STUDY ON THE COMPOSITION OF LAYOUT PLANNING AND ENVIRONMENTAL COGNITION IN THE COLLECTIVE HOUSING AT MAKUHARI BAYTOWN

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ABSTRACT

This study adopts one of the modern city theories followed in the design of a housing complex on an urban scale, with the aim of alleviating the shortage of houses. A plan was created to make the centre of a complex at Makuhari Baytown multi-storeyed and standardised.

Experts argue that an efficient urban and architectural planning method for the new living environment, namely, collective housing, has not been created. However, the supply of high-rise residential settlements has been generalized, despite the known negative effects associated with urban verticalization.

In the planning of collective housing, an effective technique must consider secular changes, including the relevance of the surroundings and living environment. To construct productive planning methods for the increase of high-rise housing, in-depth research is needed.

This research was conducted at Makuhari Baytown, a model of super high-rise urban housing. The research employed a questionnaire survey, as well as aggregative analysis theory to determine the aggregate curve. A multivariate analysis was performed based on the various data from environmental recognition. Local residents' individual cognitive characteristics were grasped by classification. From the above research, the attributions of environmental cognition and life territory were determined, particularly those regarding the floors of residents of super high-rise towers. These findings enabled the appropriate attribution of data for the living-together-in-a-concentrated-community project.

KEYWORDS

Environmental recognition, Cognitive area, Collective housing, Makuhari Baytown, Living environment

1. INTRODUCTION

The plan for the multi-storey centre included standardisation, following a modern city theory for the design of an urban housing complex aimed at alleviating the housing shortage. According to the investigation of Real Estate Economic Institute Co., LTD, greater verticalisation of collective housing is projected for the next 3 years; specifically, about 100,000 collective housing units are planned in the capital region of Japan. Additionally, a robust trend towards permanent dwellings in high-rise residential settlements has been noted.

However, an efficient urban and architectural planning method for the new living environment− collective housing − has not been developed, although the supply of high-rise residential settlements has been generalised. It is common knowledge that high-rise urban verticalisation has various negative effects.

Current plans for collective housing do not reflect valid modifications to the initial plans with their predictable problems. The inadequacy of research on collective housing is exemplified in the history of immature planning methods. An effective planning technique must reflect considerations for secular change and the relevance of the environment surrounding a residential living space. More efficient planning methods for improving productivity in the construction of high-rise housing is needed to meet the increased demand for such space.

In previous studies, mid-rise and roadside courtyard-type residences have been analysed and classified in terms of the consciousness of neighbourhood inhabitants and the degree of openness reflected in a courtyard’ s design. These studies identify design characteristics of courtyard-type residences; further, they address cognitive domain.[1]

In addition, research was conducted previously in Ohkawabata River City 21, a pioneering model for super high-rise urban housing. The research analysed the factors and changes associated with the cognitive domain, which reflects a vertical direction. The concept of layer variation was extracted from the study, and it provides a planning method for collective housing that is based on cognition and vertical direction.[5]

An effective planning method for collective housing with respect to different heights has not been identified yet. In this paper, characteristics recognised by residents, layout plans, and cognitive domains of residents in mid-rise and high-rise dwellings and the residential skyscraper in the courtyard-type residential settlement in Makuhari Baytown are examined.

2. INVESTIGATION AND OUTLINE OF ANALYSIS

2.1. Region included in research investigation

The investigation covered Makuhari Baytown, which is a visionary model for collective housing in Japan. In this region, urban planning is based on a Western style of regional planning (i.e. roadside courtyard-type residential buildings). It is an exceptional reflection of Japan’s culture. In addition, the network of city blocks has been designed using a grid pattern as a skeletal structure. Parks, green spaces, and open spaces are arranged according to an axis scale of the landscape, which includes Mount Fuji, the sea, and so on. The district’s design process emphasises flexibility for consultations; thus, a living body has been planned that includes an area measuring 84 ha, a planned population of 26,000 people, and 9,600 housing units. Makuhari Baytown was intended to be an international business city that would be formed step-by-step over 20 years. As a result, the characteristic cityscape has been formed; it includes public facilities, land for commercial use, green space, and water in and outside of the region (Figure 1).

