the improvement of urban construction and facilities development,

the actual condition of such aspects as convenience, amenity, healthy, safety, etc. are surely to have been improved than before. This means that the expectations of residents on residential environment quality are increasing faster than the actual improvement during these years, which should also be taken into consideration by developer and designer during city planning and construction.

8 Conclusions

The following conclusions can be drawn from the above researches:

The present residential environment situation evaluated by on-site residents can be grasped all over Saga City, as well as the regional characteristics and the influence on residential environment evaluation, which can be served as the data-base for the urban planning and decision-making.

Hierarchical multi-attribute index system on 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 results on model fitness showed 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.

Four personal residential preference types were identified and their influences on residential environment evaluation were also studied.

The temporal changes of evaluation on residential environment in one area during 3 years were also studied. It showed that the expectations of residents on residential environment were increasing faster than the actual improvement during these years, which should also be taken into consideration by developer and designer during city planning and construction.

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