

STUDY ON THE CONTINUED MAINTENANCE FACTOR FOR THE DESIGN OF USER MANUAL IN APARTMENT HOUSING ACCORDING TO THE RESIDENTS' NEEDS.

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ABSTRACT: With the recent global trends in environmental preservation, the importance of sustainable construction is being highlighted in Korea. In particular, the trend is being discussed about life cycle of the apartment houses in various aspects. However the Korean construction market and housing policy have been increasingly focusing on supplier. Structures become progressively obsolete after a certain period, but their durability can be extended with proper maintenance management. Accordingly, if maintenance management on the structures is made efficiently, waste of construction energy and damage to the environment and economic loss due to early demolition and reconstruction can be effectively prevented. Therefore, this study aims to suggest the user manual design for the efficient maintenance in apartment housing

Keywords: Apartment Housing, Maintenance, Inhabitant-Centered, User Manual.

1. INTRODUCTION

1.1 Background and Objective of This Paper

Concentration of population and industries to the urban areas as a result of rapid economic growth since 1970's caused housing shortage eventually and thus Korean government has been focusing on building apartment housing that can supply housings in great quantities to solve the problem. Housing supplying ratio, however, in Korea reaches 100% now and therefore evidently management of stock will be more important than building new housing as the case is with advanced countries [1]. Consumer's recognition on dwelling in the houses has been changing and developing in much diversified forms according to the socio economic changes [2]. However, we were interested only in building and supplying the housings not paying meaningful attention to the housing maintenance that affects daily living of the residents [3]. In particular, professional management of apartment housing to maintain physical environments is essential to cope with time-worn housings as the residents share various facilities and spaces therein altogether [4].

We are required to focus on the management and maintenance of housings as well as supplying them to

extend their life-span and provide pleasant living environment continuously, for such purpose efficient management thereof should be emphasize further than now.

In this regard, this research intends to collect the key factors for efficient management of apartment housing and provide basic data to develop the residents(users) manual for the management and maintenance of such dwellings and such data and information are obtained partly by way of conducting survey of the residents therein

1.2 Scope and Methodology of Research

Scope of this research is limited to such residence end as apartment housing which occupies more than 70% of the residence ends as is reported by 2010 Population and Housing Census of Korea in order to investigate the extent of demand on the factors of managing and maintaining Exclusive and common space of the residents.

Apartment housings are divided into the Exclusive area owned by individual residents and common area shared with other residents out of various environmental factors for the residents. Both the Exclusive and common areas are incorporated with this study to investigate the extent of demand on the factors of management and

maintenance of such housings. Furthermore, priority was given to the factors to be managed and maintained by the residents for the purpose of providing data and information to write the Users' Manual as pre-research for it but the subjects of managing and maintaining the apartment housings were not limited.

This research conducted survey 3 times as a tool of substantive investigation with the residents living in apartment housings, those who manage and maintain them and the designers

2. BACKGROUND OF CASE STUDIES

2.1 Definition of Managing and Maintaining Apartment Housings

Management and maintenance of apartment housings means all the business to provide and preserve convenient and pleasant living environment of the residents by way of managing various facilities therein efficiently such as the apartment housings, their ancillary facilities and welfare facilities to maintain their functions properly and prevent any accidents, which results in maximizing the

period of durability and preserving the housing inventory[4]

Area and scope of the management and maintenance of apartment housings may be understood in several ways. In general, management and maintenance of such housings is regular inspection to maintain their physical conditions and general and special repairing works. Also it is inclusive of the hardware management to plan and implement remodeling to improve the apartment housing to satisfy social requirements which are changing as time elapses [5].