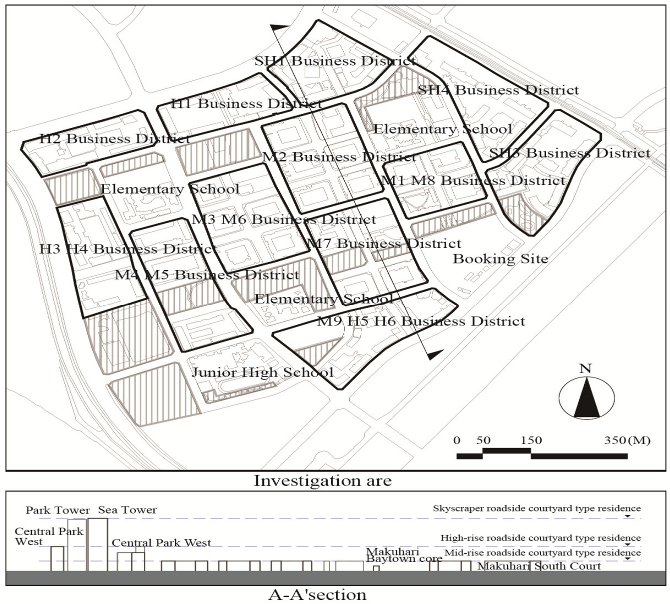


Figure 1. Investigation area

2.2. Methods of investigation and analysis

In this study, an initial survey questionnaire was administered to investigate the cognitive domains of residents. Survey results were analysed using a multivariate analysis with quantitative indicators. Multivariate analysis was conducted according to Quantification III [*1], and common factors were extracted; additionally, characteristics of the cognition were discussed and a pattern classification analysis using factors axis was conducted. From this sequence of analyses, characteristics of the residents' cognitive domains and composition of arrangement planning were studied.

2.3. Outline of the investigation

The first survey was conducted during August and September in 2010. The second survey was conducted during July and August in 2012. The survey, designed to clarify residents' cognitive domains, was distributed to residents over the age of 13 in 43 buildings throughout Makuhari Baytown. It was conducted on site using the sphere graphic method [*2], and residents surveyed were located in a variety of locations to eliminate bias.

The survey was conducted according to the overview above, and we obtained 335 valid responses. Survey content is shown in Table 1.

No.	Contents
1	Attribute investigation
2	Everyday route investigation
3	Cognitive domain research area of movement
4	Research component cognitive domain
5	Survey of visible components
6	Survey of consciousness range recognized as neighbors.
7	Cognitive domain investigation of “My town, Familiar waterside, Familiar green area, Prosperity, Landmark”
8	Comparative study of the city I lived in before
9	Change of the city since the survey started living in

Table 1. Survey content

3. CONSIDERATION OF RESIDENTS’ ENVIRONMENTAL PERCEPTION

The cognitive area maps for low, mid-level, and high (upper) residence floors were derived from an aggregate analysis of the results of the survey questionnaire using the sphere graphic method. The residents’ cognitive domain areas were based on ‘perceived range of the neighbourhood’, ‘range of activities’, ‘my town’, ‘familiar waterside’, ‘familiar green space’, ‘bustle’, and ‘landmark’. Furthermore, calculations of perceived area and a comparison analysis based on storey level were performed.

4. CONSIDERATION OF COGNITIVE CONSTRUCTS USING MULTIVARIATE ANALYSIS

In this section, the structure and attribution of residents’ cognitive perceptions were analysed using multivariate data obtained from the survey described in the previous section. Using Quantification III and a cluster analysis, the multivariate data were analysed. Personal data obtained from the completed questionnaires were classified into 30 items and 134 categories, as shown in Table 2; subsequently, Quantification III was executed. The factors that are notable in terms of cognitive characteristics were extracted based on three axes, as described below.

