PUBLIC LOW-COST HOUSING IN MALAYSIA: CASE STUDIES ON PPR LOW-COST FLATS IN KUALA LUMPUR

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Abstract

This paper examines the design quality of People's Housing Project (*Program Perumahan Rakyat* or PPR) low cost high rise flats developed by the National Housing Department (*Jabatan Perumahan Negara* or JPN) in Kuala Lumpur since the 1998. Quality Function Deployment method is used as a tool to analyze the current status and to prioritize the demanded quality from the selected PPR low-cost high rise flats' users. The study revealed that factors in determining a quality low-cost high-rise flat arranged in descending degrees of importance are house safety, provision of public amenities, unit internal environment, maintenance and surrounding environment, location, sanitary fittings, unit size, type of house, material used, unit internal layout, quality of workmanship, structure of the house and appearance. A Quality Chart for PPR low-cost high-rise flats in Kuala Lumpur was presented. Authority (47 per cent) has the highest relative degree of importance in determining the quality of PPR flats, followed by Design Element (34 per cent) and Quality of Living (19 per cent). Accordingly, the success of the schemes relies strongly on effective control and enforcement by the authorities. However, it can be improved by tackling on the Design Element (Architectural), whereby a revised typical unit layout plan and typical details have been proposed at the last section of the paper.

Keywords: Quality Low-cost Housing, Quality Function Deployment, Program Perumahan Rakyat (PPR)

Introduction

Housing has been recognised as an important development tool for restructuring a society and eradicating poverty. Further to the Istanbul Declaration on Human Settlement and Habitat Agenda to ensure adequate shelter for all in 1996, the Malaysian government has committed billions of Ringgit Malaysia for providing its citizen with adequate, affordable and quality housing. In 1996, the 'Zero Squatter by 2005' policy was implemented in the whole Malaysia. Further to the economic recession in the late 1997, a four-tier pricing system on PPR schemes in cities and major town for the resettlement of squatters has been implemented in order to ensure its citizen, particularly lower income groups, to continue enjoying the benefits of adequate, affordable and quality housing. However, it is important to ensure that the provisions of housing are able to create a harmonious society and promoting a

sustainable living environment. In census 2000, Kuala Lumpur has reached the status of 100 percent urban population followed by Selangor State with 87.6 percent of urban population. As per guideline for type of house stated in four-tier pricing system introduced in 1998 (see Table 1), all public low-cost housing units developed in the urban areas to be high rise flats.

Table 1: Four Tier Pricing For Low Cost Houses

Cost per unit (RM)	Cost per unit* (RM)	Location (land cost per sq. m.)	Income Group RM)	Types of Houses**
42, 000	35,000	Cities and major towns (RM45 and above)	1,200-1,500	> five storey flats
35, 000	30,000	Major towns and fringes (RM15 – RM44.99)	1,000-1,350	Five storey flats
30, 000	28,000	Small towns (RM10 – RM14.99)	850 – 1, 200	Terrace and cluster
25, 000	25,000	Rural areas (Less than RM10)	750 – 1, 000	Terrace and cluster

Note:
* *House cost per unit for PAKR sambungan and RRR Dimiliki*
** *No restriction to build other type of houses but the ceiling price maintains the same for houses sale at different location as stated in the chart.*
As the types of houses, for Sabah & Sarawak, an increase of up to 20% can be added to the above 4-tier pricing.

(Source: Seventh Malaysia Plan)

Shuid (2004) highlighted that 32.7 per cent of the household in Kuala Lumpur have monthly income of less than Ringgit Malaysia (RM) 2,000 whereby19.9 per cent has monthly income of less than RM 1,500 in year 2002. This means that 32.7 per cent of households in Kuala Lumpur can only afford to buy a low-cost house.

Chapter 21, Ninth Malaysian Plan (PP 440) stated that under the PPR schemes, 37,241 low-cost houses were built, completed and rented to those eligible, and out of this total, 24,654 units or 72.29 per cent were built in Kuala Lumpur, and 12,587 units in other major town through the country. Table 2 shows the distribution of the PPR low-cost houses in Malaysia. Table 3 presents the list of 24 PPR schemes in Kuala Lumpur with a total of 34,106 units. All low-cost high-rise flats built under PPR schemes in Kuala Lumpur and Klang Valley, Selangor have adopted the standard 18-storey high-rise flat design with 20 units per floor (see Figures 1 and 2). Since unit and storey layout of PPR high-rise flats are similar in design, three sites were selected as case studies: PPR Cochrane Perkasa, PPR Salak Selatan and PPR Kg. Muhibbah Puchong.

Table 2: Distribution of the PPR schemes in Malaysia

	State	No Target Units	Percentage
1	Kuala Lumpur	34,106	53.81
2	Sabah	10,671	16.84
3	Johor	6,952	10.97
4	Pahang	3,650	5.76
5	Kedah	1,894	2.99
6	Selangor	1,580	2.49
7	Sarawak	1,496	2.36
8	Perlis	1,228	1.94
9	Pulau Pinang	698	1.10
10	Perak	682	1.08
11	N. Sembilan	420	0.66
	Total	**63,377**	100.00

(Source: JPN, 2006)

