Project Title

Elderly- and Dementia-Inclusive Environment

Project Lead and Members

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Organisation(s) Involved

Nanyang Polytechnic, Dementia Singapore (formerly Alzheimer's Disease Association)

Healthcare Family Group(s) Involved in this Project

Healthcare Administration, Nursing, Allied Health

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Dementia and Ageing Research, Industrial Design

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To provide an easy guidance for laypersons, educators, students and professionals who are unfamiliar with designing an elderly- and dementia-inclusive physical environment.

Project Category

Care & Process Redesign

Build Environment, Space Planning, Access to Care, Value Base Care

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Elderly- and Dementia-Inclusive Environment

Guidance on elderly- and dementia-inclusive features; covering both the internal and external environment
Recommendations July 2019

ALZHEIMER'S DISEASE ASSOCIATION

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Preface

Singapore is faced with a fast ageing population. Between 2020 to 2030, the number of people aged 65 years and above in Singapore will triple. Those who are 60 years and above will increase two-fold from 19.5% (1.1 million) in 2017 to 40.1% (2.6 million) in 2050 *(United Nations, 2017)*. Of this, 1 in 10 people who are 60 years old and above has dementia *(Subramaniam et al, 2015).* This has significant impact on intergenerational families as most elderly and people with dementia are still cared for at home by their families.

Arising from the aforementioned, the Elderly- and Dementia-Friendly HDB Review Team comprising Alzheimer's Disease Association (ADA) and Nanyang Polytechnic (NYP) was formed in Jul 2018.

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- site visit to the showflat at My Home Gallery (Toa Payoh HDB Hub) in Aug 2018;
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- Asia PR Werkz Pte Ltd and Qinglian Realty for facilitating the site visit to Jadescape on 25 Jan 2019;
- Hwan Jing's aunt (Ms Tan Kim Liang) for graciously offering her apartment for viewing, hosting us and providing a personalised tour of Kampung Admiralty on 6 Apr 2019; and
- the seven family caregivers of persons with dementia and the two persons with dementia for taking the time to participate and assist in the tedious and time-consuming evaluation of Kampung Admiralty on 6 Apr 2019.

The team hopes to make meaningful use of their valuable inputs and contributions in paving the way for a more elderly- and dementia-inclusive Singapore.

Elderly- and Dementia-Friendly HDB Review Team members

- Alzheimer's Disease Association (ADA) - Koh Hwan Jing, Stephen Chan
- Nanyang Polytechnic (NYP) - Alan Ong, Michael Tan, Tan Khee Soon, Dr Wan-Koo May Yeok (main author)

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Foreword

Why is environmental design needed for the elderly and persons with dementia?

This book is prepared and written to provide an easy guidance for lay-persons, educators, students and professionals who are unfamiliar with designing an elderly- and dementia-inclusive physical environment. It aims to offer a starting point for supportive, innovative and sustainable design; especially in the context of the Housing and Development Board (HDB) flat/ apartment where most Singaporeans reside in and in which most elderly and persons with dementia are living with their families.

The physical environment plays an instrumental role in enhancing the well-being of the elderly and persons with dementia. As such, a well-planned therapeutic design of the physical environment is important as it can reduce dysfunctional symptoms and behaviours. For the elderly and persons with dementia to live well with their families, the physical environment must be facilitative of a good quality of life; enabling the individual to thrive and interact positively in one's own home and remain at home for as long as possible. This, compared with early institutionalisation, is still the preferred option by most elderly, persons with dementia and their families.

How to use this book?

This book is organised into two chapters and seven appendices.

Chapter One (01): Internal Environment - Apartment

This Chapter informs users on the recommended therapeutic design of the internal environment - Apartment - whilst adhering to the following principles:

- Spatial Environment
- Wayfinding
- Accessibility and Safety
- Lighting and Nature
- Colour Contrast
- Tranquil Environment

Chapter Two (02): External Environment - Residential Estate

This Chapter informs users on the recommended therapeutic design of the external environment - Residential Estate - whilst adhering to the following principles:

- Spatial Environment
- Wayfinding
- Accessibility and Safety
- Lighting and Nature
- Colour Contrast
- Tranquil Environment
- Barriers or Challenges if Any

Appendix 1: Ramp Gradient

Appendix 1 covers recommendation of the ramp gradient for three different types of users

- 1:12 for independent wheelchair users
- 1:20 for wheelchair users who are assisted by a caregiver
- 1:20 for older persons (ambulating independently or with walking aids) with cognitive impairment and/ or dementia

Appendix 2: Types of Junction

Appendix 2 presents 4 different types of junction with the T-, forked and staggered junctions being recommended as dementia-inclusive.

- Crossroad
- T-junction
- Forked junction
- Staggered junction

Appendix 3: Types of Grid Pattern

Appendix 3 presents 3 different types of grid pattern with the irregular grid pattern being recommended as dementia-inclusive.

- Uniform grid pattern
- 'Lollipop' grid pattern
- Irregular grid pattern

Appendix 4: Letter Heights for Signage

Appendix 4 presents the recommended letter heights (from 25 to 200mm) for signage in relation to the viewing distance (from 750 to 6,000mm).

Appendix 5: Elderly- and Dementia-Inclusive Environment Checklist for HDB

Appendix 5 provides users with a 79-item checklist comprising 7 sub-headers: Spatial Environment (5 questions); Wayfinding (31 questions); Accessibility and Safety (22 questions); Lighting and Nature (8 questions); Colour Contrast (9 questions); Tranquil Environment (3 questions); and Barriers or Challenges if Any (1 question) - to remind/ advice users on what to focus on when considering an Elderly- and Dementia-Inclusive Environment.

Appendix 6: Sample Specifications when Designing and Building an Elderly- and Dementia-Inclusive Apartment

Appendix 6 provides a sample specification when designing and building an elderly- and dementia-inclusive apartment with detailed coverage of the living room, kitchen, laundry, bedroom, bathroom-toilet, and store room cum bomb-shelter areas.

Appendix 7: Colour Wheel

Appendix 7 presents users with a colour wheel to advise on colour contrasting. The colour wheel is by no means exhaustive but serves to remind users on the use of colour contrast involving the primary colours, that is, blue, green, yellow and red.

01: Internal Environment - Apartment

Photo 1: Apartment with a balcony comprising vertical green walls on both sides

Photo 2: Living room with floor-to-ceiling window

Photo 3: Box window with plants/ herbs

Spatial Environment

The apartment should preferably be designed with a balcony (photo 1), patio or terrace. If a balcony is not possible, at least floor-to-ceiling window (photo 2) should be included in the design. For the floor-to-ceiling windows, they should ideally be wide enough (end-to-end) to provide an unobstructed view to the outside/ external environment (photo 2); essentially, to prevent the sensation of feeling "boxed-in" and also, to allow natural lighting into the apartment and connect the person with dementia with nature.

Box windows that can allow occupants of high-rise apartments to have a visible view of nature are recommended (photo 3). Plants could be, for example, the *Yellow Singapore Daisies* that are low maintenance. Other examples are the *Cycad/ Cardboard plant, Cordyline Fruticose, Liriope* which thrive in the tropics; *(source: http://kyora.com.au/low-maintenance-plants/)* and offer a variety of tones and colours. Herbs could also be possible alternatives for residents with green fingers. In essence, the afore-mentioned concept can drive and support environmental sustainability/ eco-living.

The space in a fully furnished apartment should still have the ability to promote circulation areas to encourage interaction amongst the occupants and be able to accommodate a person requiring mobility aids to move around within the apartment - with or without assistance (photo 4 which depicts an apartment with open-concept floor plan. See Appendix 6 for the specifications).

Wayfinding

The apartment's unit number should follow the recommended colour contrast, letter height and font (photo 5i and Appendix 4).

The apartment should have an open-concept floor plan with no obvious corridors (photo 4) if possible, and relatively unobstructed visible access to the outdoors, especially the natural environment and social activities.

The person with dementia needs to have a clear and direct view of the en-suite bath-room-toilet from the bedroom/ bed (photo 6).

