

**DOCTORAL DISSERTATION**

**ANALYSIS OF OLD PUBLIC HOUSING IMPROVEMENT  
BASED ON POST-OCCUPANCY EVALUATION IN BANGKOK**

**by**

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## Abstract

Public housing has been providing in Thailand for low and middle income people, implemented by the National Housing Authority more than 40 years especially in urban area such as Bangkok. However, the quality of living is addressed as a scepticism condition on how dwellers satisfy their living based on physical housing characteristics. Therefore, the existing affordable housing program in term of old and new development schemes which are operated by government agency had been placed to investigate and review. The old public housing, Klong Chan Flat Project, in Bangkok was investigated based on Post-Occupancy Evaluation as well as residents' feedback and compared to new public housing scheme, Buengkum Baan Eur Arthron.

Gathering information of both projects by questionnaire and field survey were analysed with statistical method approach. 30 variables associated with dwelling, building and community features, revealed that residents' satisfaction of Klong Chan Flat Project could be increased through size of living area, cost of management, and security of neighborhood as high beta coefficient value. These influenced factors are specially synthesis on three aspects; dwelling unit performance analysis with spatial and thermal comfort aspects, building management and cost situation in order to create a predictive model of building expenditure cost, then the community safety has been analyzed to identify a safety system and a risk area with relationship of safety perception that can be useful for safety management. Finally, to understand public housing on the Eco-village concept under low carbon society of National Housing Authority (NHA) has been examined to find a barrier of housing improvement. It is a long-term housing strategy planning to respond environmental sustainability and energy efficiency for the development of low-income housing. Unfortunately, the purchase housing type is seen a limited development as well as retrofitting to contribute based on Eco-Village vision. To deal with low-income housing development, we need to understand how poor people do concern on Low Carbon Society as a beginning process of Eco-Village implementation. Low-income residents have rated their attitudes in positive through fifteen variables. It is very useful for the government agencies to promote and enhance a rehabilitation program to poor people.

The results of this research provide unique information from which improvements in future housing projects could be made. The results of research into the influenced factors of case study may assist the project owners and relevant public housing stakeholders to prioritize specific actions. This result enables analytical platform of in-depth public housing study to identify the ways in improving the quality of life for low income people through living and cultural context approach to sustainable public housing development vision.

Keywords: *post-occupancy evaluation, low-income public housing, three aspects of improvement*

## Table of Contents

Abstract.....	i
Acknowledgements.....	ii
Table of Contents .....	iii
List of Figures.....	vi
List of Tables.....	ix

### CHAPTER 1 INTRODUCTION AND PURPOSE OF RESEARCH

1.1 Background .....	1
1.2 Research Statement .....	3
1.3 Research Questions .....	5
1.4 Research Objectives .....	5
1.5 Scope of Research.....	6
1.6 Research Outlines .....	6

### CHAPTER 2 AN OVERVIEW OF PUBLIC HOUSING DEVELOPMENT IN THAILAND AND EVALUATION

2.1 Public Housing Overview in Thailand.....	9
2.1.1 Public Housing Policy.....	9
2.1.2 Public Housing Characteristics .....	10
2.2 Evaluating Public Housing Features and Environments .....	15
2.2.1 Theory of Evaluating Existing Public Housing Conditions .....	15
2.2.3 Public Housing Satisfaction Evaluation of National Housing Authority Project.....	18
2.3 Public Housing Development Vision .....	22
2.3.1 Low-Carbon Society in Thailand and its Contribution in Public Housing.....	23
2.4 Conclusion .....	26

### CHAPTER 3 RESEARCH METHODOLOGY

3.1 Case Study.....	27
3.2 Data Collection .....	30
3.3 Method and Analysis Techniques.....	32
3.4 Research Framework.....	35

## Table of Contents

### **CHAPTER 4 RESIDENT SATISFACTION ANALYSIS OF “OLD” AND “NEW” PUBLIC HOUSING BASED ON POST-OCCUPANCY EVALUATION**

4.1 Respondent Profile .....	37
4.2 Public Housing Satisfaction of “Old” and “New” project .....	40
4.3 Analysis of Personal Information (demographic/socio-economic/living conditions) with Living Satisfaction .....	47
4.4 Investigating the Influence of Variables on Overall Satisfaction.....	56
4.4.1 Results of the Influence of Personal Profile Variables on Overall satisfaction .....	57
4.4.2 Results of Sub-variable Satisfaction on Overall Satisfaction.....	60
4.5 Conclusion .....	63

### **CHAPTER 5 ANALYSIS OF DWELLING UNIT FEATURES AND ITS EFFECT TO OCCUPANTS COMFORT**

5.1 Dwelling Unit Analysis.....	66
5.2 Occupants’ Lifestyle and Self-Maintaining Dwelling Unit .....	70
5.3 Case study of Investigating Dwelling unit Performance through a Thermal Comfort.....	72
5.3.1 Introduction.....	72
5.3.2 Methodology .....	73
5.3.3 Result and Discussion .....	75
5.4 Conclusion .....	82

### **CHAPTER 6 ANALYSIS OF THE COMPONENTS AND MAINTENANCE COST OF OLD PUBLIC HOUSING PROJECT**

6.1 Assessment Public Housing Maintenance.....	83
6.1.1 Methodology and Analysis Tools .....	84
6.1.2 Existing Klong Chan Flat Management of Co-ownership Property Analysis .....	85
6.1.3 Examining Resident Satisfaction based on Group of Administration and Size of Dwelling Unit.....	94
6.2 Analysis of the Building Maintenance Cost Situation .....	97
6.2.1 Income and Expenditures Challenges for Public Housing Improvement.....	97
6.2.2 Analysis Affecting Factors on Maintenance Cost of Klong Chan Flat Project.....	104
6.2.2.1 Previous Researches .....	104
6.2.2.2 Methods .....	104
6.2.2.3 Results.....	106

## Table of Contents

6.3	Cost Performance by Annual Report and Case Study of Expenditure Prediction.....	108
6.3.1	Income and Expenditure Situation .....	108
6.3.2	Case Study of Building Development Cost Prediction .....	113
6.3.2.1	Maintenance Cost Trend of Flat 8.....	113
6.3.2.2	Building Development Cost Prediction of Flat 8.....	115
6.4	Conclusion .....	117

### **CHAPTER 7 INVESTIGATING COMMUNITY SAFETY AND ITS EFFECT TO RESIDENTS OF KLONG CHAN FLAT**

7.1	Previous Study on Community Safety .....	119
7.2	Investigating Safety Issues of Klong Chan Flat Project .....	121
7.3	Relationship Analysis on Neighborhood Safety Satisfaction.....	124
7.4	Analysis Unsafe Condition of Klong Chan Flat.....	126
7.4.1	Crime Incidents Statistic of Klong Chan Flat .....	128
7.4.2	Analysis of Crime Incident Rate and Physical Condition of Klong Chan Flat .....	131
7.5	Challenging Community Safety Management of Klong Chan Flat .....	134
7.6	Conclusion .....	136

### **CHAPTER 8 STAKEHOLDER INVOLVEMENT IN OLD PUBLIC HOUSING DEVELOPMENT**

8.1	National Housing Authority Policy for Public Housing Development.....	137
8.2	Resident Attitudes towards LCS on Public Housing Development .....	140
8.3	Stakeholder Involvement and Barriers for Klong Chan Flat Project Improvement .....	142
8.4	Conclusion .....	146

### **CHAPTER 9 CONCLUSION AND RECOMMENDATION**

9.1	Summary of Research Study .....	147
9.2	Key Findings of Research .....	149
9.3	Future Research.....	151

<b>REFERENCES</b> .....	152
Appendix I .....	xii
Appendix II .....	xvi
Appendix III.....	xvii
Appendix IV .....	xviii

## List of Figures

Figure 1.1	A shortage affordable housing for low income groups in BMR	1
Figure 1.2	Public housing types and unit in BMR by NHA	2
Figure 1.3	Example of old public housing condition in Bangkok	4
Figure 1.4	Eco-Village principle of NHA	5
Figure 1.5	Research outline	8
Figure 2.1	Housing system and policy in Thailand	9
Figure 2.2	Low-rise public housing characteristic of National Housing Authority	12
Figure 2.3	Post-occupancy evaluation frameworks	16
Figure 2.4	Temperature changes map in South-East Asia of RCP4.5 scenario	22
Figure 2.5	Fossil consumption and CO <sub>2</sub> emission by sector	22
Figure 2.6	GHG comprehensive measures guideline	24
Figure 2.7	Five main missions of NHA organization	25
Figure 2.8	Public housing satisfaction assessment model	26
Figure 3.1	Location and boundary of Klong Chan Flat Project	28
Figure 3.2	Floor plan and elevation of Klong Chan Flat Project	28
Figure 3.3	Location and boundary of Buengkum Baan Eur Arthron Project	29
Figure 3.4	Floor plan and elevation of Buengkum Baan Eur Arthron Project	29
Figure 3.5	Research framework	36
Figure 4.1	Respondents' background	37
Figure 4.2	Dwelling unit features in both the public housing projects	40
Figure 4.3	Building unit features in both the public housing projects	43
Figure 4.4	Community unit features in both the public housing projects	45
Figure 4.5	Top reasons living in both the public housing projects	46
Figure 4.6	Significant of three aspects based on socio-economic by Independent-Samples T-Test	50
Figure 4.7	Significant statistics between groups of education on satisfaction	52
Figure 4.8	Significant statistics between groups of age on satisfaction	52
Figure 4.9	Significant statistics between groups of occupation on satisfaction	53
Figure 4.10	Significant statistics between groups of income on satisfaction	53
Figure 4.11	Significant statistics between groups of family size on satisfaction score	54
Figure 4.12	Significant statistics between groups of length of residency on satisfaction score	54
Figure 4.13	Independents and dependent analysis concept	55
Figure 5.1	Dwelling unit improvement by occupants	72
Figure 5.2	Testing airflow speed of two-bedroom type of Klong Chan Flat	75

## List of Figures

Figure 5.3	Comparative indoor temperature and humidity of three case studies with outdoor climate on April 18, 2016	76
Figure 5.4	Comparative indoor temperature and humidity of three case studies with outdoor climate on April 19, 2016	76
Figure 5.5	Comparative indoor temperature and humidity of three case studies with outdoor climate on April 20, 2016	76
Figure 5.6	Comparative indoor temperature and humidity of three case studies with outdoor climate on April 21, 2016	77
Figure 5.7	Comparative hourly indoor and outdoor humidity of case study with comfort zone of Bangkok in summer	78
Figure 5.8	Weekend activity of dwellers and natural ventilation in living area	79
Figure 5.9	Airflow speed test by wind tunnel	80
Figure 5.10	Airflow speed test by wind tunnel	81
Figure 5.11	Original type of dwelling unit	81
Figure 5.12	Exam Modified type of dwelling unit	81
Figure 6.1	Data collection of old public housing management	85
Figure 6.2	The most building renovation activity of occupant's experiences	92
Figure 6.3	Example of external income by rental fee of facility services in Klong Chan Flat Project	97
Figure 6.4	Example of spending building development expenditure of Klong Chan Flat Project	101
Figure 6.5	Income Monthly income and expenditure of group A (108 unit)	102
Figure 6.6	Income Monthly income and expenditure of group B (180 unit)	102
Figure 6.7	Income Monthly income and expenditure of group C (180 unit)	103
Figure 6.8	Income Monthly income and expenditure of group D (270 unit)	103
Figure 6.9	Income Monthly income and expenditure of group E (198 unit)	104
Figure 6.10	Income and building expenditure of Flat 4	109
Figure 6.11	Income and building expenditure of Flat 8	109
Figure 6.12	Income and building expenditure of Flat 20	110
Figure 6.13	Income and building expenditure of Flat 23	110
Figure 6.14	Income and building expenditure of Flat 24	111
Figure 6.15	Income and building expenditure of Flat 26	111
Figure 6.16	Income and building expenditure of Flat 29	112
Figure 6.17	Yearly income and building expenditure of Flat 8	112
Figure 6.18	Income and building expenditure of Flat 8	113
Figure 6.19	Development cost of Flat 8	114
Figure 7.1	Links between safety and well-being	120
Figure 7.2	Dwelling unit safety by adding a steel frame in front of windows and doors	121

## List of Figures

Figure 7.3	Building's CCTV for building security	122
Figure 7.4	Adding a lighting pole in front of building and back side	122
Figure 7.5	Motorcycle parking lot and cage to store a residents' stuff	123
Figure 7.6	Opened community accessibility condition	123
Figure 7.7	Security office & check point in the community by residents' volunteer	124
Figure 7.8	Getting information from the CJP representative about community safety	126
Figure 7.9	Community environment of unsafe area in Klong Chan Flat	127
Figure 7.10	Criminal incidents in 2012 – 2016 (5-Year)	128
Figure 7.11	Criminal victims in 2012 – 2016 (5-Year)	128
Figure 7.12	Classifying a criminal case in 2012 – 2016 (5-Year)	129
Figure 7.13	Mapping crime of Klong Chan Flat Project	132
Figure 7.14	The old public housing in Bangkok that should be investigated their condition and crime	133
Figure 7.15	Community safety through physical aspects management and stakeholders involvement	134
Figure 8.1	Inadequate promoting the policy on purchase public housing towards Eco-Village	139
Figure 8.2	Understanding resident attitudes on LCS and source of information	141
Figure 8.3	Financial constraints for improvement of Klong Chan Flat Project	145

## List of Tables

Table 1.1	Number of housing unit in Thailand, 2010	1
Table 2.1	List of low-rise public housing affordable program since NHA is established	13
Table 2.2	POE approaches in public housing study	17
Table 2.3	Summarized previous study on public housing evaluation of National Housing Authority	21
Table 3.1	Case study profiles	27
Table 3.2	Variables of questionnaire on public housing satisfaction	30
Table 4.1	Respondents' background on length of residency	39
Table 4.2	Testing relationship between ownership status and plan to move out of project	40
Table 4.3	Mean score of three dimensions	40
Table 4.4	Comparing dwelling unit satisfaction of size	41
Table 4.5	Comparing the number of family members with dwelling unit satisfaction	41
Table 4.6	Comparing dwelling unit satisfaction of quality	42
Table 4.7	Comparing dwelling unit satisfaction of indoor environment quality	43
Table 4.8	Comparing building unit satisfaction of building attributes	44
Table 4.9	Comparing community unit satisfaction	45
Table 4.10	Hypothesis test of residential satisfaction through socio-economic background	48
Table 4.11	Comparative living satisfaction by independents and dependent variable	49
Table 4.12	Satisfaction of three dimensions based on socio-economic by One-Way ANOVA	51
Table 4.13	Independent variables demographics, socio-economic and living conditions	56
Table 4.14	The 30 variables in classified group of three dimensions	57
Table 4.15	Influenced of personal profiles on dwelling satisfaction	58
Table 4.16	Influenced of personal profiles on building satisfaction	59
Table 4.17	Influenced of personal profiles on community satisfaction	60
Table 4.18	Influence of sub-variables on overall satisfaction in dwelling dimension	62
Table 4.19	Influence of sub-variables on overall satisfaction in building dimension	62
Table 4.20	Influence of sub-variables on overall satisfaction in community dimension	63
Table 5.1	Minimum dwelling unit standard of National Housing Authority of Thailand	66
Table 5.2	Dwelling unit analysis of Klong Chan Flat Project	67
Table 5.3	Dwelling unit analysis of Buengkum Baan Eur Arthron Project	68
Table 5.4	Comparing dwelling of Klong Chan Flat Project and Buengkum Baan Eur Arthron Project	69

## List of Tables

Table 5.5	Comparing number of family members with size satisfaction of dwelling unit	70
Table 5.6	Two main electricity appliances in dwelling unit for occupants' comfort	71
Table 5.7	Occupant's behaviour for creating their comfort in term of light and ventilation	71
Table 5.8	Typical dwelling unit of thermal investigation of Klong Chan Flat	74
Table 6.1	Surveying profiles of group A	86
Table 6.2	Surveying profiles of group B	87
Table 6.3	Surveying profiles of group C	88
Table 6.4	Surveying profiles of group D	89
Table 6.5	Surveying profiles of group E	90
Table 6.6	Summary of exiting maintenance and management of Klong Chan Flat Project	93
Table 6.7	Building satisfaction components	94
Table 6.8	Mean score of residents' satisfaction with different administration	95
Table 6.9	Correlation of residents' satisfaction and administration group by Chi-Square Tests	95
Table 6.10	Mean score of residents with five groups of dwelling unit size	96
Table 6.11	Correlation of residents' satisfaction and five groups by Chi-Square Tests	96
Table 6.12	Sources of Klong Chan Flat income	98
Table 6.13	Building fee rate and residents' satisfaction on cost variable	98
Table 6.14	Different building fee and residents' satisfaction on building variables analysis	99
Table 6.15	Potential key variables to explain maintenance expenditure	105
Table 6.16	Correlation matrix between covariates (10 variables)	107
Table 6.17	Affecting variables to predicting old building expenditure by Enter Method	107
Table 6.18	Affecting variables to predicting old building expenditure by Stepwise Method	108
Table 6.19	Comparative annual development cost	112
Table 6.20	Building development cost of Flat 8	114
Table 6.21	Variables to explain maintenance expenditure cost of Flat 8	115
Table 6.22	Correlation matrix between covariates (15 variables)	116
Table 6.23	Affecting variables to predicting old building expenditure by Stepwise Method	116
Table 7.1	Variables in association of residents' satisfaction on neighborhood safety	125
Table 7.2	Correlation matrix between covariates (3 variables)	126
Table 7.3	Criminal frequency incidents in Klong Chan Flat Project in 2012 - 2016	130
Table 7.4	Variables explained of relationship analysis	132

## **List of Tables**

Table 7.5	Correlation matrix between covariates (5 variables)	132
Table 7.6	The old public housing project in Bangkok with old conditions	133
Table 8.1	Key Five-ins conditions and barriers to improved energy efficiency in public housing	139
Table 8.2	Attitudes toward public housing improvement components	140
Table 8.3	Residents' attitudes on LCS on dwelling unit perspective improvement	141
Table 8.4	Residents' attitudes on LCS on building unit perspective improvement	142
Table 8.5	Residents' attitudes on LCS on community unit perspective improvement	142
Table 8.6	Klong Chan Flat project improvement program to enhance residents' satisfaction	143
Table 8.7	Interview the National Housing Authority officer on public housing improvement	144

## CHAPTER 2

### AN OVERVIEW OF PUBLIC HOUSING DEVELOPMENT IN THAILAND AND IT'S EVALUATION

Literature reviews of this chapter are illustrated, a lack of consideration from other studies is drawn in details including public housing situation in Thailand. Investigation public housing conditions by post occupancy evaluation and public housing on environmental issues is described for analysis contribution.

#### 2.1. Overview of Public Housing in Thailand

##### 2.1.1. Public housing policy

Housing system in Thailand can be divided into three broadly types: “owned housing sector”, “public housing sector”, and “private housing sector” (Kritayanuwat & Phanitchapakdi, 2008). As previous mentioned in Chapter 1 that National Housing Authority plays a main role important public housing development in Thailand, however to understanding background, there are fourth significant public housing situation periods that shows in Figure 2.1 and described below.

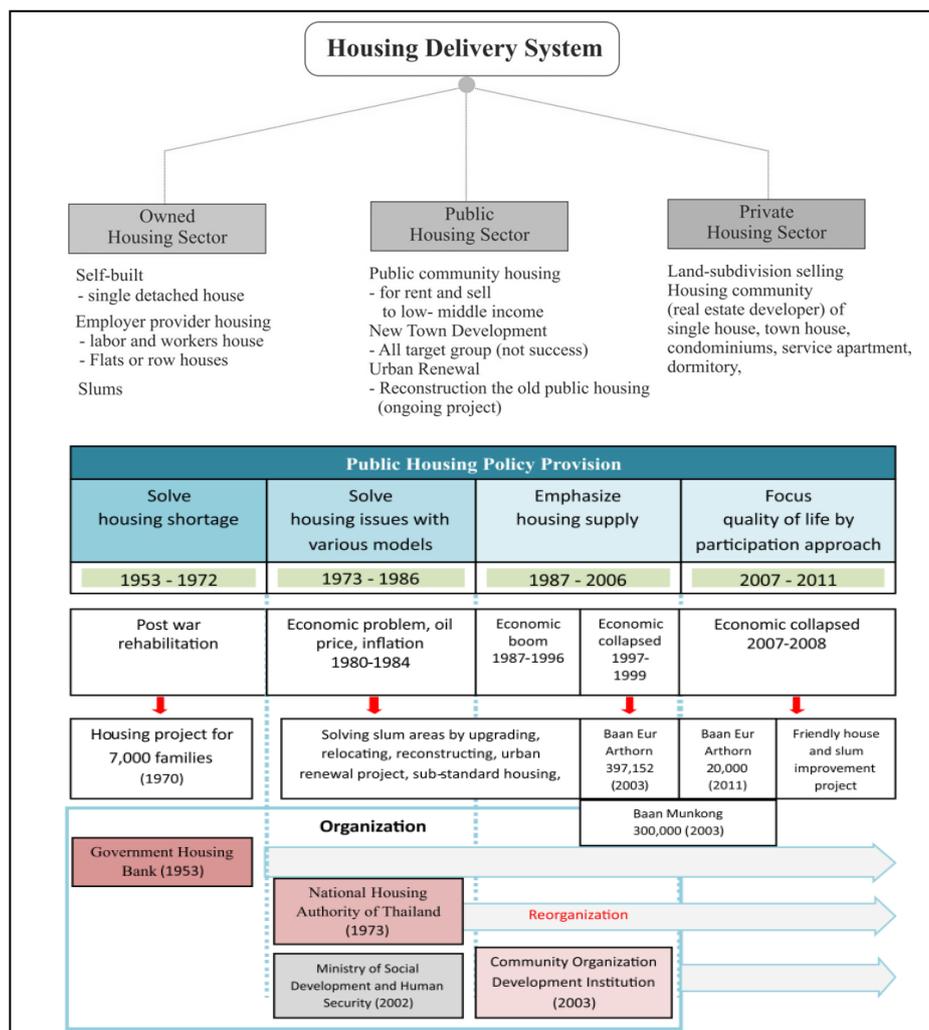


Figure 2.1 Housing system and policy in Thailand

- *First period*, the public housing in Thailand was operated in 1953. Government Housing Bank (GH Bank) is established as a role of housing developer for middle- and low-income customers and promotes housing finance under the Ministry of Finance. GH Bank operated a housing project developer which about 7,000 families became owners. In 1972, the government has established the National Housing Authority (NHA) as a state enterprise under the Ministry of Interior and then change to under the Minister of Social Development and Human Security to conduct public housing development throughout the country.

- *Second period*, the beginning public housing policy has been practical implementing since the 3<sup>rd</sup> National Economic and Social Development Plan (NESDP) in 1973-1976. The welfare public housing and slum clearance provision were addressed. NHA has built the varieties of affordable house including 5 stories flat, twin house, and single detached house.

- *Third period*, 1987 -2006, the government subsidy was focused only low income and middle income group by using cost-recovery. The government also established Urban Community Development Office (UCDO) 1992 to address the problems of urban poor which had grown rapidly during the period of high economic expansion. Meanwhile, NHA was authorized to afford house for low-middle income group by constructing the Baan Ear-Arthon based on national policy as one price for whole country in operating with private cooperation condition. On this period, the housing development policy has been decentralized to local government according Decentralization Act 2546 B.E. In addition, the slum solving and planning in integrating public participation approach has been emerged for solving urban poor issues.

- *Fourth period*, the project of Baan Ear-Arthon has been continuing operation to meet 600,000 units of target for low income people. Also, NHA focused more on social equality with promote social public welfare especially as well as a standard housing for improving people's quality of life.

### **2.1.2. Public Housing Characteristics**

NHA provided a low-rise building for low income families since 1976. Thus, a typical low-rise and high-rise residential pattern of NHA is widely constructed in the country to low and middle income group at low-cost public housing option. A policy dimension concerning National Development Plan, NHA policy and its concepts in affordable housing program were investigated and reviewed by gathering secondary documents in order to understand a comprehensive public housing characteristic. Characteristics of low-rise public housing development (1973 – present), low-rise public housing in Thailand links the substantial contribution of social sustainability to enhance the quality of life in proper living space. As the result, policy on sustainable development has been specified in housing security aspects providing shelter for all. The overview of National Development Plan and National Housing Authority in policy, concept, and features of public housing has been drawn into Figure 2.2.

From Figure 2.2 classifies public housing development policy and its different characteristics in the following:

1. Slum clearance and housing shortage after the World War II in Thailand was prominently fundamental policy. Since there was no specific strategy and lack of knowledge in shelter management, a

public housing model from Singapore was applied (Siriyotipan, 2011). Solving large low-income families in urban area, low-rise building was constructed hastily with concrete structure. Due to the fact that the land price is continually rising, flat is a reasonable type of dwelling to low-income people. For example, Ding Dang Flat, dwelling size unit of studio type is quite large (40 m<sup>2</sup>) and provides a simple function to support for 3 – 4 family members. It has rooms including living area, kitchen, toilet, and balcony. The ground floor of the building is provided for commercial purposes whereas from the second to the fifth floor is living unit area.

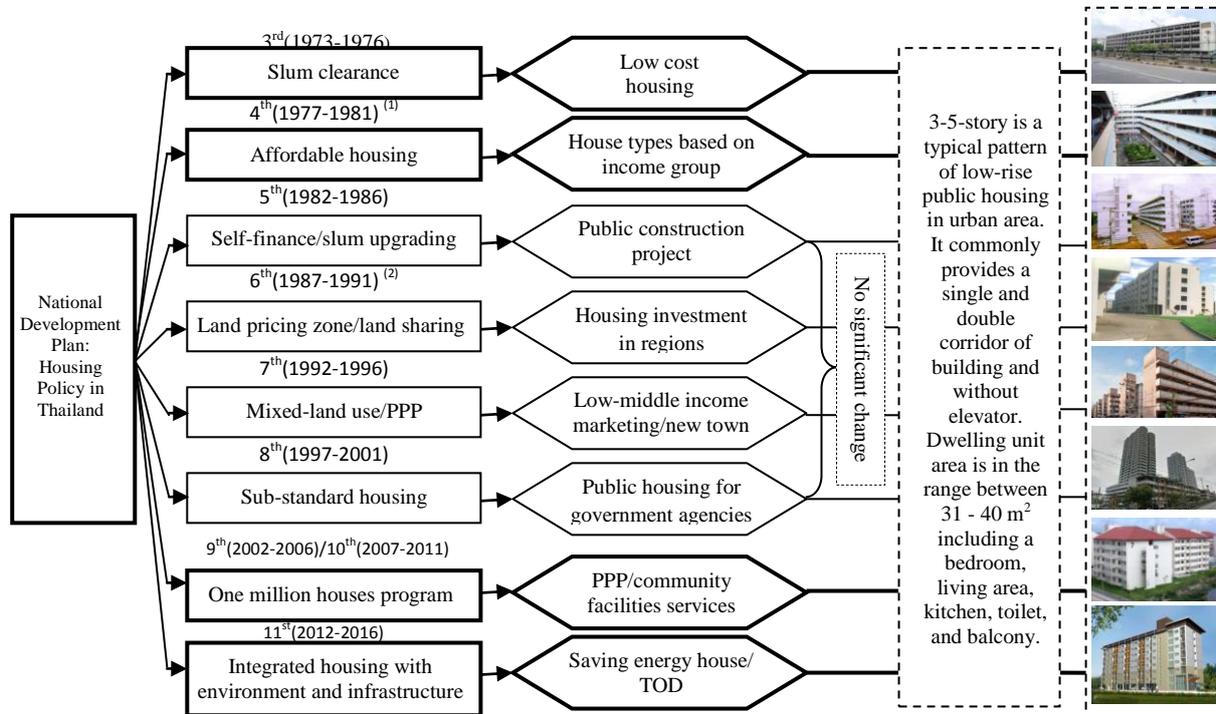
2. The increase of low and middle-income people in urbanized area with no living place was a serious concern in 4<sup>th</sup> national development plan period. Affordable housing program was set up to provide a various type of dwellings. Residents were also able to meet other basic living costs with different prices based on the rental and purchase condition. NHA designed its low-rise public housing standard in this period. Good environment and community elements are expected to be able to improve low and middle income people. Therefore, low-rise public housing projects were built in large scale with complete facility services. Court space inside the building, two types of dwelling unit (one bedroom and two bedroom type) and facilities (car park, public park, market) were designed to comply NHA standard. Klongchan Public Housing Community Project is well represented as a prototype of this period with five-story housing and the average unit area is about 33.82 m<sup>2</sup> and 47.52 m<sup>2</sup> for one and two bedroom type respectively.

3. During the 5<sup>th</sup> – 8<sup>th</sup> National Development Plan, economy recession occurred which affected the government financial allocation to subsidy the public housing program of NHA. Self-finance policy has been emerged for NHA in obtaining the projects profits. Public private partnership (PPP) is also used to be a crucial investment. To follow this policy, the land pricing zone and mixed land use were involved in offering different project features in which low income, middle income and higher income people were integrated to live as social group in the same site. The characteristic of low-rise building remains the same as five-story feature with double corridor and the dwelling unit is approximately 24 m<sup>2</sup> -31 m<sup>2</sup> (substandard of housing unit area has been promoted to use land and cost effectively).

4. In 2002 - 2011, having policy on one million houses program (Baan Eur Arthon Project by 600,000 units in 5 years) has created a huge supply of public housing unit for low-income people since 2003. The substandard of dwelling unit size at 24 m<sup>2</sup> - 33 m<sup>2</sup> has been assigned to low and middle income residents without elevator. There are community center; nursery, market, park, car park, commercial area depending on the scale of the project to contribute the resident's living. Precast construction technique is remarkable for a huge quantity of units for this period in using a minimum time by mass products. Public private partnership (PPP) is mainly a key of implementation for the private company contractor to seek a vacant land while NHA is responsible for financial support and evaluates all of the process. Baan Eur Arthon Rangsit Klong 3 is the first pilot project constructed in 2003.

5. Presently, 11th National Development Plan (2012 – 2016) ensures that housing security is not a physical setting only. Socio-economic and environmental consciousness are also to fulfill in public

housing development. Involving people to participate and deal with public housing management has been promoted to strengthen the community organization. Moreover, to share house market demand for middle-income with comfort and environmentally designed in urban area, NHA's New Life projects are supposed to be provided in the whole country.



Source: the Author, 2014 <sup>(1)</sup> \*Building Control Act was enacted in 1979.  
<sup>(2)</sup> \*The Office of Urban Community Development was established in 1991.

Figure 2.2 Low-rise public housing characteristic of National Housing Authority

It could be mentioned that the low-rise public housing development pattern in Thailand significantly depends on the policies, according to National Development Plan as a guidance of socio and economic. On the other hand, the low-cost public housing pattern in the country generally seems well-developed and successful as a living place for all low-income people in sustainable aspects. Substandard dwelling unit of NHA is established to comply with law and building regulation as proper site planning, infrastructure and services, public circulation, housing pattern, zoning area, and standard of dwelling unit. However, as a part of important space, dwelling unit can be used as a measure of adequacy, composition and needs of the occupants (Yockey,1977).

As we seen above summary housing development periods of Thailand, there are many low-cost public housing for serving low and middle-income people. However, consideration of significant periods there are two typologies of public housing should be studied as differential characteristics and dweller livings. Housing Community Project and Baan Eur-Arthorn Project are shown in Table 2.1.

Table 2.1 List of low-rise public housing affordable program since NHA is established

Project	No. Unit	Building Features		Built	Completed	Age* (Year)
		Flat	Commercial			
National Development Plan 3 <sup>rd</sup> (1973-1976)						
1. Din Dang 12	826	664	162	1975	1977	37
2. Din Dang Mai Phase 1	308	308	-	1975	1977	37
3. Prachaniwet 1	120	120	-	1976	1976	38
National Development Plan 4 <sup>th</sup> (1977-1981)						
1. Huai Khwang Phase 3	1600	1600	-	1975	1978	36
2. Huai Khwang Phase 4	160	160	-	1977	1978	36
3. Bonkai Soi 1	816	816	-	1976	1978	36
4. Klong Teoi Phase 1	1126	1126	-	1975	1978	36
5. Klong Chan Phase 1*	936	936	-	1975	1978	36
6. Klong Chan Phase 2*	936	936	-	1975	1978	36
7. Klong Chan Phase 6*	990	990	-	1976	1978	36
8. Din Dang 3	1020	952	68	1975	1979	35
9. Piboon Wattana	410	404	6	1975	1979	35
10. Bang chan Phase 1	916	916	-	1976	1979	35
11. Hatyai Phase 1 Part 1	224	224	-	1976	1978	36
12. Din Dang Mai Phase 2 , 3	676	676	-	1978	1980	34
13. Klong Teoi Phase 2	972	972	-	1976	1980	34
14. Bang Na	1656	1656	-	1976	1980	34
15. Klong Chan Phase 3*	540	540	-	1975	1979	35
16. Klong Chan Phase 4*	1350	1350	-	1976	1980	34
17. Klong Chan Phase 5*	1062	1062	-	1976	1980	34
18. Hatyai Phase 2 Part 2	144	144	-	1979	1980	34
19. Din Dang 4 Phase 2	674	674	-	1980	1981	33
National Development Plan 5 <sup>th</sup> (1982-1986)						
1. Din Dang 4 Phase 1	972	972	-	1980	1982	32
2. Klong Teoi 3 Area 1 Part 1	558	558	-	1981	1982	32
3. Bonkai Phase 2	380	380	-	1978	1982	32
4. Navanakron	567	567	-	1982	1983	31
5. Thung Song Hong (Additional)	1111	1056	55	1982	1984	30
6. Klong Teoi 3 Area 1 Part 2	882	882	-	1982	1983	31
7. Navanakron (Additional)	189	189	-	1983	1984	30
National Development Plan 7 <sup>th</sup> (1992-1996)						
1. Din Dang 4	352	352	-	1990	1992	22
2. Navanakron 2	324	324	-	1991	1992	22
3. Bang Phi 2 Part 2E2	1728	1728	-	1990	1992	22
4. Thonburi 1/7	111	108	3	1991	1993	21
5. Thung Song Hong 3	258	258	-	1991	1993	21
6. Laksi	2420	2420	-	1990	1993	21
7. Klong Teoi Part 1	480	480	-	1991	1993	21
8. Samutprakran 2 Phase 2	111	108	3	1991	1993	21
9. Pattaya 2 Phase 1	1064	1064	-	1991	1993	21
10. Hatyai Phase 2 (purchase)	420	420	-	1992	1993	21
11. Thonburi 1/6	788	753	35	1992	1993	21
12. Bangchan 2	348	336	12	1992	1994	20
13. Bang Phi 2 Phase 1 (E9/1)	1760	1760	-	1992	1994	20
14. Bang Phi 2 Phase 1 (E9/2)	1680	1680	-	1992	1994	20
15. Phuket 2	928	928	-	1992	1994	20
16. Klong Teoi Part 2	430	430	-	1993	1994	20
17. Romkow Phase 4 contract 1	2431	2431	-	1993	1996	18
18. Ponpha Ruang Pasit contract 1	1005	1005	-	1994	1996	18
19. Thonburi 2 Phase 1	1935	1935	-	1994	1996	18
20. Bang Phi 2 (E9/4)	1536	1536	-	1994	1996	18

Table 2.1 List of low-rise public housing affordable program since NHA is established (continued)

Project	No. Unit	Building Features		Built	Completed	Age* (Year)
		Flat	Commercial			
<b>National Development Plan 7<sup>th</sup> (1992-1996)</b>						
21. Bang Phi 2 (E9/5)	1536	1536	-	1994	1996	18
22. Hatyai Phase 4	180	180	-	1994	1995	19
<b>National Development Plan 8<sup>th</sup> (1997-2001)</b>						
1. Songkla Phase 2	320	320	-	1993	1996	18
2. Bonkai Phase 3 Part 1	1046	1008	38	1994	1997	17
3. Bang Phi Complex (pc2)	218	218	-	1994	1997	17
4. Chiang Mai Phase 3	483	483	-	1994	1996	18
5. Nakron Ratchasima Phase 4	172	172	-	1995	1996	18
6. Pattalung	99	99	-	1996	1997	17
7. Aur Ngeng Phase 2	2262	2262	-	1994	1998	16
8. Prachaniwet Rehabilitation	840	840	-	1995	1998	16
9. Nakron Ratchasima Phase 5	688	688	-	1996	1998	16
10. Chaiyaphum (rental)	190	190	-	1996	1998	16
11. Mahasakharm (rental)	127	127	-	1996	1998	16
12. Romkow Phase 3 Part 2	1628	1628	-	1996	1998	16
13. Thonburi 2 Phase 2	1312	1312	-	1996	1999	15
14. Chiang Rai 2 Phase 2	196	196	-	1996	1999	15
15. Nakronsawan 2 (rental)	130	130	-	1997	1999	15
16. Satul (rental)	116	116	-	1997	1998	16
17. Klong Chan Sriboonruang 2	560	560	-	1996	1999	15
18. Din Dang 5	270	270	-	1996	2000	14
19. Romkow Phase 3 Part 3	2522	2522	-	1996	2001	13
20. Naratiwat (rental)	92	92	-	1999	2001	13
<b>National Development Plan 9<sup>th</sup> (2002-2006)</b>						
1. Karasin (Treasury land)	79	79	-	2000	2002	12
2. Ubonrachtani 2 (rental) Part 1	296	296	-	2000	2002	12
3. Pachemburi 2 (rental)	78	78	-	2000	2002	12
4. Roiet (Treasury land)	134	134	-	2000	2002	12
5. Ubonrachtani 2 (rental) Part 2	243	243	-	2001	2003	11
6. Pachuapkirikhan (rental)	145	145	-	2001	2003	11
7. Udontani (Treasury land) 1	72	72	-	2003	2004	10
8. Srisaket (Treasury land) 1	78	78	-	2003	2005	9
9. Konkhan (Treasury land) 1	48	48	-	2003	2005	9
10. Rayong (Treasury land) 1	70	70	-	2003	2005	9
11. Suratani (Treasury land) 1	232	232	-	2004	2005	9
12. Karasin (Municipal area) 2	78	78	-	2005	2006	8
13. Saraburi (Treasury land) 2	50	50	-	2005	2006	8
14. Trat (Treasury land) 2	79	79	-	2004	2006	8
15. Tak (Treasury land) 2	72	72	-	2005	2006	8
<b>National Development Plan 9<sup>th</sup> (2002-2006) Baan Eur Arthorn Program</b>						
1. Huamak	692	692	-			
2. Bang Phi	1216	1216	-			
3. Bang Chalong Phase 1	836	836	-			
4. Aur Ngeng	650	650	-			
5. Romkow Phase 3 Part 1	125	125	-	2003-	2005-	9-5
6. Romkow Phase 3 Part 2	30	30	-	2007	2009	
7. Romkow Phase 3 Part 3	99	99	-			
8. Prachaniwet	1530	1530	-			
9. Bang Chalong Phase 2	1084	1084	-			
10. Salaya (Nakron Prathom)	1048	1048	-			
11. Bang Phi E9/4,5	456	456	-			
12. Shongprapa	748	748	-			

Table 2.1 List of low-rise public housing affordable program since NHA is established (continued)

Project	No. Unit	Building Features		Built	Completed	Age* (Year)
		Flat	Commercial			
National Development Plan 9 <sup>th</sup> (2002-2006) Baan Eur Arthorn Program						
13. Ladkrabang	1360	1360	-			
14. Minburi	2980	2980	-			
15. Ponpha Ruang Pasit	1005	1005	-			
16. Petchakasem 81	1708	1708	-			
17. Bueng Kum**	5872	5872	-			
18. Phuttamonthon sai 4	524	524	-			
19. Phuttamonthon sai 5	1228	1228	-			
20. Nakron Prathom 2	612	612	-			
21. Salaya 2 (Nakron Prathom)	436	436	-			
22. Phuttamonthon 5	790	790	-			
23. Ratanatibet (Ta-it) Nontaburi	1756	1756	-	2003-	2005-	9-5
24. Ratchapruk (Nontaburi)	1140	1140	-	2007	2009	
25. Bang Buathong	2724	2724	-			
26. Tivanon (Bangkadi)	1620	1620	-			
27. Pahonyothin (Soikhunpha)	1620	1620	-			
28. Rangsit Klong 1	2500	2500	-			
29. Lamlukka Klong 4	436	436	-			
30. Taparak (Samutprakran)	960	960	-			
31. Pranksa (Samutprakran)	2576	2576	-			
32. Setakit 1	832	832	-			
33. Setakit 2	1404	1404	-			
34. Setakit 3	524	524	-			

Source: National Housing Authority and compiled by author, 2014

Remark: 1) \* Standard of public housing for low income people was created and used as prototype

2)\*\* Development standard of public housing for low-income by applying Eco-Village principle

## 2.2. Evaluating Public Housing Features and Environments

This section aims to understand how a public housing development is examined as well as the feedbacks from residents to the project owner or relevant stakeholders in Thailand by NHA. As housing is a driving force of socio-economic dynamics, many researchers have been interested to examine and investigate public housing living condition. Moreover, clearly knowledge of public housing evaluation from relevant research and theory also is described on this part for applying of research.

### 2.2.1. Theory of evaluating existing public housing conditions

Quality of life and residential satisfaction are involved in project evaluation. Using quality of life indicators by NHA is useful to find out a characteristic public housing performance in household socio-economic, physicals and environments, and housing management. However, it's rather presents in comprehensive context in term of public housing community level for individual project, whereas there is limited information and study available to post-occupancy evaluation (POE) experience as lacking of POE to monitoring to improve living condition.

#### Post-Occupancy Evaluation:

A widely used building performance instrument that has been developed in helping to improve the performance of the built environment is post-occupancy evaluation (POE). POE is recognized and valued

among users and owners of buildings. A basic structured approach to evaluate the performance of buildings is recommended once buildings have been occupied. POE was introduced in the 1960s and then integrated into the first handbook of The Royal Institute of British Architects (RIBA) in 1965 (Bechtel, 1997). The domains in which POE was applied at the beginning included housing, college dorms, mental health centres, and residential institutions with respect to environmental design (Harvey & Hennings, 1987; Presier, 1994). In the 1970s POE was extended to use with large-scale buildings, such as public housing projects and schools, with an emphasis on technical and functional factors. This helped to increase the popularity and influence of POE (Francescato et al., 1979) with research into a wide range of building types, such as offices, hotels, retail stores and shopping centres. POE was employed in studies during 1980–1990s particularly by owners who managed a large number of facilities and had an ongoing development and renovation programme (Harvey & Hennings, 1987).

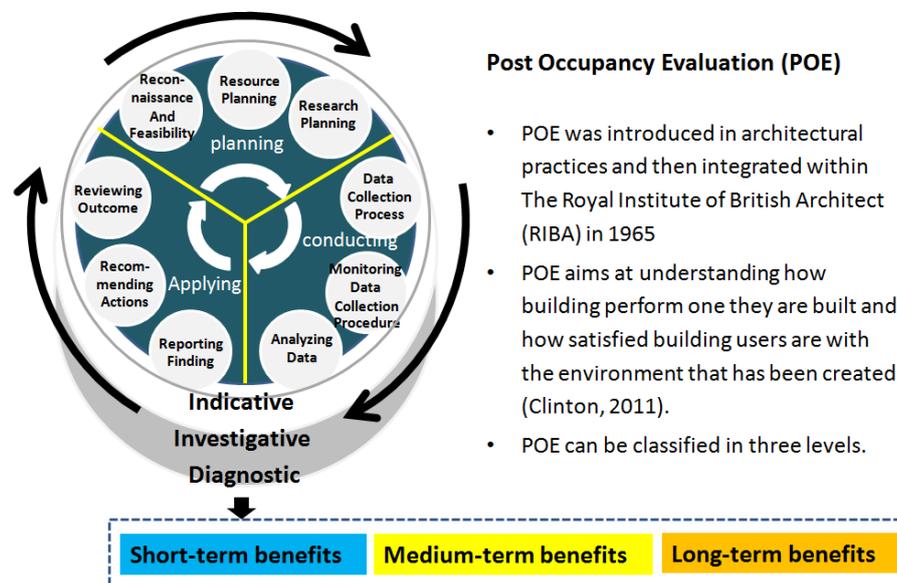


Figure 2.3 Post-occupancy evaluation frameworks

The term POE is very broad as many theorists and practitioners have proposed various terms, namely “environmental design evaluation” (Zimring, 2001), “environmental audit or building-in-use assessment” (Vischer, 1996), “post-occupancy assessment”, “facility assessment”, and “building performance evaluations” (Clinton & Wellington, 2011). However, in general, it can be seen as a broad range of activities aimed at understanding how buildings perform after they are built and how satisfied building users are with the environment that has been created (Clinton & Wellington, 2011). The main features to be evaluated include users’ satisfaction, users’ assessment of building comfort and function, as well as users’ behaviour (Zimring, 2001). Financial performance and the impact of building on the business process should also be considered (Heerwagen, 2001). The POE concept has been further developed in various academic fields as most scholars were interested in POE based environmental psychology (Cooper, 2001). Growing research on environment and behavior of social scientists, designers, and planners was developed to understand the building performance of occupants in representing “non-paying” clients (Zimring & Rosenheck, 2001). POE is broadly expanded in research and its application in environmental behaviour,

particularly within the residential environment, to consider the needs and lifestyles of the occupants for whom the housing development is intended. Table 2 shows prior research studies on POE in public housing with techniques and the evaluated dimensions. From Table 2.2, it can be seen that residents' preferences as well as their satisfaction of physical and environmental factors are integrated in POE studies.

**Housing Satisfaction:**

Housing satisfaction is defined by Galster (Varady & Preiser, 1998) as the “perceived gap between a respondent’s needs and aspiration and the reality of the current residential context”. It is a complex attitude and encompasses satisfaction with the dwelling unit and satisfaction with the neighbourhood (Onibokun, 1974). According to Ogu (2002) the concept of residential satisfaction is often employed to evaluate residents’ perceptions of, and their feelings for, their housing units and environment. For Ramdane and Abdullah (2000), measuring housing satisfaction is based on five major objectives: 1) to predict an individual’s perception of the overall quality of life, 2) to serve as an indicator of individual mobility, which later changes the demand on housing and influences changes to the surrounding area, 3) to provide specific measurement of private sector development success, 4) to function as an evaluation tool to measure residents’ acceptance of prevailing shortcomings for existing surrounding area development, and 5) to become a variable in determining the relationship between the residents’ background and their attitude to mobility.

To measure housing satisfaction requires attention to many issues. Housing characteristics are a critical factor that past researchers have highlighted. The size of the dwelling elements and the size of the house are claimed to be related to occupants’ satisfaction (Salleh, 2010). According to Elsinga and Hoekstra (2005) the higher the quality of the dwelling is the higher the residents’ satisfaction. The internal aspects of a dwelling, the external appearance of a building and its surrounding area are also important aspects (Ramdane and Abdullah (2000). According to Oh (2000) there are three main qualities that influence housing quality, including the dwelling, environment, and urban site. Various aspects have been studied to consider the objective or subjective dimensions. For example, the study of Mastura, Noor, Osman, & Ramayah (2005) has three structures which are divided into housing characteristics, location, and demographic of the housing. Salleh (2010) considers four dimensions, namely socio-economic, building features, building quality, and neighbourhood aspects. Waziri (2014) has focused on household demography, socio-economic factors and housing satisfaction in Nigeria. Obtaining feedback from public housing dwellers is necessary to integrate both objective and subjective attributes of the assessment (Mohamad, Mansor, & Yong, 2010).

Table 2.2 POE approaches in public housing study

Reference	Scopes	Techniques	Evaluated dimension
Ettouney and Kader (2003)	User’s participation in low cost housing projects, 10 years five story apartment walk-ups, Egypt	Interviews and questionnaires by	Gradual completion, affordability, organization by descriptive statistic
Dryden (2004)	POE of low-income housing, do users’ values and preferences overlap with sustainable	Walkthrough and questionnaires	Private and neighborhood outdoor space, rating and prioritization of outdoor

	development principle?, two development projects in Oakland, CA		space, and a tradeoff question section, comparing to suitable site design guidelines
Kowaltowski et.al (2004)	From post occupancy to design evaluation: site planning guidelines for low income housing,	Questionnaires	User satisfaction, use of space thermal control in five housing area
Kowaltowski et.al (2006)	Quality of life and sustainability issues as seen by population of low-income housing in the region of Campinas, Brazil, 10 years apartment and house projects	questionnaires observation, and design analysis	Neighborhood and site-planning as physical and environment features were investigated, not focused in detail of residential units
Taylor et.al (2010)	Developing post-occupancy evaluation techniques for assessing the environmental performance of apartment building in Wales	Questionnaires	Occupant behavior, environmental performance, thermal simulation of building performance
Clinton and Wellington (2011)	Housing experience of South African low-income beneficiaries, four housing subsidy locations (single house), Johannesburg	Interviews and questionnaires	Beneficiaries' profile, unit and overall housing satisfaction by descriptive statistic, comparative expectation after-before allocation
Adesoji (2012)	Post-occupancy evaluation of residential satisfaction in Lagos, Nigeria: Feedback for residential improvement	Questionnaires, observation	Demographic characteristics of respondents, residential satisfaction, and dwellings' physical characteristics. Chi-square test

### 2.2.2. Public housing satisfaction evaluation of National Housing Authority Project

Since affordable low-cost public housing has been operated in Thailand and it expected to enhancing and raising a prosperity security of people's life that limited to afford house for basically physical needs. There are many studied researches on public housing development to evaluate and reported to identify a problem of resident and recommend improving those projects. The related study to public housing evaluation regarding satisfaction was listed below:

Boonsahorn (2003) has evaluated the community services and quality of life expectation in three case areas in Bangchalong, Prachanives and Huamark Aur – Arthorn Housing Project (NHA) by using 500 sample sizes. Key finding was a family size average about 2.8 persons and all respondents were satisfied in community service at 2.50 score of 4.00 and it correlated with types of dwelling and household number. Quality of life expectation was found highly level in facilities service at 29.5 percents while neighbor relationship, economic, location, and social concerns were approximately 23, 20, 15, and 12 respectively.

Supawittayanan (2003) examined four project areas of Baan Eau Arthorn Project (phase 1) in Bangkok and found that a haft of respondents were not interested. They were concerned on quality of dwelling unit as well as standard, too small room to fit their family members and difficult to extent the areas, and lifestyles changes inform of community based to individual living.

Verapreyagura (2006) distributed questionnaires to 2,083 respondents of five regions of Thailand who lived in housing project of National Housing Authority. Major complaints are two primarily concerned with physical and environment standards and management standards. For physical and environment housing standard problems should be improved there were roof tile/ceiling, size of stairs, roof connection/size of beam, pest control pipe inside house, brick layer, roof structure installation, parking lot decoration, flooring condition, household drainage pipe system, landscape design, lavatory quality and standard, housing surrounding and garbage, and public park design. And housing management problems were life and property security, management regulation; physical building improvement/shop/parking lot/, and dwellers type or group should be classified for rearranging in a different living of social context.

Wongsawat (2007) studied the levels of quality of life by comparative and test the relationship between quality of life and society's character, family relations and social support of dwellers in low-cost housing project (Kantana). The sample size was 310 dwellers. The dwellers had average quality of life at moderate level (3.16). The environmental problems of the dwellers in the project consisted of noisy sound, cleanliness, safety in life and property, offensive smell, deregulation and building structure. The social relation problems consisted of management problem, changing of juristic persons and local community intervention. In term of general information; gender, age, marital status, number of dwellers, member status was found indifferent result of comparative study. However, the education, working status, income, duration of residing and activity participation was found significant differences in quality of life of dwellers at .05. For society character, a relation analysis found that family relations and social support had related to quality of life with statistical significance at 0.1level.

Pakam (2008) has evaluated the occupation's satisfaction and expectation in Baan Eau Arthon Project in Chiang Mai Province. There were three projects and completely occupied by low-middle come people were employed to analyze in different location with 8 indicators including building form and standard, public utilities, environments community, location, participation, public housing service office, financial institute service, and others. Average occupants' satisfaction of two project sites was low level especially on site of project, building form and standard, and participation in the public housing community. Meanwhile, the occupants were highly expected regarding Baan Eau Arthon Project. Quality of life and residential satisfaction are involved in project evaluation. Using quality of life indicators by NHA is useful to find out a characteristic public housing performance in household socio- economic, physicals and environments, and housing management. However, it's rather presents in comprehensive context in term of public housing community level for individual project, whereas there is limited information.

Chanma (2010) studied about customer's satisfaction in Paton Ban Eur Arthon Project, Muang Chaingmai Province through 8 indicators including building form and standard, public utilities, environments community, location, participation, public housing service office, financial institute service, and others. This study investigated a single house type and found all respondents' satisfaction of the project was low on lacking space of parking and post occupied with no quality of building material and construction. Therefore, inspection of dwelling unit indoor and outdoor condition must be handled.

Vajirakachorn & Buranasin (2010) assessed the community's achievement level of implementing activities to promote the quality of life of residence in the projects of National Housing Authority (NHA) operated in 2010 in both the output and outcome. The projects assessed comprised 23 Uer - Arthon projects and 1 community housing project. Key indicators for community's achievement assessment include participation and satisfaction toward the benefits of community housing project. Assessment of outcome involved the residential quality of life in NHA's communities for 4 elements: the strength of community, warm family, the strength of community economy, and good environment. In overall the participation in activities conforming to the quality of life standard of NHA was at level 5 (high), the satisfaction towards the activities was at level 3 (moderate) with mean 3.12, and the quality of life in line with NHA's quality of life standards was at level 3 (moderate) with mean 3.24. The community's achievement in operating the residence standards in NHA's communities was at level 4 (relatively high) with mean 3.74. The important ranking among the 4 elements toward the quality of life standard found that all elements had some significantly effect on the quality of life standard with the explaining power of 42.8 % (R square = 0.428). The orders of significance are 1) good environment, 2) the strength of community, 3) the strength of community economy, and 4) warm family, respectively.

Maneepong, Webster, Chiasakul, and Wittayarungruang Sri (2010) have reviewed the study researches of low-income housing project that found there are similar problems. The quality of ponds, parks, parking areas, playgrounds, drainage, and increase income should be improved while they lived far from the city center. In term of walk-up flat public housing project, the financial problem as organized by itself community could not improve and management their facilities. In addition, the majority of residents didn't fully understand their roles and responsibilities living in a community with common facilities and services. For the old public housing project by using the "before and after" living conditions in Romklao Project (constructed in 1981) and Orngern Project (constructed in 1996) indicated that most residents and workers in both case study projects are moderately satisfied with the projects ("medium satisfaction"). In terms of "before-after" impacts, findings from both sites are relatively similar in terms of easy access to markets and stores; with on-site infrastructure, facilities, and green space. They also express high satisfaction in regard to relationships with neighbors and other residents. Also, interviewees at both sites did not indicate much difference in the comfort of their houses relative to their previous housing condition. At Orngern, satisfaction with "comfort ability of house" increased only slightly from 3.51 to 3.81, and increased even less in the case of Ronklao from 3.51 to 3.66. This contrasts with the much more significant improvements noted by residents in terms of environs, on-site facilities, land security, and safety. This study indicates higher satisfaction with community services, which appeared to be valued, than housing units. Therefore, the forgoing question the NHA should focus on community building and allow the private sector to deliver low cost housing in quality services.

Keyen (2011) examined the factors affecting the quality of life in the community of National Housing Authority. The samples were the 310 units (households) in Tong Song Hong Housing Community Project, flat for rent. The result revealed that the people in Tong Song Hong Housing Community Project had the quality of life at the medium level (average 3.11). Moreover, the 3 aspects qualities of life, namely

the physical quality of life, the mental health quality of life and social quality of life were also at the medium level (average 3.65, 3.47 and 3.14 respectively). From 19 independent variables based on the general characteristic factor, relationship in family factor, and social support factor there were 9 independent variables which related to the quality of life as following: education, social support from family, household income, family activity, love and respect of family, consultation and decision making, rational solution and social support from neighbors and cousins had the positive correlation.

Srinarong (2011) studied of resident's satisfaction on physical environment and infrastructure provisions for the low-income group in the NHA's public housing projects in Pitsanulok Province. This research focused three public housing projects in 2008. Five scales of criteria were used by defining the satisfaction. Regarding the general environment in community consists of layout of building and its environment was moderate level (3.06). In term of infrastructure and public utilities, the satisfaction was rather high (4.024), such as the location can access to transport network. The recommendations for community planning were to select the location for linking to the city center and to assimilate the use of space together with to create the exuberance in the area. Residents also should play significant roles on the realization of community belonging by promoting bicycle or walking as a main transport to create positive attitudes towards their community and safety in their living.

Table 2.3 Summarized previous study on public housing evaluation of National Housing Authority

Researcher	Project Type	Evaluated dimensions	Case study
Boonsahorn (2003)	New	community services and quality of life expectation	500 sample sizes of three projects
Supawittayanon (2003)	New	quality expectation of Baan Eau Arthorn Project	4 Baan Eur-Arthorn Projects
Verapreyagura (2006)	Old	Physical, environment and management standards	2,083 respondents of five regions in NHA project
Wongsawat (2007)	New	comparative and test the relationship between quality of life and society's character, family relations and social support	sample size was 310 dwellers
Pakam (2008)	New	building form and standard, public utilities, environments community, location, participation, public housing service office, financial institute service	three projects and completely occupied by low-middle come people
Maneepong (2010)	New	before and after living conditions in various aspects	two projects
Chanma (2010)	New	customer's satisfaction on building form and standard, public utilities, environments community, location, participation, public housing service office, financial institute service	one projects
Vajirakachorn & Buranasin (2010)	Old and New	the community's achievement level by focusing participation and satisfaction toward the benefits of community housing project	23 Baan Eur-Arthorn Projects and 1 community housing project
Keyen (2011)	Old	physical quality of life, the mental health quality of life and social quality of life	Samples were the 310 units
Srinarong (2011)	New	physical environment and infrastructure of building and community	Three public housing projects

Noted: \*Old = Public housing community project form which aged building is more than 30 years.

\*\*New = Baan Eur-Arthorn Project form which aged building is less than 10 years.

### 2.3. Public Housing Development Vision

A trend of green house gas (GHG) is continually rising due to direct and indirect products of human activities such as fossil energy consumption, industrial operations, massive land use changes, and deforestation. In 2100, the consequence of emitting CO<sub>2</sub> and other pollutants the world temperature will raise 1.1 – 6.4°C approximately (Intergovernmental Panel on Climate Change [IPCC], 2013). As showing the temperature change map by using RCP4.5 scenario (Figure 1) in 2016–2035, 2046–2065 and 2081–2100 with respect to 1986–2005 founds the Southeast Asia Countries have been encountering a raised temperature with extreme weather events (IPCC, 2013). Global emissions increased by 1.4% over 2011, reaching a total of 34.5 billion tones in 2012 (Jos, 2013). This huge emission volume is majority generated by energy consumption, transport and industry, while residential and commercial buildings, forestry (including deforestation) and the agricultural sector have been growing at a lower rate (Pawinee & Phasakorn, 2013).

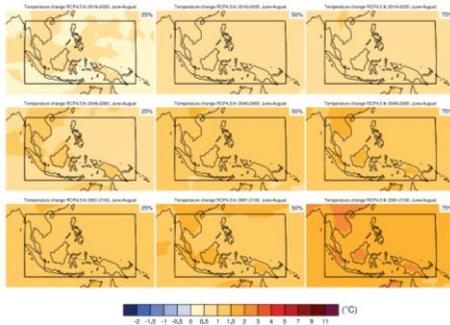


Figure 2.4 Temperature changes map in South-East Asia of RCP4.5 scenario (IPCC, 2013)

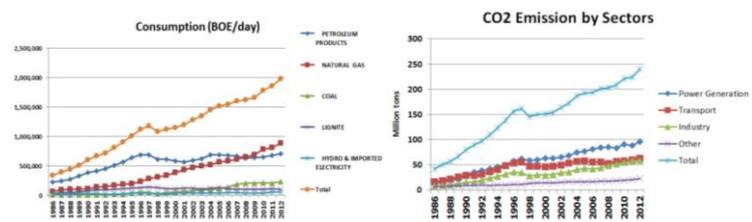


Figure 2.5 Fossil consumption and CO<sub>2</sub> emission by sector (Ministry of Energy, 2013)

This impact of climate changes has seriously affected to ecosystems-humans inclusive. Particularly the developing countries such as Thailand, the climate change issues has been taking place from gradual changes in temperature and sea level, from increased climate variability and extremes including more intense floods and droughts. Thailand is ranked 22<sup>nd</sup> of the largest emitter with total emission is 29,888 million tons (Trin, 2013). According to ASEAN Community Progress Monitoring System report, Thailand produces per capita 4.1 metric tons of CO<sub>2</sub> emission that is ranked 4<sup>th</sup> whereas Brunei, Malaysia, and Singapore produce the highest CO<sub>2</sub> emission in the ASEAN region of 15.5, 7.1 and 6.39 metric tons respectively. Four sectors of CO<sub>2</sub> emission in the Thailand include power generation, transport, industry, and other by causing a boosting economic and rapid urbanization with highly fossil consumption rate (Figure 2.5). Addressing this challenge of climate change, low-carbon society has been addressed in the 11<sup>st</sup> National Economic and Social Development Plan (2012-2016) by having national policy and technology approach application to minimize CO<sub>2</sub> Thailand. In order to mitigate the emission to a lower level, several comprehensive measures such as diffusion of low-carbon technologies in the residential sector, energy efficient buildings, energy efficient industry and fuel switching, and fuel substitution in the transport sector and electricity generation sector are needed (SIIT, 2010). However, the residential sector in term of public housing, especially low-income people, is slightly less concerned when it comes to strategies that seek to lessen the impact of climate change on households. These public housing were build

by poorly adapted to climate change, develops the housing is rather over represented in low cost construction throughout the country under low-income circumstances.

