Investigating Low-Income Public Housing Management and Maintenance Cost

Tanaphoom Wongbumru[1]*, Bart Dewancker[2]

[1] *Faculty of Architecture, Rajamangala University of Technology Thanyaburi, Khlong Luang, Pathum Thani 12110, Thailand*

[2] *Department of Architecture, The University of Kitakyushu, Wakamatsu-ku, Kitakyushu 808-0135, Japan*

* Corresponding author e-mail: tanaphoom_w@rmutt.ac.th

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Abstract

A low-cost public housing management has been the challenging issues in Thailand. The number of 30 buildings which have been more than 40 years were selected to evaluate the existing management and the maintenance conditions. Collecting cost expenditures and building managers interviewing was empirically investigated. The results show that a group of independent administrative management performed better than a co-administrative management due to flexibility in work. In terms of cost maintenance and building management relationship found that influent factors for building maintenance cost were dwelling unit occupied and common property area in significant level at 0.05. To predict maintenance cost based on age of building, the significant variables were highlighted reliability; co-operative, electricity, insurance and other costs of the activities. These variables should be specifically taken into account of maintenance program policy for enhancing quality of living. The study could provide significant information to support National Housing Authority policy on public housing management.

Keywords: public housing, maintenance cost, building management, factor

1. Introduction

Affordable housing policy of Thailand has mainly operated by National Housing Authority (NHA) to promote a low-cost housing for rental and affordable homeownership since 1973 (Kritayanavaj & Phanitchapakdi, 2008). The walk-up flat (5-storeys) is a standard form of public housing projects that provided by National Housing Authority (NHA). NHA plays as a key actor in offering affordable housing to low- and middle-income earners by public housing various patterns; flat, twin house, or detached house (Wongbumru & Dewancker, 2015). There is public housing completed more than 524,267 units or 12% sharing of total public housing units (4,451,540) that was provided in Bangkok Metropolitan Region (BMR) (Wongbumru & Dewancker, 2018). As the result, a maintenance program and work are necessary to ensure the building conditions for residents' safety and the stay. The maintenance investigation on public housing has been addressed in concerned with the management and the physical conditions. Previous research like the studying on public housing maintenance was found that insufficient funds for maintenance housing project leads to deteriorating physical condition and common facilities (Angsuthara, 2010) (Lohmeng, 2007). The operating and capital expenses trend increased according to the age of the building (Arpaponkul, 2008). The improvement of the management building program will increase the common facility management fee payment rate through the appropriate management system (Mesiri, 2009). The maintenance is the best option for building owners when seeking to reduce the possibility of their building deteriorating (Nor, Shardy & Nurul, 2012). There are a few studies of the maintenance issue of the old-aged building with a large hire-purchase public housing type for low-income that constructed during NHA establishment. Klong Chan Flat has been 40 years and beyond. It was built in 1975 to 1977 and located in the urban area of Bangkok. The project included 30 buildings with 5,872 units. All buildings of this project were arranged under the Condominium Juristic Person (CJP) Law into 30 CJPs as a self-operation. The main issues that what 30 buildings do manage or organize their property in the area of maintenance. Therefore, it needs to be investigated and analyzed; how CJP of each building did maintain a building condition to enhance the living quality of residents whereas the maintenance cost is limitation for low-middle income group who occupied of the building.

2. Literature review

2.1 Building Maintenance

Maintenance can be mentioned in term of preserving the building that suitable for its use (El-Haram & Horner, 2002). It seeks to extend the life of the building elements through day-to-day work (Hills & Worthing, 2006). Moreover, providing appropriate operation is necessary to prevent the condition of the building from deteriorating for residents' safety (Hui, 2005). However, due to budget limitation, a maintenance operation must be reliable and economical (Flores-Colen & Brito, 2010). Using maintenance factor is varying based on building types and maintenance concepts. There are six items to assess housing maintenance in public housing; providing good services, easy to contract, keeps residents informed, good value for money, good overall services, and sufficient resources by focusing on the residents' perception (Nor, Shardy, Nurul, 2013). According to AL-khatam (2003), the listed nineteen factors affecting maintenance that can be grouped into six groups; process design, using materials, environments, knowledge of maintenance, financial management, and maintenance strategy. These factors were found in the studying factors affecting maintenance cost of institution buildings in Nigeria by Faremi, Ademga, Dada, & John (2014), to evaluate building's physical, functional and operational performance. According to Horner, El-Haram & Munus (1997), in housing maintenance, there are many alternative options available to the building manager. The manager can decide whether to carry out periodic maintenance at fixed intervals whether to carry out regular inspection, or whether simply to respond to the requests of the residents when problems occurred. Also, building maintenance plan can be operated based on reactive, proactive, and modernization and improvement with a new legislation and regulations (Horner, El-Haram & Munus, (1997).

2.2 Maintenace costs

Maintenance costs include all money spent on keeping the building up to an acceptable standard. It associates with day-to-day repair, preventive and improvement takes. The maintenance cost also is related to the direct such as materials, plants, staff management. Indirect costs include penalty costs due to the unavailability of the building and revenue (El-Haram & Horner, 2002). There are seventeen factors affecting maintenance cost through mean score ranking of questionnaire survey and those were top ten ranked; 1) building age, 2) building area or size, 3) vandalism by users, 4) faulty design, 5) building services, 6) building materials, 7) deferred maintenance,

8) poor maintenance tracking, 9) budget constraint, and 10) low concern for future maintenance (Faremi, Ademga, Dada, & John, 2014). The maintenance cost differs in various places such as location, availability of resources, materials, funds and transportation (Ali, 2009). Another approach to identify maintenance performance is found in the study of office building, five dependent variables were significantly correlated between characteristics of scheduled maintenance and cost consisting of skill and knowledge of labor, level of spare part and material stock, quality of spare parts and materials, length of predetermined maintenance interval, and amount of maintenance and failure downtime (Au-Yong, Ali, & Ahmad, 2014). Five factors could be affecting maintenance cost including high expectation of tenants of maintenance standards, budget constraints, improper use of property, energy costs, and policy (El-Haram & Horner, 2002). Au-Yong, Ali, and Ahmad (2014) investigated the relationship between the characteristics and the performance through inferential analysis; then, to develop a regression model for prediction purpose. Four attributes were skill manager, management monitoring, maintenance information, and frequency of building inspection to predict cost performance. From above, the critical factors through a literature review was extent to identify the maintenance cost factors of old public housing in Bangkok as show in Table 1.