Table 3: 24 PPR schemes in the Kuala Lumpur

1 PPR Lembah Subang
2 PPR Sg. Besi
3 PPR Pekan Batu 5, Jalan Ipoh
4 PPR Taman Wahyu II
5* PPR Kg Batu Muda
6* PPR Lembah Pantai Kerinchi (1896 units)
7 PPR Pudu Ulu
8 PPR Bukit Jalil I
9 PPR Bukit Jalil II
10 PPR Taman Intan Baiduri
11 PPR Taman Wahyu I
12 PPR Ampang Hilir
13 PPR Linear City
14 PPR Kg Malaysia Permai
15 PPR Air Jerneh, Sg Bonus
16 PPR Kg Baru Air Panas, Tambahan
17 PPR Salak Selatan
18 PPR Jalan Lapangan Terbang Lama
19 PPR Linear City II
20 PPR Kg Muhibbah, Puchong
21 PPR Kg Limau Pantai Dalam
22 PPR Pekan Keping
23 PPR Kg Seri Malaysia
24 PPR Jalan Chocrane

Note:
* projects under SPNB
Density = 40 units/ acre, 70 units/ acre for KL

(Source: JPN, 2005)

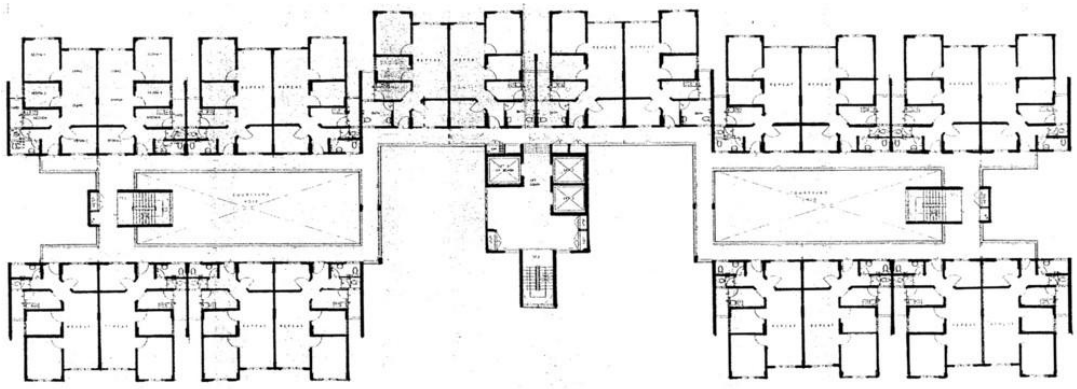

Figure 1: Typical Plan for 18-storey Low-cost Flat
(Source: Housing Department, DBKL, 2006)

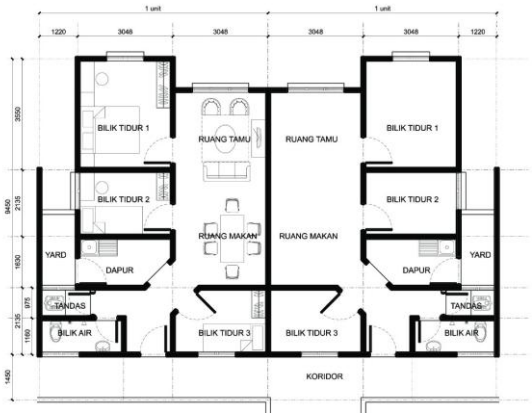

Figure 2: Standard Unit Layout Plan for 18-storey Low-cost Flat
(Source: by the Author using JPN's standard unit layout plan, 2006)

Research Aim and Methodology

In 2003, Human Rights Commission of Malaysia criticised that the Malaysian government only carried out official planning and implementation of the low-cost housing schemes for the poor but failed to address the issues related to habitability, suitability, defects and shoddy workmanship, lack of maintenance and physical safety of the occupants. Therefore, the aim of this study is to get feedback and perception of users on existing condition and their 'wish list' for 'Quality Home'.

Quality is a measure of the extent to which customer (low-cost housing owners/ tenants/users) requirements and expectations are satisfied. The three (3) prominent quality management gurus Deming, Juran and Crosby, agreed that quality means meeting customer requirements and that increased productivity is the result of quality improvement (Bauer, et al., 2002). Akao (1994) noted that quality problems could be studied by using two approaches; the analytic approach and the design approach. Analytical approach is by handling defects and improvement scheme whereas design approach is to design to meet customer demanded quality.

Quality Function Deployment (QFD) is a design management method that emphasis on the voice of the customer. It provides a systematic means to ensure customer or market demands that are translated into accurate technical requirements and actions taken throughout each stage of product development (Akao,1994: Abdul-Rahman, 1999). Chow (1996) concluded that

technical-wise, QFD method can be very useful and effective in improving quality, lowering cost and shortening design time in the construction industry in Malaysia. Therefore, QFD method was used as design approach to study the problems of quality low-cost housing and to develop a typical Quality Chart for a low-cost flat based on users' demand.

The summary of number of respondents in the questionnaire survey was presented in Table 4. Majority of the respondents have household size of from 3 to 6, with mean of 4.66 (see Figure 3).

Table 4: Total Number of Respondents in the Survey

Site	Malay	Chinese	India	Total
PPR Chocrane	12	12	0	24
PPR Salak Selatan	1	11	2	14
PPR Kg. Muhibbah	5	3	4	12
Total	18	26	6	50

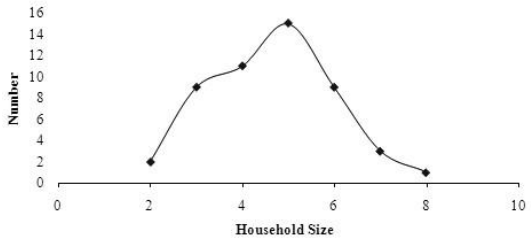

Figure 3: Survey Household Size

Alternative unit internal layout (see Figure 4) and variation on each room size was proposed and users' opinions on the degree of appropriateness for its room size and internal layout are shown in Figures 6 and 7. Out of the 50 respondents, 35 respondents preferred the alternative unit layout, 11 respondents preferred the existing layout and 4 respondents believed that both layouts were acceptable.