### **2.3.1. Low-Carbon Society in Thailand and its Contribution in Public Housing**

Thailand has signed to the UN Framework Convention on Climate Change (UNFCCC) in 1994 and is in the group which polluted a low rate of CO<sub>2</sub>. However, the impacts of overall climate change on Thailand will not relatively as its low emission rates. The impacts of climate change on Thailand can be seriously issues throughout whole country such as sea level, temperature rise, drought and flooding. After Kyoto Protocol in 2002, Thailand has addressed a climate change by implementing Clean Development Mechanisms (CDM) to encourage clean and environmental friendly technologies for GHG reduction. The Office of Natural Resources & Environmental Policy and Planning (ONEP), under the Ministry of Natural Resources & Environment (MONRE), is the responsible and main organization to outline mechanisms and measures that would need to be undertaken by various agencies (SIIT, 2010). In 2006, the Thai cabinet approved the setting up of National Board on Climate Change Policy, Climate Change Coordinating Office and Thailand Greenhouse gas management Organization (TGO) to overlook Clean Development Mechanism (CDM) in Thailand. TGO is the autonomous governmental organization to undertake CDM and promote low carbon activities, investment and marketing on GHG emission reductions, establishment of GHG information centers, review of CDM projects for approval, and provides capacity development and outreach for CDM stakeholders. Presently, National Strategic Plan on Climate Change (NPCC) 2013 – 2017 and Thailand Climate Change Master Plan (TCCM) 2012 – 2050 have been drawn up to be used by relevant agencies as guidelines to develop their own plan to address climate change. Especially, TCCM of 2012 – 2050 is a long term framework and guideline on climate change preparedness, adaptation in efficient competitiveness and development sufficient economy and low-carbon society. Three key management strategies are:

Strategy 1: Adaptation for coping with the negative effects of climate change

Strategy 2: Mitigation of greenhouse gas emissions and increase of greenhouse gas sinks

Strategy 3: Strengthening the capacity of human resources and institutions and to manage the risks from the effects of climate change and cross cutting issues.

In Strategy 2, LSC is added of TCCM to promote and support development cities and communities toward efficient and sustainably low carbon society. Recently to achieve LCS on national strategy, Thailand has joint collaboration with among Asian countries and Japan under the Low-Carbon Society Scenarios towards 2050 project and funded by Environment Research and Development Fund of the Ministry of the Environment, Japan (MOEJ). Up to this point, Thailand's LCS Vision 2030 envisages the possibility of reducing about 42.5% of the 563,730 kt-CO<sub>2</sub> as total CO<sub>2</sub> emission of business-as-usual (BAU) case to 324,170 kt-CO<sub>2</sub> of countermeasure (CM) scenario (SIIT, 2010). In order to mitigate GHG there are mainly comprehensive measures in the residential, commercial, industrial, transport, and power sectors as shown in Figure 2.6.

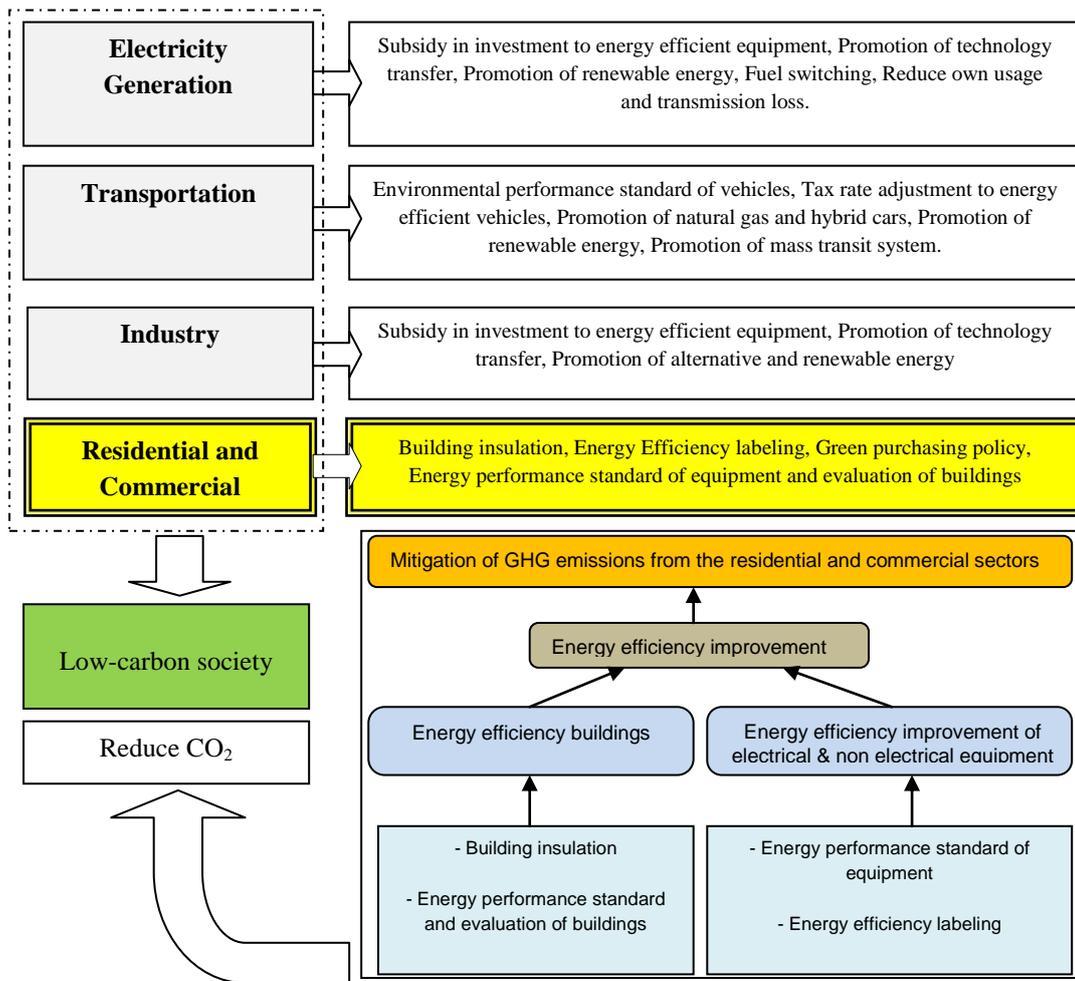


Figure 2.6 GHG comprehensive measures guideline (Adapted from SIIT, 2010)

As shown in Figure 2.6, to promote GHG mitigation measures in the residential and commercial sectors, it would require policies related to building design, building codes, energy efficient equipment and use of renewable energy. Key policies are energy performance standard of buildings, building insulation, building codes, energy efficiency labeling of electric devices, and green purchasing policy of the government. These parameters of energy performance in residential sector would be influence revision in improving housing development both local and national perspectives especially for National Housing Authority of Thailand that need to cope GHG emissions with play an important role in social housing. The National Housing Authority (NHA) is a state enterprise attached to the Ministry of Social Development and Human Security. It currently operates under the National Housing Authority Act (1994), with the objectives to provide housing for low and middle income earners, to provide financial assistance to those who need to have their own housing, to deal with the business of building construction and land acquisition, and to upgrade, demolish or relocate slums in order to assist people in achieving better living, social and economic conditions. The NHA is not only responsible for development of housing for low-income people, but also for improvement of the quality of life of community members to receive physical, social and economic development that would help engender good-living communities. Public housing for low income people has been provided in Thailand more than 40 years especially in urbanized area such

Bangkok that more than thirty public housing projects are built. To achieve the organization’s vision, and to enhance the organization’s operational efficiency, the following missions as shown in Figure 2.7 were established for implementation:

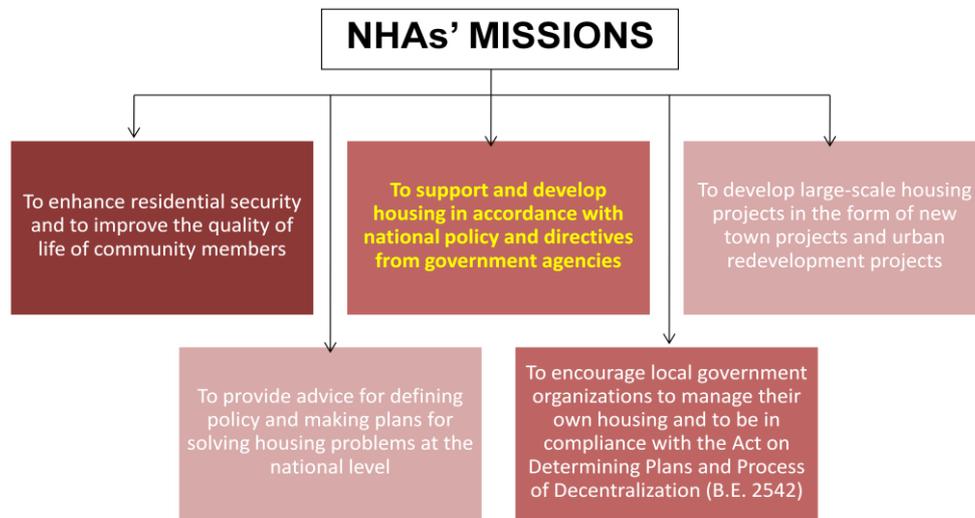


Figure 2.7 Five main missions of NHA organization

In 2013, the New Paradigm of Housing and Urban Development in Thailand by in conjunction between NHA and the Pacific Rim Council on Urban Development (PRCUD) under the expert’s knowledge and experience found there are five main topics should be promoted including 1) Urban development and housing development along the transportation network, 2) Public-private partnership or PPP, 3) Resilience form flooding climate change, 4) Housing finance and affordability and 5) Urban development planning and development of infrastructure of the city. Especially, a resilient form flooding climate change theme indicates that NHA is concerned on climate change in preparing for flooding, water management, open space and green city, infrastructure and building design as well as environmentally friendly approach. Also, participating with community, policymakers and development financial institutions are associated in development. A pilot project to demonstrate and promote the campaign for housing and urban development in the future has been establishing.

From above literature review on concept and principle it can be summarized that a low-carbon society is a tool for taking action of sustainable development underlying three pillar aspects; economy, social and environment as not only focusing one side of development. Furthermore, low-carbon society is an advanced stage of low-carbon economy that contributes to reducing GHG emissions. To approaching low-carbon society, using high energy efficiency, low-carbon energy, low-carbon manufacturing technologies, and adopt low-carbon living and consumption styles have been integrated substitution to cope with climate change in different of country contexts. Government policy as from national organization has present LCS vision in the country however it seems the least influential to archive in all sectors practice on global warming with sustainable development basis. Based on the 11<sup>st</sup> National Development Plan which has been using since 2012 to 2016 focusing on economic development in environmental friendly provision,

therefore, the state agencies such NHA which has the mission in housing and urban development, is on going to study and develop their policy and knowledge. As seen in the above missions of NHA, those are not confronted to a climate change policy in directly. However, the extensive increase in climate change study as well as low cost housing and energy efficiency transformation in research and community development is ongoing to be a pathway of NHA implementation projects.

## 2.4. Conclusion

From above literature review of public housing development in Thailand and theoretical post-occupancy evaluation (POE) and satisfaction based on the previous studied, researcher has extent POE for this study research as an important identification method for providing key influence factors of public housing improvement approaches. Moreover, researchers have previously investigated the Baan Eur Arthorn Project regarding resident’s quality of life, such as communities’ achievement on a physical and environmental level and social aspects. While the old walk-up flat community is in a poor condition, few studies have been conducted only on evaluating the quality of life and management perspectives. It could be mentioned that the housing standard issue in Thailand is still seriously condition to deal with quality of living.

As there was limited information available on specific physical conditions and environments, the aim was to investigate and identify the old and new patterns on a scale of dwelling, building and community, based on occupants’ satisfaction by using POE. The objective was to understand the relationship between personal background factors of residents in the three aspects (dwelling, building and community), and their influence on or association with overall satisfaction. The intention of the POE research was that the results would compliment public housing research in Thailand and hence contribute to the decision-making and policy formulation of future housing policy and improvement initiatives. Factors that are relevant to residential satisfaction for this study comprise household characteristics, dwelling and physical conditions, and environments. This is illustrated as a conceptual model in Figure 2.8. Three scales included dwelling units, building units, and community contexts, and occupants’ satisfaction with two public housing development projects of old and new scheme.

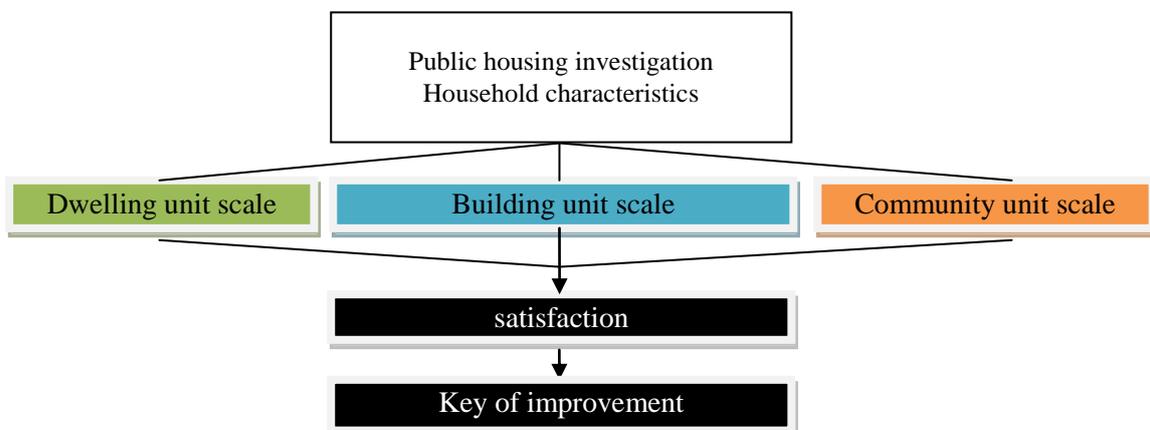


Figure 2.8 Public housing satisfaction assessment model

## CHAPTER 3

### RESEARCH METHODOLOGY

This chapter discusses the research methodology for answering the research questions and objectives, followed by an explanation of the research design, data collection procedure, sampling method, and data analysis. Research framework composes of three main parts including 1) investigating living satisfaction of public housing project through post-occupancy evaluation, 2) assessing the three aspects including dwelling, building, and community unit to contribute occupants satisfaction, and 3) integrated results of analysis of old public housing improvement program.

#### 3.1. Case Study

Klong Chan Flat Project is selected because of the first prototype of low-cost public housing development and the one largest community in Thailand which was built in 1976; comprising 30 buildings with total 5,814 units. It located in Bangkapi District, Bangkok. The project covers a land about 120.98 acres. There are two room types with the total unit area is 34.32 m<sup>2</sup> and 45.76 m<sup>2</sup> respectively. This project is applied in-depth analysis in term of three aspects; dwelling, building, and community. However, to understand how old public housing and new public housing project are different, Buengkum Baan Eur Arthon Project is also employed that constructed in 2005 and completed in 2007. This is the largest public housing development scheme under the Baan Eur Arthon Program (2003). The project covers a land about 45.07 acres. This project is built in form of walk-up flat (5 story), with two room types of 24 m<sup>2</sup> and 33 m<sup>2</sup> respectively. There are 5,872 dwelling units.

Table 3.1 Case study profiles

<b>Klong Chan Flat Project</b>		<b>Buengkum Baan Eur Arthon Project</b>	
			
Type	Walk-up flat (5 story)	Type	Walk-up flat ( 5 story)
Project scale	30 buildings	Project scale	134 buildings
Area	306 rai ≈ 120.98 acres	Area	114 rai ≈ 45.07 acres
Ownership	Building and some facilities are belong to dwellers	Ownership	Building and facilities are belong to dwellers
	Land of project (except site of building) is belong to government		Land of project is belong to dwellers
Total unit	5,814 units	Total unit	5,872 units
Built	1975 - 1976	Built	2005
Completed	1978 - 1980	Completed	2007
Age	35 – 37 years	Age	8 years

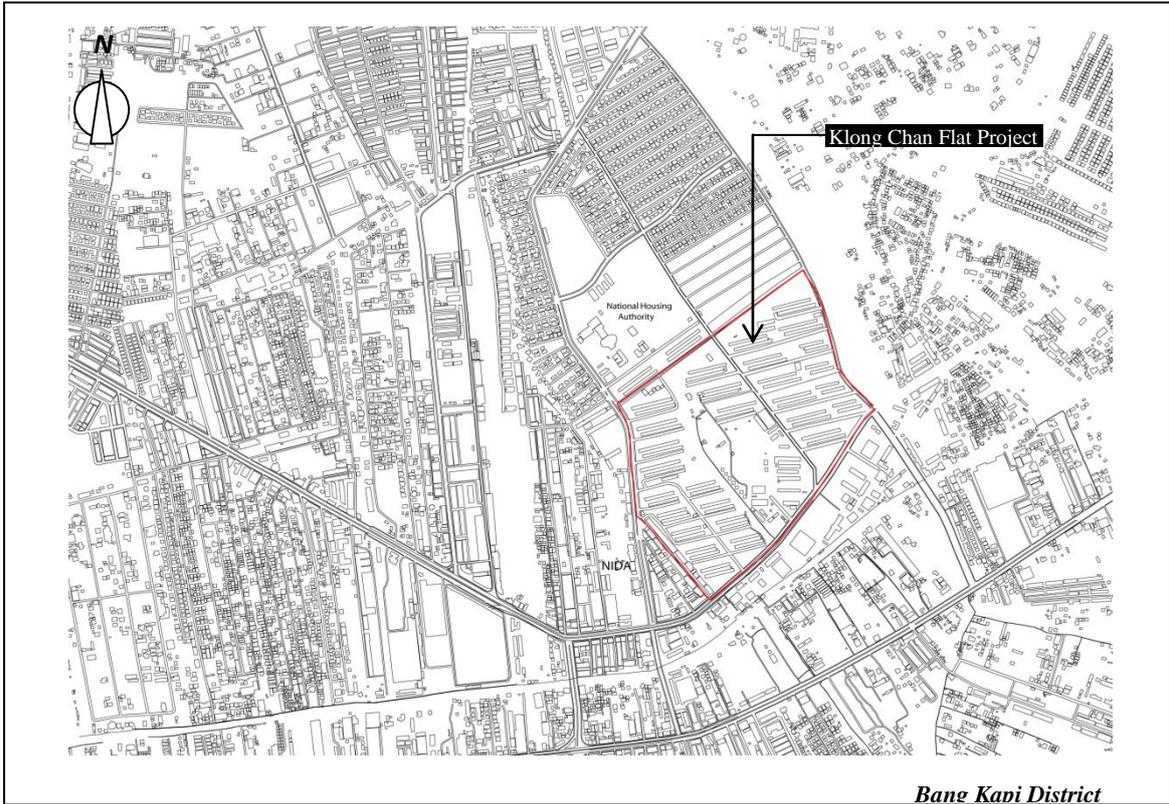


Figure 3.1 Location and boundary of Klong Chan Flat Project

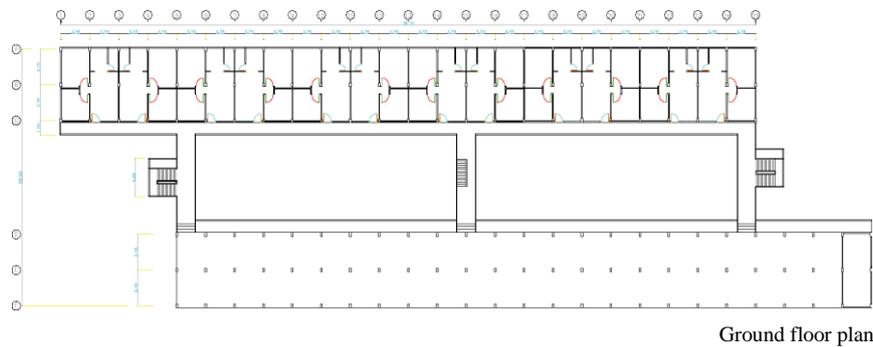
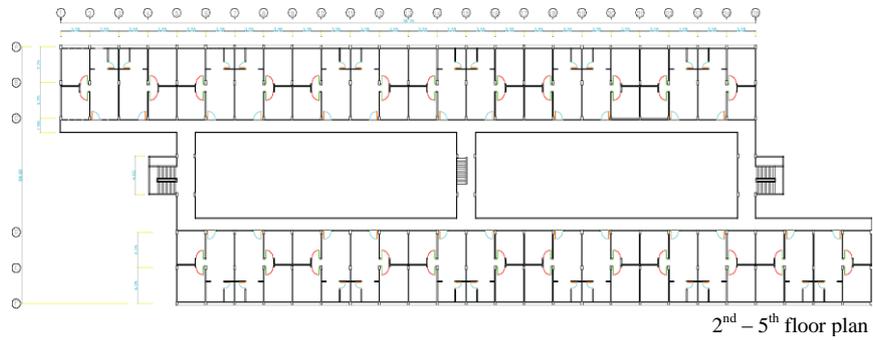


Figure 3.2 Floor plan and elevation of Klong Chan Flat Project

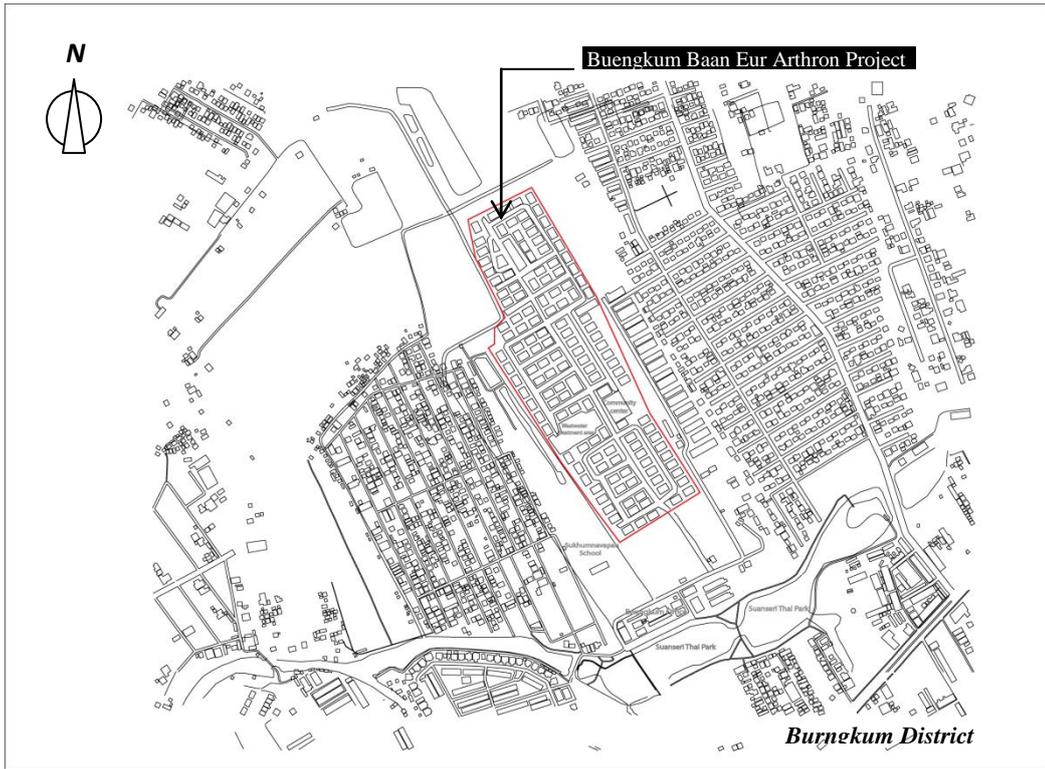


Figure 3.3 Location and boundary of Buengkum Baan Eur Arthron Project

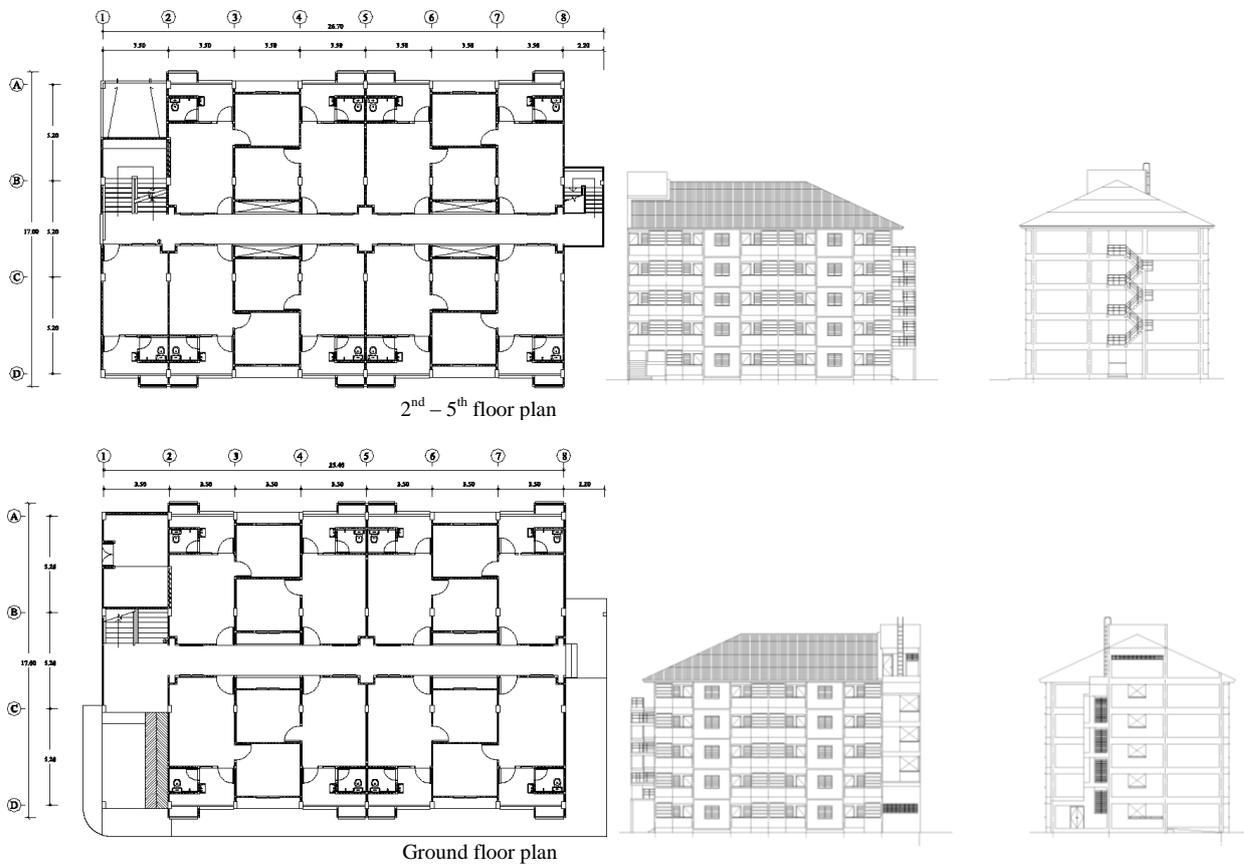


Figure 3.4 Floor plan and elevation of Buengkum Baan Eur Arthron Project

### 3.2 Data Collection

The data collection of this research study includes both primary data and secondary data. Qualitative and quantitative methods were consisted of the primary data; questionnaires, interviews, observation, case-studies of experiments. These data were more described in details below this section. For secondary data, the related information to public housing development in Thailand, building management report of Klong Chan Flat, and development plan of National Housing Authority (NHA) were collected.

#### *Questionnaire design and sampling size:*

##### 1) Questionnaire

The questionnaire consists of four parts including general background information of respondents, three aspects of satisfaction, living behavior, and attitudes toward of public housing development (see Appendix A).

#### *Background information of respondents and three aspects of satisfaction assessment*

A questionnaire survey is prepared to identify dwellers experienced. The questionnaire framework has been set to indicate the variables consisting two parts by 30 variables as shown in Table 3.2.

1) Household characteristics or Socio-economic characteristic of the dwellers: this component refers to the residents' general background including gender, age, education, career, average income, number of family member and age, period of living, reason of selecting habitat, refurbishment of exist dwelling condition which likely to impact public housing satisfaction.

2) Dwelling condition and environment: it represents the dwellers' experience of physical environment as an individual's perception of how dwelling unit, building, and community treats him or her., one another such living environment (Adriaanse, 2007). This section comprises three scales; dwelling unit, building, and community surrounding.

Table 3.2 Variables of questionnaire on public housing satisfaction

<b>1) Socio-economic characteristic of the dwellers</b>		
gender, age, education, career, average income, number of family member and age, period of living, reason of selecting habitat, refurbishment of exist dwelling condition		
<b>2) Dwelling condition and environment</b>		
Three scale	Items	No. variables
Dwelling unit scale	size	5
	material	6
	environment	4
Building scale	design, lighting, facility, materials, paints, garbage storage, cleanness, management rules, cost of maintenance	9
Community scale	location, security, public park, sport/playground facilities, car park, accessibility	6
<i>Total variables</i>		30

Source: The Author, 2014

### Living behaviors

The basic information to understanding how occupants make their comfort was asked respondents of both projects including using natural light, natural ventilation, electric appliances as air conditioner and fan. This part includes check list and rating score by Likert-scale application. The reliability of questionnaire is except for this part because the number of question is lower than fifteen which might get an error of Cronbach's alpha analysis.

### Attitudes toward of public housing development

Getting an opinion of low-income people regards three aspects that how respondents think on attributes on participation, willingness to change or adapted environmental friendly for public housing improvement, and public housing policy. The reliability of questionnaire is except for this part as the same reason as already mentioned above.

Five-point Likert Scale (1-5) is applied for above questionnaire the form of answer. The respondents will be asked by rating the scale: (1) very dissatisfied; (2) dissatisfied; (3) fairly satisfied; (4) satisfied; (5) very satisfied. For interpreting questionnaire information of these satisfaction items based on Likert Scale will be rating by equidistant points between each of the scale elements on absolute criteria [21]. The averages score of five scales (1-5) is 4.51- 5.00 = very satisfied, 3.51 – 4.50 = satisfied, 2.51 – 3.50 = fair satisfied, 1.51 – 2.50 = dissatisfied, and 1.00 - 1.50 = very dissatisfied.

## **2) Sampling size**

Sampling size of questionnaire survey was calculated based on Taro Yamane technique (1967) from a total of 5,814 dwelling units of Klong Chan Public Housing Project and 5,872 dwelling units of Klongchan Public Housing Project and Buengkum Baan Eur Arthron with 95% confidence level.

$$n = \frac{N}{1 + Ne^2}$$

where, n = Sample size

N = Total of population by number of dwelling unit (5,814 and 5,827)

e = the acceptance of probability of error (equal to 95%)

$$\text{Klong Chan Public Housing Project} \quad n = \frac{5,814}{1 + 5,814 \times (0.05)^2} = 362$$

$$\text{Buengkum Baan Eur Arthron} \quad n = \frac{5,872}{1 + 5,872 \times (0.05)^2} = 370.79$$

Therefore, making a simple number of respondents, this study conducts with a group of 370 households for both projects. Also, a randomly sampling technique is applied for questionnaire distribution that the occupant selected be representative of Klong Chan Public Housing Project and Buengkum Baan Eur Arthron.

***Interviews:***

As opened question in the questionnaire survey, some occupants were employed to give their opinions and comments as well as giving a feedback of living condition of both public housing projects. Condominium Juristic Person (CJP) who manage Klong Chan Public Housing Project was also involved to participate on gathering building and management information of old public housing project situation. And staffs of NHA who managed Klong Chan Flat Project were determined by purposively method in selecting the officials that more experiences and related to the project development.

***Observation:***

To understand three aspects of the study; dwelling, building, and community performance in current situation, the researcher has took a photo record as data collection. This method has been done during questionnaire and interview process of the case studies. Especially, this technique is important to evaluate building physical condition (applied in Chapter 6).

***Case-studies of experiments:***

The experimental of dwelling unit performance has been investigated in Chapter 5 as the result of Chapter 4 that reveals the influenced factor to contribute occupants' satisfaction. This experiment scopes only old public housing project because the occupant lives in poor physical conditions than new public housing project. Two typical of dwelling unit; one bedroom and two bed room with examining temperature, humidity, and airflow model were described in details of Chapter 5.

**3.3 Method and Analysis Technique****Qualitative analysis**

It includes the data from interviewing local government officers, condominium juristic person, and field observation. Data analysis includes interpretation of the opinion of the respondents to identify the issue for improving public housing. Usually, descriptive and explanation the result by content analysis were adapted.

**Quantitative analysis**

Quantitative analysis of questionnaires as general information on personal background (socio-economic, i.e., income, education level, living condition) were presented by descriptive statistic such as ratio, percentage, frequency, mean, and standard deviation (SD). T-test, one-way ANOVA, chi-square were employed for indentify satisfaction to test differences of score based on independent groups. Correlation and regression analysis is a mainly tool for significant evidence of public housing performances in term of predicting factors. Statistics Package for the Social Sciences (SPSS) is mainly technique of qualitative data analysis.

**1) Reliability test**

Reliability (internal consistency) is important fundamental aspect of questionnaire measurement in form of Likert-type scales. The instrument's reliability by using Cronbach's alpha is a first-step to estimate

all possible ways of splitting the test items in an inter-item correlation matrix.

$$\alpha = (k/(k-1)) * [1 - \sum (s^2_i) / s^2_{sum}]$$

where,

$\alpha$  = reliability of questionnaire instrument

$k$  = number of question

$s^2_i$  = summary of variance score of each item

$s^2_{sum}$  = variance score of questionnaire instrument

Cronbach's alpha reliability coefficient normally ranges between 0 and 1. The closer Cronbach's alpha is to 1.0 the greater internal consistency of the items in the scale [19] There is a reliability degree as the following rules of thumb: "> .9 – Excellent, > .8 – Good, > .7 – Acceptable, > .6 – Questionable, > .5 – Poor, and < .5 – Unacceptable". Therefore, it should be noted the coefficient reliability is considerable to be acceptable when Cronbach's alpha > 0.7 [20].

Reliability of the 30 variables was tested by using Cronbach's alpha. The result was .93 for Klong Chan Flat and .95 for Buengkum Baan Eur Arthon. These are higher than the acceptable level of Cronbach's alpha at .70 (Field, 2000).

### 1) Independent Sample t-test

This test is applicable when independent variables are interval or ratio scale. The hypothesis should be set up to explore whether respondents in term of socio-economic background such as gender, old and new project, etc..as long as the tested members of each group are different satisfaction. For example, male and female in old public housing project and new project (independent variable) are different satisfactions in significant. So the null hypothesis should be:  $H_0$ : Male  $\neq$  Female and  $H_1$ : Male = Female.

P-value is used to determine the significant value if the value falls below the standard of ".05," it can declare a significant difference between groups.

$$t = \frac{M_x - M_y}{\sqrt{\frac{[(\sum x^2 - (\frac{\sum x^2}{N_x})) + (\sum y^2 - (\frac{\sum y^2}{N_y}))] \cdot [\frac{1}{N_x} + \frac{1}{N_y}]}{N_x + N_y - 2}}}$$

where,

$\sum$  = sum the following scores

$M_x$  = mean for Group A

$M_y$  = mean for Group B

$X$  = score in Group 1

$Y$  = score in Group 2

$N_x$  = number of scores in Group 1

$N_y$  = number of scores in Group 2

### 2) One-way ANOVA

The one-way ANOVA compares the means between the groups that researcher are interested in and determines whether any of those means are significantly different from each other. If, however, the

one-way ANOVA returns a significant result, we accept the alternative hypothesis ( $H_A$ ), which is that there are at least 2 group means that are significantly different from each other. At this point, it is important to realize that the one-way ANOVA is an *omnibus* test statistic and cannot tell you which specific groups were significantly different from each other, only which at least two groups were. To determine which specific groups differed from each other, you need to use a *post hoc* test. The test has its own formula:

$$F = (SSE1 - SSE2 / m) / SSE2 / n-k,$$

where,

$SSE$  = residual sum of squares

$m$  = number of restrictions

$k$  = number of independent variables

Find the F Statistic (the critical value for this test). The F statistic formula is:

F Statistic = variance of the group means / mean of the within group variances.

### 3) Chi-square

It commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. The chi-square test is always testing what scientists call the null hypothesis, which states that there is no significant difference between the expected and observed result.

The formula for calculating chi-square ( $X^2$ ) is:

$$X^2 c = \sum(o-e)^2/e$$

That is, chi-square is the sum of the squared difference between observed value ( $o$ ) and the expected value ( $e$ ) data (or the deviation,  $d$ ), divided by the expected data in all possible categories, and  $c$  is degree of freedom.

### 4) Correlation

Correlation test examines the relationship between two or more variables separately, meaning that relationship between two variables is independent of other variables. These variables measure the strength and direction of the linear relationship between the two variables. The correlation coefficient can range from -1 to +1, with -1 indicating a perfect negative correlation, +1 indicating a perfect positive correlation, and 0 indicating no correlation at all (Diamond, 2006). However, to select variables for next regression model for a validate regression model, a correlation coefficient should be more than 0.3 or above denoting a strong relationship and those variables is required a p-value of less than .05 to indicate statistically significant (Sauder, Lewis, and Thornhill, 2009).

### 5) Regression

- *Linear Regression Model:*

A liner regression was employed as casual method based on the assumption that the variable to be forecast (dependent variable) has cause-and-effect relationship with one or more other (independent) by linear trends Gor (2014). The formula for a regression line is:

$$Y = a + bX$$

where X is the explanatory variable and Y is the dependent variable. The slope of the line is b, and a is the intercept (the value of y when x = 0).

*- Multiple Regression Model:*

Multiple regression is an extension of simple linear regression analysis and uses to assess the association between two or more independent variables and a single continuous dependent variable. The general form of the multiple regression equation can be used as the following equation:

$$Y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k + \varepsilon$$

where,

- $Y$  = the dependent or response variable,
- $X_1, X_2, X_3, \dots, X_k$  = the independent or predictor variables,
- $E(Y) = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k$  = is the deterministic component of the model,
- $\beta_i$  = the contribution of the independent variable  $X_i$  and,
- $\varepsilon$  = a random error of the model.

Firstly, the variable in the model is a linear relationship between the dependent and dependent variables. Secondly, the independent variables must be linearly independent. Thirdly, there is no highly correlated among the variables (multicollinearity test). And finally, the error distribution should also be normal (Saunders, 2009).

*- Logistic Regression Model:*

Logistic regression determines the impact of multiple independent variables presented simultaneously to predict membership of one or other of the two dependent variable categories. To predict positive impact on overall satisfaction in public housing project the logistic regression equation can be used as the following equation:

$$Prob (satisfied) = \frac{1e^{\beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_px_p}}{1 + e^{-(\beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_px_p)}}$$

where,

- $Prob$  = the probability that a case is in a particular category,
- $e$  = the base of natural logarithms (approx 2.718),
- $\beta_0$  = the constant of the equation and,
- $\beta_1$  = the coefficient of the predictor variables.

Or

$$Prob (satisfied) = \frac{1}{1 + e^{-z}}$$

where,

$$z = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_px_p$$

### 3.5 Research Framework

The research process shows in Figure 3.5 that beginning of research starts to investigate two projects. Then identify influenced factors of three aspects for in-depth analysis in part 2. Specific analysis of selecting high value of those factors are envisaged and integrated to relevant stakeholders for improvements.

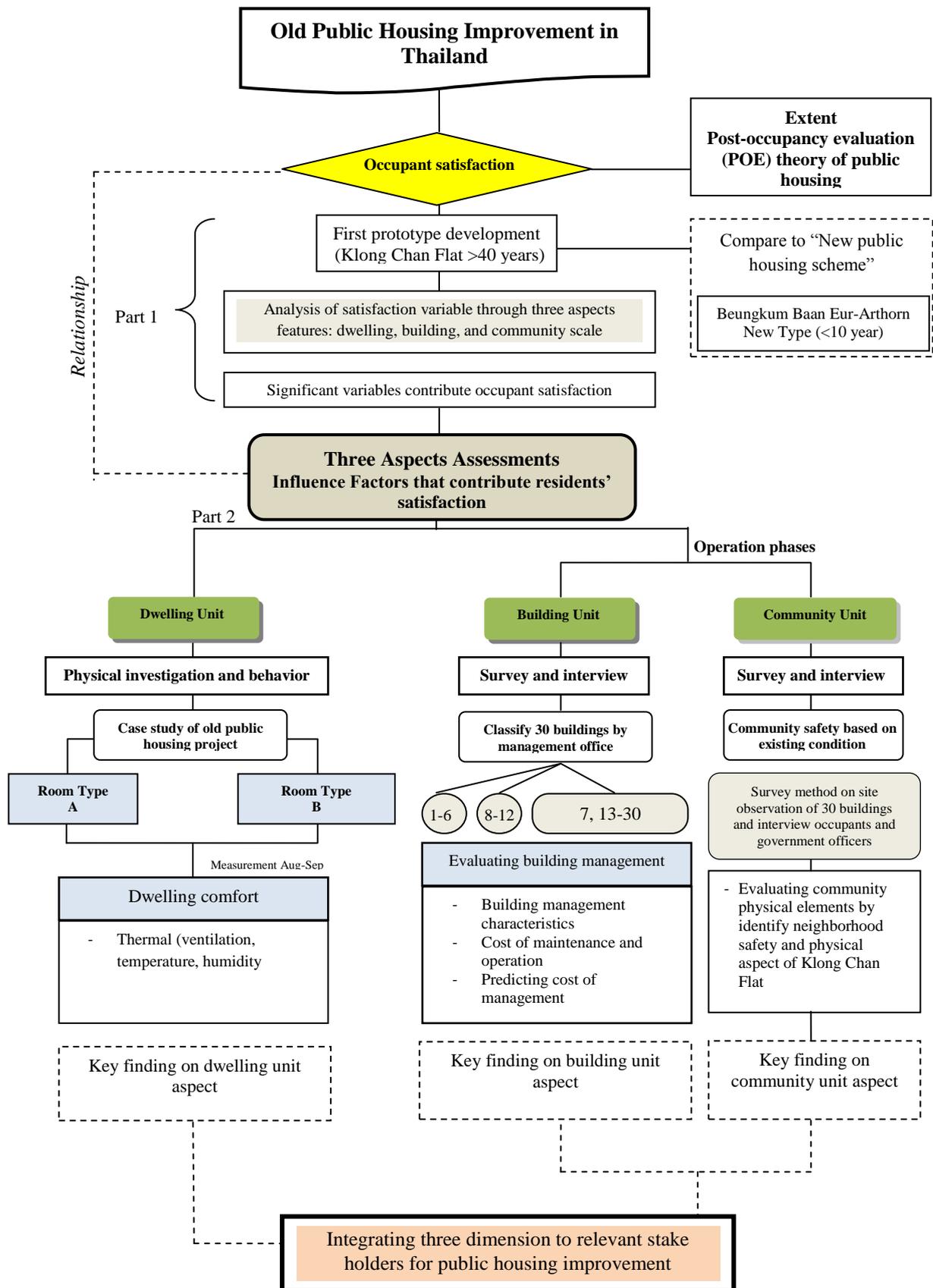


Figure 3.5 Research framework

## CHAPTER 4

### RESIDENT SATISFACTION ANALYSIS OF “OLD” AND “NEW” PUBLIC HOUSING BASED ON POST-OCCUPANCY EVALUATION

This section of research is to understand the resident satisfaction in the existing condition of “old” and “new” public housing scheme. A public housing in Thailand; two case studies in Bangkok were selected including Klong Chan Flat and Buengkum Baan Eur Arthron. A resident survey of both projects was monitoring public housing performance on the operation phase. This will be basis information for improvements as preferred satisfaction based on resident’s assessment. Furthermore, to explore residents’ satisfaction to deal with sustainable living condition is also the key to enhance quality of life.

#### 4.1 Respondent Profile

A personal and household socio-economic characteristic as a basic information to understand a dwellers’ background of Klong Chan Flat Project and Buengkum Baan Eur Arthron Project including gender, age, education, occupation, income, family member, and length of residency shows in the Figure 4.1 below.

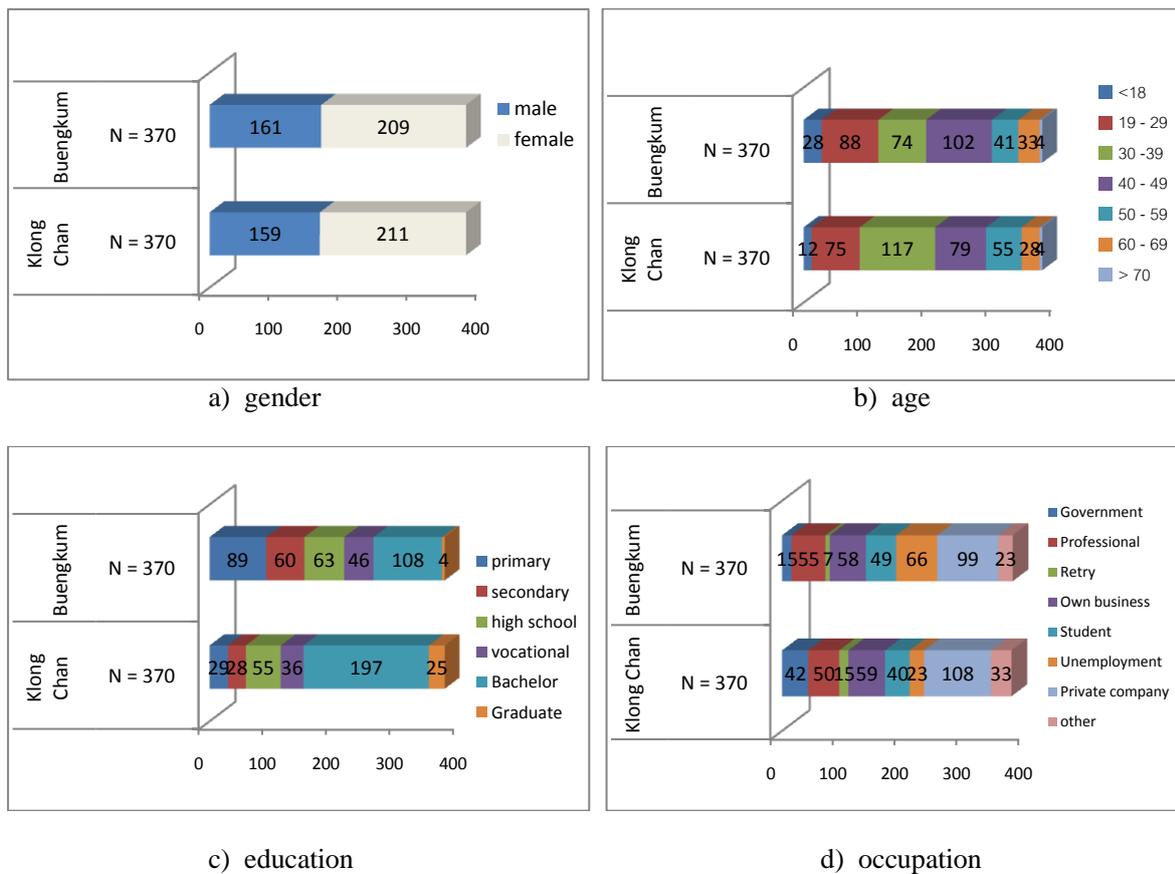


Figure 4.1 Respondents’ background

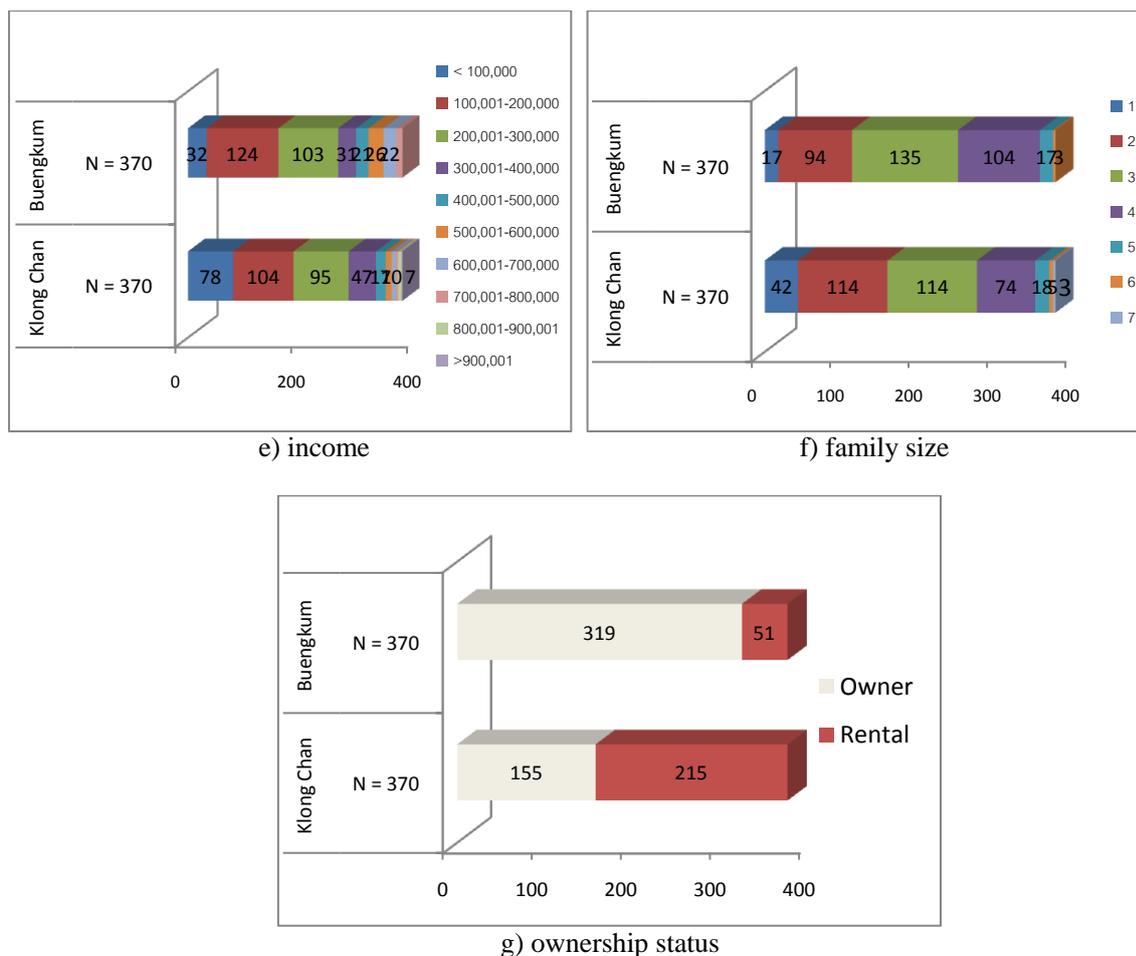


Figure 4.1 Respondents' background (continued)

As shown in Figure 4.1, it was revealed that the majority of the respondents of Klong Chan Flat and Buengkum Baan Eur Arthron were females by the percentage were not quite different by representing 57% and 56.5% whereas 43% and 43.5% were males. The respondent's ages starts from 16 to 74 years in Klong Chan Flat. 30 – 39 years was indicated as a large group (31.6%). Meanwhile the respondents in Buengkum Baan Eur Arthron were 40 -49 years or 27.3%. Education background of respondents is one important that might affect the person's attitude and the way for looking social phenomenon. Bachelor degree was a high percentage of respondents attaining by 53.2% and 28.6% of Klong Chan Flat and Buengkum Baan Eur Arthron. However, the respondents in Buengkum Baan Eur Arthron were mostly educated in primary and secondary comparing to the Klong Chan Flat. For occupation, it is evident from questionnaire information that most of respondents have a job as monthly wage earners in private company (29.2% and 25.9%), whereas the percentages of the respondents engaged in own business, freelance profession, and student were not quite difference. High rate of unemployment condition was found in Buengkum Baan Eur Arthron as 18.4%. To understand the situation of low-income and middle-income respondents who live in both projects, important characteristics have been presented. Respondents have a job in the government and private sectors (29.2% of Klong Chan Flat and 25.9% of Buengkum Baan Eur Arthron). Unemployment was found in the Buengkum Baan Eur Arthron at a level of 18.4%. Income is a key factor in public housing and represents an important measure on economic conditions. The annual income of

respondents ranged from \$3,300 to \$6,600 for 28.1% and 33.8% of Klong Chan Flat and Buengkum Baan Eur Arthron households, respectively. This was lower than the average household income in Bangkok in 2013, which was about \$19,600 (Puapan, Punpiemrach, & Kamlai, 2012). Investigating household size was found 2 – 3 people (61.6%) mainly in Klong Chan Flat where 3 – 4 people were found in Buengkum Baan Eur Arthron. According to forecasting household size of Thailand, it is unsurprisingly the average household size that will be gradually going to a small from 5.7 in 1960 to 3.09 in 2020 (Public Health Ministry, 2007). So, the space and household size were examined and analyzed in the Chapter 5. Asking a property right to residents found that 58.1% were rental status and 41.9% for owner of Klong Chan Flat. This implied that some the original owners were allocated the room to others by sold or renting. Those tenants rented a room because of easily access to workplaces and rental price is reasonable (3,400 baht/two bedrooms and 2,700 baht/one bedroom, field survey, 2014). Residents in Buengkum Baan Eur Arthron were own status about 86.2%. Length of residency in Klong Chan Flat was below 10 years (64.9%) where a percentage of residents who lived more than 11 to 30 years were 30.3% (Table 4.1). Only 4.9% represented for living more than 31 years. In case of Buengkum Baan Eur Arthron, the mean average of living period was 4.49 years. 8 years were represented only 10% of respondents that has been living since the project built.

Table 4.1 Respondents' background on length of residency

Attributes	Klong Chan Flat Project			Buengkum Baan Eur Arthron Project		
	Year	N = 370	%	Year	N = 370	%
Length of residency	1-10	240	64.9	1	32	8.6
	11-20	70	18.9	2	39	10.5
	21-30	42	11.4	3	68	18.4
	>31	18	4.9	4	44	11.9
				5	60	16.2
				6	53	14.3
		11.03 years (average)		7	37	10.0
				8	37	10.0
				4.49 years (average)		

Source: field survey, 2014

Also, asking on the plan of moving out the project found 29.5% of respondents of Klong Chan Flat Project planned to move out by most of them were tenants (20%) whereas owners were a small proportion just 9.5%. Meanwhile, most respondents of Buengkum Baan Eur Arthron were owner (82%) and tenants (18%) respectively. Only 15.1% of respondents were found having planned to move out. As the project ages are 8 years and most of respondents are under the long rental-purchasing contract 20-30 years, therefore, the owner proportion of Buengkum Baan Eur Arthron still shows quit high rate. Chi-square test was employed to test relationship between ownership status and plan to move out of project. The result showed statistically significant by *p*-value was less than 0.05 of Klong Chan Flat where there was no statistically significant of Buengkum Baan Eur Arthron. In case of Klong Chan Flat, the reasons of moving out were going back hometown and finding a living place in countryside, this project was poor environments, inefficiency building management and services, and risk of crimes (Field interviewed, 2014). Therefore, the poor conditions of old public housing should be addressed in the housing policy makers of NHA to rethink post-occupancy condition in order to achieve affordable public housing sustainability.

Table 4.2 Testing relationship between ownership status and plan to move out of project

Ownership status		Plan to move out of project			p-value (Pearson Chi-Square)
		Yes	No	Not sure	
Klong Chan Flat Project	Rental	74	75	66	.005*
	Owner	35	79	41	
Buengkum Baan Eur Arthron Project	Rental	9	22	20	.726
	Owner	47	129	143	

\*P-Value is significant at the 0.05 level

#### 4.2 Public Housing Satisfaction of “Old” and “New” Project

First, the overall satisfaction was examined and found that Buengkum Baan Eur Arthron respondents’ satisfaction level in the three aspects was higher than that of Klong Chan Flat respondents. This result is in line with the report of the NHA (NHA, 2006), indicating that the physical environmental context of Baan Eur Arthron Project (at 3.60) is more satisfied than that of the Public Housing Community programme (at 3.30). However, a comparative mean score among the three dimensions of both projects indicated that satisfaction with the dwelling units’ features was higher than satisfaction with the building unit and community unit features, as shown in Table 4.3.

Table 4.3 Mean score of three dimensions

Three aspects	Klong Chan Flat (Old)			Buengkum (New)		
	$\bar{x}$	SD	level*	$\bar{x}$	SD	Level*
Dwelling feature satisfaction	3.34	.752	Fair	3.54	.793	Satisfied
Building feature satisfaction	3.10	.840	Fair	3.46	.779	Fair
Community feature satisfaction	3.04	.780	Fair	3.38	.799	Fair

Source: the Author, 2014.

\*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.

##### 4.2.1 Dwelling unit satisfaction analysis

Two case studies were examined in a comparison between a spatial dwelling’s standard size of function area and minimum public housing size standard of NHA. Basic elements of dwelling unit comprise of bedroom, living area, dining area, kitchen area, and toilet shown in Figure 4.2.

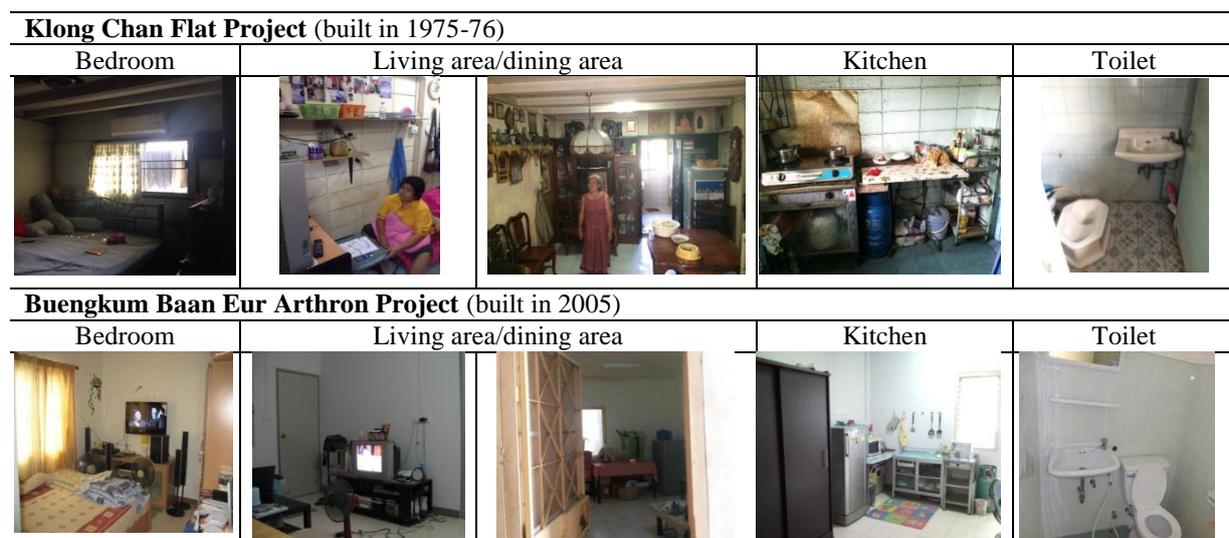
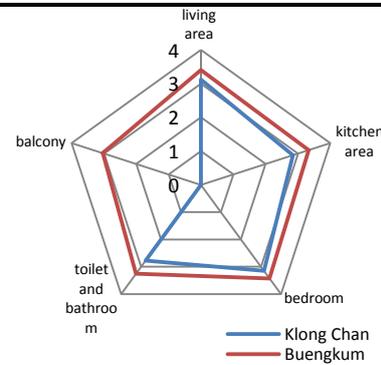


Figure 4.2 Dwelling unit features in both the public housing projects

Regarding the size of dwelling, which included the living area, kitchen, bedroom, toilet, and balcony, these variables were ranked on a fair level (2.51–3.50) for both projects. The toilet and balcony were ranked the lowest at 2.77 and 3.04, respectively, whereas bedroom size was ranked the highest, scoring 3.15 for Klong Chan Flat and 3.43 for Buengkum Baan Eur Arthron, as shown in Table 4.4.

