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MANAGING INDOOR FACILITIES IN PUBLIC HOUSING TO IMPROVE ELDERLY QUALITY OF LIFE

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ABSTRACT

The proportion of elderly persons aged 65 and over in Hong Kong is currently 13.3% and is expected to reach 26.5% by 2031. When experiencing failing health, most elders rely heavily on the indoor facilities available in public housing. However, most public housing is not purposely built for the elderly. To improve elderly quality of life (QoL), appropriate facilities should be provided. Hence, this paper aims to investigate the relationship between the indoor facilities management (FM) of public housing and elderly QoL by a questionnaire survey using the post-occupancy evaluation method. In order to understand the complicated relationships among FM and elderly QoL, reliability analysis, t-test, and correlation analysis were adopted. The results of the t-test and correlation analysis indicated that (1) FM components presented significant differences between old and new public housing; and (2) several FM components, such as distance, lighting, non-slip flooring, and doors, had a significant relationship with final elderly QoL in public housing. Based on the findings, several practical

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recommendations are proposed, including wide entrances with barrier-free access, the repositioning of power sources to seating or table level and installation of non-slip floors in the bathrooms, and handrails near bath cubicles, toilets, and beds.

Key words: Elderly; Facilities management; Public housing; Quality of life

Introduction

Hong Kong is facing the problem of a rapidly aging population. The total number of the elderly population in Hong Kong has exceeded 964,600, representing a proportion of 13.3% of the total population, which will reach 26.5% by 2031 [1]. The increasingly aging population is causing a sharp rise in the demand for elderly-friendly housing. According to a recent survey, 85% of the elderly in Hong Kong live in residential buildings, while more than 50% are living in public or subsidized housing [1]. However, most public housing is not purposely built for the elderly and provides sub-standard facilities. In fact, in their daily lives elders rely heavily on the facilities provided in the buildings, especially indoor facilities, because they spend most of their time at home [2]. Therefore, in order to improve elderly quality of life (QoL), indoor facilities in public housing need to be designed and operated in consideration of elders' specific requirements. Aside from services and assisting living devices that are important for elderly OoL, in general, other major indoor environmental factors including type and level of light, noise, temperature, humidity and so on that can affect such QoL regardless of elderly health conditions [3, 4].

To deliver a satisfactory living environment for the elderly, construction professionals should understand their special requirements and make appropriate planning and management decisions for facilities. Most research has focused on the building environment [5], but study of the impact of facilities management (FM) on QoL remains rare, especially in relation to the elderly. Thus this study aims to investigate the relationships between FM components in public housing and the overall QoL of the residential elderly. In order to achieve this aim, the post-occupancy evaluation method is adopted to evaluate elderly actual satisfaction with the FM components.

Facilities Management in Public Housing

FM is the process of delivering and sustaining functions in the building environment to meet strategic needs [6]. FM in public housing should consider the health and needs of the elderly, and provide a comfortable and convenient living environment for elderly residents. Indoor FM can be categorized as space planning, building services, and supporting facilities [7].

Space planning refers to the layout and design of the indoor living environment [8]. It includes the *allocation of spaces and areas* for daily living and the *distance* between functional rooms such as bedrooms, bathrooms, toilets, kitchens, and living rooms [3]. Appropriate space planning (both area allocation and distances) can utilize the limited indoor area and fulfil end-users' various requirements, including movement and social gatherings.

Building services serve the main functions of a building and fulfil the needs of the elderly. Lighting, ventilation, indoor air, noise, and electricity are considered building services components that affect the living environment of elderly residents [10]. The elderly are highly dependent on building services components to compensate their physical or cognitive frailties [3] and ensure better QoL.

Supporting facilities are used to support the daily life of elderly and improve their QoL [11]. FM components such as decoration, safety and security, non-slip floors, and handrail are classified as supporting facilities. As the elderly spend most of their time at home, the indoor decoration can increase their comfort and subsequently improve their psychological wellbeing [7].

Elderly Quality of Life

Quality of life (QoL) refers to the subjective evaluation of individual overall life satisfaction and wellbeing [12]. It is a multidimensional concept that consists of individual physical health, psychological state, and level of independence, social relationships, and their relationship to living environment [13]. For the aging population, their QoL includes not only their basic needs, but also psychological and social needs, and their health and safety. Hence, elderly QoL should include both personal (physical and psychological health) and social dimensions (relationships with family and neighbors, leisure/social activities, and environment) [3].