Using a 1 to 5 scale, where 1 means 'not important/ satisfied/ appropriate at all' and 5 means 'Extremely important/ satisfied/ appropriate'. The average degree of importance, average degree of satisfaction, and average degree of appropriateness given by the respondents were tabulated with the method as stated below.

$$Average degree of\ importance = \frac{Sum of\ all\ the\ scales\ given\ by\ respondents}{Number of\ respondents}$$

$$Average degree of\ satisfaction = \frac{Sum of\ all\ the\ scales\ given\ by\ respondents}{Number of\ respondents}$$

$$Average degree of\ appropriateness = \frac{Sum of\ all\ the\ scales\ given\ by\ respondents}{Number of\ respondents}$$

The comparison between the degree of importance and degree of satisfaction on the factors influencing the quality of low-cost PPR flats is illustrated in Figure 5. Factors from highest to lowest degree of importance as rated by the respondents were placed in the order from left to right. For comparison, the degree of satisfaction for each of the factor was positioned base on the sequence of degree of importance.

Figure 4: Alternative Unit Layout Plan for 18-storey Low-cost Flat

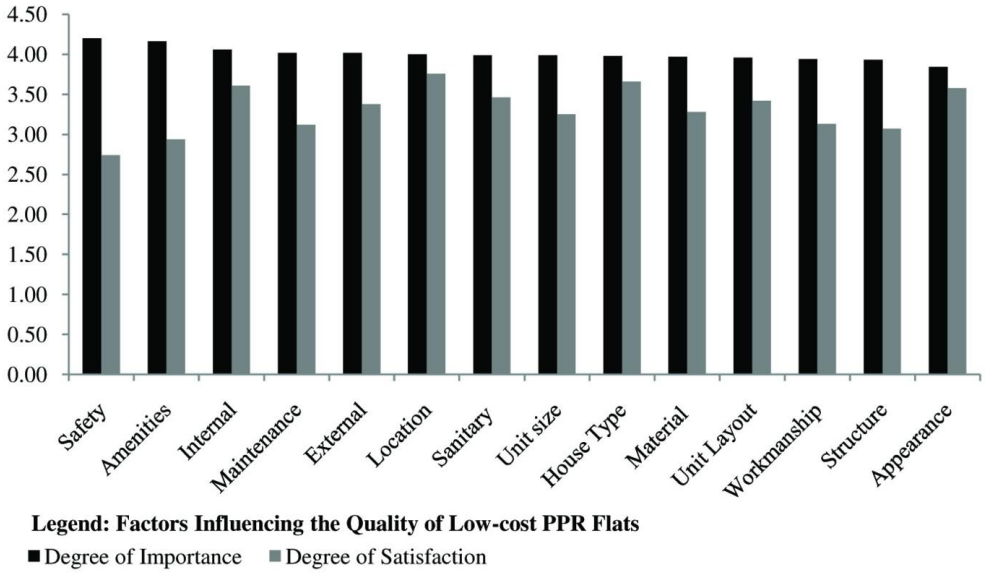

Figure 5: Comparison between the Degree of Importance and Degree of Satisfaction on the Factors Influencing the Quality of Low-cost PPR Flats

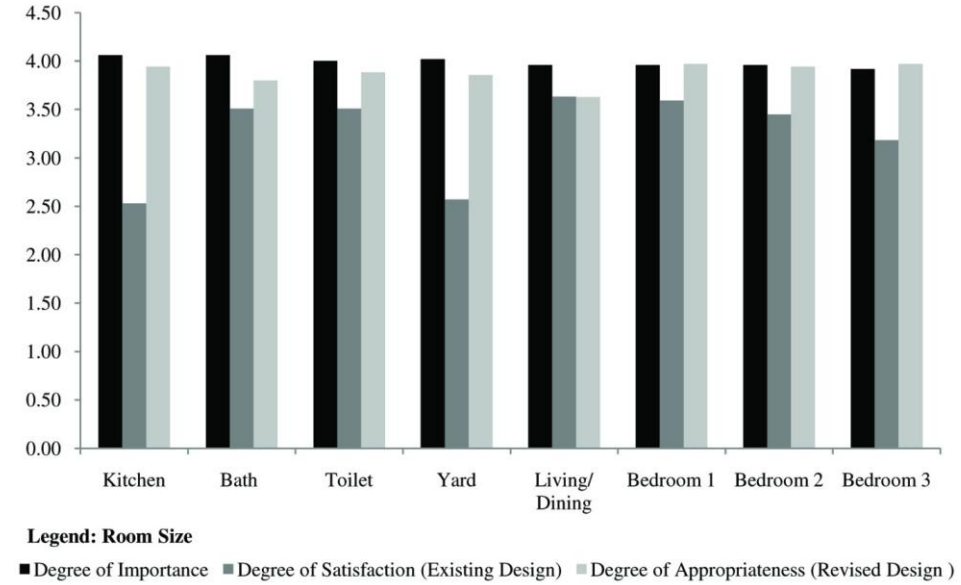

Figure 6: Room Size, Degree of Importance, Degree of Satisfaction and Degree of Appropriateness

Figure 7: Room Layout, Degree of Importance, Degree of Satisfaction and Degree of Appropriateness

Quality Function Deployment – Quality Chart

"…*One of the basic concepts of quality control implementation is management by prioritization….The quality chart is a chart in which true quality (demanded by customer) is systematized around functions and the relationship between these functions and quality characteristics… quality chart is the basis for systematically promoting quality control activities*." (Takayanagi, 1994: 41 & 44)

The demanded quality or quality element deployment chart, also called the quality chart. The customer's voices obtained from questionnaire survey were used to formulate the quality chart. This chart demonstrates the relationship between demanded quality and housing quality elements. On the left hand side of the chart was the demanded quality deployment chart.