Article 2, Clause 29 of the Special Act on the Safety Control of Public Structures defines the management as follows; "Management and maintenance of public structures means such activities as routine inspection and repair of the structures and restore any damages parts to preserve the functions of those completed and the activities to improve, repair and reinforce the structures as is required as time elapses". Definition on such management and maintenance varies according to the institutions and researchers, which is summarized in <Table 1> below:

Table1. Review of the Advanced Research on the Definition of Management and Maintenance of Public Structures

Part	Title	Author	Definition
home	Study on the Efficient Management System of Apartment Housing	Korea Research Institute of Human Settlements (1987).	Efforts to restore the structure's value to be deteriorated as time elapses by artificial behavior
	Development of Guide to the Management and Maintenance of Existing Buildings	Korea Institute of Construction Technology (1993).	Preservation, acquisition, operation and disposal of economic feasibility and productivity of buildings In narrow sense, managerial works such as repairing and trimming to prevent declining value and efficiency of buildings
	Special Act on the Safety Control of Public Structures	Housing Institute of Korea Housing Corp. (1996).	Routine maintenance of facilities and restoration of damages parts. Improvement, repair, reinforcement, inspection and cleaning of the facilities.
Over seas	Maintenance and management of buildings	飯塚 裕 (1979).	It means protection, acquisition, operation or disposal of economic feasibility and productivity of the fixed asset of buildings. In narrow sense, it means managerial works such repairing and trimming to prevent the value and efficiency of buildings from being deteriorated. In further narrower sense, repair is excluded from construction works. In broad sense, it indicates all the works and business related to the management of fixed assets.
	Building Maintenance Management	ReginaldLee, MPhil, FRICS (1987).	Works to maintain and restore acceptable standards including minimum improvement

2.2 Necessity of Maintenance and Management and Study Trend

History of managing apartment housing in Korea is not long enough and it did not attract public attention as it was regarded as a private issue like the case of a detached house [4]. However, as public interests in the maintenance and remodeling the buildings are raised recently, study on the building management to extend its life span and enhance its function is being implemented actively by various methods[6]. Life span of apartment housing is affected much by its management and thus it may be turned to slum if it is neglected. Accordingly, systematical management of apartment housing is not less important than its design and construction [7]. Housing is a commodity of high price having durability and it should not be treated as a simple consumable but it should be durable consumable that can provide proper living service

for long term [8]. Efficient management, therefore, should be able to create the effect of improved property management as well as improve sustainable satisfaction with the buildings.

Housing management in many advanced countries is concentrated on stabilizing dwelling and improving living environment as a social material through rental system rather than recognizing a house as a means of possession. Such recognition on housing could develop housing management system as one of important social systems.

In particular, public housing in U.K. is supplied to the low income families by local governments and therefore, management of apartment housing is regarded as one of social welfare programs to be performed by the local administration authorities, which provide diversified opportunities to incorporate opinion of the residents and their benefit [9]. On the other hand, in Japan, autonomous

management system was set up since 1963 for the owners to manage the housings in the complex under their own efforts and responsibility and afterwards when the apartment housing complex service organizations were established, most of them and other complex buildings are entrusted with them for management. Web based building management performance is investigated in the U.S.A. and investigation on the facility management and studies on the assessment by the residents are actively conducted in New Zealand and Canada.

2.3 Necessity of Developing User's Manual

Inducing the residents who are apt to be closed, self-centered and negative in an apartment housing complex to participation and cooperation for them to have positive living practice becomes another new job of the apartment housing management[11]. Investigation on the tools and systems required to improve the apartment housing management revealed a manual (4.26), system (4.09) and training (4.3), which indicated that the residents needed a manual and training for better management [6]. Therefore, development of the Users' Manual and training should be implemented to develop the management of apartment housing complex systematically.

Table2. Advanced Research on the Management Guide and Manual

Part	Advanced Research
Maintenance instructions and manuals	<ul style="list-style-type: none"> □ A study on the Efficient Maintenance System Establishment for the Apartment, Jang, J.H., 2005 □ A Study of Long-rang Repair Plan for Mintenance of Apartment Housing, Han, B.J., 2003 □ A Study on Extracting Process of the Evaluation Indices of Building Sustainability, Lee, K.H., 2002 □ The Requirement Analysis for the Maintenance System Design of Apartment Buildings, Kim, T.H., 2003

Providing the measures for the deterioration of buildings and reduction of management fee but few data on preparing the manual for residents were found. Therefore, studies on the practical management of the housing are insufficient due to lack of correct data concerned. Current manual for the apartment housing management and the guide to building management published by Ministry of Construction & Transportation and Korea Institute of Construction Technology respectively consisted of the factors for the subjects of managing the housing not for the users. Furthermore, terminologies therein are professional ones which can hardly be understood by most of the residents who do not have knowledge on construction business and they cannot be applied easily to daily inspection. In this regard, we need to develop such manual as can be used easily by the managers (residents) who are not specialists in construction business. This paper tries to find all the factors that the residents need for better management of their apartment housing complex by way of conducting survey with them to provide basic data to prepare the manual focused on the practical use by the residents, which is differentiated from the advanced researches

made so far.