Doors (if any) within the apartment should have colour or tonal contrast to the wall. Adding a signage on the door may be helpful if needed; signages can be a photograph of the specific room with large enough, colour contrasted text in Sans Serif (photo 7). Doors can also be camouflaged (photo 8) if the intent is to deter a person with dementia (at a later stage when he/ she has decreased

Photo 4: Open-concept floor plan

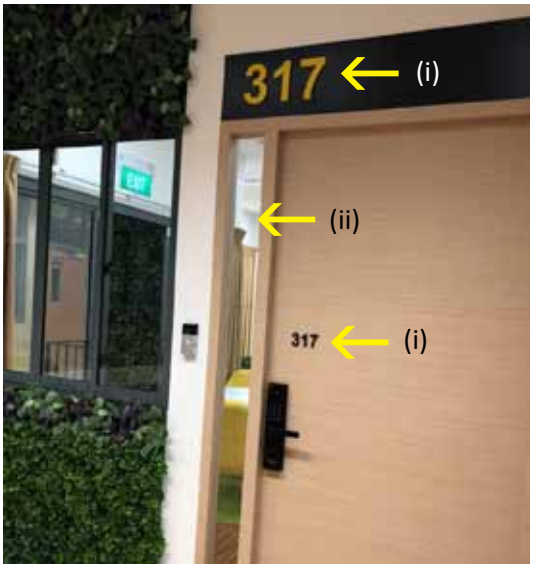

Photo 5: (i) Unit number; (ii) See-through side panel at the main door (indicated by yellow arrows)

spatial and safety awareness) from wandering into a potentially hazardous part of the apartment; e.g. a cluttered storeroom.

Accessibility and Safety

A see-through side panel at the main door (indicated by the yellow arrow in photo 5ii) is more accessible for the elderly person on a wheelchair or person with dementia when they need to determine who is at the front door. Frosted/ tinted glass or blinds over the panel can be alternatives to address privacy concerns.

The flooring and pathways should be mostly flat, plain, non-reflective, wide, non-slip and paved in clear colour and textural contrast to the walls, doors, etc.

For example, compliant flooring *(Lachance et al 2017)* which has a natural look and feel can be used (photo 4). Compliant flooring can be timber for the living and bedrooms and sheet vinyl flooring for the bathroom. This type of flooring as compared to concrete is a safer alternative for elderly when addressing the impact sustained from falls.

Photo 6: En-suite bathroom-toilet

Photo 8: Door with camouflage

As mentioned under spatial environment in page 5, there should be ample moving space for an elderly person on mobility aids (e.g. wheelchair) to move around freely; assisted by one caregiver (see Appendix 6 for specifications).

There should be adequate storage space and no cluttering. See photo 9 (yellow arrow indicate the storage space for items to be placed out of sight) and photo 10 of a store-room that is wheelchair accessible.

Photo 9: Utility cabinet near the main door

Photo 7: Signage for the bedroom

Photo 10: Storeroom

Built-in kitchen cabinets and wardrobes should be adequately contrasted with the walls and have 'see-through' panels or open shelving units (photos 11 & 12) to provide visual access to items inside the cabinets for the person with dementia. Providing visual access to items allows the person with dementia to recall and retrieve items so that he/ she is able to perform tasks efficiently/ independently. Hoarding will also be minimised.

The countertop should have a wheelchair recess and mobile island (photo 11) to allow the elderly person on a wheelchair to perform his/ her own independent activities of daily living; for example, food preparation.

Photo 11: Kitchen cabinet with mobile island

The top units of the kitchen cabinets should be accessible for an elderly person on a wheelchair (photo 12) by installing pull down shelves. Height-adjustable installation such as this is useful for fall prevention.

For an elderly-inclusive apartment, an emergency pull cord alarm should be installed at the bathroom-toilet and bedroom; next to the shower and bed areas.

Windows, gates and doors should be easy to open; example, install levered handles that presumably do not require more than 2kg of pressure. Alternatively. sliding windows and doors within the apartment could be considered. However, it must be noted that sliding windows that are not able to slide into the

Photo 12: Height-adjustable kitchen cabinet

Photo 13: Ramp at the bathroom-toilet entrance

walls will not permit better ventilation as compared to a casement window.

The ramp at the main entrance and bath-room-toilet entrance must be gentle enough (photo 13). Recommended gradient is 1:20 (Appendix 1, Diagram 1 and its corresponding table). No kerbs or steps in the apartment would be most ideal.

Levers/ handles of doors, windows, wardrobes, cabinets, switches, toilet seat covers, flush handles/ buttons, sink faucets and handrails should be colour contrasted (photos 14 & 15, Appendix 7).

Photo 14: Colour contrasted horizontal and vertical grab bars, toilet seat cover, flush handle/ button, sink faucet and handrails

Photo 15: Sliding door with colour contrasted grab handle

Under HDB's current EASE Programme (HDB 2019), apart from the bathroom-toilet, residents can install "up to five ramps in the flat, and/ or at the main entrance - if this is possible to construct."

A side panel at the main door with "see-through" or frosted glass is more accessible for a person with dementia or an elderly with mobility issues to access (photo 5ii). Alternatively, CCTV with motion sensors could be installed to assist family caregivers to manage/ monitor situations at home remotely via their mobile devices.

Levered door handles for the main entrance and grab bar door handles for sliding doors (photo 15) within the apartment are appropriate.

The door lock at the main door needs to be one that is suitable for an elderly person with limited hand dexterity and/ or less strength (photo 16). This should be non-reflective with a matte finish if meant for a person with dementia.

Other doors within the apartment should preferably not be installed with locks; especially when living with a person with dementia. If necessary, a coin-operated door lock would be most ideal for doors within the apartment.

Provide a wall-mounted laundry hanger so that it is reachable to an elderly who is confined to a wheelchair (photo 17i).
A person with dementia will also be better able to notice the hanger that is in plain sight compared to one that is ceiling-mounted.
Switches (photo 17ii) that are mounted at approximately 1000mm from the floor, are much more accessible and provide optimal usability for all population.

Photo 16: Levered door handle and latch door lock (Cavity Sliders USA Inc 2019)

Lighting and Nature

The apartment should facilitate a sense of connection to the wider world/ external environment. Windows should be fairly large with low sills. This would facilitate some views of nature, as well as for natural light to penetrate the entire apartment, allowing the occupants to sense the cycle of day and night. The glass used for windows should be anti-glare and non-reflective.

If corridors cannot be avoided, they should be short and single banked to allow natural light and unobstructed views of the outside.

There must be adequate lighting to light up the apartment at night. The entrance to the apartment should be well-lit and using as much natural light as possible. There should be no pools of bright light or deep shadows within the apartment.

Photo 17: (i) Wall-mounted laundry hanger (ii) Wall switch

Colour Contrast

Features such as plain, clear colour and tonal contrasts between door handles and doors, walls and floors, handrails and wall, doors and walls, sanitation ware and floors and walls, toilet seats, flush handles/ buttons and toilets, taps and basins, furniture and walls/ floors must be apparent in the apartment (see Appendix 7 on how colour contrast can be done optimally).

Tranquil Environment

If the apartment is located at a busy traffic junction or major traffic interaction area where traffic noise is anticipated; noise reduction is necessary. Unplasticised Polyvinyl Chloride (uPVC) windows and doors can be considered for the apartment if not constrained by cost. When used in conjunction with double glazed windows, uPVC can help to reduce noise by up to 40 decibels or almost 80%.

Findings from longitudinal studies *(Carey et al 2018; WHO 2011)* have indicated the extent of environmental noise towards cognitive impairment and dementia.

Appended are benefits of uPVC windows and doors:

1. Low maintenance;
2. Long lasting;
3. Durable;
4. Soundproof;
5. Secure;
6. Insulating;
7. Good ventilation;
8. Flame retardant; and
9. Environmentally friendly.

For sound insulation, green walls may be deployed (*Azkorra et al 2015*. Photo 1 on page 5 shows a vertical green wall on both sides of the apartment's balcony).

02: External Environment - Residential Estate

Photo 18: NTUC FairPrice Supermarket

Photo 19: POSB Bank

Photo 20: Sheltered plaza with shops and space for community activities at Level 1

Photo 21: Kopitiam Food Court

Spatial Environment

The apartment block/ building should promote circulation areas (photos 18 to 22), is part of the public realm and has a natural environment (gardens and playgrounds at various levels); example, the Rooftop Community Farm at Kampung Admiralty (photo 22) to encourage interaction.

A multi-purpose space accommodating a range of activities (photos 18 to 22) is most ideal. It should be integrated and self-contained with all the required amenities

Photo 22: Rooftop Community Farm

as well as being conveniently located and within walking proximity to the transportation hub such as the MRT station and bus interchange.