Table 2. Item category plot

IN	Item	CN	Category	FRE	PN	IN	Item	CN	Category	FRE	PN
1	Sex	1	male	180	11	16	Green (Count)	1	1	191	F1
		2	famale	155	12			2	2	86	F2
2	Age	1	10's-20's	32	21			3	3-	58	F3
		2	30's	67	22	17	Neighberhood (Visibility)	1	Visible	198	G1
		3	40's-44's	87	23			2	Invisible	101	G2
		4	45's-49's	47	24			3	unknown	36	G3
		5	50's	59	25	18	Activities (Visibility)	1	Visible	128	H1
		6	60's-	43	26			2	Invisible	194	H2
3	Residence yaer	1	3， 4	74	31			3	unknown	13	H3
		2	5,6	77	32	19	Water (Visibility)	1	Visible	152	I1
		3	7,8	60	33			2	Invisible	170	I2
		4	9,10	50	34			3	unknown	13	I3
		5	11-	74	35	20	Green (Visibility)	1	Visible	158	J1
4	Residence floor	1	1-3	83	41			2	Invisible	163	J2
		2	4-6	101	42			3	unknown	14	J3
		3	7-9	51	43	21	Neighberhood -Activities	1	Comprehension	225	K1
		4	10-12	32	44			2	Overlap	48	K2
		5	13-15	31	45			3	Contact	20	K3
		6	16-	37	46			4	Separation	42	K4
5	Number of leisure activities	1	1	160	51	22	Neighberhood -Water	1	Comprehension	6	L1
		2	2	91	52			2	Overlap	26	L2
		3	3-	34	53			3	Contact	28	L3
		4	0	50	54			4	Separation	275	L4
6	Consciousness (vertical)	1	Regognize	235	61	23	Neighberhood -Green	1	Comprehension	22	M1
		2	Unrecognize	100	62			2	Overlap	61	M2
7	Range (vertical)	1	Up and dwon to 9th fllor	113	71			3	Contact	88	M3
		2	Living inside and outside of buildings	122	72			4	Separation	164	M4
		3	Unrecognize	100	73	24	Activities -Water	1	Comprehension	29	N1
8	Factor (vertical)	1	Physical condition	118	81			2	Overlap	44	N2
		2	Conscious condition	47	82			3	Contact	84	N3
		3	Time element	70	83			4	Separation	178	N4
		4	Unrecognize	100	84	25	Activities -Green	1	Comprehension	135	O1
9	Neighberhood (attribute)	1	Point	129	91			2	Overlap	66	O2
		2	Line	25	92			3	Contact	60	O3
		3	Plane	104	93			4	Separation	74	O4
		4	Time element	77	94	26	Water -Green	1	Comprehension	26	P1
10	Activities (attribute)	1	Point	130	01			2	Overlap	44	P2
		2	Line	64	02			3	Contact	65	P3
		3	Plane	48	03			4	Separation	200	P4
		4	Time element	93	04	27	Neighberhood (ha)	1	0-2	64	Q1
11	Water (attribute)	1	Point	41	A1			2	2.1-6	67	Q2
		2	Line	149	A2			3	6.1-20	75	Q3
		3	Plane	102	A3			4	20.1-50	46	Q4
		4	Time element	43	A4			5	50.1-	83	Q5
12	Green (attribute)	1	Point	154	B1	28	Activities(ha)	1	0-20	86	R1
		2	Line	39	B2			2	20.1-40	40	R2
		3	Plane	104	B3			3	40.1-90	73	R3
		4	Time element	38	B4			4	90.1-150	60	R4
13	Neighberhood (Count)	1	1	273	C1			5	150-	76	R5
		2	2	47	C2	29	Water(ha)	1	0-10	77	S1
		3	3-	15	C3			2	10.1-25	83	S2
14	Activities (Count)	1	1	203	D1			3	25.1-40	58	S3
		2	2	72	D2			4	40.1-60	49	S4
		3	3-	60	D3			5	60.1-	68	S5
15	Water (Count)	1	1	202	E1	30	Green(ha)	1	0-5	58	T1
		2	2	108	E2			2	5.1-12	76	T2
		3	3-	25	E3			3	12.1-18	77	T3
The number of valid samples : 335								4	18.1-30	64	T4
								5	30.1-	60	T5