3. Design of Study

3.1 Establish and Design Subjects of Study

In order to prepare and implement efficient Management Manual for the residents, first of all the factors required by them in their daily life should be found to apply such factors to the routine management of the apartment housing complex.

In this regard, this research conducted a survey with the residents living in the complex and the managers trying to identify the factors they need in the daily life.

Table3. Design of Study

Stage		Description	
Pre-Study	Decide subjects of study	What are the factors focused on the residents according to their requirements?	
	Designate specialists	managers and residents of apartment housing complex	
Survey	1st	Design survey factors	open end questions by areas according to 3 upper hierarchies of management factors
		Analyze survey	Categorize answers by factors. Integrate or remove similar factors of questions obtained from the advanced researches
	2nd	Design survey factors	Analyze necessity of the final factors selected through integration and removal out of those drawn from open end questions
		Analyze survey	Draw the factors for 3 rd survey excluding those of substantially low necessity
	3rd	Design survey factors	Analyze importance of each item by Likert 5 point scale
		Analyze survey	Verify validity and reliability of composing factors

3.2 Organize Specialists

Survey was conducted 3 times with those who are currently living in an apartment housing or lived there for more than 5 years (70%), managers of apartment housing and the designers(30%). Survey carried out by this research tried to include the details that the residents who are non-professional may neglect by including the managers who have managed apartment housing complex and the designers who are aware of even all the details that are not visible in the survey.

Table4. Composition of Respondent

Part	Manager and Architecture	Residents
Respondent	15 (30%)	35 (70%)
total	50	

3.3 Design of Survey Factors and Analyzing Methodology

3 surveys consisted of 1 open end and 2 closed end was conducted to draw objectified results and experimental analysis was made at each stage to achieve the purpose of this study.

Table5. Process of Survey and Analysis Methodology

State		Description
1st	Design survey	Design open end survey, interview
	Analyze survey	Measure overlapped words replied and frequency of priority
2nd	Design survey	Questionnaires to analyze necessity according to 1 st survey. design(closed end, questionnaires)
	Analyze survey	Modify and supplement after comparing survey results and existing studies
3rd	Design survey	Design survey to analyze importance according to the 2 nd analysis on the importance(closed end questionnaire, written questionnaires)
	Analyze survey	analyze priority(average, deviation)

4. Results of Research

4.1 1st Survey Factors of Management and Maintenance (Open End Questionnaires)

Based upon Article 2, Clause 12 of the Special Act on the Safety Control of Public Structures, management and maintenance are classified into functional aspect, convenient aspect and safety aspect to carry out the survey. Similar or equivalent factors were either integrated or removed from among the factors drawn by first open end survey to get 122 factors as are described on Table 6 below.

Table6. Result of 1st Survey.