Wayfinding

Short corridors within the apartment block/ residential estate are acceptable as long as these are served by openings at the end of corridors to the external environment and facilitated by natural lighting (photo 23).

Ideally, lifts should be directly visible to the person with dementia when they first exit from their apartments.

Large, realistic graphics/ signages in clear, colour contrast to the background on essential destinations; and contrasting colours, e.g. between different doors or corridors at the apartment block/ building are recommended (photos 24 & 25); showing signages with large enough, well contrasted numbers and text).

Photo 23: Short corridors

Directional signs/ signages need to be located either above eye level, slightly below eye level and/ or on the floor (photo 24) with fonts that are in San Serifs and appropriately sized (see Appendix 5, Table 1 for recommended letter heights of signages in relation to the viewing distance).

Signs (photos 24 & 25) are fixed to blocks they refer to, well-lit and must also be available at eye level. Highly stylised or abstract images or icons should not be used as representations on signage used.

Entrances to the residential block/ building need to be made obvious. For example, in photos 24 & 25, at the carpark, the number of the residential blocks 676A and 676B, where the entrance is at, is using the correct font, large enough and contrasted against a pastel coloured wall to facilitate unobstructed visualisation from afar (see Appendix 7).

Photo 24: Doors to lift lobby and signage at the carpark of residential block 676A

Photo 25: Number of block 676B

The apartment block is "conveniently located" close to services, facilities, community activities and open space (photos 18 to 22). There is a mix of uses, including plenty of services, facilities and open spaces. The facilities designed reflect uses by way of their distinct shop and service name/ logo (photos 18 & 19).

The architecture should, as much as possible, reflect local character. However, sometimes this may not be necessarily so, as illustrated in Kampung Admiralty's case which use a new architectural concept - an integrated design approach. The obvious landmarks and environmental cues are the usual shops and/ or services such as the NTUC Fairprice supermarket and the POSB Bank (photos 18 & 19).

There should be obvious landmarks, distinctive structures with special features (e.g. wall murals, street furniture, postboxes, telephone boxes, trees, statues) present at junctions, open spaces or places of activitiy to aid wayfinding (photos 26 & 27).

There should be frequent sightings of public seating (photo 28) in warm materials, designed with proper arm and/ or backrests. They should not be abstract-looking (photo 29).

Handrails and seating at public areas (e.g. car/ taxi waiting area or drop-off point) must be designed with clearly contrasted colour.

Linkways/ paths leading to and away from the residential blocks are recommended to have clear signages to aid the person with dementia.

Photo 26: Artwork by Mr Yip Yew Chong (Courtesy: Mr Yip Yew Chong)

Photo 28: Public seating

Photo 27: Street sculpture in open space as an aid in wayfinding

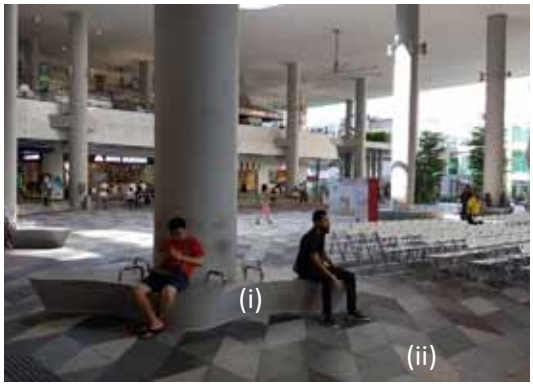

Photo 29: (i) Abstract looking public seating; (ii) Patterned flooring with different tones

Residential blocks need to have identifiable block number and should be distinguishable from each other to aid the person with dementia in identifying his/ her own residential block.

NOTE: Avoid crossroads (see Appendix 2, Figure 1); although they are supposed to provide more connectivity and choices but are unsafe and sensed as unending and tedious, akin to a lollipop pattern (see Appendix 3, Figure 2); thus, posing as safety concerns, and are confusing for the person with dementia.

On the other hand, irregular grids (see Appendix 3, Figure 2) provide a sense of what is at the other end as compared to regular grids which feel like the road is never ending. Staggered, forked or T-junctions (see Appendix 2, Figure 1) reduce the number of options for the person with dementia to choose from and are recommended as they provide a focus for the person with dementia. This feature maintains connectivity, concentration and provides directional clues for the person with dementia.

Accessibility and Safety

A ramp should be easy for a person or his/ her caregiver to push the wheelchair up or down with minimal effort, that is, without having

Photo 30: Handrails along the ramp (source: https:// www.roofedge.co.uk/news/story/ access-for-all-with-key-access-fittings)

Ramps, kerbs, steps and escalators should be clearly marked with colour contrasted handrails, non-slip surfaces and strips (photos 30 to 32).

Photo 31: Car/ taxi waiting area or drop-off point with yellow handrails and kerb markings

Photo 32: Steps marked with yellow paint/ strips (I'DGO 2014)

to struggle or slip, particularly during wet days (see Appendix 1 and refer to I'DGO 2014).

There should be sufficient handrails at the residential area. These need to be matte and in clear colour contrast to walls/ surrounding fixtures (photos 30 & 31).

Public seats and seats at, e.g. the car/ taxi waiting area or drop-off point, plaza, food court, garden, must be suitable for older people and/ or persons with dementia. Example, elderly-friendly seats - height appropriate with arm and backrests; dementia-friendly seats with colour contrast (photo 28).

Photo 33: Colour contrasted lift buttons (source: Google image)

Photo 34: Clearly marked glass doors

The push button for disabled access doors, e.g. doors of lifts or automatic doors, need to be immediately/ visually obvious. The buttons should be non-reflective and contrasted against the surface/ background (photo 33).

Glass walls and doors should be clearly marked (photo 34).

There should be designated cycling/ personal mobility device lanes (photo 35). Its absence poses an obvious hazard to the elderly and persons with dementia.

Photo 35: Example of shared surfaces (source: Creative Commons)

There should be available wide, flat, smooth, plain, non-slip footways, separate from cycling lanes (photo 35).

The estate is recommended to have shared external surfaces that give priority to pedestrians, especially the elderly and persons with dementia.

There should be frequent pedestrian crossings with audible and visual cues suitable for older people. Audible cues at pedestrian crossings need to be sufficiently loud. Crossing times must be long enough too.

There should be permeable buffer zones, such as trees and/ or grass verges, between busy roads and footways (photo 36). A green buffer zone should be created between pedestrians and cars on busy roads (photo 37).

The carpark lot for elderly persons using mobility aids should be strategically located with distinctive logo and blue coloured lot marking. Access needs to be barrier-free too (photo 38).

Avoid locating steps immediately at the base of the ramp (photo 39) as these would pose a safety hazard to elderly persons or persons with dementia on mobility devices. Elongated rounded tables without sharp corners (photo 40) address safety concerns and promote intergenerational bonding.

Photo 36: Green buffer zone

Photo 37: Trees, hedges and lawns as green buffer zone

Photo 38: Carpark lot for persons using mobility aids

Lighting and Nature

Corridors if unavoidable should be minimum in numbers. They should be wide, short and single banked, without dead ends or blind bends, with views along them to functional destinations and views of the outside allowing natural light to pass through (photo 23).

The number of lighting must be adequate to light up the lift lobby serving the amenities and common services at night (see Appendix 6 under 'Lighting and Switches' for specification).

Avoid pools of bright light or deep shadows where natural light is obstructed (photo 29).

Colour Contrast

Handrails must be colour contrasted and non-reflective (photos 30 & 31; see Appendix 7).The corners/ edges of kerbs, any steps, if any, should be colour contrasted (photos 31 & 32).

Tranquil Environment

The residential estate should have a quiet environment with calm surroundings, populated by permeable green buffer zones, common fruit trees, plants, flowers (photos 36 & 37, 41 to 46), and a constant view of nature to create a stimulating yet tranquil environment for the person with dementia. Greeneries such as trees and bamboo plants best attenuate road traffic noise when

Photo 39: Steps at the base of the ramp at the Rooftop Community Farm

located close to the road (over the first 10 to 20 metres). However, the rate of attenuation decreases as the distance between greeneries and the road increases *(Peng, Bullen & Kean 2014, van Leeuwen 2016).*

The availability of authentic hawker food provides reminiscence therapy for the person with dementia (photo 47).

Please refer to (NParks, 2017) for the design of a therapeutic garden for an elderly and person with dementia.