4.1. Correlation coefficient for the first axis: 0.359284

In the first and second axis item category plot chart (Figure 2), the area of perceived range and degree of overlapping range show the consecutive distribution, which can form the axis. The area and overlap is so major and overlapping as to the positive direction, whereas is small and dissevering as to the negative direction. Therefore, a factor analysis for the first axis was based on the area of the perceived range and the degree of overlap, considered as ‘a composite of the range by the mutual relationship’.

4.2. Correlation coefficient for the second axis: 0.33572

In the category plot chart for the second/third axis and first/second axis, ‘vertical consciousness’, ‘range of vertical consciousness’, ‘factor of vertical consciousness’, ‘age’, ‘residential floor level’, and ‘attributes of components*3’ reveal the consecutive distribution forming an axis. (Figure 2). Vertical consciousness, range of vertical consciousness, and factor of vertical consciousness do not reflect a negative direction. Residential floor level, applicable to the high-rise buildings and skyscraper, reflects a positive direction, whereas the low-rise and mid-rise residences indicate a negative direction. Points for the consciousness of neighbourhood residents are understood in the positive direction, whereas time is understood in the negative direction. Thus, the factor analysis of the second axis was conducted for vertical consciousness, residential floor level, and consciousness of neighbourhood residents. The axis shows the ‘expanse of the consciousness of the neighbourhood residents to the vertical and horizontal direction that is subjected to the residential floor level’.

4.3. Correlation coefficient for the third axis: 0.304834

The category plot charts for the first/second axis and second/third axis show consecutive distribution mainly in respect to visibility, residence year, and attributes of the components, which form the causal axis component. (Figure 2). Visibility indicates a positive direction, and invisibility a negative direction. Residence year as ‘more than 11 years’ reflects a positive direction, and ‘7 to 8 years’ reflects a negative direction. Attributes of components (range of activities) reflect a positive direction for time and a negative direction for points. Therefore, factors of the third axis are visibility, residence year, and component attributes, expressed as ‘change of visual and cognitive structure due to the time change’.

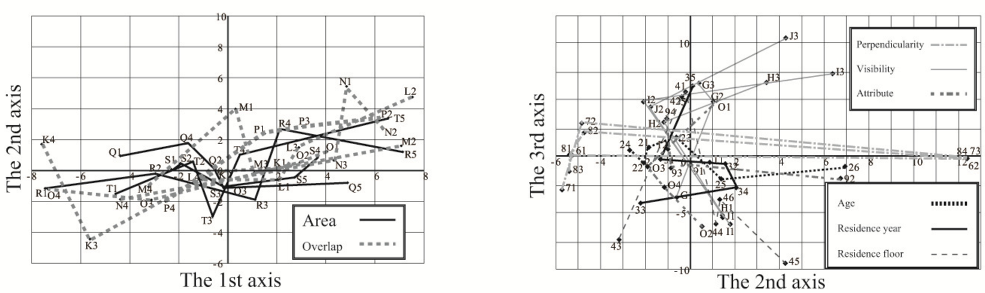


Figure 2. Item category plot 1-2 axis (left) and 2-3 axis (right)

5. CONSIDERATION OF STRUCTURAL CHANGES IN THE RESIDENT FACTOR ANALYSIS AND TYPOLOGY

This study reveals the features of each type of pattern recognition by the characteristics of each type obtained from a sample score of Quantification III and cluster analysis (Ward’s method). In this study, a tree diagram from the cluster analysis was used to identify two classification types when the Euclidian distance was greater than 400 and five types when the Euclidean distance was greater than 100 (Figure 3).