Table 1. The extent a literature review of maintenance cost to study old public housing maintenance

Year	Method	Factor affecting maintenance cost approach				
		building characteristics	**maintenance**	**Tenant**	**Political**	**Other**
El-Haram & Horner, 2002	Questionnaire: 50 local authority and housing associations (24 factors)	-	budget constraints, energy costs,	improper use of property, high expectation of tenants of maintenance standards,	policy and regulation	-
Ali, 2009	quantitative and qualitative approaches: semi-structured interviews with ten building managers and questionnaire survey	existing building condition	-	complaint received regarding building performance	-	-
Faremi, Ademga, Dada, and John, 2014	80 questionnaires were administered to maintenance departments of institutional buildings	building age, building area or size, building materials, faulty design, building services	deferred maintenance, poor maintenance tracking, budget constraint	vandalism by users	-	low concern for future maintenance
Au-Yong, Ali, and Ahmad, 2014	80 questionnaires were distributed to relevant respondents such as building managers or supervisors, maintenance management staff and others.	building materials, building age	skill manager, management monitoring, maintenance information, and frequency of building inspection	-	-	-

Therefore, the limitation of investigating maintenance condition of old public housing in urban area, this study was applied above literature reviewed focusing on factor of maintenance; building characteristics and building management to predicting maintenance cost. This was to identify main issues and factors for ensuring a sustainable public housing maintenance and management.

3. Methods

The aim of the study is to assess factors that affect maintenance cost of old public housing through examine building characteristics and building management. Both building characteristics and management were conducted of Klong Chan Flat throughout 30 buildings by obtaining data from questionnaire and interviewing. There are two different characteristics of management were investigated; co-administrative management (sharing office center, staffs, and facilities) and independent management (operating themselves by their own office center, staffs, and facilities) as shown in Table 2.

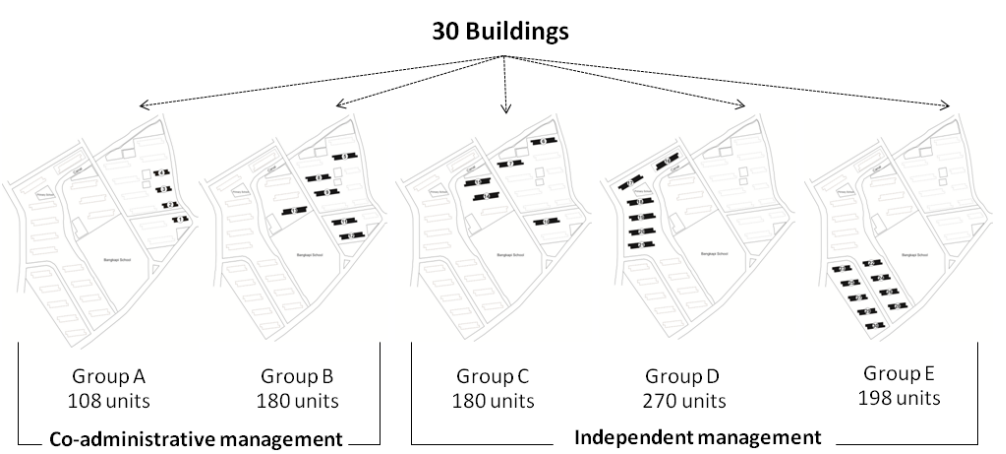
Data collection and analysis method can be divided into three parts:

1) Building management system

A semi structured interviews 30 condominium juridical managers (technical term called of Thai law) that registered in Condominium Act B.E.2522 (1979) was conducted. The interviewees were considerably expert in the maintenance operation, and thus able to provide accurate and reliable answers towards the questions. The interviewing consists an important issue to reveal a problem and management situation through instructed interview questions, those should be recommended in order to rising the efficient building management with high satisfaction of residents for Kong Chan Flat. Also, the six questions to assess residents' satisfaction on their building from questionnaire survey of 370 samples in Klong Chan Flat were conducted before interviewing process.

Table 2. Field survey based on group of management

Field survey based on group management and number of dwelling unit



4 buildings (*108/building)	6 buildings (*180/building)	5 buildings (*180/building)	6 buildings	9 buildings (*198/building)
Flat 1, 2, 3, 4	Flat 5, 8, 9, 11, 12, 13	Flat 6, 7, 10, 14, 15	Flat 16, 17, 18, 19, 20, 21	Flat 22, 23, 24, 25, 26, 27, 28, 29, 30

* dwelling unit/ building

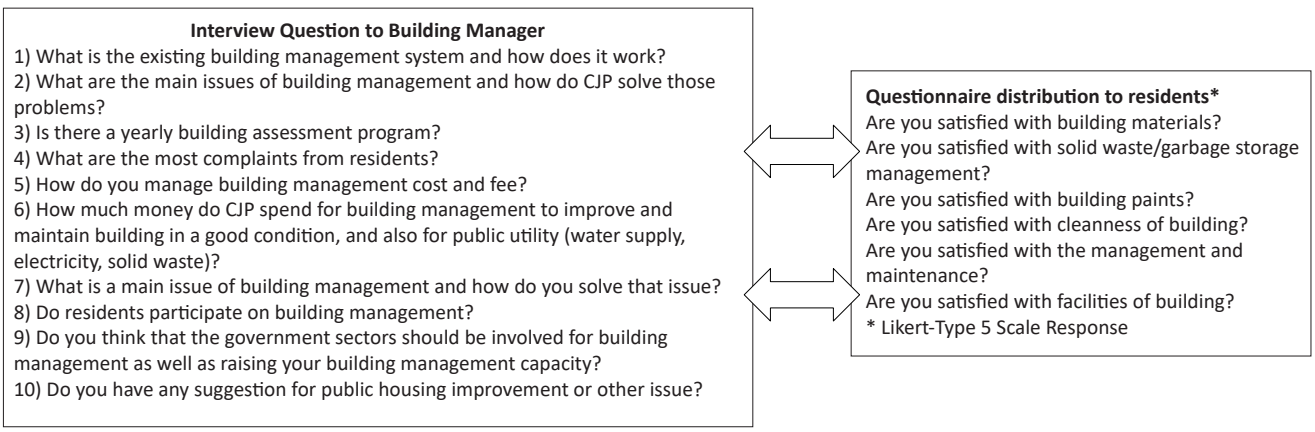


Figure 1. Interview and questions pattern to building managers and residents

2) Building characteristics

In classifying physical building of Klong Chan Flat, the evaluation sheets; building structure, building facilities service, building regulation, public utility, and open space area were distributed to all building managers to assess their buildingconditions on the four scale evaluation (very good, good, fair, and poor) (Ahmad, Siti, Nasyairi, & Normazwin, (2012) that how it remains in good conditions. Also, a usage of common area of each flat have been investigated to evident how the CJP manage under the building regulation.