Photo 40: Tables with rounded corners

Photo 41: Garden outside the Senior Citizens' and Children Centres

Photo 42: Rooftop Community Farm

Photo 43: Starfruit/ Averrhoa carambola at the Rooftop Community Farm

Photo 44: Buah long long/ Kedondong/ Spondias dulcis at the Rooftop Community Farm

Photo 45: Acalypha hispida/ Chenille plant/ red hot cat's tail and fox tail/ pokok ekor kucing at the Rooftop Community Farm

Photo 46: Food court with a view of nature

Photo 47: Authentic hawker food as part of reminiscence therapy

Barriers or Challenges If Any

Avoid patterned flooring with different colour tones (photo 29ii) as this may be confusing for the person with dementia who "sees these as black holes".

Food court and amenities should be directly accessible from the lifts serving the residential blocks. This is so that residents (elderly, persons with dementia and persons requiring mobility aids) are not inconvenienced and required to access via lifts that are situated at another block meant for common use.

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04: Appendices

Appendix 1 - Ramp Gradient

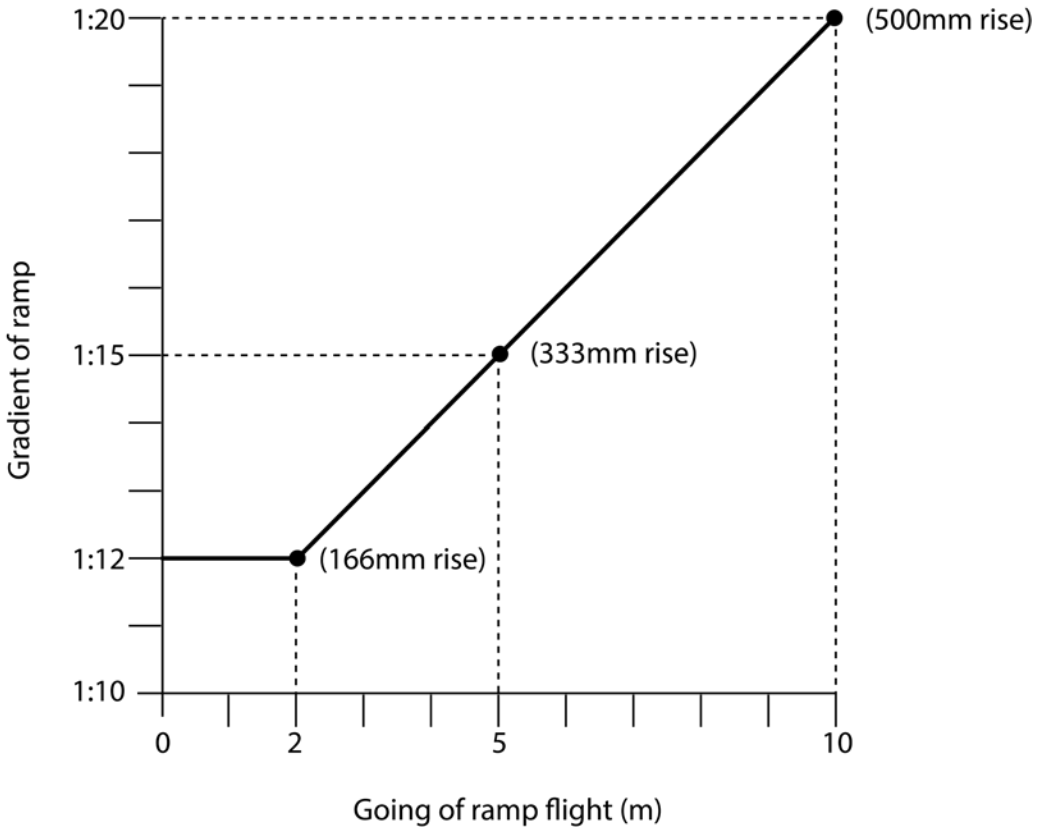


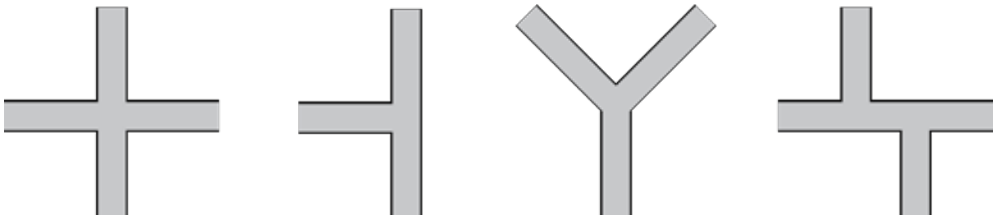
Diagram 1: Relationship of ramp gradient to the going of a flight (Access Appraisals Ltd, 2019)

NOTE: The slope gradient may vary across different group of users as tabled below:

User Group	Gradient	Remarks
i) Independent wheelchair users (e.g. paraplegics) with good antigravity strength of upper limbs (i.e. Motor power = 5/5)	1 : 12	Even a slope gradient of 1:12 has obvious negative effects over time [e.g. (1) the wear and tear effect due to the repetitive strain of the muscles, tendons and ligaments of the upper limbs which are not meant to function like those of the lower limbs]; (2) physiological effects such as an increase in heart rate and blood pressure *(Choi et al, 2015).*

User Group	Gradient	Remarks
ii) Wheelchair users who are assisted by a caregiver. Has decreased antigravity strength of upper limbs (i.e. Motor power < 5/5) - e.g. a tetraplegic, hemiplegic client, elderly person. Refer to I'DGO (2014).	1 : 20	Even a slope gradient of 1:12 has obvious negative effects over time [e.g. (1) the wear and tear effect due to the repetitive strain of the muscles, tendons and ligaments of the upper limbs which are not meant to function like those of the lower limbs]; (2) physiological effects such as an increase in heart rate and blood pressure *(Choi et al, 2015).*
iii) Older persons (ambulating independently or with walking aids) with cognitive impairment and dementia. Has decreased spatial awareness. Also, antigravity strength is likely to decrease over time. Refer to I'DGO (2014).	1 : 20	i) Falls involving elderly Singaporeans over 65 years old are very common. An estimated >17.2% of community-dwelling-elderly from this age group experience falls yearly *(Lim, 2010).* ii) About 10% of these falls result in serious injuries and fatality *(Tinetti, 1995),* posing a huge financial and caregiving burden on the family and health/ social care. iii) Elderly most at risks for falls = those with cognitive impairment and poor balance *(Whitney et al, 2012; Woo et al, 2017).* iv) Environmental factors alone, being the most common cause, accounting for 25% to 40% of all falls *(Lim, 2010).* v) Preventive strategies in the form of built environment being elderly- and dementia -inclusive could address this looming concern related to a progressively ageing population.

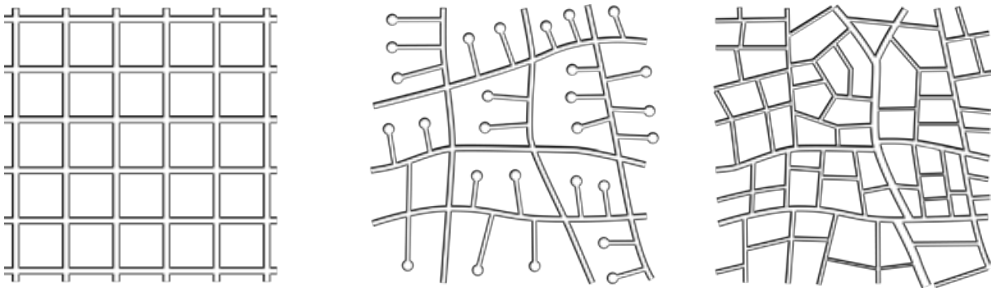
Appendix 2 - Types of Junction



Crossroad *T-junction* *Forked junction* *Staggered junction*

Figure 1: (Source: Burton & Mitchell, 2006; Mitchell & Burton, 2010)

Appendix 3 - Types of Grid Pattern



Uniform grid pattern *'Lollipop' pattern* *Irregular grid pattern*

Figure 2: (Source: Burton & Mitchell, 2006; Mitchell & Burton, 2010)

Appendix 4 - Letter Heights for Signage

Table 1 below provides the recommended letter heights for signage in relation to the viewing distance.

