




## Article

# The Design of Local-Authority Rental Housing for the Elderly That Improves Their Quality of Life

Yukiko Kuboshima \* , Jacqueline McIntosh  and Geoff Thomas 

School of Architecture, Victoria University of Wellington, Wellington 6011, New Zealand;

Jacqueline.McIntosh@vuw.ac.nz (J.M.); Geoff.Thomas@vuw.ac.nz (G.T.)

\* Correspondence: Yukiko.Kuboshima@vuw.ac.nz

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**Abstract:** As the population ages, the demand for suitable rental housing will increase. Suitable housing means housing that can accommodate those impairments that typically correspond with ageing. This paper explores the quality of life (QoL) requirements of those elderly with high-care needs who live in rental housing. Using a qualitative case study approach, it examines the living experiences of six elderly people who need assistance and are living in local-authority rental housing in New Zealand. The themes of QoL were identified from the literature and related to the larger themes of; 1. Activities and independence, 2. Sense of control, 3. Privacy, 4. Relationships, 5. Quality of care, and 6. Comfort. The survey consisted of a detailed documentation of the physical environment, followed by interviews with and full-day observations of the residents and their caregivers. The study finds that the design of housing that improves their QoL requires solutions to accommodate the various conflicting needs for their QoL that include those derived from the diversity in the user's preferences and impairments. In the design of rental housing, there is greater need for additional or reorganized space to accommodate caregivers and visitors, maintain residents' independence, privacy, and other aspects important for their QoL.

**Keywords:** elderly; quality of life; housing design; rental housing; high care needs; post occupancy evaluation; qualitative research

## 1. Introduction

The ageing population is increasing both in the proportion and in the number of people over 65 living in New Zealand, as well as many other developed countries. As people age, they have a greater propensity for impairment and difficulty performing everyday tasks. In addition, psychological concerns such as insecurity and loneliness also become more prevalent [1,2]. At some point, typically in their 70s or later, these factors may induce them to seek a more suitable dwelling [3]. Some consider moving closer to their children; however, most New Zealanders prefer to avoid 'being a burden' [4]. To accommodate the projected rapid growth in the older people with high care needs [5], there is an increasing need for housing that supports those who require assistance to live independently. 'Ageing in place' can provide a greater quality of life (QoL) for the elderly [4] and for this reason it is promoted by the New Zealand government and internationally [6], increasing the demand for housing that enables those elderly with high-care needs to live as independently as possible.

Currently, in New Zealand, there are three main types of housing that provide some level of care and assistance to the elderly; retirement villages, public-sector housing (central government housing and local-authority housing), and private-sector rental housing, which includes community providers and religious and charitable groups. While retirement villages offer company and security and reduce concerns about home maintenance and care, they are only viable options for homeowners and those relatively well-off [7]. The demand for rental housing by the ageing population is projected

to increase rapidly, influenced by the decline of levels of homeownership [8–11]. In response, recent government initiatives are seeking to address this situation, by encouraging community housing sectors to grow [12].

Rental housing tends to be less suitable for those elderly with disabilities, in terms of the provision of care and support, and access and facilities for the disabled when compared with housing in retirement villages [13]. While a high proportion of residents receive personal care in rental housing, the current rental housing generally fails to accommodate those with higher levels of dependency [14]. There is a growing demand to provide physical environments that facilitate the high-needs elderly to live independently in rental housing.

The quality of life of high-needs older people has been studied by many researchers [15,16]. Common themes include needs for independence, activities, relationships, identity, and quality of care. With increased needs for assistance, privacy is also an issue for those receiving care, both in a facility and at home [1,17]. In addition to the general effects of ageing, it has been reported that living in rental housing has a negative impact on resident QoL [18–20]. For example, they have less autonomy in making modifications to their dwelling to make it suitable for their use, compared with homeowners [18]. With these two factors in mind, there should be careful consideration of the design of rental housing in order to provide the high-needs elderly with greater QoL.