Part		Factors of Management
Functional Aspect (48 factors)	Exclusive Area C	Inspect main entrance, Entrance and interphone camera, Inspect entrance lighting sensor, Inspect door lock of entrance door, Inspect home net-works, Inspect lighting fixtures, Inspect ventilation duct, Inspect built-in furniture, Inspect bathroom ventilator, Inspect kitchen facility(built-in furniture), Inspect lighting of cooking stand at a kitchen, Inspect dish washer, Inspect gas range hood, Inspect flowing backward of storm drain pipe at a balcony, Prevent condensation at a balcony, Inspect water leakage at a balcony, Inspect cement corrosion at utility room, Inspect laundry hanger, Inspect boiler, Inspect running water valve, Inspect water meter, Inspect gas meter, Inspect electricity meter, Inspect telecommunication and broadcasting system, Inspect power supply and maintenance, Inspect pipes to prevent freezing and bursting, Inspect cold and hot water meter to prevent freezing and bursting, Inspect hot water inlet, Inspect water leakage during heavy rainfall, Inspect the
	Public Area (20 factors)	Gate at entrance to the complex, Inspect automatic door at main entrance, Inspect the key and sensor at main entrance, Inspect lighting brightness inside a lift, Inspect a lift ventilator, Inspect a lift air conditioner, Inspect lift buttons, Inspect lift operation, Inspect water leakage at a corridor and staircase, Inspect lighting fixtures at a corridor and staircase, Inspect ventilation duct at a corridor and staircase, Inspect brightness of lighting at a corridor and staircase, Inspect lighting fixtures and parking facilities at underground car park, Inspect street lightings in the complex, Maintenance of landscaping and trees in the complex, Replace landscaping trees in the complex, Inspect resting facilities in the complex, Inspect garbage treatment facility, Inspect recycling garbage and separate collecting facilities, Inspect convenient facilities for the disabled
Convenient and Comfortable Aspect (34 factors)	Exclusive Area (20 factors)	Maintenance of cleaning entrance floor tiles, Shoe rack sterilization, Cleaning window panes at living room, Inspect lighting fixture switches, Cleaning lighting fixture and electric bulb covers, Inspect comfortable extent of indoor air, Inspect cleaning outdoor plant of air conditioner, Sterilizing kitchen(insect and germs), Inspect hygiene of convenient facility for kitchen, Inspect contaminated tiles at a kitchen and crack, Cleaning food stuff dryer, Cleaning dish washer, Inspect cleaning sanitary device at a bathroom, Inspect cleaning ventilator at a bathroom, Inspect sterilization of washing basin and bath tub, Remove mold from bathroom tiles, Inspect drainage of bathroom floor and washing basin, Inspect when the sanitary devices at a bathroom are replaced due to their deterioration, Cracks of balcony walls and tiles and cleaning them, Sterilizing the germs at a bed and bed clothing
	Public Area (14 factors)	Cleaning a lift, Cleaning a corridor and staircase, Inspect sanitation of the tiles at a corridor and staircase, Inspect wall falling at a corridor and staircase, Inspect sanitation of underground car park, Inspect air pollution in the underground car park, Cleaning 1st floor entrance, Inspect cleaning mail box, Cleaning external wall, Inspect fixing safety signs in the complex, Inspect road signs, Inspect sanitation of playground for children, Inspect sanitation of convenient facilities for the residents, Inspect telecommunication facilities
Safety Aspect (40 factors)	Exclusive Area (19 factors)	Inspect balustrade of a balcony, Inspect corrosion of finish material for safety, Inspect locking device of windows and an entrance door, Inspect broken windows, Inspect anti burglar window, Inspect damaged anti insect screen, Inspect indoor fire extinguisher, Inspect when indoor fire extinguishers are replaced due to their deterioration, Inspect indoor fire sensors, Inspect sprinkler operation, Inspect distortion of bottom sink, Inspect tile crack and repair, Inspect gas, Inspect tightening gas valve for safety, Inspect running water leakage, Inspect crack and damage of electric consent, Inspect leakage current circuit breaker, Inspect storm water drain pipe damage, Inspect security alarm
	Public Area (21 factors)	Inspect fire alarm system operation, Inspect sprinkler operation, Inspect fire hydrant, Inspect broadcasting system, Inspect emergency lamp operation, Inspect CCTV operation, Inspect anti insect screen at a corridor and window locking, Inspect wall concrete crack at a corridor and staircase, Inspect handrails and corridor stair, Inspect damaged tiles at a corridor and staircase, Inspect evacuation passage and space, Inspect emergency escape, Security system for children's playground and car park, Inspect safety facility of children's playground and lounge, Inspect safety of children's playground, Inspect preventing fallings at main entrance, Inspect alarm operation of parking system, Inspect safety facility in a car park, Inspect cardioverter operation, Inspect street lightings, Inspect hazard to the safety of flower garden

4.2 2nd Survey Necessity (Closed End Survey)

Second survey, a closed end, was consisted of the questionnaires to evaluate the necessity of the management factors according to the factors drawn by

advanced investigation and first survey(open end question) based upon the existing advanced studies. For second survey questionnaires, 48 factors of functional aspects, 34 factors of convenient and comfortable aspect

and 40 factors of safety aspect drawn from the first survey were proposed.