Table 4.4 Comparing dwelling unit satisfaction of size

Topics Dwelling satisfaction	Klong Chan			Buengkum		
	$\bar{x}$	SD	level*	$\bar{x}$	SD	Level <sup>†</sup>
The size of living area	3.12	.816	Fair	3.40	.875	Fair
The size of kitchen area	2.84	.804	Fair	3.33	.973	Fair
The size of bedroom area	3.15	.773	Fair	3.43	.912	Fair
The size of toilet and bathroom	2.77	.877	Fair	3.25	.863	Fair
The size of balcony	-	-	Fair	3.04	.952	Fair



Source: the Author, 2014

\*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

Questions that asked residents how satisfied they were with room size and whether it was adequate for their family members revealed that the respondents were fairly satisfied, with scores of 3.42 and 3.12 (Table 4.5) for Buengkum Baan Eur Arthron and Klong Chan Flat, respectively. Family members in both projects ranged from 1 to 7 persons; therefore, it can be assumed that the dwelling unit with 5 persons (a maximum based on the NHA standard designed for the dwelling unit) would be more satisfying than the unit with 6–7 persons. According to the correlation analysis, negative correlation with family size and satisfaction at correlation coefficients of 0.143 and 0.109 was statistically significant at the level 0.01 ( $P = 0.006$  and  $0.035$ ) for Buengkum Baan Eur Arthron and Klong Chan Flat, respectively; but it showed very low correlation coefficients of less than 0.3 (Hinkle, Wiersma, & Jurs 1998). However, T-test analysis between groups showed significant differences at 0.006 and 0.035. The respondents who lived with 5 members were more highly satisfied than those who lived with more than 6 persons, as shown in Table 4.5. Unsurprisingly, it is evident that living in a high density unit results in a lower satisfaction rating compared to those in less dense units, as found in both housing projects.

Table 4.5 Comparing the number of family members with dwelling unit satisfaction

Satisfaction based on family members		Klong Chan Flat				Buengkum Baan Eur Arthron			
		$\bar{x}$	S.D.	<i>T</i>	<i>P</i> -	$\bar{x}$	S.D.	<i>t</i>	<i>P</i> -
The size of this room is adequate for your family	5 persons	3.18	.804	2.760	.006*	3.43	.899	2.113	.035*
	> 6 persons	2.38**	1.188			2.33**	.577		

\*P-Value is significant at the 0.05 level.

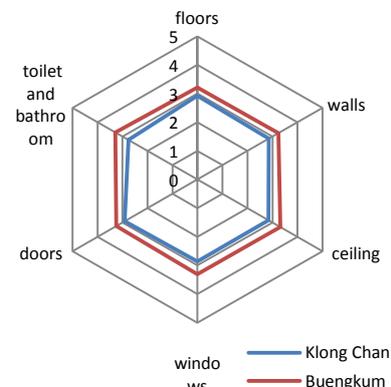
\*\*Satisfied level: 1.00–1.50 = Highly Dissatisfied, 1.51- 2.50 = Dissatisfied, 2.51–3.50 = Fair satisfied, 3.51–

Questions on dwelling material satisfaction were asked to residents who might experience many problems, such as cracking, leaking, and separating and degradation of floors, walls and ceiling over their lifetime. There were also questions on how building elements perform based on their durability. The operation of windows, doors, and sanitary facilities was also assessed. Operation of the toilet and sanitary facilities of Klong Chan Flat scored the lowest satisfaction score of 2.76 (Table 4.6). Using low-quality sanitary facilities such the squat toilets is not suitable for the elderly and those with joint problems, and there was

no sink or shower. This was uncomfortable usage even though it is understandable that the project managers must have aimed at saving cost for construction, but public health should be an important concern (Field interview, 2014). Overall, the dwelling materials of Buengkum Baan Eur Arthron received higher scores than those of Klong Chan Flat, although these were still at a fair level. As new projects have been developed the materials used within the dwelling units have improved, which enhance the quality of life for the residents. This includes the addition of ceramic floor tiles, Poly Vinyl Chloride toilet doors instead of wood, and providing seated toilets, showers, and sinks. Nevertheless, satisfaction with the materials used in floors of dwellings was at 3.21, which was ranked the lowest. This is an important issue confirmed in residents' complaints to the NHA about the use of low quality ceramics, and floor tiles peeling off (Field interview, 2014).

Table 4.6 Comparing dwelling unit satisfaction of quality

Topics Dwelling satisfaction	Klong Chan			Buengkum		
	$\bar{x}$	S.D.	level*	$\bar{x}$	S.D.	Level <sup>2</sup>
Quality of materials used in floors	2.92	.928	Fair	3.21	.893	Fair
Quality of materials used in walls	2.85	.849	Fair	3.24	.871	Fair
Quality of materials used in ceiling	2.84	.854	Fair	3.31	.858	Fair
Quality and operation of windows	2.86	.859	Fair	3.31	.864	Fair
Quality and operation of doors	2.91	.845	Fair	3.25	.915	Fair
Quality and operation of sanitary in toilet and bathroom	2.76	.878	Fair	3.29	.868	Fair



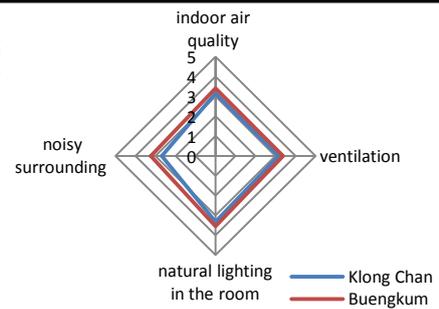
Source: the Author, 2014

\*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

Satisfaction with the indoor environment was related to air quality, ventilation, natural lighting and noise. Buengkum Baan Eur Arthron received a higher score than Klong Chan Flat, with natural lighting scoring the highest at 3.53 (satisfied level). The noisy environment of Klong Chan Flat received a very low score of 2.68. with the noise generated by the adjacent fresh markets, passing motor vehicles and noise from neighbours. In terms of natural lighting and ventilation both projects offer single access and double access off corridors, which affects cross ventilation and light. The single sided access corridor allows sunlight and ventilation to the rooms in Klong Chan Flat. This is better than the situation at Buengkum Baan Eur Arthron. However, to distribute ventilation through the corridors of the second and fifth floors at Buengkum Baan Eur Arthron there are airflow voids designed in front of the rooms, and a door and windows at the rear of the living unit to assist cross ventilation. Balconies provide shade for dwelling units and help to prevent direct sunlight entering rooms and hence control heat gain within the units. Klong Chan Flat does not have balconies, only a small façade projection above the windows. At Klong Chan Flat the direct sunlight at the front of the dwelling unit is too strong for comfort. Changing the glass louver window to other types with film insulation and adding a sun shade canvas (the cheapest method) to block the sunlight have resolved this issue in some dwellings. However, there is a need to further investigate ผลพลได้! ไม่ได้กำหนดที่คั่นหน้า natural lighting levels and how it affects the occupants.

Table 4.7 Comparing dwelling unit satisfaction of indoor environment quality

Topics Dwelling satisfaction	Klong Chan			Buengkum		
	$\bar{x}$	S.D.	level*	$\bar{x}$	S.D.	Level <sup>‡</sup>
Quality of indoor air quality	3.15	.807	Fair	3.41	.736	Fair
Quality of ventilation	3.16	.821	Fair	3.38	7.46	Fair
Quality of natural lighting in the room	3.32	.840	Fair	3.54	7.83	Satisfie
Quality of room from noisy surrounding	2.68	.935	Fair	3.24	.908	Fair



Source: the Author, 2014

\*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

#### 4.2.2 Building unit satisfaction analysis

Generally, the basic of building elements of Klong Chan Flat and Buengkum Baan Eur Arthron is based on a low cost- public housing project in saving cost of construction which affordable price. Klong Chan Flat is five story building; concrete structure without plastering as a common feature of NHA in that period (conventional construction system). External appearance of building is painted in light color. There are two sides of garbage chimney as collecting household waste to the ground floor. There is no elevator installation. Single corridor is provided to access all units in 1.20m of width. Ground floor of one side building is used an open space for multi-purpose; motorcycle parking; residents gathering place, office of management building. Buengkum Baan Eur Arthron is also five story building without elevator. The industrialized construction system as precast concrete panels is used for the elements of building; walls, floors, and terrace panels. Presently, this is commonly system for NHA project throughout the country. There is water supply tank on the deck floor and also installing a roof structure. Double corridor is provided to access all units in 1.50m of width. The ground floor is provided a multiple purpose for residents and office of management building.

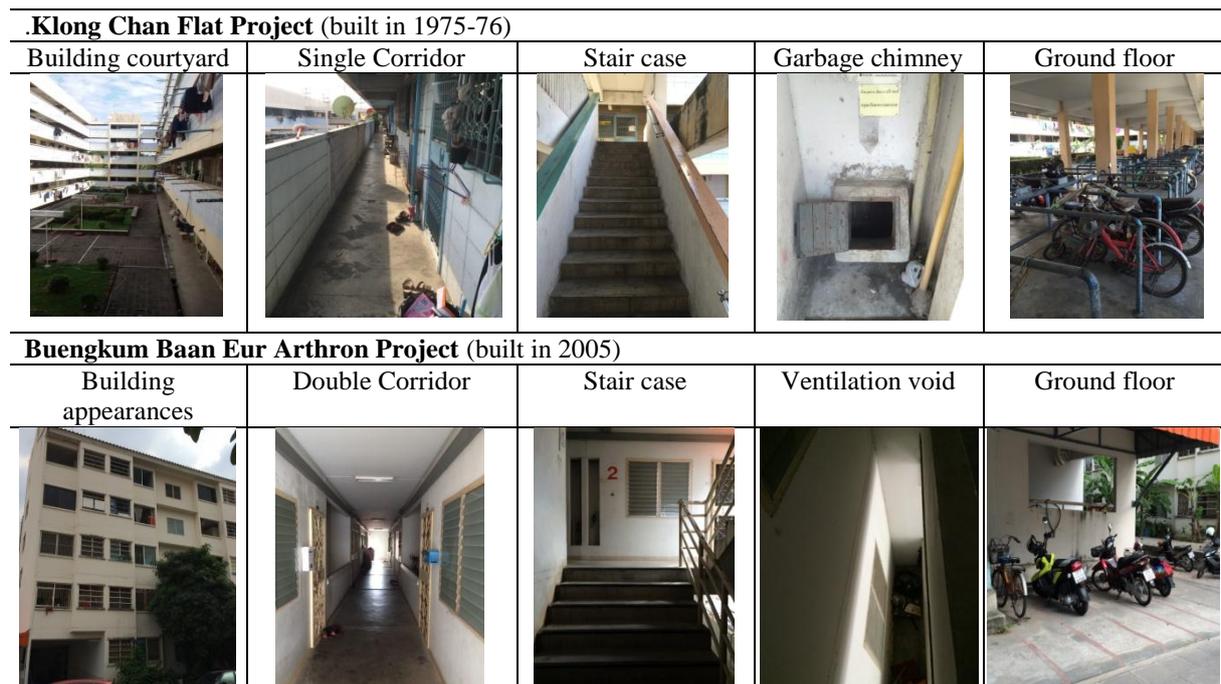
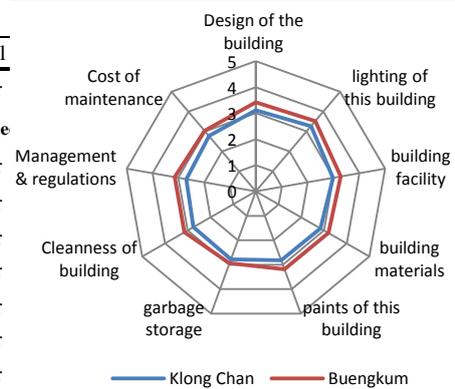


Figure 4.3 Building unit features in both the public housing projects

In relation to the building unit satisfaction the natural lighting was still ranked the highest, as shown in Table 4.8. The design of the building was the second best score at 3.11 and 3.42 for Klong Chan Flat and Buengkum Baan Eur Arthron respectively. The existing buildings meet peoples' basic needs; however, respondents mentioned that designs and layouts are not limited to affordability; "Innovative design through aesthetics should also be considered, design which presents public housing identity in harmony with tropical architecture" (Field interview, 2014). For well-maintained buildings management regulation and cost both scored low in terms of satisfaction especially for Klong Chan Flat at 2.69 and 2.78 respectively. For the self-managed buildings in Klong Chan Flat there was very little opportunity to manage the whole building complex due to the limited financial capacity of the residents.

Table 4.8 Comparing building unit satisfaction of building attributes

Topics Building satisfaction	Klong Chan			Buengkum		
	$\bar{x}$	SD	level	$\bar{x}$	SD	level
Design of the building	3.11	.752	Fair	3.42	.804	Fair
Natural lighting of this building	3.27	.778	Fair	3.52	.790	Satisfie
Quality of building facility	2.98	.904	Fair	3.28	.923	Fair
Quality of building materials	2.84	.815	Fair	3.20	.915	Fair
Quality of paints of this building	2.82	.878	Fair	3.18	.913	Fair
Quality of garbage storage	2.78	.940	Fair	2.94	.987	Fair
Cleanness of building	2.75	.886	Fair	3.15	.912	Fair
Management rules & regulations	2.69	.878	Fair	3.14	.835	Fair
Cost of maintenance	2.78	.873	Fair	3.04	.817	Fair



Source: the Author, 2014

\*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

#### 4.2.3 Community unit satisfaction analysis

Klong Chan Flat's community feature is quit larger than Buengkum Baan Eur Arthron. As it is a prototype public housing development of NHA, a basic community element is provided for residents: park, sport area/playground, community center, nursery, and kindergarten. Also, there is school, bank, police station, and super market is nearby the project; it is convenient by walking. However, overall physical community environments on those facilities are not well maintain and management even under responsibility of local government and NHA such as roads and collecting household wastes by Bangkok Metropolitan Authority whereas park, sport area/playground are operated by NHA. Individual building management offices are responsible for building facility, parking, and security by themselves. In case of Buengkum Baan Eur Arthron, the community elements are not quite differences. Generally, comparing physical community conditions of this project is better than Klong Chan Flat. Enclosed community is a residential form by controlled entrance for pedestrians, bicycle, and automobile which indicated of security of residents are safe. 24 hours convenient stores and fresh market are served at the gated community (outside the project). There is a minibus service to access the community that far from the main road about 2 km. Facility of community is normally divided for local authority and self-management. Royal Frame Management is a private company that is employed by NHA for management.

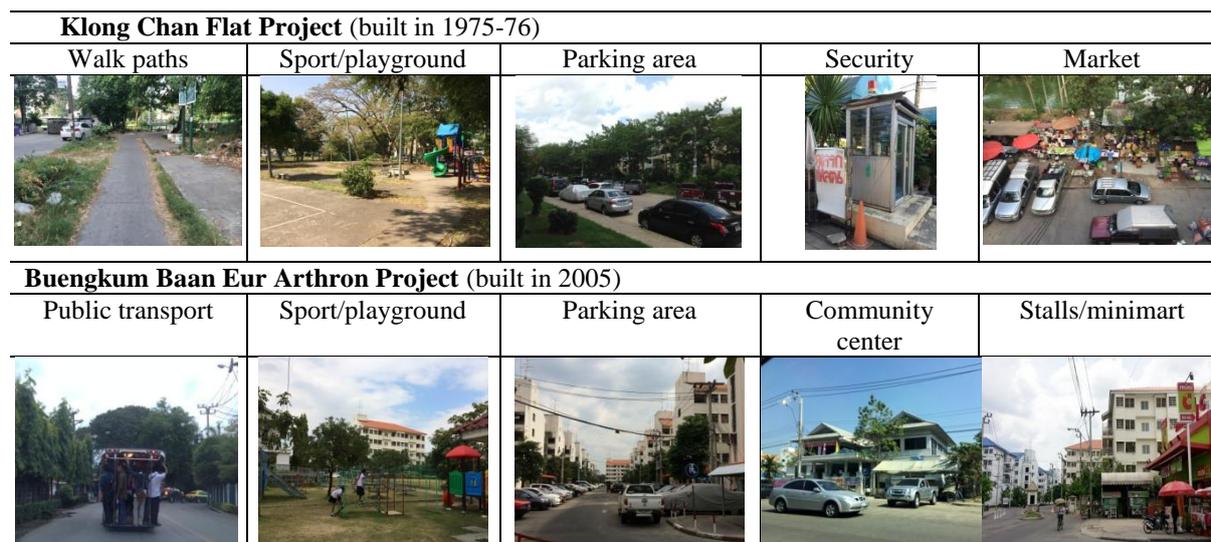
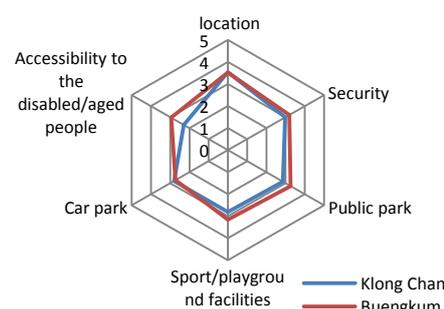


Figure 4.4 Community unit features in both the public housing projects

For community feature satisfaction, location had the highest score at 3.54 and 3.52 for Klong Chan Flat and Buengkum Baan Eur Arthron respectively as they are located in urban areas that are convenient for travelling. However, accessibility for disabled and elder people, and car parking, scored the lowest rating for Klong Chan Flat. Accessibility to leisure and daily activities for the disabled was identified in the interviews as being important to the residents' wellbeing and enjoyment of their surroundings (Field interview, 2014). Inadequate space to accommodate cars in Buengkum Baan Eur Arthron needs to be addressed by management, even though 1,086 parking lots have been provided at 1 : 5.4 units. The ratio is higher than the NHA standard (1:10 units) but it still does not serve the residents' needs (Khamhaeng, 2008). There is no space for parking, especially in the evening, and the crowded parking lots and double parking were identified as the main problem for Buengkum Baan Eur Arthron residents (Field interview, 2014).

Table 4.9 Comparing community unit satisfaction

Topics Community satisfaction	Klong Chan			Buengkum		
	$\bar{x}$	SD	level	$\bar{x}$	SD	level
Community location	3.54	.740	Satisfied	3.52	.793	Satisfie
Security of your neighborhood	2.98	2.38	Fair	3.20	1.00	Fair
Public park	2.86	.921	Fair	3.26	.925	Fair
Sport/playground facilities	2.81	.838	Fair	3.16	.919	Fair
Car park	2.79	.928	Fair	2.73	1.10	Fair
Accessibility to the disabled/aged people	2.30	.927	Low	2.95	1.108	Fair



Source: the Author, 2014

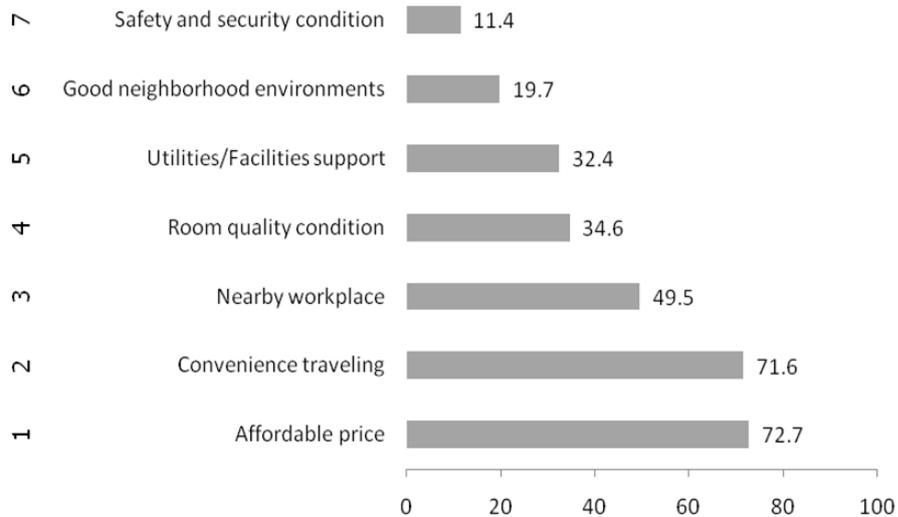
\*Satisfied level: 1.00 – 1.50 = Highly Dissatisfied, 1.51- 2.50 = Dissatisfied, 2.51- 3.50 = Fair satisfied, 3.51 – 4.50 = Satisfied, 4.51 -5.00 = Highly satisfied

These satisfactions score could be confirmed by the reasons why respondents lived in both projects. 65.4% of respondents of Klong Chan Flat indicated that a convenient traveling was the first reason. Meanwhile, 72.7% of affordable price was the first ranked and convenient traveling of 71.6% was the second of Buengkum Baan Eur Arthron. Affordable price in social housing was a conventional policy approach for

low-middle income people in Thailand. For that reason, by having a living place in urban core with low price is more important along with location as seen in Buengkum Baan Eur Arthron. The percentage of nearby workplaces of both projects was not quite difference (53% and 49.5%). Room quality condition of both projects showed the same ranked with 31.1% and 34.6%. Providing a low price of dwelling, the respondents did not expect much of quality (field interview, 2014). Safety and security condition reason was the lowest ranked by only 13.8% and 11.4% respectively.



a) Klong Chan Flat Project



b) Buengkum Baan Eur Arthron

Figure 4.5 Top reasons of living in both the public housing projects

### **4.3 Analysis of Personal Information (demographic/socio-economic/living conditions) with Living Satisfaction**

Residential satisfaction is influenced by individual perceptions, therefore, demographic, socio-economic, and living conditions components as well as occupants' backgrounds been found related to living satisfaction of the project. According to the Mastura (2005), the housing concept does not lie on the individuals' dwelling. It is a composite of physical and social components. Further, housing satisfaction is influenced various components including: age, marital status, number of children and family size, socioeconomic status; income, education, employment and welfare, length of residency, housing physical condition and management services, social participation and interaction. To examine satisfaction how between groups of independents groups are different satisfaction, independents of Mastura (2005) as and available data of field survey were combined into 9 independents. Independent-Samples T-test and One-Way ANOVA are main statistic methods. 9 independent variables were listed in category below:

#### **1) Demographic:**

##### Gender:

Housing satisfaction study by Tan and Hamzah (1979) and Varady and Carrozza (2000) was done by using genders as predictors to find out purchasing power of household decisions. Therefore, gender status would also include as one indicator of satisfaction.

##### Age:

Galster, 1987 found that the elderly are more likely to be satisfied with their homes than younger. So, this independent variable was involved as one parameter to analyze between groups toward satisfaction.

#### **2) Socio-economic:**

##### Occupation:

Difference occupation's types of respondents: government officer, private company officer, own business as a socioeconomic status would affect different living satisfactions.

##### Income:

Both of projects are built for low to middle income people that has been encountered a housing shortage. Living in the projects that provide affordable price based on income might assume that respondents have more satisfied.

##### Education:

A level literacy as education background of respondents within the project should include for satisfaction analysis. High and low literacy level of education would affect residents' attitude toward their living conditions.

#### **3) Living conditions:**

##### Family size:

Size and crowding are both important aspects of satisfaction. It is expected that there will be significant differences in respondents' satisfaction. Number of family members from 1-7 persons found in the both questionnaire survey of projects will affect satisfaction.

Ownership:

As major respondents of case study consist of dwelling unit owners those are the purchasers and another group is tenants; individual renting for living. Thus, ownership status is addressed to examine satisfaction relationship between the groups.

Length of residency:

To investigate the residents on different length of residency in both projects those who have lived longer in Klong Chan Flat Project (> 30 years old of project) and Buengkum Baan Eur Arthron Project (about 8 years old of project) may assume that they would have different satisfaction.

Dwelling renovation:

The case studies are old and new conditions of residents living. Some dwelling units in both projects have been renovated/remodeled/improved in order to enhance their living.

From above 9 independents, the hypothesis to test different between groups of independent variables and dependent variable (overall living satisfaction) is listed in Table 4.10.

Table 4.10 Hypothesis test of residential satisfaction through socio-economic background

Independent-Samples T-Test	Gender, Ownership, Dwelling renovation
Hypothesis:	
<i>H1:</i> Gender variable affects on different residential satisfaction in statistical significant.	
<i>H2:</i> Ownership status variable affects on different residential satisfaction in statistical significant.	
<i>H3:</i> Dwelling renovation variable affects on different residential satisfaction in statistical significant.	
One-Way ANOVA	Age, Education, Occupation, Income, Family size, Length of residency
<i>H4:</i> Age variable affects on different residential satisfaction in statistical significant.	
<i>H5:</i> Education variable affects on different residential satisfaction in statistical significant.	
<i>H6:</i> Occupation variable affects on different residential satisfaction in statistical significant.	
<i>H7:</i> Income variable affects on different residential satisfaction in statistical significant.	
<i>H8:</i> Family size variable affects on different residential satisfaction in statistical significant.	
<i>H9:</i> Length of residency variable affects on different residential satisfaction in statistical significant.	

From the result of Table 4.11 in demographic dimension found there was no difference between the groups of gender, but age showed significant difference between the groups at 0.05 of Klong Chan Flat; the older residents and students group were higher satisfied than the others. Meanwhile, the gender of Buengkum Baan Eur Arthron was found different between the groups at statistical significant of 0.006 by male was satisfied than female (3.34 > 3.18). Socio-economic dimension, occupation and education showed no difference between groups. Only income has shown significant difference between the groups at 0.013 of Klong Chan Flat. The household income range of 500,001 – 600,000 baht (\$17,000 to \$20,000/annual) shows higher satisfied at 3.50. In case of Buengkum Baan Eur Arthron, occupation, education showed significant difference between the groups at 0.00, 0.00, and 0.02 respectively. Employee retirements and others occupation (housewife/volunteer) groups, household income range of 700,001 – 800,000 baht (\$23,000 to \$27,000/annual), and respondents’ background of vocational education showed higher satisfaction than other groups. In term of living condition (family size, homeownership, length of residency, dwelling renovation) of Klong Chan Flat found there were difference between the homeownership and length of residency in statistical significant of 0.003 and 0.004, the room owners and

the respondents who stayed more than 31 years have high satisfaction than other groups. Family size, length of residency and dwelling renovation of Buengkum Baan Eur Arthron were found higher satisfaction between the groups on significant difference at 0.005, 0.000, and 0.015 respectively. Number of family members between 5 – 6 persons, the respondents who stayed in this project about 2 - 3 years, and the dwelling unit which no renovation given high score of satisfaction than other groups.

Table 4.11 Comparative overall satisfaction of socio-economic background

Overall living satisfaction		Klong Chan Flat				Buengkum Baan Eur Arthorn				
		$\bar{x}$	SD	t (f)	t-value (P-Value)	$\bar{x}$	SD	t (f)	t-value (P-Value)	
<b>Demographic</b>										
<b>- Gender</b>	Male	2.90	.508	-857	.388	3.34	.536	<b>2.772</b>	<b>.006*</b>	
	Female	2.95	.541			3.18	.581			
<b>- Age</b>	<18	3.23	.524	<b>(3.123)</b>	<b>(.005*)</b>	3.17	.505	<b>(.431)</b>	<b>(.853)</b>	
	19 - 29	2.99	.551			3.24	.512			
	30 -39	2.80	.444			3.33	.594			
	40 - 49	2.89	.560			3.25	.596			
	50 - 59	2.96	.481			3.21	.641			
	60 - 69	3.11	.649			3.19	.563			
	> 70	3.33	.474			3.34	.208			
<b>Socio-economic</b>										
<b>- occupation</b>	Government/public	2.86	.631	<b>(1.771)</b>	<b>(.092)</b>	3.48	.629	<b>(3.879)</b>	<b>(.000*)</b>	
	Professional	2.89	.436			3.21	.534			
	Retry	3.13	.439			<b>3.81</b>	<b>.621</b>			
	Own business	2.98	.546			3.35	.621			
	Student	3.13	.471			3.15	.453			
	Unemployment	2.92	.350			3.24	.412			
	Private company	2.85	.525			3.12	.605			
	Other	2.87	.628			<b>3.57</b>	<b>.647</b>			
<b>- income</b>	< 100,000	2.93	.495	<b>(2.379)</b>	<b>(.013*)</b>	2.80	.549	<b>(26.449)</b>	<b>(.000*)</b>	
	100,001-200,000	2.83	.501			3.11	.416			
	200,001-300,000	2.99	.516			3.12	.475			
	300,001-400,000	2.88	.494			3.23	.543			
	400,001-500,000	2.81	.470			3.48	.434			
	500,001-600,000	3.50	.555			<b>3.92</b>	<b>.462</b>			
	600,001-700,000	3.22	.858			<b>3.87</b>	<b>.493</b>			
	700,001-800,000	3.04	.872			<b>4.12</b>	<b>.430</b>			
	800,001-900,000	2.95	.735			-	-			
>900,001	2.79	.114	-	-						
<b>- education</b>	primary	2.79	.438	<b>(.722)</b>	<b>(.607)</b>	3.18	.476	<b>(3.821)</b>	<b>(.002*)</b>	
	secondary	2.96	.461			3.17	.613			
	high school	3.00	.526			3.12	.573			
	vocational	2.97	.636			3.49	.644			
	bachelor	2.92	.539			3.34	.533			
	graduate	2.88	.423			2.91	.677			
<b>Living condition</b>										
<b>- family size</b>	1	3.00	.456	<b>(1.618)</b>	<b>(.141)</b>	3.48	.668	<b>(3.404)</b>	<b>(.005*)</b>	
	2	2.87	.474			3.22	.574			
	3	2.97	.545			3.28	.478			
	4	2.96	.603			3.13	.630			
	5	2.89	.466			<b>3.62</b>	<b>.509</b>			
	6	2.66	.619			<b>3.65</b>	<b>.136</b>			
	7	2.22	.506			-	-			
<b>- homeownership status</b>	owner	3.03	.572	<b>-2.969</b>	<b>.003*</b>	3.23	.557	1.333	.183	
	tenant	2.86	.482			3.25	.625			
<b>- length of residency</b>	1			<b>4.530</b>	<b>(.004*)</b>	3.31	.714	<b>(7.902)</b>	<b>(.000*)</b>	
	2					3.41	.500			
	< 10	3	2.86			.502	3.44			.485
	11 – 20	4	3.00			5.06	3.35			.450
	21 – 30	5	3.03			.605	3.29			.560
	< 31	6	3.24			.586	3.25			.539
	7						2.94			.550
	8						2.79			.493
							3.15			.527
<b>- Renovation</b>	Renovated	2.92	.533	-.043	.965	3.15	.527	<b>-2.433</b>	<b>.015*</b>	
	No renovate	2.93	.514			3.30	.582			

\* significant at the 0.05 level/ and there is relationship at least 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

The statistical analysis of mean ( $\bar{x}$ ) average of resident satisfaction of three aspects based on gender, ownership status, and dwelling renovation which represented on significant level ( $P < 0.05$ ) was selected to present in Figure 4.6. There were two items at significant level of 0.05; living area and accessibility to the disabled and age people in terms of gender variable. Meanwhile, ownership status based on owner and rental showed that it resulted of satisfaction level of ten items. These items were clearly classification that original owners of dwelling unit rated a scale of satisfaction rather higher than rental people, especially on building scale (BS) and community scale (CS).

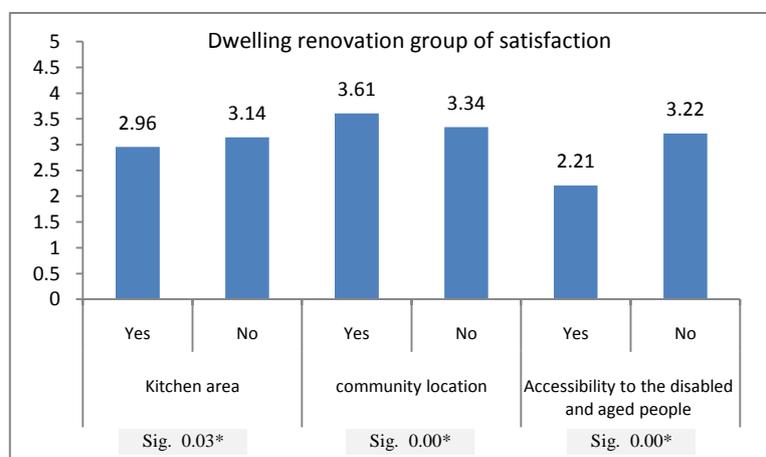
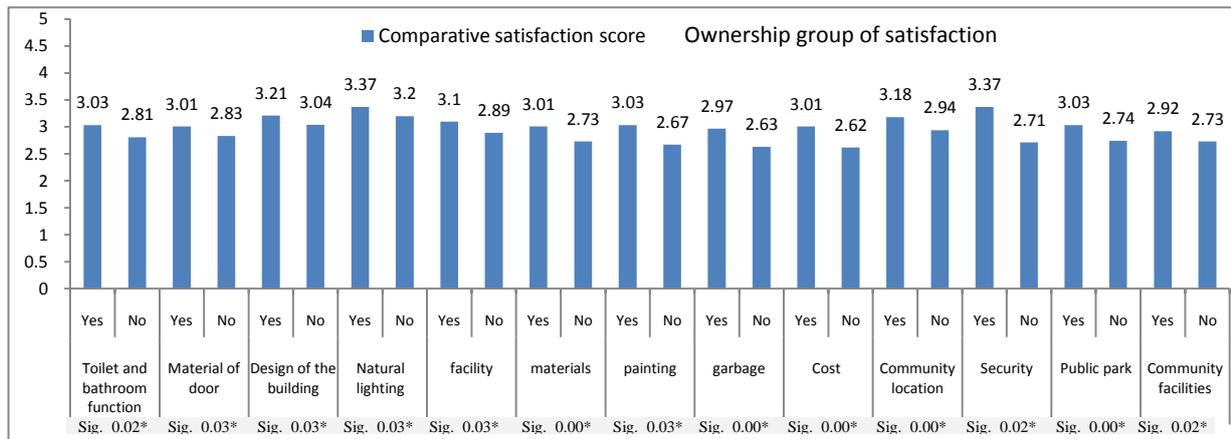
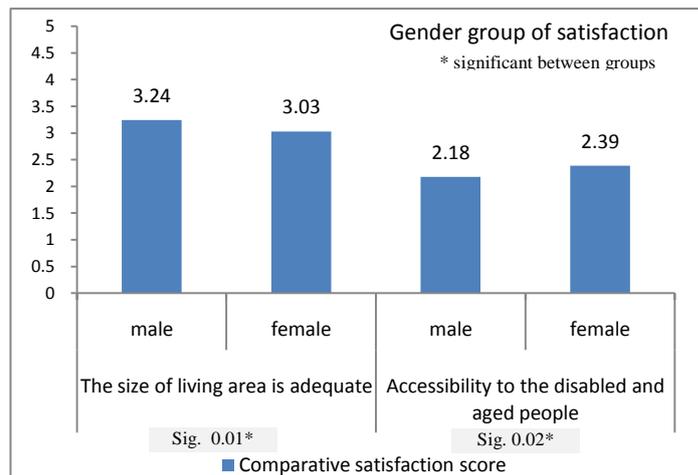


Figure 4.6 Satisfaction of three aspects based on socio-economic by Independent-Samples T-Test

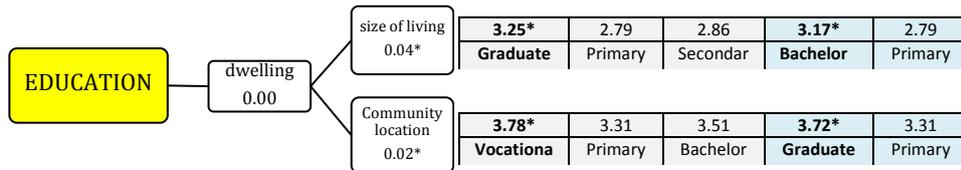
This result reveals that the ownership as owner was a little bit more satisfied with the place of living than a tenant. For dwelling renovation, there were three variables of mean of resident satisfaction is different between on kitchen area, public housing location, and accessibility to the disabled and aged people in the community of statistical significant at 0.05. For One-Way ANOVA analysis, all variables in different of resident satisfaction were showed in Figure 4.7, 4.8, 4.9, 4.10, 4.11 and 4.12.

Table 4.12 Satisfaction of three dimensions based on socio-economic by One-Way ANOVA

Independent variable	Satisfaction	F	Sig.
<b>H4 : AGE</b>	material of ceiling	2.340	0.03*
	noisy	2.470	0.02*
	design of building	3.784	0.00*
	building facilities	2.204	0.04*
	building materials	3.495	0.00*
	building painting	4.675	0.00*
	garbage storage	2.202	0.04*
	building management	2.224	0.04*
	maintenance cost	4.749	0.00*
	community location	4.224	0.00*
	community facilities	2.732	0.01*
	car park	2.352	0.03*
	accessibility to aged people	3.385	0.00*
<b>H5 : EDUCATION</b>	size of living area	2.173	0.04*
	community location	2.607	0.02*
<b>H6 : OCCUPATION</b>	dining area	2.286	0.03*
	bedroom	2.119	0.04*
	size of living area	2.155	0.04*
	size of kitchen space	2.277	0.03*
	size of bedroom	2.137	0.04*
	materials used in floors	2.766	0.00*
	building materials	2.871	0.00*
	building painting	2.330	0.02*
	garbage storage	2.285	0.03*
	maintenance cost	2.752	0.01*
	accessibility to aged people	3.189	0.00*
<b>H7 : INCOME</b>	size of kitchen	1.929	0.04*
	size of bedroom	1.938	0.05*
	size of toilet	2.119	0.03*
	quality of window	2.827	0.00*
	quality of toilet and indoor air quality	2.467	0.01*
	noisy	3.006	0.00*
	noisy	2.341	0.01*
	design of building	2.094	0.03*
	building painting	1.922	0.05*
	building management	2.210	0.02*
	community facilities	2.010	0.04*
accessibility to aged people	4.457	0.00*	
<b>H8: FAMILY SIZE</b>	size of kitchen	3.081	0.00*
	noisy	2.423	0.02*
	building painting	2.379	0.00*
	garbage storage	2.148	0.05*
	building management	2.445	0.02*
<b>H9: LENGTH OF RESIDENCY</b>	car park	2.173	0.05*
	quality of door	2.797	0.04*
	quality of toilet	2.974	0.03*
	noisy	2.884	0.04*
	design of building	4.201	0.00*
	building lighting	3.623	0.01*
	building facilities	2.880	0.04*
	building materials	4.330	0.00*
	building painting	7.400	0.00*
	garbage storage	5.320	0.00*
	maintenance cost	4.758	0.00*
	community location	6.530	0.00*
	community facilities	2.722	0.04*

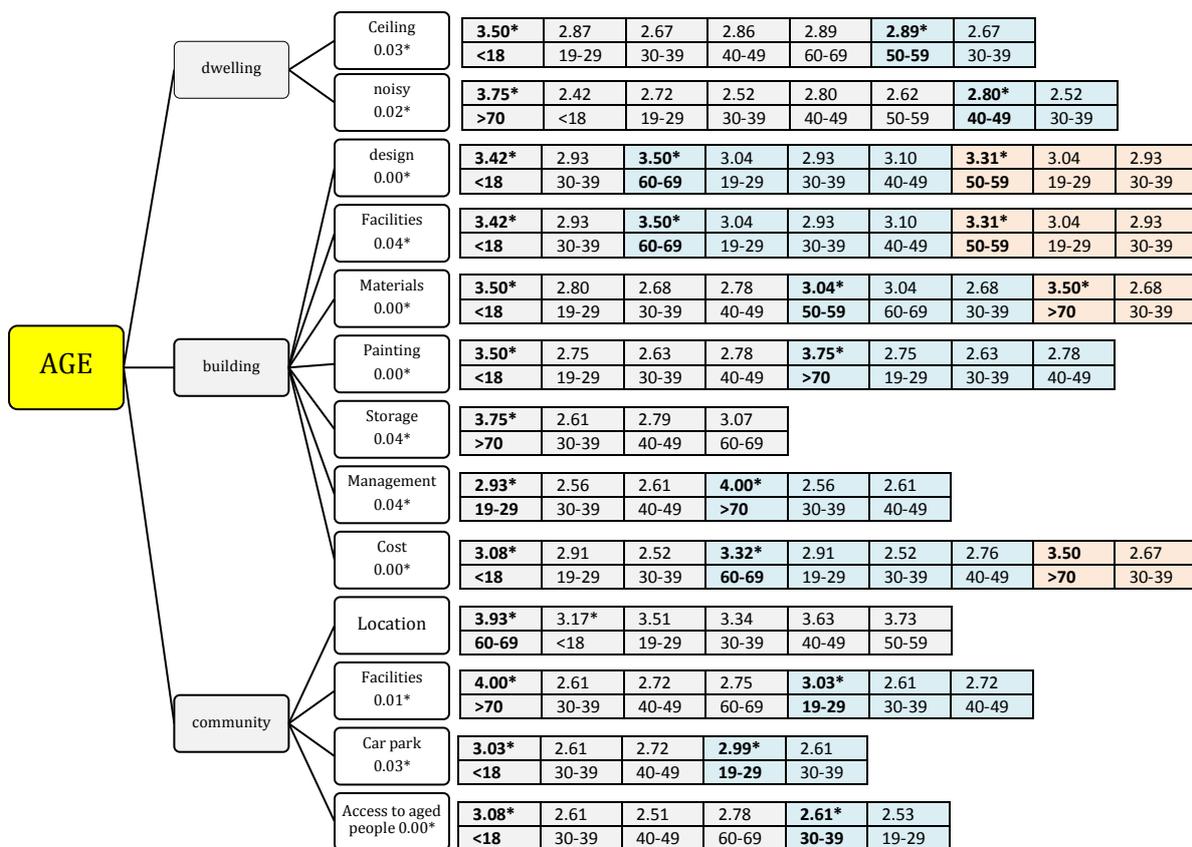
\* P-value <0.05

Using the socio-economic background of residents revealed some variable related to satisfaction level at statistically significant based gender, ownership, dwelling renovation, age, education, occupation, income, family size, and length of residency. This result shows important implications to approach user-centered as the building performance is assessed according to the degree of satisfaction. However, determining variable factor that would increase the level of satisfaction will be studied on the next part by regression for predicting factor of satisfaction.



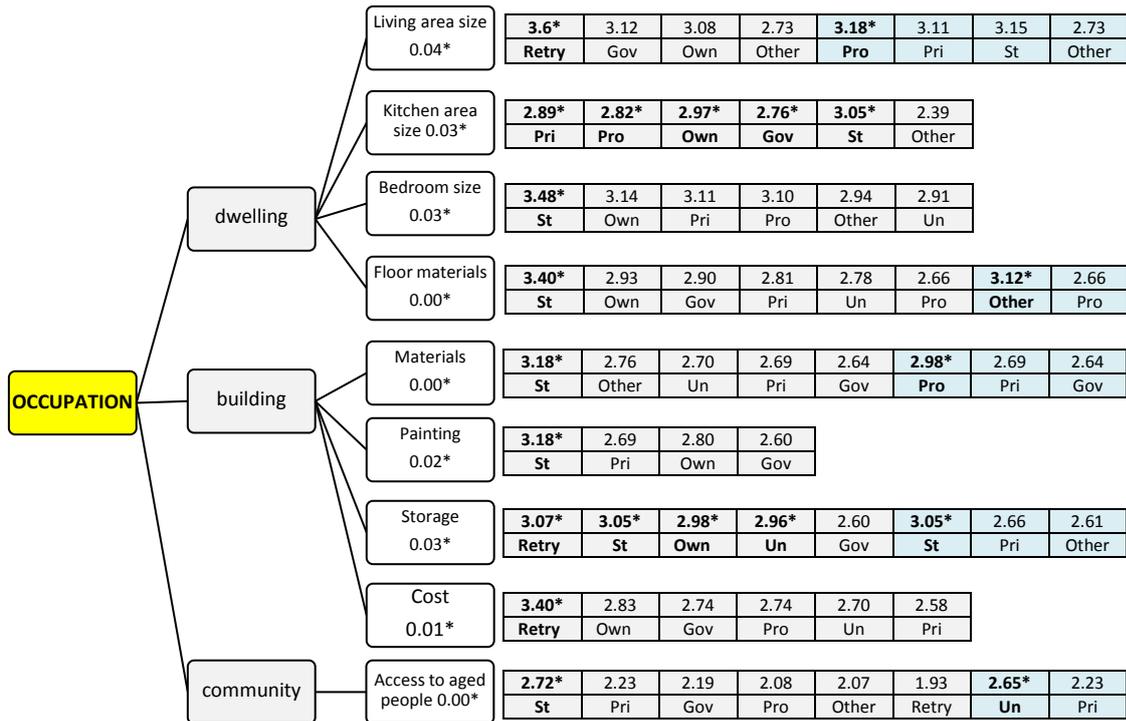
\*The mean score of satisfaction is significant statistic difference between groups at .05

Figure 4.7 Significant statistics between groups of education on satisfaction



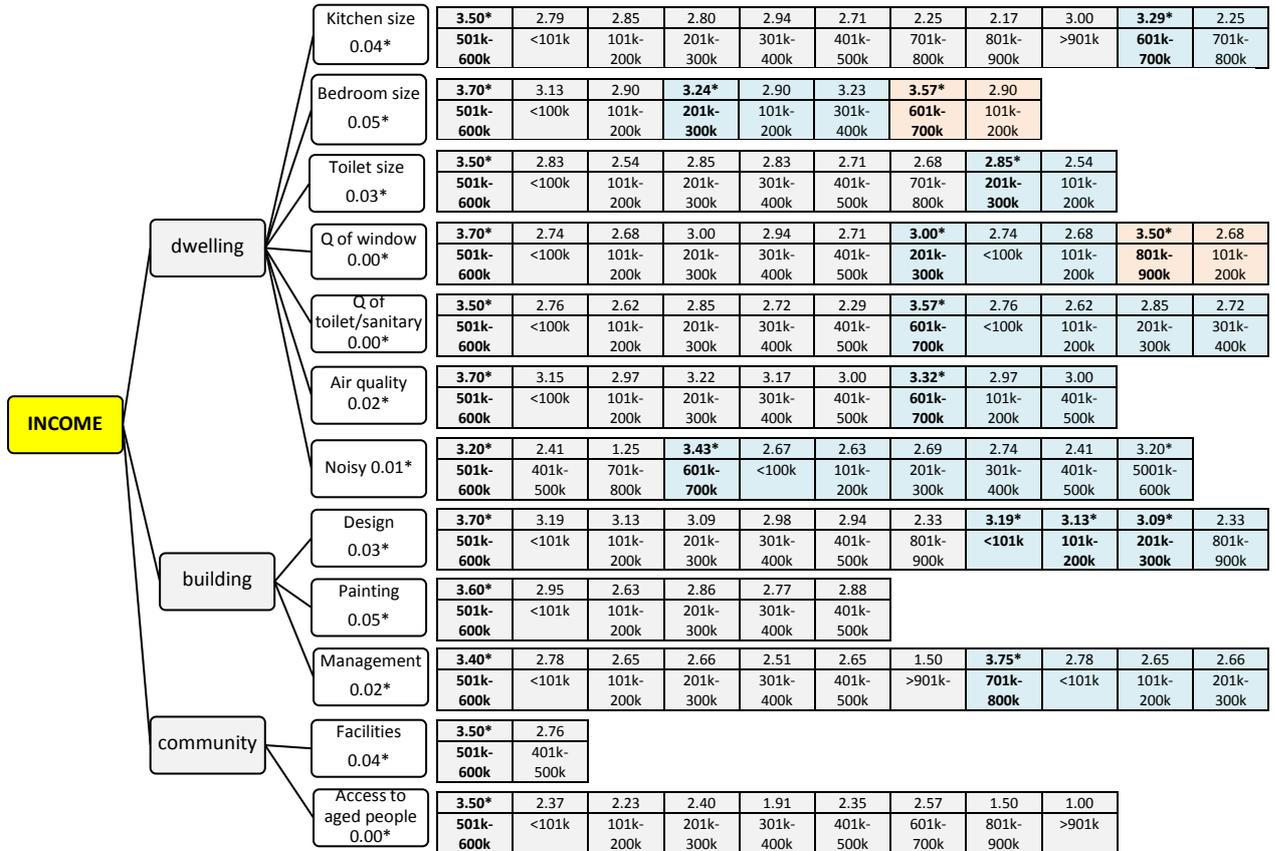
\*The mean score of satisfaction is significant statistic difference between groups at .05

Figure 4.8 Significant statistics between groups of age on satisfaction



Occupation: St = Student, Own = Owner business, Retry, Gov = Government/public officer, Pri = Private company, Pro = Professional freelance, Un = Unemployment, Other  
 \*The mean score of satisfaction is significant statistic difference between groups at .05

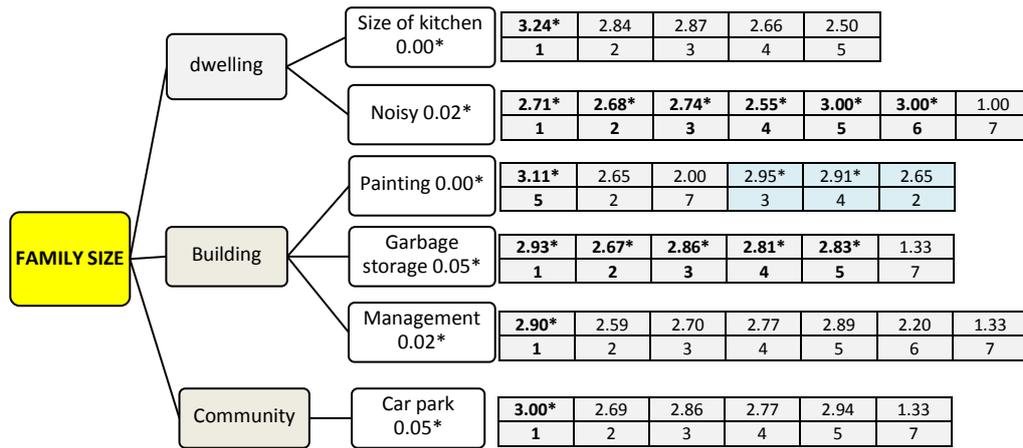
Figure 4.9 Significant statistics between groups of occupation on satisfaction



100k = 100,000 Baht

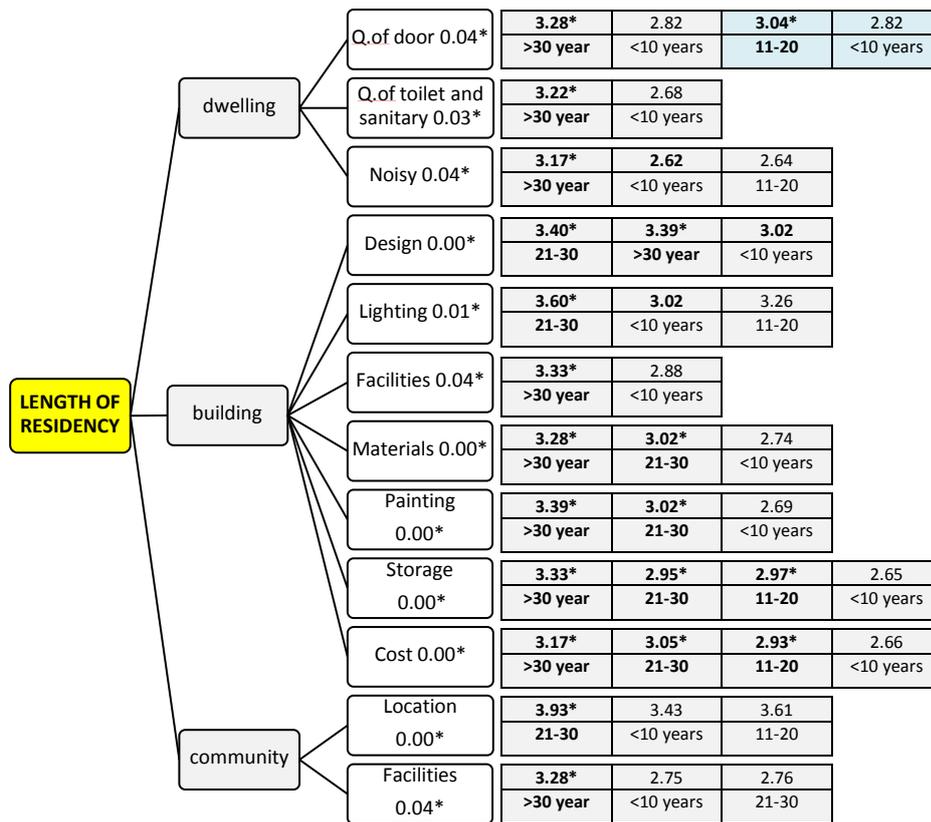
\*The mean score of satisfaction is significant statistic difference between groups at .05

Figure 4.10 Significant statistics between groups of income on satisfaction



Family size: 1 = 1 member (single), 2 = 2 members, 3 = 3 members, 4 = 4 members, 5 = 5 members, 6 = 6 members, 7 = 7 members  
 \*The mean score of satisfaction is significant statistic difference between groups at .05

Figure 4.11 Significant statistics between groups of family size on satisfaction score



Occupation: St = Student, Own = Owner business, Retry, Gov = Government/public officer, Pri = Private company, Pro = Professional freelance, Un = Unemployment, Other  
 \*The mean score of satisfaction is significant statistic difference between groups at .05

Figure 4.12 Significant statistics between groups of length of residency on satisfaction score

#### 4.4 Investigating the Influence of Variables on Overall Satisfaction

This section discusses the models to figure out the significant relationship between the variables of personal information of respondents (demographics, socio-economic and living conditions) and variables of three aspects of living satisfaction (dwelling, building and community) in “Old” and “New” public housing project as shown in Figure 4.13. The living satisfaction is related to or associated with these independents. 9 independents as already mentioned in section 4.3 and 30 variables in the questionnaire survey were involved in logistic regression analysis.

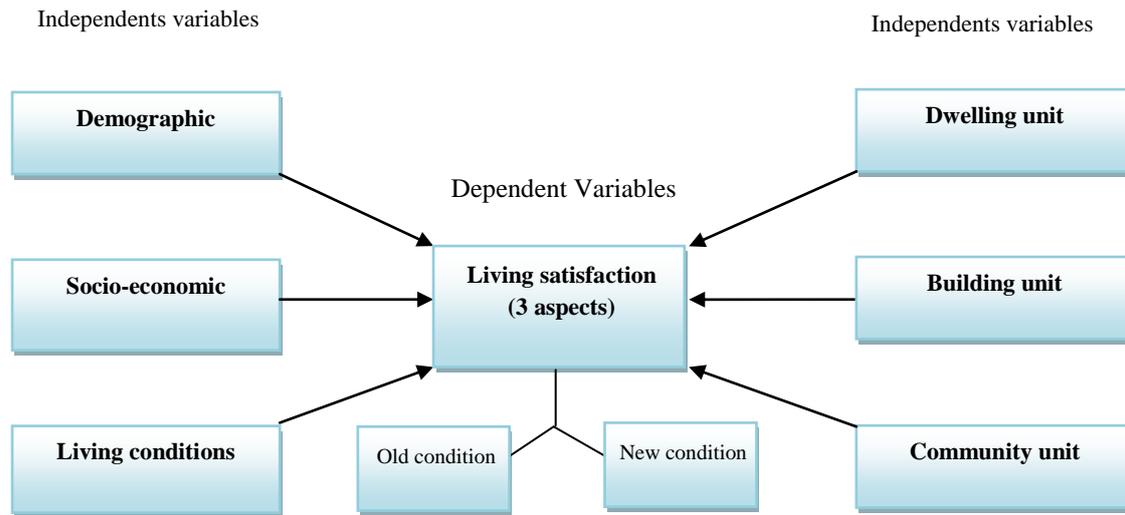


Figure 4.13 Independents and dependent analysis concept

Determining satisfaction is very subjective since it is dependent on emotions and personal experiences; it can be a positive or a negative feeling (Hinkle, Wiersma, & Jurs 1998). Oliver (1989) proposed that the level of expectations could be within a normal range, or surprisingly positive and delightful. According to EGAT (2013), high and low satisfactions were classified as dichotomous data (dummy variables). From a 5-point Likert scale, 3–5 represents high satisfaction and 1–2 represents low satisfaction based on a binominal scale for logistic regression. The levels of satisfaction from a 5-point Likert scale in this study have been formulated by grouping them into dummy variables as shown in Table 4.13. Demographics, socio-economic factors and living conditions were recorded as dichotomous data including gender, age, education, occupation, income, family size, ownership status, length of residency, and dwelling renovation. All variables were categorized into nominal scale. For example, sub-variable of education and income is divided by basic criteria that for education variable would influence to satisfaction as living perception of those who are different educated backgrounds between below and upper bachelor degree. For income variable, the researcher has separated the range of income level of respondents of questionnaire survey according with annual income average of population in Bangkok about 600,000 Baht/year (Puapan, Punpiemrach, & Kamlai, 2012). Also, each variable is normally distributed underlying a basic assumption

for collinearity diagnostics. Binary logistic regression was applied to analyze the relationship between general information and the 30 variables in the three aspects of overall satisfaction as show in Table 4.14.

**Table 4.13** Independent variables demographics, socio-economic and living conditions

Items	Sub-variables	Dummy value
Gender	- Male	Yes = 1
	- Female	Otherwise = 0
Age	- Years	Number
Education*	- > Bachelor	Yes = 1
	- < Below	Otherwise = 0
Occupation	- Government/private	Yes = 1 Otherwise = 0
	- Own business	Yes = 1 Otherwise = 0
	- Unemployment	Yes = 1 Otherwise = 0
Income*	- < 600,000	Yes = 1
	- > 600,001	Otherwise = 0
Family size	- Members	Number
Ownership	- Owner	Yes = 1
	- Rental	Otherwise = 0
Length of residency	- Years	Number
Dwelling renovation	- Yes	Yes = 1
	- No	Otherwise = 0

Logistic regression determines the impact of multiple independent variables presented simultaneously to predict membership of one or other of the two dependent variable categories. To predict positive impact on overall satisfaction in public housing project the logistic regression equation can be used as the following equation:

$$Prob (satisfied) = \frac{1e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p}}{1 + e^{-(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p)}}$$

where,

- $Prob$  = the probability that a case is in a particular category,
- $e$  = the base of natural logarithms (approx 2.718),
- $\beta_0$  = the constant of the equation and,
- $\beta_1$  = the coefficient of the predictor variables.