3) Predicting maintenance cost.

According to Building Control Act B.E. 2522 (1979), transferring a building ownership under Condominium ActB.E.2522 (1979) is required, all flats of Klong Chan Flat must be annually inspected and every five years for grand inspection. Available 5-Year report of representative group (A, B, C, and D) flat was collected to investigate how physical of building change based on maintenance work. These documents can be supporting the buildings field survey. Also, the report was giving cost of maintenance, income, fees of building that was the attributes in predicting cost model by SPSS. A correlation and regression analysis model widely applied for prediction process (Au-Yong, Ali & Ahmad, 2014). The multiple linear regression model is formulated as:

$$Y = \beta 0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_k x_k+\varepsilon \quad \text{(Eq.1)}$$

Where:

Y = the dependent or response variable, (Maintenance expenditure)

$X_1, X_2, X_3, \ldots, X_k$ = the independent or predictor variables, (Variables; management type, building charge, structure, facility service, open space, tidiness of building, dwelling unit occupied, site of building project, common property area that will be the significant performing Pearson's correlation analysis)

$E(Y)$ = $\beta 0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_k x_k$ = is the deterministic component of the model,

β_1 = the contribution of the independent variable X_i and,

ε = a random error of the model.

4. Results and discusion

4.1 Building management system and existing maintenance of public housing

Based on the evaluation sheet (Table 3) of building conditions, the results of two different characteristics of management were investigated.

Co-administrative management:

1) Group A (108units): this group is smaller size by number of dwelling unit. To manage these buildings each flat have their own a CJP board and building manager (1 person/flat) under the mandated of Condominium Act B.E.2522 (1979). Flat 3 is co-administrative office center sharing staffs and facilities for this group. The field observation and evaluation sheet indicate that Flat 2 and 4 were quite worse in term of building maintenance conditions.

2) Group B (180 units): Flat 8 is the co-administration office center. This group was found to be a good organized management on common area and the clean court yard and the ground floor. Meanwhile, Flat 13, 11, and 9 were found unorganized and careless in this group.
Independent administrative management:

3) Group C (180 units): They have own the administration office. Flat 14, 7, and 6 were found well management of their properties. Keeping a green area inside and in front of building were found in this group, they regularly maintained by trimming trees. Additional functions at the court space of building as a playground was encouraging a meaningful public area.

4) Group D (270 units): This is the largest building group in term of number of dwelling unit. Most of these flats were found in good management. Flat 16 performed well maintenance with restriction of building regulation and provided a green area for residents.

5) Group E (198 units): a good condition of physical building and surrounding area of this group were found of Flat 22, 24, and 26 with the cleanness and well organized. Green areas inside and in front of building were found in this group.

As the above investigation, it could be mentioned that a physical maintenance of building condition was quite not distinctive between two groups of management. All building structure was still in good conditions. However, the exterior materials and surrounding environments depend on the building maintenance program and the regulation to the tenants. The unauthorized installations commonly found were T.V. satellites, cages, drying racks, lightweight canopies and supporting frames for air conditioner along public corridor. These objects were placed without prior approval from CJP. Thus, residents seem to be unaware of building regulations due to the fact that most occupants also behave inattentively. This directly affected the ambience of buildings. This issue was in line with Chan (2000) regarding maintenance of the old buildings in Hong Kong. The study was shown the protruding unauthorized structures might directly result in building decay and maintenance on external walls that was obstructed by those disorganized objects. In terms of multi-purpose area, all flats have been provided with bikes and motorcycles parking, relaxing area with benches and trolley booth space. However, areas of some flats still were found not well-organized as planned, for example, NHA provides a zone for relaxing green space as public area of the building court, unfortunately, the area is changed by tree removal with the space for renting storage instead. The results of Ahn & Kim (2011) and Chareonsuk, Nagarur & Tabycanon (1997) revealed that the planned maintenance is the predetermined tasks that are well organized and performed in advance so as to reduce or to prevent any damages to the building components or items. Two perceived characteristics of the building management (co-administration and independent administration) of residents showed that a mean score of independent administration group (M= 2.85, SD= .694) was higher than co-administrative management level (M= 2.70, SD=.721). However, the score indicated a fair satisfied level and there was no significant difference between two groups at P-Value = .061. The result of Halim, Muthusamy, Chia, and Lam (2011) mentioned that the building users' low satisfaction was mainly due to issues such as lack of maintenance staffs, expertise, tools, technology, insufficient allocations and inappropriate maintenance strategies.

4.2 Predicting factors to maintenance and cost

This part indicated maintenance factors by examining the building expenditures that was divided into four main categories; administrative, water supply, electricity supply and building development & maintenance cost based on annual building report (Table 5).