Table7. Result of 2nd Survey (Functional aspect)

Part	Functional Aspect(48 factors)	Necessity	
Exclusive Area	Inspect main entrance, Entrance and interphone camera	71.1%	
	Inspect entrance lighting sensor	66.7%	
	Inspect door lock of entrance door	73.3%	
	Inspect home net works.	46.7%	
	Inspect lighting fixtures	53.3%	
	Inspect ventilation duct	37.8%	
	Inspect built-in furniture	22.2%	
	Inspect bathroom ventilator	55.6%	
	Inspect kitchen facility(built-in furniture)	37.8%	
	Inspect lighting of cooking stand at a kitchen	24.4%	
	Inspect dish washer	17.8%	
	Inspect gas range hood	46.7%	
	Inspect flowing backward of storm drain pipe at a balcony	66.7%	
	Prevent condensation at a balcony	73.3%	
	Inspect water leakage at a balcony	66.7%	
	Inspect cement corrosion at utility room	42.2%	
	Inspect laundry hanger	11.1%	
	Inspect boiler	71.1%	
	Inspect running water valve	62.2%	
	Inspect water meter	68.9%	
	Inspect gas meter	73.3%	
	Inspect electricity meter	64.4%	
	Inspect telecommunication and broadcasting system	46.7%	
	Inspect power supply and maintenance	48.9%	
	Inspect pipes to prevent freezing and bursting	68.9%	
	Inspect cold and hot water meter to prevent freezing and bursting	73.3%	
	Inspect hot water inlet	48.9%	
	Inspect water leakage during heavy rainfall	64.4%	
	Public area	Inspect the gate at entrance to the complex	64.4%
		Inspect automatic door at main entrance	77.8%
		Inspect the key and sensor at main entrance	46.7%
		Inspect lighting brightness inside a lift	40.0%
		Inspect a lift ventilator	53.3%
Inspect a lift air conditioner		46.7%	
Inspect lift buttons		66.7%	
Inspect lift operation		82.2%	
Inspect water leakage at a corridor and staircase		57.8%	
Inspect lighting fixtures at a corridor and staircase		51.1%	
Inspect ventilation duct at a corridor and staircase		42.2%	
Inspect brightness of lighting at a corridor and staircase		33.3%	
Inspect lighting fixtures and parking facilities at underground car park		77.8%	
Inspect street lightings in the complex		68.9%	
Maintenance of landscaping and trees in the complex		37.8%	
Replace landscaping trees in the complex		20.0%	
Inspect resting facilities in the complex		46.7%	
Inspect garbage treatment facility		80.0%	
Inspect recycling garbage and separate collecting facilities		77.8%	
Inspect convenient facilities for the disabled		55.6%	

Factors of the Exclusive area in functional aspect carry the necessity of 53.37% in average, while the inspection of door lock showed the requirement of 73.3%, preventing condensation 73.3%, operation of gas meter 73.3%, preventing freezing and bursting of cold and hot water meter 73.3%. On the other hand, necessity of inspecting public area was 56.33%, lift operation 82.2%, garbage treating facility 80.0%, automatic door of main entrance 77.8%, lighting fixture at underground car park and operation of parking facility 77.8% and recycling garbage and separate collecting facility 77.8%.

Table8. Result of 2nd Survey (Convenient and Comfortable aspect)