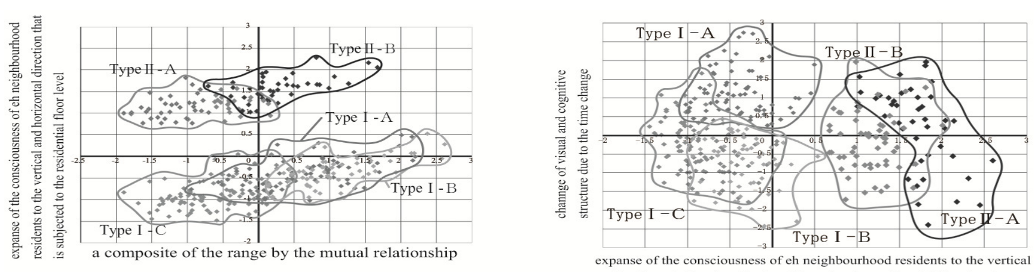


Figure 3. Sample plot based on cluster analysis 1 -2 axis (left), 2-3 axis (right)

5.1. Type I-A (73 samples)

Type I-A is a group of residents who live on low and middle floors of buildings within an entire city block. They are conscious of the neighbourhood in the vertical direction (i.e. upper and lower floors in residential buildings). However, range of activities, waterfront, and green space are not included in the visible area. Yet, the cognitive area covers a relatively wide range. The cognitive area for the range of activities encloses green space and a range of the neighbourhood. Furthermore, the neighbourhood range, waterfront, and green space are separated from each other.

5.2. Type I-B (57 samples)

Type I-B is a group of residents who live on the upper floors of high-rise buildings within a city block. They are conscious of the neighbourhood in the vertical direction (i.e. upper and lower floors in residential buildings). The range of activities, waterfront, and green space are included in the visible area. Further, the cognitive area covers a wide range. The cognitive area for the range of activities encloses green space and the range of the neighbourhood. In fact, cognitive domains of green space and the neighbourhood are duplicated.

5.3. Type I-C (105 samples)

Type I-C is a group of residents who live below the ninth floor in high-rise buildings within a city block. They are conscious of the neighbourhood in the vertical direction. The range of activities, waterfront, and green space are not included in the visible area. Further, the area of the cognitive domain is small and regional compared to other types. Additionally, the range of the neighbourhood and range of activities are duplicated in the cognitive domains. Finally, the neighbourhood range, waterfront, and green space are separated.

5.4. Type II-A (58 samples)

Type II-A is a group of residents who live on lower and middle floors of residential buildings within an entire city block. They are not conscious of the neighbourhood in the vertical direction. Further, a range of activities and green space are not included in the visible area. The area of the cognitive domain is small and regional compared to other types. Further, cognitive domains are separated.

5.5. Type II-B (42 samples)

Type II-B is a group of residents who live on lower and middle floors of high-rise residential buildings within a city block. They are not conscious of the neighbourhood in the vertical direction. The range of activities, water, and green space are included in the visible area.