Post Occupancy Evaluation (POE) refers to the assessment of how buildings are used to support buildings' environmental performance and occupant wellbeing and productivity [21,22], which 'provides evidence of a wide range of environmental, social and economic benefits core to sustainability [22] (p. 6)'. POE has been conducted in various building types, commonly on public buildings such as schools, but on housing as well [23,24]. Increasingly the significance of POE has been recognized internationally. For example, POE has been introduced into the curriculum of many architecture schools in the UK [25] and the Institute of British Architects called on all central government-funded projects to commit to POE in 2017 [26]. In New Zealand, POE has been conducted for public educational buildings since 2015 [27]. It has also been reported that design professionals' interest in POE is growing in large architecture firms in the US and Canada [28]. While systematic approaches have been sought, a range of approaches and methods are currently used to carry out POE, depending on the focus of the particular outcome and range from data monitoring and quantitative evaluation to the qualitative surveys of occupants [22].

This paper focuses on QoL for the high-needs elderly who live in local-authority rental housing specially built for the elderly in the Wellington region in New Zealand. This research examines how the physical environment supports or undermines their independent life with high QoL, which provides evidence and directions for the effective design of rental housing for a sustainable society with a growing ageing population.

## 2. Method

An ethnographic case study was conducted for six elderly people who need assistance in daily life and are living in senior housing complexes in the Wellington Region of New Zealand. Ethnography is a qualitative method that has a great deal of potential in post-occupancy studies and many uses in architecture and the built environment [29]. Inclusion criteria were those who received assistance from a professional caregiver, were more than 70 years of age, and were interested in participating in the survey. Participants were selected through a questionnaire for the elderly which formed part of a prior study of housing options for those with high care needs. The survey consisted of: 1. documentation of the physical environment of the house; 2. semi-structured interviews with the elderly residents and their caregivers; and 3. personal observations of the residents during a full day, including unstructured interviews and informal conversation. Ethics approval was obtained from Victoria University Human Ethics Committee [Approval number: 23243]. For the focus of this study, six elderly people who lived in local-authority rental housing were selected for analysis (Table 1). Through the analysis of transcribed interviews and observation notes, the themes that emerged were coded in relation to

broader QoL themes. For each theme, similarities and differences among the cases and the reasons of them were analyzed and relevant design themes were identified. Integrating the results and the design considerations of housing for the elderly that improve their QoL are discussed.

### 3. Themes for QoL

Through analysis, sub-themes were identified and related to the larger themes of; 1. Activities and independence, 2. Sense of control, 3. Privacy, 4. Relationships, 5. Quality of care and 6. Comfort, which is described in this section.

#### 3.1. Activities and Independence

##### 3.1.1. Circulation and Space for Movement

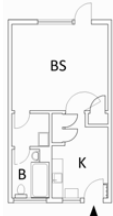
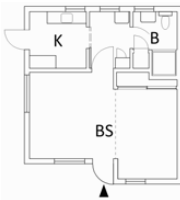

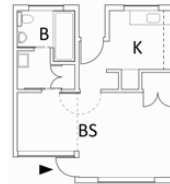
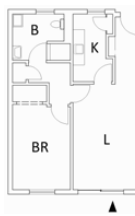

All residents wanted barrier-free environments. They experienced difficulties in moving with their walker frames (Residents 1, 5) and felt pain when going up and down the steps (Resident 3). Residents 1, 5, and 6, who did not always use an aid indoors, needed to hold walls, furniture and fixtures to maintain balance while walking. Resident 2, who was dependent on a trolley for support with walking, had to be very careful when moving with hot drinks or soup on the trolley over the connection between different floor materials, some of which had less than a centimeter level difference. Putting low tables in the middle of the room could result in a fall (Resident 6). There should be enough space both for walking and for furniture layout along the wall.

For outdoor mobility, Resident 1 had trouble going down three steps with a walker frame to the roadway to get on a taxi. Resident 2 experienced difficulty passing through the exterior swing door with a threshold while holding the trolley, while Resident 6, who could hold the walker frame over the same level difference, did not have trouble in getting in and out. Resident 5 had a sliding door at the unit entrance; however, there was a big level difference just out of the door, which was difficult for the resident to step out with a walker frame. To mitigate the inconvenience, a step (a brick) was installed to fill the level difference.

Vehicles were also used by some residents. Resident 2 used a mobility scooter, which was stored in the unit. To reach the scooter, the resident had to use the trolley to get close enough to transfer from the trolley to the scooter, then turn the scooter around to exit. Resident 3, used a bicycle, but had to store it on an exposed concrete deck. Accessible under cover storage is desirable for these mobility aids.

