SUSTAINABLE PUBLIC HOUSING DEVELOPMENT – HONG KONG CASE STUDY

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ABSTRACT

High-density residential development is always a challenging and attractive issue, particular in those countries have shortage of land for development. Whilst the concepts of sustainability are being introduced throughout the world, high-density development is considered to be a feasible option in the future built environment. However, it comes up another issue of how to provide a better living environment and quality of life in high-density development, and how to ensure the development will provide a sustainable living for local residents. This paper gathers the results of pubic opinion on their living environment, particularly the thermal comfort, air quality and flat design. It produces indicators for its readers to understand how high-density housing be achieved stronger sustainability at the local level.

KEYWORDS

High-density, high-rise housing, public housing, people satisfaction

INTRODUCTION - CHANGES AND MOTIVATIONS

Hong Kong (HK) is situated below the Tropic of Cancer and enjoys distinct seasons over the year. Its winter spans from December to February when temperatures sometimes drop below 10°C in urban areas. The month of March and April experience the highest humidity. It is very common for condensation to form on walls and ceiling. HK summers start in May and last until August when afternoon temperatures often exceed 31°C, and at night temperatures generally remain around 26°C with high humidity. Over the year, average monthly rainfall is about 391 millimetres. It is usual tropical cyclones that cross HK in September. As reported by Hong Kong Observatory, about 31 tropical cyclones are formed in the western North Pacific or China Seas every year (some of them may reach 118 kilometres per hour or more).

In its early years, HK was a fishing village with a population of 3 650, scattered over 20 villages and hamlets, and 2 000 fishermen lived on board their boats in the harbour. It has since been developed as an international city with a population of 6.9 million on its land area of only 1 098 square kilometres. The average land population density per square kilometre was 6 390 in 2000. Presently, about 2.1 million people or 31 per cent of Hong Kong's population live in public rental housing estates managed by the Hong Kong Housing Authority (HKHA) or the Hong Kong Housing Society (HKHS).

OBJECTIVES AND METHODOLOGY

The objectives of this research are study is to understand local residents' perception on the standard housing design in view of environmental comforts. Very defined area of environmental comfort, by summer, winter, living room and bedroom, were identified in the questionnaire. In November 2001, the research was carried out and more than 200 residents' responses have been collected and analysed.

Two standard housing designs namely Harmony Block (including Harmony Annex Block) and Single Aspect Blocks were selected in this research. Housing estates were carefully selected in 3 geographic districts, which have been developed within the last 10 years by HKHA. Residents were selected from different floor levels and different orientations in the housing blocks in these estates.

The questionnaire was divided into few main sections, which related to indoor-environmental comfort, layout and design. Residents' health conditions were also briefly questioned. Although it is not an objective for this research to analyse the relationship between the health condition of residents and building design, it will be important for the exploration of the research continuation in a later stage.

ENVIRONMENTAL ISSUES AND STANDARD DESIGN

Environmental issues are also one of the planning considerations in these public housing developments. One of the biggest concerns is noise pollution and the provision of green space. In many housing estates, noise barriers are installed, such as green mounds and artificial barriers between the pubic highway and neighbouring properties. In terms of the design, most housing blocks do not direct face the north. Because of their density and their height, problems of overlooking and overshadowing are the main concerns of planning considerations.

Characters of Harmony Blocks and Single Aspect Blocks

Harmony Block is 'Cross' shaped with 4 wings. There are about 16-20 flats on each floor. The number of storeys varies in each estate. Normally, there are about 35-40 storeys in each block. Within the public space on each storey, there are 6 lifts installed. The typical characters of Harmony Block are the 'side-to-side' kitchen and the 'door-to-door' corridor. In addition, the drying facilities are installed outside the kitchens. A grilled metal gate is installed in front of the timber door at the entrance to each flat. There are 5 sizes of flat of approximately 52.2 square metres maximum (three bedroom flat) to a minimum 16.3 square metres (1 bedroom flat).

Single Aspect is a contemporary public housing design, and it is also considered one of the environmentally responsive designs in public housing estates. The aim of the design is to reduce noise transference to the residents by repositioning the layout of each storey. The typical character of the housing block is the relocation of all services, such as lifts, meter boxes, stairs and refuse collection points on each side of the building, which are adjacent to the public highway. The number of storeys is also varied. Under special circumstances for example, elderly accommodation, individual

kitchen and dinning rooms are replaced by communal kitchen and dinning rooms. Similar to the designs of Harmony Blocks there are few sizes of flats.