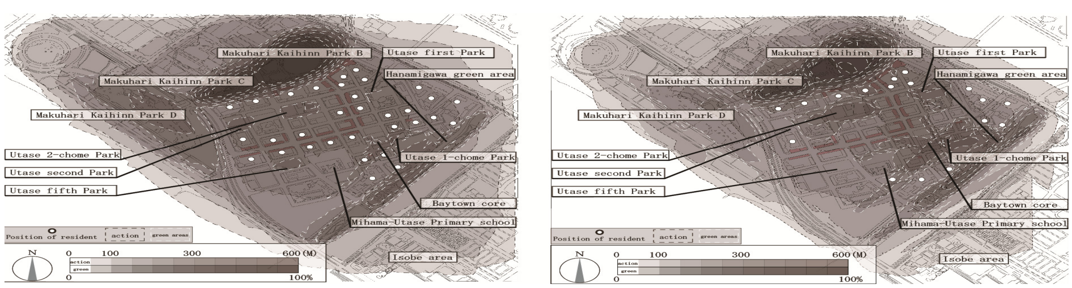
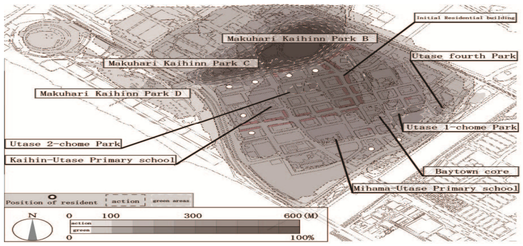


Figure 4. Cognitive region map for range of activity and familiar green area [Type I-A] (left)

Figure 5. Cognitive region map for range of activity and familiar green area [Type I-B] (right)



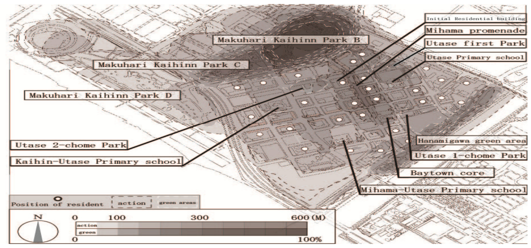


Figure 6. Cognitive region map for range of activity and familiar green area [Type I-C] (left)

Figure 7. Cognitive region map for range of activity and familiar green area [Type II-A] (right)

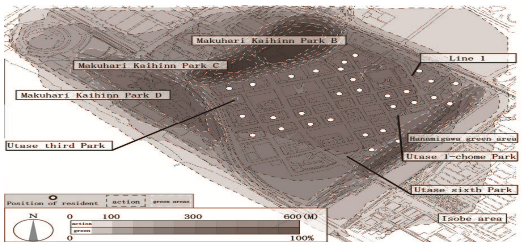


Figure 8. Cognitive region map for range of activity and familiar green area [Type II-B]

Furthermore, the cognitive domain of the range of activities and the neighbourhood is wide compared to other types. There is an overlap in the green space with the neighbouring range, and cognitive domains are duplicated. The range of the neighbourhood with green space, and the range of activities for the waterfront are duplicated in the cognitive domains. In addition, cognitive domains of green space enclose the cognitive domains of the range of activities.

Item	Category	I-A	I-B	I-C	II-A	II-B
Neighborhood Perpendicular	Perpendicular	Recognize			Not recognize	
City block	City block	All city block	Upper	Upper	All city block	Upper Skyscraper
Floor	Residential floor	Low layer Middle lamella	Upper	Below the 9th floor	Low layer Middle lamella	Low layer Middle lamella
Visibility	Neighborhood		Visible	Visible	Visible	Visible
	Action	Invisible	Visible	Invisible	Invisible	Visible
	Water	Invisible	Visible	Invisible		Visible
	Green Area	Invisible	Visible			Visible
Average Area	Neighborhood	47.05	46.64	23.18	14.02	34.27
	Action	165.73	103.40	39.99	31.34	148.78
	Water	50.41	48.58	28.71	34.39	37.49
	Green Area	24.54	37.55	12.39	18.90	25.21
Attribute	Action	Time		Dot	Dot	Time
Over lap	Neighborhood green	separate	Internal capsule	separate	separate	Internal capsule
	Action water	separate	separate	separate	separate	Internal capsule
	Action green	Internal capsule	Internal capsule	separate	separate	Internal capsule

Table 3. Characteristics of each type

6. CONCLUSION

The results of this study are summarized as follows. Figure 9 presents the summary of the overlapping range of the cognitive domain according to each type, illustrated with respect to the height of the building, the expansion of the cognitive area in the vertical direction of the upper and lower floor, the range of neighborhood awareness, the range of the activities of the residents, and the cognitive ranges of the familiar water side and green area.