Viewing Distance (mm)	Recommended Letter Height (mm)
6000	200
4600	150
2500	100
2300	100
1500	50
750	25

Table 1: Recommended letter heights for signage

Appendix 5 - Elderly- and Dementia-Inclusive Environment Checklist for HDB *(Adapted from Health Facilities Scotland, 2007)*

Questions	Yes or No	Comments/ Notes/ Remarks
Spatial Environment 1) Does the apartment have a large balcony, patio or terrace? ***(Recommended)***		
2) Can a person or his/ her family member who requires mobility aids move around or use the space in the apartment easily? ***(Recommended)***		
3) Does the apartment and/ or block promote circulation areas to encourage interaction? ***(Recommended)***		
4) Is the apartment building part of the street and public realm and nurturing the natural environment? ***(Recommended)***		
5) Does the residential area have a multi -purpose space accommodating a range of activities? ***(Recommended)***		
6) Is the residential area conveniently located and within walking proximity? ***(Recommended)***		
7) Does the residential area have clusters of shops supporting a few blocks of apartments? ***(Recommended)***		
8) Is the apartment block located close to services, facilities, community activities and open spaces? ***(Recommended)***		
9) Is there a mix of uses, including plenty of services, facilities and open spaces? ***(Recommended)***		

Questions	Yes or No	Comments/ Notes/ Remarks
Wayfinding 1) Is there visual access, e.g. a clear view of the en-suite toilet from the bed? *(Recommended)*		
2) Does the apartment have easy and visible access to the outdoors, especially natural environments? *(Recommended)*		
3) Are the doors painted with different colours? *(Recommended)*		
4) Are there numerous corridors within the apartment block/ building and/ or the residential estate? *(Not Recommended)*		
5) Does the apartment and/ or block have internal corridors? *(Not Recommended)*		
6) Are large, realistic graphics in clear, colour contrast to the background on essential destinations, such as toilet doors? *(Recommended)*		
7) Are contrasting colours, e.g. between different doors or corridors present at the apartment block/ building and/ or the residential estate? *(Recommended)*		
8) Are entrances clearly visible and obvious? *(Recommended)*		
9) Are there obvious entrances to the apartment block? *(Recommended)*		
10) Are porches, canopies and clear signs available and made obvious at the various entrance/ linkways to the apartment blocks? *(Recommended)*		
11) Is the apartment block located close to services, facilities, community activities and open spaces? *(Recommended)*		

12) Is there a mix of uses, including plenty of services, facilities and open spaces? ***(Recommended)***		
13) Are the buildings and facilities designed to reflect uses? ***(Recommended)***		
14) Does the estate comprise small blocks laid out on an irregular (deformed) grid with minimal crossroads? ***(Recommended)***		
15) Is there a hierarchy of familiar types of streets, including main roads, avenues and residential streets? ***(Recommended)***		
16) Are the streets gently winding? ***(Recommended)***		
17) Does the architecture reflect local character? ***(Recommended)***		
18) Are there obvious landmarks and environmental cues at the residential area? ***(Recommended)***		
19) Are there wayfinding cues, such as art work, potted plants, ornaments, placed at strategic spots? ***(Recommended)***		
20) Are there trees and street furniture where possible? ***(Recommended)***		
21) Are there landmarks, special/ distinctive structures/ features (e.g. street furniture, postboxes, telephone boxes, trees, statues) present at junctions, open spaces or places of activity, particularly complex ones? ***(Recommended)***		
22) Are there clear signs throughout? ***(Recommended)***		
23) Are signages clear, in bold face with good contrast between text and background/ surface they are mounted on? ***(Recommended)***		

Questions	Yes or No	Comments/ Notes/ Remarks
Wayfinding (continued) 24) Are the signs fixed to the doors they refer to? Avoid fixing on adjacent surfaces. ***(Recommended)***		
25) Are the signs at eyel level and well-lit (especially at night)? ***(Recommended)***		
26) Are highly stylised or abstract images or icons as representations on signage used? ***(Not Recommended)***		
27) Are there frequent sightings of sturdy public seating in warm materials, with arm and backrests? ***(Recommended)***		
28) In larger premises, is a seating area available, especially in waiting areas? ***(Recommended)***		
29) What type of seating do you see in the neighbourhood? Does it look like seating, e.g. a wooden bench, rather than an abstract metal Z-shaped bench? ***(Recommended)***		
30) Are bus shelters/ stops equipped with seating and transparent walls or large, clear windows? ***(Recommended)***		
31) Are bus shelters/ stops designed with colour constrasted handrails and seating? ***(Recommended)***		
Accessibility and Safety 1) Is the apartment's flooring and pathways flat, plain, non-reflective, wide, non-slip and paved in clear colour and textural contrast to the walls, doors, etc? ***(Recommended)***		
2) What about the flooring and pathways of the block and estate? Are changes in floor finish flushed rather than stepped? ***(Recommended)***		

3) Does a person or his/ her family member who requires mobility aids have minimal difficulty or constraints in moving around or using the space in the apartment? ***(Recommended)***		
4) Does the apartment have adequate storage space to avoid cluttering? ***(Recommended)***		
5) Are windows, gates and doors easy to open, i.e. levered handles and no more than 2kg of pressure? ***(Recommended)***		
6) If a ramp is present, is it easy for a person to push the wheelchair up or down the ramp with minimal effort, i.e. without having to struggle or slip, particularly during wet days? ***(Recommended)***		
7) Are ramps and steps clearly marked and well-lit with colour contrasted handrails and non-slip, non-glare surfaces? ***(Recommended)***		
8) Are there sufficient number of handrails in the apartment and at the residential estate? ***(Recommended)***		
9) Are there kerbs or steps in the apartment or residential estate? ***(Not Recommended)***		
10) Are there any clear markings to indicate the presence of kerbs or steps? E.g. colour contrasted edge or corner of kerbs or steps, and handrails? ***(Recommended)***		
11) Are the public seats, toilets and bus shelters suitable for older people? E.g. elderly-friendly seats with appropriate height, arm and backrests. ***(Recommended)***		
12) Is the push button for disabled access doors, e.g. doors of lifts, post office, supermarket, immediately/ visually obvious? ***(Recommended)***		

Questions	Yes or No	Comments/ Notes/ Remarks
Accessibility and Safety (continued) 13) Are the glass walls and doors clearly marked? ***(Recommended)***		
14) Are cycle lanes separate from pedestrian footways? ***(Recommended)***		
15) Are the widths of footways wide enough? ***(Recommended)***		
16) Are there wide, flat, smooth, plain non-slip footways separate from cycle lanes? ***(Recommended)***		
17) Does the estate have shared external surfaces that give priority to pedestrians? ***(Recommended)***		
18) Are there frequent pedestrian crossings with audible and visual cues suitable for older people? ***(Recommended)***		
19) Are the audible cues at pedestrian crossings sufficiently loud? ***(Recommended)***		
20) Are the crossing times long enough? ***(Recommended)***		
21) Are there permeable buffer zones, such as trees and/ or grass verges, between busy roads and footways? ***(Recommended)***		
22) Is a green buffer zone present between pedestrians and cars on busy roads? ***(Recommended)***		
Lighting and Nature 1) While inside the apartment, is there a sense of connection to the wider world? ***(Recommended)***		
2) Does the apartment have natural light which allows the occupants to sense the cycle of day and night? ***(Recommended)***		

3)	Does the apartment have large windows with low sills, with plenty of views of nature? E.g. interesting views, natural light and ventilation. ***(Recommended)***		
4)	If corridors are present, are they minimum in number, wide, short and single banked to allow natural light and views of the outside? ***(Recommended)***		
5)	Are corridors without dead ends or blind bends and with views along them to functional destinations and interesting wayfinding cues, while avoiding clutter and trip hazards? ***(Recommended)***		
6)	Is the number of lighting adequate to light up the paths, linkways and/ or corridors at night? ***(Recommended)***		
7)	Are entrances well-lit and using as much natural light as possible? ***(Recommended)***		
8)	Are there pools of bright light and deep shadows? ***(Not Recommended)***		
Colour Contrast 1)	Are these features present in the apartment - plain, clear colour contrasts between door handles and doors, walls and floors, handrails and walls, doors and walls, sanitation ware and walls and floors, toilet seats/ flush handles/ buttons and toilets, taps and basins, furniture and walls/ floors? ***(Recommended)***		
2)	Are handrails in clear colour contrast to walls/ the surrounding fixtures? ***(Recommended)***		
3)	Are there any clear markings to indicate the pesence of kerbs or steps? E.g. colour contrasted edge of kerbs or steps, and handrails. ***(Recommended)***		

Questions	Yes or No	Comments/ Notes/ Remarks
Colour Contrast (continued) 4) Does the apartment have large windows and glazed doors? Is the glass anti-glare and non-reflective? *(Recommended)*		
5) Are doors and windows painted with different colours and have added details such as window boxes? *(Recommended)*		
6) Are large, realistic graphics in clear, colour contrast to the background on essential destinations, such as toilet doors; and contrasting colours; e.g. between different doors or corridors present at the apartment block/ building and/ or the residential estate? *(Recommended)*		
7) Are signages clear, in bold face with good contrast between the text and background? *(Recommended)*		
8) Is there contrast between the sign and the surface it is mounted on? *(Recommended)*		
9) Are handrails present at crossings, bus stops, safety islands and their corners colour contrasted? *(Recommended)*		
Tranquil Environment 1) Is it a quiet environment with calm surroundings? *(Recommended)*		
2) Are alarms, if present, discreet? *(Recommended)*		
3) Are there plants to buffer traffic noise? *(Recommended)*		
Barriers or Challenges if Any 1) What are the barriers or challenges you see?		