Table 3. The evaluation of building conditions

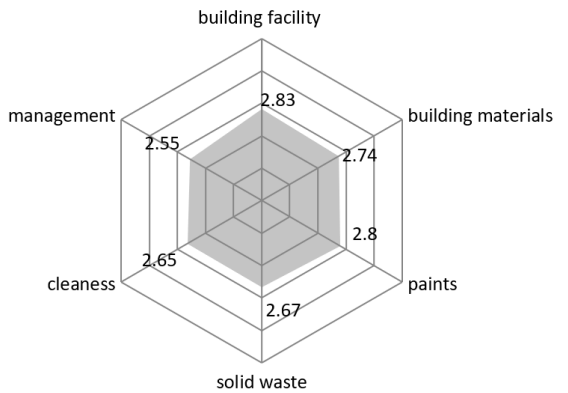
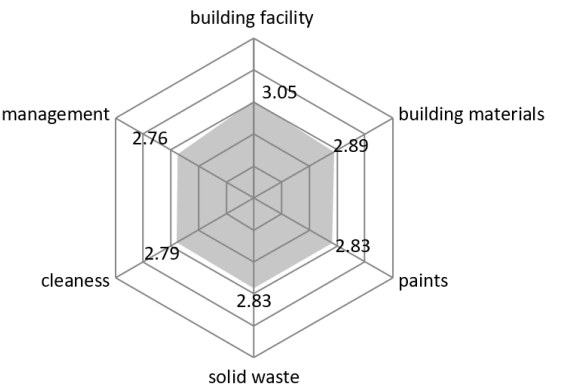
Maintenance and management of co-ownership property	Co-Administration office and resources										Independent Management																			
	Group A				Group B						Group C					Group D						Group E								
	1	2	3	4	5	8	9	11	12	13	6	7	10	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Building structure*																														
- column, beam, walls refer annual inspection report	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
- roof structure and tile	○	○	○	○	○	○	○	○	○	○	○	⊗	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Building facilities services***																														
- good condition of stair and add handrail for elders	○	⊗	⊗	⊗	●	○	○	⊙	○	○	⊗	⊗	○	○	⊗	○	○	⊗	⊗	⊙	●	○	○	⊗	○	○	○	⊙	○	○
- CCTV	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
- fire safety (exit sign, fire extinguisher)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Building regulation***																														
- do not put a stuff along corridor	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
- do not install TV. satellite at corridor wall	⊗	⊗	●	⊗	⊙	⊙	⊙	⊗	⊙	⊗	⊗	⊗	⊗	⊙	⊗	⊙	⊗	⊗	⊙	⊙	⊗	⊗	⊗	⊙	⊗	⊙	⊙	⊙	⊗	⊙
- do not install a condenser air in front of room	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊗	⊙	⊙	⊙	⊙	⊗	⊙	⊙	⊙	⊙	⊗	⊙	⊙	⊙	⊙	⊗	⊙	⊗	⊙	⊙	⊙	⊗	⊙
Public utility***																														
- drainage pipe system in good condition	●	⊗	●	⊗	○	○	●	●	○	●	○	●	●	○	●	○	●	●	○	○	○	●	○	○	○	○	○	●	○	○
- lighting system of building	○	○	○	○	○	○	●	○	○	●	●	○	○	○	●	○	⊙	●	○	○	●	○	⊙	⊙	○	⊙	●	●	○	○
- available telephone, internet, washing and water machines services	○	●	○	○	⊙	○	○	●	⊗	●	○	⊙	⊙	⊙	●	⊙	●	○	⊙	⊙	●	●	○	⊙	○	⊙	○	○	○	⊙
Open space area***																														
- organized and cleanness of ground floor area for parking zone, activity	⊙	●	○	●	○	○	●	●	○	○	○	●	○	⊙	○	⊙	○	○	⊙	○	○	●	○	⊙	●	⊙	○	○	●	⊙
- maintain building court with remain a green area and sport area for livable place**	○	●	●	○	○	●	●	⊗	○	●	●	●	●	○	●	○	⊗	●	●	●	●	⊗	⊗	●	⊗	○	●	⊗	●	●
- surrounded area cleanness, and providing green area in front of flat**	⊙	○	●	○	⊙	○	●	○	⊙	●	⊙	○	○	⊙	⊗	⊙	⊙	●	⊙	●	○	●	○	⊙	●	○	●	○	⊙	⊙

* From annual building inspection under Building Control Act. B.E.2522 (1979) report that building must be inspected every 5 years

** Based on NHA purposed in greenery and creating space activity

*** Building evaluation by observation and interview ⊙ = Very good ○ = Good ● = Fair ⊗ = Poor

Table 4. Mean score of residents' satisfaction with different administration groups

Co-administration	Independent-administration
	
Total mean score = 2.70** (S.D. .721)	Total mean score = 2.85** (S.D. .694)

T-test Analysis

H1= Co = In H1= Co≠ In	Levene's Test for Equality of Variances		t	df	Sig. (P-Value)
	F	Sig.			
Satisfaction	1.094	.296	-1.876	368	**.061***

* No significant at the 0.05 level between two groups

**Satisfied level: 1.00–1.50 = Highly Dissatisfied, 1.51- 2.50 = Dissatisfied, 2.51–3.50 = Fair satisfied, 3.51–4.50 = Satisfied, 4.51–5.00 = Highly satisfied.

These expenditures were discussed below.

1) Administrative cost

The administrative cost mainly consists of the staff salary and the office equipment which were considered as the significant amount of building expenditure. Especially, those flats operated under an independent management feature (Group C, D, and E) granted a half of building fee income. Meanwhile, Group A and B (co-administrative management) performed better on administrative cost management because of sharing staffs. However, salary of staff and building managers was considered a significant factor affecting an increase or decrease of expenditures based on an employment rate.

2) Water supply cost

This fee was first ranked among other expenditures and significantly consumed an amount of income collecting from residents by CJP. As the result, Group D paid water supply fees are more than other groups. The water fee control is in accordance with an announcement of National Housing Authority. The base charge for consumption of water is 55 baht (0-5 m^3) and service charge is 25 baht. A progressive rate charge tap water will be charged 10.50% (6 - 10 m^3), 11.00% (11-20 m^3), and 11.50% (21-30 m^3) respectively. Fine from delayed payment and water meter lock will be conducted to enforce residents.

3) Electricity supply cost

In terms of the electricity cost, there was no significant difference among all flats even they were different in size of building units. Installation of additional light bulbs or light poles, to provide more security to residents and their properties at night, was taken place for all flats. The expenditures of these flats were found not much different in total. However, the CJP was concerned to high electricity cost due to the facility of light poles provided in parking areas.