Due to the decline of their physical health and functions, the elderly tend to stay at home for much of the time and rely on facilities to support their daily life. Hence, living environment and facilities significantly influence elderly satisfaction and their QoL [10]. Investigation of the relationships between indoor FM components and elderly QoL in public housing can be used to support the elderly and subsequently improve their final QoL.

Research Methodology

Based on an extensive literature review of FM and elderly QoL, a questionnaire survey was designed comprising three parts: (1) background information, (2) FM components, and (3) elderly QoL (as summarized in Table 1). To measure FM components, post-occupancy evaluation (POE) was used. POE is the systematic assessment of FM components based on user satisfaction with the actual performance [14]. Elderly QoL is measured as the evaluation of the overall QoL and health.

All questionnaires were distributed purposively to elderly individuals aged over 60 who had lived in public housing for more than three months. Sixty respondents returned their questionnaire. The respondents were aged 61-65 (8%), 66-70 (37%), 71-75 (25%), 76-80 (18%), and over 81 (12%) (see Figure 1a). They are in bad (11.7%), normal (18%), good (32%), and very good (3%) health. Forty five percent of respondents were male. Eight percent of elders were uneducated, 37% had only finished secondary school education, and 55% had only primary school education. The public housing in which the respondents lived was built in different periods, the age of the buildings ranging from 120 (40%) to above 20 years (60%) (Figure 1b).

Table 1 : Summary of Indoor FM Components in Public Housing.

Space Planning		**Supporting Facilities**	
F1	Store area	F17	Convenience of windows
F2	Area of bathroom	F18	Design of door locks
F3	Distance between rooms	F19	Convenience of doors
F4	Distance between furniture	F20	Width of doors
		F21	Floor color
Building Services		F22	Wall color
F5	Taps	F23	Non-slip floor in kitchens
F6	Temperature of shower	F24	Non-slip floor in bathrooms
F7	Water yield of shower	F25	Indoor barrier-free
F8	Electrical appliances	F26	Handrails in toilets
F9	Location of power sources	F27	Handrails in bathrooms
F10	Location of switches	F28	Height of toilets
F11	Natural lighting	F29	Convenience of bath cubicles
F12	Artificial lighting	F30	Handrails near beds
F13	Indoor temperature	F31	Safety of furniture
F14	Natural ventilation	F32	Safety alarm services
F15	Artificial ventilation	F33	Emergency phones
F16	Indoor noise		

In order to investigate the complicated relationships between indoor FM components and elderly QoL, several statistical methods, including *t*-test and Pearson correlation, were adopted with the software SPSS version 20.0 [7]. *T*-test was adopted to compare the differences in FM components in public housing with different building ages. Pearson correlation was applied to investigate the complicated relationships between indoor FM components and final QoL of elderly in public housing.

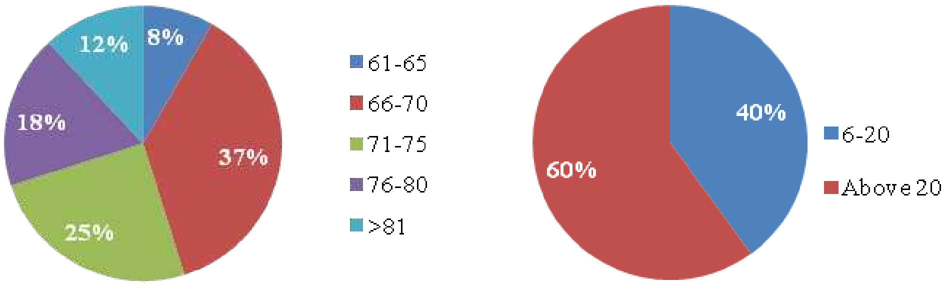

Figure 1 : (a) Elders of Different Ages. (b) Public Housing of Different Ages.

Results

T-test

FM components largely depend on the age of the building. To investigate different satisfaction levels of FM components in different public housing, the respondents were divided into two groups, (1) the elderly in new public housing with the building age of 1-20 years old, and (2) those in old public housing built more than 20 years ago. Independent samples *t*-test was used to compare the mean differences of FM components between the two types of public housing. The results showed that most FM components differed significantly between new and old public housing. As shown in Table 2, the mean values of store area (F1), area of bathroom (F2), distances between rooms (F3), and distances between furniture (F4) in the old buildings were significantly lower than in new buildings, with the mean difference of -0.667 (t=-3.886, p=0.000), -1.125 (t=-5.571, p=0.000), -0.583 (t=-3.317, p=0.002), and -0.528 ((F2: t=-3.442, p=0.000)). In terms of building services, the facilities of new public housing (1-20 years old) were significantly better than those of old housing (21-40 years old), with the exception of taps (F5) and natural lighting (F11). Supporting facilities, with the exception of handrails in bathrooms (F27), presented significant differences between old and new public housing.