Or

$$Prob (satisfied) = \frac{1}{1 + e^{-z}}$$

where,

$$z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p$$

Table 4.14 The 30 variables in classified group of three aspects

Code	Satisfaction variables	Code	Satisfaction variables
Dwelling scale (15 variables)		Building scale (9 variables)	
Ds_1	Size of living area	Bs_1	Design of the building
Ds_2	Size of kitchen space	Bs_2	Natural lighting of this building
Ds_3	Size of bedroom	Bs_3	Quality of building facility
Ds_4	Size of toilet and bathroom	Bs_4	Quality of building materials
Ds_5	Size of balcony	Bs_5	Quality of paints of this building
Ds_6	Quality of materials used in floors	Bs_6	Quality of garbage storage
Ds_7	Quality of materials used in walls	Bs_7	Cleanness of building
Ds_8	Quality of materials used in ceiling	Bs_8	Management rules & regulations
Ds_9	The operation of windows is ok	Bs_9	Cost of maintenance
Ds_10	The operation of doors	Community scale (6 variables)	
Ds_11	The operation of sanitary in toilet	Cs_1	Community location
Ds_12	Quality of indoor air quality	Cs_2	Security of your neighborhood
Ds_13	Quality of ventilation	Cs_3	Public park
Ds_14	Quality of natural lighting in the room	Cs_4	Sport/playground facilities
Ds_15	Quality of room from noisy surrounding	Cs_5	Car park
		Cs_6	Accessibility to the disabled/aged people

#### 4.4.1 Results of the influence of personal profile variables on overall satisfaction

To understand how the personal background and socioeconomic factors of the respondents could affect satisfaction a number of factors were analyzed. A logistic regression model provided coefficients (Omnibus tests) for all three aspects of both projects at  $< .05$  (see Table 4.15-4.17). This indicated that the predictor variables significantly affected the dependent variables. Significant variables of personal profiles were analyzed as follows:

- ***Dwelling satisfaction***

R values (Nagelkerke's) of variables on overall dwelling feature satisfaction showed the relationship at 10.1% for Klong Chan Flat and 21.7% for Buengkum Baan Eur Arthron. Family size was a significant variable predicting dwelling satisfaction of Klong Chan Flat with a p-value of .003 with a negative value of  $-.444$ . For Buengkum Baan Eur Arthron, occupation 1 (owner business) and family size were found to have significant influence with p-values of .008 and .019 respectively; however, these variables indicated less satisfaction with negative values at  $-1.324$  and  $-.514$  respectively. These results are in line with the study of Theodori (2001) and Varady, Walker, & Wang (2001). According to prior studies by Ogu (2002) and Apgar (2004), the type of housing ownership of residents could affect satisfaction, meanwhile gender had no effect on satisfaction (Mastura, Noor, Osman, & Ramayah, 2005). However, Ibem & Amole (2012) found that length of residency is not a predictor of housing satisfaction. From Table 4.15 shows a logistic coefficient ( $\beta$ ) that can create a predictive equation formula as below:

1) Klong Chan Flat Project:-

$$Prob(event) = \frac{1}{1 + e^{-(8.579-.444(FAMILY SIZE))}}$$

2) Buengkum Baan Eur Arthron Project:-

$$Prob(event) = \frac{1}{1 + e^{-(25.604-1.324(OCCUPATION1)-.514(FAMILY SIZE))}}$$

Table 4.15 Influenced of personal profiles on dwelling satisfaction

Klong Chan Flat (Old Project Condition)				Buengkum Baan Eur Arthron (New Project Condition)			
Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )	Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )
- GENDER	.475	.223	1.607	- GENDER	.561	.158	1.753
- AGE	-.018	.293	.982	- AGE	-.028	.093	.972
- EDUCATION	.063	.882	1.065	- EDUCATION	-.010	.985	.990
- OCCUPATION (1)	-.436	.319	.646	- OCCUPATION (1)	-1.114	.061	.328
- OCCUPATION (2)	.197	.705	1.218	- <b>OCCUPATION (2)</b>	<b>-1.324</b>	<b>.008</b>	<b>.266</b>
- INCOME	.433	.525	1.542	- INCOME	-18.971	.988	.000
- <b>FAMILY SIZE</b>	<b>-.444</b>	<b>.003</b>	<b>.641</b>	- <b>FAMILY SIZE</b>	<b>-.514</b>	<b>.019</b>	<b>.598</b>
- LENGTH OF RESIDENCY	.023	.461	1.024	- LENGTH OF RESIDENCY	-.227	.060	.797
- OWNER	-.247	.675	.781	- OWNER	-1.141	.128	.319
- RENOVATE	.446	.311	1.562	- RENOVATE	.432	.283	1.541
<b>Constant</b>	<b>3.579</b>	<b>.013</b>	<b>35.848</b>	<b>Constant</b>	<b>25.604</b>	<b>.997</b>	<b>1.317</b>
Omnibus tests of Model Coefficients = 18.625/df 10/sig .045				Omnibus tests of Model Coefficients = 38.658/df 10/sig .000			
Hosmer and Lemeshow = 8.496,df =8,sig. = .387				Hosmer and Lemeshow = 4.408,df =8,sig.= .819			
-2 Log likelihood = 226.301, Cox & Snell R2 =.049, Nagellkerke R <sup>2</sup> =.101 (10%)				-2 Log likelihood = 181.057, Cox & Snell R2 =.100 , Nagellkerke R <sup>2</sup> =.217 (21.7%)			
Prediction percentage correct 89.7%				Prediction percentage correct 97.0%			

• **Building satisfaction**

R values were 7.8% for Klong Chan Flat and 20.3% for Buengkum Baan Eur Arthron. Age, family size, and length of residency were considered significant variables for Klong Chan Flat with p-values of .022, .039 and .018 respectively. Length of residency was the only positive value which increased overall satisfaction with building features. This finding supports the study of Varady and Preiser (1998) in which length of residency affects satisfaction. For Buengkum Baan Eur Arthron, five predictor variables were found significant with p-values < .05. These include age = .031, occupation1 (owner business) = .002, occupation2 (government/private) = .007, length of residency = .000, and owner = .000. Age was a positively significant variable that contributes to satisfaction in line with the study by Varady & Carrozza (2000). From Table 4.16 shows a logistic coefficient ( $\beta$ ) that can create a predictive equation formula as below:

1) Klong Chan Flat Project:-

$$Prob(event) = \frac{1}{1 + e^{-(2.494-.032(AGE)-.256((FAMILY SIZE)-.061(LENGTH OF RESIDENCY))}}$$

2) Buengkum Baan Eur Arthron Project:-

$$Prob(event) = \frac{1}{1 + e^{-(5.483+.037(AGE)-.1587(OCCUPATION)-1.495(OCCUPATION2)-.272(LENGTH OF RESIDENCY)-2.417(OWNER)}}$$

Table 4.16 Influenced of personal profiles on building satisfaction

Klong Chan Flat (Old Project Condition)				Buengkum Baan Eur Arthron (New Project Condition)			
Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )	Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )
- GENDER	.467	.125	1.595	- GENDER	.147	.692	1.158
- AGE	<b>-.032</b>	<b>.022</b>	<b>.969</b>	- AGE	<b>.037</b>	<b>.031</b>	1.038
- EDUCATION	-.499	.150	.607	- EDUCATION	-.233	.599	.792
- OCCUPATION (1)	-.082	.823	.921	- <b>OCCUPATION (1)</b>	<b>-1.587</b>	<b>.002</b>	.204
- OCCUPATION (2)	-.350	.362	.705	- <b>OCCUPATION (2)</b>	<b>-1.495</b>	<b>.007</b>	<b>.224</b>
- INCOME	.447	.433	1.564	- INCOME	-.996	.359	.369
- FAMILY SIZE	<b>-.256</b>	<b>.039</b>	<b>.774</b>	- FAMILY SIZE	.109	.578	<b>1.115</b>
- LENGTH OF RESIDENCY	<b>.061</b>	<b>.018</b>	<b>1.063</b>	- LENGTH OF RESIDENCY	<b>-.227</b>	<b>.000</b>	.592
- OWNER	.492	.271	1.636	- OWNER	<b>-2.417</b>	<b>.000</b>	.089
- RENOVATE	.146	.657	1.158	- RENOVATE	.057	.886	1.059
<b>Constant</b>	<b>2.484</b>	<b>.035</b>	<b>11.990</b>	<b>Constant</b>	<b>5.483</b>	<b>.000</b>	<b>240.501</b>
Omnibus tests of Model Coefficients = 17.699/df 10/sig .000				Omnibus tests of Model Coefficients = 38.620/df 10/sig .000			
Hosmer and Lemeshow = 6.503,df =8,sig. = .591				Hosmer and Lemeshow = 6.217,df =8,sig.= .623			
-2 Log likelihood = 319.974, Cox & Snell R2 =.047, Nagellkerke R <sup>2</sup> =.078 (7.8%)				-2 Log likelihood = 210.165, Cox & Snell R2 =.100 , Nagellkerke R <sup>2</sup> =.203 (20.3%)			
Prediction percentage correct 83.0%				Prediction percentage correct 97.0%			

• **Community satisfaction**

R values were 8.5% for Klong Chan Flat and 14.6% for Buengkum Baan Eur Arthron. Owner was the only one significant variable affecting community satisfaction for Klong Chan Flat with a p-value of .016 and a negative value of beta indicating low satisfaction. For Buengkum Baan Eur Arthron, occupation 1 = .005, family size = .012, length of residency = .008, and owner = .038 were significant predictors. Family size variable gave a positive value to increase satisfaction. From the Table 4.17 shows a logistic coefficient ( $\beta$ ) that can create a predictive equation formula as below:

1) Klong Chan Flat Project:-

$$Prob(event) = \frac{1}{1 + e^{-(2.484-.032(AGE)-.256(FAMILY SIZE)-.061(LENGTH OF RESIDENCY)}}$$

2) Buengkum Baan Eur Arthron Project:-

$$Prob(event) = \frac{1}{1 + e^{-(5.484+.037(AGE)-.1587(OCCUPATION1)-1.495(OCCUPATION2)-.221(LENGTH OF RESIDENCY)-2.417(OWNER)}}$$

Table 4.17 Influenced of personal profiles on community satisfaction

Klong Chan Flat (Old Project Condition)				Buengkum Baan Eur Arthron (New Project Condition)			
Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )	Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )
- GENDER	-.140	.622	.869	- GENDER	-.181	.614	.834
- AGE	-.022	.122	.979	- AGE	.002	.911	1.002
- EDUCATION	-.281	.403	.755	- EDUCATION	-.893	.061	.410
- OCCUPATION (1)	-.345	.317	.708	- <b>OCCUPATION (1)</b>	<b>-.829</b>	<b>.050</b>	.437
- OCCUPATION (2)	.206	.600	1.228	- OCCUPATION (2)	.091	.841	1.096
- INCOME	.877	.087	2.404	- INCOME	-.918	.384	.399
- FAMILY SIZE	-.072	.564	.931	- <b>FAMILY SIZE</b>	<b>.489</b>	<b>.012</b>	<b>1.613</b>
- LENGTH OF RESIDENCY	-.012	.655	.988	- <b>LENGTH OF RESIDENCY</b>	<b>-.291</b>	<b>.008</b>	<b>.747</b>
- <b>OWNER</b>	<b>-1.238</b>	<b>.016</b>	<b>.290</b>	- <b>OWNER</b>	<b>-1.228</b>	<b>.038</b>	<b>.293</b>
- RENOVATE	-.009	.977	.991	- RENOVATE	.618	.357	2.992
<b>Constant</b>	<b>2.954</b>	<b>.012</b>	<b>19.19</b>	<b>Constant</b>	<b>3.688</b>	<b>.010</b>	<b>39.983</b>
Omnibus tests of Model Coefficients= 19.944/df 10/sig .030				Omnibus tests of Model Coefficients = 28.328/df 10/sig .002			
Hosmer and Lemeshow = 10.510,df =8,sig. = .231				Hosmer and Lemeshow = 10.217,df =8,sig.= .250			
-2 Log likelihood = 338.989, Cox & Snell R2 =.052, Nagellkerke R <sup>2</sup> =.085 (8.5%)				-2 Log likelihood = 233.00, Cox & Snell R2 =.74 , Nagellkerke R <sup>2</sup> =.146 (14.60%)			
Prediction percentage correct 81.6%				Prediction percentage correct 88.3%			

#### 4.4.2 Results of sub-variable satisfaction on overall satisfaction

The significant variables driving performances in the three aspects were presented in Table 4.18, 4.19, and 4.20. Omnibus tests for compatibility indicated a p-value of < .005. The models of both projects were statistically significant. Hosmer and Lemeshow test of both projects showed insignificant chi-square with p-values of >.005. It revealed compatibility between the model and the data collection of this study (Salleh, Yusof, Salleh, & Johari, 2011). R values (Cox and Shell) indicated a percentage improvement for the model with sub-variables (predictors) compared with the null model.

The influencing variables of old and new public housing are summarized as follows:

- **Klong Chan Flat (Old project)**

Sub-variables that influenced overall dwelling satisfaction of the project with positive values were; size of living area, size of toilet & bathroom, flooring materials, operation of doors, and operation of sanitary appliances in the toilet with p-values of < .05. The influencing factors showing the highest beta coefficient were; the size of the living area (B = 1.592), followed by materials used for flooring (B = 1.456), operation of sanitary appliances in the toilet (B = 1.355), and size of toilet and bathroom (B = 1.069). For overall building satisfaction the influencing variables were; design, natural lighting, building facility, cleanness, maintenance cost of the building, all showing significant influence with p-values of <.05. In considering beta values, the design of the building (B = 2.533) and cost of maintenance (B = 1.658) play a role for contributing to satisfaction with positive coefficient values. In terms of overall community satisfaction, the location, neighborhood security, public park, and sport/playground facilities had significant influence with p-values of <.05. The neighborhood security created a high beta value

(B = 2.548) which contributed to satisfaction with the Klong Chan Flat project. From the Table 4.18 shows a logistic coefficient ( $\beta$ ) that can create a predictive equation formula as below:

1) Dwelling unit aspect

$$Prob(event) = \frac{1}{1 + e^{-(0.348) + (1.592 \times DS1) + (1.069 \times DS4) + (1.456 \times DS6) + (1.355 \times DS11)}}$$

2) Building unit aspect

$$Prob(event) = \frac{1}{1 + e^{-(2.537) + (2.533 \times BS1) + (.992 \times BS2) + (1.196 \times BS3) + (1.2685 \times BS7) + (1.658 \times BS9)}}$$

3) Community unit aspect

$$Prob(event) = \frac{1}{1 + e^{-(3.133) + (1.993 \times CS1) + (2.548 \times CS2) + (1.584 \times CS3) + (1.245 \times CS4)}}$$

- **Buengkum Baan Eur Arthron (New project)**

Materials used in the walls and indoor air quality were found to have significant influence on satisfaction with a p-value of < .05, and both variables had positive beta values (B = 2.217 and 2.077 respectively). Meanwhile, materials used for the floors were found to have significant influence on satisfaction and it was predicted to lead to less satisfaction as a result of a negative beta value. Regarding overall building satisfaction, design, natural lighting, quality of paints, quality of garbage storage, and maintenance cost were found to be significant. Natural lighting, quality of paints, design of building showed positive coefficient values (B = 3.532, 3.391, and 3.185 respectively) leading to satisfaction. Quality of garbage storage was a significant predictor that resulted in low satisfaction. Three independents variables were found to have significant influence with a p-value of <.05 on overall community satisfaction, these were location, neighbourhood security, and accessibility for the disabled and elder people. All showed positive coefficient values. Accessibility for the disabled and elder people was an important influencing factor with beta values of 1.377 that encouraged satisfaction.

1) Dwelling unit aspect

$$Prob(event) = \frac{1}{1 + e^{-(1.290) - 1.48(DS6) + 2.217(DS7) + 2.077(DS12)}}$$

2) Building unit aspect

$$Prob(event) = \frac{1}{1 + e^{-(4.140) + (3.185 \times BS1) + (3.532 \times BS2) + (3.391 \times BS5) - (2.136 \times BS6) + (2.003 \times BS9)}}$$

3) Community unit aspect

$$Prob(event) = \frac{1}{1 + e^{-(1.038) + (1.038 \times CS1) + (1.016 \times CS2) + (1.377 \times CS6)}}$$

Table 4.18 Influence of sub-variables on overall satisfaction in dwelling aspect

Sub-variables satisfaction on overall dwelling feature satisfaction							
Klong Chan Flat Project (Old Project Condition)				Buengkum Baan Eur Arthron Project (New Project Condition)			
Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )	Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )
<b>Dwelling features</b>				<b>Dwelling features</b>			
Ds_1 Size of living area	1.592	.000	4.911	Ds_1 Size of living area	.103	.880	1.109
Ds_2 Size of kitchen space	-0.088	.853	0.916	Ds_2 Size of kitchen space	.696	.250	2.006
Ds_3 Size of bedroom	0.090	.855	1.094	Ds_3 Size of bedroom	.576	.388	1.780
<b>Ds_4 Size of toilet &amp; bathroom</b>	<b>1.069</b>	<b>.021</b>	<b>2.913</b>	Ds_4 Size of toilet & bathroom	.394	.508	1.483
<b>Ds_6 Materials used in floors</b>	<b>1.456</b>	<b>.003</b>	<b>4.290</b>	Ds_5 Size of balcony	.221	.701	1.247
Ds_7 Materials used in walls	-1.029	.077	0.357	<b>Ds_6 Materials used in floors</b>	<b>-1.482</b>	<b>.042</b>	<b>.227</b>
Ds_8 Materials used in ceiling	-0.397	.477	0.672	<b>Ds_7 Materials used in walls</b>	<b>2.217</b>	<b>.000</b>	<b>9.177</b>
Ds_9 Operation of windows	-0.580	.313	0.560	Ds_8 Materials used in ceiling	.554	.430	1.741
<b>Ds_10 Operation of doors</b>	<b>0.740</b>	<b>.196</b>	<b>2.095</b>	Ds_9 Operation of windows	.412	.552	1.511
<b>Ds_11 Operation of sanitary in toilet</b>	<b>1.355</b>	<b>.011</b>	<b>3.875</b>	Ds_10 Operation of doors	-.780	.307	.458
Ds_12 Quality of indoor air quality	0.116	.843	1.124	Ds_11 Operation of sanitary in toilet	.157	.830	1.170
Ds_13 Quality of ventilation	-0.012	.986	0.988	<b>Ds_12 Quality of indoor air quality</b>	<b>2.077</b>	<b>.018</b>	<b>7.980</b>
Ds_14 Quality of natural lighting	0.388	.533	1.474	Ds_13 Quality of ventilation	-.543	.558	.581
Ds_15 Quality of room from noisy	-0.290	.527	0.749	Ds_14 Quality of natural lighting	.417	.613	1.517
				Ds_15 Quality of room from noisy	-.135	.858	.874
<b>Constant</b>	<b>-0.348</b>	<b>0.533</b>	<b>0.706</b>	<b>Constant</b>	<b>-1.290</b>	<b>.055</b>	<b>.275</b>
Omnibus tests of Model Coefficients = 66.063/df 14/sig .000				Omnibus tests of Model Coefficients = 67.000/df 15/sig .000			
Hosmer and Lemeshow = 4.480,df =7,sig. =.735				Hosmer and Lemeshow = 14.947,df =5,sig.= .112			
-2 Log likelihood = 178.863, Cox & Snell R <sup>2</sup> =.164,				-2 Log likelihood = 160.101, Cox & Snell R <sup>2</sup> =.166, Nagellkerke R <sup>2</sup>			
Nagellkerke R <sup>2</sup> =.338 (33.8%)				=.361 (36.1%)			
Prediction percentage correct 91.1%				Prediction percentage correct 93.2%			

Table 4.19 Influence of sub-variables on overall satisfaction in building aspect

Sub-variables satisfaction on overall dwelling feature satisfaction							
Klong Chan Flat Project (Old Project Condition)				Buengkum Baan Eur Arthron Project (New Project Condition)			
Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )	Independents Variables	$\beta$	Sig.	Exp ( $\beta$ )
<b>Building features</b>				<b>Building features</b>			
Bs_1 Design of the building	2.533	.000	12.585	Bs_1 Design of the building	3.185	.000	24.170
Bs_2 Natural lighting of this building	.992	.024	2.696	Bs_2 Natural lighting of this building	3.532	.000	34.180
<b>Bs_3 Quality of building facility</b>	<b>1.196</b>	<b>.003</b>	<b>3.306</b>	Bs_3 Quality of building facility	.382	.621	1.465
Bs_4 Quality of building materials	-.701	.128	.496	Bs_4 Quality of building materials	-.694	.325	.499
Bs_5 Quality of paints of this building	-.879	.064	.415	<b>Bs_5 Quality of paints of this building</b>	<b>3.391</b>	<b>.000</b>	<b>29.681</b>
Bs_6 Quality of garbage storage	.200	.651	1.222	<b>Bs_6 Quality of garbage storage</b>	<b>-2.136</b>	<b>.006</b>	<b>.118</b>
<b>Bs_7 Cleanness of building</b>	<b>1.268</b>	<b>.009</b>	<b>3.555</b>	Bs_7 Cleanness of building	-1.159	.184	.314
Bs_8 Management rules & regulations	.351	.485	1.420	Bs_8 Management rules & regulations	.460	.594	1.584
<b>Bs_9 Cost of maintenance</b>	<b>1.658</b>	<b>.000</b>	<b>5.248</b>	<b>Bs_9 Cost of maintenance</b>	<b>2.003</b>	<b>.017</b>	<b>7.410</b>
<b>Constant</b>	<b>-2.537</b>	<b>0.000</b>	<b>.079</b>	<b>Constant</b>	<b>-4.140</b>	<b>.000</b>	<b>.016</b>
Omnibus tests of Model Coefficients = 135.480/df 9/sig .000				Omnibus tests of Model Coefficients = 153.317/df 9/sig .000			
Hosmer and Lemeshow = 4.709 df =6,sig.=.582				Hosmer and Lemeshow = 51.027,df =5,sig.=.344			
-2 Log likelihood = 202.192, Cox & Snell R <sup>2</sup> =.307,				-2 Log likelihood = 95.915, Cox & Snell R <sup>2</sup> =.339, Nagellkerke R <sup>2</sup>			
Nagellkerke R <sup>2</sup> =.512 (51.2%)				=.692 (69.2%)			
Prediction percentage correct 87.8%				Prediction percentage correct 96.2%			

Table 4.20 Influence of sub-variables on overall satisfaction in community aspect

Sub-variables satisfaction on overall dwelling feature satisfaction									
Klong Chan Flat Project (Old Project Condition)					Buengkum Baan Eur Arthron Project (New Project Condition)				
Variables		$\beta$	Sig.	Exp ( $\beta$ )	Variables		$\beta$	Sig.	Exp ( $\beta$ )
<b>Community features</b>					<b>Community features</b>				
Cs_1	Community location	1.993	.008	7.338	Cs_1	Community location	1.038	.040	2.824
Cs_2	Security of your neighborhood	2.548	.000	12.784	Cs_2	Security of your neighborhood	1.016	.022	2.761
Cs_3	Public park	1.584	.000	4.875	Cs_3	Public park	.675	.130	1.964
Cs_4	Sport/playground facilities	1.245	.009	3.473	Cs_4	Sport/playground facilities	.713	.120	2.041
Cs_5	Car park	.042	.923	1.043	Cs_5	Car park	.284	.562	1.329
Cs_6	Accessibility to the disabled and aged people	.265	.608	1.304	Cs_6	Accessibility to the disabled and aged people	1.377	.008	3.964
<b>Constant</b>		<b>-3.133</b>	<b>.000</b>	<b>.044</b>	<b>Constant</b>		<b>-1.038</b>	<b>.020</b>	<b>.354</b>
Omnibus tests of Model Coefficients = 169.534/df 6/sig .000					Omnibus tests of Model Coefficients = 79.837/df 6/sig .000				
Hosmer and Lemeshow = 8.291/df =6,sig.=.218					Hosmer and Lemeshow = 9.368,df =5,sig.= .095				
-2 Log likelihood =188.558, Cox & Snell R <sup>2</sup> =.369,					-2 Log likelihood = 181.974, Cox & Snell R <sup>2</sup> =.194,				
Nagellkerke R <sup>2</sup> =.593 (59.3%)					Nagellkerke R <sup>2</sup> =.383 (38.3%)				
Prediction percentage correct 90.2%					Prediction percentage correct 91.4%				

#### 4.5 Conclusion

Klong Chan Flat Project and Buengkum Baan Eur Arthron Project were represented “Old” and “New” affordable low-income public housing scheme in Bangkok by National Housing Authority (NHA). 740 questionnaires were distributed to both projects to understand satisfaction by post-occupancy evaluation theory. The result of questionnaire based on 30 variables found that most of mean score satisfactions based on three aspects of Klong Chan Flat Project was lower than Buengkum Baan Eur Arthron Project. Measuring subjective satisfaction is depend on individual perception and their socio-economic status the study uses T-test and One-way ANOVA to examine a difference satisfaction between group of gender, age, education, occupation income, family size, length of residency, homeownership, and renovate room. These variables have showed a significant attribute that it could be focused on specific group of occupants to enhance their satisfaction. In the process logistic regression has let us knows the influence variables which are the highest beta coefficient value for predicting high satisfaction of both projects. Therefore, considering these variables into public housing improvement program would be contributing high satisfaction level of people that requires close attention.

Measuring dwellers’ satisfaction with specific aspects of old and new housing projects was conducted to provide a comprehensive data set, from which it is possible to make recommendations for future improvements to public housing quality. The three main recommendations are:

**(1) Improvement of Dwelling Unit Features**

For the physical elements of the dwelling units both projects scored fair satisfaction levels. The residents living in Buengkum Baan Eur Arthron have higher satisfaction than those in Klong Chan Flat

(where the room sizes are larger than the standard). Providing sub-standard dwelling units with small-sized rooms under the policy of the National Housing Authority does not lead to a decrease in residents' satisfaction. However, family size is a significant factor as shown in Table 5 and Table 6 that directly affects the satisfaction with dwelling unit size, quality of materials, and indoor environments (thermal comfort). Improvement programmes of government agencies and the dwelling owners should consider the requirements of all members of the household. For example, the density of the living unit and the environmental comfort of the unit should be assessed. This can inform the basis to deal with effective design performance and enhance the quality of living based on individual behaviors. Although the development of affordable public housing for low-income people is limited by the physical size provided, understanding the context of users and their requirements should be brought into focus for the decision-makers of future housing programmes.

### **(2) *Improvement of Building Unit Features***

The research revealed that the old Klong Chan Flat project had lower satisfaction scores compared to the newer Buengkum Baan Eur Arthron project. To improve all the elements may not be possible due to the very limited budget, and so it is necessary to consider priority based on satisfaction levels. The influencing variable affecting satisfaction level in Table 6 is the building design, which should be more aesthetically pleasing. Because the project has its own management system and the residents are from low-income groups, changing the appearance of the existing buildings may be quite difficult. Better building maintenance, such as building cleaning, could be proposed as an initiative with low cost implications since it mainly requires residents' participation. For Buengkum Baan Eur Arthron the building design, lighting quality, and painting of the building were significant factors for improving satisfaction levels. These should be monitored and measured. Even though this project is a new type of public housing development, using the same building styles for the whole country may result in less satisfaction. The technologies associated with prefabricated construction for entire buildings, which are claimed to be faster and reduce environmental impacts compared to traditional construction, caused the residents to worry about the strength of the units when they wanted to renovate the rooms. They were primarily concerned with avoiding structural damage when they altered the interior layout. To ensure buildings are operated in good condition it is essential those performance improvements are cost-effective, although setting monthly rents at an appropriate and affordable level is a challenge. Furthermore, the statistical results of residents' characteristics of Klong Chan Flat indicated that the length of residency, the experience of the building and age groups, such as children, working age, and elders, in case of Buengkum Baan Eur Arthron should be considered in future building improvement initiatives.

### **(3) *Improvement of Community Unit Features***

Satisfaction with the physical community and location of both projects was at a satisfied level. Location plays an important factor that influenced satisfaction, as indicated by coefficient beta values. Both projects are located in urban areas and near public service and commercial zones. This can reduce the

cost of travelling for low-income people. Providing the public housing development nearby public transit services should be considered so as to increase satisfaction of residents. The distinctive difference of Klong Chan Flat is an opened-community context that can affect neighbourhood security with a low satisfaction score. Automobile accidents, theft, and crimes are problems related to this project. Monitoring and physical disorders survey within the community should be conducted in particular areas. Public parks, sport and playground facilities are under NHA responsibility. Improvement of these existing facilities will enhance the quality of the community. The most influencing factor of Buengkum Baan Eur Arthron is accessibility for disabled and elders. This factor does not contribute to satisfaction in case of Klong Chan Flat. However, to provide a universal design principle for all residents it is important to create an inclusive environment of wellbeing for the elderly and disabled persons. Demographic factors including family size that influence, or help to explain, levels of satisfaction should also be investigated in relation to community development.

To conclude, the results of our research into the level of residents' satisfaction with the two housing schemes may assist the project owners and relevant public housing stakeholders to prioritize specific actions. These actions, based on evidence, should aim to improve the level of residents' satisfaction

## CHAPTER 5

### ANALYSIS OF DWELLING UNIT FEATURES AND ITS EFFECT TO OCCUPANTS COMFORT

This chapter purposed to study the result of post-occupancy evaluation (POE) of Chapter 4 on the dwelling unit aspect. To improve public housing with highly satisfied level of occupants, there were four influence factors including size of living area, size of toilet & baht room, materials used in floor, and operation of sanitary in toilet. It can mention that those factors are highly related to occupants' behavior and activity as using frequency on dwelling's functions. In spite of this, the researcher has conducted a whole dwelling unit assessment and observed a living condition especially of the old public housing project that has been ran-down. Beside, a basic of indoor environment on temperature and airflow was also focus investigated that how those dwelling unit features performs to contribute an occupant living comfort.

#### 5.1 Dwelling Unit Analysis

The substandard dwelling unit of National Housing Authority of Thailand (NHA) is established to comply with a law and building regulation as layout proper site planning, infrastructure and services, public circulation, housing pattern, zoning area, and standard of dwelling unit (Department of Local Administrations, 2006). Dwelling unit can be a parameter assessment of adequacy, composition and needs of the occupants. Therefore, in order to examine of dwelling unit on a different function and size of old and new public housing condition, "Klongchan Public Housing Project" and "Buengkum Baan Eur Arthron Project" were selected to analyze the public housing characteristics and spatial features. These areas are investigated to compare with a minimum standard requirement of NHA as shown in Table 5.1. The dwelling size unit was analyzed by using plan and functions to find the internal area. The features of public housing on building structure and architectural appearance are not the focus of this analysis.

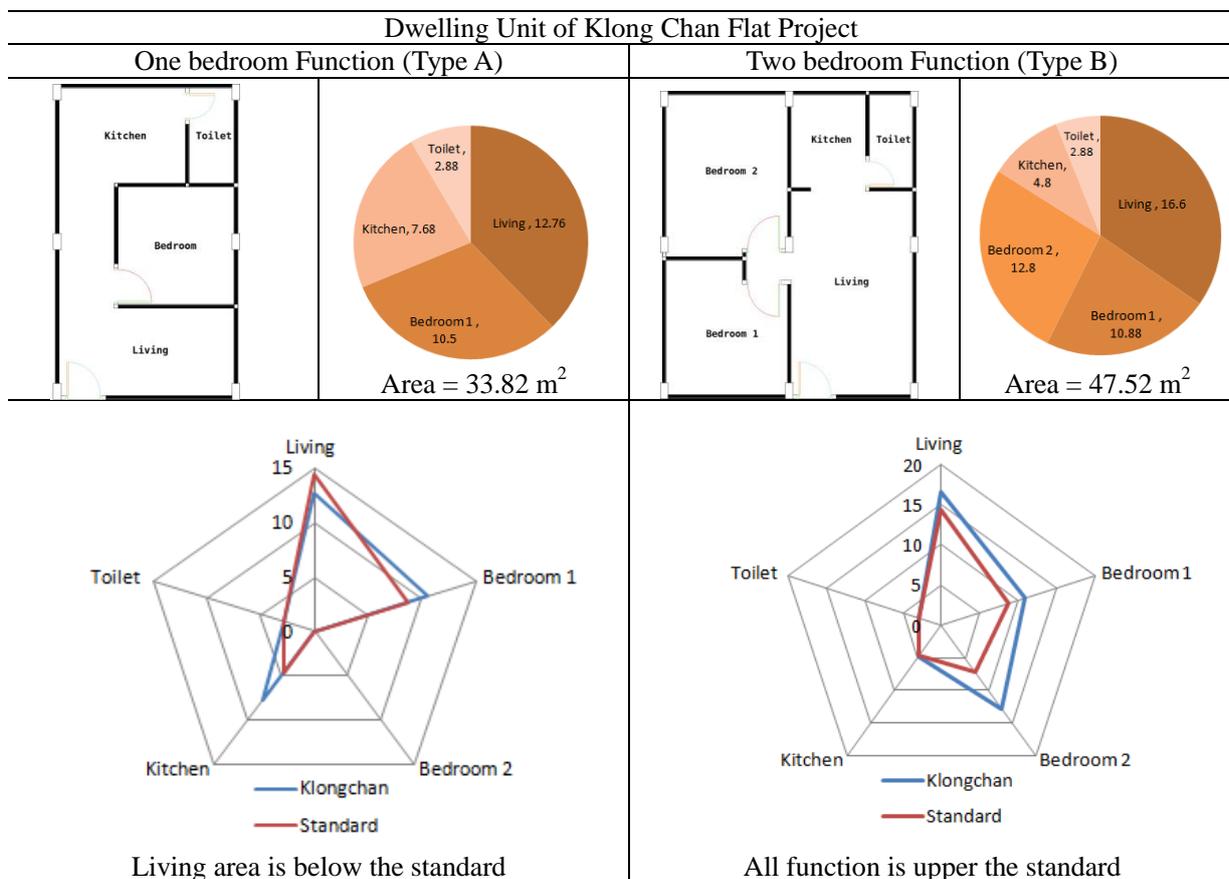
Table 5.1 Minimum dwelling unit standard of National Housing Authority of Thailand

Standard of NHA			Standard of NHA		
Function	Minimum Area (m <sup>2</sup> )	Width (m)	Function	Minimum Area (m <sup>2</sup> )	Width (m)
Master bedroom	8.64	2.40	Living area	14.40	2.40
Bedroom 1	7.20	2.40	Dining area	8.64	2.40
Bedroom 2	5.76	2.40	Preparing Food	4.32	1.80
Bathroom (shower/sink/toilet bowl)	2.16	1.20	Kitchen	4.67	2.10
Bathroom (shower/toilet bowl/washing area)	2.88	1.80	Each dwelling unit includes bedroom, living area, dining area, kitchen area, and toilet (shower/toilet bowl/washing area).		
Separate toilet	1.44	1.20			
Separate bathroom	1.08	1.20			

Source: Department of Local Administrations (DOLA), 2006

Plan and function of both dwelling unit projects were classified to analyze the space offering to dwellers and compared with the minimum standard. The results were shown in Table 5.2 and Table 5.3. For Klong Chan Flat Project of unit A and B, the element of function was not quite different including living area, bedroom, kitchen, and toilet. Using NHA minimum standard to examine a function area of each element, it is found that living area of Type A is below the standard ( $12.76\text{m}^2 < 14.46\text{m}^2$ ) whereas all function areas of type B meet the standard and have higher standard than NHA standard. Particularly, bedroom space of both types ( $10.5\text{m}^2$  and  $10.88\text{m}^2$ ), as shown in chart diagram of standard measurement, is higher than the minimum standard of NHA ( $8.64\text{m}^2$ ) and standard of Building Control Act B.E.2522 (1979) of Thailand which is required at  $8.00\text{m}^2$ . The phenomenon of providing a large space of dwelling unit was in 1976, as the first period of operating public housing development where the government fully subsidized the cost (100%). NHA is able to offer the affordable housing for low to middle income people so that they could live in a large space without considering the construction cost (Chogwilas, 2002). Serving a large area on different type of dwelling unit for single and family purpose has shown significant contribution of NHA. In home population density, a family size is used to examine space of dwelling unit. The questionnaire survey found that Klong Chan Flat Project has a mean average size of family about 2.06 in type A and 3.07 in type B. Therefore, living space per capita of both types are approximately  $16.41\text{m}^2$  and  $15.47\text{m}^2$  which is better than the standard which defined for  $5.6\text{m}^2/\text{person}$  or  $28\text{m}^2/5\text{ persons}$ .

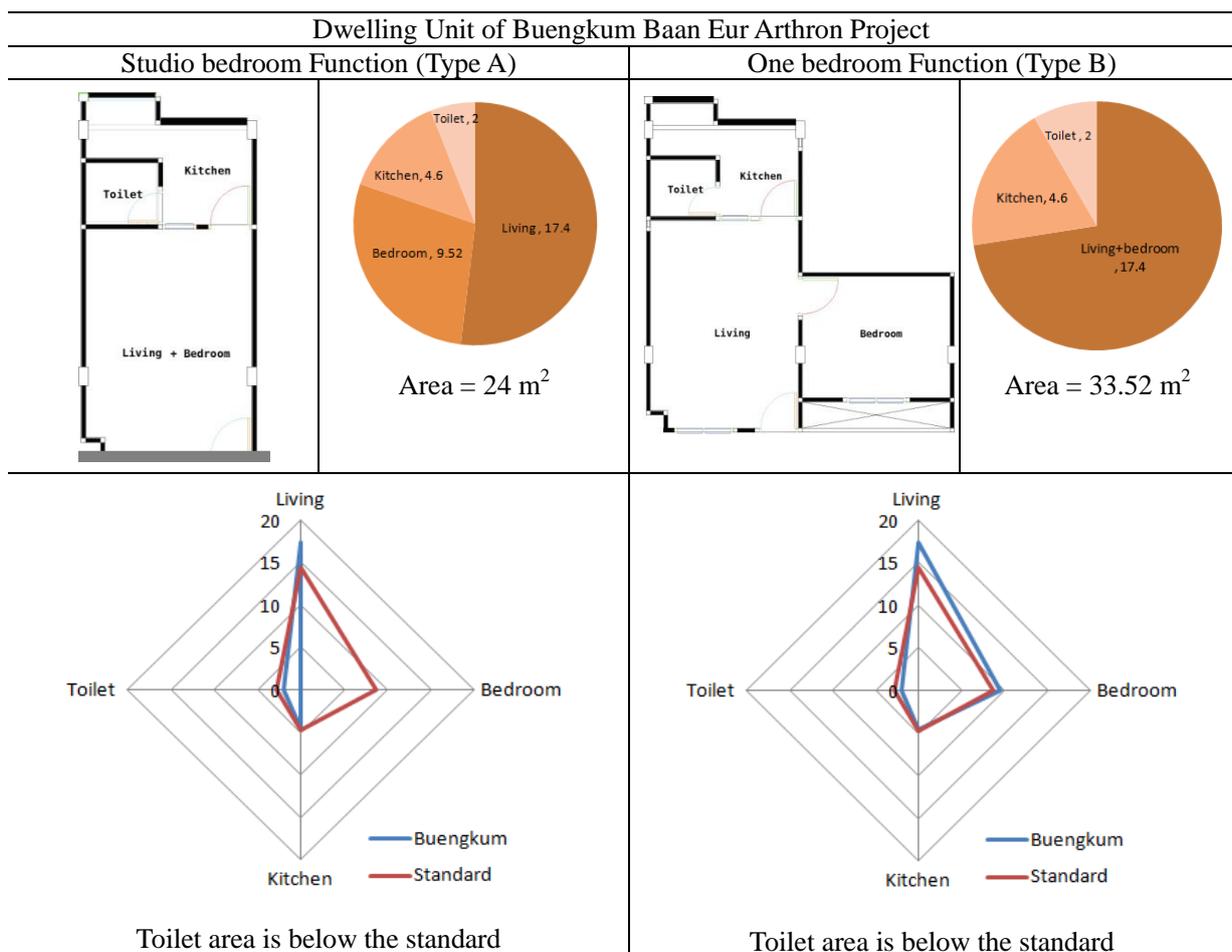
Table 5.2 Dwelling unit analysis of Klong Chan Flat Project



Source: the Author, 2014

In the case of Buengkum Baan Eur Arthron Project, the dwelling spatial feature of new low-rise public housing pattern was analyzed and it was found that both type A and B in term of function was similar including living area, bedroom, kitchen and toilet as well as basic element for single and family. All functions of Type A and B were investigated. It was found that especially Type A provided a combined area for living and bedroom at 17.4m<sup>2</sup> meanwhile the minimum of NHA standard for living room and bedroom is 14.40m<sup>2</sup> and 7.2m<sup>2</sup> (a total area is 21.6m<sup>2</sup>). It shows that the area of Type A was lower than the NHA standard and Building Control Act B.E.2522 (1979) at 9m<sup>2</sup> for bedroom. In addition, a space of toilet both types were found below the NHA standard of 2.00 m<sup>2</sup><2.88 m<sup>2</sup>. However, comparing to the Building Control Act B.E.2522 (1979), 1.80 m<sup>2</sup> is a minimum space of toilet including a shower area, so the toilet area of both types was acceptable based on the standard code. A physical element of this low-rise public housing unit in this period (2003) shown that a mass product of public housing unit in the country was offered by this project (Baan Eur Arthron) for low and middle income. The result of questionnaire survey found that Buengkum Baan Eur Arthron Project has a mean average size of family about 3.05. Therefore, dwelling unit space per capita of type B is approximately 10.66m<sup>2</sup> which is better than the NHA standard which defined for 5.6 m<sup>2</sup>/person or 28m<sup>2</sup>/5 persons.

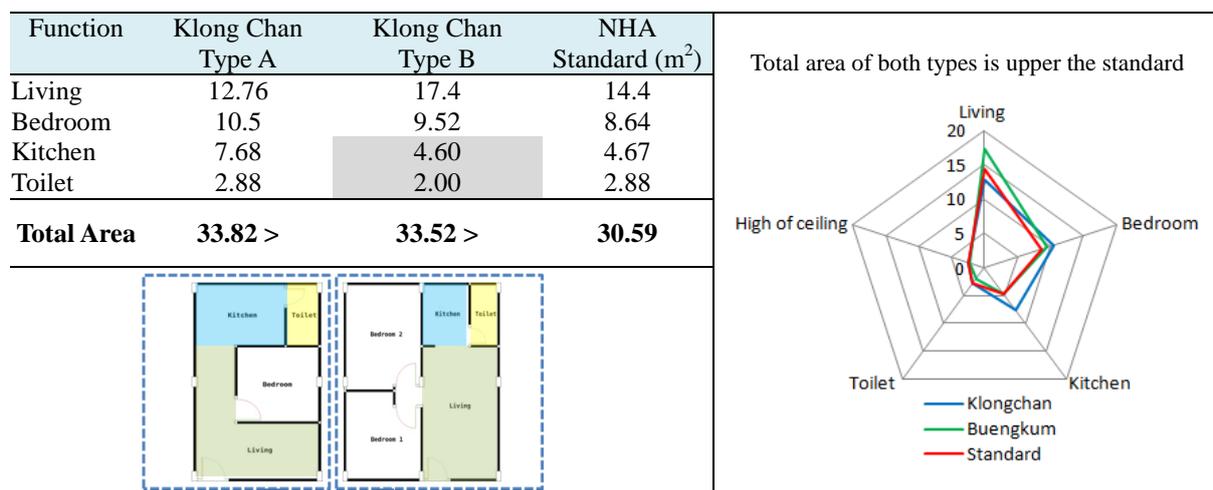
Table 5.3 Dwelling unit analysis of Buengkum Baan Eur Arthron Project



Source: the Author, 2014

The small size as well as minimum standard is the concern in addressing the issues for saving construction cost and providing more dwelling units (600,000 units) in principles so that people can meet their own basic needs of living. Therefore, type A is designed in a studio type that could support a modern living style as it is a prototype for affordable housing unit in condominium without a privacy room (bedroom). The space for living and sleeping area is 24 m<sup>2</sup>. It shows that a flexible function in small size is a single dweller trend in Thailand. Comparing a similar function between dwelling unit (Type A: one bedroom) of Klong Chan Flat Project and (Type B: one bedroom) Buengkum Baan Eur Arthron Project, it is found that total area of 33.82m<sup>2</sup> and 33.52m<sup>2</sup> is not much different. These both units are higher than NHA standard, as shown in Table 5.4. However, defining each element of function (living room, bedroom, kitchen and toilet), the living room of Buengkum Baan Eur Arthron Project offers more relaxing area or extended multipurpose area for family than Klong Chan Flat Project which is only about 5m<sup>2</sup>. On the other hand, the space for toilet and kitchen area is small. Both areas are lower than the old public housing project (Klong Chan Flat Project) and NHA standard.

Table 5.4 Comparing dwelling of Klong Chan Flat Project with National Housing Standard



Source: the Author, 2014

The questionnaire survey found that the average size of family in Klong Chan Flat Project was about 2.06 persons for a one-bedroom unit and 3.07 persons for a two-bedroom unit. The living space per capita of both dwelling types was approximately 16.41 m<sup>2</sup> and 15.47 m<sup>2</sup>, which were better than the standard at 5.6 m<sup>2</sup>/person or 28 m<sup>2</sup>/5 persons. The average family size in Buengkum Baan Eur Arthron Project was 3.05 persons. Therefore, the dwelling unit space per capita of a one-bedroom unit was approximately 10.66 m<sup>2</sup> and this was better than the NHA standard. From above investigation in terms of room size of both projects had already seen that it was able to serve residents according to average size number from question survey. However, the question about how are you satisfied with this room size that adequate for your family members found that the respondents were faire satisfied level at 3.42 and 3.12 of Buengkum Baan Eur Arthron Project and Klong Chan Flat Project respectively. Nevertheless, as found family members ranged from 1 – 7 persons of both projects therefore this situation can be assumption that the dwelling unit with 5 family size members (number of maximum people that designed per dwelling unit based NHA standard) is

satisfied than 6-7 persons. The result by correlation analysis to explain satisfaction found negatively correlated with family size (correlation coefficients = -0.143 and -0.109) was statistically significant at the level 0.01 ( $P = 0.006$  and  $0.035$ ) of Buengkum Baan Eur Arthron Project and Klong Chan Flat Project respectively, but this showed very low correlation coefficients under 0.3 (Hinkle, 1998). However, T-test analysis showed significantly different at 0.006 and 0.35 that the respondents who stayed with 5 persons members than those stayed with family member more than 6 persons of both project. Therefore, it could be mentioned that living in public housing on more density might caused a low score of satisfaction as shown in Table 5.5.

Table 5.5 Comparing number of family members with size satisfaction of dwelling unit

Satisfaction		Klong Chan				Buengkum			
		$\bar{x}$	S.D.	t	P-	$\bar{x}$	S.D.	t	P-
The size of this room is adequate for your family	Family members ( 5 persons)	3.18	.804	2.760	.006*	3.43	.899	2.113	.035*
	Family members (> 6 persons)	2.38**	1.188			2.33**	.577		

\*P-Value is significant at the 0.05 level

\*\*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

## 5.2 Occupants' Lifestyle and Self-Maintaining Dwelling Unit

To clearly understand occupants living as their lifestyles of Klong Chan Flat Project and Buengkum Baan Eur Arthron Project regarding occupants comfort, therefore the existing condition of dwelling unit that how it performs on passive or active approach were questioned. Asking the occupants about a main electricity appliance in dwelling unit for their comfort found that 59.5% and 78.1% indicated using air conditioner of Klong Chan Flat Project and Buengkum Baan Eur Arthron Project respectively (Table 5.6). Meanwhile, 40.5% and 21.9% present who do not have air conditioner. It can be seen that nearly a half of total respondent of the old public housing project (Klong Chan Flat) did not have air conditioner due to expensive appliance (interview, 2014). Electric fan was found a preferred electricity appliance of both projects (95.9% and 91.4%). Using the number of electric fan of household in Klong Chan Flat found that it has correlated with family size of coefficients value of 0.236 by statistically significant at the level 0.01 ( $P=0.000$ ). These results show that an electricity appliance plays important role for both projects' occupants especially the new public housing project was quite high rate of air conditioner which implied that those occupants were easily adjustable their thermal comfort in dwelling unit rather than the old project.

Moreover, a rating occupants' behavior on simply methods for improving comfort condition based on six variables in Table 5.7 found that Buengkum Baan Eur Arthron Project were highly good performed behaviors in using natural light, saving light bulbs, natural air (if weather is good), electric fan, close windows and doors when air conditioner is on, and having regularly maintain of air conditioner. However, both projects were average highly level that ranked between 3.51 - 4.50. It could be mentioned all respondents were aware and have a good manner in term of using passive and active living approach.

Table 5.6 Two main electricity appliances in dwelling unit for occupants' comfort

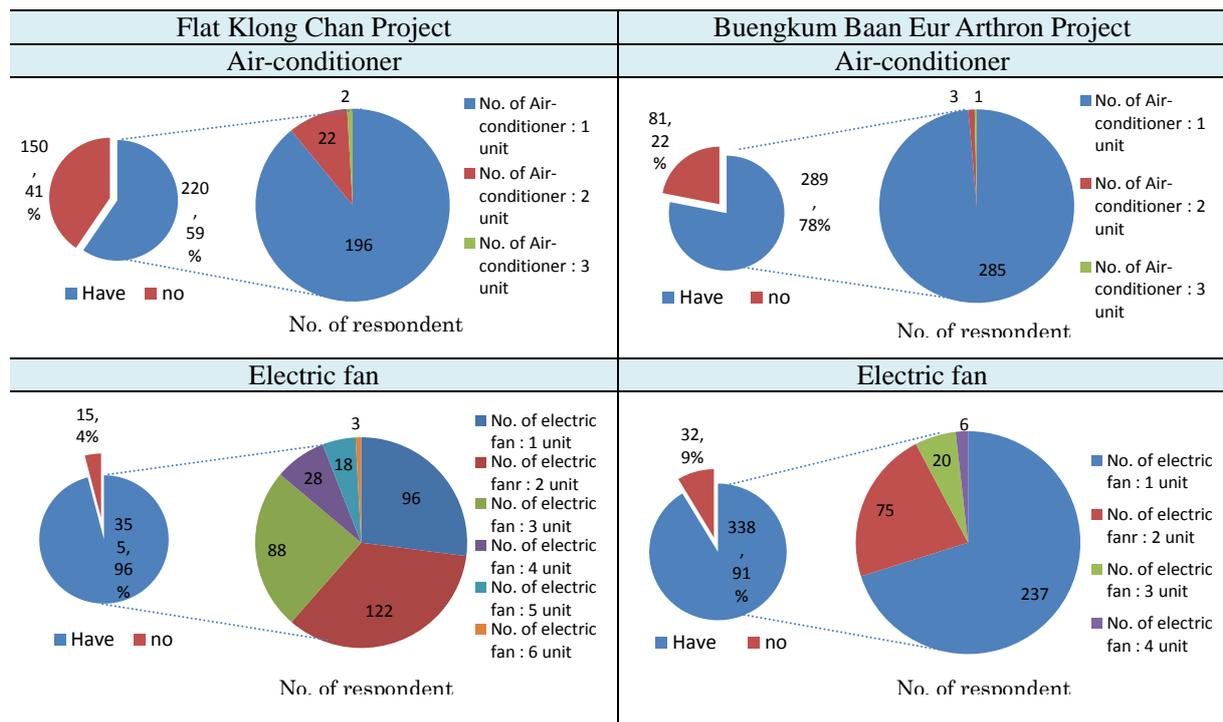


Table 5.7 Occupant's behavior for creating their comfort in term of light and ventilation

Occupant behavior	Klong Chan			Buengkum		
	$\bar{x}$	S.D.	level*	$\bar{x}$	S.D.	Level*
Using natural light instead of bulbs or fluorescents during daytime	3.67	1.00	High	3.90	.943	High
Using energy saving light bulbs	3.91	.951	High	4.17	.758	High
Use natural wind instead of air conditioner if a weather is good	3.81	1.02	High	3.98	.889	High
Use electric fan rather than opening air conditioner	3.93	.963	High	4.00	.805	High
Close windows and doors when air conditioner is on	4.11	.974	High	4.17	.843	High
Have regularly maintenance of air conditioner	3.73	.986	High	3.91	.819	High

\*Frequency level: 1.00 – 1.50 = not at all do it, 1.51- 2.50 = slightly do it, 2.51- 3.50 = moderate do it, 3.51 – 4.50 = highly do it, 4.51 -5.00 = extremely do it

In addition, physical improvement of dwelling unit scale was asked the respondents for ranking a kind of renovation. Interior painting was ranked the first of 59.7% (221 respondents) of Klong Chan Flat, where replacement/repairing of windows /doors and drainage system were ranked the second and third of 41.9% (155 respondents) and 35.4% (131 respondents) respectively. For painting a room is due to easy and low cost of renovation and creating room looks new for living. Replacement window and door were a reason of security, modern styles, and ventilation purpose such as using a slide window to avoid air condition flow out (Field interview, 2014). On other hand, Buengkum Baan Eur Arthron was not found such a much improvement as its very new condition. Therefore, a replacement window or door by changing from an original pattern of dwelling unit could affect occupants' thermal comfort. So, a prioritized issue of old building improvement as found in Figure 5.1 was addressed to examine in the next section.

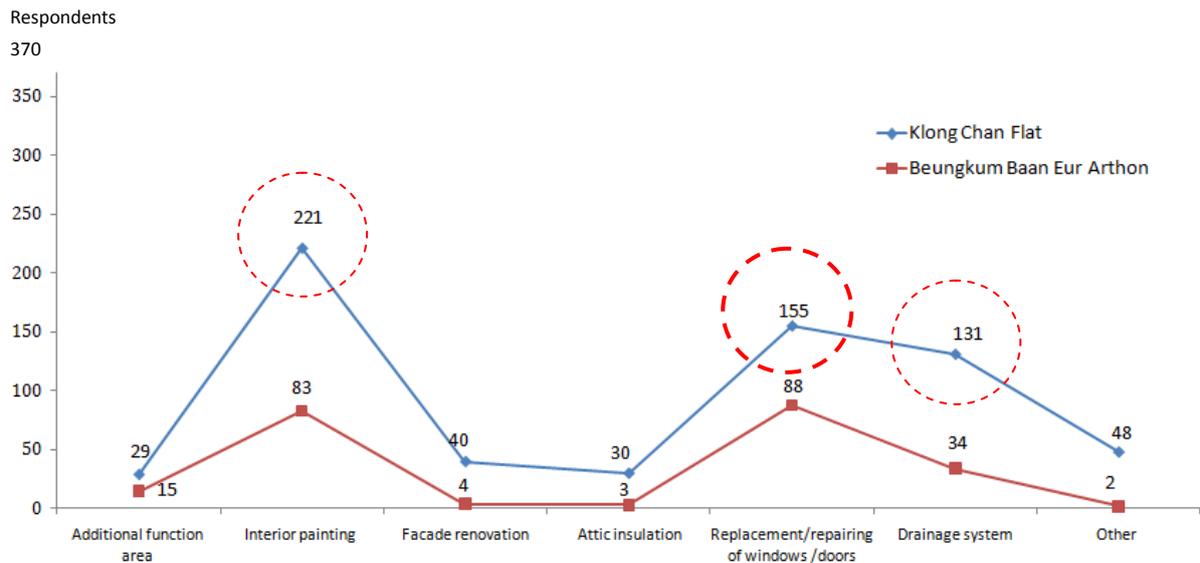


Figure 5.1 Dwelling unit improvement by occupants

### 5.3 Case Study of Investigating Dwelling Unit Performance through a Thermal Comfort

This part of research gives an extent study to analysis a dwelling unit of Klong Chan Flat Project that has been assessed of room size, lifestyle, and maintaining dwelling unit of the old and new project feature in previous section. Living is associated with environment conditions therefore to evaluate existing dwelling performance based on thermal comfort was carried out in this part. As long established and its old conditions of Klong Chan Flat Project, the research focused only indoor temperatures in the indoor living space of this project to provide a valuable information for public housing improvement.

#### 5.3.1. Introduction

Affordable public housing to low-middle income people has been long development in Thailand in order to enhance a quality of life and alleviation of housing shortage. Living with a minimum standard is setup by National Housing Authority of Thailand (NHA). Not only physical aspect (size, function, and materials) has been concerned, but living in a good indoor and outdoor environment also provides to create comfortable living. The first typical walk-up flat (5-storey) was operated during 1973 and that period a simply housing unit feature with a basic passive design especially on natural ventilation to versus tropical climate was applied to occupants. Klong Chan Flat is a representative of this period development which aged over 40 years (built 1975). Regarding occupant comfort living in tropical climate therefore this paper focuses on assessing indoor thermal comfort of dwelling unit performance. Indoor thermal is part of the indoor environment quality component based on climatic condition. High daily air temperature, higher humidity, and a little wind movement have greatly affect occupant's comfort in buildings (Jamaladin et al., 2014). Thermal comfort can express satisfaction of living condition. Thermal comfort is key component of quality of indoor environments and environmental elements such as heat from electrical lighting, less ventilation, high humidity level, and poor building envelope that can contribute to poor thermal comfort (Kamaruzzman&Tazilan, 2015). Previous studies in the topics of thermal comfort in residential building have been widely conducted by many researchers. Tumm (2014) studied typical house design of low and

medium income (2-storey house) in rural area of four region of Thailand for thermal comfort assessment and comparing with lifestyle, climate and tradition of people. It found that people in the southern feel comfort under higher operative temperature than other regions. Nuntasiri & Rasisutta (2015) conducted field survey to study thermal comfort and adaptation of low income resident (Baan Mankong Non Nong Wat 2 community) in urban area. The temperature of comfort was found 26.2-31.6°C with 62.9-82.4% of relative humidity in rainy season and winter season was 27.4 -30.7°C with 33.4-73.9% of relative humidity. Oonpai & Yiemwattana (2013) studied 9-storey apartment to determine a passive cooling method of thermal comfort which focused on heat load on the wall structure, airflow movement, natural light, and humidity components. As there was limited information available on specific thermal comfort in old public housing project which plays important role in the country. Therefore, the intention of the thermal comfort was that results would contribute to improving occupants' living environment and compliment old public housing research in Thailand.

### **5.3.2 Methodology**

#### **1) Experimental set up**

The field study took place in Klong Chang Flat project, Bangkok in a tropical hot-humid environment. As providing two typical feature of dwelling unit of project, the target include one bed room type (Flat 16-30) and two bedroom type (Flat 1-15). Flat No.16 and No.20 were selected as a representative one bedroom type and Flat No.8 presents for two bedroom type (Table 5.8). The three cases for studying a temperature and humidity of dwelling unit are based on available experimental setup of four-day with the permission of building manager and room owner. These cases study is represent original feature as keeping the same function of room with louvered window and flush door as well as designed by National Housing Authority (NHA). Dwelling of flat 16 was selected with different building lay-out direction. The physical data for the indoor environment of the dwelling unit were measured by Temperature/Humidity Data Logger DR-22D series with sensory accuracy of  $\pm 0.5^{\circ}\text{C}$  and  $\pm 0.3^{\circ}\text{RH}$ . This equipment uses for measuring ambient temperature and relative humidity. Data Logger was set up to record 24-hour indoor temperature with humidity on April, 2016 that was a period of highest temperature during hot season in Thailand (March – June) based on average temperature and rainfall amount 30 year (Thai Meteorological Department, 2016). Also, the Data Logger was carried out in living room because most activities of occupants are in this area to watching, chatting, or working frequently. Due to a short available of equipment, the four-day to measure temperature was conducted on 18 – 21 April, 2016 for this experiment.

In order to testing airflow in dwelling unit, a wind tunnel instrument with a model of two-bedroom type (Fig.5.2) that was employed as experimental airflow testing indoor temperature due to can be show for both type. A three-dimension model was set up with scale 1:20 and it must be not over 20% of cross-sectional area of the wind tunnel (Sagnungsub, 2005). A unit of airflow speed measurement was m/sec and it has been reported in a percentile. A Hot Wire (AirFlow Meter KM4003) was used to measure airflow speed at three levels of height; 0.00, 0.90, and 2.00 respectively these levels were normally related with a

high of window and door Oonpai & Yiemwattana (2013). Air speed was set up at 0.5m/s (100%) that acceptable rate creating a comfort condition to occupants of indoor living space in tropical climate of Thailand (if >1.5m/s, the occupants feel wind disturbing) (Sagnungsub, 2005).

Table 5.8 Typical dwelling unit of thermal investigation of Klong Chan Flat

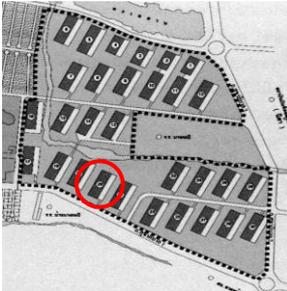
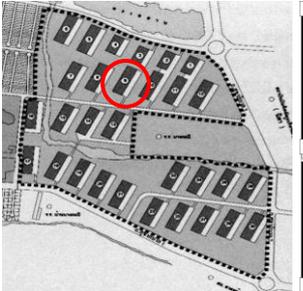
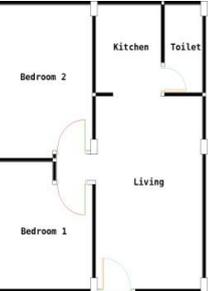
Room type A			Case A (Flat 16)		
					
<b>Function</b>	<b>Area/ Size</b>	<b>Room condition</b>	Family size: 3 people Flat 16		
Living room, 1 bedroom, kitchen, toilet	33.82 m <sup>2</sup> For 1-3 persons	Original feature with air-conditioner	● DR-22 Model measurement (24 hrs average temperature and humidity)		
Room type A			Case B (Flat 20)		
					
<b>Function</b>	<b>Area/ Size</b>	<b>Room condition</b>	Family size: 4 people Flat 20		
Living room, 1 bedroom, kitchen, toilet	33.82 m <sup>2</sup> For 1-3 persons	Original feature with air-conditioner	● DR-22 Model measurement (24 hrs average temperature and humidity)		
Room type B			Room type B (FLAT 8)		
					
<b>Function</b>	<b>Area/ Size</b>	<b>Room condition</b>	Family size: 4 people Flat 8		
Living room, 2 bedroom, kitchen, toilet	47.52 m <sup>2</sup> For 4-5 persons	Original Feature with no air-conditioner	● DR-22 Model measurement (24 hrs average temperature and humidity)		



Figure 5.2 Testing airflow speed of two-bedroom type of Klong Chan Flat, Faculty of Architecture, Rajamangala University of Technology Thanyaburi (RMUTT), 2015

## 2) Questionnaire and observation procedure

Interview and questionnaire survey with observation of the room owners had been conducted to clarify understanding existing condition with associated occupants' living style. Two main parts of questionnaire; part one includes general information personal background, family members and second part is occupant's behavior (type of clothes and daily activity) with comfort condition (see Appendix III). Both parts were described in descriptive statistic rather than analyzing a correlation of variables as this experiment focused on small experimental case.