It was an arrangement of reworded quality demands from the customers that split into 3 levels. The degrees of importance were based on the average degree of importance for every factor resulted from the questionnaire survey. The horizontal top portion of the chart was the quality elements deployment, in which the elements indicate the quality of housing.

Quality elements were defined as design elements that could be measured when one evaluates quality. Design characteristics were the measurable aspects of quality elements. Therefore, a set of design elements to match the demanded quality elements provide by the customers could be developed by the designer (architect and engineer). The degree of importance of a demanded quality is converted to the degree of importance of the quality element by the independent scoring method (Abdul-Rahman, 1999: Akao, 1990). The three levels of possible correlations were stated as below (King, 1989 cited in Abdul-Rahman, 1999):

(1) Strong correlation is assigned a value of 5;
(2) Some correlation is assigned a value of 3; and
(3) Possible correlation is assigned a value of 1

If there is no relationship could be determined, then the space was left blank. The symbols @, # and * were used to indicate the strength of the correlation between the demanded quality and design elements. They were given 5, 3 and 1 points respectively. Then, the absolute degree of importance and relative degree of importance for the quality elements can be calculated (Burn, 1994 cited in Abdul-Rahman, 1999). Table 5 gives the quality chart for low-cost PPR flats in Kuala Lumpur.

Table 5: Quality Chart for Low-cost PPR Flats in Kuala Lumpur

	Quality Element		1st Level	Quality of Living														Design Element						Authority					
	Demand		2nd Level	Indoor Environment					Outdoor Environment		Residential facilities					Bldg mgmt.		Architecture				Engr'ng		Control & Enforcement					
			3rd Level																										
	1st Level	2nd Level	3rd Level	degree of importance (scale of 1 to 5)	Openness	Lighting	Ventilation	Heat	Noise insulation	air pollution	sound pollution	Transportation	Shopping	Admin service	shops, clinic, parking	park & Playground	Maintenance services	Cleanliness	Efficient Layout	Innovative Design	Good Detailing	Good Specification	sound structure	construction method	Standard requirement	Planning & Dev Policy	Strict enforcement	Std Material spec	Quality builders	strict super vision
1	Location	convenience	close to work	4.00								@	#	#	#											#			
			close to school/ market	4.00								@	@	@	@											#			
2	Amenities	flat facilities	vehicle parking	4.16								*			@											@			
			playground/ garden	4.16											@	@										@	@		
			convenient shops/ clinic	4.16											@											@	@		
3	Maintenance	preserve good cond. of flat	repair works	4.02													@										@		
			cleanliness lifts & drains	4.02						*								@									@		
			rubbish collection	4.02						*								@									@		
4	External Environment	Air quality and peaceful environment	dusty	4.02						@																	*		
			traffic	4.02						#	@																*		
			noisy	4.02							@																*		
5	Safety	Security	crime - parking & garden	4.20												@			#						#	@	#			
			fire	4.20															@	#		@					#	@		
			thives	4.20															@	@	*	#					#	@		
6	Appearance	Aesthetic	external appearance	3.84															#	@	*	#				@				
			block arrangement	3.84															@	@						#				
7	House Type	No. of storey	with/ without lifts	3.98															#	@						@	@			
8	Material	Building materials	roof/ ceiling/ floor	3.96					*										#	@	#		@	@	#		@	@		
			internal/ external wall	3.94				*	*													#	@	@			@	@		
			window suitability	3.98																#	@	@			@		@	@	*	
			door durability	3.97																#	@	@			@		@	@	*	
9	Structure	structural defect	roof/ ceiling leakage	3.92																			@	#			#		#	@
			floor/ ceiling not level	3.88																				@			#			@
			window water seepage	4.02																*	@	@		@	@		#		@	@
10	Workman-ship	Poor work quality	door/ window poor fixing	3.98																	#	#					#		@	@
			plastering thickness	3.92																		#		#	*		#	#	@	#
			plumbing work poor	3.94																		#		*			#	@	@	@
			tiling not even	3.92																	*	#					#	#	@	#
			painting work incomplete	3.86																		#					#		@	#
			electrical work poor	4.04																		#					#	#	@	#
11	Unit size	Space usage	Living/ Dining	3.96	*	*	*	*											#	@					@	#	#			
			Bedroom 1	3.96		*	*	*											#	@					@	#	#			
			Bedroom 2	3.96		*	*	*											#	@					@	#	#			
			Bedroom 3	3.92		*	*	*											#	@					@	#	#			
			Kitchen too small	4.06	*	*	*	*											#	@					@	#	#			
			Bath	4.06		*	*												#	@					@	#	#			
			Toilet	4.00			*												#	@					@	#	#			
			yard too small, No store	4.02		*	*	*											#	@					@	#	#			
12	Unit Layout	Internal Layout for space usage	Living/ Dining	3.96	*	*	*	*	*										@	#					#	*				
			Bedroom 1	3.96		*	*	*	*										@	#					#	*				
			Bedroom 2	3.94		*	*	*	*										@	#					#	*				
			Bedroom 3	3.96		*	*	*	*										@	#					#	*				
			Kitchen	3.98	*	*	*												@	#					#	*				
			Bath	3.92		*	*										*		@	#					#	*				
			Toilet too close to kitchen	4.00		*	*										*		@	#					#	*				
			yard too close to kitchen	3.96	*	*	*	*											@	#					#	*				
13	Internal environment	Ventilation and lighting	Ventilation	4.06	#		@	#											@	*	*	*			*					
			indoor temperature	4.08	#	*	#	@											@	*	*	*			*					
			Natural Lighting	4.06	#	@	#												@	*	*	*			*					
14	Sanitary Fitting & Piping	Durability of sani fittings & pipings	Kitchen sink durability	4.00																		@			@		#	@	*	
			Toilet fitting & piping	4.00																		@			@		#	@	@	#
			bath fitting & piping	3.98																		@			@		#	@	@	#
					352.78					80.04		244.36					68.04		1190.81				165.56		1893.24					
			Absolute important		745.22														1356.37						1893.24					
			Relative important		**19**														**34**						**47**					