There were differences in the suitability of the physical environment depending on the types/levels of impairment, which, in turn, related to requirements for aids/vehicles for moving indoors and outdoors. The differences included the need to hold walls when walking and the extent to which barrier-free interventions were needed. Corridor and passageway widths should be considered in terms of walls and furniture required to support walking. Design for accessibility should be carefully considered in the door design, as well as floor design in both interior and outdoor spaces.

**Table 1.** Basic information on residents and settings.

Cases	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
<b>Resident</b>						
Age group	80–84	70–74	75–79	75–79	85–89	85–89
Levels of dependency	High (DS <sup>1</sup> = 7)	High (DS = 4)	Low (DS = 2)	Low (DS = 1)	High (DS = 4)	Low (DS = 0)
Types of impairment	Arthritis (legs) Had operations in knees and shoulders.	Post stroke (has left hemiplegia, the right hand shakes) Pain/arthritis (shoulder, back)	Diabetes Pain/arthritis (knees) Had hip replacement Pancreatitis	Spinal conditions Pulmonary conditions Pain/arthritis (shoulder)	Pain/arthritis (legs/knees)	Arthritis (legs) Cataracts Post stroke (currently few aftereffects remain)
Required assistance	Bathing Dressing Personal hygiene Put on/off compression stockings Household tasks	Bathing Personal hygiene Put on/off compression stockings Household tasks	Bathing Personal hygiene Household tasks	Bathing Household tasks	Bathing Dressing Household tasks	Household tasks
Mobility aid	Walker frame (in/outdoors)	Trolley (indoors), mobility scooter (outdoors)	Walker frame and bicycle (outdoors)	None	Stick (indoor), walker frame (in/outdoors)	Walker frame (in/outdoors)
Years of residence	26	9	9	7	17	7
<b>Setting</b>						
Unit type <sup>2</sup>	Bedsit B	Bedsit A	One-bedroom	Bedsit A	One-bedroom	One-bedroom
Building type	Apartment (outdoor access)	Semi-detached (outdoor access)	Semi-detached (outdoor access)	Apartment (outdoor access)	Apartment (outdoor access)	Semi-detached (outdoor access)
Unit size	32 m <sup>2</sup>	35 m <sup>2</sup>	41 m <sup>2</sup>	32 m <sup>2</sup>	45 m <sup>2</sup>	42 m <sup>2</sup>
Unit plan <sup>2</sup>						
Communal room	No	Yes	No	Yes	No	Yes

<sup>1</sup> DS ('Dependency Score'): For each person, six activities (bathing, dressing, personal hygiene, moving indoors, moving from bed to wheelchair/chair and eating) were given the scores of 0–2 or 0–3, according to the degree of assistance they receive. They were given a 'Dependency Score,' the total of the six scores for each activity. <sup>2</sup> Bedsit units are divided into two types; the bed area and the lounge being separated by the curtain (A) and otherwise (B). <sup>2</sup> Abbreviations used in the plans stand for; L: lounge, BR: bedroom, BS: bedsit, B: bathroom, K: kitchen.

### 3.1.2. Spaces for Sitting and Various Activities

All participants sat most of the time on a chair in their lounge/bedsit space, except for one resident, who spent his time mostly in his bedroom lying on a bed or sitting at desks (Resident 5). Four of them used an armchair, which allowed them to rest in their most comfortable posture and to adjust their leg and back position. Resident 4 mainly sat on an unpadded side chair at the table in the lounge part of his bedsit, which allowed him to sit straight, and by doing so he could avoid spinal pain.

While there were common activities for all in the sitting space such as watching TV, other activities varied depending on preferences. For example, Residents 2, 3, 4, and 5 liked playing games or messaging with their PC, while Residents 1 and 6 liked knitting, reading and/or crosswords, for which the space was used differently. There were also differences in activities, depending on the level/type of impairment. Residents 2, 4, and 5 sat at the PC desk for playing computer games or emailing/online chatting. Sitting at the desk was particularly necessary for Resident 2 to support a paralyzed left arm, while Resident 3 could operate his laptop putting it on the armrest of the armchair. Some residents also liked to see outside, which gave them chance to talk to neighbors (Residents 2, 4, and 6). Feelings of keeping occupied were important for them. Resident 3 could carry out multiple activities while sitting in the armchair such as looking at a PC that was put on the armrest for playing games while hearing was mostly attuned to the TV. For the various activities to be carried out from the sitting space, there were level surfaces within their reach such as tables, a kitchen bench, or shelves (including those under a kitchen bench and those of a trolley). These were essential to accommodate various things such as glasses, phones, remote controls, medicine, cups of tea, mail, pens, and papers.