Appendix 6 - Sample Specifications When Designing and Building an Elderly- and Dementia-Inclusive Apartment

Reference Source: Grey, Pierce, Cahill & Dyer (2015)

1 EXTERNAL FACADE OF THE HOME/ APARTMENT

1.1 The external facade should incorporate the following:

a) Ensure all signs are clear, consistent and easy to understand.
b) Use a clear Sans Serif typeface.
c) Use capitals only at the beginning of sentences and names, and align wording to the left.
d) Keep wording brief and avoid abbreviations.
e) Use internationally recognised and/ or easily understood symbols and pictorial signs where possible.
f) Use large arrows to signal direction.
g) Use contrasting colours or shades and avoid glare by using matte or satin finishes.
h) Suspended signs should be higher than 2250mm above floor level.
i) Ensure signage is properly and adequately lit.

Recommended letter heights for signs

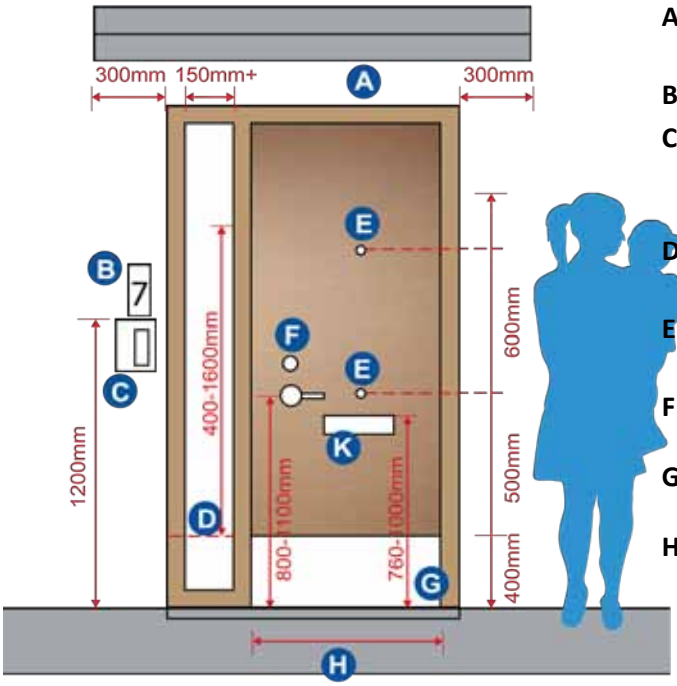
Viewing Distance (mm)	Recommended Letter Height (mm)
6000	200
4600	150
2500	100
2300	100
1500	50
750	25

1.2 The main entrance of the home/ apartment shall incorporate the following:

a) The house unit number. There should be good colour contrast between the unit number and the plate/ wall.
b) The gate (if necessary) should contrast with the other boundary treatment to make it easy to identify where the entrance is. A levered gate handle is recommended as it is easier for the elderly to grip. The gate handle must be contrasted with the frame to guide the person with dementia to where it is. A coloured door handle is also preferred for better contrast.
c) The gate and door entrance must be a minimum of 813mm wide. If the entrance is located in the typical common corridor and requires turning a wheelchair, a 914mm wide entrance is required.
d) The main door of the home/ apartment should have a gentle slope (gradient of 1:20) from the inside to the outside to prevent water from the outside to flow

in and to facilitate wheelchair access. There should be good colour contrast between external, threshold and internal floor surfaces. The front door is preferably made up of a 'cat and kitten' door that can allow wide opening widths.

e) Provide lighting to illuminate the door, the house number and location of the entry system, separate to a general external light.
f) Ensure that the external light is controlled from inside the home or is sensor-activated.
g) Provide a compressible level threshold which reduces to a maximum upstand of 10mm, or a level threshold of 5 to 10mm with chamfered, ramped or pencil-rounded edges, to all entrance doors.
h) The auto lock, doorbell and/ or any intercom system should be installed at an accessible height to facilitate access for a wheelchair user. Provision should be made for secure entry systems that provide audio and/ or visual communication, or remote opening, to help everyone manage the home more easily.
i) Ensure that the entrance door contrasts visually with the adjacent wall or screens. Provide an entrance door with a clear width of between 850 and 900mm.
j) Provide a 300mm clear space on the leading-edge side of the door externally and internally.
k) Provide a large door number that contrasts in colour or tone with the background.
l) Provide pull or lever door handles that are colour contrasted rather than knobs; if and when required.
m) Position lever door handles between 800 and 1100mm above floor level, preferably at 900mm.
n) Ensure the lever door handle returns back towards the door to avoid catching clothes.
o) Install a panel ("see-through" or frosted hammer-glass). **NOTE:** This may not be required if viewing of visitors is enabled via a smart intercom system. Blinds may be installed for "see-through" panel to address privacy concerns.
p) Consider the need for 200 to 400mm kick-plates to protect the bottom of the door. This is in consideration of individuals who are confined to wheelchairs.
q) Position the door bell and home entry system/ intercom no higher than 1200mm above external ground level.
r) Provide visual and audio intercom.
s) Provide an electrical spur to facilitate future fitting of remote control door opening devices. Magnetic locking is most suitable for remote opening systems.
t) Provide a door bell that is lit internally or spot lit from outside, so that it is easily visible to callers.
u) Provide a separate pull-handle on the door in order to pull it shut when leaving the home.
v) Provide remote entrance door opening facility to be controlled from the living room, kitchen, main bedroom and mobile devices.



Legend:

A = Lighting position option: internal or sensor activated

B = Well-lit and clear house number

C = Well-lit home entry system no higher than 1200mm from floor level

D = Vision panel from 400 to 1600mm as a minimum

E = Door viewers at 900 and 1500mm from floor level

F = Door lock positioned above the door handle

G = Kick-plate 400mm high to protect base of door

H = Clear opening width of between 800 and 900mm

Figure 1: Technical drawing to indicate specific measurement

2 LIVING ROOM, KITCHEN, LAUNDRY, BEDROOM, BATHROOM-TOILET AND STOREROOM CUM BOMB SHELTER AREAS

2.1 Open concept for living room and kitchen is recommended. Less walls, or half walls.

2.2 The space planning of the home/ apartment shall take into consideration the following:

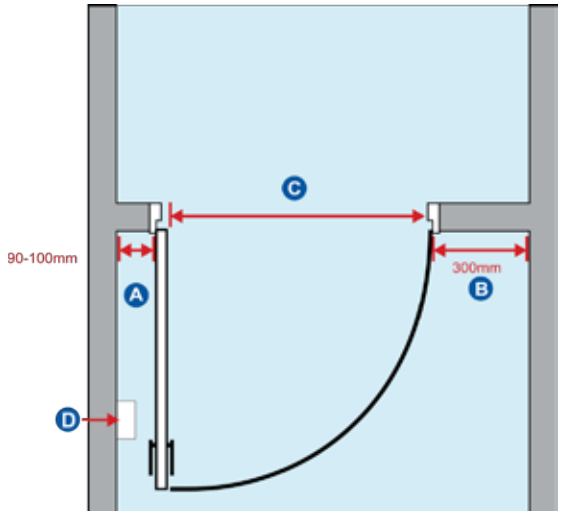
a) Entrance hallway to the living room

1) Provide entrance hallways with a space of between 1500 x 1500mm and 1800 x 1800mm adjacent to the entrance door. (Additionally, provide entrance hallways with a space of at least 1800 x 1800mm adjacent to the entrance door).
2) Provide space for storing items such as umbrellas, shoes, shopping trolley, mobility aids.
3) Ensure hallways are well-lit to 200 lux measured at floor level.
4) Provide a dimmer switch for changing the lighting level in the hallway.
5) Provide natural daylight directly or indirectly to the entrance hall. Indirect daylight may be introduced into the hallway by using glazed doors where rooms have natural light.
6) Provide a flow of fresh air from windows or controlled ventilation system.
7) Provide a power point for charging.