Correlation Factor		
Symbol	**Point**	**Correlation**
@	5	Strong
#	3	Some
*	1	Possible

Where,

$$Absolute Importance = \sum (Degree of Importance \times Correlation Factors)$$

$$Relative Importance (\%) = \frac{\sum (Degree of Importance \times Correlation Factors) \times 100}{\sum (Absolute Importance)}$$

Findings and Discussions

Following the interview with Ar. Chong Lee Siong[1], the design brief from the JPN for each unit of high-rise low cost flats is for a family with average household size of 5 persons. Therefore, it has shown a positive relationship between the design brief and the household size. For an average family member of 5 persons per unit of low-cost flat, the area per person is 130 square feet per person. This figure is much more above the United Kingdom minimum standard of 50 square feet per person, Japan minimum standard of 62 square feet per person and Hong Kong minimum standard of 25 square feet per person in early 1980s (MHLG, 1981; Loo, 1977). Means, the minimum size standard of 650 square feet for a 3 bedroom type flat is appropriate and acceptable. Table 6 shows a comparison of area per person for 3 bedroom type flats in the city of Kuala Lumpur in 1977 and 2000. It has proven that the current minimum standard size of flat is much better compared with the standard in 1977.

Table 6: Comparison of Area for 3 Bedroom Type Flats in the City of Kuala Lumpur in 1977 and 2000

Function of Room	Jalan Shaw 17-storey, 1977 Floor Space (square feet)	PPR 18-storey, 2000 Floor Space (square feet)
Living Room Area	147	260
Bedroom Area	351	258
Kitchen & Bath Area	74	100
Yard	0	31
Total Area of Flat	572	650
Average Number of Persons Designated for	12	5
Area per person (sq.ft)	47.7	130

(Source: Leong, 1979: 95; JPN, 2000)

[1] A member from the Construction Industry Standard (CIS)'s technical group

The factors in determining a quality low-cost flat arranged in descending degrees of importance are: house safety, provision of public amenities, unit internal environment, maintenance and surrounding environment, location, sanitary fittings, unit size, type of house, material used, unit internal layout, quality of workmanship, structure of the house and appearance.

House safety is the most important factor influencing the quality of current PPR low-cost flat. Generally, respondents were concerned on their safety due to increasing crime cases within the PPR scheme compound. This fact was supported by respondents' comments such as not enough lamp posts at car parking and garden area, no proper motorbike parking zone that equipped with metal bars for locking the motorbikes, no humps on driveways causing vehicle to race at driveway, no proper pathway from flats to garden or playground causing danger to kids who cross the driveway to the playground (see Figure 8) and 1200mm enclosed yard space enable thieves to climb into the unit from the yard (see Figure 12).

Figure 8: Kids walk on vehicle driveway in order to go to the garden or playground

Provision of amenities is the second important factors influencing the quality of current PPR low-cost flat. This fact was supported by respondents' comments of public amenities such as convenient shops are not operate at the time when the respondents took vacant possession of the flats, and shortage of parking bays especially if the development area is lack of public transport services, i.e. at PPR Kampung Muhibbah Puchong. The car parking provision ratio of 1 car parking bay for every 4 units of flat may need to be reviewed. Even with good public transport system, the number of car ownership is rising, thus more car parking spaces are required.

Unit internal environment has became the third important factor influence the quality of low-cost flats mainly because all respondents are hoping for a house that needs less energy consumption in view of the increase of electricity bills rate.

Maintenance is the forth important factor influencing the quality of low-cost PPR flats. Although there were 3 lifts serving every floor, the frequent break down of the lift system despite it is less than 2 years old has caused respondents to worry about the reliability of the lifts. Besides, high maintenance cost for the lifts may result for the customer unable to bare the maintenance cost if the flat is managed by customer themselves in the future.

Good surrounding environment such as level of sound pollution, water pollution and air pollution became the fifth important factor influencing the quality of low-cost flat. Location is only ranked as the sixth important factor influencing the quality of low-cost flat. In real estate, location is critically important in determine the value of the property, however for low-cost flat, if the flat is located near work place and with good public amenities such as public transportation, school, market and so on, the location become not so critical.

Among the factors influencing the quality of low-cost flat, the location had the higher degree of satisfaction followed by type of house, internal unit environment, appearance, sanitary fitting, unit internal layout, surrounding environment, material used, unit size, quality workmanship, maintenance, structure of the house, facilities and public amenities and lastly the safety of house. Most of the respondents except respondents from PPR Kampung Mihibbah Puchong, are quite happy with the location of the flats because they are located within the cities centre, near their work place and close to public amenities.