### 5.3.3. Results and discussion

Using a Data Logger in living area of three cases to investigate 24-hour indoor temperature and humidity as well as occupation comfort on their old dwelling units found that indoor temperature were rather high between 13.00 a.m. – 16.00 p.m. of 33.47°C - 34.23°C (Figure 5.3, Figure 5.4, Figure 5.5, and Figure 5.6). Meanwhile the humidity in living area was high between 04.00 a.m. – 07.00 a.m. of 67%-73%. Outdoor temperature was obtained from the nearest weather center in Bangkok that was Bang Na Weather Station of Thai Meteorological Department by using a similar day of indoor temperature measurement. Four-day temperature and humidity of three cases have been compared with indoor temperature. As shown of four-day experiments of three case studies found that the peak of outdoor temperature was 37.20°C higher than the peak indoor temperature of three cases at 19.00 p.m. and cools down to 30.67°C ~ 28.95 after 23.00 p.m. Whereas the indoor temperature of all cases remain higher the outdoor climate about 2-4°C at night hours, it must be highlighted that this was uncomfortable condition. These results of the indoor temperature and humidity in living area was in line with the thermal environments study by Tummu (2014) that the minimize and maximize of indoor thermal in typical houses (2-storey of detached house) in the central region of Thailand were ranged 30.6°C-33.5°C. However, in term of relative humidity found 58%-67.7% that slightly lower than this experiment. According to Jutakron (2002), using 30 years database in 1981-2000 of temperature and humidity in 1971-2000 of Thai Metrological Department was applied in Mohoney's tables to find out a comfort temperature of Thai people. Temperature in daytime of Central area of Thailand (Bangkok located in this region) was pleasantly warm throughout a year by the highest temperature of comfort condition was not over 35°C. People feel hot in March – April with average temperature was 35°C - 37°C. The temperature at night was also comfort.

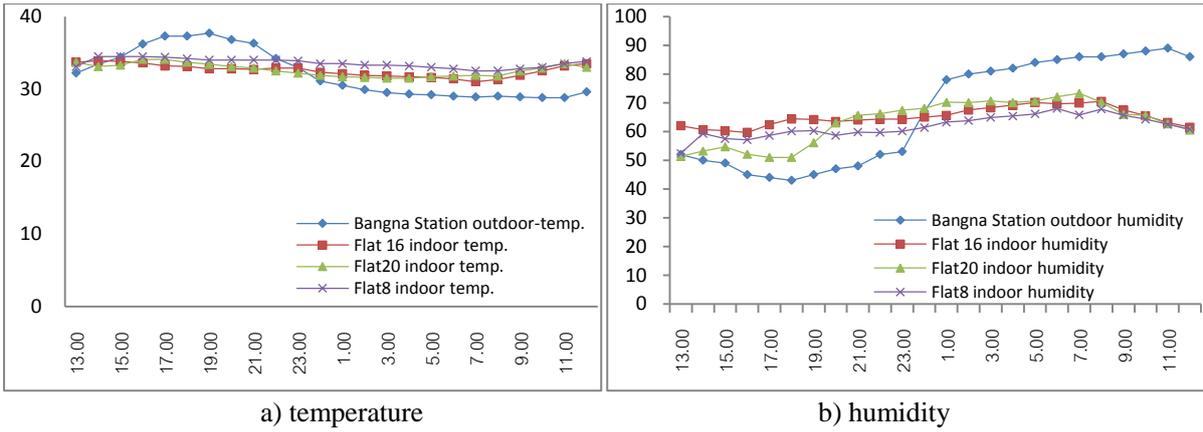


Figure 5.3 Comparative indoor temperature and humidity of three case studies with outdoor climate on April 18, 2016

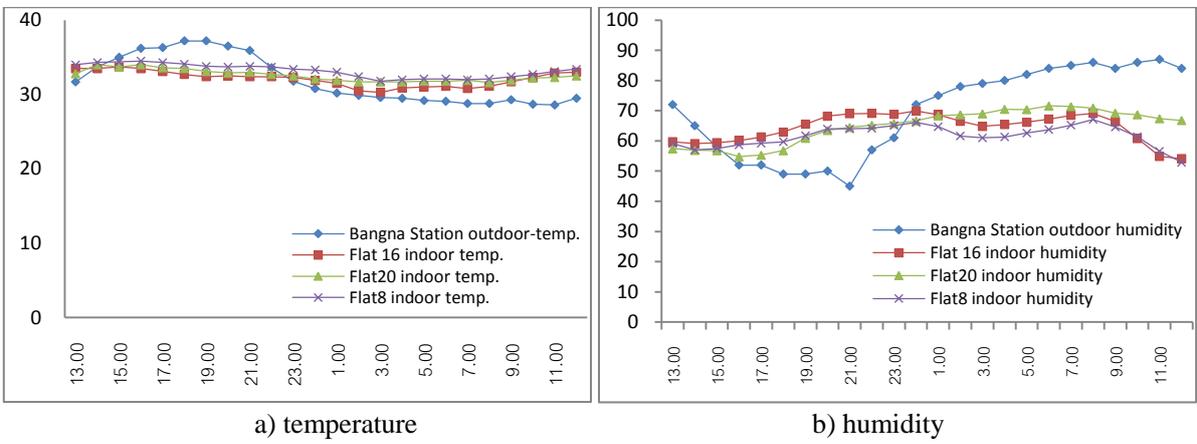


Figure 5.4 Comparative indoor temperature and humidity of three case studies with outdoor climate on April 19, 2016

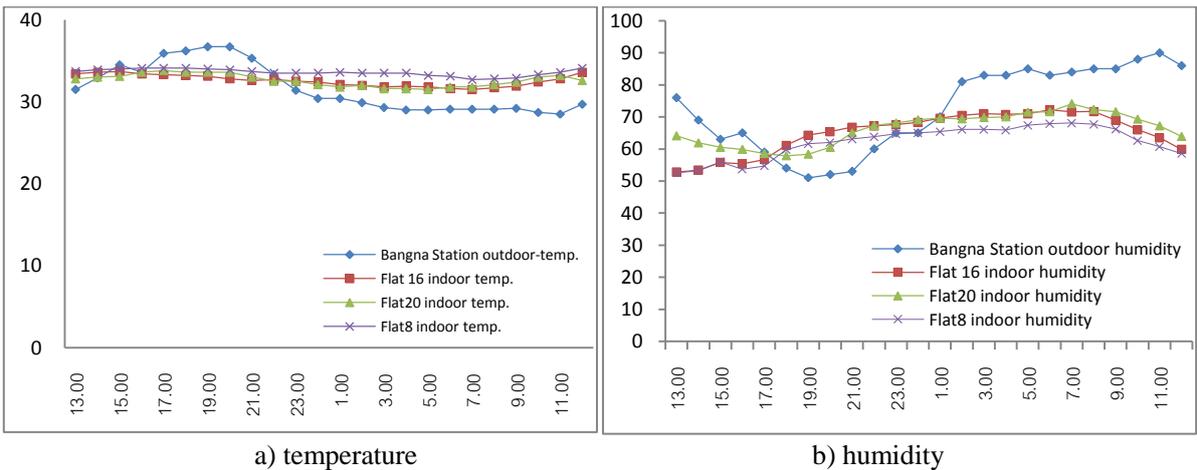


Figure 5.5 Comparative indoor temperature and humidity of three case studies with outdoor climate on April 20, 2016

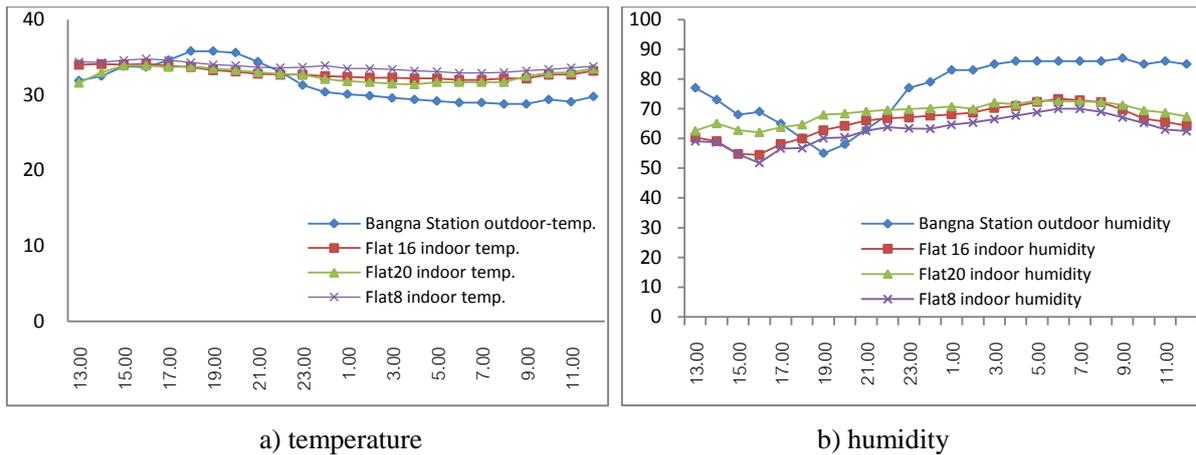


Figure 5.6 Comparative indoor temperature and humidity of three case studies with outdoor climate on April 21, 2016

However, according to indoor temperature comfort by Szokolay & Auliciems (1981) who studied thermal comfort zone limit adaptive model found it ranged 24.5°C -28.5°C. This was also lower than case study as mention above. Comparing with the comfort zone limit adaptive model of Szokolay & Auliciems (1981), the humidity of living areas were also higher that should be not over 50%. Additional, compare to the experiment study of thermal comfort zone of Thai people by Taweekun & Tantiwichien (2013) found that the indoor temperature of case study higher than acceptable range of relative humidity 50%-70% and effective temperatures 24°C -27°C.

The researcher has also compared the above temperature of three case studies with a comfort zone of Bangkok in order to indicating a comfort condition of living in the old public housing project. The previous research of comfort zone in summer in Bangkok by Saguansub (2010) was applied as a reference. The temperature of six months (April – Oct, 2015) in Bangkok; 30.5°C (Apr), 30.2°C (May), 29.7°C (Jun), 29.2°C (Jul), 29.2°C (Aug), and 28.8°C (Sep) was used to calculate a mean of six month temperature and it was 29.4°C. Using Comfort Zone Limit Adaptive Model that created by S.V.Szokolay & Auliciems (Saguansub ,2010) can calculate a summer comfort in Bangkok as follows:

#### Comfort Zone Limit Adaptive Model

$$T_n = 17.6 + 0.310 \times 29.4 = 26.7 (+/-) \text{ Summer}$$

Mean = Temp. 26.7 (°C) Rh. 50%

Maximum = Temp. 28.7 (°C) Rh. 50%

Minimum = Temp. 24.7 (°C) Rh. 50%

#### Set Line Slope

Maximum = 0.025 x (28.7-14) x 12.8 = 4.7Et (Ah/Psychometric Chart)

Minimum = 0.025 x (24.7-14) x 9.9 = 2.6Et (Ah/Psychometric Chart)

The result of hourly three cases and the comfort zone in summer of Bangkok were interpreted into psychrometric chart as shown in Figure 5.7. Obviously, those case studies were out of the comfort boundary. Therefore, it could be noted that the indoor temperature and humidity of case study is significant discomfort condition for occupants' living of this project in summer. In addition, to reduce the indoor temperature with a preferred condition of occupant should be addressed as providing alternative solution for improvement such a material or insulation techniques and conventional air technique.

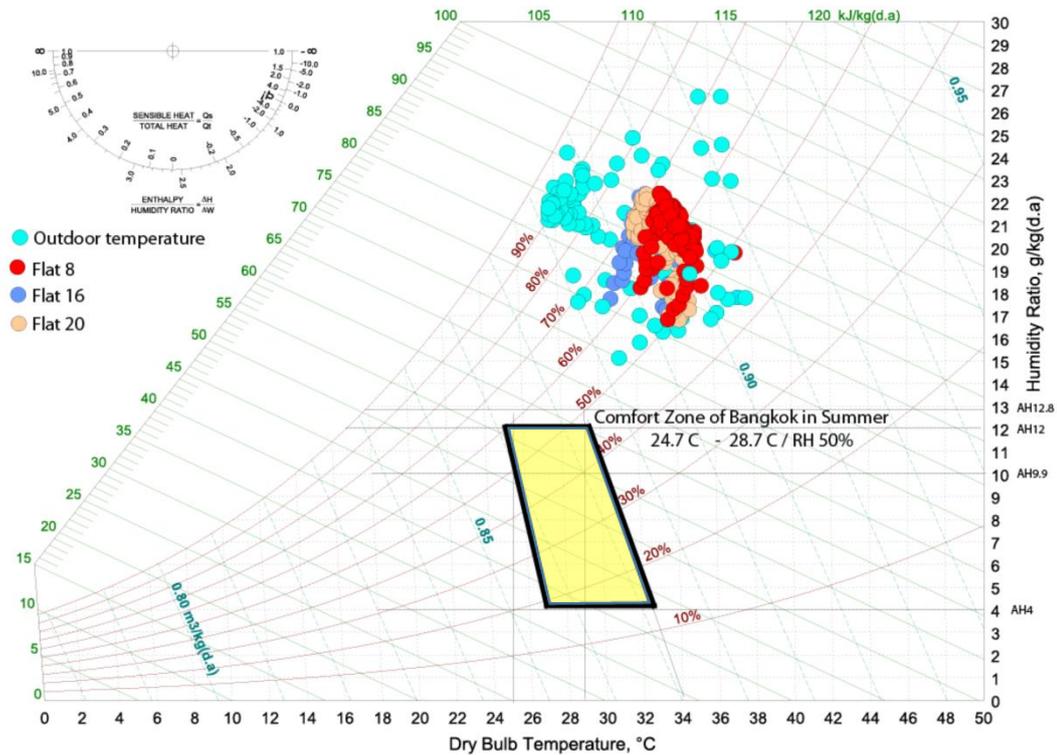


Figure 5.7 Comparative hourly indoor and outdoor humidity of case study with comfort zone of Bangkok in summer

*Occupants' living comfort and their behavior:*

Asking a family member of the three cases study found that in term of wearing cloth did not different pattern. The men and women wear a short shirt and short pants however some respondents (children) did not wear a shirt because a hot climate in their room. These wearing cloth pattern observation were estimated based on ASHRAE Standard 55. The average clothing value (Clo) was 0.53 that similar to the study human comfort in the urban area of Chiang Mai City (Thailand) found Clo average of respondent about 0.55 (Srivanit and Auttarat, 2015). For daily activity, most of respondents usually went out for their working and studying at 8.00 a.m. and come home around 16.30 p.m. whereas they stayed often at home on weekend all whole day for relaxing by watching T.V., reading or playing computer. These daily activities indicate that the occupants have confronted a high indoor temperature especially during weekend such uncomfortable condition. As rating the overall thermal comfort by occupants during the questionnaire survey, they feel slightly hot (+3) on the 7-scale of ASHRAE where the indoor temperature in the noon of three cases were range between 33.74°C – 34.12°C. Therefore, electric equipment for contributing occupant's comfort has been observed and it is very important for them. Observation dwelling unit of three

cases study found that the electrical fan is commonly equipment for minimizing a hot climate by air movement in the living area. Also, more air movement in the dwelling unit by opening a door and a window was found on Case A, B, and C. However, a wire screen with steel frame of the doors and windows for making their security could affect airflow speed rate. Air-conditioner was installed in bedroom in Case A and B for occupant comfort at night during a sleeping time.

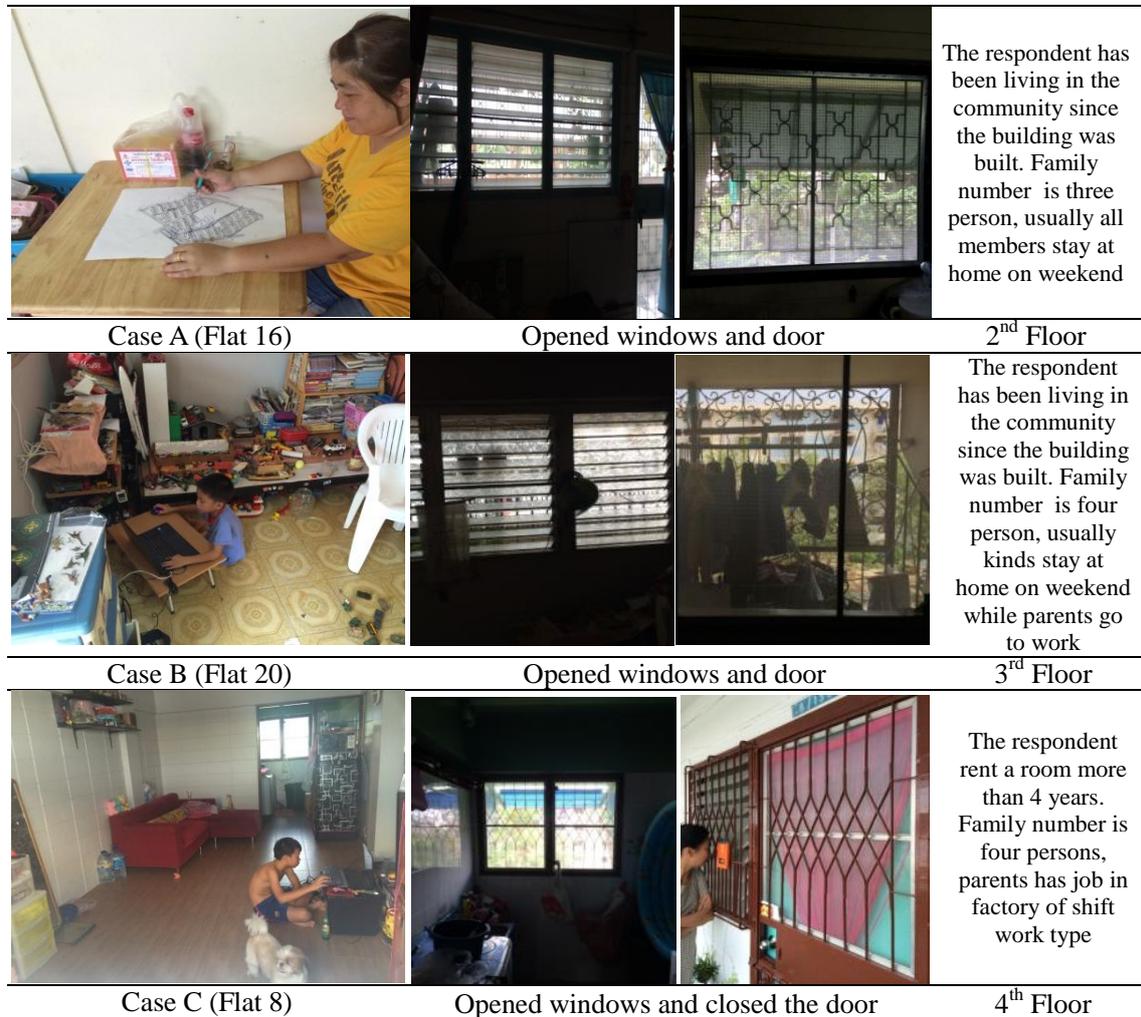


Figure 5.8 Weekend activity of dwellers and natural ventilation in living area

From the result of occupant's interview and observation, it can be mentioned that the occupants' behaviors in terms of wearing cloths is not much different as they lives in tropical climate. Electrical fan is mainly equipment in living area. However, using all electrical appliances as a mechanic solution for cooling in their indoor environment comfort would consequence increasing to existing energy demands in the low-public housing.

#### *Existing pattern of dwelling unit*

Furthermore, to investigate how existing pattern of dwelling unit contributing occupant's comfort, the wind tunnel was employ for airflow experimental study. However, airflow testing was conducted for two-bedroom type only because as less possibly distribute natural ventilation through all space compare to one

bedroom unit. In case of opening all windows and doors both external and inside of dwelling unit found that measuring airflow speed at three levels (0.00, 0.90, 2.00 m.) was different value (Figure 5.9 – 5.10). At 0.90 m. indicates a good airflow performance of living area and toilet area as a high percentage 12%-30% through opening the windows and the doors. Although, airflow speed at 2.00 m. seemed quite good distribution in dwelling unit but it was low percentage speed average (12%-26%) compared to at 0.90m level. For external window and door opened (inside was closed) was also analyzed airflow speed based on occupant behaviors that they would be privacy in living and bedroom. It found a low airflow speed at 0.00 m. level of 0%, then measured at 0.90 m. found airflow speed was slightly good distribution inside the room especially in front and rear side of dwelling unit but low percentage about 12%-14%. At 2.00 m. indicates a haft of dwelling unit space is getting well airflow speed distribution from a high entry pattern. Using the wind tunnel experiment of investigate airflow speed pattern can be clearly noted that opening window and door would contribute occupants comfort even it was a less airflow speed. Designing entry and outlet in proper scale can be offering effectiveness of ventilation but controlling airflow direction through body zone level must be concerned. Providing a gap between the wall and ceiling has been purposed of National Housing Authority (NHA) to create comfortable living for low-income people as simplest natural ventilation system.

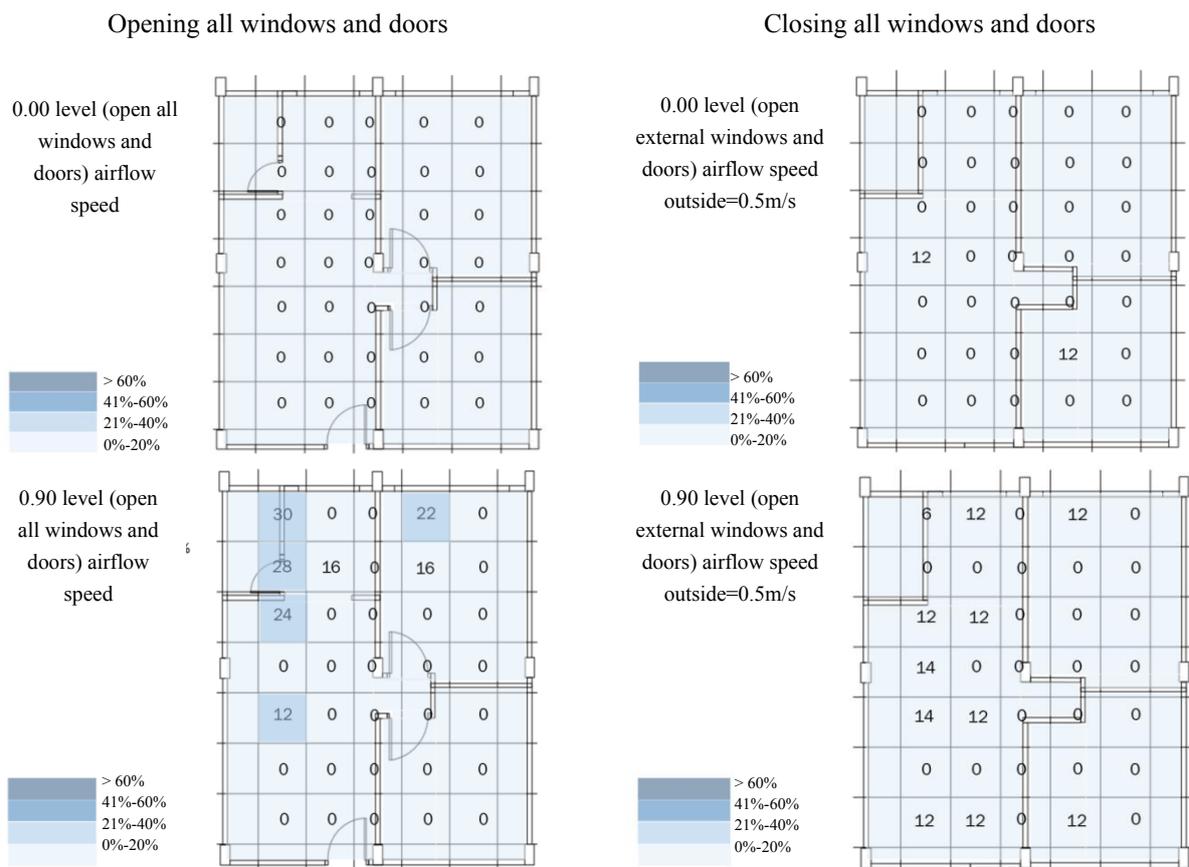


Figure 5.9 Airflow speed test by wind tunnel

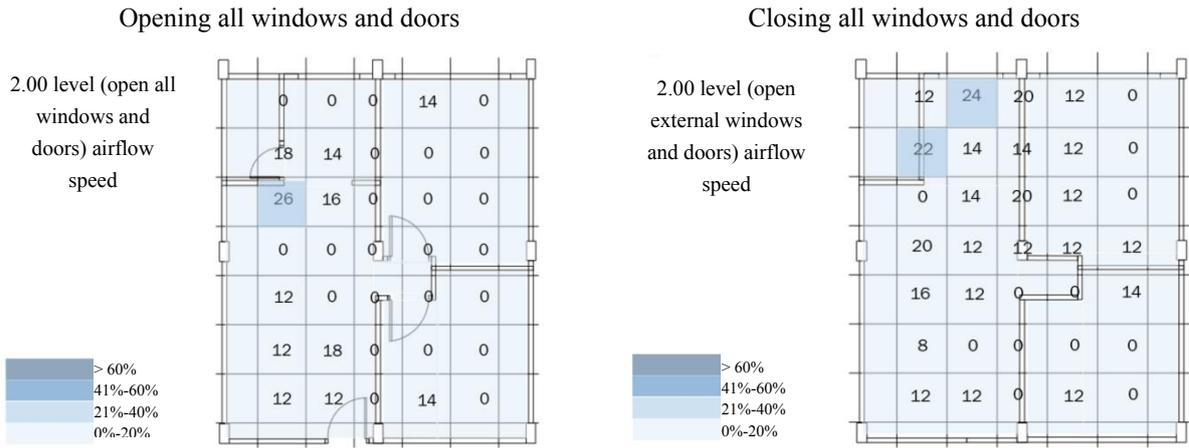


Figure 5.10 Airflow speed test by wind tunnel

NHA's architects had designed a gap about 0.30 m of width. There are some original feature still remain exists as shown in Figure 5.11. Unfortunately, the both case studies have been filled the gap of bedroom because the owner needs privacy, reducing noise when sleeping and installed air-conditioning for making cool comfort (field interview, 2016) as shown in Figure 5.12. This can be mentioned that providing ventilation and keeping privacy is very important to occupant's lifestyles. National Housing Authority purpose has failed of providing a good ventilation of this typical dwelling unit of Klong Chan Flat. Therefore, high entry pattern of airflow speed in the case study might be not helpful of air movement than experiment study (Model) and ineffective transferring hot indoor temperature flows out.

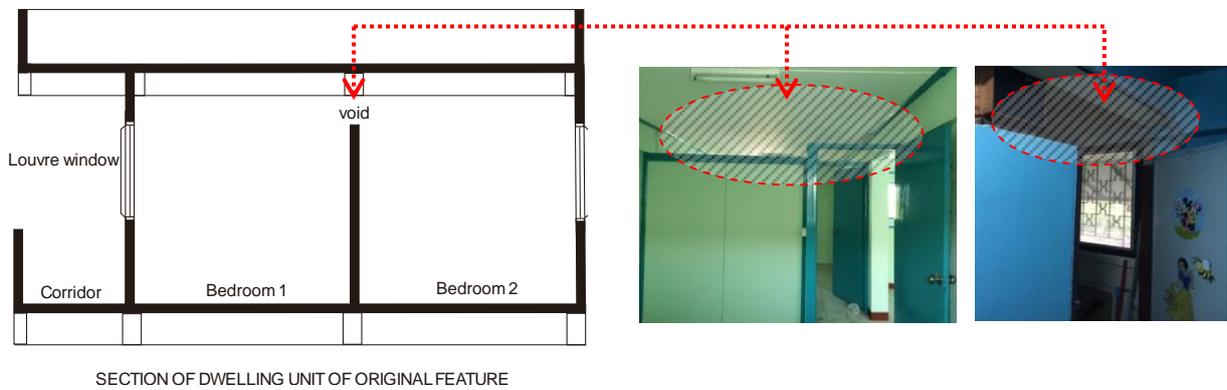


Figure 5.11 Original type of dwelling unit

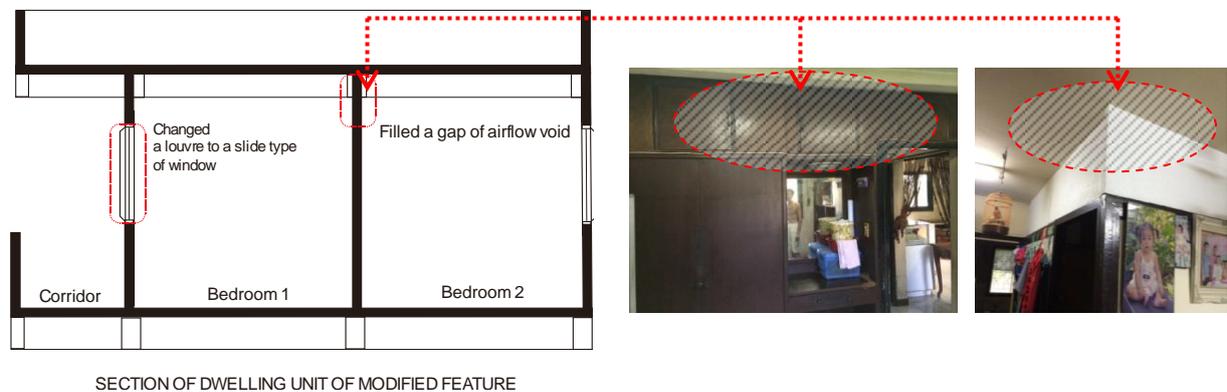


Figure 5.12 Modified type of dwelling unit

## 5.4 Conclusion

Comparing residential result in term of different period development shows that the old public housing project provides a large area of functions than the new public housing development project. This implies that a trend of dwelling unit is going to be a small area but it still complies with the minimum standard of National Housing Authority. Therefore, a minimum standard guarantees the right of low and middle income people to receive an adequate standard of living. Then, with significant factor reflecting occupant satisfaction of function on dwelling unit, the investigated indoor temperature, humidity, and airflow inside the existing dwelling unit condition was handled in the old public housing project. Although, the case study was conducted only three case studies however it has been starting a point of view research for contributing public housing improvement with a comprehensive on physical performance rather than focusing a size of unit. The temperature inside of case study was slightly high than outdoor temperature at night. Additional, living in existing condition of the three case studies found that the occupants have changed and adapted their lifestyles for preferred comfort. Using electric fan with opening door and window is the most preferred application for making indoor temperature comfort. In additional, some dwelling units have installed air conditioner system for cooling purpose by blocking airflow outlet as it design for ventilation purpose with lightweight materials. This might be leading to inefficiency air velocity under natural ventilation in the dwelling unit. Based on the value of wind tunnel through model experiment indicates a low airflow in the dwelling unit of case study. Therefore, more air movement by electric fan with preferred speed of occupants is important for their comfort. Moreover, the value of airflow testing of the model is different the real conditions which comprises a surrounded building, seasonal weathers, existing room conditions. Also, this model testing airflow speed is based on the southern wind direction of Thailand as local climate and the model was also setup to perpendicular of airflow outlet. So, other airflow directions could show a different result. Finally, the intention of this part provides a basic investigation framework for evaluating design assessment of public housing. The onsite experimental study on thermal comfort should be promoted. This would lead to extend the effort of National Housing Authority towards sustainable low-income housing development in the country. Therefore, this result of the study can be fulfill indoor design condition to relevant stakeholders and encouraging awareness of occupants to concern their improving living place that could make a positive impact for better indoor thermal environment.

## CHAPTER 6

### ANALYSIS OF THE COMPONENTS AND MAINTENANCE COST OF OLD PUBLIC HOUSING PROJECT

A building management after post-occupancy evaluation (POE) of residents is most significant impact on building that keeping in a good condition can be longer usage with high efficiency of building area management. As the result of overall satisfaction variables analysis on building unit aspect in Chapter 4 of Klong Chan Flat Project found that the design features of the building and costs of maintenance variables affect dweller's satisfaction significantly. However, to improve physical building in good condition, operating cost is associated with building management which is inevitable issue. Therefore, the study of operating costs and expenditures of old building of Klong Chan Flat in order constantly striving higher satisfaction of residents have been studied and analyzed for ensuring a sustainable building management. This study can be applied to relevant projects; old project of low income public housing of National Housing Authority (NHA) that distributes in Thailand and encountering in the same situation.

#### **6.1. Assessment Public Housing Maintenance**

Klong Chan Flat, the case study, is a hire-purchase public housing type for those low-income. All buildings, there are total 30 building units with 5,872 units, have been transferred ownership to residents and registered under Condominium Act B.E. 2522 (1979) in 2000. Since 1978 – 2000, operation maintenance and management of all buildings were conducted by NHA (before transferring ownership). Then, for improving and operating these buildings, the Condominium Juristic Person (CJP) is established for self operation and management. Therefore, throughout 15 years after all buildings have been operated, it needs to be investigated and analyzed; how condominium juristic person do handle their building to maintain living quality and satisfaction of residents as corresponding NHA provision. Moreover, the problems and obstacles issues are identified for providing more understand and be a guideline of old building management.

As changing an operation management of public housing development of NHA, there are the previous researchers were interested on this issues. Angsuthara (2010) had investigated the management and physical conditions of the public housing project as well as financial management within the Thonburi Condominium Housing Estate (public housing project). It was found juristic persons that have appropriate policy planning and a clearly specified and systematic scope of work was able to devise effective administrative and managerial plans for operation. Regarding financial matters, the most important revenue for juristic persons was monthly payment for shared expenses from residents. However, they had insufficient funds for proper maintenance of the housing project leading to their deteriorating physical condition. Also, lacking of resident's' adherences on the rule and regulation caused a worse building. Insufficient funds in managing condominiums common facilities also were found the similar issues in Laksi Public Housing Project, Bangkok. This research studies the current conditions and problems in

management of the common facilities. As far as expenditures, it is not possible to collect a large sum from residents to solve problems, and amount that can be collected for common facilities management is sufficient. In addition, the board members do not have enough knowledge about how to manage common facilities nor about the laws governing this (Lohmeng, A, 2007). Cost and maintenance were extent studied on low rise condominium in CBD, Bangkok in term of private owner project through financial documents and interviews of the condominiums' juristic managers (Arpaponkul, 2008). The cost was an upward trend in the following expenses: administration and management, salary payments, building services, and public utilities. The operating and capital expenses trend increase in proportion to the age of the condominium. The factors affecting the expense rate of the condominium included facilities services and building systems. It is necessary to have good knowledge on the structure and control the administrative budget can be allocated appropriately and in a worthwhile way. Mesiri (1999) study how the management of mid-income condominium in Bangkok affects resident's life quality and condominium environment through an interview of condominium juridical managers, the condominium juridical boards and observations of the building facilities. Four 4 types of condominium management were type 1: the condominium juridical manager is elected resident; type 2: the condominium juridical manager is a non-resident; type 3: the condominium juridical manager is a non-resident who is hired from a condominium management firm and works full-time; and type4: the condominium juridical manager is a non-resident who is hired from a condominium management firm and works part-time. Based on the findings, none of condominium management type is considered the best. All of them have both strong and weak points and they are applied according to the need of residents. The recommendation for an improvement of management therefore, proposed to solve their existing problems, particularly on the measure to increase the common facility management fee payment rate. Furthermore, it is recommend that in order for the owner to choose the most appropriate management system for their project they have to be aware of their own right as well as of others.

#### **6.1.1. Methodology and analysis tools**

To analyze physical data and the management building of Klong Chan Flat, researchers have conducted a survey throughout thirty buildings and interviewed staffs regarding a building maintenance program. All information are used to formulate and analysis. Data collection by field survey can be divided into three parts as shown in Figure.

##### **1) Building and physical surrounded survey**

In classifying physical building of Klong Chan Flat as well as a structure cracks, building facilities, co-ownership area, and surrounded building that how it remains in good conditions for residents. Also, a different function area of co-ownership of each flats have been investigated to evident how the condominium juristic person manage and use an efficiently building regulation.

##### **2) Interviewing condominium juristic persons**

Interview all condominium juridical managers (technical term called of Thai law) that registered in Condominium Act B.E.2522 (1979). The interviewing consist an important issue to reveal a problem and management situation as well as obstacles through instructed interview question (Appendix), those

should be recommend in order to rising the efficient building management with high satisfaction of residents for Kong Chan Flat.

### 3) Gathering of building management and cost annual report

Transferring a building ownership under Condominium Act B.E.2522 (1979), according to Building Control Act B.E.2522 (1979), all flats of Klong Chan Project must be inspected annually and every five years for grand inspection. The annual inspection report could be clearly condition of these buildings how does a physical change which might affect building structures, materials, live load, and so on. This evident document can also be supporting the buildings field survey on physical condition. And maintenance programs, annual report including cost of maintenance, income, building fees, have been gathered to assess and apply through resident’s satisfaction analysis of building improvement.

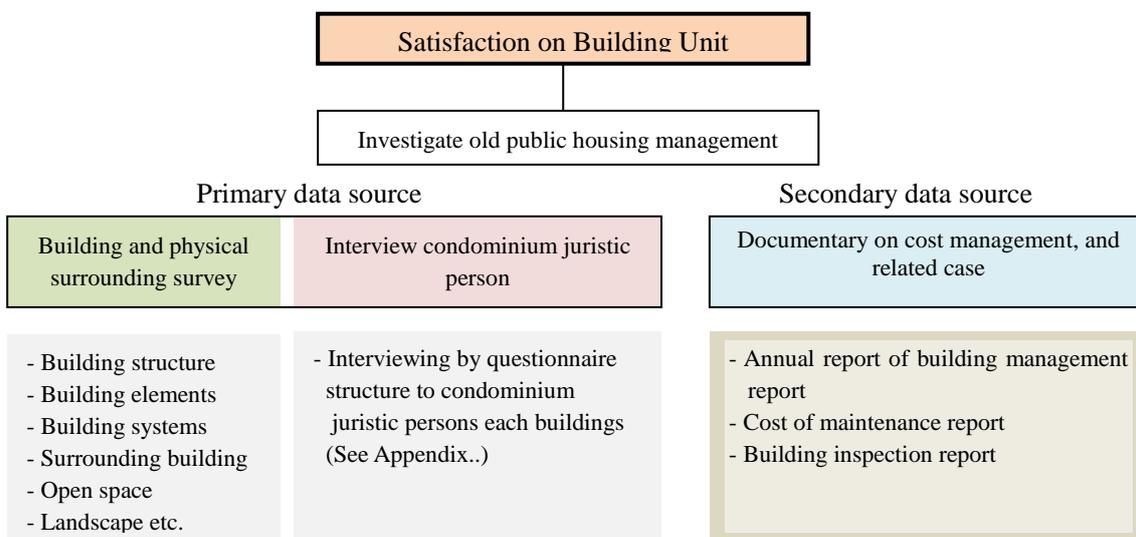


Figure 6.1. Data collection of old public housing management

#### 6.1.2 Existing Klong Chan Flat management of co-ownership property analysis

##### Field survey and interview of 30 buildings:

Klong Chan Flat Project has a total area of approximately 103.63 acres, there are three ownerships responsibility in maintenance and management as the following:

- Condominium juristic person: all building site area (1-30 buildings) which covered 3 meters distance from building shape, total area is 45.55 acres.
- National Housing Authority: open space as a green area, a playground, a sport field, a parking lot, and a stall shop, total area is 49.19 acres.
- Bangkok Metropolitan Authority: a public road and water treatment area, total area is 8.89 acres.

As the field survey of Klong Chan Flat management of common asset through 30 buildings, it can identify two perspectives of management including the co-administrative management and the independent management. To understanding the condominium juristic person operation there are five groups were separated by size of dwelling unit:

Co-administrative management:

1) Group A (104 units): this group of Klong Chan Flat project is smaller size by number of dwelling unit than other groups that includes Flat 1, 2, 3 and 4. To manage these building, each flat have their own a condominium juristic person board (not more than 9 persons) and building manager (1 persons/flat) as mandated of Condominium Act B.E.2522 (1979). Flat 3 has been selected co-administrative office center for sharing staffs and facilities for example an accounting staff and a maintenance technician. A preliminary investigation by field observation found that Flat 2 and 4 were quietly worse in term of general building conditions than flat 1 and 3 as shown in Table 6.1.

Table 6.1 Surveying profiles of group A

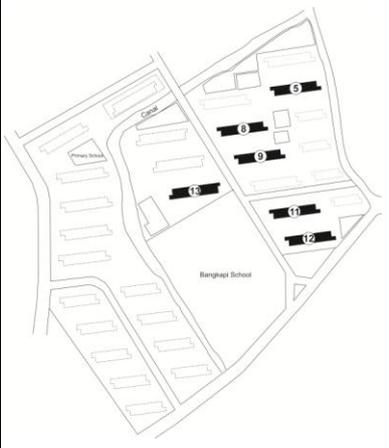
		Building site and surrounded area			
		Flat 1	Flat 2	Flat 3	Flat 4
		3742 m <sup>2</sup>	3736 m <sup>2</sup>	3855 m <sup>2</sup>	3734 m <sup>2</sup>
		Co-ownership area under Condominium Act B.E.2522 (1979)			
		Structure			
		Colum, beam, footing, foundation, wall, roof			
		Stair			
		2 main stairs of 1.55m width			
		Corridor			
		Corridor along a dwelling unit of 1.20m width.			
		Ground floor			
		Multi-purpose area is about 561.6 m <sup>2</sup> .			
		Building court			
		Area between two buildings is about 532.8 m <sup>2</sup> .			
		Building facility			
		Garbage chimney, water tank, drainage system			
		Public utility			
		Water supply pipe, electricity system, fire alarm			
		Surrounded area			
		3 m. from building structure			
		Office			
		Condominium juristic person office is about 22.8 m <sup>2</sup> .			
Existing building conditions under condominium juristic person operation of Group A					
F	External physical	Elements	Ground floor	Open space	Landscape
1					
2					
3					
4					

Remark: survey and interview of Klong Chan Flat were conducted on November, 2015.

2) Group B (180 units): this group includes Flat 5, 8, 9, 11, 12 and 13. Condominium juristic person board and building manager are required for all flats. Flat 8 is co-administration office center. Flat 5, 12, and 8 were found good organized management on co-ownership properties and clean especially on

open space area (court yard and ground floor) as shown in Table 6.2. Meanwhile, Flat 13, 11, and 9 were found unorganized and careless in this group.

Table 6.2 Surveying profiles of group B

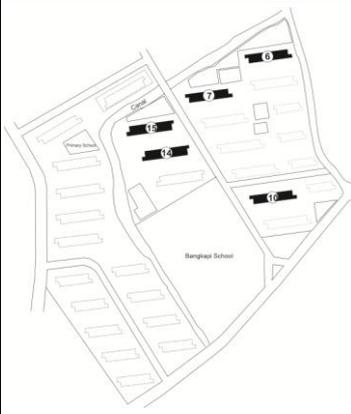
		Building site and surrounded area					
		Flat 5	Flat 8	Flat 9	Flat 11	Flat 12	Flat 13
		5597 m <sup>2</sup>	5800 m <sup>2</sup>	5644 m <sup>2</sup>	5800 m <sup>2</sup>	5616 m <sup>2</sup>	5276 m <sup>2</sup>
		Co-ownership area under Condominium Act B.E.2522 (1979)					
Structure		Colum, beam, footing, foundation, wall, roof					
Stair		2 main stairs of 1.55m width, and middle stair of 1 m					
Corridor		Corridor along a dwelling unit of 1.20m width.					
Ground floor		Multi-purpose area is about 936 m <sup>2</sup> .					
Building court		Area between two buildings is about 1035.63 m <sup>2</sup> .					
Building facility		Garbage chimney, water tank, drainage system					
Public utility		Water supply pipe, electricity system, fire alarm					
Surrounded area		3 m. from building structure					
Office		Condominium juristic person office is about 22.8 m <sup>2</sup> .					
Existing building conditions under condominium juristic person operation of Group B							
F	External physical	Elements	Ground floor	Open space	landscape		
5							
8							
9							
11							
12							
13							

Remark: survey and interview of Klong Chan Flat were conducted on November, 2015.

Independent administrative management:

3) Group C (180 units): this group includes Flat 6, 7, 10, 14 and 15. They have own the administration office for handling building operation with difference decoration. Flat 14, 7, and 6 were found well management of their properties. Keeping a green area inside and in front of building as much as possible, they regularly maintained by trimming trees. For Flat 10 and 15, additional functions into the court space as play ground is encouraging a meaningful public area by NHA's objective, however both buildings are not well maintenance as playground equipments get rust and surrounding area inside of building does not clean. Especially, Flat 15 was founded quietly messy area (Table 6.3).

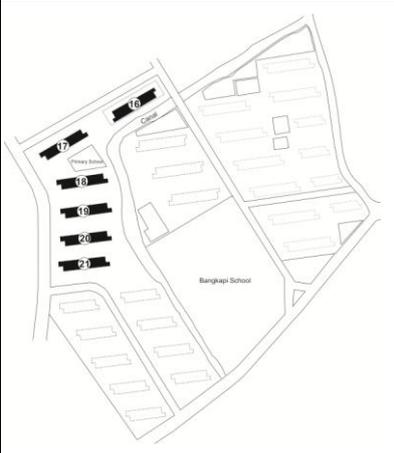
Table 6.3 Surveying profiles of group C

		Building site and surrounded area					
		Flat 6	Flat 7	Flat 10	Flat 14	Flat 15	
		5636 m <sup>2</sup>	5776 m <sup>2</sup>	5748 m <sup>2</sup>	5540 m <sup>2</sup>	5468 m <sup>2</sup>	
		Co-ownership area under Condominium Act B.E.2522 (1979)					
		Structure	Colum, beam, footing, foundation, wall, roof				
		Stair	2 main stairs of 1.55m width, and middle stair of 1 m				
		Corridor	Corridor along a dwelling unit of 1.20m width.				
		Ground floor	Multi-purpose area is about 936 m <sup>2</sup> .				
		Building court	Area between two buildings is about 1035.63 m <sup>2</sup> .				
		Building facility	Garbage chimney, water tank, drainage system				
		Public utility	Water supply pipe, electricity system, fire alarm				
		Surrounded area	3 m. from building structure				
		Office	Condominium juristic person office is about 22.8 m <sup>2</sup> .				
Existing building conditions under condominium juristic person operation of Group C							
F	External physical	Elements	Ground floor	Open space	landscape		
6							
7							
10							
14							
15							

Remark: survey and interview of Klong Chan Flat were conducted on November, 2015.

4) Group D (270 units): this group includes Flat 16, 17, 18, 19, 20 and 21 (Table 6.4). This is a largest building in term of number of dwelling unit. Each flat have their own a condominium juristic person board and building manager. Also, they have own the administration office for handling building operation. Most of these flats group researcher conducted in this field survey found in rather good management. Flat 16 performs well in the maintenance with restriction of usage external wall, not allow installing and drilling the wall, and provided a good green area for residents. Drilling the external wall causes directly material deterioration and aesthetics of building.

Table 6.4 Surveying profiles of group D

		Building site and surrounded area					
		Flat 16	Flat 17	Flat 18	Flat 19	Flat 20	Flat 21
		5984 m <sup>2</sup>	5732 m <sup>2</sup>	5728 m <sup>2</sup>	5808 m <sup>2</sup>	5928 m <sup>2</sup>	5856 m <sup>2</sup>
		Co-ownership area under Condominium Act B.E.2522 (1979)					
		Structure	Colum, beam, footing, foundation, wall, roof				
		Stair	2 main stairs of 1.55m width, and middle stair of 1 m				
		Corridor	Corridor along a dwelling unit of 1.20m width.				
		Ground floor	Multi-purpose area is about 982.80 m <sup>2</sup> .				
		Building court	Area between two buildings is about 1157.73 m <sup>2</sup> .				
		Building facility	Garbage chimney, water tank, drainage system				
		Public utility	Water supply pipe, electricity system, fire alarm				
		Surrounded area	3 m. from building structure				
		Office	Condominium juristic person office is about 35.2 m <sup>2</sup> .				
Existing building conditions under condominium juristic person operation of Group D							
F	External physical	Elements	Ground floor	Open space	landscape		
16							
17							
18							
19							
20							

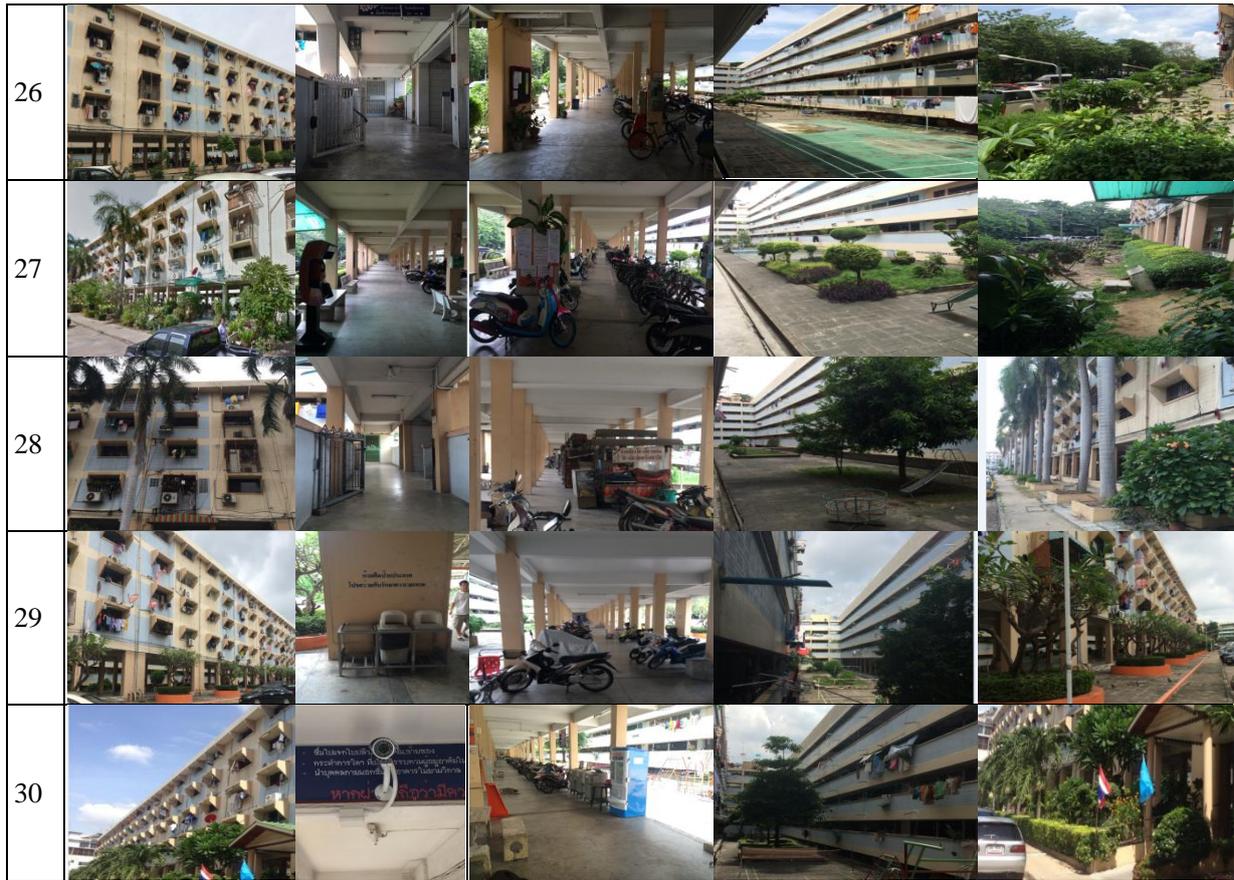


Remark: survey and interview of Klong Chan Flat were conducted on November, 2015.

5) Group E (198 units): this group includes Flat 22, 23, 24, 25, 26, 27, 28, 29 and 30. A well condition of physical building and surrounding area of this group includes Flat 22, 24, and 26 with cleanness and organized. Keeping a green area inside and in front of building as much as possible, they regularly maintained by trimming trees. Second group of moderately conditions are Flat 27, 28, 29, and 30. There are two flats at fairly condition including Flat 23 and 25 (Table 6.5).

Table 6.5 Surveying profile of group E

		Building site and surrounded area								
		Flat 22	Flat 23	Flat 24	Flat 25	Flat 26	Flat 27	Flat 28	Flat 29	Flat 30
		4312 m <sup>2</sup>	4308 m <sup>2</sup>	4324 m <sup>2</sup>	4336 m <sup>2</sup>	4480 m <sup>2</sup>	4300 m <sup>2</sup>	4320 m <sup>2</sup>	4372 m <sup>2</sup>	4352 m <sup>2</sup>
		Co-ownership area under Condominium Act B.E.2522 (1979)								
		Structure		Colum, beam, footing, foundation, wall, roof						
		Stair		2 main stairs of 1.55m width, and middle stair of 1 m						
		Corridor		Corridor along a dwelling unit of 1.20m width.						
		Ground floor		Multi-purpose area is about 720.72 m <sup>2</sup> .						
		Building court		Area between two buildings is about 792.54 m <sup>2</sup> .						
		Building facility		Garbage chimney, water tank, drainage system						
		Public utility		Water supply pipe, electricity system, fire alarm						
		Surrounded area		3 m. from building structure						
		Office		Condominium juristic person office is about 35.2 m <sup>2</sup> .						
Existing building conditions under condominium juristic person operation of Group E										
F	External physical	Elements	Ground floor	Open space	landscape					
22										
23										
24										
25										



Remark: survey and interview of Klong Chan Flat were conducted on November, 2015.

According to surveying four buildings, it can be summarized existing building condition and its maintenances on co-ownership properties of 30 flats as below.

- According to Annual Inspection Report B.E.2558 (2014), the building structures are still a good condition. Generally, a crack on the building can be found on the exterior wall but there is no significant impact nevertheless the building ground subside is primary problem because Bangkok is soft clay land. However, a roof frame structure is made from wood and it becomes a risk issue from moistures as well as wood deterioration. Also, a cement roof tile leaking has been normally maintaining issue as the cement roof tile is used since the building was constructed. In term of building exterior color, all building had been painted in 2004, it is getting poor condition as colored peel off from materials. Due to a wall of building is a brick construction without cement plastering therefore using a high quality of color shield to protect exterior brick surface is very important. In term of exterior wall of building, do not allow residents to add or install structures, changing a window and creating more function area with a curved steel fame. This directly affects wall deterioration and aesthetic building appearance of building.

- The staircase structure has been gradually slide-down and causing a level of dwelling unit building floor and staircase is quite a bit different.

- Corridor is a co-ownership area and it seems be an occupied space by residents. Tree constrainers, waste materials, and residents' stuffs are a bulk on corridor. The problem was found entire of all building groups. Residents may not see such a problem as common habit that all most residents did.

- Multipurpose area of ground floor flat is fixable function, using to support residents' living,

this area could reveal the condominium juristic person's management in term of organizing and maintaining the area regards to its functions. Normally, all flats have provided area for secure bike and motorcycle parking, relaxing area (benches), and trolley booths. From the survey, ground floor flat 1 is quite good maintenance as well organized and painted. Some flats are not well organized of those areas.

- For building facility system, fire systems including fire safety signs, escape route map, and fire extinguisher must be provided according to Building Control Act B.E.2522. All flats have followed a building law. However, some fire devices get poor conditions where no a practical fire drill. A handrail of stair, stainless steel, is added for convenient walking of residents especially an elder in some flats. Install closed-circuit television for resident's property security, it has been covered of all flats except Flat 7.

- Water and drainage pipe system is a majority issue for maintaining cost of building management. The pipe is a steel and usage more than 35 years that have corrosion. Changes a steel pipe to PVC pipe can be seen of all buildings. For lighting of building, it is provided through public area as corridor and ground floor area. There are some building have installed a light pole outside (in front of building) building for security. Other public utilities; internet box, water machine, prepaid machine, washing machine, and litter container have been provided of each building. However, these all functions are not completely provided, it depends on the condominium juristic person management.

- Open space of building including court yard inside and surrounded area of building is quietly different. Court yard inside the building purpose to be a green area for a good atmospheric living. Some flats are good maintenance and keeping clean with tree trimming. More functions such a small playground by providing a kids exercise equipment and locker for collecting stuffs have been added into court yard space. However, these equipments are found rather old condition as long term usage. For space in front of building National Housing Authority (NHA) purposed a green area with a perennial plant (palm trees) for shading building and be more livable place. At present, there are few buildings have changed the space to hard landscape by cement blocks instead to reduce a burden maintenance cost. Meanwhile former landscapes by NHA of some building are inadequate of maintenance.

As above mentioned on building problem conditions, most respondents have seen their building developed and renovated by exterior painting and installed lighting pole of the first and second rank in old public housing project. Also, comparing to new project, it has been more developed as the old conditions.

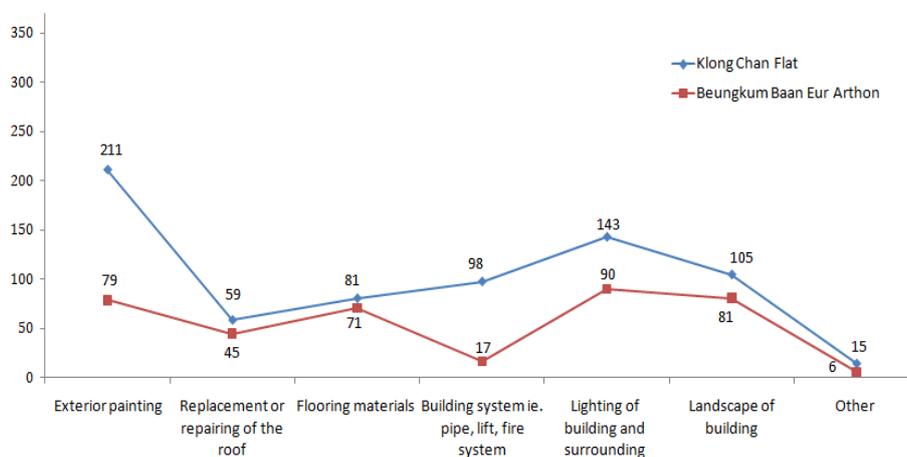


Figure 6.2 The most building renovation activity of occupant's experiences

Table 6.6 Summary of exiting maintenance and management of Klong Chan Flat Project

Maintenance and management of	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
co-ownership property	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Building structure*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
- column, beam, walls refer annual inspection report	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
- roof structure and tile	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Building facilities services***	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
- good condition of stair and add hand rail for elders	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
- good condition of 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

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

\*\*\* Building evaluation by observation and interview a representative of Condominium Juristic Person (CJP)

○ = Very good    ○ = Good    ● = Fair    ⊗ = Poor

### 6.1.3 Examining resident satisfaction based on group of administration and size of dwelling unit

For this section, two characteristics of building management (co-administration and individual administration) and five groups by separating number of dwelling unit (Group A: 104 units, Group B: 180 units, Group C: 180 units, Group D: 270 units, and Group E: 198 units) as summarized in Table 6.6 are conducted to investigate resident's satisfaction. This analysis is based on the assumption that different building management and scale of building might show different satisfaction. The six questions from questionnaire survey of 370 samples in Klong Chan Flat, which had been used for analysis in Chapter 4, were applied. Reliability Coefficients gives us the Cronbach's alpha reliability coefficient for the set of six items. At .891 it indicates good internal consistency (Table 6.7).