The spatial organization of sitting spaces should allow a layout with an armchair and immediately adjacent tables and shelves to keep things within reach. The design of these spaces should also facilitate residents' various activities including watching TV. In particular, space that accommodates a table as well as a chair is necessary for high-dependency elderly with limited posture options.

## 3.2. *Sense of Control*

### 3.2.1. Ease of Maintenance, Keeping Space Clean and Tidy

It was important for residents to keep their spaces clean and tidy to maintain their sense of control. Resident 3 had many shelves at various heights within reach, which were very useful. However, Residents 1, 2, 4, and 6 did not have enough shelves and filled an adjacent table with necessary things; two of them did so in a less organized way as well as on the floor near their chair. They wanted more shelves at an appropriate height near their chair. Higher shelves were rarely used by those with higher levels of impairment, because they could only reach the front of the shelf and could not use a step ladder to reach the rear area of the shelf. Resident 2, whose hands shook, often spilt liquids (tea/soup) and did not like carpet, which stained easily and was never cleaned, even by the home-helper.

Difficulties in keeping the space clean and tidy varied depending on the types/levels of impairment. There should be consideration with regard to the interior elevation that provides shelves and storage of appropriate height and depth. Greater consideration of maintenance and cleaning with respect to floor materials is also required.

### 3.2.2. Control over Visitors

All six participants experienced a sense of control when they could see visitors were coming before they actually arrived. Each had a view of the doorway from their sitting space; however, there were differences in the extent to which the view of the visitors was restricted before they actually arrived, depending on the spatial layout. Three residents had lounge spaces facing the front of the dwelling with a view to a long driveway and liked that they could see who was coming (Residents 2, 3, and 6). Particularly Residents 3 and 6, who had enough distance between the unit and the pathway could have time to mentally prepare for having guests. However, Resident 1, whose lounge did not face the front, could only see who was coming through the window next to the front door at a distance

just before they arrived. Residents 1 and 2, who had limited mobility, often invited visitors in while remaining seated, calling out a greeting and invitation to ‘Come in.’ Resident 5, who spent their time mostly in the bedroom, could not see nor hear the visitor arrive. For those with mobility issues, there should be a clear line of sight from the sitting space to the door, as well as sufficient proximity for a visitor to hear their greeting and welcome through the door.

### 3.3. Privacy

#### 3.3.1. Privacy against Passers-By

When there was insufficient space between the dwelling unit and pathway, some residents felt a loss of privacy (Resident 1) and would shut the curtain (Resident 2) because ‘people can easily look inside’. This was not a worry of others such as Residents 3, 5, and 6 who had no path nearby where many people could pass by. Privacy concerns are particularly important in small dwellings where many people can pass by in close proximity. Resident 4 also criticized the path layout in his site that allowed public access through the site late at night, despite the notice of ‘No Public Access’.

#### 3.3.2. High Privacy Needs for Incontinence

Resident 2 had high privacy needs related to incontinence. When the lead researcher was situated near the sitting space for the observation part of the survey, the resident tried to hide and pass water in the next room (approx. 3 m away); however, they were unable to reach the privacy of this room in time and passed water near the armchair. Resident 3 also mentioned frequent toileting at night (every 2 h); however, this did not impact on privacy. There should be consideration in the spatial design of spaces for highly dependent people that meet the special needs for privacy related to issues such as incontinence.

### 3.4. Relationships

#### 3.4.1. Socializing through Communal Activities

Residents 1, 4, and 6 were fond of socializing and maintaining relationships with others; they actively engaged in various kinds of social activities such as personal hobby groups and social gatherings in council housing complexes. One of them wished for a community room in their own site. In contrast, Resident 2 did not attend any communal activities organized for residents because of concerns with incontinence. Residents 3 and 5, who had no organized activities nor any communal space in the complex where they lived, did not wish for them, because they preferred to keep in touch with other residents more personally. Differences in the manner of socializing with others can be affected by impairment as well as personal preferences.