b) Corridors and doors in the home

1) Provide a width of corridor of 1050 to 1200mm between half walls or pillars where necessary.
2) Provide natural daylight directly or indirectly to the entrance hall.
3) Provide openable windows.
4) Ensure that lighting levels are at 100 lux at floor level.
5) Ensure that all doorways to all rooms on the entrance level of the home have a level transition and threshold.
6) Position doors that open into rooms, such as living rooms, bedrooms and kitchens, so that the hinge-side of the door is adjacent to a return wall. Sliding doors are ideal for rooms within the home if absolutely necessary.
7) Provide a 300mm clear area besides the leading edge of all doors at entrance level.
8) Provide effective clear door widths as follows, depending on the direction of approach.

Effective clear opening width of door (mm)	**Direction of approach and width of corridor**
800	Straight-on approach
800	Right-angled approach via corridor at least 1100mm wide
850	Right-angled approach via corridor less than 1150mm wide



Legend:

A = Space on the hinge-side of the door allows the door to be opened more than 90° so that the door handle does not obstruct the opening

B = Space on the leading edge of the door gives ease of access to the door

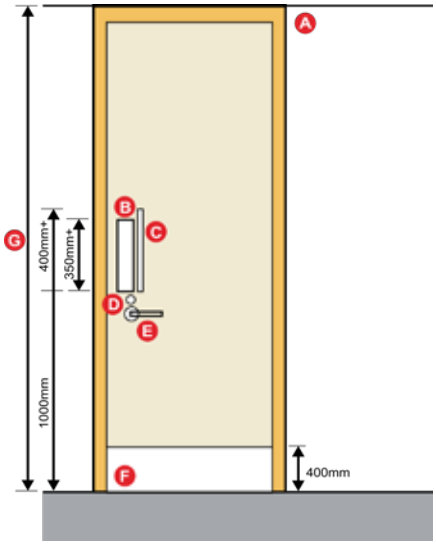
C = Clear width opening depends on the angle of approach

D = Use door stops to prevent damage to walls if the door opens more than 90°

Figure 2: Dimensions for leading edges of entrance doors

9) Ensure doors or the architraves round them are colour and tone-contrasted with the adjacent walls for good orientation and wayfinding around the home.

10) Where door closers are unavoidable, they should be selected to suit the type of door, size, weight and location. Ensure door closers are adjustable.
11) Install wider doorways of 850 to 1200mm, such as double doors or leaf-and-a-half doors (cat and kitten doors) to provide additional flexibility and better circulation.
12) Provide power spurs at each door for remote control or assisted opening.
13) Window controls should be lever handles (colour and tone contrasted) capable of being operated by one hand and at a height between 850 and 1200mm above floor level.
14) Window sills in habitable rooms should be not more than 850mm above floor level.
15) Provide door handles that are clearly identifiable and contrast with the door background, are within reach and easy to use; preferably grab door handles.
16) Provide pull and/ or lever handles rather than knobs to doors. Position lever handles between 800 and 1100mm above floor level, preferably at 900mm.
17) Use only winged or lever thumb-bolts where necessary for toilets and bathrooms. Preferably coin-operated or without locks.
18) Locate door locks above the handle, or at least 72mm below the handle.
19) Install low-friction hinges to minimise opening and closing forces.
20) Provide handles that use a material such as timber or plastic-coated steel for increased comfort.
21) A door to a potentially hazardous part of the home (e.g. the storeroom) can be camouflaged with door murals to prevent a person with dementia from entering at a later stage of their dementia when spatial awareness has declined.



Legend:
A = Colour contrast between door, frame and walls
B = Push plate of at least 350mm long
C = Pull handle of at least 400mm long
D = Lock located above the handle or at least 72mm below
E = Lever handle is preferred for ease of use with handle height at 800 - 1100mm above floor level
F = 400mm kick-plate at base of door helps prevent damage
G = Full storey height door where possible

Figure 3: Internal doors and ironmongery

c) Living room

1) Provide a 900 to 1200m wide clear route between items, in front of windows, and on routes between doors.
2) Provide a clear space for a 2400mm minimum turning circle in all habitable rooms.
3) Provide a clear space of 1200mm all around the dining table. No obstructions from supports beneath the table. Directly adjacent to kitchen beyond.
4) Provide colour contrast between the floor and walls. No loose rugs as they may be a trip hazard.
5) Provide open plan arrangements as they allow for clear visual communication.
6) Avoid reflective surfaces as these can be disorienting for some people with cognitive and visual difficulties.
7) Large windows with easy to reach opening sections would be ideal.
8) Windows should be operable with one hand, with lever fixings between 800 and 1200mm only.
9) Windows should have one section without a transom between 800 and 1500mm.
10) Provide and install plain, non-patterned blinds/ curtains that are between 6000 to 12000mm that are colour contrasted with the walls or windows. Blinds/ curtains should not prevent natural sunlight from coming into the room unless it is very glaring.

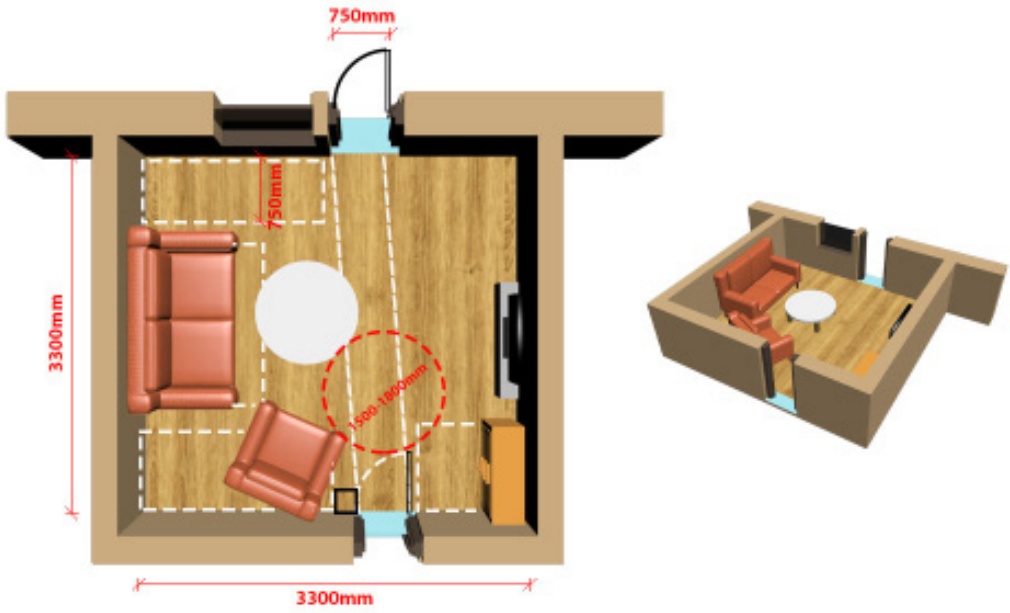
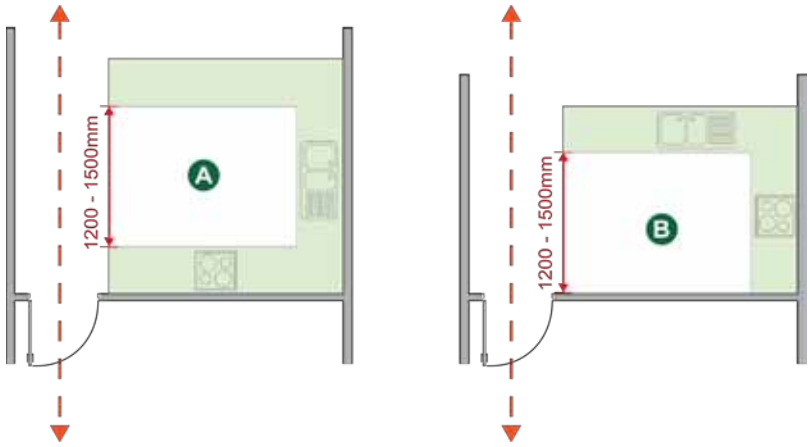