ANALYSIS

Section 1 - Indoor environment comfort

In this section, the residents' perception toward the indoor environmental comfort was examined, which questioned their attitude towards room temperature, air movement, daylight, dust, traffic and kitchen fumes and noise pollution.

TABLE 1
Room temperature

	Summer		Winter	
	Day	Night	Day	Night
%	LR / BR[1]	LR / BR	LR / BR	LR / BR
Very cold	0.00 / 0.00	0.00 / 0.00	12.50 / 12.50	24.04 / 21.15
Cold	1.92 / 0.96	5.77 / 2.88	22.12 / 15.38	18.27 / 19.23
Neutral	57.69 / 51.92	54.81 / 50.96	54.81 / 59.62	44.23 / 48.08
Warm	16.35 / 19.23	15.38 / 22.12	0.96 / 1.92	0.96 / 0.96
Very warm	19.23 / 20.19	15.38 / 17.31	0.00 / 0.00	0.00 / 0.00

About 35% and 39% of residents feel warm or very warm in their living room / bedroom respectively during daytime in the summer. And about 42% and 40% of residents feel cold or very cold in living room and bedroom respectively at night in the winter. More than 50% and 74% of residents have installed air-conditioners and fans respectively. Although more than 88% of residents will open windows if necessary, it would not be a solution for some residents living near to the public highway.

TABLE 2
Air movement

	Summer		Winter	
	Day	Night	Day	Night
%	LR / BR	LR / BR	LR / BR	LR / BR
Very still	15.38 / 16.35	4.81 / 8.65	1.92 / 2.88	3.85 / 6.73
Still	13.46 / 15.38	11.54 / 10.58	5.77 / 5.77	3.85 / 1.92
Neutral	51.92 / 53.85	52.88 / 57.69	53.85 / 53.85	50.96 / 48.08
Draughty	5.77 / 1.92	10.58 / 7.69	10.58 / 11.54	11.54 / 16.35
Very Draughty	7.69 / 7.69	10.58 / 8.65	16.35 / 15.38	18.27 / 16.35

During the summer days, more than 28% and 31% of residents feel the air is still and very still in their living room and bedroom respectively, the figures improve during summer nights. During the winter, more than 26% of residents feel draughty or very draughty in both their living room and bedroom. More than 29% and 32% of residents feel draughty and very draughty in their living room and bedroom respectively in winter night.

[1] LR: Living room: BR: Bedroom

TABLE 3
Daylight

	Summer		Winter	
General %	LR	BR	LR	BR
Very dark	6.73	6.73	8.65	8.65
Dark	6.73	1.92	10.58	7.69
Neutral	33.65	40.38	38.46	46.15
Bright	18.27	16.35	14.42	9.62
Very bright	29.81	29.81	18.27	20.19

	Summer		Winter	
Up to 10th floor %	LR	BR	LR	BR
Very dark	7.9	7.9	10.5	10.5
Dark	13.2	5.3	18.4	10.5
Neutral	31.6	42.1	34.2	44.7
Bright	13.2	10.5	5.3	2.6
Very bright	23.7	21.1	13.2	15.8

	Summer		Winter	
Over 21st %	LR	BR	LR	BR
Very dark	9.1	9.1	9.1	12.1
Dark	6.1	0.0	9.1	9.1
Neutral	15.2	27.3	33.3	36.4
Bright	33.3	27.3	27.3	21.2
Very bright	33.3	36.4	18.2	21.2

Generally, more than 40% of residents feel that their living rooms are bright or very bright during the summer. More than 60% of residents, living in higher levels, mention their living room and bedroom are bright or very bright. About 20% of residents feel that their living rooms are dark or very dark during the winter. About 20% of residents feel that their living rooms are dark or very dark during the winter. In the winter, at lower levels, more than 20% of residents concern their living room and bedroom are dark or very dark.

Traffic emission is one of the sources of dusts. Air quality sometimes is worse if the site is still under construction or being a new development. In addition, it also is varied in different seasons. As shown in the below table, about 30% and 23% of residents find that their living rooms and bedrooms are dusty or very dusty in summer and winter respectively.