Table 2 : Independent Samples t-test of FM components between different building groups

Factors			Building age	N	Mean	Mean difference	t	Sig.
Space planning								
F1	Store area	•••	> 20 1-20	36 24	3.75 4.42	-0.667	-3.886	0.000
F2	Area of bathroom	•••	> 20 1-20	36 24	3.33 4.46	-1.125	-5.571	0.000
F3	Distances between rooms	••	> 20 1-20	36 24	4.00 4.58	-0.583	-3.317	0.002
F4	Distances between furniture	•••	> 20 1-20	36 24	4.14 4.67	-0.528	-3.442	0.000
Building services								
F5	Taps		> 20 1-20	36 24	4.36 4.63	-0.264	-1.911	0.061
F6	Temperature of shower	••	> 20 1-20	36 24	3.81 4.33	-0.528	-3.182	0.002
F7	Water yield of shower	••	> 20 1-20	36 24	4.17 4.67	-0.500	-3.375	0.001
F8	Electrical appliances	••	> 20 1-20	36 24	4.33 4.79	-0.458	-2.706	0.009
F9	Location of power sources	••	> 20 1-20	36 24	4.31 4.75	-0.444	-3.197	0.002
F10	Location of switches	••	> 20 1-20	36 24	4.36 4.75	-0.389	-2.742	0.008
F11	Natural lighting		> 20 1-20	36 24	4.25 4.54	-0.292	-1.521	0.134
F12	Artificial lighting	••	> 20 1-20	36 24	4.31 4.75	-0.444	-3.197	0.002
F13	Indoor temperature	••	> 20 1-20	36 24	4.17 4.63	-0.458	-2.669	0.010
F14	Natural ventilation	••	> 20 1-20	36 24	4.06 4.67	-0.611	-3.517	0.001
F15	Artificial ventilation	•••	> 20 1-20	36 24	4.20 4.75	-0.550	-4.173	0.000
F16	Indoor noise	•	> 20 1-20	36 24	4.19 4.58	-0.389	-2.144	0.036
F17	Convenience of windows	•	> 20 1-20	36 24	4.47 4.79	-0.319	-2.567	0.013

Table 2 : Independent Samples t-test of FM Components between different building groups (continued)

Factors			Building age	N	Mean	Mean difference	t	Sig.
Supporting facilities								
F17	Convenience of windows	•	> 20	36	4.47	-0.319	-2.567	0.013
			1-20	24	4.79			
F18	Design of door locks	•	> 20	36	4.47	-0.319	-2.244	0.029
			1-20	24	4.79			
F19	Convenience of doors	•	> 20	36	4.53	-0.264	-2.121	0.038
			1-20	24	4.79			
F20	Width of doors	•••	> 20	36	3.52	-0.897	-4.579	0.000
			1-20	24	4.42			
F21	Floor color	•	> 20	36	4.19	-0.514	-2.601	0.012
			1-20	24	4.71			
F22	Wall color	••	> 20	36	4.17	-0.583	-3.338	0.001
			1-20	24	4.75			
F23	Non-slip flooring in kitchens	•	> 20	36	3.42	-0.792	-2.647	0.010
			1-20	24	4.21			
F24	Non-slip flooring in bathrooms	••	> 20	36	3.67	-0.708	-3.173	0.002
			1-20	24	4.38			
F25	Barrier-free access		> 20	36	4.44	-0.264	-1.916	0.060
			1-20	24	4.71			
F26	Handrails near toilets	•	> 20	36	3.58	-0.583	-2.599	0.012
			1-20	24	4.17			
F27	Handrails in bathrooms		> 20	36	3.64	-0.444	-1.851	0.069
			1-20	24	4.08			
F28	Height of toilets	••	> 20	36	4.17	-0.542	-2.961	0.004
			1-20	24	4.71			
F29	Convenient of bath cubicles	•••	> 20	36	3.61	-0.764	-4.315	0.000
			1-20	24	4.38			
F30	Handrails near beds	••	> 20	36	3.97	-0.611	-2.994	0.004
			1-20	24	4.58			
F31	Safety of furniture	••	> 20	36	4.25	-0.500	-3.479	0.001
			1-20	24	4.75			
F32	Safety bells	•	> 20	36	4.33	-0.362	-2.414	0.021
			1-20	24	4.70			
F33	Emergency calls	••	> 20	36	4.00	-0.895	-3.829	0.001
			1-20	24	4.89			

Note: ••• - significance value less than 0.001; •• - significance value less than 0.01; and •- significance value less than 0.05.