Table 5. Averaging expenditures of Klong Chan Flat

FLAT			**Expenditures** (Baht/month)					
			Co-Admin fee	Administration	Water supply	Electricity	Building & maintenance development	Total (100%)
Co- Administrative Management	Group A 108 units	1	2105.75 (20.22)	N/A	N/A	N/A	8310.00 (79.78)	10415.75 (100)
		2	2105.75 (24.54)	6109.00 (13.41)	N/A	30852.61 (67.75)	8580.00 (18.84)	45541.61 (100)
		3	2105.75 (9.20)	8688.00 (37.95)	N/A	N/A	12101.00 (52.85)	20789.00 (100)
		4	2105.75 (4.66)	17651.17 (39.07)	13353.99 (29.56)	8604.48 (19.04)	3464.73 (7.67)	45180.12 (100)
	Group B 180 units	5	1402.95 (5.91)	16815.50 (70.89)	N/A	N/A	5502.00 (23.20)	23720.45(100)
		8	1387.66 (1.95)	15457.00 (21.73)	25443.00 (35.76)	14485.00 (20.36)	14371.00 (20.20)	71143.66 (100)
		9	1379.78 (2.18)	18054.00 (28.58)	26550.93 (42.02)	13304.63 (21.06)	3890.00 (6.16)	63179.34 (100)
		11	1400.12 (1.29)	14494.00 (13.34)	30036.50 (27.64)	N/A	62725.00 (57.73)	108655.62 (100)
		12	1379.79 (1.82)	22172.00 (29.27)	25103.70 (33.13)	15205.00 (20.07)	11902.00 (15.71)	75762.49 (100)
		13	1397.04 (1.63)	17474.00 (20.37)	24682.06 (28.78)	14427.11 (16.82)	27795.00 (32.40)	85775.21 (100)
Independent Administrative Management	Group C 180 units	6	N/A	N/A	N/A	N/A	N/A	N/A
		7	-	N/A	N/A	N/A	N/A	N/A
		10	N/A	N/A	N/A	N/A	N/A	N/A
		14	-	25418.92 (35.62)	23889.18 (33.48)	12188.06 (17.08)	9858.14 (13.82)	71354.29 (100)
		15	-	22370.00 (31.78)	26486.00 (37.63)	11444.00 (16.26)	10112.00 (14.36)	70394.00 (100)
	Group D 270 units	16	-	24005.42 (24.55)	39411.70 (40.31)	18178.37 (18.59)	16177.92 (16.55)	97773.41 (100)
		17	-	32547.19 (28.80)	35617.52 (31.52)	16809.23 (14.87)	28036.62 (24.81)	113010.56 (100)
		18	-	N/A	N/A	N/A	N/A	N/A
		19	-	28960.00 (25.47)	30584.00 (26.89)	16989.00 (14.94)	37191.00 (32.70)	113724.00 (100)
		20	-	30189.21 (29.93)	31718.27 (31.44)	18668.63 (18.51)	20299.91 (20.12)	100876.02 (100)
		21	N/A	N/A	N/A	N/A	N/A	N/A
	Group E 198 units	22	-	23000.00 (31.89)	25377.19 (35.18)	12986.18 (18.00)	10764.00 (14.92)	72127.37 (100)
		23	-	22409.67 (28.22)	25646.81 (32.30)	15817.62 (19.92)	15532.58 (19.56)	79406.68 (100)
		24	-	24259.84 (35.45)	21825.74 (31.90)	13616.10 (19.90)	8726.26 (12.75)	68427.94 (100)
		25	-	26243.25 (28.56)	14569.21 (15.85)	25544.00 (27.80)	25544 (27.80)	91900.46 (100)
		26	-	21938.63 (22.47)	24116.09 (24.70)	13385.14 (13.71)	38202.88 (39.13)	97642.74 (100)
		27	-	24300.00 (31.50)	25263.24 (32.75)	12555.53 (16.28)	15016.55 (19.47)	77135.32 (100)
		28	-	27750.00 (38.28)	25491.15 (35.16)	11986.21 (16.53)	7264.00 (10.02)	72491.36 (100)
		29	-	28692.58 (31.03)	21863.96 (23.64)	14186.25 (15.34)	27733.80 (29.99)	92476.59 (100)
		30	-	26300.00 (38.34)	25500.00 (37.18)	14500.00 (21.14)	2291.66 (3.34)	68591.66 (100)

Noted: expenditures were based on monthly average, N/A = data not available

4) Building development cost

The cost of building maintenance was quite difficult to be managed in regular basis as the action must depend on causes of fault or damage. The cost typically includes structure repairs, lighting system, pipe/drainage system, roof, landscape, waste collection, cleaning, insurance and other related activities. Therefore, to maintain building in pleasant conditions, the budget is considered very important (Chan, 2000). However, the amount of income allocated for building development was towards corrective-based maintenance to presently serve quality of living rather than accounted as budget for long-term plan.

Figure 1. Building maintenance conditions of Klong Chan Flat Project

5) Factor affecting building expenditures

To clarify influence factors in terms of maintenance and expenditures, the possible variables have been integrated into this analysis (Table 6) that included the dependent and independent variables in a regression analysis.

Table 7 showed the significant relationship between building expenditure and variables of three features; building management, building physical condition and building features by performing Pearson's correlation analysis. Three variables were found significantly correlated with building expenditure variance by giving a perfect correlation that should be more than 0.3 or above denoting a strong relationship and those variables has required a p-value of less than .05 to indicate statistically significant (Sauders, Lewis, & Thornhill, 2009).

The three variables: building charge, a number of dwelling unit and common area were added in the multiple linear regression model. This method was also applied in the study of Au-Yong CP, Ali, and Ahmad (2014). The result showed that the explanatory variables in the maintenance expenditure of Model 1 (Table 8) accounted for 78.2 percent of the variance in this model (R^2=0.782 whereas Adjusted R^2 .725. By keeping these three variables constant, the analysis results revealed that one independent

Table 6. Potential key variables to explain maintenance expenditure

Dependent variables			Independent variables			
	Unit	**Type**			**Unit**	**Type**
Maintenance expenditure	Baht	continuous		**Management type**	Type	categorical
Variables criteria explained: the most important factor for keeping buildings in good condition upon stated public housing improvement			Management system	Variables criteria explained: two different characteristics of Klong Chan Flat are co-operation management and individual management. This data obtained from field survey and related documents.		
				Building charge	Baht	categorical
				Amount of building charges for improvement might decrease the maintenance performance (not include sinking fund).		
			Building physical condition*	**Structure**	Score	continuous
				Facility service	Score	continuous
				Open space	Score	continuous
				Tidiness of building	Score	continuous
				Existing building conditions towards physical maintenance including structures, facilities, public utilities, cleaning and open spaces could affect maintenance cost.		
			Building management	**Dwelling unit occupied****	No. of Room	continuous
				Different numbers of dwelling units occupied could affect maintenance cost.		
				Site of building project	M^2	continuous
				Different sites of building could affect maintenance cost.		
				Common property area	M^2	continuous
				Total area of common property in terms of open space and ground floor was used to identify influence factors.		

Noted: * Four independents of building physical condition; structure, facility of building service, open space and tidiness were transformed from the evaluation checklist into 4 (Very Good), 3 (Good), 2 (Fair), and 1 (Poor). By this application of rating scale, the Cronbach's alpha was employed to test the reliability of score and found at 0.67 that reflects acceptable reliability level (0.6-0.7 = acceptable).