Part	Convenient and Comfortable Aspect (34 factors)	Necessity	
Exclusive area	Maintenance of cleaning entrance floor tiles	33.3%	
	Shoe rack sterilization	35.6%	
	Cleaning window panes at living room	33.3%	
	Inspect lighting fixture switches	64.4%	
	Cleaning lighting fixture and electric bulb covers	35.6%	
	Inspect comfortable extent of indoor air	44.4%	
	Inspect cleaning outdoor plant of air conditioner	60.0%	
	Sterilizing kitchen(insect and germs)	73.3%	
	Inspect hygiene of convenient facility for kitchen	40.0%	
	Inspect contaminated tiles at a kitchen and crack	46.7%	
	Cleaning food stuff dryer	44.4%	
	Cleaning dish washer	55.6%	
	Inspect cleaning sanitary device at a bathroom	55.6%	
	Inspect cleaning ventilator at a bathroom	60.0%	
	Inspect sterilization of washing basin and bath tub	37.8%	
	Remove mold from bathroom tiles	60.0%	
	Inspect drainage of bathroom floor and washing basin	64.4%	
	Inspect when the sanitary devices at a bathroom are replaced due to their deterioration	55.6%	
	Cracks of balcony walls and tiles and cleaning them	40.0%	
	Sterilizing the germs at a bed and bed clothing	48.9%	
	Public area	Cleaning a lift	77.8%
		Cleaning a corridor and staircase	77.8%
		Inspect sanitation of the tiles at a corridor and staircase	31.1%
Inspect wall falling at a corridor and staircase		42.2%	
Inspect sanitation of underground car park		57.8%	
Inspect air pollution in the underground car park		57.8%	
Cleaning 1 st floor entrance		53.3%	
Inspect cleaning mail box		44.4%	
Cleaning external wall		57.8%	
Inspect fixing safety signs in the complex		51.1%	
Inspect road signs		40.0%	
Inspect sanitation of playground for children	84.4%		
Inspect sanitation of convenient facilities for the residents	71.1%		
Inspect telecommunication facilities	62.2%		

Exclusive area of convenient and comfortable aspect was found to be 49.44%, which showed less necessity

than functional aspect. Factors of investigating sanitation and sterilization of a kitchen 73.3%, switch operation 64.4%, and drainage of bathroom floor and washing basin 64.4% were found to have comparatively higher necessity. Necessity of public area 57.7% is higher than Exclusive area. Necessity of inspecting sanitation of children's playground was 84.4%, cleaning a lift 77.8% and cleaning a corridor and a staircase 77.8%.

Table9. Result of 2nd Survey (Safety aspect)

Part	Safety Aspect(40 factors)	Necessity
Exclusive area	Inspect balustrade of a balcony	80.0%
	Inspect corrosion of finish material for safety	53.3%
	Inspect locking device of windows and an entrance door	75.6%
	Inspect broken windows	51.1%
	Inspect anti burglar window	71.1%
	Inspect damaged anti insect screen	53.3%
	Inspect indoor fire extinguisher	71.1%
	Inspect when indoor fire extinguishers are replaced due to their deterioration	82.2%
	Inspect indoor fire sensors	86.7%
	Inspect sprinkler operation	66.7%
	Inspect distortion of bottom sink	24.4%
	Inspect tile crack and repair	22.2%
	Inspect gas	80.0%
	Inspect tightening gas valve for safety	71.1%
	Inspect running water leakage	75.6%
	Inspect crack and damage of electric consent	57.8%
	Inspect leakage current circuit breaker	82.2%
	Inspect storm water drain pipe damage	64.4%
Inspect security alarm	82.2%	
Public area	Inspect fire alarm system operation	93.3%
	Inspect sprinkler operation	73.3%
	Inspect fire hydrant	73.3%
	Inspect broadcasting system	68.9%
	Inspect emergency lamp operation	71.1%
	Inspect CCTV operation	82.2%
	Inspect anti insect screen at a corridor and window locking	55.6%
	Inspect wall concrete crack at a corridor and staircase	44.4%
	Inspect handrails and corridor stair	55.6%
	Inspect damaged tiles at a corridor and staircase	42.2%
	Inspect evacuation passage and space	64.4%
	Inspect emergency escape	77.8%
	Security system for children's playground and car park	77.8%
	Inspect safety facility of children's playground and lounge	73.3%
	Inspect safety of children's playground	77.8%
	Inspect preventing fallings at main entrance	62.2%
	Inspect alarm operation of parking system	62.2%
	Inspect safety facility in a car park	55.6%
	Inspect cardioverter operation	37.8%
	Inspect street lightings	64.4%
	Inspect hazard to the safety of flower garden	51.1%

Necessity of Exclusive area in safety aspect was as high as 65.85% and public area was 64.97% in average, of which necessity is similar with the Exclusive area. Factors of the Exclusive requiring high necessity were inspection of fire sensor operation 86.7%, time to replace worn out indoor fire extinguisher 82.2%, operation of

leakage current circuit breaker 82.2%, operation of security alarm 82.2%. Factors of public area requiring necessity were inspection of fire alarm system operation 93.3% and CCTV operation 82.2%.