#### 3.4.2. Space for Having Guests

All residents had visits from families and friends, which was important for them. Residents 1 and 4, who had only a bedsit space, did not have opportunities to have guests stay the night. One of them wished for a separate lounge because the room was ‘more like a bedroom’. Resident 2 wished for a solid wall rather than a curtain between the sitting space and the bed space for improved privacy. Resident 3 living in a one-bedroom unit liked the layout of their space with a dedicated private bedroom. Resident 5 used the lounge only when guests visited, but he appreciated having it. Resident 6 liked the idea of having a second bedroom for a visitor to stay. To accommodate a larger number of day-time visitors, Resident 6 used the open lawn space leading out from her lounge.

### 3.5. *Quality of Care*

#### 3.5.1. Spaces for Assisted Showering

Five residents had a bathroom with a step at the entrance. (Resident 6 had a shower area with no level difference, and did not require assistance in showering.) Residents 1 and 4 had a bathtub with an overhead shower attached to the wall. These factors increased their caregiver's labor when assisting the mobility-impaired residents to bend forward and draw water with a bucket, as well as increasing the resident's risk of falling. Residents 3, 4, and 5 had a small, enclosed shower booth with a step at the entrance (less than 1-m square). This was not preferred by the caregiver because it was not big enough for her to go in to assist with washing. Bathroom size was also problematic for Resident 1 as it did not have enough space for drying with a caregiver's assistance. For assisted showering, sufficient space is required for a caregiver both for washing and for drying off.

#### 3.5.2. Independence and Privacy in Assisted Showering

The amount of assistance required for showering varied by level of impairment. All residents wanted to do as much as possible themselves during showering to keep their independence and privacy. Resident 3, who only needed assistance in washing their legs and back and in drying, undressed themselves by their armchair before the caregiver arrived, then washed themselves in the shower with the curtain closed before requesting assistance, to maintain privacy. Resident 5 also shut the curtain during washing except for when he required assistance in washing his back. Their caregiver said that it was important 'for their dignity.' Resident 1, who required assistance in every activity associated with showering except for undressing, could have had greater independence and privacy if the shower type was not the one attached to the wall. A detached hose-type shower could have allowed them to wash private areas independently.

Special consideration of the fittings, furnishings and fixtures in the shower area is required for elderly people with mobility impairments. In addition, consideration should be given to the design of showering areas so as to allow the caregiver to keep out of the sight of residents for their privacy and dignity. The proximity of the space used for undressing to the bathroom is also important for improving privacy.

### 3.6. *Comfort*

#### Warmth and the Sun

Residents 1, 2, and 5 felt their units were cold. Particularly Resident 5 complained about coldness, even when using his own electric heater, which encouraged him to stay in the bed rather than sit. On the contrary, Resident 3, who had a heat pump, did not feel cold. Resident 1's caregiver commented on the importance of insulation in the walls. A carpet was preferred by many residents to a vinyl floor, because it was warmer (Residents 1, 3, 4, 6).

Sunshine was important for warmth as well as brightness for all residents; however, access to sunlight varied due to both issues related to their impairments as well as spatial design. Resident 2 opened the curtains only when it was sunny, because of high privacy needs resulting from health concerns. Resident 6, who had an issue with eyesight, had to be careful not to expose their eyes to the sunlight. Glare and reflection on the TV and PC screens limited access to natural light for Resident 3, who found it necessary to shut one of the curtains during the daytime. In the design and placement of windows, there is a need to meet both enhanced requirements for privacy as well as controlled access to sunlight to limit glare on TV/computer screens. The trees near resident's units and unit layout also affected sunlight. Resident 4 complained that tall trees planted in the north aspect from the unit blocked the sun and desired smaller trees. Resident 5, whose unit faced the west, also desired to get more sun, which was blocked by other blocks of three-story apartments. On the contrary, Resident 1

could fully enjoy the sun without any obstacles. The porch facing the north was used by one resident to sit in the sun in summer (Resident 1).

#### 4. Design Considerations

For each sub-theme for QoL, similarities and differences for three cases were analyzed qualitatively and the relevant design issues for each of the themes for QoL were distilled and summarized in Table 2.