TABLE 4
Dust

	Summer		Winter	
%	LR	BR	LR	BR
Very dusty	13.46	12.50	11.54	12.50
Dusty	18.27	15.38	12.50	11.54
Neutral	55.77	57.69	53.85	54.81
Clean	4.81	6.73	9.62	10.58
Very clean	1.92	2.88	1.92	1.92

TABLE 5
Kitchen fumes

	Summer		Winter	
%	LR	BR	LR	BR
Very smoky	5.77	1.92	4.81	1.92
Smoky	7.69	5.77	5.77	5.77
Neutral	47.12	48.08	46.15	44.23
Clean	15.38	13.46	16.35	15.38
Very clean	15.38	23.08	14.42	21.15

Although most of residents do not feel that their living rooms and bedrooms are smoky, it has to be mentioned that there are more than 60% of residents have installed exhaust fans. As mentioned before, the typical design of Harmony Block is the 'side-to-side' kitchen and the drying facilities are installed outside the kitchen. According to the statistics, more than 50% of residents use these drying facilities. In this research, a lot of residents complain about the poor location of the drying facility, since the kitchen fume always cause the problem of the washing greasy when they are hanging outside. Recently, many people use dehumidifiers or washing dryers to sort their drying problems.

TABLE 6.1
Noise

	LR / BR				
%	Traffic	Outdoor activities	Adjoining flats	Upper floor	Lower floor
Very noisy	21.15 / 21.15	11.54 / 11.54	4.81 / 3.85	4.81 / 4.81	1.92 / 0.96
Noisy	12.50 / 15.38	8.65 / 8.65	6.73 / 3.85	11.54 / 6.73	5.77 / 4.81
Neutral	38.46 / 34.62	51.92 / 44.23	47.12 / 44.23	41.35 / 43.27	40.38 / 39.42
Quiet	7.69 / 8.65	2.88 / 6.73	9.62 / 13.46	8.65 / 10.58	9.62 / 13.46
Very quiet	10.58 / 10.58	6.73 / 8.65	13.46 / 15.38	16.35 / 17.31	24.04 / 23.08

About 12% of residents do not feel quieter even though they closed their windows. The most unsatisfied source is the traffic noise. More than 30% of residents feel that their living rooms and bedrooms are noisy or very noisy. There is no significant different between their living room and bedroom.

TABLE 7
Layout

%	View	Living room design	Bedroom design	Flat layout	Floor area	Size of windows
Very Uncomfortable	1.92	1.92	1.92	3.85	6.73	1.92
Uncomfortable	7.69	9.62	9.62	18.27	21.15	5.77
Acceptable	50.00	56.73	52.88	44.23	43.27	48.08
Comfortable	25.96	19.23	18.27	23.08	18.27	16.35
Very comfortable	7.69	3.85	8.65	3.85	5.77	22.12

Flat layout and floor areas are most unsatisfied aspects in the residents' view points. More 20% and 27% of residents feel they are uncomfortable or very uncomfortable in their living accommodation. More than 26% of residents feel comfortable on the view from their properties.

Section 2 - Health and hygiene conditions

Although it is not the aim of the research to understand the relationship between the built form and health conditions, it is inevitable that the poor built environment would affect resident's health conditions.

TABLE 8
Summary of the health conditions

%	Headaches	Itchy / Irritated skin	Respiratory problems	Itchy / watery eyes	Dry throat
Yes	33.65	40.38	16.35	22.12	33.65
No	50.00	49.04	66.35	61.54	52.88

Whilst the environmental comforts are analysed, the above summary provides a brief background of health conditions of local residents. About 16% and 33% of the residents have symptoms of respiratory problems and dry throat. More than 40% of the residents have symptoms of itchy/irritated skin.

DISCUSSION

Resident's responses show that the environmental comfort in higher levels is different from that in lower levels. The height and distance between blocks and building wings are the causes of overshadowing, and are the factors that have influenced responses. The enjoyment of daylight and indoor noise pollution can be different for the smaller and bigger flats. The reason for this is that the smaller flats are always situated near the lobby or at the corner of the block whilst the bigger flats are situated at the end of each corridor.

Traffic noise and emissions are the most crucial issues in high-density development. Although most of residents feel it is quieter when they close their windows, this compromises the air ventilation in their living accommodation. Dust is one of the main issues for environmental consideration. However, the housing design and construction process could be improved in order to minimise the impact to residents.

To conclude, high-density development can provide a comfortable place for local residents, in which most residents can enjoy their life in this compact city. Furthermore, this type of development can be an alternative for improving quality of life, in which you can achieve a comfortable living environment and can provide most of what residents' need within walking distance.

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