Table 6.7 Building satisfaction components

Building conditions (5-Likert scale)		Cronbach's alpha (N=370)
1	Quality of building facility is good	.651
2	Quality of building materials is good	.671
3	Quality of paints of this building is good	.670
4	Quality of solid waste/garbage storage is good	.785
5	Are you satisfied with cleanness of building	.778
6	Are you satisfied with the management rules & regulations on this public housing	.704
<i>Total</i>		$\Sigma = .891^*$

\*Cronbach's alpha reliability coefficient normally ranges between 0 and 1. There is a reliability degree as the following rules of thumb: "> .9 – Excellent, > .8 – Good, > .7 – Acceptable, > .6 – Questionable, > .5 – Poor, and < .5 – Unacceptable".

The hypothesis testing was analyzed by Independent-Samples T-Test, One-Way ANOVA, and Chi-square.

#### Hypothesis:

##### Characteristics of building management by Independent-Samples T-Test:

*H1*: Administration variable affects on different residential satisfaction in statistical significant.

*H0*: Administration variable no affects on different residential satisfaction in statistical significant.

##### Different groups of building dwelling unit by One-Way ANOVA:

*H1*: Different group variable affects on different residential satisfaction in statistical significant.

*H0*: Different group variable no affects on different residential satisfaction in statistical significant.

##### There is associated between building management and level of by Chi-square:

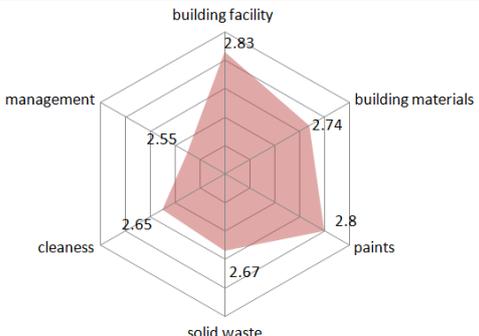
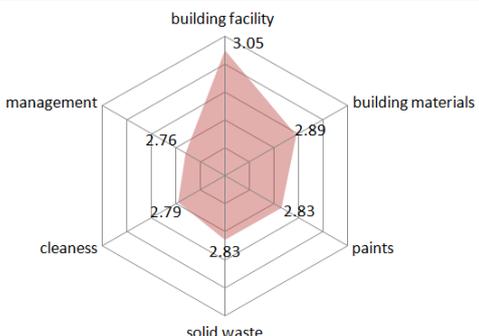
*H1*: Different group variable affects on different residential satisfaction in statistical significant.

*H0*: Different group variable no affects on different residential satisfaction in statistical significant.

Table 6.8, an independent-samples t-test was conducted residents' satisfaction based on type of administration of Klong Chan Flat. The result found that there was not a significant difference in the scores for Co-administration level (M= 2.70, SD=.721) and individual administration level (M= 2.85, SD= .694) conditions;  $t(368) = -1.876$ ,  $p = .061$ . However, to find out a relationship between dependence and independence variable, the chi-square test is applied to discover between two categorical variables

(administration and level of satisfaction of building scale). The result as shown in Table 6.8 was no significant relationship between administration and level of satisfaction that P-value (.763) is more than the significance level (0.05) that accepted the null hypothesis.

Table 6.8 Mean score of residents' satisfaction with different administration

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	<b>.061*</b>

\* No significant at the 0.05 level between two groups

Table 6.9 Correlation of residents' satisfaction and administration group by Chi-Square Tests

Group	Score		Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
	Low	Hight				
Co-administration	78	33	Pearson Chi-Square*	.091 <sup>a</sup>	1	<b>.763</b>
			Likelihood Ratio	.090	1	.764
Individual administration	186	73	Linear-by-Linear Association	.090	1	.764
			Total	264	106	N of Valid Cases <sup>b</sup>

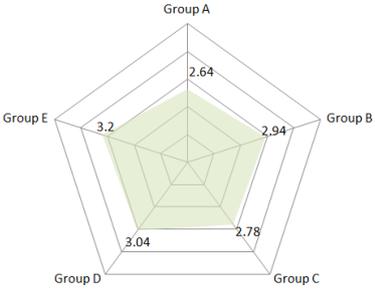
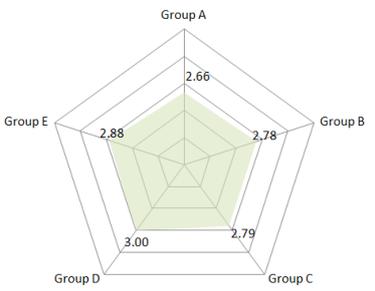
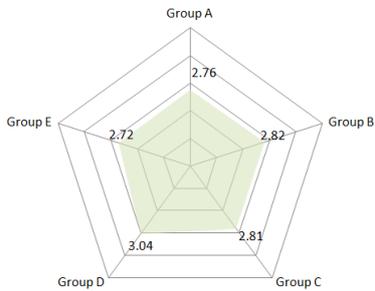
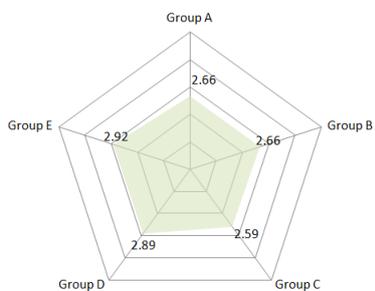
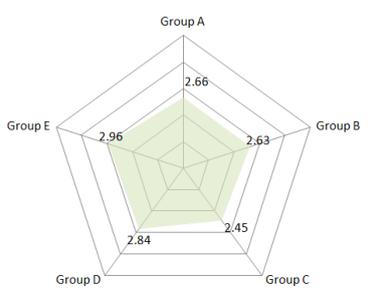
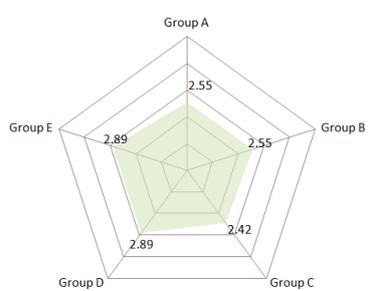
\* No significant at the 0.05 level between two groups

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 31.80.

For testing residents' satisfaction level among groups of building size dividing groups into five independent groups, a one-way ANOVA is used to understand these variables. The result found that the resident satisfaction on materials, paints, and garbage collection between groups (five groups) were not a significant difference in the scores by F-test > .05 as shown in Table 6.10. There were only three dependents; building facility, cleanness, and management & regulation showing statistically significant difference between groups by F-test < .05. Then, determining which of these groups differ from each other is important. Using a post-hoc test by Scheffe method found residents' satisfaction in building facilities aspect of Group E was a statistically significant difference between groups at .017 and .041 by score higher than Group A and C. Also, residents' satisfaction in cleanness and management & regulation aspect of Group E was a statistically significant difference between groups that less than .05. The residents' satisfaction in cleanness of Group D was a statistically significant difference by score higher than Group D. These above results can be interpreted that maintaining a good building performance in term of physical

conditions which Group D and E have been done (Table 6.10), the residents' satisfaction as well as their preferences was higher than another group.

Table 6.10 Mean score of residents with five groups of dwelling unit size

Building facilities			Materials			Paints		
								
<i>F-test</i> = 4.377 (Sig. .002)			<i>F-test</i> = 1.327 (Sig. .260)			<i>F-test</i> = 1.679 (Sig. .154)		
<b>Group E</b>	GroupA	Sig. .017	No different between groups			No different between groups		
	GroupC	Sig. .041						
Garbage collection			Cleanness			Management & regulation		
								
<i>F-test</i> = 2.089 (Sig. .082)			<i>F-test</i> = 4.511 (Sig. .001)			<i>F-test</i> = 5.137 (Sig. .000)		
No different between groups			<b>Group E</b>	Group B	Sig. .013	<b>Group E</b>	Group A	Sig. .026
				Group C	Sig. .000		Group B	Sig. .009
			<b>Group D</b>	Group C	Sig. .009		Group C	Sig. .000

\* Significant at the 0.05 level between two groups

Moreover, to find out a relationship between dependence and independence variable, the chi-square test is applied to discover between two categorical variables (five group and level of satisfaction of building scale). The result in Table 6.11 was no significant relationship between size of building and level of satisfaction that P-value (.132) is more than the significance level (0.05) that accepted the null hypothesis.

Table 6.11 Correlation of residents' satisfaction and five groups by Chi-Square Tests

Dwelling unit size group	Score		Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
	Low	Hight				
Group A	34	8	Pearson Chi-Square Likelihood Ratio Linear-by-Linear Association	7.082 <sup>a</sup>	4	.132
Group B	44	25		7.322	4	.120
Group C	59	15		.741	1	.389
Group D	44	21				
Group E	83	37				
Total	264	106	N of Valid Cases	370		

\* No significant at the 0.05 level between two groups

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.03.

## 6.2. Analysis of Building Maintenance Cost Situation

### 6.2.1. Income and expenditures challenges for public housing improvement

There are three sources of income for operating Klong Chan Flat Project in charge by condominium juristic person (CJP) including co-ownership properties fee, security deposits for water meter, and capital fund (Table 6.12). However, the security deposits and capital fund are provided in case of emergency situations and one-third of capital fund can be only used for those situations through residents' agreement. Therefore, using a financial of co-ownership properties fee is mainly available in operating and developing their buildings. The co-ownership properties fee was specified by National Housing Authority before transferring a property right to condominium juristic person. Currently, most of flats are still using the former fee rate more than fifteen years and only three flats have changed their fee rate. Based on this situation, it should be pointed out that how does a co-ownership property fee adequate for operation and upgrading services. When comparing the co-ownership property fee and dwelling unit area, the amount of this building service fee was a range at 4.43 – 7.39/ sq.m. which was not much different in term of new public housing development project (Beung Kum Baan Eur-Arthorn Project) by co-ownership property fee was about 7.69/sq.m (250 baht/32.50 sq.m.). However, collecting all co-ownership property fees from residents was difficult as delayed payment and uncollected from a vacant room, meanwhile the maintaining expenses are raising (Field interview, 2015). Therefore, additional income sources for helping the building operation including water fee (the adjustable rate based on the agreement of residents), delayed charges, and extra income (using a co-ownership property area for rental services; washing machine, fresh water vending machine, storage areas for street merchant carts or stuffs of residents) have been operating since transferred right of property to CJP.



Figure 6.3 Example of external income by rental fee of facility services in Klong Chan Flat Project

Table 6.12 Sources of Klong Chan Flat income

Flat			Main source of income (Baht)						
			Co-ownership properties fee (baht) /month			Security deposits for water meter/only one time		Capital fund/only one time	
No.	Unit	Room Area	Rate*	Rate/sq.m.	Total	Rate**	Total	Rate**	Total
1-4	108	47.52	310	6.52	32,240	600	64,000	1000	108,000
5 - 15	180	47.52	250	5.26	45,000		108,000		180,000
16	270	33.82	150	4.43	40,500		162,000		270,000
17, 20	270	33.82	200	5.91	54,000		162,000		270,000
18, 19, 21	270	33.82	250	7.39	67,500		162,000		270,000
22 - 30	198	33.82	250	7.39	49,500		198,000		198,000

Remark \* rate is based on residents' agreement of each buildings

\*\* rate is based on National Housing Authority of Thailand

From different fee charge data, therefore, building fee rate in Table was analyzed how different rates affect to resident's satisfaction score on cost. Moreover, the building fee rate has been applied indicating there was a relationship with residents' satisfaction. There are hypothesizes below:

#### Hypothesis:

by *One-Way ANOVA*:

*H1*: Different fee groups affect on different residential satisfaction in statistical significant.

*H0*: Different fee groups not affect on different residential satisfaction in statistical significant.

by *Chi-square*:

*H1*: Building fee and residential satisfaction on building are related in statistical significant.

*H0*: Building fee and residential satisfaction on building are not related in statistical significant.

Testing four groups of different building fee and residents' satisfaction level on cost variable, a one-way ANOVA (analysis of variance) is used to understand mean of these variables. Mean score of each groups shown a quite different that those buildings use a fee rate at 250 and 310 performing a low score mean of satisfaction than the fee rate group at 150 and 200 baht/mount. However, there was not statistically significant difference in the scores by F-test > .05 as shown in Table 6.13.

Table 6.13 Building fee rate and residents' satisfaction on cost variable

Comparative mean score				Result of ANOVA					
Fee rate	N	Mean	Std. Deviation	Sum of Squares	df	Mean Square	F	Sig.	
310	42	2.79	.645	Between Groups	2.367	3	.789	1.036	.377*
250	294	2.75	.914						
200	22	3.05	.785	Within Groups	278.900	366	.762		
150	12	3.00	.603						
Total	370	2.78	.873	Total	281.268	369			

\* No significant at the 0.05 level between four groups

Also, using building fee groups to find out a relationship with six variables by Chi-Square Test has been analyzed as shown in Table 6.14. The result shows that there are no statistical significant relationship between the difference building fee groups with score of satisfaction on; quality of facility, building materials, solid waste or garbage storage, quality of cleanness, and management regulation of building. there was only one variable indicating a statically significant relationship between different building fee and satisfaction level of paints quality that P-value (0.05) is equal the significance level (0.05) with accepted the null hypothesis ( $H_0$ ).

Table 6.14 Different building fee and residents' satisfaction on building variables analysis

Quality of facility is good		Building materials are good	
Fee group	Satisfy score of difference fee group	Fee group	Satisfy score of difference fee group
310		310	
250		250	
200		200	
150		150	
Pearson		Pearson	
Chi-Square.145		Chi-Square.152	
Paints of this building is good		Solid waste/garbage storage is good	
Fee group	Satisfy score of difference fee group	Fee group	Satisfy score of difference fee group
310		310	
250		250	
200		200	
150		150	
Pearson		Pearson	
Chi-Square.05		Chi-Square.231	
Quality of cleanness is good		Management and registration of building	
Fee group	Satisfy score of difference fee group	Fee group	Satisfy score of difference fee group
310		310	
250		250	
200		200	
150		150	
Pearson		Pearson	
Chi-Square.736		Chi-Square.152	

\*significant at the .05 level

As shown in Table 6.15, considering expectation building fees of charge (if all units paid) and actual collected from occupancy's unit found that 16 flats of 25 flats (available monthly report data) or 64% have collected amount of building fee charge less than expectation fee. This amount of building fee is paid to cover three categories; administration, electricity, and building development expenditures and it could be affecting a running cost of whole building management as insufficient budgets for their operations. On the

other hand, the building maintenance in term stop working or start failing at a time as user request will be considered to carry out for saving budget (Filed interview, 2015). However, the failure of building components can cause a large amount of consequential damage to other elements, for example, roof failure can cause to ceiling and interior of dwelling unit damage (Kenley & Seppänen, 2009). Therefore, this approach might lead to extremely expensive than saving side. Although, the total incomes of all flats are quiet higher than total expenditures including delay charge and area rental so they have enough income for operation and management, but there are 6 flats paying more over incomes which could be a problem as unable collect money based on expectation fee. Therefore, more clearly extent their incomes and expenditures, 12-month accounting period has been investigated of cost situation.

For expenditure part, using the CJP's monthly report is normally divided into four categories; administrative, water, electricity, and development cost. The lists of these expenditures were presented below:

1) Administration cost

From the Table, the administrative cost including salary of staffs and office equipments consumed highest amount of building fee income. Especially, those flats have an independent-administration feature without sharing staffs (Group C, D, and E) and their expenditures were ranked at 23,000 – 32,000 baht/month by consuming a haft of building fee income. Meanwhile, the Group A and B (co-administrative office with a sharing office, staffs, and materials) performed better on administrative cost about 14,000 – 22,000 baht/month. It should be mentioned that salary of staffs and building manager can play important role to increase or reduce of expenditures. However, asking CJP about salary of staffs found that all building provides salary with low rate (6,000 – 10,000 baht which lower than minimum wage at 15,000 baht/month) for manager (1 person) and staff (2 persons) as insufficient incomes (Field interview, 2015).

2) Water supply cost

Water supply fee was the first ranked among expenditure lists which consumed a large amount of income. With large dwelling unit, Group D paid water expenditure than other groups. However, it does not a big issue for condominium juristic persons (CJP) to pay water expenditure to Metropolitan Waterworks Authority (MWA) because they earned income by selling water to residents with a progressive rate. Delayed payment fine and locked water meter (unpaid 3 months) will be handled to enforce residents.

3) Electricity supply cost

In term of electricity cost there was not quite different among all flats at 12,000 – 18,000 baht even they are different size of building. And the result of filed survey, added a light bulb or light pole in the area of ground floor and building surrounding in order to providing security of resident at night and their property has been done in case of Flat 11, 17, 20, 21, 23, 24, 26 and 27. However, these flats' expenditure of electricity was not much different compare to other buildings. Increasing electricity cost based on the frequency and how long they turn on the light that also depends on income situation (Field interview, 2015).

#### 4) Building development cost

According to development building expenditure in Figure 6.5 - 6.9, amount of this cost for maintaining and improving a whole building and surrounding is difficult situation to control in term of limited budget and building fault or damage. The building development cost includes structure repair, lighting system, pipe/drainage system, roof, landscape, garbage collection, cleaning, insurance, and other related activities. Group D and Group E have spent lot of budgets more than Group A and B. To perform of the old public housing building in good condition, therefore, budget or income is very important for quality of all flats. However, how much does the income distribute for building development is followed a critical issue as corrective-based maintenance and residents needed as serving their living quality rather than providing budget for long term plan (proactive maintenance approach). Additional, a development provision of condominium juristic person board is one influent factor to contribute quality of building; some buildings could not allocate budgets for building development as well as limited income.

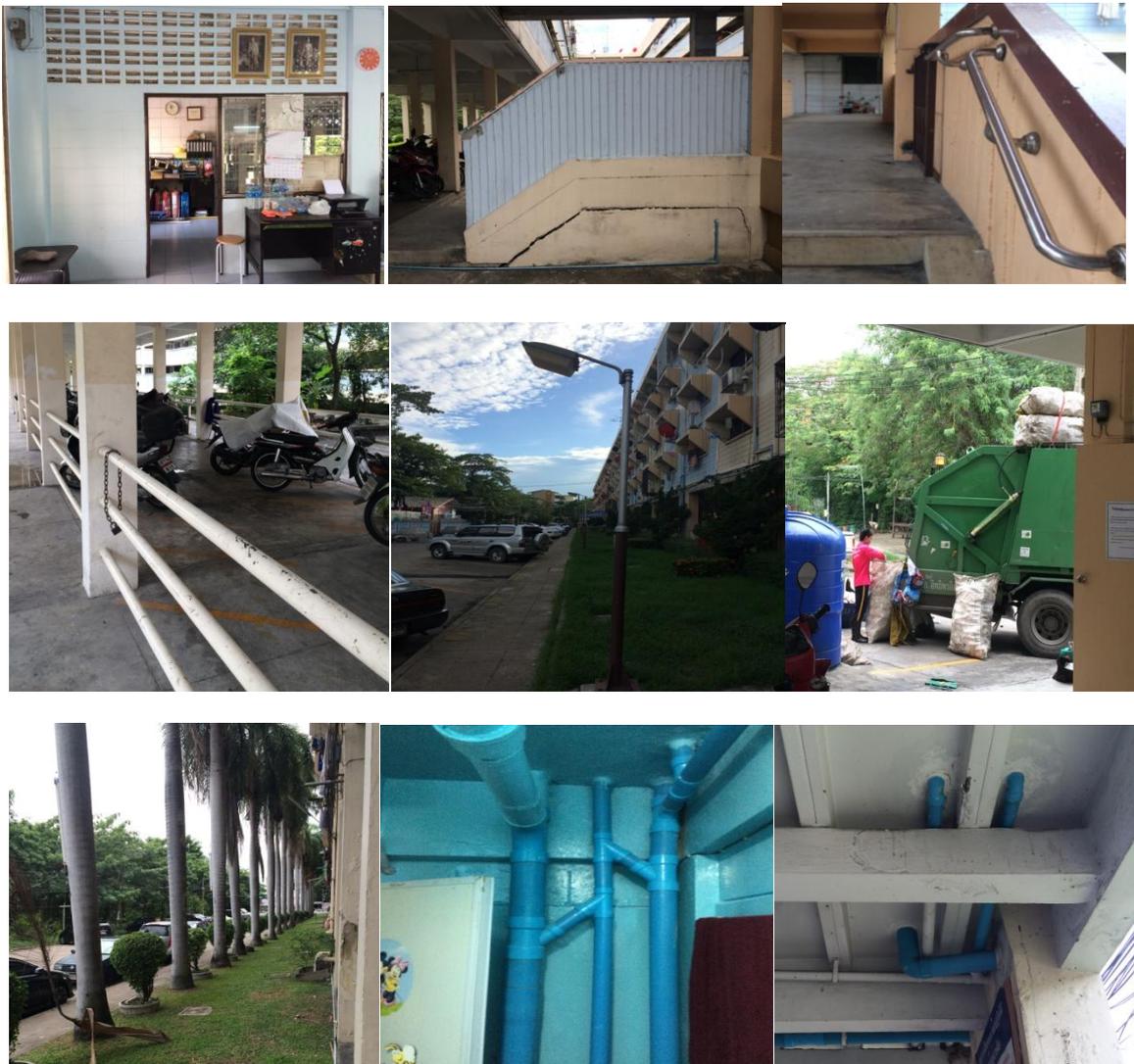
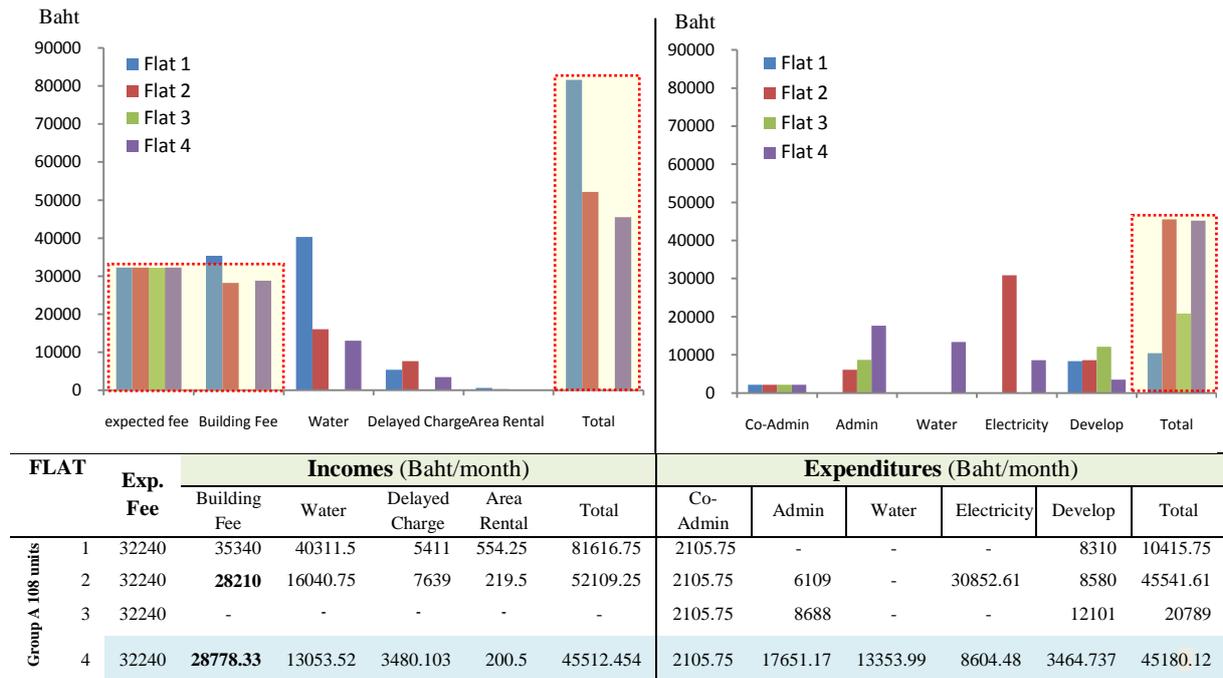
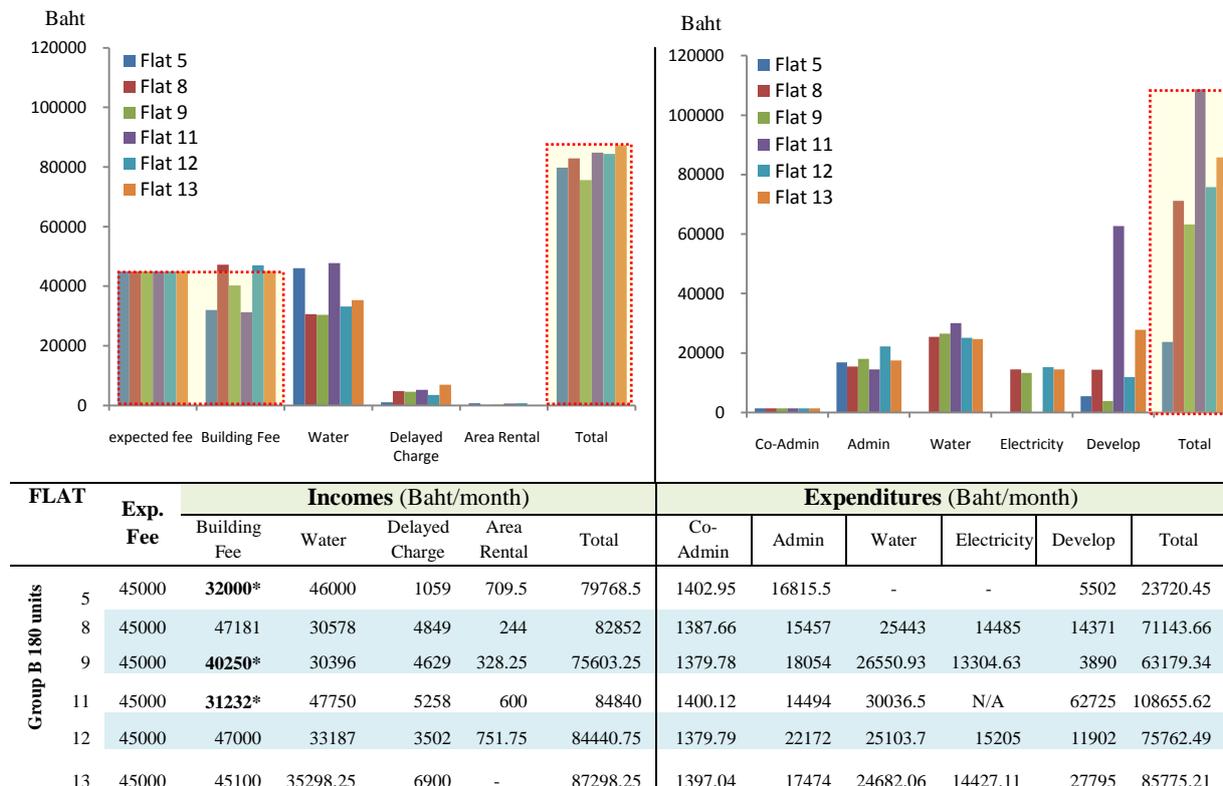


Figure 6.4 Example of building development expenditure of Klong Chan Flat improvement



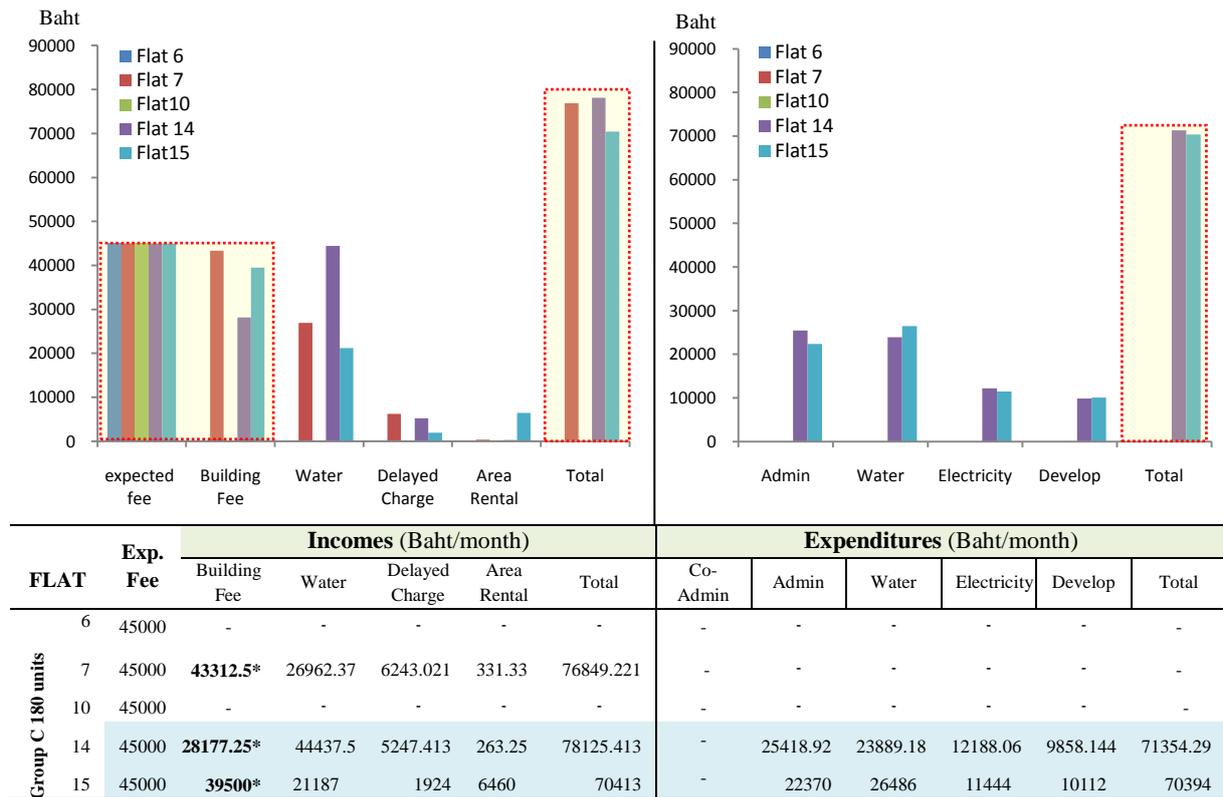
Flat 4 was selected for next analysis part of monthly expenditure prediction as available data of income and expenditure items.

Figure 6.5 Monthly income and expenditure of group A (108 unit)



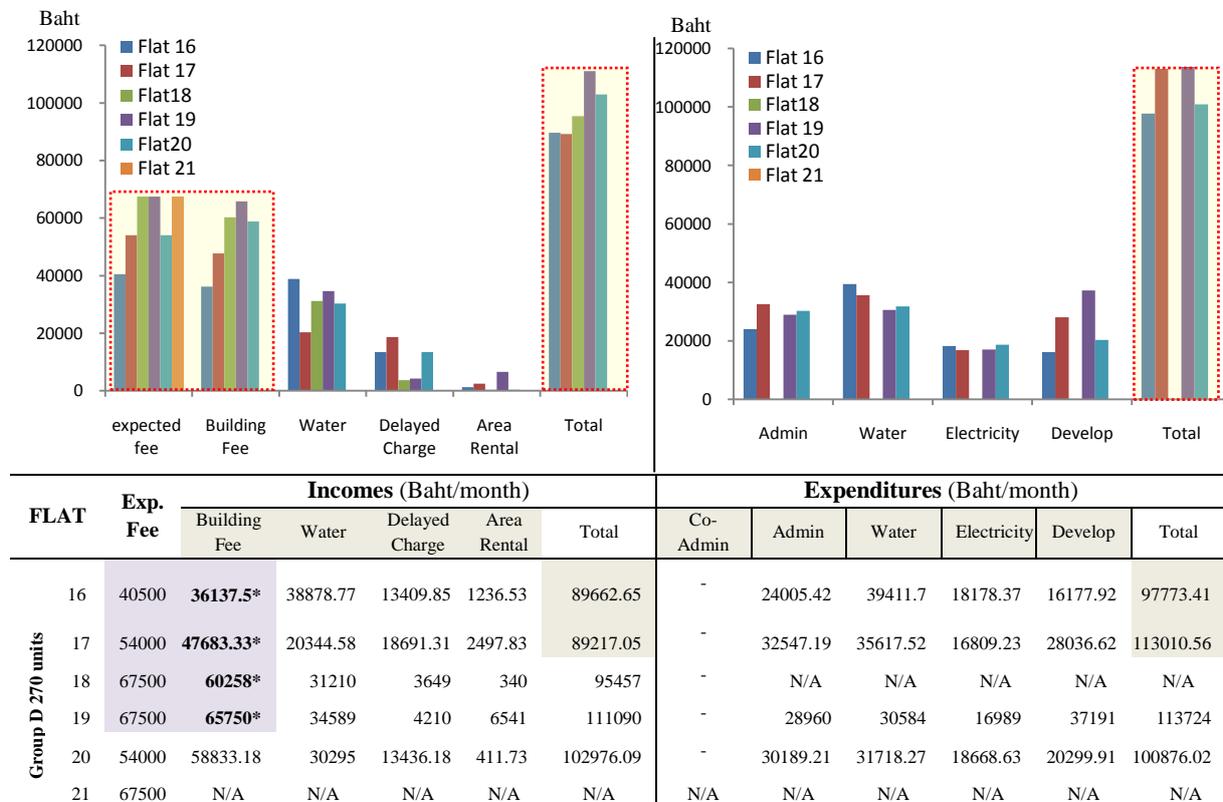
Flat 8, 9 and 12 were selected for next analysis part of monthly expenditure prediction as available data of income and expenditure items.

Figure 6.6 Monthly income and expenditure of group B (180 unit)



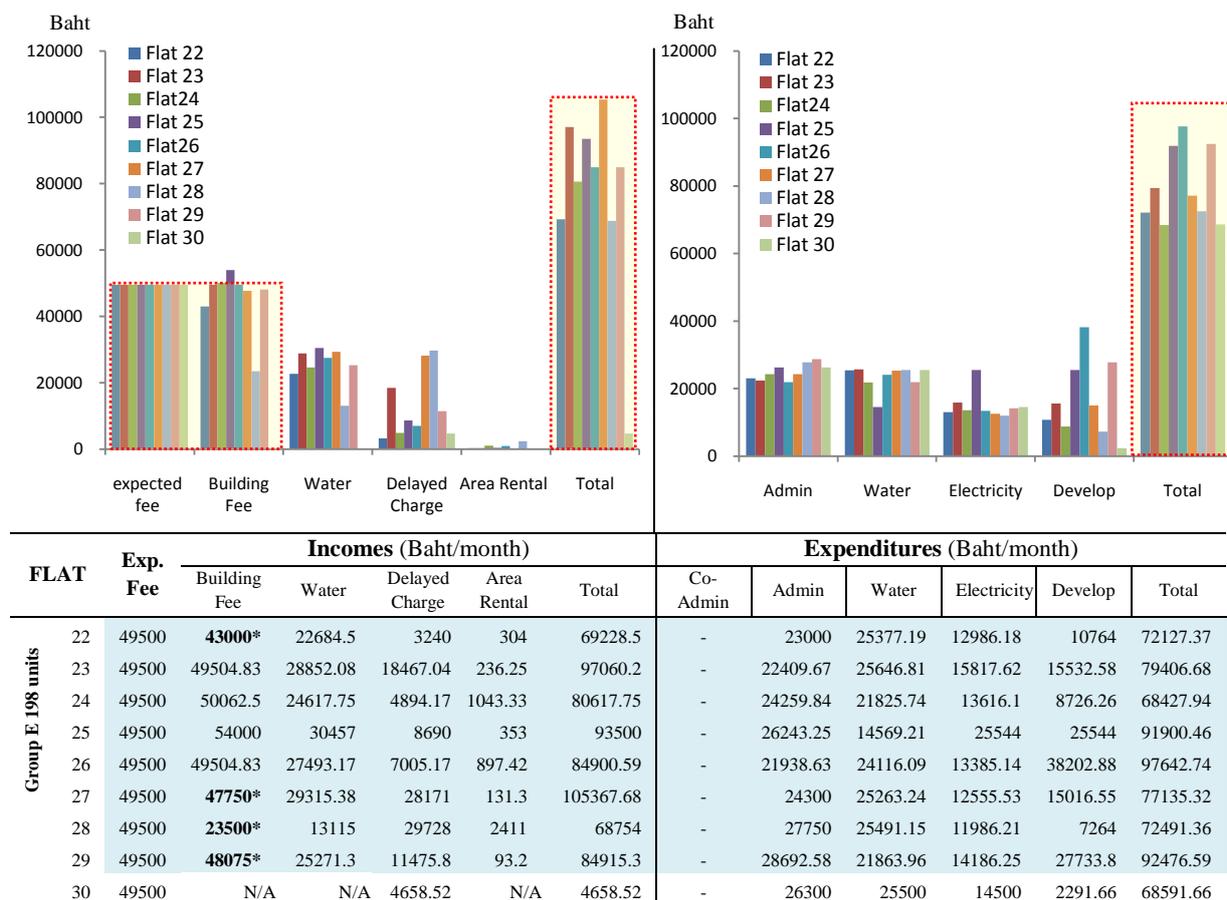
Flat 14 and 15 were selected for next analysis part of monthly expenditure prediction as available data of income and expenditure items.

Figure 6.7 Monthly income and expenditure of group C (180 unit)



Flat 8, 9 and 12 were selected for next analysis part of monthly expenditure prediction as available data of income and expenditure items.

Figure 6.8 Monthly income and expenditure of group D (270 unit)



Flat 22 - 29 were selected for next analysis part of monthly expenditure prediction as available data of income and expenditure items.

Figure 6.9 Monthly income and expenditure of group E (198 unit)

### 6.2.2. Analysis affecting factors on maintenance cost of Klong Chan Flat Project

This section analysis aims to clarify influence factors of Klong Chan Public Housing project in term of maintenance and operation on expenditures. It is expected that maintenance building will become more important and serious issue for low-income residents. To analysis an influence factor, the previous study and research related maintenance housing were reviewed and applied.

#### 6.2.2.1. Previous research

AL-khatam (2003) listed nineteen factors affecting maintenance cost including design, faulty design, low concern for future maintenance, life cycle cost, poor quality control, lack knowledge of maintenance, unfamiliarity with local condition, unfamiliarity to identify the main and true cause of the defect, life cycle cost, labor skill, material selection, misusing materials as using cheap materials, fluctuation of material prices, climate change affects chemical reaction of materials, unqualified maintenance contractor, age of building, poor management, poor financial management, user neglected importance of maintenance work, misuse of building after construction is complete, attitude of users, and improper maintenance strategy. These factors are also involved to the studying factors affecting maintenance cost of institution buildings in Nigeria by Faremi, Ademga, Dada, and John (2014), there are the seventeen factors 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. The study of EI-haram and Horner (2002) found there are four categories comprising building characteristic, political, technical, and administrative, especially on building characteristic comprises sub-variables as building size, building age, function, height of building, type of structure, finishes, building materials, and building components. For technical and administrative factor are associated with poor workmanship, poor maintenance management, budget constraints, and poor budget control (EI-haram and Horner, 2002). However, the building characteristics are different in terms of the building amenities provided as well as facilities and services (Sonthya, 2006). Also, maintenance cost differs in various places such as location, available of resources, materials, funds, transportation. Other factors are third-party vandalism and lack of training that can affect building maintenance cost as unclearly control and develop buildings profitably (Zulkarnain, Zawawi, Ralunau, Mustafa, 2011). Another approach to indentify maintenance performance is founded in the study of office building by Au-Yong, Ali, and Ahmad (2013), five dependents variables were significantly correlation between characteristics of scheduled maintenance and cost consisting 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.

#### 6.2.2.2. Methods

##### 1) Potential variables:

Based on above literature reviews, these factors have been considered and adapted as possible variables to identify significant building maintenance expenditure factors of old public housing project. Moreover, with data analysis in building management through physical condition (Section 6.2) and expenditure cost (Section 6.3) have been integrated analyses. Table presents the variables between the building characteristics, maintenance features, and user behavior. Twenty-five Flats of those have showed monthly building expenditure reported as shown in Table, they were selected in this regression analysis.

Table 6.15 Potential key variables to explain maintenance expenditure

Dependent variables			Variables criteria explained	
	Unit	Type		
Building expenditure of maintenance	Baht	continuous	The most important factor for keeping building in a good condition as conditioned public housing improvement.	
Independent variables			Variables criteria explained	
	Unit	Type		
Maintenance management	Type	categorical	Two different characteristics of Klong Chan Flat are co-operation management and individual management. This data obtained from field survey and documents.	
Building charge	Baht	categorical	Amount of building charges for improvement might be limiting a maintenance performance.	
Building physical condition*			Existing building condition as physical maintenance including structures, facilities, public utilities, cleaning, and open spaces could affect maintenance cost.	
Structure	Score	continuous		
Facility of building service	Score	continuous		
Open space	Score	continuous		
Tidiness of building	Score	continuous		
Building features			Different number of dwelling unit occupation of building will affect maintenance cost.	
Dwelling unit occupied**	No. of Room	continuous		
Site of building project	M <sup>2</sup>	continuous		Different site of building will affect maintenance cost.
Common property area	M <sup>2</sup>	continuous		Total area of common property in term of open space and ground floor is used to identify influence factor.

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 as rating scale, the Cronbach's alpha is tested 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 is used to assume the all flats are fully living.

## 2) Correlation Test

Correlation examines the relationship between two or more variables separately, meaning that relationship between two variables is independent of other variables. These variables measure the strength and direction of the linear relationship between the two variables. The correlation coefficient can range from -1 to +1, with -1 indicating a perfect negative correlation, +1 indicating a perfect positive correlation, and 0 indicating no correlation at all (Diamond, 2006). However, to select variables for next regression model for a validate regression model, a correlation coefficient should be more than 0.3 or above denoting a strong relationship and those variables is required a p-value of less than .05 to indicate statistically significant (Sauder, Lewis, and Thornhill, 2009).

## 3) Multiple Regression Model:

Multiple regression is an extension of simple linear regression analysis and uses to assess the association between two or more independent variables and a single continuous dependent variable. The general form of the multiple regression equation can be used as the following equation:

$$Y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k + \varepsilon \quad \text{equation.....1}$$

Where:

$Y$  = the dependent or response variable,  
 $X_1, X_2, X_3, \dots, X_k$  = the independent or predictor variables,  
 $E(Y) = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k$  = is the deterministic component of the model,  
 $\beta_1$  = the contribution of the independent variable  $X_1$  and,  
 $\varepsilon$  = a random error of the model.

Firstly, the variable in the model is a linear relationship between the dependent and dependent variables. Secondly, the independent variables must be linearly independent. Thirdly, there is no highly correlated among the variables (multicollinearity test). And finally, the error distribution should also be normal.

### 6.2.2.3. Results

Table 6.16 presents the significant relationships between building expenditure of Klong Chan Flat and variables of three features; building management, building physical condition, and building features by performing Pearson's correlation analysis. From the result, the three variables were found to be significantly correlated to the building expenditure variance by giving a perfect positive correlation. The three variables: building charge, number of dwelling unit, and common property were added in the multiple regression model. The result shows that the explanatory variables in the maintenance expenditure of Model 1 (Table 6.17) accounted for 76.4 percent of the variance in this model ( $R^2=0.764$ ). After keeping three variables constant, the analysis results have revealed that one independents was not significant with P-value of more than .05 (Building\_Charge = .238). Meanwhile Dwelling\_Occupied and Common\_Area independents proved to be significant indicating dependent variance.

Table 6.16 Correlation matrix between covariates (10 variables)

Variables	BT	MT	BC	DO	SBP	CP	ST	FB	OP	TB
Building expenditure	1.00									
Management type	.401	1.00								
Building charge	<b>-.630**</b>	-.387	1.00							
Dwelling unit occupied	<b>.739**</b>	<b>.717**</b>	<b>-.710**</b>	1.00						
Site of building project	.442	-.131	<b>-.665**</b>	.242	1.00					
Common property area	<b>.469*</b>	-.053	<b>-.710**</b>	.305	<b>.927**</b>	1.00				
Structures	.301	.099	<b>-.450*</b>	.259	.165	.110	1.00			
Facility service	.293	<b>.513*</b>	-.278	<b>.529*</b>	.139	.023	.001	1.00		
Open space	.067	.031	-.140	.124	.299	.242	-.218	<b>.541*</b>	1.00	
Tidiness of building	-.124	-.069	-.186	.084	.363	.310	.156	.331	<b>.487*</b>	1.00

Noted: BT = Building total expenditure, MT = Management type, BC = Building charge, DO = Dwelling unit occupied, SBT = 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 6.17 Affecting variables to predicting old building expenditure by Enter Method

Variables	B	t	Sig.	Collinearity Statistics	
				Tolerance	VIF
(Constant)	-51.671	-1.011	.327		
Building_Charge (BC)	.159	1.234	.235	.284	3.523
Dewelling_Occupied (DO)	18.174	4.794	.000	.440	2.274
Common_Area (CA)	100.468	2.607	.019	.533	1.875

Constant = -54077.071; SE<sub>test</sub> ± 9.13  
R = .874; R<sup>2</sup> = .764; F = 17.276 ; P-value = .000

\* Significant at the 0.05 level

From Model 1, it can be used to create a predictive equation formula as below:

$$BMM = -51.671 + 0.159BC + 18.174DO + 100.468CA \quad \text{equation.....2}$$

To eliminate the non-significant predictors as shown in Model 1 and produce a validated equation therefore, another model was produced that showed in Table 6.18. In Model 2, two independents were identified as significant factor of building maintenance expenditure variance including Dwelling\_Occupied and Common\_Area by 71.1 percent can be predicted with these predictors. Thus, these variables must be taken into consideration when preparing investigation public housing expenditure of NHA. If proper attention is paid to these predictors, the building maintenance expenditure cost would be focused for planning.

Model 2: (Stepwise Method)

Table 6.18 Affecting variables to predicting old building expenditure by Stepwise Method

Variables	B	t	Sig.	Collinearity Statistics	
				Tolerance	VIF
(Constant)	9.433	.732	.001		
Dwelling_Occupied	14.828	2.698	.000	.900	1.111
Common_Area	70.092	2.342	.032	.900	1.111

Constant = -54077.071; SE<sub>test</sub> ± 9.2  
R = .861; R<sup>2</sup> = .711; F = 24.37 ; P-value = .000

\* Significant at the 0.05 level

From Model 2, it can be used to create a predictive equation formula as below:

$$BMM = 9.433 + 14.8282DO + 70.092CA \quad \text{equation.....3}$$

Both models were check a validation of the regression that tolerance and VIF value were more than 0.1 and lower than 10 (Saunders, 2009) respectively. In applied multivariate regression model of maintenance expenditure, this is to be expected that maintenance cost of old public housing project would be calculate through size of dwelling occupation and common area. So, these variables should be addressed in the policy of monitoring old public housing of National Housing Authority to examine maintenance expenditure issues that find a way how low-income residents solve their buildings in according with these predicting factors.

### 6.3. Cost Performance by Annual Report and Case Study of Expenditure Prediction

#### 6.3.1. Income and expenditure situation

To extent investigation of building development cost, the annual report is an informative data to understand expenditure situations of those flats how they pay attention for physical development or related activity. 7 of 30 flats were selected including Group A: Flat 4, Group B: Flat 8, Group D: Flat 20 and Group E: Flat 23, 24, 26, and 29 respectively. The results were described below.

Figure 6.10 shows the actual fee of 12-months of Flat 4 was lower expected fee (32,240 Baht/month) and it could be calculated for monthly actual fee average was 28,788 Baht/month. External fee contributed building development cost by average of 5,886 Baht/month. Then, extended analysis on total expense (building development cost) was analyzed and found that administration cost ratio is very high than electricity and development cost ratio at 57%, 28%, and 15% respectively. So, using monthly average, this building pay attention on administration management of 17,651 Baht/month even it is small size of building (108 units) meanwhile only 4,560 Bath/month or 54,731 Baht/year was paid on development cost. A garbage collection plays role important in development cost. Considering the income and expenditure of this flat as usual situation, their income are able to cover building expenditure cost (389,507.2 baht/year > 369,799 Baht/year).

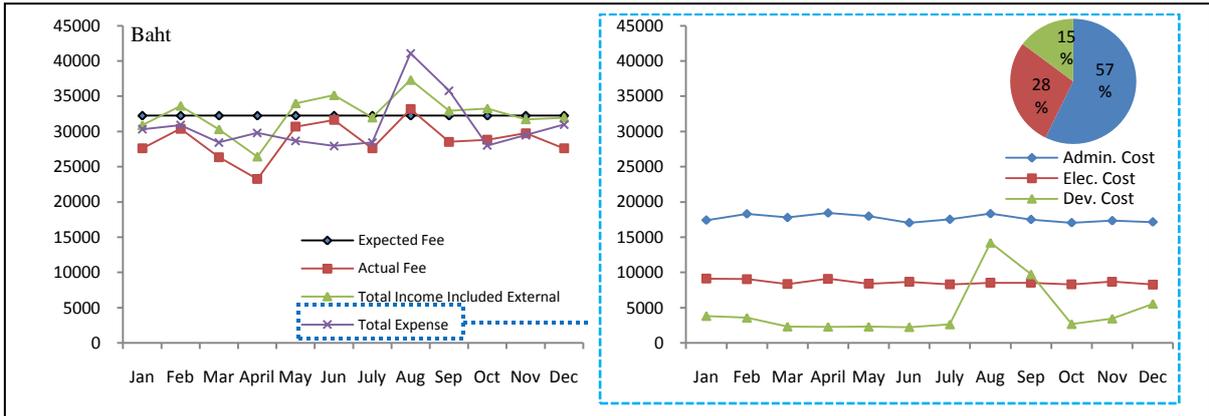


Figure 6.10 Income and building expenditure of Flat 4

Flat 8, Figure 6.11 shows a half of monthly actual fee is below expected fee line (45,000 Baht/month) by monthly actual fee average was 41,780 Baht/month. Building development cost with average external fee of 5,092 Baht/month is contributed this flat. However, the total expense was still found higher than the total income (included external fee) which spent on structure repairs. Comparative ratio of total expenses (building development cost) found the three categorized; administration cost, electricity and, development cost are not much different of 35%, 31%, and 34% respectively. Especially, monthly average development cost for improving building is higher than Flat 4 at 16,065 Baht/month and administration cost was 16,844 Baht/month. This average reveals that even this flat is bigger than Flat 4 (180 units) but administration cost is lower. Considering the total income and total expenditure of this flat of 562,479 baht/year and 568,737 Baht/year it could be noted that the income are unable to cover building expenditure cost if they are going manage as usual situation.

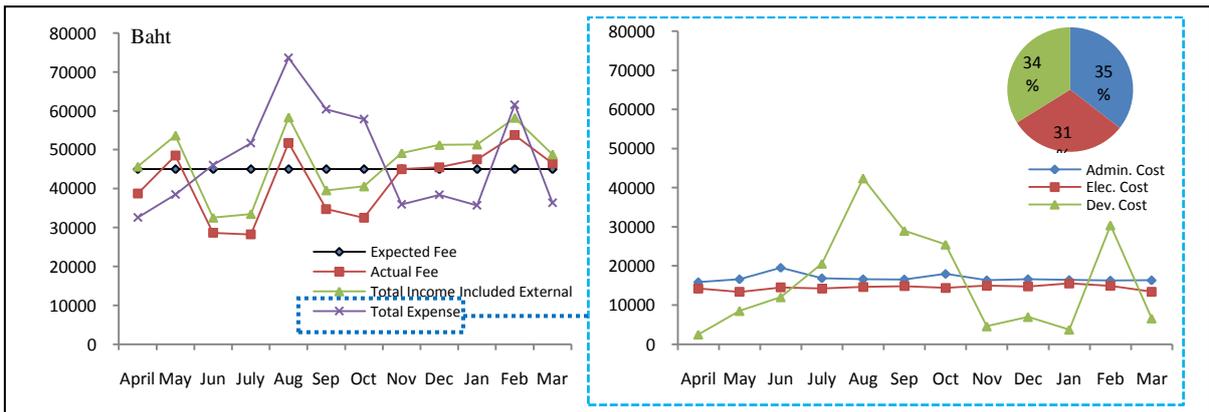


Figure 6.11 Income and building expenditure of Flat 8

Flat 20, Figure 6.12 shows mostly the actual fee of this flat meets the expected fee (54,000 Baht/month) and monthly actual fee average is 58,833 Baht/month. The external fee contributed building development cost about 13,847 Baht/month. Plus this amount of income is able to cover all expenditures.

For total expense (building development cost) found that administration cost ratio is higher than electricity and development cost at 42%, 32% and 26% respectively. Administration management cost therefore plays role important of monthly average 30,189 Baht/month. Meanwhile monthly average of 23,240 Baht/moth was paid on development cost in pipe/drainage system. Considering the total income and total expenditure of this flat of 799,492 baht/year and 793,083 Baht/year it could be noted that the income are able to cover building expenditure cost if they are going manage as usual situation.

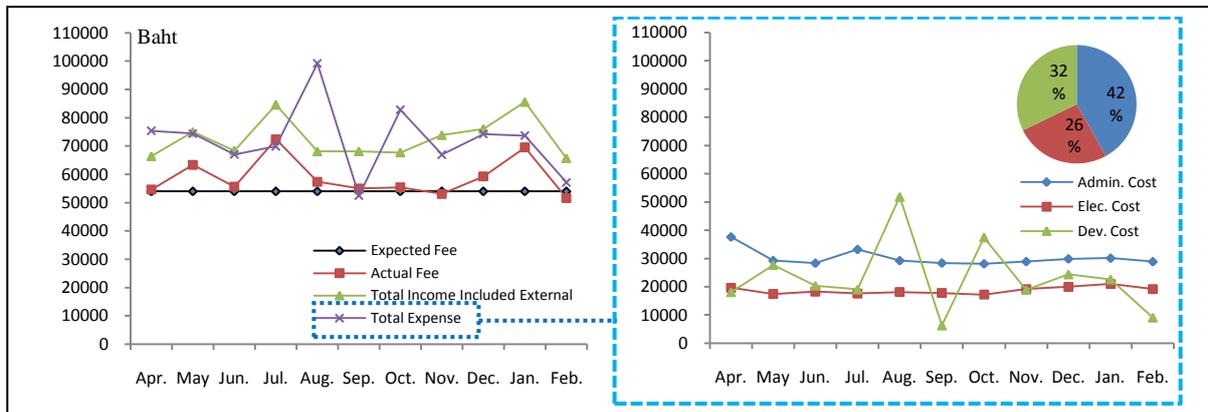


Figure 6.12 Income and building expenditure of Flat 20

Flat 23, Figure 6.13 shows the actual fee meets the expected fee (49,500) by monthly average was a bit higher of 49,504 Baht/month. External fee had contributed building development cost of 18,703 Baht/month that is higher than Flat 4, 8, 20. It could note that this flat has more capacity development based on external income budget. For total expense (building development cost), the administration cost was still be major part as ratio was higher than electricity and development cost of 42%, 29% and 29% respectively. Its monthly average was 22,409 Baht/month. Meanwhile 15,532 Baht/moth was paid on development cost on other activity such social events. The total income and total expenditure of this flat found 818,498 baht/year and 645,118Baht/year it could be noted that the income are able to cover building expenditure cost if they are going manage as usual situation.

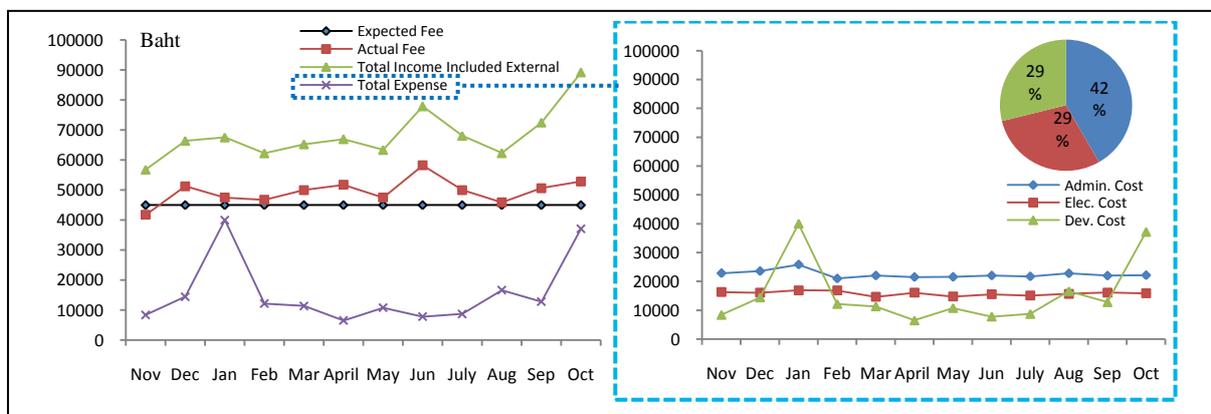


Figure 6.13 Income and building expenditure of Flat 23

Flat 24, Figure 6.14 shows only six months of the actual fee meets the expected fee line however averaging actual income through a year found higher than expected fee (50,062 > 49,500 Baht/month). However, external fee found at 5,937 Baht/month that shows quite low of contribution. For total expense (building development cost), the administration cost ration was quite high than electricity and development cost at 43%, 39%, and 18% respectively. It plays important role by spending at 24,259 Baht/month. Meanwhile 10,061 Baht/year was paid on development cost that occupied by landscape maintenance. This result shows this flat paid less on building development. According this information, if this flat collects fee and pays building expenditure cost as usual situation the total income are unable to cover building expenditure cost (672,000 baht/year < 673,767 Baht/year).

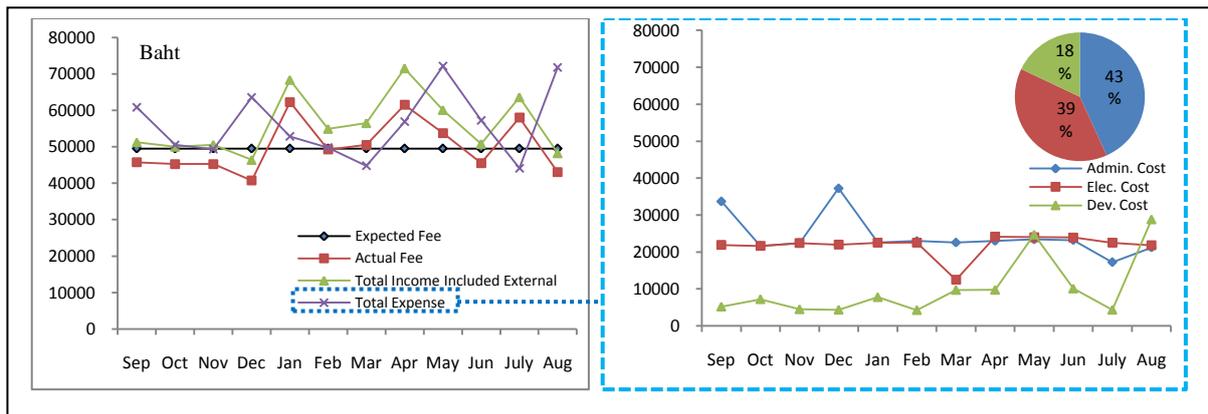


Figure 6.14 Income and building expenditure of Flat 24

Flat 26, Figure 6.15 shows the actual fee meets the expected fee by monthly actual income average throughout a year found a bit higher than expected fee (49,516 > 49,500 Baht/month). External fee contributes actual income as its average shows of 17,774 Baht/month. Furthermore, the total expense (building development cost) found that administration cost ratio was quite low than electricity and development cost at 25%, 28%, and 47% respectively. Its average is 21,938 Baht/month, whereas development cost plays important role of 74,768 Baht/month which is the highest among case studies. The development cost most occupied by pipe/drainage system and social events. Considering the total income and total expenditure of this flat of 729,909 baht/year and 1,036,861 Baht/year it could be noted that the income are unable to cover building expenditure cost if they are going manage as usual situation.