**Table 2.** Analysis of themes for Quality of Life (QoL) and relevant design themes.

Themes for QoL	Similarities	Differences <sup>1</sup>	Design Themes
Independence and activities			
Circulation and space for movement	Desire for environments with no level changes	(I) Assistance requirements for walking (I) Suitable storage space for mobility vehicles (P) Walkability	Spatial organization (interior/exterior) Floor design Door design
Spaces for spending most of the time and various activities	Preference for spending most of the time sitting or lying	(I) Type of chair (P) Kinds of space required for varied activities (I) Required seating configuration for activities	Spatial organization (interior)
Sense of control			
Ease of maintenance, keeping space clean and tidy	Preference for shelves of appropriate height and depth	(I) Preferences for floor finishes (floors to be cleaned easily). (I) Ability to access to storage	Flooring design Storage design Interior elevation design
Control over visitors	Preference for a view to the door from their sitting space	(I) Requirements for the view and proximity to the door	Spatial organization (interior/exterior) Exterior elevation design
Privacy			
Space for privacy against passers-by	-	-	Spatial organization (interior/exterior) Exterior elevation design Path layout
High privacy needs for incontinence	-	(I) Degrees of privacy needs depending on the health issue	Spatial organization (interior/exterior)
Relationships			
Socializing through communal activities	-	(I,P) Ways of socializing with others	Communal space
Space for welcoming visitors	Preference for the separation of bedroom from the lounge	(P) Number of visitors and manners of accommodating guests	Spatial organization (interior/exterior)
Quality of care			
Space for assisted showering	Need for an accessible shower area and space for caregivers to assist washing and drying	-	Size of space (shower area) Types of shower and the area
Independence and privacy in assisted showering	Wish to do as much as they could by themselves	(I) The amount of the assistance required	Equipment/fixture Spatial organization (shower area)
Comfort			
Warmth and the sun	Preference for warmth and the sun	(I,P) The degree of sunlight preferred	Spatial organization (interior/exterior) Exterior elevation design Floor design Insulation, heater Unit layout

<sup>1</sup> (I): differences by types/levels of impairments, (P): by preferences.

Considerate design of interior space in individual units and adjacent facilities with regards to exterior space can improve the QoL for older people with restricted mobility. Important design



considerations are discussed for each design theme, integrating the information obtained through the analysis.

#### 4.1. Consideration for Accommodating Various Levels/Types of Impairments and Preferences

The design requirements for greater QoL are affected by the type and level of impairments. There were differences in the design requirements to accommodate individual preferences. Accordingly, it is necessary to provide different types of units that residents can choose from or increased flexibility in the design of housing units or complexes to accommodate the diversity in preferences. Alternatively, given that the level and type of impairments may change as people age, a universal design that meets different requirements could best support ageing-in-place and thereby enhance QoL.

#### 4.2. Design Consideration by Themes

##### 4.2.1. Spatial Organization Surrounding the Sitting Area and the Sequential Space (Interior/Exterior)

There were different preferences in spaces that participants liked to stay; however, most participants liked to stay in their sitting space in their lounge. In the design of the space for people with restricted mobility, there should be careful consideration of the micro environment surrounding their sitting area (Figure 1). In particular, the sequence of space from the sitting area to the outside must be designed for access and control. The spatial organization should allow the layout of a chair (typically an adjustable armchair) and adjacent tables and/or shelves to ensure things are within the occupant's reach to enhance control of their environment. Consideration of preferred activities can ensure that the space can accommodate intended use. For example, given that watching TV is a common activity, layouts should permit location and proximity of TV options with respect to armchair location and in addition, the adjacency of any windows to avoid glare on the screen. There should be enough space for visitors in the quasi-public areas of the unit and a separation of the lounge from the bedroom. The spatial organization that allows residents to view visitors coming while the resident is seated improves their sense of control. The front door should be within sight of the sitting space as well as close enough for the voice to reach through the door. Windows should also be positioned to provide the resident outside views, but limit views from the outside to the inside.