Pearson Correlation

Pearson correlation was conducted to investigate the interrelationship between the 33 FM components and final elderly QoL in public housing. The results indicated that one FM component in space planning, distances between rooms, was positively related to elderly QoL and health at a high significance level of 0.000. Among building services facilities, taps (F5), temperature of shower (F6), electrical appliances (F8), location of switches (F10), natural lighting (F11), artificial light (F12) and indoor temperature (F13) were positively related to elderly QoL at the significance level of 0.000. Most supporting facilities, with the exception of safety bells (F32) and emergency calls (F33), were significantly related to elderly QoL; and convenience of windows (F17), design of door locks (F18), convenience of doors (F19), non-slip flooring in bathrooms (F24), barrier free access (F25), handrails near toilets (F26), handrails in bathrooms (F27), and safety of furniture (F31) were positively related to overall health at the significance level of 0.000 (see Table 3).

Discussion

From the early 1950s to the present, the design of the public housing in Hong Kong has changed. The early public housing was mainly built in 'Mark I–VI' and 'slab' forms, while the new public housing is mainly built in 'harmony', 'concord', and 'new cruciform block' forms (see Figure 2). Facilities in the old and new public housing are also different and exert diverse impacts on elderly QoL.

(a) (b)

Figure 2 :. Public housing block types: a) old public housing; b) new public housing

This study compared different FM components in old and new public housing and investigated the relationships between FM components and overall elderly QoL and their health. The results are illustrated in Figure 3. This study focused on the indoor facilities which have relationship with elderly QoL at the 0.001 significance level and those facilities presenting significant difference between old and new public housing at the 0.01 significance level.

Table 3 : Correlation between FM Components and Elderly QoL.

Factors		t-test	Overall QoL	Overall health
Space planning				
F1	*Store area*	•••	0.294*	0.213
F2	*Area of bathroom*	•••	0.218	0.140
F3	***Distances between rooms***	••	**0.545***	**0.460***
F4	*Distances between furniture*	•••	0.405**	0.223
Building services				
F5	**Taps**		**0.489***	0.215*
F6	***Temperature of shower***	••	0.421**	**0.437***
F7	*Water yield of shower*	••	0.434**	0.164
F8	***Electrical appliances***	••	**0.683***	**0.487****
F9	*Location of power sources*	••	0.031	-0.062
F10	***Location of switches***	••	**0.714***	**0.519***
F11	**Natural lighting**		**0.596***	0.343**
F12	***Artificial lighting***	••	**0.596***	**0.523***
F13	***Indoor temperature***	••	**0.465***	0.385**
F14	*Natural ventilation*	••	0.251	0.201
F15	*Artificial ventilation*	•••	0.274*	0.122
F16	Indoor noise	•	0.229	0.031
Supporting facilities				
F17	**Convenience of windows**	•	**0.631***	**0.503***
F18	**Design of door locks**	•	**0.647***	**0.591***
F19	**Convenience of doors**	•	**0.627***	**0.507***
F20	**Width of doors**	•••	**0.484***	**0.372**
F21	**Floor color**	•	**0.58***	**0.436**
F22	***Wall color***	••	**0.531***	**0.363**
F23	**Non-slip flooring in kitchens**	•	**0.445***	**0.373**
F24	**Non-slip flooring in bathrooms**	••	**0.556***	**0.496***
F25	**Barrier-free access**		**0.512***	0.433**
F26	**Handrails near toilets**	•	***0.573****	***0.469****
F27	**Handrails in bathrooms**		**0.550***	**0.538***
F28	***Height of toilets***	••	**0.453***	0.365**
F29	***Convenient of bath cubicles***	•••	**0.659***	0.417*
F30	***Handrails near beds***	••	**0.482***	0.280*
F31	***Safety of furniture***	••	**0.748***	**0.502***

Note: *t*-test results (•, ••, •••) refer to Table 2; * Correlation is significant at the 0.05 level (two-tailed); ** Correlation is significant at the 0.01 level (two-tailed); *** Correlation is significant at the 0.001 level (two-tailed); **xx** FM components were related to elderly QoL at 0.001 significance level; and xx – FM components had significant differences at 0.01 level.