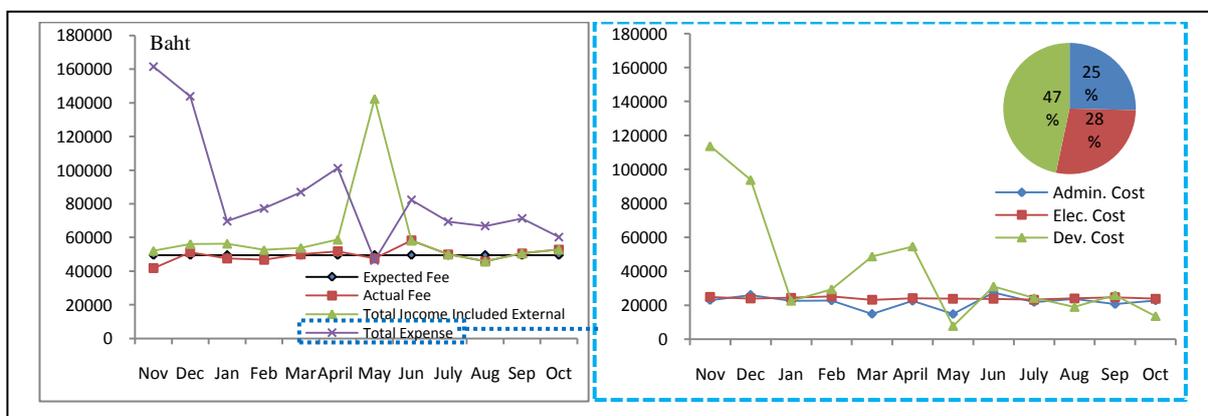


Figure 6.15 Income and building expenditure of Flat 26

Flat 29, Figure 6.16 shows the actual fee was quite below expected fee line. Averaging actual income per month found lower than expected fee (48,075 < 49,500 Baht/month). External fee contributed the actual income with average of 12,407 Baht/month. Furthermore, analysis on total expense (building development cost) found that amount of administration cost ratio and development cost ratio was higher than electricity cost at 40%, 40%, and 20% respectively. For development cost was average at 24,259 Baht/month and it paid on structure. According this information, if this flat collects income and pays on building expenditure cost as usual situation, the total income would unable to cover building expenditure cost (596,440 baht/year < 721,343 Baht/year).

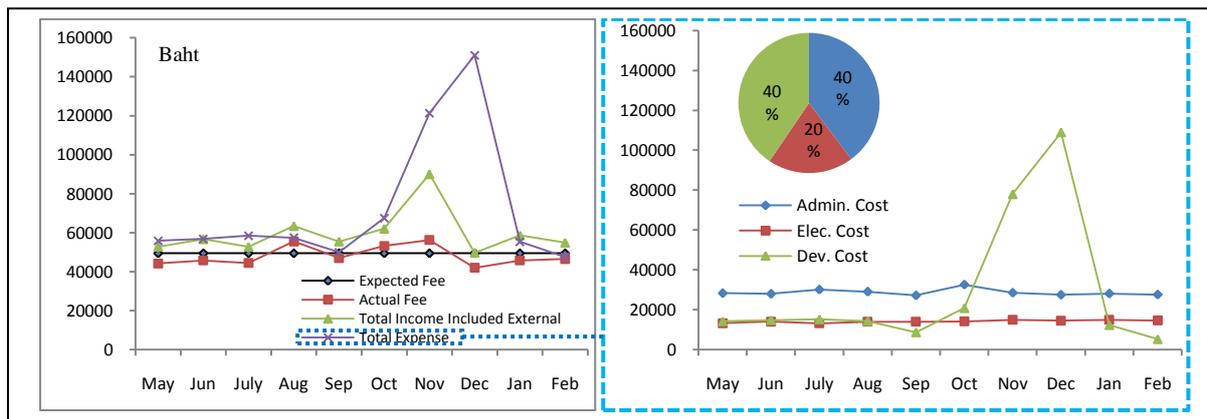


Figure 6.16 Income and building expenditure of Flat 29

This analysis of annual income and expenditure through 7 flats can be summarized; first, although there are some buildings could solve their expenditures by collecting extra incomes but collecting actual fee from unpaid residents should be restricted to increase sufficient income for building expenditures. Second, earning extra income based on CJP policy and building location. Flat is nearby market which are able to charge money for car parking and rental area for storing of merchants. Third, three flats (8, 24, 26) show the building development cost still be higher total income even there is external income support, therefore rethinking building fee should be considered. Fourth, administration management cost is possible to change and preparing a budget for unexpected event of building collision should be more attention.

Table 6.19 Comparative annual development cost

Expenditure	Group	A	B	D	E		
	Flat 4	Flat 8*	Flat 20	Flat 23	Flat 24	Flat 26	Flat 29
Structure, repair	-	51,700	54,040	3,500	-	19,913	95,000
Lighting	2,818	4,650	27,784	4,859	-	12,401	19,358
Pipe/drainage system	6,679	46,588	94,736	51,460	13,188	100,041	59,950
Landscape	-	13,000	10,860	11,350	46,037	167,760	11,580
Roof	-	15,700	-	800	-	1,958	2,500
Garbage collection	24,000	30,000	26,100	30,000	30,000	30,000	25,000
Clean	1,033	7,979	-	10,090	11,600	17,923	2,300
Insurance	13,154	20,325	32,348	-	16,018	19,570	15,208
Other	7,047	2,855	9,779	74,296	3,890	108,438	61,658
Total	54,731	192,788	255,647	186,391	120,733	478,004	292,554

Flat 8 was selected for analysis yearly cost of expenditure as data available of six years

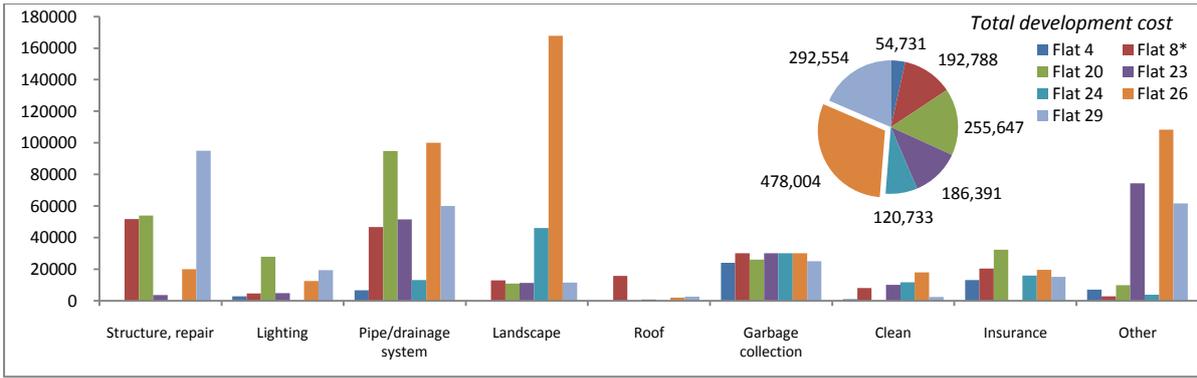


Figure 6.17 Yearly income and building expenditure of Flat 8

### 6.3.2. Case study of building development cost prediction

Although using the annual report of income and expenditure is given insight into flat's situation based on monthly data, however a past year data should be studied to find out how trend of income and expenditure spending for building improvement. This section, therefore, has been analyzed and provided decision making information to CJP (Condominium Juristic Person) and relevant stakeholders towards maintenance planning in proper maintenance management of their buildings in the future. Flat 8 was a representative case study because there was only one building that available data set with six-year record.

#### 6.3.2.1. Maintenance cost trend of Flat 8

The analysis result of six years income and expenditure regarding building development of Flat 8 reveals that actual fee line in a year of 2010 and 2014 was quite below expected fee line. Considering this actual incomes were unable to cover building development expenditure. External fee had contributed this flat as in 2009 and 2011. However, there were two years of expenditure exceeding the total income in 2010 and 2014. A trend of income decreased from 2011 to 2014. In term of building development expenses found that the administration cost not much change meanwhile electricity cost was a bit raising. For development cost was found very high compare to other costs in 2010 and 2011 and it turned down in 2012 and 2013. In 2014, all cost categories were not quite different as shown in Table 6.21. Focusing development cost that how CJP spent lot of cost throughout six-year found that a lighting repair and installation electricity devices was the first ranked consuming cost. Second and third were pipe/drainage system and garbage collection respectively. From the top three ranks could be noted that this flat pays attention to improve and maintain their building by a prioritized concerning of problems.

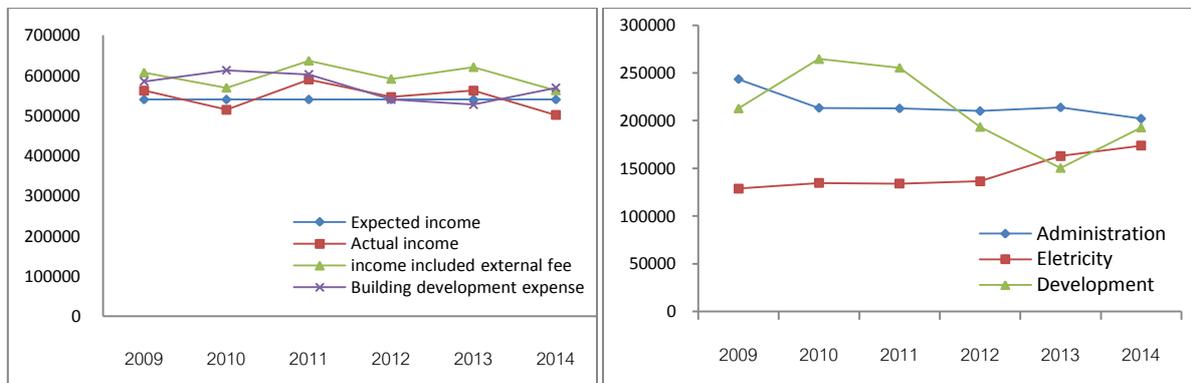


Figure 6.18 Income and building expenditure of Flat 8

Table 6.20 Building development cost of Flat 8

Expenditure	Year	Building Development Cost: Flat 8 (Cost unit = baht)					
		2009	2010	2011	2012	2013	2014
<b>Management and services</b>							
Co-operation cost		12,055	14,843	15,367	16,875	16,354	16,653
Administration management		231333.4	198505.5	197393	193212	197464	185479.5
Electricity		128710.5	134682.16	133886.68	136461.1	162959.37	173817.02
Total (1)		372,098.9	348,030.66	346,646.68	346,548.1	376,777.37	375,949.52
<b>Development cost</b>							
Structure, repair, replace		75405.75	13881	2463	18300	10209	51,700
Lighting/electricity devices		28161	91176	98591	5336	11793.4	4,650
Pipe/drainage system		5035	48492	39503	40915	30288	46,588
Landscape		12090	28000	19200	54500	12000	13,000
Roof repair		-	4848	16350	12225	5995	15,700
Garbage collection		30000	30000	30000	28000	30000	30,000
Clean		-	6418	2594	5516	4040	7,979
Insurance		-	24168.09	23724	23724	21974	20,325
Insect spraying		24251	400	-	1180	21800	-
Inspection of building		10600	-	10000	-	-	-
Other activity		27338	17259	13086.5	3695.75	1730	2,855
Total (2)		212,880.75	264,642.09	255,511.5	193,391.75	150,330	192,788
<b>Total (1)+(2)</b>		<b>584,980</b>	<b>612,672.8</b>	<b>602,158.3</b>	<b>539,939.6</b>	<b>527,107.7</b>	<b>568,737.1</b>

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.

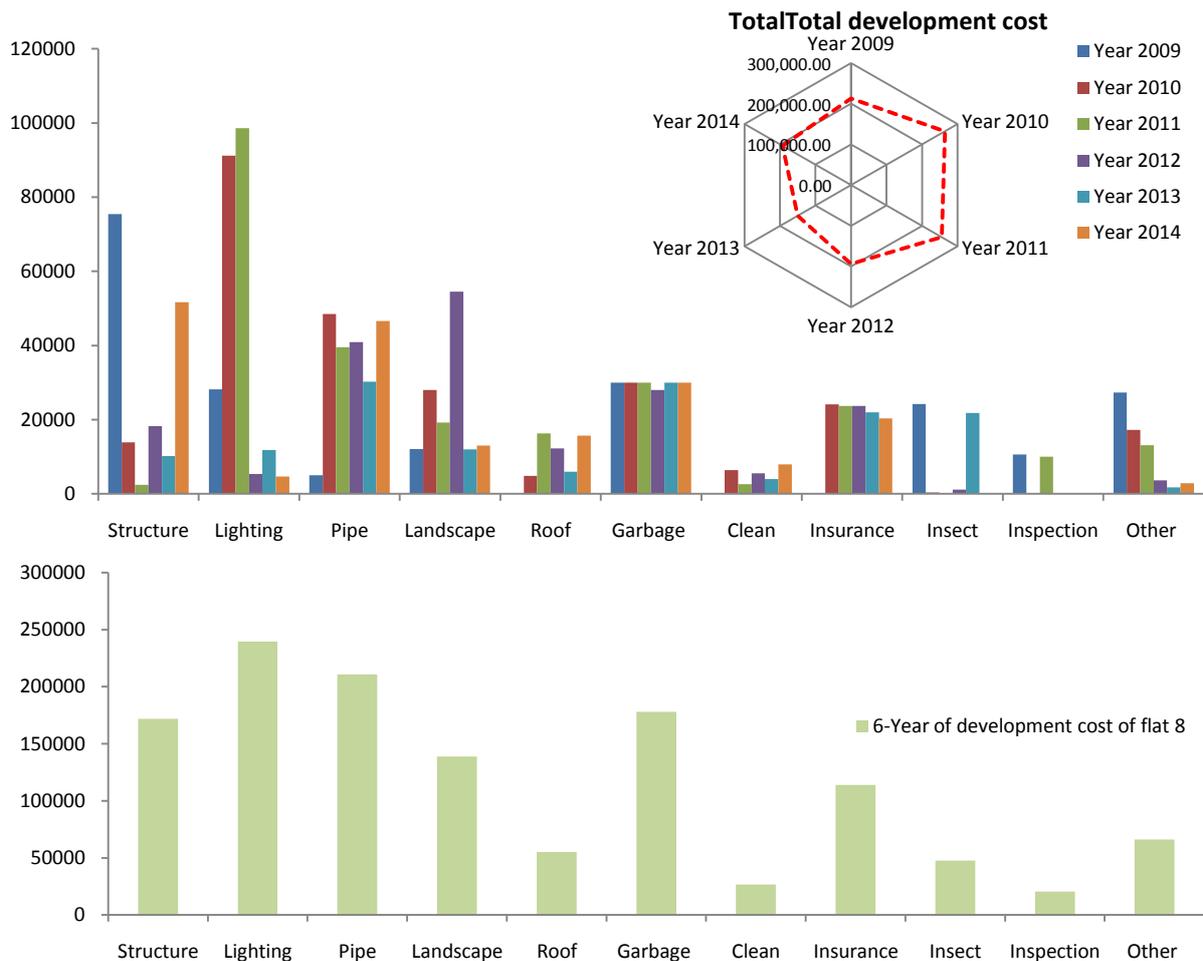


Figure 6.19 Development cost of Flat 8

### 6.3.2.2. Building development cost prediction of Flat 8

To predict the building development cost of Flat 8 based on the information in Table 6.20, the variables in the table has been classified into two categories; independent and dependent variables in Table 6.21. According to Faremi, Ademga, Dada, and John (2014) pointed out that a building age plays important role to maintaining cost of building, therefore a yearly report of building development cost of Flat 8 (established in 1976) was represented as age by recoding 33 years (2009), 34 years (2010), 35 years (2011), 36 years (2012), 37 years (2013), and 38 years (2014) respectively. So, the age variable was 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 activity were dependent variables which would be changed based on the age of building. Correlation and linear regression analysis were employed to reveal significant factor of prediction model.

Table 6.21 Variables to 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
X2	Administration management	X2	lighting/electric devices
X3	Electricity	X3	pipe and drainage system
		X4	landscape
		X5	roof
		X6	solid waste
		X7	cleaning
		X8	insect protection
		X9	insurance
		X10	inspection
		X11	other activity

Fifteen variables were tested in correlation coefficient statistic relationship between among dependent variables and independent for a validate regression model. A correlation coefficient should be more than 0.3 as mention in section 6.2.2. Table 6.22 presents the result significant independent of Flat 8 by giving a perfect positive correlation including three variables; co-operative, electricity, insurance, and other activity of .864, .902, -.898, and -.939 respectively.

As age of building was setup to be independent for predicting cost of Flat 8, a liner regression was employed as casual method based on the assumption that the variable to be forecast (dependent variable) has cause-and-effect relationship with one or more other (independent) by linear trends Gor (2014). The formula for a regression line is:

$$Y = a + bX \quad \text{equation.....4}$$

where X is the explanatory variable and Y is the dependent variable. The slope of the line is b, and a is the intercept (the value of y when x = 0).

Table 6.22 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	<b>0.864*</b>	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	<b>0.902*</b>	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	<b>-0.898*</b>	-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	<b>-0.939**</b>	-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 = Administration cost, EL= Electricity cost, DEV = Development cost, ST = Structures cost, LT = Lighting and electricity device cost, P = pipe and drainage system, 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).

Therefore, the four strong variables relationship with age of building were co-operative, electricity, insurance and other activity cost have been addressed in the regression model by using SPSS program. The result shows that the explanatory variables in the building expenditure cost of prediction (Table 6.23) accounted for 74.7, 81.3, 80.6, and 88.1percent of the variance in this model. The analysis results have revealed that independent (age of building) was significant with P-value of less than .05.

Table 6.23 Affecting variables to predicting old building expenditure by Stepwise Method

Variables	B	t	Sig.	Collinearity Statistics	
				Tolerance	VIF
Co-operative cost (Constant)	-1.411	-1.648	.017*		
Age	.083	3.437	.026*	1.000	1.000
Constant = -1.411; SE <sub>test</sub> ± .857					
R = .864; R <sup>2</sup> = .747; F = 11.82; P-value = .026*					
Electricity cost (Constant)	-17.233	-2.260	.008*		
Age	.894	4.168	.014*	1.000	1.000
Constant = -17.233; SE <sub>test</sub> ± 7.624					
R = .902; R <sup>2</sup> = .813; F = 17.372; P-value = .014*					

Insurance cost (Constant)	4.961	7.593	.002*		
Age	-.075	-4.074	.015*	1.000	1.000
Constant = 4.961; SE <sub>test</sub> ± .653					
R = .898; R <sup>2</sup> = .806; F = 16.594; P-value = .015*					
Other activity cost (Constant)	19.194	5.763	.004*		
Age	-.510	-5.439	.006*	1.000	1.000
Constant = 19.194; SE <sub>test</sub> ± 3.33					
R = .939; R <sup>2</sup> = .881; F = 29.587; P-value = .006*					

\* Significant at the 0.05 level

From the prediction model , it can be used to create a predictive equation formula as below:

$$\text{Co-operative cost} = -1.411 + .083(\text{Age}) \quad \text{equation} \dots \dots 5$$

$$\text{Electricity cost} = -17.233 + .894(\text{Age}) \quad \text{equation} \dots \dots 6$$

$$\text{Insurance cost} = 4.916 - .075(\text{Age}) \quad \text{equation} \dots \dots 7$$

$$\text{Other activity cost} = 19.194 - .510(\text{Age}) \quad \text{equation} \dots \dots 8$$

For example, in 2016 the age of Flat 8 will be 40 years that would be predicted to cost of co-operative cost as below:

$$\begin{aligned} \text{Co-operative cost} &= -1.411 + .083(40 \text{ Years}) \\ &= -1.411 + 3.32 \\ &= 1.909(10,000) \\ &= 19,090 \text{ Baht} \end{aligned}$$

The models were check a validation of the regression that tolerance and VIF value were more than 0.1 and lower than 10 (Saunders, 2009) respectively. In applied linear regression model of building expenditure cost, this is to be expected that yearly cost of Flat 8 would be calculated through age of building. So, these variables should be considered in the maintenance program to control and manage building cost as well as income and expenditure capacity.

#### 6.4. Conclusion

Chapter 6 analyzes the management and operating costs of Klong Chan Flat (old low-income public housing) to encourage occupants' satisfaction and ensuring a sustainable building management for condominium juristic person (CJP) and to relevant stakeholders. 30 buildings of Klong Chan Flat were selected for case study. The analysis process based on building and physical surrounded survey, interview condominium juristic persons, and management & cost annual report. First, the assessment public housing

maintenance condition with different management approach; co-administrative management and independent administrative management was investigated. It found that the buildings are owned by independent administrative group showed quite good physical condition based on their management but there was no a significant difference statistic for resident's satisfaction in term of management pattern. Then, 30 buildings were separated into five groups by number of dwelling unit to investigate resident's satisfaction. It found only three dependents; building facility, cleanness, and management & regulation showing statistically significant difference between groups. It could be noted that a good maintaining building performance in term of physical conditions would be reflect high score of resident's satisfaction but there was no relationship with number of dwelling unit. Second, the analysis the building maintenance cost situation was conducted. 30 buildings have a different fee of charge to occupants and the result revealed that there were no statistically significant differences between four groups. However, mean score of occupants who pays 100 and 200 baht/moth more satisfied on building fee of charge.

The important of low-public expenditures were administration cost, water supply cost, electricity supply cost, and building development cost. To perform of the old public housing building in good condition, budget or income is very important to contribute expenditures therefore the fourth step was set up to analysis affecting factors on maintenance cost of Klong Chan Flat Project. 25 flats were involved on correlation and linear regression analysis. The three variables were found to be significantly correlated to the building expenditure; building fee charge, dwelling unit occupied, and common property area. However, a final model found that only dwelling unit occupied and common property area variables were identified as significant factor of building maintenance expenditure. Thus, these variables must be taken into consideration when preparing investigation public housing expenditure of Klong Chan Flat and NHA's low-income public housing project. Finally, to predict annual cost of Klong Chan Flat (case study was Flat 8) by using casual model method (linear regression) based on age of building (independent variable) found that the four significant factors of prediction model of fourteen dependent variables were co-operative, electricity, insurance, and other activity cost with showed a strong relationship to independent of coefficient and high  $R^2$  value. Therefore, these variables should be considered in term of CJP's maintenance program to control and manage building cost under the income and expenditure capacity in the future.

So, this chapter has provided insight of old public housing through management situation and cost prediction which could be useful for preparedness maintenance cost for related project in Thailand as the first step after NHA transferring property right to low-income people which must manage building by themselves.

## CHAPTER 7

### INVESTIGATING COMMUNITY SAFETY AND ITS EFFECT TO RESIDENTS OF KLONG CHAN FLAT

The influent factor on the community aspect of occupant satisfaction had been identified in Chapter 4 including neighborhood security (the highest beta coefficient value), community location, public park, and sport/playground facilities that plays important value of Klong Chan Flat Project. Meanwhile, the community location, neighborhood security, and accessibility to the disabled and aged people factor were given a high positive satisfaction value for Buengkum Baan Eur Arthron Project. Two factors; community location, and neighborhood security were found significant variables of both projects. Therefore, the researcher had focused on a security issue. However, Klong Chan Flat was selected to the analyst as an opened access community because it is difficult to control and monitor than the enclosed community (Buengkum Baan Eur Arthron Project).

#### 7.1 Previous Study on Community Safety

Safety is interpreted with regard to a discipline for public health, sociology, geography, criminology, architecture, political science, and urban planning (Whitzman, 2008a). It is used as an individual condition that required an essential quality in society. Housing has the relationship with safety as more than just a building, including several aspects of a social, psychological, cultural and economic nature (Lawrence, 2002). The community and the immediate environment (or neighborhood) is one concept of housing definition as well as sense of residents' living in community (Bonney et al., 2009). In current research, the housing environments are concerns about safety from various perspectives (Bonney, 2007; Ormandy, 2009). Also, the housing area and local amenities also play a part of influence of safety (Macintyre et al., 1993). Therefore, the researchers have been predominately focusing on the conditions in individual dwellings to paying more attention to the quality of the neighborhood (Lujanen, 2001). Braubach (2010) stated that socio-economic factors seem to be involved as residential segregation based on where people settle down and feed. Low socio-economic condition is associated with housing environment such as crime, fear of crime and social behavior (Davidson, 2009). Another factor of safety as residents' perception in their neighborhood may also influence their physical activity (Wendel-Vos et al., 2007). A healthy and safety neighborhood can be successful development including five main features 1) physical feature of the environment, 2) availability environments at home, work, and play, 3) facility services provided as well-maintained outdoor environments, street cleaning and sufficient lighting, 4) social functions with norms, values, and degree of community integration, and 5) self-esteem of residents on who moves in and out (Macintyre et al., 2002). Normally, a safety includes both subjective and objective aspects. It is a fundamental human need and will be a pre-requisite in maintenance and improvement of well-being. Figure 7.1 shows a link between environment and behavior to safety condition (WHO, 1998).

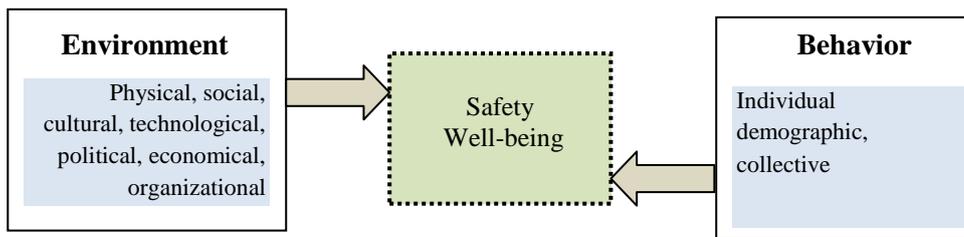


Figure 7.1 Links between safety and well-being

For objective condition of safety is to be protected from hazards and risks as well as in relation to crime control that strongly related to residents' perception of feeling unsafe (Kawachi et al., 1999). Level of crime in a neighborhood has been recognized as a key stressor in the residential environment and its roots in planning, architecture, psychology, and criminology (Kullberg, 2010). Safety as a subjective condition based on the sense of ontological security. In community areas are most relevant to surrounding neighborhoods that people's perception on safety by avoiding a place of physical environment deterioration in daytime or nighttime of walking, because of lacking maintenance in poor areas contributes a fear by graffiti, wall painting, and not enough public lighting. Also, the design of those buildings or places might increase a crime in closed space and causing violence as well (Kihl, M., et al., 2005). A messy community as unorganized physical surrounding and abandoned areas shows a result of unawareness management and it reduces a potential community (Wilson and Kelling, 1982). There are four key successful of crime prevention; surveillance, access control, territorial reinforcement, and maintenance and management (Royal Thai Police, 2007). Regarding community safety research, there are relevant studies address this issue for investigation. Srisopon (2012) has studied about safety and sense from crime in the environment of old community in Bangkok. The research uses field survey, observation, and interview with local people. Sense of safety is varied by group of population as natives and migrants. Physical environmental condition and social conditions could replace unsafe feeling towards physical environment which was risky to have crime happening in the community. Mhankatidham (2015) founds that in the slum area in Bangkok had a year crime average about 32.8% by the risk major area including invisible point, area without lighting, and secluded path during 18.00 – 24.00 pm. Hughes & Rowe (2007) has examined policy development relating to neighborhood policing and crime and disorder reduction partnerships in Britain to explore the issues and found that community engagement and co-production are very important while cultural and institutional factors are likely to prove inimical to efforts to respond effectively to community needs. Understanding the relationship between residents' evaluation for residential environment and the present physical environment, it was found that the improvement in amenity of living environment and townscape in Nagano City was important for enhancing the residents' consciousness of residence, and it was especially necessary to improve the safety and amenity in the residential environment improvement project at the residential area level safety (Fuji, Y., and Kawata, A, 2007).

Therefore, the analysis in this study focused on the safety of the community environment of Klong Chan Flat through three steps. First, a physical community was investigated to find an obvious issue on three scale of occupants' safety; dwelling, building, and community. The field survey, condominium juristic people (CJP), and police officers were conducted to identify a problem. Second, it is important to understand a relationship between resident satisfaction on neighborhood security (dependent variable) with socio-economic and physical features of community (independent variables) that how individual personal background and environment affects safety satisfaction. Correlation and Logistic Regression method were employed on this analytical process. Third, the current roles of relevant stakeholders of community safety were also investigated to understand a challenge condition and obstacle of safety management.

## 7.2 Investigating Safety Issues of Klong Chan Flat Project

To classify a community safety in Klong Chan Flat it can be listed into three scales of dwelling unit, building unit, and community unit as below:

### Dwelling unit:

A survey of the thirty buildings found that the protection of resident safety of life and property by the residents have installed a steel frame of window and door (Figure 7.2) (this common solution cannot be achieved in case of rental public housing of National Housing Authority as a prohibiting the modification of any building parts). This is a normal pattern as well as a basic security of Thai living styles. Living in a low income community condition is a possibly risk area of crime due to socio-economic as noted in the research of Freedman (2010). A thief broke into a room where the owner absent, walking up of strangers in the building, and groups' activity in the room by illegal purpose have been concerning of residents. "I have been living here in Klong Chan Flat, a drug is serious problems because our flats have become crowded with lots of people come and go as age between 15 – 23 year (a short stay of rental, for example, 6 month or 1 year). These students shall rent a room and then move out routinely. I found guilty on drug addiction and the mingling of several flats. Federal police should more investigate to all flats with office managers. Some flat managers do not take care of those problems just the incident is reported to the police office by resident themselves. Additionally, a local authority as police will come when there is an incident not continuously monitoring (interview, 2015)".



Figure 7.2 Dwelling unit safety by adding a steel frame in front of windows and doors

Therefore, National Housing Authority should pay attention on safety living in public housing projects in the context of affordable housing development for low income group which related on robbery, burglary, assault, or property crime.

Building unit:

The project area is opened accessibility therefore a safety measurement to protect the residents of buildings has been operated by individual Condominium Juristic Person (CJP) of 30 buildings. A building security system is based on individual administrative strategies in providing security to residents. Three main responsibility of CJP are:

1) Installation of closed-circuit television (CCTV) 16 points in the 29 building (except Flat 29) since 2001 was contributed by National Housing Authority through a special community development fund that was allocated from the government budget amendment. However, the installation CCTV spot by NHA did not consult with the CJP that some spots cannot cover for surveillance. The CJP indicated that CCTV could help residents feel more safety however electricity bill and maintenance cost must be performed by them which are a burden cost that must be managed carefully (Interview, 2015).



Figure 7.3 Building's CCTV for building security

2) Installation of lighting in the building of the first floor as the area of sharing public space has been done in Flat 6, 7, 8, 11, 12, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29, and 30 to prevent a crime at night and could monitor a motorcycle parking area easily. However, the installation of lighting in front of the building depends on management policy of each flat. For the car parking area is belongs to the National Housing Authority, the lighting cannot be installed without negotiation. Thus, there are no lights at night of parking area it will be a risk area where a cost of installation and bill still be the obstacle for CJP management.



Figure 7.4 Adding a lighting pole in front of building and back side

3) Provide a motorcycle parking area of the building. Motorcycle dock is provided for resident to prevent a theft. Due to a low budget, a steel bar with chains can be seen in some flats. A steel cage for storage resident stuffs is provided as an option of rental services. This security found of 17 flats including Flat 1, 3, 7, 9, 10, 14, 15, 16, 18, 20, 21, 22, 24, 25, 26, 27, and 29.



Figure 7.5 Motorcycle parking lot and cage to store a residents' stuff

Community unit:

Because Klong Chan Flat is the large community, the intersection of place and safety as an explicit desired outcome is important. Fifteen building managers who represent the Condominium Juristic Person (CJP) were asked about the community safety issues. The interviews found that most the crimes incidents in the community were a basic crime which could be normally occur in a society including crimes property such as theft, burglary, and robbery. Those offenders were resident in the community. Another type of crime was rampant alcohol, a drug abuse, and violence. According to the report crime of Ladphrao Police Station, Klong Chan Flat community was the highest risk areas in three zone of the police boundary area and the community was unsafe especially at night. Adding more light and CCTV were required to reduce insecurity situation for daily life of residents. (Interview, 2015).



Figure 7.6 Opened community accessibility condition

By interviewing the police officers indicated that Klong Chan Flat has a burglary, robbery, and motorcycle theft often. A check point of the building at the ground floor area shall be signed by police to monitor a surrounding of residential area. An overview of crimes statistic of Ladphrao Police Station from 1 October 2014 to 30 September 2015 found a robbery was the first rank case of 701 that higher than Thong Lho Police Station (575 cases), and Minburi Police Station (542 cases) respectively. Klong Chan Flat was ranked the 2<sup>nd</sup> risk areas of Ladprao Police Station where Ladprao Soi 101 and Klong Saen Saeb were ranked the 1<sup>st</sup> and 3<sup>rd</sup> respectively. Therefore, an intensive crime prevention program of these areas must be handled by involving a local people (the residents in the area) for patrol monitoring. It cannot be done with a few police staffs of responsibility (Interview, 2015).



Figure 7.7 Security office & check point in the community by residents' volunteer

### 7.3 Relationship Analysis on Neighborhood Safety Satisfaction

According to the literature reviews on the previous section 7.1, it indicates that to encourage people's perception of satisfaction on community safety there is an approach in physical environments. Therefore, researcher has investigated how those variables affect community safety in Klong Chan Flat. The physical environments (independent variables) from section 7.2 include the result of the community survey combining a security management of CJP of each flat (CCTV, lighting, motorcycle parking lot) and unsafe area that was identified by the residents. To find a relationship of neighborhood safety, the result of questionnaire survey on neighborhood safety in Chapter 4 has been applied as a dependent variable. The hypotheses for chi-square analysis are shown below:

#### Hypothesis:

*by Chi-square test:*

*H1:* There is no association between satisfaction on neighborhood safety and room safety.

*H0:* There is association between satisfaction on neighborhood safety and room safety.

*H1:* There is no association between satisfaction on neighborhood safety and building safety.

*H0:* There is association between satisfaction on neighborhood safety and building safety.

*H1:* There is no association between satisfaction on neighborhood safety and area safety.

*H0:* There is association between satisfaction on neighborhood safety and area safety.

Using the satisfaction on neighborhood safety to find out a relationship with three variables by Chi-Square Test was shown in Table 7.1. The result shows that there is no statistical significant relationship between room safety groups with score of satisfaction on neighborhood safety (P-value = .206 > 0.05). For building safety and community safety variables found there is association with a statically significant relationship that P-value less than 0.05 (.009 and .00) with accepted the null hypothesis (*H0*). Therefore, this confirmed that providing safety condition especially both aspects of building and community affects resident satisfaction.

Table 7.1 Variables in association of residents' satisfaction on neighborhood safety

Satisfaction on neighborhood safety				
Room safety		Score of satisfy		
		Low	High	
Don't have	Pearson Chi- Square .206	57	157	
Install a steel cage of window and door		51	105	
Total		108	262	
Satisfaction on neighborhood safety				
Building safty (CCTV, lighting, motorcycle parking)		Score of satisfy		
		Low	High	
Not completed	Pearson Chi- Square .009*	71	173	
Fully provided		37	89	
Total		108	262	
Satisfaction on neighborhood safety				
Community safety map		Score of satisfy		
		Low	High	
On the listed of unsafe area	Pearson Chi- Square .000*	73	177	
Not on the listed		35	85	
Total		108	262	

In addition, a comprising three elements (CCTV, lighting, and motorcycle parking) of building safety on security satisfaction has been analyzed in order to indicate a high relationship among them. Correlation analysis was employed. Table 7.2 shows the significant relationships between building safety variable and three features; CCTV, lighting, and motorcycle parking. Motorcycle parking found a high significantly correlated by giving a positive correlation coefficient at .631 whereas lighting and CCTV are ranked second and third with .507 and .137 of correlation coefficient value. However, two variables that giving a high value of relationship should be addressed in term of security management at building scale as higher than 0.3 (Sauder, Lewis, and Thornhill, 2009). According to the result of the study of Siripon (2012) found that the residents have a sense of security based on four factors by helping each other among neighbors, regularly patrol by police, well-maintained of physical environment, and a requirement of equipment and technology related to security (Srisopon, 2012).

Table 7.2 Correlation matrix between covariates (3 variables)

Variables		Building safety	CCTV	lighting	Motorcycle parking
<b>Building safety</b>	Pearson correlation	1	.137**	.507**	.631**
	Sig. (2-tailed)		.008	.000	.000
CCTV	Pearson correlation	.137**	1	-.135**	-.167**
	Sig. (2-tailed)	.008		.010	.001
Lighting	Pearson correlation	.507**	-.135**	1	-.006
	Sig. (2-tailed)	.000	.010		.908
Motorcycle parking	Pearson correlation	.631**	-.167**	-.006	1
	Sig. (2-tailed)	.000	.001	.908	

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

#### 7.4 Analysis Unsafe Condition of Klong Chan Flat

The researcher had discussed and gathered information with local residents and office manager (CJP) (Figure 7.8) including Flat 3, 8, 15, 16, 20, 23, 24, and 28 to identify a risk or problem area of insecurity condition of Klong Chan Flat Project which can be identified into five zone; A, B, C, D, and E in Figure 7.9.



Figure 7.8 Getting information from the CJP representative about community safety

##### Zone A :

It includes the area of Flat 5, 7, 8, 9 and playground. There is a teenage drug abuse around this area, especially at evening. It might lead a commission of violent crimes. And the playground is not well maintained that appears to be used less frequently. It also could be a serious problem at night because no lighting is provided for nighttime use of the playground and walking path for residents.

##### Zone B :

This area is busily every morning because there are a lot of shops and daily market which located behind Flat 16 and Flat 17. Although the sub-main has crowded activities but a completed public facility is

not provided especially a street lighting at night. Poor street lighting is an important contributory cause of the thefts. In front of Flat 16, along the canal, there is homeless who lives around this area.

**Zone C :**

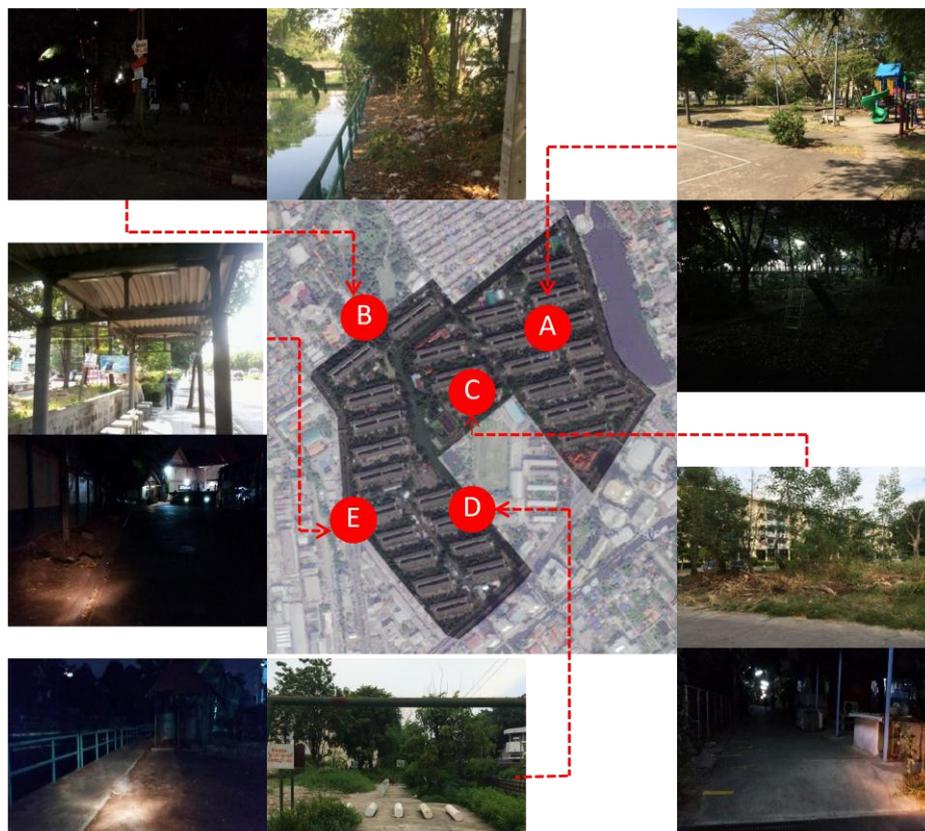
For this area of Flat 18, 14, 13, the residents go to work or school usually use a bridge as a walking path to a bus stop. This zone was very quiet and a surrounding building was lack of maintenance which could affect criminal problems. It can also affect not just nighttime crime, but daylight crime as well. For property and lives of residents, Flat 14 has installed a light bulb around the bridge even though the area is NHA own where lack of budget in improvement.

**Zone D :**

Along a canal is abandoned management area of NHA especially at Flat 22, 24, 26, and 28, it can be hazardous to the resident as a gangster of drug abuse. Walking path along this canal should be revitalization with NHA responsibility. It needs to keep a favorable attitude toward residents of the communities where the damage took place.

**Zone E:**

There are five bus stop services the community which in charged by local government. Condition of bus stop is lack of maintenance especially there is no light enough at night. It could affect unsafely living of the residents. There was an occasion theft on personal properties around a bus stop of Flat 20 and Flat 23. To improve bus stop condition, a light bulb was installed by CJP to providing more security of residents who lived nearby and use bus stop daily.



Source: field survey, 2015

Figure 7.9 Community environment of unsafe area in Klong Chan Flat

From above investigation of unsafe areas in the community could confirm that a living's resident based on the security would be more serious on crime. According to the previous result of questionnaire survey in Chapter 4, it absolutely showed a reason that living in Klong Chan Flat Project with regarding safety and security condition was the lowest percentage out of seven attributes (convenience traveling, nearby workplace, affordable price, and room quality condition). In addition, in terms of physical community aspects including utilities/facilities support and good neighborhood environments were less percentage of choices of respondents choosing. Therefore, these five zones of unsafe must be involved consideration into a program improvement by related stakeholders of responsibility.

### 7.4.1 Crime incidents statistic of Klong Chan Flat

According to the criminal record incidents 5-years during 2012 – 2016 of Klong Chan Flat of Ladphrao Police Station, it is detailing specific offenses and outlining trends that can help the stakeholders better understand crime threats at locally. 154 cases of criminal events were found of community with four majority categories; drug, theft, violence, and others (dunk, fighting, and gambling) especially in 2012, 2014, and 2015 which was slightly high (Figure 7.10). A total number of victims were 82 cases by male 44 cases and female 38 cases (Figure 7.11). Theft was the first criminal incidents in the community meanwhile drug, violence, and other was found lower respectively.

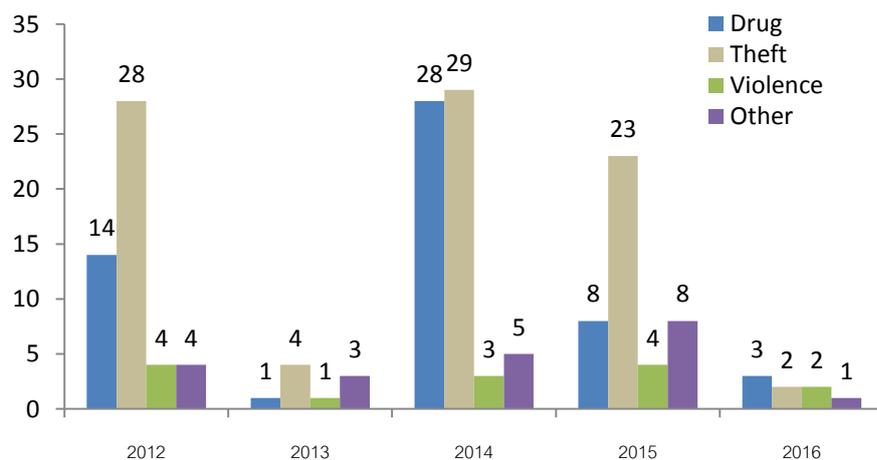


Figure 7.10 Criminal incidents in 2012 – 2016 (5-Year)

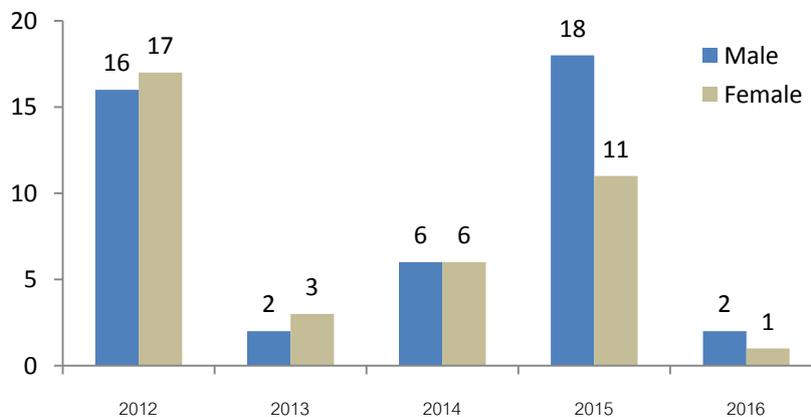


Figure 7.11 Criminal victims in 2012 – 2016 (5-Year)

Considering a criminal event in the community of each year was obviously indicating that motor vehicle theft was a big problem. Interviewing a police (Pol.Col.Saksit Meesawat, Ladphrao Police Station) about this issue has mentioned that vehicle theft was usually occurred at 18.00 pm. – 24.00 pm. Other thefts, it was a kind of robbery a personal property in dwelling unit and a personal belonging, found at 24.00 pm. – 6.00 pm. For drug criminal, it can be categorized into issues that selling and using type, a selling type was higher than using drug in this community which usually found at 12.00 pm. – 18.00 pm. Based on criminal incidents of this community, it could be timely warning notices as crime alerts to residents and condominium juristic person (CJP) to make every effort to properly classify a criminal incident when issuing in the community.

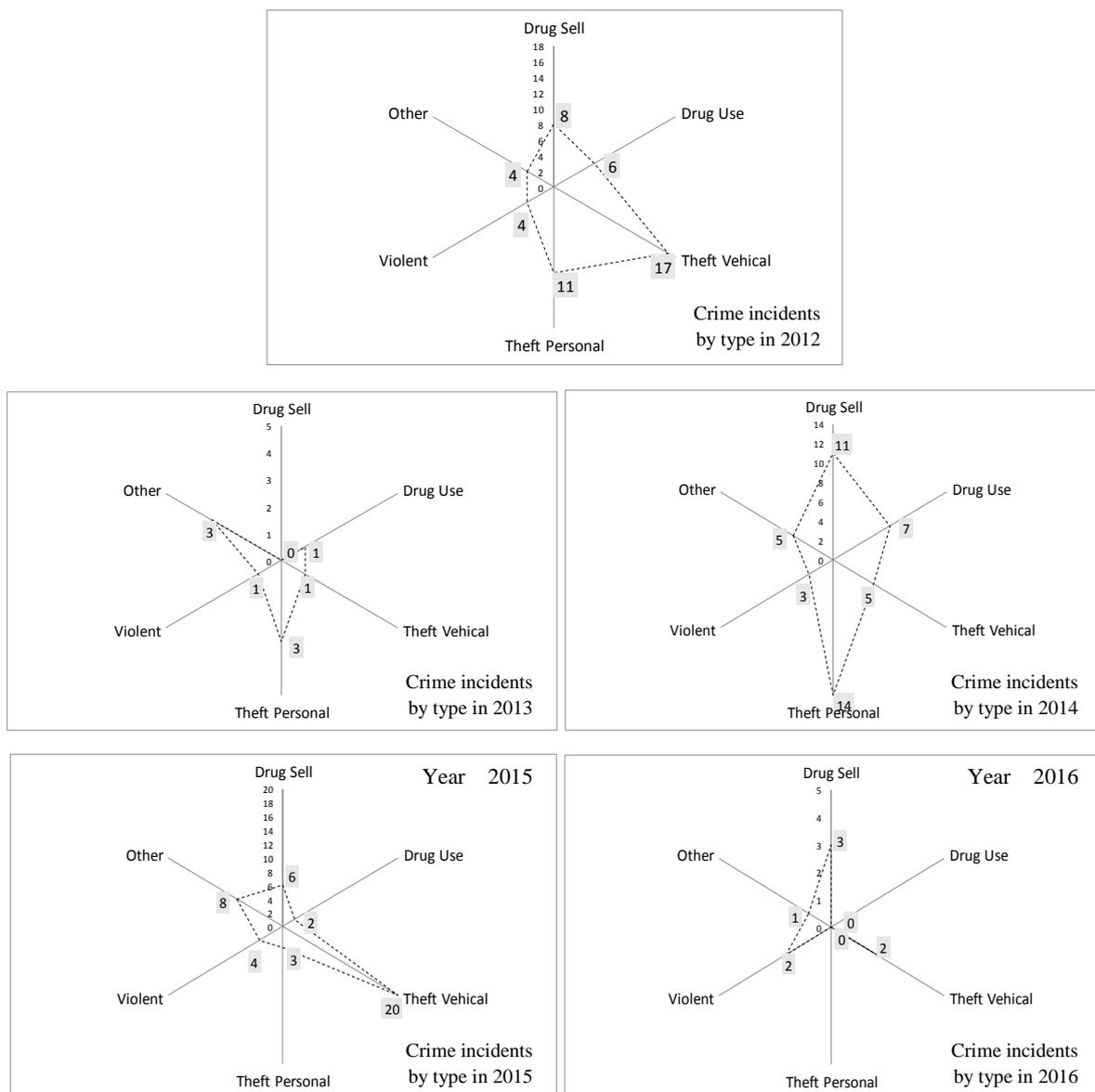


Figure 7.12 Classifying a criminal case in 2012 – 2016 (5-Year)

Table 7.3 shows the details information of 5-year criminal incidents of Klong Chan Flat Project that could inform about crime that the resident and CJP didn't know in their neighbourhood. This information has

been drawn into a crime map. It is the most usable to show a recorded crime with building location on which the crime took place and the type of crime. This also could be a database for community safety management and gives some insights into specific spot and would become an increasingly crucial part of criminal investigation.

Table 7.3 Criminal frequency incidents in Klong Chan Flat Project in 2012 - 2016

Flat No.	Frequency						Drug		Theft		Violence	Others	Injured person	
	2012	2013*	2014	2015	2016*	Total	Sell	Use	Vehicle	Steal			Male	Female
1				1		1	1							
2	2		2	2		6		1	3	1		1	2	2
3	3			1		4	1		2	1				3
4	3		2		2	7	2	2	1			2		1
5	1			3		4		3	1					1
6	1			1		3			2	1			2	1
7	2		5	2		9		1	1	4	1	2	2	
8	2		2	3		7	1		3	1	1	1	3	2
9	2	1	5	2		9	2	1	4		1	1	4	1
10	2		5	1		8	5		1	1		1	1	1
11	1		2	2	1	7	1		2	2	2		3	3
12	1		1	1		3		1	1	1			1	1
13			1			1				1			1	
14		1	2	1	1	4			1	3			4	
15	3		1	1	2	7	2	1	1	1	2		2	1
16			1	1		2	1			1				
17	2	1	1	5		9	1	1	1		3	3	1	3
18	2	1	5		1	9	1	3	3			2	1	1
19	2		1	1		4			2	1		1	1	1
20	3	1	3	1		8	2		1	4		1	3	1
21	4		2	1		7	2	1	2	1	1		2	2
22	2	2	1	2		7			3		1	3	1	5
23	2			2		4	1	1			1	1	1	1
24	2			1		1	1							
25	2					2			1	1				1
26	3		1	2	1	7	2		1	1	1	2	2	1
27	1	2		1		4			2	2			2	2
28	3			3		6	1		4	1			2	3
29														
30	1		1	2		4	1		2	1			3	

Source: Ladphrao Police Station and classified criminal case of Klong Chan Flat by author, 2016

\*criminal incident is not completed recording as showing a haft year information

Integrating information from the residents and criminal statistic of Table 7.3 could clearly identify areas of community surveillance. 29 flats encountered a criminal incident especially on theft and drug, except Flat No. 29 which there was no report throughout 5-years. So, a physical and safety management of this flat in term as well as policy can be a lesson for other flats. Zone A, B, C, D shows mostly risk area of crime, drug problems were found in 5, 9, 10, and 15. These zones are nearby shops and market which might be increasing a crime rate. Where, Zone E 23, 25, 27, 29, 30 was a few criminal incidents of theft. These criminal spots should be management for long-term security to persist violence and concentrated on urban neighborhoods that several aspects must be involved investigation.



Figure 7.13 Mapping crime of Klong Chan Flat Project

#### 7.4.2 Analysis of crime incident rate and physical condition of Klong Chan Flat

The information of section 7.2 shows a three scale of exist safety management and identifies that lighting and motorcycle parking are high value of correlation coefficient on resident satisfaction. While section 7.4.1 informs a risk area as well as a crime incident frequency spot of public housing project, however a relationship between both aspects does not investigate. Thus, this part is to figure out a significant variable which should be addressed to reduce crime's effect on life satisfaction. The variables

were listed in Table Table 7.4. Correlation was employed to examine the relationship between variables that a p-value less than .05 to indicate statistically significant (Sauder, Lewis, and Thornhill, 2009).

Table 7.4 Variables explained of relationship analysis

Variables	Value	Variable explained
Crime incidents of Klong Chan Flat	Continuous	There is criminal incident of 30 flats, criminal data in 2012, 2014, and 2015 (3 Years) was applied as accuracy information of giving an less error calculation
Building condition	score	The building condition by lacking physical management could be related to risk of crime (score is in chapter 6)
Ground floor	score	Unorganized ground floor of flat will have relationship crime issue
Surrounded building	score	Area surrounded building as unmaintained condition, some flats are well maintained and one another is unconcerned, is relevant to crime incidents and people's perception on safety
Safety system	categorical	Incompletely installation of safety system (CCTV, lighting, motorcycle parking will have relationship crime issue)

The result of correlation analysis by SPSS found that there are three significant variables which associated with crime incidents of Klong Chan Flat. The three variables are building condition, ground floor, and surrounded building by performing Pearson's correlation analysis at .05, .011, and 0.15 respectively. Surrounded building area is given highly coefficient value than another at -.447 and second and third is ground floor and building condition at -.465 and -.366 respectively. It could be mentioned that a physical of living place and surrounding environments have been associated with criminal issues as unorganized surrounding and abandoned areas of community increased unsafe condition of residents (Srisopon, 2012).

Table 7.5 Correlation matrix between covariates (5 variables)

Variables	CI	BC	GF	SR	SS
Crime incidents <i>Sig. (2-tailed)</i>	1.00				
Building condition <i>Sig. (2-tailed)</i>	<b>-.366*</b> .05	1.00			
Ground floor <i>Sig. (2-tailed)</i>	<b>-.465**</b> .011	<b>.755**</b> .000	1.00		
Surrounded building <i>Sig. (2-tailed)</i>	<b>-.447**</b> .015	<b>.504**</b> .005	.347 .060	1.00	
Safety system <i>Sig. (2-tailed)</i>	.082 .672	-.044 .819	-.062 .745	-.192 .309	1.00

Noted: CI = Crime incidents, BC = Building condition, GF = Ground floor, SR = Surrounded building, SS = Safety system,

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

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

Therefore, to prevent criminal issue of all flats, theses variable should be involved for physical improvement through properly management. It is not only for safety but mental health as well. Although, the safety system is not significant contribution of crime but it could be ensured more security for resident

as found significantly satisfaction of residents (section 7.3). However, there are many factors causing crime based on socio-economic side of low income people that should be considering further investigation. From this result, the physical and surrounding of public housing is more important that can protect and reduce a criminal incident in the community. The researcher suggested that the old public housing in Bangkok as been encountering with deterioration and disorganization as shown in Table 7.6 and Figure 7.13 should be investigated especially in open access community project for safety of residents.

Table 7.6 The old public housing project in Bangkok with old conditions

No.	Project	Built	unit	Accessibility	Year
1	Din Dang, Ding Daeng District	1977	4,868 unit	Closed access (Concrete fence)	39
2	Huay Khwang , Huay Khwang District	1978	1,760 unit	Closed access (Concrete fence)	38
3	Bonkai, Soi 1, Pathumwan District	1978	2,204 unit	Open access	38
4	Klong Teoi, Klong Teoi District	1978	4,448 unit	Open access	38
5	Bangchan, Min Buri District	1979	1,252 unit	Open access	37
6	Klong Chan, Bang Kapi District	1979	5,814 unit	Open access (case study)	37
7	Thung Song Hong , Dong Muang District	1984	1, 314 unit	Closed access (Concrete fence)	32
8	Thonburi, Bang Bon District	1993	4,108 unit	Open access	23
9	Laksi, Lak Si District	1993	2,420 unit	Closed access (Concrete fence)	23
10	Romkow, Lat Krabang District	1996	6,581 unit	Closed access (Concrete fence)	20
11	Aur Ngeng, Saimai District	1998	2,262 unit	Open access	18

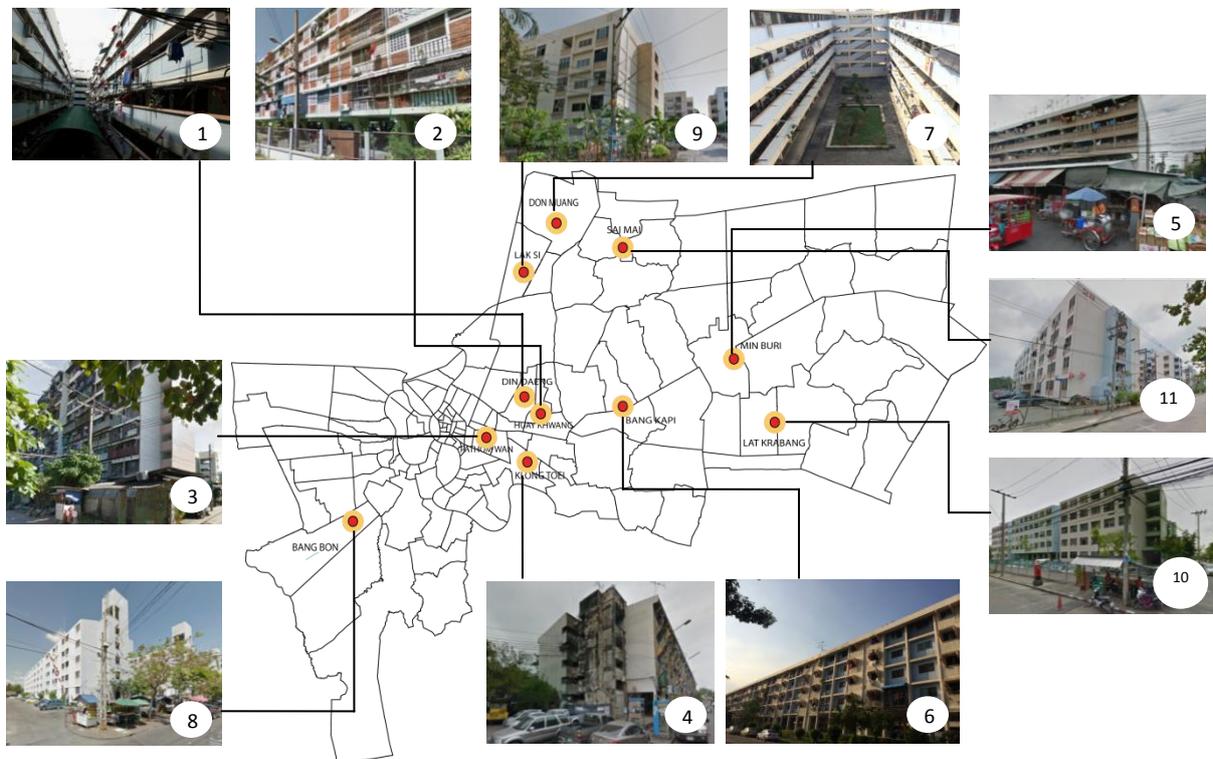


Figure 7.14 The old public housing in Bangkok that should be investigated their condition and crime

## 7.5 Challenging Community Safety Management of Klong Chan Flat

Being a safety is a basic human right. However, environmental setting for low-income living in urban community can be difficult to achieve livable community. As conditions on low cost of low-income development project is inclusive limitation for rental-purchasing type. Therefore, a basic need for low income community just provided, then after a property right transfer is done with insufficient capacity of residents and condominium juristic person (CJP) to manage a whole safety community by themselves. With this challenge, it is very important to enumerate a critical safety community barrier for residents to feel safe and empowered. According to the result of analysis based on three scales of physical safety features; dwelling unit, building unit, and community unit, it could identify the mains stakeholders to handle a safety management. Figure 7.13 illus a frame work of responsibility in securing Klong Chan Flat condition. The three levels of community safety through those elements should be effectively management by relevant stakeholders to protect people and their properties from the risks.