Current PPR high-rise low-cost flat typology is acceptable by most respondents with the reasons that each floor is served by three lifts, maintenance works are carried out by local authorities and maintenance cost is absorbed

within the rental of RM124 per month paid by the tenants. Most respondents are happy with the internal environment of their unit especially respondents from block with east west orientation, where their units are bright during a sunny day, with good cross ventilation and with cool internal spaces. Besides, the cross ventilation of the unit was enhanced by having the unit entrance door open during the daytime. In order to enjoy good cross ventilation and at the same time not to sacrifice the safety of the unit, metal grilles are installed by some tenants at the entrance door (see Figure 9).

Figure 9: Metal grilles installed at unit entrance door to enhance internal cross ventilation yet not sacrificed safety

The appearance of the PPR flats received better degree of satisfaction compared with unit internal layout and unit internal room size. Respondents are very happy with the current provision of 3 bedrooms, 1 living cum dining space, 1 kitchen, 1 yard, 1 bathroom and 1 toilet. However, the size and position of the kitchen and yard are found at the unsatisfactory level. Respondents commented that the existing kitchen size of 4.515 square meters (less than 49 square feet) is too small to carry out its function. Most Malaysians, especially low-cost flats' tenants are not depending on electronic devices such as oven, electrical hood and hob to prepare their food. In addition, smokes from cooking escape through opening at yard located adjacent to the kitchen, this has indirectly caused yard space cannot fully perform its function. Figure 10, 11 and 12 show how yard space been utilized the as cooking area as result from the inappropriate size of existing kitchen.

Figure 10: Existing kitchen space only able to house a small fridge, small counter space for food preparation

Figure 11: Heavy cooking normally carrying out at the yard space. Also to prevent smokes from cooking to enter the house

Figure 12: External view of the yard space. The illegal grilles extension at yard space made for cooking and drying purposes. Grilles to prevent thieve enter unit via yard space

Most of the respondents commented that the yard is too small (27 square feet) for hanging blankets and clothes. In addition, its location could hardly get any sunlight unless the block is north south oriented. Therefore, common corridors and windows become their new clothes drying area. Figure 13, 14 and 15 showing how these spaces have been utilized as drying area.

Figure 13: Unit's windows become the clothes drying area

Figure 14: Common corridors as blankets and clothes drying area

Figure 15: Common corridors as cloths drying and storage space

Respondents are quite satisfied with the materials used for the current PPR flats except the types of window and entrance door with its lockset. For security reason, a better quality door and lockset should be used for the unit main entrance door. Otherwise metal grilles sliding door should be installed in front of unit main entrance for security reason as well as to improve ventilation of the unit. Respondents agreed that the adjustable louvered windows are better for air movement compared with casement or top hung windows; however it has carried the risk of glass panes falling from the higher floor if the catches are not function properly. This problem becomes critical when windows been utilized as clothes drying area (see Figure 13). Respondents ranked

maintenance works as quite satisfactory. The maintenance works include overall building maintenance, efficiency in repairing the defective item, number of time for rubbish collection and cleanliness of drains.

Kuala Lumpur City Council (DBKL) Housing Maintenance Division highlighted that complaints frequently reported are water pipe burst, water seepage through wall and ceiling, rain water entering the house through window, and manhole clogged. Table 7 shows the compilation of complaints received by DBKL Housing Maintenance Division for PPR Cochrane Perkasa 1 site.

Table 7: List of Complaints for PPR Cochrane (from Jan 2006 to June 2006)

	Description of Complaint	Number of Complaint Reported
1	Water pipe burst	20
2	Water seepage through wall	15
3	Rain water enter house through window	25
4	Door damage	2
5	UPVC pipe clogged/ broken	3
6	Mainhole clogged	19

(Source: Low-Cost Housing Maintenance Division, DBKL, Zone 1)

The most frequent complaints were rain water entered house through window. There are two main reasons to the problem. Firstly, the faulty detailing where a concrete copping is placed at the bottom of the window opening (see Figure 16). When rain water hits the concrete copping at the bottom of the window, rain water then bounces into the interior space of the unit through gaps between the glass panes. Secondly, the quality of workmanship where gaps between wall openings and window frames is not water tight, water seepage occurred at gaps between window and wall. Water proofing problem especially at toilet and bath is very crucial. Good site supervision and workmanship is critically important to resolve the problem. Otherwise, it is very costly and troublesome if to carry out any remedial work after completion.

Figure 16: Water splattering due to the copping at the bottom of the window

With the overall unit size of 650 square feet, in order to provide bigger kitchen, yard and bathroom, other rooms might need to be reduced in size. Table 8 shows the size comparison for room function between the By-law 42 & 43 of Uniform Building By-Law (UBBL), CIS 2 and existing design (PPR 2000). It is important to highlight that even the existing design (PPR 2000) is not meeting the minimum unit size stated in the CIS 2. Although Bedroom 3 received the lowest degree of satisfaction compared with bedroom 1 and bedroom 2 because of the existing odd corner, generally respondents are quite satisfied with the sizes of existing bedroom 1, bedroom 2 and bedroom 3. The size of existing

kitchen is smaller than minimum as stated in CIS 2 but still complying with the minimum size as stated in UBBL. So, the question is should the revised design to comply with CIS 2 standard or is that any alternative size which is more appropriate.