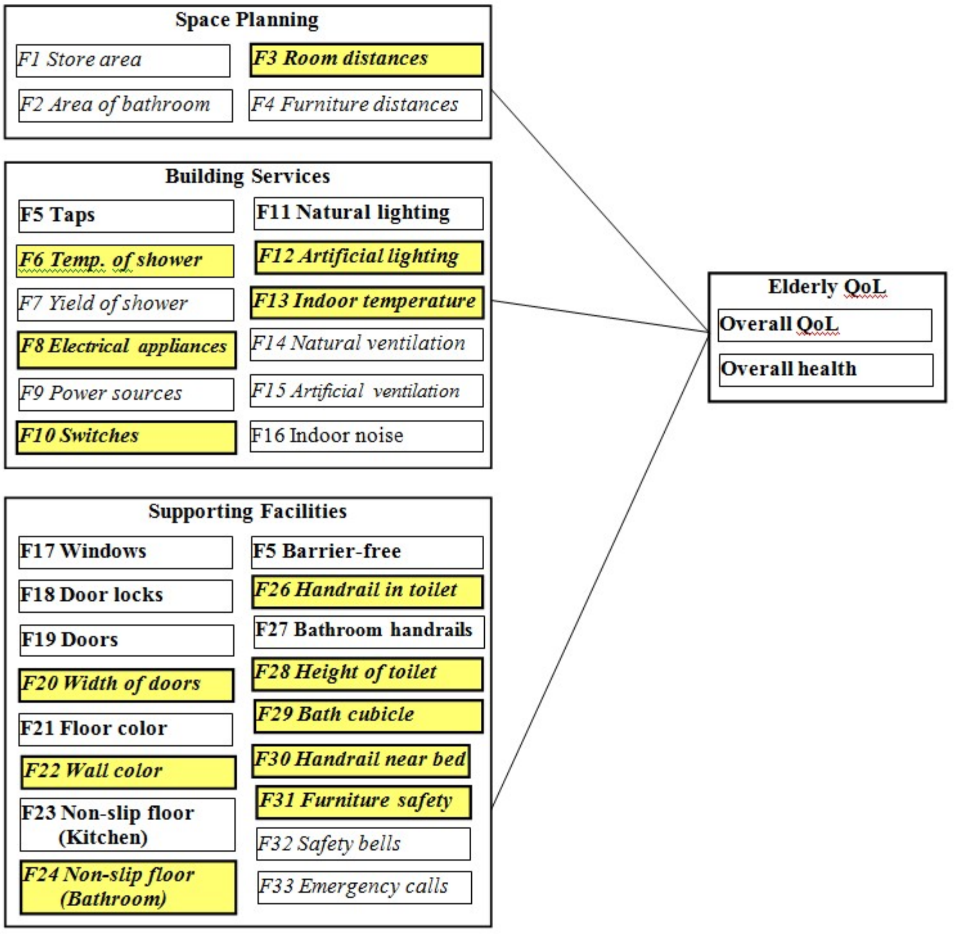

Figure 3 : Relationships between FM Components and Elderly QoL in public housing.

Note: Refer to Table 3 for the relationships;

—— positive linear significant relationship – shown in correlation;

xxx variables presented significant differences between old and new buildings;

xxx variables had positive relationships with final elderly QoL;

xxx variables had relationship with final QoL and significant differences.

One of space planning components, indoor *distances* between different rooms, relates positively to elderly QoL. Appropriate space planning provides sufficient living spaces for the elderly and supports their social gatherings with family and friends [15]. The results also reveal that distances between rooms differ between old and new housing. Current senior housing provides sufficient areas in consideration of the special needs of the elderly, especially those in wheelchairs. The elderly living in sufficient spaces with practical distance can move around and live more independently, which leads to better QoL.

From the aspect of building services, temperature of shower and indoor temperature differed significantly in old and new public housing, and also related to overall elderly QoL and health. Since the elderly experience a decline in heat storage capacity, e.g., due to changes in metabolism and (reduction of) the fat layers under skin, it is easy for them to get hypothermia and infections [16]. To maintain elders' health, several new public housing buildings are installed with a single lever-type mixer to provide stable hot water for seniors. Along with increased age, the physical function and the height of the elderly are changing. It is inappropriate to install electrical appliances, power sources, and switches too high or too low. Moreover, elders also experience significant deterioration of vision. *Sufficient lighting* supports the residential elderly living more conveniently and comfortably, meeting their needs and subsequently increasing final QoL [17].