4.3 3rd Survey on the Importance (Close End Survey)

Questionnaires of third survey were consisted of those of which necessity was found to be more than 50% to find their importance using 5 point Likert Scale. Necessity of such factors was verified by second survey and third one was conducted to determine their priority.

Table10. Result of 3rd Survey (Functional aspect)

Part	Functional Aspect (28 factors)	Average	Standard deviation	
Exclusive area	inspect main entrance, Entrance and interphone camera	4.19	0.88	
	inspect entrance lighting sensor	3.89	1.02	
	Inspect door lock of entrance door	4.46	0.90	
	Inspect lighting fixtures	3.84	0.87	
	Inspect bathroom ventilator	3.43	1.01	
	Inspect flowing backward of storm drain pipe at a balcony	3.92	0.98	
	Prevent condensation at a balcony	4.00	1.08	
	Inspect water leakage at a balcony	3.92	1.12	
	Inspect boiler	4.41	0.80	
	Inspect running water valve	4.11	0.99	
	Inspect water meter	4.05	1.00	
	Inspect gas meter	4.24	1.01	
	Inspect electricity meter	4.11	0.99	
	Inspect pipes to prevent freezing and bursting	4.41	0.98	
	Inspect cold and hot water meter to prevent freezing and bursting	4.35	0.92	
	Inspect water leakage during heavy rainfall	4.00	1.00	
	Public area	Inspect the gate at entrance to the complex	3.95	1.03
		Inspect automatic door at main entrance	4.32	0.71
Inspect a lift ventilator		3.59	0.98	
Inspect lift buttons		4.14	0.89	
Inspect lift operation		4.46	0.80	
Inspect water leakage at a corridor and staircase		3.78	1.08	
Inspect lighting fixtures at a corridor and staircase		3.92	0.92	
Inspect lighting fixtures and parking facilities at underground car park		4.19	0.97	
Inspect street lightings in the complex		4.00	0.75	
Inspect garbage treatment facility		3.89	0.74	
Inspect recycling garbage and separate collecting facilities	3.81	0.84		
Inspect convenient facilities for the disabled	3.89	0.97		

Importance of Exclusive area in functional aspect was 4.08 in average while the one of public area was 4.0 in average, which was slightly lower than the Exclusive area. Factors of higher importance were inspection of door lock of the entrance door 4.46, boiler operation 4.41, preventing the pipes from freezing and bursting 4.41, lift operation at the public area 4.46, lighting fixture at underground car park and operation of parking facility 4.19 and lift operating buttons 4.14.

Table11. Result of 3rd Survey (Convenient and Comfortable aspect)

Part	Convenient and Comfortable Aspect (19 factors)	Average	Standard deviation
Exclusive area	Inspect lighting fixture switches	4.00	0.71
	Inspect cleaning outdoor plant of air conditioner	3.59	0.93
	sterilizing kitchen(insect and germs)	4.24	0.83
	Cleaning dish washer	3.97	1.01
	Inspect cleaning sanitary device at a bathroom	3.97	0.96
	Inspect cleaning ventilator at a bathroom	3.73	0.90
	Remove mold from bathroom tiles	4.00	0.85
	Inspect drainage of bathroom floor and washing basin	4.22	0.82
	Inspect when the sanitary devices at a bathroom are replaced due to their deterioration	3.97	0.90
	Public area	Cleaning a lift	3.70
Cleaning a corridor and staircase		3.57	0.83
Inspect sanitation of underground car park		3.49	0.99
Inspect air pollution in the underground car park		4.03	0.96
Cleaning 1 st floor entrance		3.81	0.91
Cleaning external wall		3.41	0.98
Inspect fixing safety signs in the complex		3.84	0.93
Inspect sanitation of playground for children		4.22	0.75
Inspect sanitation of convenient facilities for the residents		4.05	0.94
Inspect telecommunication facilities		4.08	1.04

Importance of the Exclusive area in convenient and comfortable aspect was found to be 3.97 in average and the one of public areas was 3.82, which was lower than the importance in function aspect. Factors of higher importance in the Exclusive area were sterilization and sanitation of a kitchen 4.24, inspection of the bathroom floor and drainage of washing basin 4.22, inspection of lighting fixture switch operation 4.00, removing mold from bathroom tiles 4.00, for the public area, inspection of children's playground 4.22, inspection of telecommunication networks 4.08 and inspection of air pollution at underground car park 4.03.