** Dwelling unit occupied by residents of this study was assumed that all flats were full occupied rate.

Table 7. Correlation matrix between covariates (10 variables)

Variables	BT	MT	BC	DO	SBP	CP	ST	FB	OP	TB
Building expenditure	1.00									
Management type	.570	1.00								
Building charge	**-.699****	-.376	1.00							
Dwelling unit occupied	**.809****	**.642****	**-.815****	1.00						
Site of building project	.442	-.140	-.645**	.242	1.00					
Common area	**.622***	.263	**-.717****	.305	**.815****	1.00				
Structures	.386	.037	**-.402***	.187	-.004	.047	1.00			
Facility of building service	.187	**.410***	-.353	**.613***	.289	.059	.073	1.00		
Open space	-.233	-.068	-.078	.122	.254	.0.33	-.0.66	**.461***	1.00	
Tidiness of building	-.126	.095	-.331	.190	.115	.123	.326	.538	**.758***	1.00

Noted: BT = Building total expenditure, MT = Management type, BC = Building charge, DO = Dwelling unit occupied, SBP = Site of building project, CP = Common property area, ST = Structures, FB = Facility of building service, OP = Open space, and TB = Tidiness of building,
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Model 1: (Enter Method)

Table 8. Variables predicting building expenditure by Enter Method

Variables	B	t	Sig.	Collinearity Statistics	
				Tolerance	VIF
(Constant)	-50.451	-1.002	.401		
Building_Charge (BC)	.145	1.064	.345	.184	3.386
Dwelling_Occupied (DO)	17.103	4.224	.005	.420	3.114
Common_Area (CA)	100.208	2.356	.002	.395	2.529
Constant = -50.451; SEtest + 9.57					
R = .823; R^2 = .782; Adjusted R^2 = .725; F = 15.826; P-value = .000; Durbin-Watson = 2.217					

* Significant at the 0.05 level

Model 2: (Stepwise Method)

Table 9. Variables predicting building expenditure by Stepwise Method

Variables	B	t	Sig.	Collinearity Statistics	
				Tolerance	VIF
(Constant)	8.673	.744	.001		
Dwelling_Occupied	13.594	2.448	.000	.400	1.361
Common_Area	68.062	2.371	.001	.446	1.031
Constant = 8.673; SEtest + 9.13					
R = .842; R^2 = .724; Adjusted R^2 = .692; F = 22.23; P-value = .000; Durbin-Watson = 2.234					

* Significant at the 0.05 level

From Model 1, a predictive equation formula was determined as below.

$$BMM = -50.451 + 0.145BC + 17.103DO + 100.208CA$$

To eliminate the non-significant predictors as shown in Model 1 and define a validated equation, therefore, stepwise model was analyzed as shown in Table 9. In Model 2, two independents were identified including Dwelling Occupied and Common Area with 72.40 percent reliable as predictors. Thus, these variables must be taken into consideration when determining public housing expenditure investigation.

From Model 2, a predictive equation formula was determined as below.

$$BMM = 8.673 + 13.594DO + 68.062CA$$

Both models were determined by a validation of the regression with tolerance, VIF value more than 0.1 and lower than 10 (Sauder, Lewis, & Thornhill, 2009), Durbin-Watson 2.217 and 2.234 respectively. In applied multivariate regression model of maintenance expenditure, the analysis indicated that monthly maintenance cost of old public housing project would be calculated by a size of dwelling occupation and common area.

6) Building development cost

To investigate the development cost of building, the yearly report of building report was collected. The seven representative buildings were examined towards maintenance cost allocation (Table 10). Flat 8 was considered as a case study based on available data of six-year record continually that to avoid missing data, which is recorded consecutively. This information was employed to analysis building development expenditure.

Table 10. Comparative annual development cost

Group / Expenditure	A	B	D			E	
	Flat 4	Flat 8*	Flat 20	Flat 23	Flat 24	Flat 26	Flat 29
Structure, repair	-	51,700.00	54,040.00	3,500.00	-	19,913.00	95,000.00
Lighting	2,818.00	4,650.00	27,784.00	4,859.00	-	12,401.00	19,358.00
Pipe/drainage system	6,679.00	46,588.00	94,736.00	51,460.00	13,188.00	100,041.00	59,950.00
Landscape	-	13,000.00	10,860.00	11,350.00	46,037.00	167,760.00	11,580.00
Roof	-	15,700.00	-	800.00	-	1,958.00	2,500.00
Garbage collection	24,000.00	30,000.00	26,100.00	30,000.00	30,000.00	30,000.00	25,000.00
Clean	1,033.00	7,979.00	-	10,090.00	11,600.00	17,923.00	2,300.00
Insurance	13,154.00	20,325.00	32,348.00	-	16,018.00	19,570.00	15,208.00
Other	7,047.00	2,855.00	9,779.00	74,296.00	3,890.00	108,438.00	61,658.00
Total	54,731.00	192,788.00	255,647.00	186,391.00	120,733.00	478,004.00	292,554.00

Remark: Flat 8 was selected for analysis yearly cost of expenditure as no missing data and data record available of six years (2013 – 2018).

In terms of building development expenses, there was no much change in administrative cost meanwhile electricity cost was slightly increased. For the development cost, the amount was found very high compared to other costs in 2014 and 2015 and steadily decreased in 2016 and 2017. In 2018, all cost categories were not quite distinctive in total as shown in Table 10. The significant amount of spending under CJP operations was lighting and installation of electricity devices as first rank. Second and third were pipe/drainage system and garbage collection respectively. From the top three ranking factors, the analysis indicated that Flat No. 8 has emphasized on improving and maintaining the buildings essentially and critically for quality of daily lives.

To predict the building development cost based on the information in Table 11, the variables have been classified into two categories; independent and dependent variables as shown in Table 12. According to the study of Faremi, Ademga, Dada, & John (2014) and Ali (2009) pointed that building age is important factor in maintaining costs of building. Therefore, a yearly report and age of building of Flat 8 (established in 1976) was coded as 38 years (2013), 39 years (2014), 40 years (2015), 41 years (2016), 42 years (2017) and 43 years (2018) respectively. Thus, the age of building variable was considered an independent variable. Fourteen variables including co-operation cost, administration management, electricity, structures, lighting/electric devices, pipe and drainage system, landscape, roof, solid waste, cleaning, insect protection, insurance, inspection and other activities were dependent variables (Table 12). Those variables were employed to reveal significant factors of a prediction model by correlation.