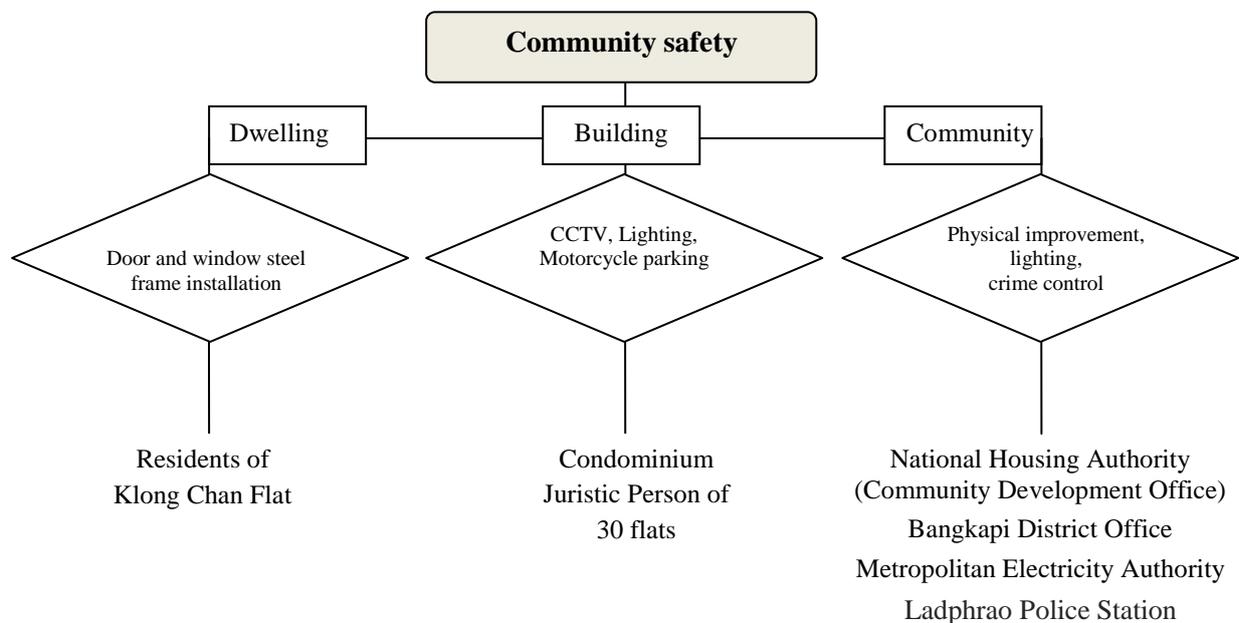


Figure 7.15 Community safety through physical aspects management and stakeholders involvement

However, to handle a community safety management is might be difficult. The challenges and barriers in providing the community safety in Klong Chan Flat are listed as the following:

- *Providing a door and window steel frame installation*

As the result of field survey, most of residents installed a steel fame of window and door. However, those completed steel fame installation has been done by the owner. So, in case of rental room there is still remaining the same condition without a steel fame because a tenant doesn't want to spend money. A steel fame is a simple structure with effective functional to prevent burglars, but installation must be allowed by CJP to protect building condition. Nevertheless, the building regulation might not be

strictly enforcement in practice because safety plays role important for residents and properties. Therefore, an unorganized steel frame on back side of room leads a mess of building. It could be a negative effect on visual perception and significantly deteriorated building condition.

- *CCTV, Lighting, Motorcycle parking*

All safety management systems of building; CCTV, lighting, and motorcycle there are problems which should be conducted properly. For CCTV, even the government (NHA) launched a surveillance system but there is no any measurement that who maintains the CCTV. Therefore, 16 points of CCTV is much of loading electricity bill and maintenance cost, the government should help the community rather than to the fate. Some buildings have charged of CCTV fee when the residents need to see a record (100 baht), it could be a few contribution of expenditure. Furthermore, there is no a technician who able to use or control properly. CCTV must also install on 2<sup>nd</sup> – 5<sup>th</sup> floor watching access route of the whole building. Self-care is achieved by CCTV as a primary solution. Safety community from crimes are requires a public sector management. In order to protect people in the community, it should be monitored by all residents. But a social changes, there is always moving in and out as tenants that can be difficult implementation to encourage awareness. Parking area should be managed by CJP; currently the CJP does not have the right for any implementation. CJP should play role of public space because NHA is unable fully maintained.

- *Physical improvement, lighting, crime monitoring*

Due to a larger community project with limited capacity building of CJP to maintain entity area of public facility and utility including roads, sidewalks, sewer systems, lighting, and water supply systems, NHA has been giving those services to related government agency. However, a physical improvement by National Housing Community Development Office 1 seems as minority improvement. Unfortunately, those public utilities and infrastructure were incomplete launched especially a car parking area of 30 buildings and public spaces of community that in charge by NHCDO is lack of concern to control accessibility and lighting which resulting a conflict between residents and NHCDO. Also, there are stores selling alcohol near school which is prohibited by of local authority that should not have a drinking bar around academic institution (interview, 2015) there is no reaction by NHA to resolve this problem as is one contribute a risk factor of residents. NHA only allocates budget for family relationships and strong community project by focusing groups of parents, children, and relatives to participate family activities. The project of strengthening community development in preventing and solving drug problem has been ongoing until present. This program focuses on social cohesion such educated and knowledge to children and youth for empowering drug abuse prevention. For crime monitoring, police surveillance has the obligation to serve the public. However, its role in the practical implementation is quite difficult as it requires the cooperation of the relevant authorities as well. To reduce a gap between the police and the public as the residents' cooperation, the attitude of community residents toward the police is an important additional influence on their willingness to cooperate. A requirement for improving security by local volunteer for investigation criminal issue is important because of number of police is a few.

## 7.5 Conclusion

The study of community safety of Klong Chang Flat based on open accessibility and located in urban area was found still a high-risk crime as filed survey by interview the residents and CJP. There are three security levels have been done through dwelling (installation steel grill of window and door), building (CCTV, lighting, motorcycle parking lot), and community unit (check-point of the police). Chi-square test found that safety on building and community level are associated relationship with resident satisfaction. Also, the identifying element of building safety found the motorcycle parking lot, light, and CCTV high coefficient value with building safety. Also the crime mappings of five risk zones help develop profile of criminal incident in the community. Mapping provides insight into the where and derivatively perhaps the why of crimes and can help law enforcement identify the areas in which citizens need protection. This investigation criminal map is not new but it is essence to isolate areas of criminal activity for particular offenders. It can be adapted into housing planning of relevant stakeholders by focusing environmental through design.

Normally, the securities were handled by the residents and CJP. Although there is co-operation of local government as police station nearby however because of the larger community, it cannot be done fully management of entity community and very limited of police capacity. Meanwhile, the capacity of CJP is also limit. Also, a conflict management under relevant stakeholders is still being the problem of responsibilities. The representative feedback from CJP revealed that the old building condition and unclear viewpoint of surrounded landscape have been affecting a people perception in the community's insecurity. This issue leads more risk in criminal situation in the area. Living in community with changing a society also is less complementary. Most people who lived for long feel to help each other. Thus, a relationship among the residents is intimately. So, the context of residential development on the safety of the community is important by more focusing creating a cooperative living. These results of the study will be a guideline for National Housing Authority to setup community revitalization in order to improve with the CJP. It can be a model for development a co-ownership in other communities for good environment. Participation must include in thinking on process or policy to share a decision-making. However, to participate in community development depends on several factors such as economic, social, and individual characteristics. The environment in the community is important in helping to prevent the entry of criminals however due to uncompleted physical condition of maintains with many entrances has been enabling criminals to easily escape. Additionally, using a public space for the community activities by rotating of each group increased safety and social interaction outside their room. Also, it can be applied to determine the direction and create a mechanism to manage the area of community to be safe and which is consistent with the trajectory of residents in the community. Moreover, a budget loss in the operation of development and rehabilitation could reduce. Further study, a community safe analysis by investigating factor should also be more in-depth of closed community system for a comparative study to opened-access community characteristic.

## CHAPTER 8

### STAKEHOLDER INVOLVEMENT IN OLD PUBLIC HOUSING DEVELOPMENT

An analysis the three aspects through post-occupancy evaluation found there are significant factors for improving public housing project. To promote and ensure a sustainability of public housing development as well as an old public housing project, the existing policy and the role of government who are involved and responsibility were identified on this Chapter. The tree aspects have been setup as an initiative program of Klong Chan Flat operation.

#### 8.1. National Housing Authority Policy for Public Housing Development

Presently, the growing interest of a low-carbon society is widely concern on various sectors which includes housing sector. In the literature review (Chapter 2) has described a visionary on housing development of National Housing Authority. Particularly, affordable public housing in Thailand for low and middle-income people in the country is one prioritized solving issues. This part presents a public housing development under NHA, what initiative program has been implemented to contribute a low-carbon innovation in the country context. Currently, Eco-Village policy on livable and sustainable community provision is promoted by NHA in 2009. The initiative researches were launched by NHA supportive which can be divided into three stages of development; planning, production, and operation. Those studies have been examined to find a gap of housing improvement for old public housing project as below:

- **Planning:** *process of building and community design*

Currently, NHA has developed a public housing program “Eco-Village” model by using conceptual and building performance assessment of LEED from U.S.A and TEEAM that was developed by PCD (Pollution Control Department, Thailand) for initiative housing industry. To archive Eco-Village, self community support in long term development is a core concept. Creating social enterprise and green community are also associated the goal. Five criteria assessments of residential performance to meet Eco-Village are site planning and landscape, building design, building system, management and building innovation (Atch, 2012). In 2014, 17, 634 dwelling units of 29 projects were purposed to be constructed in Bangkok and region areas in approaching environmentally friendly design. Public-Private Partnership (PPP system) is a type of investment (NHA, 2014). In planning and construction process in public housing, a passive design shall be discussed and studied on comfortable condition in tropical climate. Shading, airflow & natural ventilation, daylight, and energy simulation are also involved in significance assessment. Social and culture contexts of occupants also definitely are to be one important factor towards a sustainable living in providing space for sharing activities.

- **Production:** *green material and environment friendly construction technology*

Usually, the basic materials for low-middle public housing in Eco-Village concept are heat absorbing glass, saving light bulb, 5w electronic ballast, ceiling insulation and all of these materials should

be a local product of Green-Label or Carbon Footprint-Label. To operate such a pilot project, NHA and private company have launched a prototype house and community based on renewable energy concept (NHA, 2014). Research done by Thammasart University has shown a low cost saving energy housing (Two-story detached house) guideline to cope with climate change. This type of house uses an environmental friendly material and natural ventilation flow throughout space there is no air-conditioning (AC) system installation for saving energy. This pilot housing project will be applied for NHA's development project in the first phase of 56 units at Romkaol Housing Community which integrated in Eco-Village criteria assessment including site planning and landscape, building design, building system, management and building innovation. Middle and high income is target group of the project dwellers.

- **Operation:** *technology adaptation and changing behavior life styles*

In case of using technology adaption such innovative approach to reduce energy and to alter energy solution in public housing for water treatment system, the study indicated that using roof-mounted solar cells is alternative energy with capability of electricity production, heat transfer reduction from the building envelope, carbon emission reduction, and backup electricity for use during disaster and economical feasibility study (Wankanapon, 2012). The benefits on a building envelope's heat transfer is that by using solar arrays to cover about 81% of the roof area, the indoor temperature of the room adjacent to the roof can be reduced by up to 4°C. For carbon emission reduction, by using solar cells for the energy in water treatment systems, it is possible to achieve a reduction of 44.91-718.61 Ton CO<sub>2</sub>. Putting this technology application in public housing could be adapted through project of NHA. However, large scale solar installations to afford low and middle income of public housing project as energy cost and extra financial support from government and relevant energy industry should be pointed out.

From above perspectives' NHA on housing development regarding the Eco-Village, it can be mentioned that the concept and principle made benefits for the society and also the NHA organization such a tool for steering and control a quality of public housing in the most effective assessment, benchmarking and co-operation with public and private sector to handle Eco-Village Project as a practical implementation, economic and financial benefits to investors and residents in term of low cost house where high efficiency energy saving, and improved image of NHA as green business concept development. However, this is a big effort that will require many partners over an operation period of time where co-funding as well as subsidy from government to support low income people could not be ignores. Normally, there are barriers for improved energy efficiency towards LCS (UNEP SBCI, 2009; WBCSD, 2009) including incentives, information, initiative, innovation, and investment as summarized in Table 8.1. These barriers directly seem an obstacle in providing an affordable housing for low income people in Thailand without a long-term housing strategy. Spatial concentration with basic services is still being a prioritized policy. Therefore, following LCS provision and Eco-Village framework in order to transformative existing housing policy in responding environmental sustainability and energy efficiency for the development of low-income housing, the role of government and housing policy instruments should rely on good central-local coordination and also attract private developers use wide range of incentives such as tax deductions, direct subsidies, land grants. Additionally, social and cultural changes as trends in Thai's context for an

integrated approach housing program would be useful such their specific needs. Moreover, towards energy-efficient buildings and housing requires a strong institutional environment stimulating deployment of technological solutions, informing consumer choice with regard to these solutions and motivating behavioral change, while also balancing different priorities should be addressed (Oleg. 2012).

Table 8.1 Key Five-ins conditions and barriers to improved energy efficiency in public housing

Conditions	Barriers
Incentives	Low priority for energy efficiency, Energy price subsidies Split incentives or principle-agent problem (owner vs tenants) Poor enforcement of standard, corruption
Information	Inaccuracy information, Lack of awareness and knowledge
Initiative	Lack of management or leadership, Fragmentation of the stakeholder, Poor coordination and communications, Political, Organization and structure barriers
Innovation	Path development in decision making, Technical, Market barriers for efficient technology, Lack of affordable technologies
Investment	Short-term investment, Uncertainties, Risk, Lack of financial capacities, High transaction cost, High upfront costs

Source: UNEP SBCI, 2009; WBCSD, 2009

According to the research study on three aspects of planning, production, and operation of Eco-Village, it can be summarized as Figure 8.1. All three processes represented a commitment comprehensive framework to archive the public housing policy. However, retrofitting existing public housing program (old public housing condition projects) in deriving energy from design improvement and energy performance to reduce GHG emission does not account rather than focusing a new building development criteria and its benefits in affordability for middle income. Based on this point, Eco-Village provision is not emphasis in term of old public housing development retrofitting to contribute existing project especially purchase housing type. Therefore, Eco-Village vision of old public housing project should be determined and promoted in proper assessment including effects on comforts, building appearances, security and occupation behaviors to deal with green building performances and retrofitting design approaches.

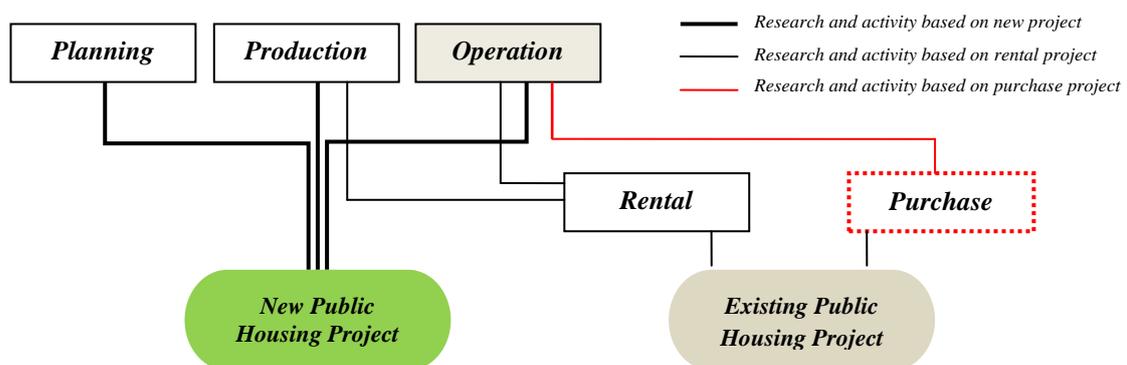


Figure 8.1 Inadequate promoting the policy on purchase public housing towards Eco-Village

## 8.2. Resident Attitudes towards LCS on Public Housing Development

Exploring residents' attitudes towards policy of public housing development toward Eco-village on three aspects of dwelling, building, and community is used to examine their attitudes. First section of questionnaire is to know a source of low carbon society information (LCS) and rating of resident interest on it. The second of questionnaire section describes the attitude on fifteen attributes on LCS which adapted from Werabenjapol (2012) and Masnui (2008) by using Likert Scale 1-5. 370 samples of Klong Chan Flat are target group. Reliability Coefficients gives us the Cronbach's alpha reliability coefficient for the set of fifteen items at .899 that indicated good internal consistency (Table 8.2). Firstly, asking in general about information of LCS and environment found that most of Klong Chan Project respondents have received that information of 70.8% meanwhile 19.7% represented do not know. Only 9.5% was unsure of knowing LCS and environmental policy. TV was main source (68.1%) by second and third is newspaper (25.7%) and website (24.9%) respectively. According to the degree of interest on LCS or environment issue, 48.9% and 29.7% shown fairly and more interested on it as shown Figure 8.2. Understanding this basic information on attitudes could illustrate that the residents as low income people of this project is rather very positive perceptions. It is helpful for a related government to promote and enhance the LCS as a development linkage to poor people.

Table 8.2 Attitudes toward public housing improvement components

Attitudes toward public housing improvement (5-Likert scale)		Cronbach's alpha (N=370)
Dwelling unit	Improving dwelling unit by using more natural daylight	.888
	Improving dwelling unit by using natural ventilation	.888
	Providing a small green area in room or balcony area	.895
	Using efficient home appliances/equipment is supplementary technique to reduce energy consumption	.889
	Use energy efficient appliances even if it is more expensive	.895
	Changing behaviors to reduce energy consumption and mitigate climate change	.890
Building unit	Improving public housing to contribute comfortable and saving energy might increase a lot of cost such rental or service fee but you are willing to pay for that	.897
	Designing a façade of building to reduce summer heat gain	.892
	Using high technology installation of building is one solution to saving energy	.894
	Planting trees around building through good landscape	.889
Community unit	We cannot do very much in mitigating environmental impacts because we are only a small group of residents	.915
	Willing to participate in the community activity to be a part of slowing down global warming	.892
	Creating livable place with economic opportunity for low income as self-contained community	.888
	Providing policy and building program to reduce low carbon emission should be promoted	.888
	Low carbon society concept contributes good environments to human that affects directly improving your quality of life	.889
<b>Total</b>		<b>Σ=.891*</b>

\*Cronbach's alpha reliability coefficient normally ranges between 0 and 1. There is a reliability degree as the following rules of thumb: "> .9 – Excellent, > .8 – Good, > .7 – Acceptable, > .6 – Questionable, > .5 – Poor, and < .5 – Unacceptable".

Information of LCS and environment

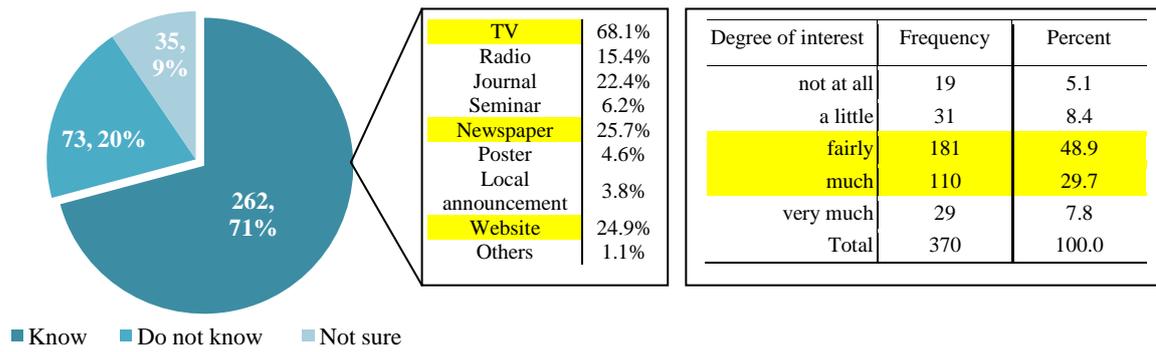


Figure 8.2 Understanding resident attitudes on LCS and source of information

Regarding the attitude variables on LCS on dwelling unit perspective improvement, these variables were found high score on agreed level (3.51–4.50). Improving dwelling unit by using more natural daylight and ventilation was ranked the highest score at 4.05 and 4.03 respectively, where score value of other variables were not quite different as shown in Table 8.3. This information implied for improving low-income housing that residents were more focused on their comfortable in approaching passive design. So, NHA could think about how to support them by more investigates thermal comforts condition. Furthermore, a resident behavior to compromise energy usage should be also investigated.

Table 8.3 Residents’ attitudes on LCS on dwelling unit perspective improvement

D1	Improving dwelling unit by using more natural daylight	4.05
D2	Improving dwelling unit by using natural ventilation	4.03
D3	Providing a small green area in room or balcony area	3.93
D4	Using efficient home appliances/equipment is supplementary technique to reduce energy consumption	3.9
D5	Use energy efficient appliances even if it is more expensive	3.74
D6	Changing behaviors to reduce energy consumption and mitigate climate change	3.87

Source: the Author, 2014

\*Satisfied level: 1.00 – 1.50 = Highly Disagreed, 1.51- 2.50 = Disagreed, 2.51- 3.50 = Fair Agreed, 3.51 – 4.50 = Agreed, 4.51 -5.00 = Strongly Agreed

In term of LCS on building development, four attitude variables were found the highly score on agreed level (3.51–4.50) in Table 8.4. Asking a cost of public housing development to combat environmental issues was importantly parameter which directed impact to resident. The result found that the low-income of Klong Chan Flat agreed (3.57) on rising cost of rental or fee services, however, a long-term beneficial to resident requires indeed. Providing a greenery landscape as a part of building surrounding must be accounted into environmental friendly design of NHA as preferable variable of the residents. Designing a building envelops and application through saving energy technology also should be determined which it was a same result on the influence factor analysis in Chapter 4 that directly affected to satisfy perception’s resident.

Table 8.4 Residents' attitudes on LCS on building unit perspective improvement

B1	Improving public housing to contribute comfortable and saving energy might increase a lot of cost such rental or service fee but you are willing to pay for that	
B2	Designing a façade of building to reduce summer heat gain	
B3	Using high technology installation of building is one solution to saving energy	
B4	Planting trees around building through good landscape	

Source: the Author, 2014

\*Satisfied level: 1.00 – 1.50 = Highly Disagreed, 1.51- 2.50 = Disagreed, 2.51- 3.50 = Fair Agreed, 3.51 – 4.50 = Agreed, 4.51 -5.00 = Strongly Agreed

Beside, the attitude variables on LCS on community unit perspective improvement including five variables, these variables were found highly score on agreed level (3.51–4.50) as shown in Table 8.5. Respondents feel somewhat they can mitigate environment impacts even they are a small group. Creating livable place with economic opportunity for low income as self-contained community is one most positive agree of respondent at 4.07 score. Low-income needs a secure place while an opportunity to help their income as living in urban area. Then, the last statement “low carbon society concept contributes good environments to human that affects directly improving your quality of life” was asked and found they did agree with 4.17 score. Therefore, LCS of NHA should not only focus on energy side but socio-economic policy interaction to encourage residents' quality plays important in sustain development.

Table 8.5 Residents' attitudes on LCS on community unit perspective improvement

C1	We cannot do very much in mitigating environmental impacts because we are only a small group of residents	
C2	Willing to participate in the community activity to be a part of slowing down global warming	
C3	Creating livable place with economic opportunity for low income as self-contained community	
C4	Providing policy and building program to reduce low carbon emission should be promoted	
C5	Low carbon society concept contributes good environments to human that affects directly improving your quality of life	

Source: the Author, 2014

\*Satisfied level: 1.00 – 1.50 = Highly Disagreed, 1.51- 2.50 = Disagreed, 2.51- 3.50 = Fair Agreed, 3.51 – 4.50 = Agreed, 4.51 -5.00 = Strongly Agreed

### 8.3. Stakeholder Involvement and Barriers for Klong Chan Flat Project Improvement

All significant indicators of three aspects analysis based on post-occupancy evaluation (POE) are identified and applied to support initiative program that will provide significant benefit to help low-income residents in ensuring their quality of life. Engaging stakeholders are involved to give shared accountability, decision making, joint learning and actions as well as to achieve expected outcomes of resident satisfaction. The action activity is setup in according with the governments' agencies duty as the result of interview that shown in Table 8.6.

Table 8.6 Klong Chan Flat project improvement program to enhance residents' satisfaction

Public Housing Improvement based on post-occupancy evaluation (POE)			Actors									
<ul style="list-style-type: none"> <li>○ Responsible (handle activity/funding)</li> <li>⊙ Accountable (monitoring)</li> <li>◆ Supportive (information/participation)</li> <li>□ Consult (knowledge and expertise)</li> </ul>			Residents	Condominium Juristic Person	National Housing Authority				Bangkapi District Office	Ladprao Police Station	Metro Electricity Authority	
					Policy and Planning Department	Urban Renewal and Urban Development	Community Management Office I	Construction Management Department				
Action			RS	CJP	PPD	URUDD	CMO	CM	BKO	LPS	MEA	
Overall Satisfaction	Klong Chan Flat	Continually investigation on residents' satisfaction by focusing socio-economic factor that effects satisfaction on three aspects including dwelling unit (family size), building unit (age, family size, length of residency), and community unit (owner).	◆	◆	□		○		◆			
	Buengkum Baan Eur Arthon	Continually investigation on residents' satisfaction by focusing socio-economic factor that effects satisfaction on three aspects including dwelling unit (family size, occupation), building unit (age, occupation, length of residency, owner), and community unit (occupation, family size, length of residency, and owner).	◆	◆	□		○		◆			
Influence factors of improvement	Klong Chan Flat	DS	Assess size of living area*	○		○						
			Changed material used in floors	○					□			
			Operation of sanitary in toilet	○					□			
		BS	Design of building	◆					○			
			Cleanness of building	⊙	○					□		
			Cost of maintenance management*	⊙	○							
	CS	Security of neighborhood*	◆	◆	□	○	○			○	○	
		Public park	◆	◆	□	○	○				○	
		Sport and playground facilities	◆	◆	□	○	○					
	Buengkum Baan Eur Arthon	DS	Changed material used in floors	○					□			
			Indoor air quality	○					□			
			Design of building	◆					○			
		BS	Natural lighting	⊙	○							
			Quality of painting	⊙	○				○			
			Quality of garbage storage		○						□	
		CS	Cost of maintenance management	⊙	○			⊙				
			Community location			○						
			Security of neighborhood	◆	◆	□	○	○			○	○
Three priority	Analysis dwelling unit on thermal comfort by focusing in depth of airflow as ventilation and behavior with energy also needs to be studies and compare to new project type	◆	◆	○	○	□	□					
	Building management that will rise satisfactory of residents that should be further studied on maintenance cost of old public housing project would be calculate through size of dwelling occupation and common area. Expenditure prediction by co-operative, electricity, insurance, and other activity cost should be provided to control and manage building cost under the income and expenditure capacity	◆	○	○		□						
	Pay attention more in the risk zone of community area; Zone A, B,C, D, E and monitoring in level of building and community level is important especially the system of motorcycle parking and lighting system to secure residents' crimes.	◆	○			□		○	○	◆		
Barrier policy	More focusing on rehabilitation of Eco-village principle.			○	○	◆						
	Provide financial for old public housing				○	○		○				
	Setup CJP group and building fee to support the building management and working with related government.	◆	○			◆		◆				
	Partnership collaboration, particularly in practice	◆	○	□	○	○	◆	○	○	◆		

Source: the author, 2016

Clearly understand on public housing improvement especially in case of Klong Chan Flat (purchase – rental housing type) on Eco-Village through sustainable living, the related NHA’s officers as a professional in the field were interviewed including the office manager of Community Management Department, the senior engineer and architectural designer of Construction Management Department. Also, CJP of Klong Chan Flat was interviewed. The key important were identified below.

Table 8.7 Interview the National Housing Authority officer on public housing improvement

Name	Position/Organization	Work experience
Mrs.Porntip Sukwatanapon	Manager Office, Klong Chan Community Section, Community Management Department	15 Years
Mr.Nuttaake Sagasongkobe	Senior Engineer, Construction Management Department	35 Years
Mrs.Supreeya Raksaphan	Director of Construction Management Department	26 Years
Condominium Juristic Person (CJP)	Flat 3, 8, 7, 10, 14, 15, 16, 17, 20, 23, 24, 26, 28, 29, 30	5 -10 Years

### 1) Eco-village concept in practical process

All fundamental elements shall be provided to low-middle income based on investment cost of NHA. Basically, being a concept of Eco-village that various parameters are taken into account especially a lay-out of the project and building orientation should be according to the wind direction through passive design approach. With low cost affordable housing and a requirement amount of unit as much as possible for a building is challenging. Also, a timing construction through efficient of workers is associated. There is no an experiment test on a process of design such a thermal comfort. After occupied by the resident, a guarantee building structure is five-year under the constructor contract. In case of public housing repair and improvement, a painting is the first program that provides by NHA due to financial aid limitation for rental housing type (Filed interview, 2015). Klong Chan Flat has been involved in socio-economic development which is one aspect of enhancement quality of life and will be archive Eco-village. Developing an organized fresh markets and shops in the community is to bring back benefits for residents. However, it is not easily to handle as there is still conflict between shop owners and NHA (area owner) that must be solved by win-win solution. It is the first priority of Community Management Department. In addition, other activities under the CSR (Corporate Social Responsibility) of NHA have long been operating of this community for example drug and environmental practice program. Those above activities are continually going, but it could mention that Klong Chan Flat is focused in the community level rather than pays attention to the details of dwelling unit or building unit.

### 2) Public housing cost maintenance and financial budget

To rehabilitation of purchase-rental public housing project is not easily to handle because, according to Condominium Act 2000, all purchase-rental unit must be transferred under Condominium Juristic Person regulation. Completed transferring property right to CJP as private organization therefore this situation the National Housing Authority is unable covering financial support on building development or any improvement program. However, in 2009, there was SML (Small, Medium and Large) Community Lending Project to village and communities by transferring fund from government through NHA to develop a security of residents in Klong Chan Flat with CCTV installation program. Unfortunately, this fund was not available since 2013 as a crisis on government financial management. However to improve

the building and residents' environmental living, there is another channel to get a financial support by a local government. Bangkok Metropolitan Authority shall allocate a budget development based on a prioritized issue in line with the city policy and program. In case of Klong Chan Project, this community must be registered on the community list of BMA to apply a fund. As the community area is owned by NHA and resident status must be registered of household record in BMA, these results affect to the community that cannot receive a funding program as another community gets. So, this would be complex situation to tackle. For physical responsibility, NHA's staff could not handle all areas of the project and insufficient financial support to deliver their statutory responsibilities (Filed interview, 2015).

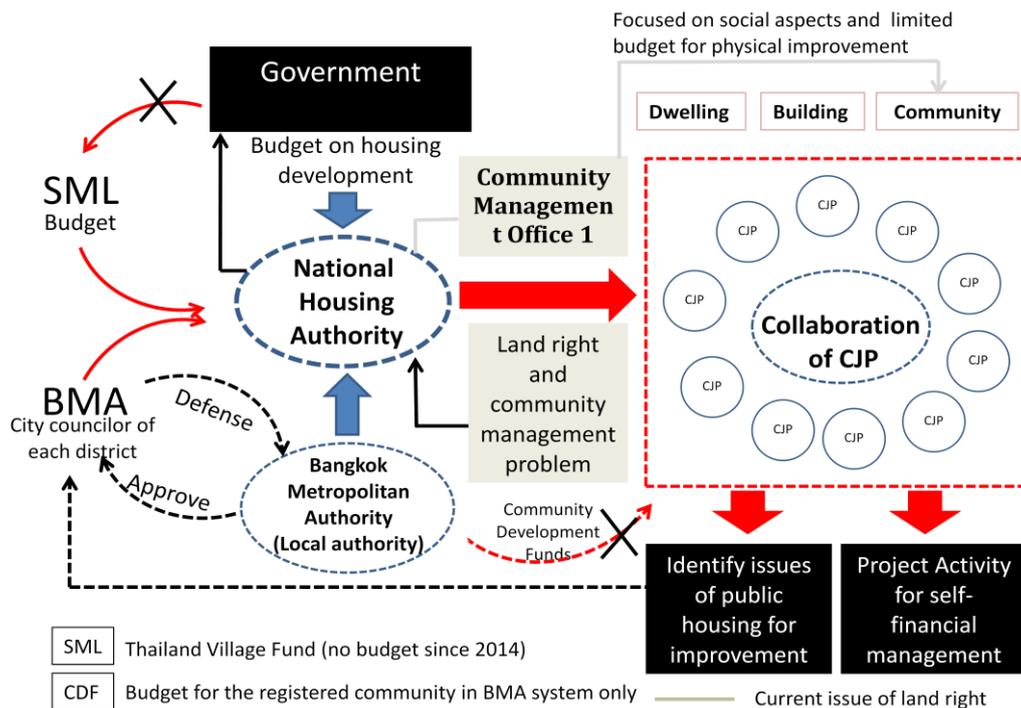


Figure 8.3 Financial constraints for improvement of Klong Chan Flat Project

### 3) Self-management

At present, there is no co-operation management among CJP of thirty-buildings. Agglomeration of those CJP in organizing community activities or events to strengthen the identity and unity can be raised and bring revenue into the community. As successfully case of Huai Khwang Public Housing Project and Din Dang Public Housing Project, a set up a management board could be possible to operate and allocate financial support to all buildings. This management concept could be achieved if it is a good co-operation among CJP (Porntip Sukwatanapon, interview 2015). There is an idea of community environment development since 2005 by establishing a working group, but does not practically undertaken. Moreover, CJP should assess the community's budget. Because of property right had been transferred to residents, they need to aware and manage by themselves. Consideration of changeable building fee based on building maintenance and management should be according with a buying room market price rate.

### 4) Partnership collaboration

As mentioned in self-management that CJP needs to corporate of Flat 1-30 in order to strengthening the community power for working with related government agencies. Individual building

representative cannot be effectively management. Therefore, participation among those flats should be encouraged. In addition, even though the Community Management Department is responsible for Klong Chan Flat Project development however another related department of NHA should be involved including Policy and Planning Department, Urban Renewal and Urban Development Department, Construction Management Department because of a large community with specific development planning required. Furthermore, continually meeting of CJP, NHA, and local government (Bangkapi District Office, Ladproh Police Station, Metro Electricity Authority) representative is beneficial feedback to improve the community. Currently, the area of fresh market management is urgent agenda of NHA which many stakeholders have collaborated (Filed interview, 2015).

#### **8.4 Conclusion**

This section contributes to understand a public housing perspective on the Eco-village concept under low carbon society of National Housing Authority (NHA). The analysis by investigating on existing NHA's researches and pilot projects on three stages of development; planning, production, and operation have been examined to find a barrier of housing improvement. The concept and principle of Eco-village made benefits for the country society. In the country perspectives, it is a big deal in a long-term housing strategy planning to respond environmental sustainability and energy efficiency for the development of low-income housing. Coordination with various stakeholders and providing a subsidy should be addressed. Unfortunately, the purchase housing type is seen a limited development as well as retrofitting to contribute based on Eco-Village vision. To deal with low-income housing development, we need to understand how poor people do concern on LCS society as a beginning process of Eco-Village implementation. Low-income residents have rated their attitudes in positive through fifteen variables. Three aspects of attitude; dwelling, building, and community on LCS and environments could mention that it is helpful for a related government to promote and enhance especially a rehabilitation program to poor people. Using the result of post-occupancy evaluation (POE) as contributing residents 'satisfaction and improve quality of living in properly environment is also significant parameter. Classified responsibility was done according with the roles of nine stakeholders in Klong Chan Flat Project. In case of purchase housing type (the case study) residents and condominium juristic person is assigned to improve their living place as a main actor while supportive related government sector of National Housing Authority is contributable. However, there is a barrier which has been identified barriers by multi-stakeholder alliances participating in the Klong Chan Flat Project development. Four issues on implementing of the community as old housing (purchase housing type) include 1) Eco-village concepts in practical process only focus on new project especially for middle and high income level, 2) public housing cost maintenance and financial budget is limited for purchase public housing and lacking budget for rehabilitation development, 3) self-management does not practically undertaken among thirty flats and there is no representative or working team setting to cooperate with government sectors, 4) partnership collaboration especially for physical community development is conflict of interest, a landholder right is ambiguous situation which has been affecting the entrust for residents.

## CHAPTER 9

### CONCLUSION AND RECCOMENDATION

This Chapter has drawn a summarized result of analysis old public housing improvement based on post-occupancy evaluation. The summary of this research starts with a crucial issue of public housing in Thailand. Research methods and importance results of investigation also pointed out a significant factor to be involved in public housing improvement. Finally, a future direction for studying on this topic is combined with this part.

#### 9.1 Summary of Research Study

A walk-up flat is a typical form of public housing projects affording low-income and middle-income citizens throughout the country. Presently, 29 public housing projects in Bangkok are aged more than 30 years. These projects were built during the 3<sup>rd</sup> – 5<sup>th</sup> National Economic and Social Development Plan and have been encountering poor conditions. Many researchers have investigated the Baan Eur Arthorn Project regarding residents' quality of life, such as communities' achievement on a physical and environmental level and social aspects. While the old walk-up flat community is in a poor condition, few studies have been conducted only on evaluating the quality of life and management perspectives. It could be mentioned that the housing standard issue in Thailand is still be seriously condition to deal with quality of living. From the literature review of public housing development in Thailand and theoretical post-occupancy evaluation (POE) and satisfaction based on the previous studied, this research has extent POE as an important identification method for providing key influence factors of public housing improvement approaches in the three aspects (dwelling, building and community). The intention of the POE research was that the results would compliment public housing research in Thailand and hence contribute to the decision-making and policy formulation of future housing policy and improvement initiatives. Klong Chan Flat Project (old condition) and Buengkum Baan Eur Arthorn Project (new condition) are the case study by collecting data through a questionnaire survey of 740 samples as the first step of identifying influenced factor of three aspects. Then, a statistical method by using SPSS program was employed to analysis. Based on 30 variables, the process logistic regression has let us knows the influence variables which are the highest beta coefficient value for predicting high satisfaction of Klong Chan Flat Project (old condition) and Buengkum Baan Eur Arthorn Project (new condition). Therefore, considering these variables into public housing improvement program would be contributing high satisfaction level of people with three main improvement approaches. The size of the living area ( $B = 1.592$ ), materials used for flooring ( $B = 1.456$ ), and operation of sanitary appliances in the toilet ( $B = 1.355$ ), and size of toilet and bathroom ( $B = 1.069$ ) contribute high satisfaction of dwelling unit scale for Klong Chan Flat Project. The design of the building ( $B = 2.533$ ) and cost of maintenance ( $B = 1.658$ ) play a role in contributing satisfaction with positive coefficient values. In terms of overall community satisfaction, the neighborhood security created a high beta value ( $B = 2.548$ ) which contributed to satisfaction. Meanwhile, materials used in the walls and

indoor air quality had positive beta values ( $B = 2.217$  and  $2.077$ ). Regarding overall building satisfaction, natural lighting, quality of paints, a design of building showed positive coefficient values ( $B = 3.532$ ,  $3.391$ , and  $3.185$  respectively). Location, neighbourhood security, and accessibility for the disabled and elder people showed positive coefficient values. Accessibility for the disabled and elder people was an important influencing factor with beta values of  $1.377$ . Based on the influenced factor of three aspects, the more investigated analysis was conducted. Four influence factors including the size of living area, the size of toilet & baht room, materials used in floor, and operation of sanitary in the toilet are highly related to occupants of Klong Chan Flat Project with a comparative study of NHA standard. Additional, a basic of the indoor environment on temperature and airflow was investigated that how the old dwelling unit features performing to contribute occupants' living comfort. Thermal comforts; indoor temperature, humidity with comparing outdoor temperature was conducted. The result indicates that both types of dwelling unit got high temperature and humidity. The airflow speed test by a wind tunnel shows very low rate in a living area and a bedroom that less contribution to occupant comfort. This result of the study can fulfil indoor design condition to relevant stakeholders and encouraging awareness of occupants to concern their improving living place that could make a positive impact for the better indoor thermal environment. Providing a solution for thermal comfort to low-income people, the designers need to understand dwellers' lifestyles and provides sustainable thermal materials for them. Beside, to reduce indoor temperature and increase airflow, it is important that awareness and knowledge of occupants on improvement side should be encouraged for long-term development. This would lead to extending the effort of National Housing Authority towards sustainable low-income housing development in the country. Ensuring occupants' living quality with good physical of old public housing is very important for long-term maintenance and management under the condominium juristic person (CJP) operation. Independent administrative group showed a quite good physical condition than co-administrative management. Materials, facilities system, open space condition, and unaware of building regulation have been majority problem of this project. It could be affecting a running cost of whole building for maintenance and management. Considering expectation and actual building fees of charge collected from occupancy's unit found that 16 flats of 25 flats or 64% have collected amount of building fee charge less than expectation fee. This amount of building fee was paid to cover three categories; administration, electricity, and building development expenditures. By the important of expenditures were administration cost, water supply cost, electricity supply cost, and building development cost. It is expected that maintenance building will become more important and serious issue for low-income residents. In a case of building decay that needs an amount of budget, hence, financial support from government needs to be addressed for low-income public housing project even transferred property right to owners in reasonable rate. Additional, to control maintenance cost, regularly monitoring and actively management of CJP need to improve as well. The influenced factors on maintenance cost of Klong Chan Flat Project found two variables significantly correlated with the monthly building expenditure; dwelling unit occupied and common property area. The predicting annual cost of Klong Chan Flat based on the age of building found four significant factors were co-operative, electricity, insurance and other activity costs. Thus, these variables must be taken into

consideration of CJP's maintenance program to control and manage their building cost under the income and expenditure capacity in the future. The community safety of Klong Chang Flat have been investigated at three levels; dwelling, building, and community unit. A thief broke into a room and drug abuse is serious problems. In term of building safety, three systems were found to protect residents; using CCTV, lighting, and motorcycle parking lot. The identifying element of building safety found the motorcycle parking lot, light, and CCTV high coefficient value with building safety. Also, a risk or problem area of insecurity condition of the community can be listed into five zones of criminal mapping. As lacking maintenance regularly of community level as well as physical development, it has been affecting a people perception in the community's insecurity. This issue leads more risk in a criminal situation. Finally, public housing improvement on the Eco-village concept under low carbon society of NHA has been examined to find a barrier of housing improvement. It is a long-term housing strategy planning to respond environmental sustainability and energy efficiency for the development of low-income housing. Unfortunately, the purchase housing type is seen a limited development in retrofitting to contribute based on Eco-Village vision. To deal with low-income housing development, we need to understand how poor people do concern on LCS society as a beginning process of Eco-Village implementation. Low-income residents have rated their attitudes in positive through fifteen variables. It is useful to the government agencies to promote and enhance especially a rehabilitation program to poor people. Classified responsibility was done according to with the roles of nine stakeholders in Klong Chan Flat Project. The case of purchase housing type (the case study) residents and condominium juristic person is assigned to improve their living place as a main actor while supportive related government sector of National Housing Authority is contributable. However, there is a barrier on implementing of the community as old housing (purchase housing type) include 1) Eco-village concepts in practical process only focus on new project especially for middle and high-income level, 2) public housing cost maintenance and financial budget is limited for purchase public housing and lacking budget for rehabilitation development, 3) self-management does not practically undertake among thirty flats and there is no representative or working team setting to cooperate with government sectors, 4) partnership collaboration especially for physical community development is conflict of interest, a landholder right is ambiguous situation which has been affecting the entrust for residents.

## **9.2 Key Findings of Research**

The findings of this research were listed as the following three research objectives:

*To explore an existing old public housing condition and new public housing type that how they have difference satisfaction level and to finding key factor for contributing their satisfactions.*

- Generally, the mean score satisfaction of Klong Chan Flat Project (old condition) was lower than Buengkum Baan Eur Arthron Project (new condition). The demographic attributions on the satisfaction of both projects are difference including age, income, homeownership, and a length of residency of Klong Chan Flat Project where gender, occupation, income, education, family size, length of residency, and dwelling renovation indicated significant of Buengkum Baan Eur Arthron Project. Also, the highest beta coefficient value of 31 variables on three features must be

addressed into public housing improvement program that would be contributing high satisfaction level of both projects as below.

Public housing project	Influence factor contribution for public housing improvement		
Klong Chan Flat Project	<b>*size of living area,</b> materials used in floor, size of toilet and bathroom, and operation of sanitary	design of the building, cleanness of building, <b>*cost of maintenance</b>	community location, <b>*security of neighborhood,</b> public park, and sport playground activity
Buengkum Baan Eur Arthron Project	materials used in wall, quality of indoor air quality	design of the building, natural lighting, painting of building, quality of garbage storage, and cost of maintenance	community location, security of neighborhood, accessibility to disabled person

\* The influence factors are prioritized to analysis for old public housing improvement

*To investigate and analyst the key influence factor on three aspects; dwelling unit, building unit, and community unit that would contribute occupant satisfaction and quality of living especially in old public housing project.*

- Dwelling size unit analysis of Klong Chan Flat project by comparing a space of function through National Housing Authority standard and a new housing project (Buengkum Baan Eur Arthron Project) found that Klong Chan Project is provided a space in line with the NHA standard and quite large than the new public housing project. A number of people in a unit should not be over 5 persons because it would be affecting satisfaction of occupant. This factor must be addressed in a design concept of NHA. As old condition of Klong Chan Flat Project, the room has been renovated by replacing windows or doors. Existing room condition based on NHA design was analyzed through basic thermal comfort investigation. The dwelling unit shows uncomfortable condition especially at night by averaging the indoor temperature of 30.67°C ~ 28.95°C which higher than outdoor climate about 2-4°C. Also, testing airflow through all space indicates a low percentage of ventilation about 12%-30% at 0.90 m. and 2.00 m which less contribute to occupants' comfort. So, the case of renovated room by blocking airflow might lead a worse uncomfortable living condition.
- Building management and cost were surveyed and conducted through 30 buildings of Klong Chan Flat, there are different types of building management system but no significant of its aspect on occupants' satisfaction. The building structure is still well-performed however the exterior wall surface peels off, unorganized public corridor, water and drain pipe broken, and lacking maintenance open space have been mainly affecting a living place condition. The aged building effects lot of expenditures on administration, electricity, and building development while income has been a constraint. A number of dwelling unit occupied rate and common property area is affecting factors on maintenance cost per month. Four attributes to predicting annual expenditure cost as following aged of the building; co-operative cost, another activity cost, electricity cost, and insurance cost giving a strong relationship of age building. These variables based on prediction model should be considered to apply in maintenance program of Klong Chan Flat under condominium juristic persons to control and manage their expenditure cost in the future.

Moreover, this study can support National Housing Authority's policy on public housing management to investigate old public housing project.

- Community safety of Klong Chang Flat was investigated and it found still be a high-risk criminal incidents issue. Three security levels are found by steel frame installation of window and door (dwelling), CCTV, lighting, motorcycle parking lot (building), and checkpoint of the police (community unit). However, the motorcycle parking lot and light found as a significant factor that contributes occupants satisfy. Although, 5-years criminal data shows slightly down of crime event but seems appear continually. Especially, the building condition and surrounded area of those flat which high criminal incident of Zone A, B, C, D, and E should be more surveillance and improve to protect crime in long-term development.

*To understand role of government that take into account for old low-public housing project and also relevant stakeholders' attitudes for coping maintenance and development issues as benefits and barriers.*

- National Housing Authority Policy has Eco-Village concept under low carbon society principle to develop and improve a quality of residents' living as a green business model but not focusing an old public housing especially purchase housing type. Asking about attitudes towards a policy of public housing development on Eco-village of three aspects of dwelling, building, and community found that low-income of Klong Chan Flat Project pay quite high attention on fifteen attributes. These attributes must be considered on government housing policy. To handle the old public housing, nine stakeholders should take part of development based on their roles on three aspects approaches to archive Eco-Village principle.

### **9.3. Further Research**

The research that has been undertaken for this thesis has highlighted a key point which further research would be beneficial. The old public housing is rental housing and closed community that has been operating by National Housing Authority more than 100 Projects should be examined in details of three scales. Especially, the influenced factor that contributes residents' satisfaction might be different aspect of Klong Chang Flat and Buengkum Baan Eur Arthron Project. Analysis POE of dwelling unit by investigating all room features as well as onsite experimental study with technical equipment of thermal comfort is beneficial to getting accuracy assessment. Crime in Klong Chan Flat should be studied how also directly affects property value as impact to a purchase housing type and crime based on population density as this case study is an urban area. Finally, the extended processes of post-occupancy evaluation could be a highlight on a characteristic of public housing and compare with developed country that what is differences in term of old public housing management based on three main aspects.

# APPENDIX I

## Questionnaire Survey

Dear Respondent,

This questionnaire is designed solely to carry out investigation on the topic of Low income Public Housing Improvement toward Low Carbon Society for a PhD Research in Architecture, The University of Kitakyushu, Japan. Your prompt cooperation in responding to the questions appropriately shall be highly appreciated. All information provided will be treated with strict confidentiality.

Thank you.

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### Part A: Personal Information

1. Gender  Male  Female
  
2. Age.....years
  
3. Educational Background  
 Primary  Secondary  High school  Professional school  
 Undergraduate  Graduated  
 Other, please specify:.....
  
4. Career  
 Civil servant  Freelancer  Unemployed  
 Business owner  Student  Retired/housewife  
 Private company officer  Other, please specify:.....
  
5. Average income of your family per year (Baht)  
 Below 1,000,000  1,000,001 – 2,000,000  
 2,000,001-3,000,000  3,000,001 – 4,000,000  
 4,000,001-5,000,000  5,000,001 – 6,000,000  
 6,000,001-7,000,000  7,000,001 – 8,000,000  
 8,000,001-9,000,000  9,000,001 – 10,000,000  
 More than 10,000,001
  
6. Number of family member living in this dwelling.....persons  
Age Below18 years old.....persons 19 – 29 years old.....persons  
30 - 39 years old.....persons 40 – 49 years old.....persons  
50 - 59 years old.....persons 60 - 69 years old.....persons  
More than 70 years old.....persons
  
7. The size of your dwelling is fitting for your family?  
 Very dissatisfied  Dissatisfied  Fairly satisfied  Satisfied  
 Very satisfied

### Part B: Dwelling Condition and Environment

1. How long have you been living in your dwelling .....
  
2. Why did you rent or purchase and live in this dwelling (Multiple choices)  
 Affordable price  Room is clean and good condition  
 Nearby workplace  Convenience traveling  
 Good neighborhood  Safety and security condition  
 Facilities support  Other, please specify:.....

4. Do you plan to move out of dwelling in the nearest future?

Yes  No

If yes, please state why: .....

5. Was the room and building ever renovated?

<b>Dwelling unit</b>		<b>Building</b>	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If yes, please state what kind of renovation was made by using ✓ in the empty box (multiple)		If yes, please state what kind of renovation was made by using ✓ in the empty box (multiple)	
<input type="checkbox"/>	Additional function area	<input type="checkbox"/>	Exterior painting
<input type="checkbox"/>	Interior painting	<input type="checkbox"/>	Replacement or repairing of the roof
<input type="checkbox"/>	Facade renovation	<input type="checkbox"/>	Flooring materials
<input type="checkbox"/>	Attic insulation	<input type="checkbox"/>	Building system ie. pipe, lift, fire system
<input type="checkbox"/>	Replacement/repairing of windows /doors	<input type="checkbox"/>	Lighting of building and surrounding
<input type="checkbox"/>	Drainage system	<input type="checkbox"/>	Landscape of building
<input type="checkbox"/>	Other .....	<input type="checkbox"/>	Other .....

Please circle the number that the most appropriate description of your level of agreement / satisfaction

Topics\degree of satisfaction	Very dissatisfied	Dissatisfied	Fairly satisfied	satisfied	Very satisfied
<b>Your dwelling physical aspect</b>					
<i>Size</i>					
The size of living area	1	2	3	4	5
The size of kitchen space	1	2	3	4	5
The size of bedroom	1	2	3	4	5
The size of toilet	1	2	3	4	5
The size of bathroom	1	2	3	4	5
The size of balcony	1	2	3	4	5
<i>Materials</i>					
Quality of materials used in floors	1	2	3	4	5
Quality of materials used in walls	1	2	3	4	5
Quality of materials used in ceiling	1	2	3	4	5
The operation of windows is ok	1	2	3	4	5
The operation of doors is ok	1	2	3	4	5
The operation of electrical fittings is ok	1	2	3	4	5
The operation of sanitary in toilet and bathroom is ok	1	2	3	4	5
<i>Environment</i>					
Are you satisfied with quality of indoor air quality	1	2	3	4	5
Are you satisfied with quality of ventilation	1	2	3	4	5
Are you satisfied with natural lighting in your room	1	2	3	4	5
Are you satisfied with your room from noisy surrounding	1	2	3	4	5
<b>Building physical aspect</b>					
Are you satisfied with this public housing building	1	2	3	4	5
Are you satisfied with the design of the building	1	2	3	4	5
Are you satisfied with this public housing location	1	2	3	4	5
Are you satisfied with natural lighting of this building	1	2	3	4	5
Quality of building facility is good	1	2	3	4	5
Quality of building materials is good	1	2	3	4	5
Quality of paints of this building is good	1	2	3	4	5
Quality of solid waste/garbage storage is good	1	2	3	4	5
Are you satisfied with cleanness of building	1	2	3	4	5
Are you satisfied with the management rules & regulations on this public housing	1	2	3	4	5
Are you satisfied with cost of maintenance of building	1	2	3	4	5

Topics\degree of satisfaction	Very dissatisfied	Dissatisfied	Fairly satisfied	satisfied	Very satisfied
<b>Community physical aspect</b>					
Are you satisfied with this public housing location	1	2	3	4	5
Are you satisfied with security of your neighborhood	1	2	3	4	5
Are you satisfied with public park	1	2	3	4	5
Are you satisfied with sport/playground facilities	1	2	3	4	5
Are you satisfied with car park	1	2	3	4	5
Accessibility to the disabled and aged people	1	2	3	4	5

### Part C: Dweller's lifestyle for comfort

Are there the homes appliances in your dwelling unit as the following?

- Air conditioner      please specify a number.....
- Refrigerator      please specify a number.....
- Washing machine      please specify a number.....
- Microwave      please specify a number.....
- Oven      please specify a number.....
- TV      please specify a number.....
- PC/Laptop      please specify a number.....
- Electric fan      please specify a number.....
- Other,..... please specify a number.....

Please indicate your opinion with the following statements:

Topics\degree of agreement	Not at all	A little	Fairly	Much	Very much
Using natural light instead of bulbs or fluorescents during daytime	1	2	3	4	5
Using energy saving light bulbs	1	2	3	4	5
Use natural wind instead of air conditioner if a weather is good	1	2	3	4	5
Use electric fan rather than opening air conditioner	1	2	3	4	5
Close windows and doors when air conditioner is on	1	2	3	4	5
Have regularly maintenance of air conditioner/heater	1	2	3	4	5

### Part D: Attitudes towards low carbon society

1. Did you know information of low carbon society or climate change before?

- Yes       No

If yes, please state what kind of information source?

- TV       Radio       Journal/Publication
- Seminar/training       Newspaper       Poster
- Local government       Website
- Other, please specify:.....

2. Do you interest on low carbon society or climate change information?

- Very much     Much     Fairly     A little     Not at all

Please circle the number to indicate your opinion on public housing improvement towards low carbon society in the following statements:

<b>Topics\degree of agreement</b>	<b>Strongly disagree</b>	<b>Disagree</b>	<b>Neutral</b>	<b>Agree</b>	<b>Strongly agree</b>
<b>Dwelling Unit</b>					
Improving your dwelling unit by using more natural daylight	1	2	3	4	5
Improving your dwelling unit by using natural ventilation	1	2	3	4	5
Providing a small tree in your room or balcony area	1	2	3	4	5
Using efficient home appliances/equipment is supplementary technique to reduce energy consumption	1	2	3	4	5
I would choose to use energy efficient appliances even if it is more expensive.	1	2	3	4	5
Changing your behaviors is the better way to reduce energy consumption and mitigate climate change	1	2	3	4	5
<b>Building Unit</b>					
Improving your dwelling unit to reduce CO <sub>2</sub> and saving energy might increase cost of public housing service fee but you are willing to pay for that.	1	2	3	4	5
Designing a roof overhangs of building can reduce summer heat gain	1	2	3	4	5
Using high technology installation of building is only the solution to saving energy	1	2	3	4	5
Planting trees around your building in good landscape would be more fresh, good scenery, and reduce CO <sub>2</sub>	1	2	3	4	5
<b>Community Unit</b>					
We cannot do very much in the reduction of CO <sub>2</sub> emission because we are only a small population compare to the whole population of the world.	1	2	3	4	5
I would be willing to make personal sacrifices for the sake of slowing down global warming even though the immediate result may not seem significant.	1	2	3	4	5
Designing of public housing layout and building should be deal with the orientation	1	2	3	4	5
Providing policy and building program from government to reduce low carbon emission should be promoted.	1	2	3	4	5
You think that low carbon society concept contributes good environments to human as well as improving your quality of life.	1	2	3	4	5

-Thank you for your assistance-

## APPENDIX II

### Interview Form for Building Management Officers of Klong Chan Flat Project

<b>General information</b>	
Building office manager:..... Name..... Age.....	Date..... Position..... How long have you been working.....
<b>Interview Questions</b>	
1	What is the existing building management system and how does it work? ..... .....
2	What are the main issues of building management and how do CJP solve those problems? ..... .....
3	Is there a yearly building assessment program? ..... .....
4	What are the most complaints from residents? ..... .....
5	How do you manage building management cost and fee? ..... .....
6	How much money do CJP spend for building management to improve and maintain building in a good condition, and also for public utility (water supply, electricity, solid waste)? ..... .....
7	What is a main issue of building management and how do you solve that issue? ..... .....
8	Do residents participate on building management? ..... .....
9	Do you think that the government sectors should be involved for building management as well as raising your building management capacity? ..... .....
10	Do you have any suggestion for public housing improvement or other issue? ..... ..... ..... .....

## APPENDIX III

### Interview Form for National Housing Authority Officer regarding Public Housing Improvement

<b>General information</b>	
Organization:.....	Date.....
Name.....	Position.....
Age.....	How long have you been working.....
<b>Interview Questions (for community area management)</b>	
1	How do you manage and improve community and facility of Klong Chan Flat project? ..... ..... .....
2	How much money do you spend for Klong Chan Flat project? ..... ..... .....
3	Do you have any program or policy to contribute a community quality of Klong Chan Flat project? ..... ..... .....
4	What is the main obstacle to manage Klong Chan Flat project in sustainability? ..... ..... .....
<b>Interview Questions (for public housing improvement program)</b>	
1	How does your organization implement the public housing improvement programs? ..... ..... .....
2	What other suggestions would you like to make that would improve the living conditions of the occupiers in old public housing project to combat climate change? ..... ..... .....
3	What is the main obstacle to improve or renovate the old public housing project? ..... ..... .....
4	Do you think that your organization should be involved for dwelling renovation and building management? ..... ..... .....
5	Do you have any suggestion for public housing improvement or other issue? ..... ..... .....

## APPENDIX IV

### Occupant Comfort Survey

Please note: All survey responses will remain confidential. Participants will remain anonymous and will only be identified by an assigned ID code.

#### Part 1: General information

Gender	Respondent:													
	1		2		3		4		5		6		7	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Age														

#### Part 2: Occupant behavior and thermal investigation

Please indicate whether you are wearing any of the items listed below.

Patterns of Wearing Cloth	Indicate	
	Yes	No
Short sleeved shirt		
Long sleeved shirt		
Pants		
Shorts		
Dress (women)		
Skirt (women)		
Pantry house (women)		
Socks		
Shoes		

Your activity during weekdays and weekends

Monday - Friday						
Wakeup	Breakfast	Working or studying	Come back home	Dinning	Sleep	
06.00	07.00-07.30	8.00-17.00	17.00-18.00	18.00-19.00	22.00-06.00	
Saturday - Sunday						
Wakeup	Breakfast	Relax at home	Lunch	Relax at home	Dinning	Sleep
07.00	8.00-09.00		12.00-13.00		18.00-19.00	22.0-07.00

Main activity of respondents

- sitting passively     
  cooking     
  lying down     
  sitting working

Please rate √ the overall thermal comfort in your dwelling unit at this moment

<b>-3</b>	<b>-2</b>	<b>-1</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>
Too cold		Comfortable		Too Hot		

Current temperature and humidity in your dwelling unit

Temperature.....Time..... Humidity..... Time.....

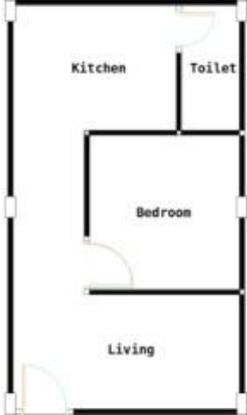
Number of air conditioner in your room.....(Living.....Bed 1.....Bed 2.....)

(Now, you opened air conditioner  Yes  NO)

Number of electric fan in your room.....(Living.....Bed 1.....Bed 2.....)

(Now, you opened electric fan  Yes  NO)

**Part 4: Room observation** (Renovated  Yes, when.....  NO)

<b>Types</b>	<b>observation</b>	<b>Types</b>	<b>observation</b>
○ <b>1 bedroom unit</b>	Note	○ <b>2 bedroom unit</b>	Note
			

Thank you for completing the survey

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