Table12. Result of 3rd Survey (Safety aspect)

Part	Safety Aspect (35 factors)	Average	Standard deviation
Exclusive area	Inspect balustrade of a balcony	4.57	0.77
	Inspect corrosion of finish material for safety	4.03	1.12
	Inspect locking device of windows and an entrance door	4.49	0.73
	Inspect broken windows	4.14	0.82
	Inspect anti burglar window	4.22	1.08
	Inspect damaged anti insect screen	3.57	1.01
	Inspect indoor fire extinguisher	4.22	0.92
	Inspect when indoor fire extinguishers are replaced due to their deterioration	4.27	0.73
	Inspect indoor fire sensors	4.35	1.11
	Inspect sprinkler operation	4.49	0.87
	Inspect gas	4.46	0.69
	Inspect tightening gas valve for safety	4.51	0.65
	Inspect running water leakage	4.03	0.90
	Inspect crack and damage of electric consent	4.22	0.92
	Inspect leakage current circuit breaker	4.46	0.73
Public area	Inspect storm water drain pipe damage	3.76	1.06
	Inspect security alarm	4.38	0.92
	Inspect fire alarm system operation	4.54	0.69
	Inspect sprinkler operation	4.49	0.65
	Inspect fire hydrant	4.46	0.69
	Inspect broadcasting system	4.22	0.95
	Inspect emergency lamp operation	4.49	0.65
	Inspect CCTV operation	4.43	0.73
	Inspect anti insect screen at a corridor and window locking	4.08	0.86
	Inspect handrails and corridor stair	4.08	0.92
	Inspect evacuation passage and space	4.43	0.87
	Inspect emergency escape	4.22	1.03
	Security system for children's playground and car park	4.43	0.80
	Inspect safety facility of children's playground and lounge	4.22	1.03
	Inspect safety of children's playground	4.30	1.00
Inspect preventing fallings at main entrance	4.24	0.86	
Inspect alarm operation of parking system	4.19	0.78	
Inspect safety facility in a car park	4.05	1.03	
Inspect street lightings	3.89	0.91	
Inspect hazard to the safety of flower garden	3.73	0.93	

Importance of the Exclusive area in safety aspect was 4.24 in average and the one of public area was 4.25 in functional aspect, which was higher than the importance

in functional and convenient/comfortable aspects. Importance of Exclusive area by each space was; inspection of balcony baluster 4.57, inspection of gas valve tightening 4.51, inspection of door lock 4.49, operation of sprinkler 4.49, while the one of public area was; operation of fire alarm system 4.54, operation of sprinkler 4.49, inspection of fire hydrant 4.49.

5. CONCLUSIONS

This research was conducted to draw the factors to be continuously maintained and managed for efficient management of apartment housing. Residents, managers and designers of apartment housing were surveyed for the purpose of research and the factors required by the residents were investigated and analyzed according to the results obtained. Results obtained by above described process can be summarized as below:

First, number of factors in the functional aspects was 48 item/40%, which was the most followed by safety aspect of 34 factors/32% and convenient/comfortable aspect, 34 factors/28%.

Second, residents realized high necessity of safety aspect both in the Exclusive area 65.85% and public area 64.97% and for the functional aspect, Exclusive area 53.73% and public area 56.33%. They realized the necessity of convenient and comfortable aspect in the Exclusive area 49.44% and public area 57.78%.

Third, according to the importance survey, the one of safety aspect was (Exclusive area 4.24 and public area 4.25), functional aspect was (Exclusive area 4.08 and public area 4.00), and convenient/comfortable aspect as (Exclusive area 3.97, public area 3.82), which was similar with the result of necessity survey.

This research revealed that maintaining safety and healthy and high quality living environment is critical in the management of apartment housing. Accordingly, proper management manual prepared complying with the requirements of the residents plays important role in the apartment housing management and better living environment. Therefore, future study should suggest the management standard of the factors that shall be managed by the residents themselves and need the assistance of management specialists and the method of management and maintenance in detail.

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