Table 11. Building development cost of Flat 8

Year / Expenditure	Building Development Cost: Flat 8 (Cost unit = baht)					
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Management and services						
Co-operation cost	12,055.00	14,843.00	15,367.00	16,875.00	16,354.00	16,653.00
Administration management	231,333.40	198,505.50	197,393.00	193,212.00	197,464.00	185,479.50
Electricity	128,710.50	134,682.16	133,886.68	136,461.10	162,959.37	173,817.02
Total (1)	372,098.90	348,030.66	346,646.68	346,548.10	376,777.37	375,949.52
Development cost						
Structure, repair, replace	75,405.75	13,881.00	2,463.00	18,300.00	10,209.00	51,700.00
Lighting/electricity devices	28,161.00	91,176.00	98,591.00	5,336.00	11,793.40	4,650.00
Pipe/drainage system	5,035.00	48,492.00	39,503.00	40,915.00	30,288.00	46,588.00
Landscape	12,090.00	28,000.00	19,200.00	54,500.00	12,000.00	13,000.00
Roof repair	-	4,848.00	16,350.00	12,225.00	5,995.00	15,700.00
Garbage collection	30,000.00	30,000.00	30,000.00	28,000.00	30,000.00	30,000.00
Cleaning	-	6,418.00	2,594.00	5,516.00	4,040.00	7,979.00
Insurance	-	24,168.09	23,724.00	23,724.00	21,974.00	20,325.00
Insect spraying	24,251.00	400	-	1,180.00	21,800.00	-
Inspection of building	10,600.00	-	10,000.00	-	-	-
Other activities	27,338.00	17,259.00	13,086.50	3,695.75	1,730.00	2,855.00
Total (2)	212,880.75	264,642.09	255,511.50	193,391.75	150,330	192,788.00
Total (1)+(2)	**584,980.00**	**612,672.80**	**602,158.30**	**539,939.60**	**527,107.70**	**568,737.10**

Noted: Water supply cost was not involved into the building development cost analysis because its covered by water fee charge directly without using building fee.

Those variables in the Table 12 were tested in correlation coefficient for statistic relationship between dependent and independent variables by a correlation coefficient must be more than 0.8. Table 13 presented the results of significant independent variables of Flat 8 by indicating a perfect positive correlation including three variables; co-operative, electricity, insurance and other activities of .864, .902, -.898, and -.939 respectively.

Therefore, four significant variables responsive with age of buildings; co-operative, electricity, insurance and other activity cost have been addressed in the regression model by using SPSS program. The linear regression model is formulated as:

$$Y = \beta 0+\beta\_1 x\_1 \quad \text{(Eq.2)}$$

Where:

Y = the dependent or response variable,(co-operative,electricity, insurance and other activity cost)

X_1 = the independent or predictor variables, (Age of building)

The result showed that the explanatory variables in the building expenditure cost of prediction (Table 14) accounted for 74.7, 81.3, 80.6, and 88.1 percent of the variance in this model. The results revealed that independent (age of building) was significant with P-value of less than .05. The models were determined by a validation of the regression with both tolerance value and VIF value more than 0.1 and lower than 10 (Sauder, Lewis, & Thornhill, 2009). Each of the variables indicated the Durbin-Watson that there was 1.596, 1.516, 1.530, and 1.507 respectively.

From the prediction model of Flat 8, it would be calculated the building expenditure, for example, co-operative cost = -1.411+.083(Age), electricity cost = -17.233+.894(Age), insurance cost = 4.916 -.075(Age), and other activity cost = 19.194 -.510(Age). These variables should be considered for the maintenance program to control and manage building cost as well as the expenditure and the budget capacity. The impacts of these factors were rated high on maintenance costs. The result is similar to Faremi, Ademga, Dada, & John (2014) that the age is one dominant factor meanwhile size of buildings, vandalism by users, faulty design and poor incorporation of building services are also dominant factors that impact the costs of maintenance. The variables could be addressed in the policy of monitoring the age public housing of National Housing Authority to monitor maintenance expenditure issues in order to find ways how low-income residents solve and deal with building conditions in accordance with these predicting models. In addition, the building manager or CJP can follow Lee & Scott (2009)'s suggestion on engaging with outsourcing strategies to minimize operation cost and further reduce the expenditure of age building.

Table 12. Variables explain maintenance expenditure cost of Flat 8

Independent variable Age of building Dependent variable (14 variables)					
	Management and services cost			Development cost	
X1	Co-operation cost	X1	structure, repair	X7	cleaning
X2	Administration management	X2	lighting/electric devices	X8	insect protection
X3	Electricity	X3	pipe and drainage system	X9	insurance
		X4	landscape	X10	inspection
		X5	roof	X11	other activities
		X6	solid waste		

Table 13. Correlation matrix between covariates (15 variables)

Variables	A	CO	AD	EL	DEV	ST	LT	P	L	R	SW	CL	I	IS	IST	O
Age	1.000	0.864*	-0.785	0.902	-0.631	-0.213	-0.552	0.514	-0.026	0.632	-0.131	0.667	0.404	-0.898*	-0.633	-0.939**
Co-operation	**0.864***	1.000	-0.932	0.610	-0.374	-0.590	-0.289	0.773	0.382	0.717	-0.410	0.760	0.298	-0.581	-0.733	-0.964**
Administration	-0.785	-0.932**	1.000	-0.588	0.084	0.588	0.035	-0.930**	-0.276	-0.784	0.202	-0.868*	-0.085	0.579	0.690	0.836*
Electricity	**0.902***	0.610	-0.588	1.000	-0.640	0.039	-0.550	0.334	-0.382	0.359	0.228	0.595	0.464	-0.982**	-0.578	-0.735
Development	-0.631	-0.374	0.084	-0.640	1.000	-0.162	0.891	0.243	0.105	0.064	0.208	-0.071	-0.718	0.584	0.397	0.597
Structure	-0.213	-0.590	0.588	0.039	-0.162	1.000	-0.449	-0.622	-0.355	-0.400	0.178	-0.272	-0.330	-0.126	0.308	0.466
Lighting	-0.552	-0.289	0.035	-0.550	0.891*	-0.449	1.000	0.237	-0.074	0.043	0.390	-0.169	-0.342	0.548	0.399	0.477
Pipe	0.514	0.773	-0.930**	0.334	0.243	-0.622	0.237	1.000	0.375	0.676	-0.176	0.874*	-0.140	-0.322	-0.644	-0.600
Landscape	-0.026	0.382	-0.276	-0.382	0.105	-0.355	-0.074	0.375	1.000	0.215	-0.928**	0.289	-0.282	0.389	-0.355	-0.240
Roof	0.632	0.717	-0.784	0.359	0.064	-0.400	0.043	0.676	0.215	1.000	-0.226	0.495	-0.228	-0.454	-0.147	-0.622
Solid waste	-0.131	-0.410	0.202	0.228	0.208	0.178	0.390	-0.176	-0.928**	-0.226	1.000	-0.187	0.147	-0.219	0.316	0.352
Cleaning	0.667	0.760	-0.868*	0.595	-0.071	-0.272	-0.169	0.874	0.289	0.495	-0.187	1.000	-0.056	-0.575	-0.857*	-0.668
Insect	0.404	0.298	-0.085	0.464	-0.718	-0.330	-0.342	-0.140	-0.282	-0.228	0.147	-0.056	1.000	-0.322	-0.336	-0.470
Insurance	**-0.898***	-0.581	0.579	-0.982**	0.584	-0.126	0.548	-0.322	0.389	-0.454	-0.219	-0.575	-0.322	1.000	0.480	0.697
Inspection	-0.633	-0.733	0.690	-0.578	0.397	0.308	0.399	-0.644	-0.355	-0.147	0.316	-0.857*	-0.336	0.480	1.000	0.718
Other	**-0.939****	-0.964**	0.836*	-0.735	0.597	0.466	0.477	-0.600	-0.240	-0.622	0.352	-0.668	-0.470	0.697	0.718	1.000