Table 8: Size Comparison for Room Function between UBBL, CIS 2 and PPR 2000

	UBBL, 1984	CIS 2: 1998	PPR, 2000
Room Function	Area (sq.m.)		
Living and Dining	Not specific		24.19
Yard	Not specific	25.20	2.90
Bedroom 1	11.00	11.70	10.82
Bedroom 2	9.30	9.90	6.67
Bedroom 3	6.50	7.20	6.51
Kitchen	4.50	5.40	4.52
Toilet	1.25	1.80	1.71
Bathroom	2.00	1.80	3.07
Total Area	Not specific	63.00	60.38

(Source: UBBL, CIS 2 and JPN Standard Plan 2000)

From the questionnaire survey, an alternative layout with kitchen size of 6.56 square meters (71 square feet) was proposed. The alternative kitchen size has received high degree of satisfaction compared with the existing kitchen size (see Figure 6). The space requirement for residential layout guideline, 1984 from Gravesham Borough Council, United Kingdom recommended that the minimum size for kitchen is 7.20 square meter or 77 square feet. Therefore, the minimum size for kitchen for the revised design should be aimed at 7.20 square meters (77 square feet). The space requirement for residential layout guideline, 1984 from Gravesham Borough Council, United Kingdom also recommended that if bathroom and water closet are to locate in the same room, the minimum size should be 3.50 square meters (38 square feet). This size is much bigger than size as stated in CIS 2 as well as the existing bathroom size. As such, the minimum bathroom size for revised design if it is complete with water closet should be aimed at 3.50 square meters. Table 9 shows the selected rooms' function sizes of floor space requirements for residential layout guideline recommended by Gravesham Borough Council.

Table 9: Floor Space Requirements for Residential Layout Guideline, 1984

Function of Room	Floor space (sq.m.)
Double Bedroom	11.20
Single Bedroom	6.50
Lounge/ diner	18.00
Bathroom and WC	3.50
WC only	1.30

(Source: http://www.gravesham.gov.uk/index.cfm?articleid=1016, 2006 Gravesham Borough Council)

Recommendations

In the quality chart developed for low-cost PPR flats (see Table 5), the consumer requirements have been prioritized in response to the consumer's assigned rate of importance.

Quality elements have been correlated to these requirements which give the absolute degree of importance and relative degree of importance to every quality element. The relative degree of importance is tabulated for easier comparison among the various quality elements in process of prioritizing (see Table 10 and Figure 17).

Table 10: Summary of Absolute Degree of Importance and Relative Degree of Importance for Quality Elements

	Quality Elements	Absolute degree of Importance	Relative degree of Importance %	Relative degree of Importance %
Quality of Living	Indoor Environment	353	9	
	Outdoor Environment	80	2	
	Residential facilities	244	6	
	Building Management	68	2	19
Design Element	Architecture	1191	30	
	Engineering	166	4	34
Authority	Control & Enforcement	1893	47	47
	Total	3995	100	100

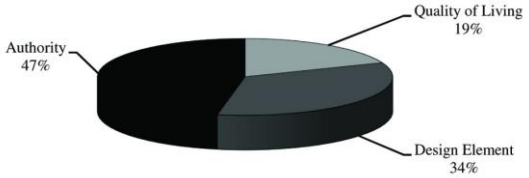

Figure 17: Relative Degree of Importance (%) of three main categories of quality elements in Low-cost PPR flats

Authority

Figure 17 demonstrates that control and enforcement by the authorities has the highest degree of importance (47 per cent). In Malaysia, the planning and minimum standards of low-cost house are controlled by various government agencies; therefore the success of the schemes are generally depends on the implementation of the policies and standards amongst all relevant authorities, including the Ministry of Housing and Local Government and the National Housing Department.

Quality control in low-cost housing will be greatly enhanced through a strict enforcement of regulations, standards and by-laws by the relevant authorities and constant monitoring of the performance of the contractors.

In addition, quality bench marking and quality assessment system (QLASSIC) should be further develop and use as a tool to control the quality of the workmanship for each of the project particularly on low-cost housing project. For example, only contractors who have good projects track records and with high QLASSIC marks will be awarded for future low-cost housing project.

Since 2002, all low-cost high-rise flats design must comply with CIS 2 standard; an ac hoc committee should be established to carry out thorough post occupancy evaluation on the selected completed low-cost housing schemes to examine whether there is any necessity to review any standards and guidelines outline in the CIS.

Design Element

Design Elements come second with the relative importance of 34 per cent (see Figure 17). The architects play a major role in producing efficient layout and innovative design for low-cost flats in order to meet the ceiling cost of the low-cost flat

without compromising on the quality and comfort of living in the flats. Among all rooms function, kitchen, yard and bath are the three most important rooms in determining the quality of low-cost flats. It is found that existing kitchen and yard size were at the unsatisfactory level (see Figure 6). Of the 50 respondents, 70 per cent of the respondents believed that the alternative layout (see Figures 6 & 7) has appeared more appropriate compared with the existing layout because of the increase size of kitchen and yard. Hence, various improvement plans at the typical standard unit to increase degree of satisfaction for existing low-cost flats have been identified and listed as follows:

Unit Room Size:

1. To have bigger kitchen;
2. To have wider yard;
3. To have bigger bathroom; and
4. To increase minimum floor to floor height from 2800mm to 3000mm

Unit Room Layout:

1. To avoid direct view to Living and dining area from common corridor – Privacy;
2. To enhance natural day lighting and cross ventilation by
3. To prevent smoke from cooking to enter the house by having a separation between cooking area and food preparation area;
4. To prevent odour from toilet or bath entering kitchen and cooking area;
5. To have yard next to living act as drying area cum relaxing corner;
6. To avoid odd corner in layout; and
7. To have storage space near entrance door

Unit Window Details:

1. To have reinforced concrete copping cantilever 300mm from the external wall located on top of window opening at external façade; and
2. To avoid copping at bottom of louvers window frames.