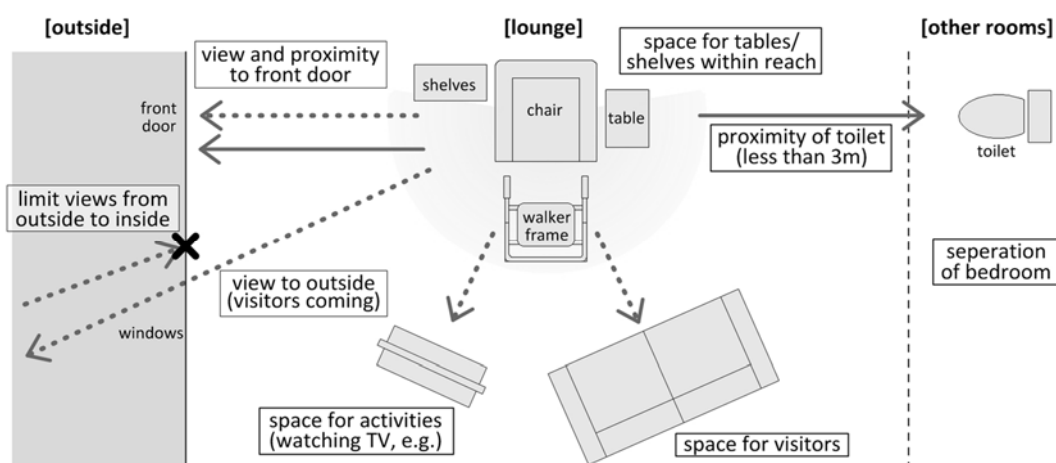


Figure 1. Diagram for spatial organization surrounding the sitting area.

Incontinence is a common problem for elderly people, the concerns of which can be worsened by restricted mobility. Locating a toilet as close to the sitting space or the bed as possible (less than 3 m) could address this issue for some people. However, for those with severe mobility concerns, accommodation should be made for toileting to occur in the lounge as well as in the bedroom through the use of a commode, or other devices. There should be enough consideration in the spatial

organization of exterior space and placement of windows to meet the conflicting needs for high levels of privacy and other desires such as looking outdoors, welcoming visitors, or just enjoying the sunshine.

#### 4.2.2. Storage

Consideration in the design of storage spaces with regard to interior elevation as well as necessary floor area is required for the common amount of objects and furniture. Built-in shelves of appropriate height are generally preferred particularly in the bathroom and the kitchen. The kitchens observed in this study generally had cupboards/shelves that were too high for ease of access by their intended user. In an attempt to provide enough storage in the limited space, often the storage was unusable for those with limited mobility. The kitchen should be redesigned or enlarged so that enough useable storage is provided.

#### 4.2.3. Floor

Strategies for floor design with no level difference indoors as well as at the external door is required to meet the requirements of those with the highest levels of impairment. Interior floor design with no threshold could be a solution. There should also be consideration in the flooring materials with respect to maintenance, as people have a higher propensity to dirty the floor and a lower ability to clean it as the level of impairment increases. One resident wanted a non-slip tile floor for the entire unit, which could be easily cleaned by a steam cleaner; however, there is a common preference for carpet for warmth. There should be consideration for easily cleanable materials that are warm to the touch.

#### 4.2.4. Door

Hinged doors, particularly when combined with a threshold with a level difference, are difficult for those walking with aids such as a trolley or a walker frame to manipulate. Sliding doors, that do not require much strength to open, are more suitable. The door serves to maintain privacy and to retain heat; however, they can be difficult to negotiate for those with limited mobility and can take up valuable space. For example, doors between the laundry and the bathroom, or the kitchen and the lounge could be removed.

#### 4.2.5. Shower Area

Special consideration of the type of shower enclosure and the degree of fixture and flexibility of the shower head is required to enhance the independence of elderly people with mobility impairments. There should be no change of level in shower areas. For assisted showering, there should be enough space for drying as well as washing to accommodate both the resident and a caregiver. In addition, showering areas should have fittings that enable assistance out-of-sight of residents to maintain their privacy. The design of walls and fixtures that could be held by the elderly with both hands to support their balance increases their safety and thereby their independence and privacy.

#### 4.2.6. Communal Space

In the design of communal space, there should be spaces that accommodate residents' preferred approach to socializing, such as meeting visitors in private common spaces as well as open organized activities. Flexible space and appropriate facilities should be provided to facilitate various preferred uses. There should be consideration in the accessibility and distance between the communal space and the unit to suit those with limited mobility and those using mobility aids. In addition, the location of toilets should be designed to meet the needs of those with incontinence.