Noted: A = Age, CO= Co-operation cost, AD = Administrative cost, EL= Electricity cost, DEV = Development cost, ST = Structures cost, LT = Lighting and electricity device cost, P = pipe and drainage system cost, L= Landscape cost, R= Roofing cost, SW= Solid waste cost, CL=Cleaning cost, I=Insect protection cost, IS= Insurance cost, IST=Inspection building cost, and O= Other activity cost.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 14. Variables predicting old building expenditure by Enter Method

Variables	B	t	Sig.	Collinearity Statistics	
				Tolerance	VIF
Co-operative cost (Dependent)	-1.411	-1.648	.017*		
Age of building (Independent)	.083	3.437	.026*	1.000	1.000
Constant = -1.411; SE_{test} + .857					
R = .864; R^2 = .747; Adjusted R^2 = .684; F = 11.82; P-value = .026*; Durbin-Watson = 1.596					
Electricity cost (Dependent)	-17.233	-2.260	.008*		
Age of building (Independent)	.894	4.168	.014*	1.000	1.000
Constant = -17.233; SE_{test} + 7.624					
R = .902; R^2 = .813; Adjusted R^2 = .766; F = 17.372; P-value = .014*; Durbin-Watson = 1.516					
Insurance cost (Dependent)	4.961	7.593	.002*		
Age of building (Independent)	-.075	-4.074	.015*	1.000	1.000
Constant = 4.961; SE_{test} + .653					
R = .898; R^2 = .806; Adjusted R^2 = .757; F = 16.594; P-value = .015*; Durbin-Watson = 1.530					
Other activity cost (Dependent)	19.194	5.763	.004*		
Age of building (Independent)	-.510	-5.439	.006*	1.000	1.000
Constant = 19.194; SE_{test} + 3.33					
R = .939; R^2 = .881; Adjusted R^2 = .851; F = 29.587; P-value = .006*; Durbin-Watson = 1.507					

* Significant at the 0.05 level

5. Conclusion and recommendation

To ensure residents' quality of living with good physical conditions, long-term maintenance and management under the CJP operations of Klong Chan Flat is important. The study was conducted on three approaches; building management investigation, building characteristics evaluation, and predicting maintenance cost in providing the information for building management regarding maintenance cost. The three main recommendations are:

(1) Building management

There were two different building management approach; co-administrative management and independent administrative management. The result of two groups was not quite distinctive in term of operating building management. However, the successful public housing management from the field survey how to inform and involve residents on the issues of management should be concerned. The co-administrative management can be effectively reducing cost among the building group members as salary of managers and staffs. On the other hand, a delay of improvement properties might be happened due to many cases of repair and maintenance program of each building. For independent administrative group, it is flexible system that a manager can solve building problems immediately without staff members' agreement. The weakness of this management approach is lacking a collaborative working with other staffs and residents. The beginning of both management approaches should be involved with residents to be a part and give their maintenance knowledge which might rise up to the highest satisfaction as needs/expectations.

(2) Building characteristics evaluation

The result of this part was showing an overview building evaluation by interviewing all 30 managers and observation. Only exterior physical evaluation was evaluated by observation and interview CJP. Most buildings have been getting old that building components could result in damage affected other functions. For example, roof problems cause damage on ceiling and interior furnishings of dwelling units. Therefore, this issue might lead to more severe case compared to saving some amount only onto requested case. It is expected that building maintenance could become more important and serious issues for low-income residents. The combination of the technical and administrative actions must be the acceptable standard to perform building functions. In case of the building decay that significant budget is needed, financial support, hence, from government needs to be addressed for low-income public housing projects.

(3) Predicting maintenance cost

Two factors; dwelling unit occupied and common area have the relationship with the building expenditure at significant at the 0.05 level as shown in Table 9. These variables must be taken into account determining expenditure investigation of Klong Chan Flat. In addition, to finding the factors affecting maintenance cost by using age of the building as independent variable, there are four significant factors running by prediction model included co-operative (R^2 =74.7), electricity (R^2 =81.3), insurance (R^2 =80.6) and other activity costs (R^2 =88.1). These variables must be specifically taken into account of maintenance program of CJP of Klong Chan Flat to control and manage building expenditures in the forthcoming future. This result would support CJP to monitor the maintenance cost and useful for building maintenance planning improvement.

To conclude, the result of the study would be contributing a public housing management operation for Klong Chan Flat Project. CJPs could manage their building improvement budget that normally paid about 25 percent covering structure repairs, lighting system, pipe/drainage system, roof, landscape, waste collection, cleaning, insurance and other related activities meanwhile about 30 percent for admonition cost. Therefore, as indicated influent variables; co-operative, electricity, insurance, and other activity costs, the CJP of Klong Chan Flat Project should be aware of these factors for the determination of maintenance cost prioritized that otherwise appears satisfactory for the occupants.

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