Residents who live in the lower and middle floors are categorized as type I-A and II-A respectively. Type I-A has a wider range of neighborhood consciousness in the vertical direction of the upper and lower floors of the building interior, whereas II-A, which is the more narrow range of the spread of the neighborhood consciousness indicates a narrow range of the cognitive region.

Types I-B and I-C refer to residents who live in the high-rise block. The cognitive domain of the residents of the upper floor shows a wider range than those who live in the lower and middle levels. Furthermore, the cognitive domains of the residents of the upper level overlap in terms of ‘range of neighbourhood consciousness’ and ‘familiar green area’, and for them, the ‘familiar green space’ is enclosed within the ‘range of activities’.

Type I-C indicates the residents who live on the middle and upper floors of the high-rise building. They indicate a narrow range of ‘range of neighbourhood consciousness’, ‘range of activity’, and ‘familiar waterside and green space’, and a separation of mutual domain units

Type II-B is the category of residents who live on the middle and upper floors of the super high-rise and high-rise buildings. They indicate a wider distribution in ‘range of neighbourhood consciousness’, ‘range of activity’, and ‘familiar waterside and green space,’ and an overlap among the domain units.

The residents of the lower and middle levels indicate the spread of the neighborhood consciousness in the vertical direction and a narrow range in the cognitive region. When the neighborhood consciousness is narrow in the vertical direction, the environmental recognition tends to fall within a wider range.

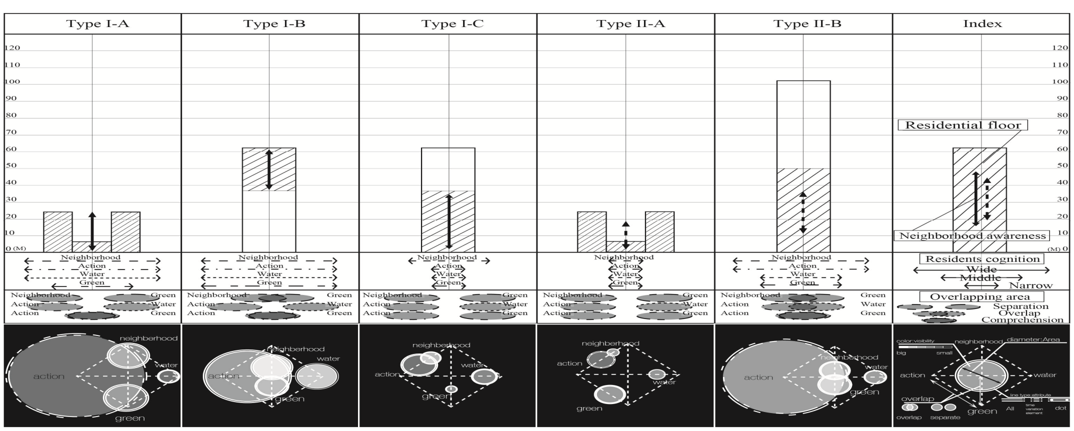


Figure 9. Conceptual diagram of characteristics of each type

NOTE

*1. Quantification III

The purpose of this analysis is to classify samples according to the relationship between categories (characteristic items) and samples. Results are shown as scatter diagrams. In the analytical procedure, the relationship between categories was examined initially. Second, latent common factors revealed from the results are shown as axes of scatter diagrams (category plots). Finally, samples on the scatter diagrams were used for classification, and characteristics were identified.

*2. Sphere graphic method

This method is effective when focused on a subject with adequate recognition of the area. It is suitable for studying relatively limited spaces in small areas, such as the area surrounding a personal dwelling. The subject's cognitive area is obtained by indirectly exploring the structure through a spread, a spatial break, etc.

*3. Components

Components of each cognitive domain were classified into point elements, line elements, plane elements, and elements with temporal variables.

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