Among supporting facilities, the width of doors had positive relationship with final elderly QoL. In public housing built more than 20 years ago, the doors are too narrow, particularly for the elderly with walking assistance and wheelchairs, while elders living in new public housing are more satisfied with the width of doors. Moreover, the color of indoor decoration (including wall and floor color) can improve the comfort of the elderly and influence their health and QoL [18].

To avoid the risks of falling and collision, the *non-slip floor* is installed in bathrooms and toilets and exerts a positive impact on final elderly QoL. The elderly also prefers to live independently and go to the bathroom by themselves [5]. Hence, in the new public housing, handrails are installed in the toilet and bathrooms to help elderly and disabled persons to use the facilities. Moreover, the height of toilets and the design of bath cubicles should also be flexible due to changing physical conditions and special requirements. *Furniture safety* also secures the safety and health of elders by protecting them from various accidents.

Recommendations

Practical Implementation

Based on the current results, several practical recommendations can be made regarding the facilities management of public housing in order to respond to elders' specific requirements. Indoor distances between different rooms (e.g., bedroom, living room, dining room, and toilet) should not be too great in consideration of elders' decreasing physical health. The route between bedroom and toilet should be short and obstacle free.

The designers and facilities managers of public housing are urged to install lamps with fewer glares to ensure sufficient artificial lighting. Power sources and switches should

be located at seating or table level for easy access. It is also important for elders' health to maintain a stable indoor temperature in both bedrooms and bathrooms. The temperature should be in the range of 18 and 23 degrees Celsius [10].
The doors should be wide enough to allow elders in wheelchairs to pass through [9]. Heaters should provide stable hot water. Non-slip floors should also be installed, especially in bathrooms and toilets, in order to reduce falling accidents. To ensure the safety of the elderly, handrails should be fixed in toilets, bathrooms, and near beds, so that they can walk and move more safely and satisfactorily.

Further Research

Although the positive relationships between FM components and final elderly QoL have been confirmed, there are still other factors influencing elderly QoL, such as the building's age and the types of financial support available. Even the location of the building, for example distance from public transit, can affect QoL [18]. The current study has provided a platform for more detailed research to further investigate design and FM in public housing. A large-scale survey on the FM of public housing for the residential elderly is strongly recommended. Moreover, to cross-validate the results of quantitative data analysis, qualitative research methods such as on-site measurement and personal interviews are also suggested.

The current study has several practical implications for facilities management in public housing. However, specific guidelines are still lacking. Further investigation into more specific and technical requirements of FM components is needed. To determine FM guidelines, holistic comparison of FM practices in different countries is strongly recommended. In particular, a follow-up study to understand the current practice and future trends/directions in this field other countries, such as United States and United Kingdom, is highly desirable. Building information modeling (BIM) [19] should also be used in the design of elder-friendly buildings with specific FM guidelines.

Conclusion

Nearly half of the elderly in Hong Kong live in public housing. To ensure elderly QoL, FM in public housing, especially the indoor facilities, should meet the expectations of residential elderly. This paper investigated the relationship between indoor FM components and elderly QoL. Based on an extensive literature review, 33 indoor FM components have been classified into three major categories: space planning (including store area, bathroom area, distances between rooms and furniture), building services (taps, temperature and water yield of shower, location of power sources, electric appliances, and switches, natural lighting, artificial lighting, indoor temperature, natural and artificial ventilation, and indoor noise), and supporting facilities (windows, doors, door locks, width of doors, non-slip flooring in kitchens and bathrooms, furniture safety, wall color, floor color, barrier-free access, bath cubicles, toilets, handrails in toilets, bathrooms, and bedrooms, safety bells, and emergency bells).

As type and quality of facilities depend heavily on the age of the building, this paper compared the FM components in both new and old public housing built between 1 and 20, and more than 20 years ago, respectively. The current results indicated that (1) FM components in old and new public housing differ significantly; and (2) several FM components, such as distance, lighting, non-slip floors, and doors, had a significant relationship with final elderly QoL in public housing. To improve elderly QoL, several practical recommendations are made, including short and obstacle-free distances between different rooms, wide doors to allow wheelchair passage, non-slip flooring installed in bathrooms and toilets, and handrails installed near toilets, bath cubicles, and beds. Moreover, this paper also provides a platform for further large-scale and case study to develop a holistic FM model for the elderly in public housing. BIM is also suggested for the design of elder-friendly residential buildings.

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