Unit Bath and Toilet Details:

1. To have doors overlapped the wall by at least 25mm at 3 sides to prevent water splashing out from the toilet or bathroom to living or dining area; and
2. To have toilet and bathroom floor finished level at least 25mm lower than finished floor level of living or dining area.

Unit Safety:

1. To install adjustable louvers window at kitchen to prevent thieves entering unit; and
2. To install sliding metal grilles in front of unit entrance door

Construction:

1. To examine for the use of pre-cast concrete toilet or bathroom to prevent water seepage problem;
2. To fully implement modular coordination system; and
3. To encourage development of industrialized building system.

Engineers must constantly ensure sound structural design to ensure safety, stability and durability of the building. Architect, engineer and contractor should always work together and search for new building materials and an innovative technology that may result in reduce construction cost and time, and at the same time increase quality in workmanship.

Revised Unit Layout Plan:

In order to increase the degree of satisfaction on architecture design elements on the existing PPR flats, with taking into consideration of the same unit width to ensure same number of unit per floor could be achieved, a revised typical unit layout plan with revised rooms' sizes has been proposed and shown in Figure 18 and Table 11. Junction details where designer (architect) should take into consideration when designing low-cost high-rise flats have been proposed and shown in Figure 19.

Table 11: Size of Revised Typical Unit

	Revised Design	
Room Function	Area (sq.m)	Area (sq.ft)
Living cum Dining area	20.66	222
Yard	2.56	28
Bedroom 1	11.21	121
Bedroom 2	6.66	72
Bedroom 3	6.55	70
Kitchen	7.34	79
Toilet	1.68	18
Bathroom	3.58	39
Total Area	60.24	649

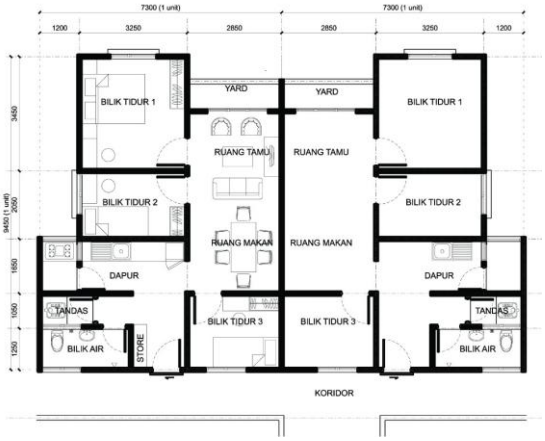

Figure 18: Revised Typical Unit Layout Plan

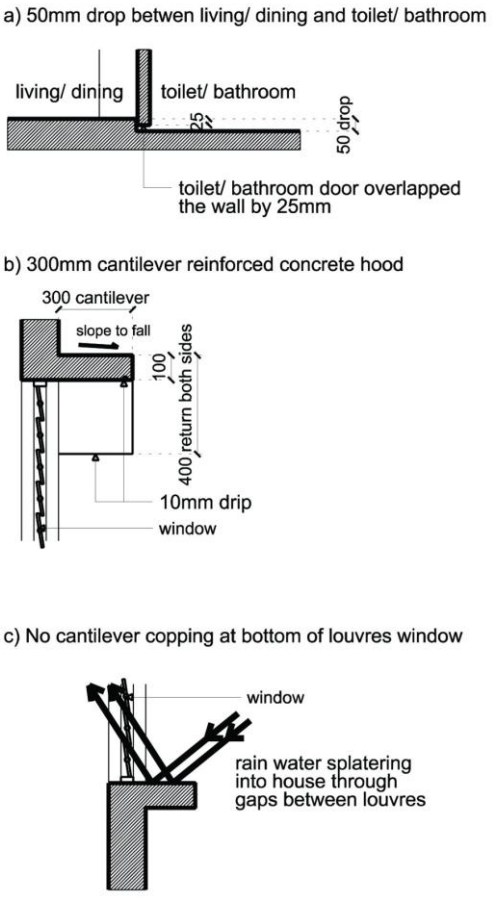

Figure 19: Diagrams of Junction Details

Quality of Living

Other general quality elements with a relative importance of 19 per cent (see Table 10 and Figure 17) includes indoor environment, outdoor environment, residential facilities and building management. Good internal and external planning of the low-cost housing scheme, better residential facilities and reliable building management team will further enhance the quality of living in low-cost flats.

Of the fourteen factors influencing quality of PPR flats, house safety and provision of public amenities are the two most important factors yet these two factors are ranked as below the quite satisfactory level by the respondents. Analytical approach is by handling defects and improvement schemes on these two factors may improve the degree of satisfaction on the existing low-cost PPR flats.

Conclusion

Generally, low-cost dwellers are satisfied with the existing PPR schemes. However, there are weaknesses in design of the existing standard unit plan for low-cost high rise flats. Therefore, a thorough and comprehensive post occupancy evaluation on completed low-cost housing scheme should be carried out by relevant parties in order to evaluate the existing status, to collect users' voices and to aim for future improvement plans. Quality Function Deployment (QFD) method is found to be a very effective management tool that can systematically list out the priority of each of the quality elements demanded by the users. QFD method helps to increase users' satisfaction by ensuring that their needs and requirements are incorporated into the future design. Therefore, it is highly recommended that QFD method to be used to analyze the users' comments to ensure improvement in quality for future low-cost housing design. In 1998, a high-rise typology is the recommended by Malaysian government for low-cost housing development in the urban area. It is highly recommended that Malaysian government to promote innovative design concept (i.e. high density low rise), housing system and housing typology in order ensure low-cost housing developments can successfully respond to the culture and social needs over time, and subsequently creating a sustainable community living environment.

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