#### 4.2.7. Exterior

In the design of a complex, external pathways should not be close enough for passers-by to look inside compromising a resident's privacy. They also should be designed so that it can prevent the public from going through the housing site. The unit layout should take account of the aspect to the sun and the distance between units so as not to block the sun to another unit, particularly in the case of the tall buildings. The exterior space close to resident units, such as a porch, is used to accommodate various extra things, including mobility aids or other vehicles. The porch is also an important space for residents to enjoy the sunshine. The common space in close proximity to the units also has great potential to be used for interaction with other residents and accommodating guests. There should be enough consideration for the accessibility from the inside of the unit as well as the spatial layout that can accommodate chairs. In the design of the open space, there should be enough consideration for the layout and choice of trees with regard to resident's units, so that residents can fully enjoy the sunshine.

#### 4.3. Design Strategies for Local-Authority Rental Housing to Accommodate the Elderly Occupants' Needs

Rental housing is typically an option for those who cannot afford to live in retirement villages. This is particularly the case for public-sector housing, where the eligibility criteria include levels of income and assets. The majority of units in the public-sector rental housing complexes for the elderly are bedsit or one-bedroom houses of 30–50 m<sup>2</sup>. To improve the QoL while meeting the financial needs of the occupants, there should be special consideration in the design strategy, without significantly increasing the cost, which relates to the floor area as well as other architectural elements. Considering that a bedsit unit limits the opportunities to have guests in their house, the one-bedroom unit where the bedroom and the lounge are separated by a wall and a door should be made the standard. Using a sliding door between the two rooms, that can be kept both opened and closed, can increase flexibility in use and reduce the space taken for the swing of a hinged door, as well as being easier to open and close for elderly occupants with limited mobility. To provide the opportunity for guests to stay overnight, the lounge space should be designed so that it can accommodate at least a sofa-bed in addition to residents' own furniture requirements. Even with the limitation in floor area, there should be consideration in the bathroom design to accommodate two people in the space for assisted drying and showering, which may require more space than conventional bathroom designs. This does not necessarily mean greater cost—under a limited budget, it can be achievable with careful design of the whole house, including reducing unnecessary elements such as corridors and doors.

Common space can be also designed to accommodate objects and activities that cannot be accommodated in the dwellings. For example, mobility aids and other vehicles can be stored in the individual porch, or in a communal storage. In either case, there should be consideration for installing electric outlets for electric wheelchairs and mobility scooters as well as level access routes between such spaces and resident's units.

### 5. Limitation and Expansion of Research

Through this study of six high-needs elderly people, the implications for design have been identified; however, further research is required with more respondents to confirm and clarify these results. In addition, to explore the most suitable models of housing for the elderly, a greater analysis is required of the implications of ethnicity, gender, living arrangements, levels and types of impairments and type of housing, to explore the most suitable models of housing for the elderly. This paper includes limited consideration for cost aspects that can affect the design of public housing units, such as those argued by Leung et al. [30]. Findings of this paper include the micro-spatial use of the elderly in their house; however, in order to identify the optimal housing size, further investigation is required for their use of the space for possessions.

The design considerations derived from the investigation of spatial usage and the perception of the occupants will contribute to the improvement in the local-authority housing as well as other types

of housing in the future. It can support the independent life of the high-needs elderly with greater QoL, and therefore provides one of the ways to overcome the demographic change in our society.

## 6. Conclusions

As the population ages, there will be an increased demand for housing that can accommodate those impairments that typically correspond with ageing. This paper examined the QoL of six elderly people with impairments living in local-authority rental housing. Analysis found that housing design has great potential to improve QoL of high-needs elderly residents in six aspects: Independence and activities; Sense of control; Privacy; Relationships; Quality of care; and Comfort. The design of housing that improves their QoL requires careful consideration for the micro-spatial organization surrounding the sitting area and sequential space towards the outside, to facilitate greater control and range of activities as well as providing adequate privacy and safety. There should be consideration of an expansion of space for accommodating the caregiver and facilitating meaningful relationships in the individual units and bathrooms, with careful design that will not significantly increase the cost. The design of indoor/outdoor common space should be flexible to accommodate comfortable relationships and activities, which is particularly effective in the design of complexes with small units. This paper also finds the design of housing that improves QoL requires solutions to accommodate a variety of conflicting needs derived from the diversity in user's preferences and the characteristics of their impairment. In the design of individual housing units and adjacent facilities, there is a greater need for reorganized or additional space to improve various aspects of QoL important for the high-needs elderly maintaining their autonomy and independence for as long as possible.

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