Figure 4: Living room

d) Kitchen

1) Large windows with easy-to-reach open sections.
2) Windows should be operable with one hand, with lever fixings between 800 and 1200mm only.
3) Windows should have one section without a transom between 800 and 1500mm.
4) Design the layout in a 'U' or 'L' shape.
5) Ensure that the cooker/ hob and sink are in the same run of worktop.
6) The kitchen space should be located next to the dining area to ease access for carrying food and crockery.
7) Provide an occasional eating space in the kitchen if the dining area is not in the same room.
8) Ensure all doors to the kitchen are outside the main workspace. Provide between 1200 to 1500mm between opposing work surfaces. (If possible, provide between 1500 to 1800mm). Otherwise, an open concept kitchen would be most ideal to facilitate wayfinding.
9) Provide colour contrasted handles to drawers and cupboards, which are easy to grip and a minimum of 100mm long, with sufficient depth for four fingers to go through.
10) Position grab handles vertically on side-hung doors and horizontally on drawers.
11) Provide "see-through" cabinets and shelves with grab handles that are colour contrasted. Cabinet and shelving height should preferably be from 375 to 1200mm so as to provide easy accessibility for the person on a wheelchair. Storage located from about 500 to 1100mm is considered optimal for wheelchair accessible kitchen designs. Optimal counter height should be 850mm.



Legend:

A = U-shaped layout with route through the room avoiding the working space.

B = L-shaped layout with route through the room avoiding the working space.

Figure 5: Kitchen configuration plans

12) Fit hinged "see-through" cupboard doors that can be opened at least 135°. If not, "see-through" sliding doors may be preferred.
13) Install glare-free task lighting above workspaces.
14) Ensure switches and sockets are clearly visible and within reach. The wall switch should be colour contrasted. This facilitates easy location of switches. The height of the wall switch from the floor should be 1200mm or less to accommodate wheelchair users.
15) Provide a level surface for ease of moving cooking pots on and off the hob.
16) Provide colour or tonal contrast on worktop counter edges, for handles and controls, between floor finish and walls, switches and sockets and their backgrounds.
17) Position switches and sockets near the front of the worktop.
18) Provide a separate oven and hob to provide further flexibility in the kitchen design.
19) Install a sensor-triggered auto lighting inside deep drawers to assist visual access to the contents.
20) Provide sinks of minimum depth 130 to 150mm. There should be adequate leg space under the sink and counter top to facilitate wheelchair access. A knee recess and depth of work surface of at least 600mm and width of at least 800mm should be provided below or adjacent to key task areas, including the cooker hob, the sink and food preparation areas.
21) The optimal kitchen sink and faucet height for the caregiver and person on a wheelchair should be 850mm. The lever swivel sink faucet should be colour contrasted to allow the person with dementia to better locate it. A valve sensor can be installed to facilitate remote turning on/ off of water using a mobile device.
22) Provide plumbing connections that are flexible for ease of adaptation.
23) Open plan kitchens are easy to use but can create acoustic and odour problems. It may help to have sliding doors to provide separation between living room and kitchen/ dining.
24) Many people can find blank elevations to cupboards confusing, whereas a mix of open shelving and glass fronted units can remind people what is inside and allow easy checking of contents.
25) Ensure a distance of 1200 to 1500mm between facing work surfaces and base units. 1500 to 1800mm if space permits.
26) Fit corner cupboards with rotating carousel units or similar. This ensures full utilisation of deeper spaces.
27) Fit the sink with centreline more than 460mm in distance from any return in the work surface.
28) Avoid locating wall cupboards above a sink or hob. Avoid the hazard of accidental knocks. If unavoidable due to space constraint, install open shelves or cupboards with sliding doors.
29) Provide a continuous worktop between sink and hob.
30) Provide space of at least 300mm on either side of the hob, and to one side of the oven.

31) Provide pull-out drawers with 600mm deep units, instead of internal shelves.
32) Install base units with a minimum plinth of 250mm above floor level for a depth of 150mm.
33) Provide a pull-out shelf below the oven or fridge/ freezer for moving things from one plae to another if there is no counter beside the oven.
34) In general, provide worktops that are 900mm high.
35) Provide the option of having sections of height adjustable or fixed height worktops between the heights of 760 and 900mm.
36) Install wall units at a maximum height of 450mm above worktop level.
37) Install a pull-down mechanism for bringing shelf contents within reach.
38) Provide a working counter height of 900mm with the potential to raise or lower the counters.

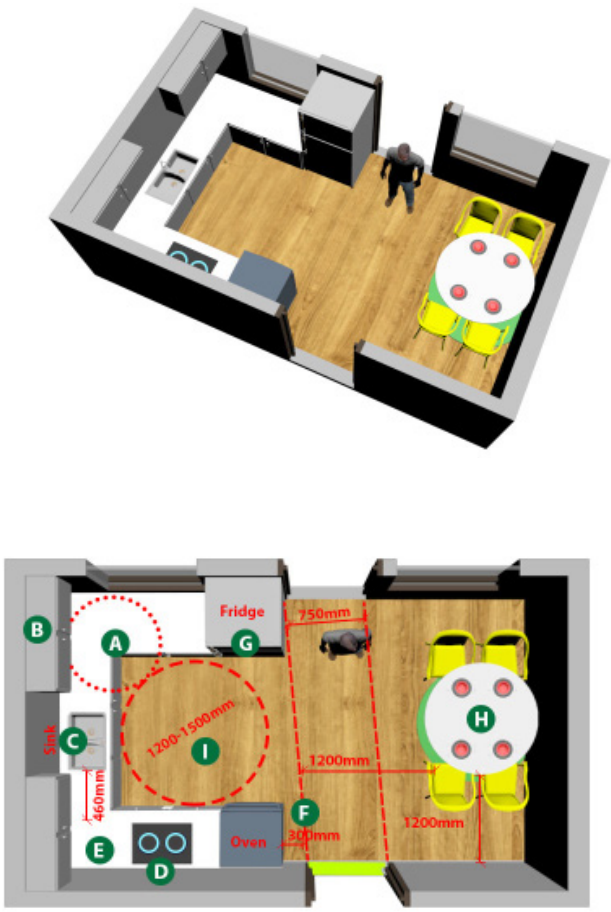


Figure 6: Kitchen and dining area (A level threshold is required at every entrance door (highlighted in red in top drawing)

Legend:

A = A carousel unit in a corner cupboard makes contents easy to access by everyone

B = Wall cupboards should be low enough for most people to reach easily

C = Locating the sink away from the corner means that one person can wash while another dries up

D = Wall cupboards should not be located above the sink or hob for safety

E = There is a continuous worktop between the sink and hob, to avoid having to carry heavy or hot dishes across the kitchen

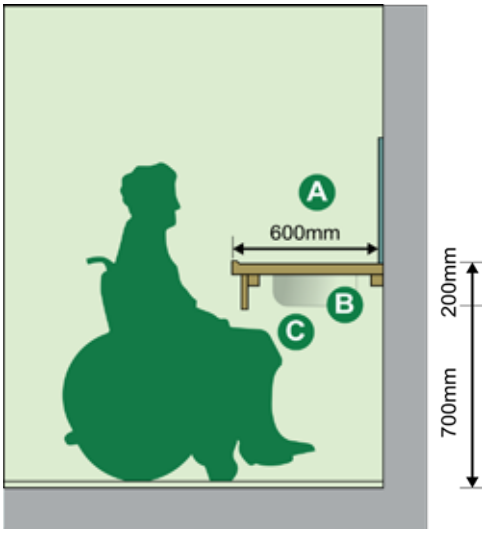
F = Clear space of at least 300mm is provided on either side of the hob and to one side of the oven for ease of moving hot pans and dishes

G = Tall units, like the oven and fridge or freezer housings, are located at the end of a run of worktop to avoid interrupting the workspace

H = The table is best located in the kitchen to minimise the distance of carrying food and drinks. There should be 1200mm clear space minimum on at least two sides of the table

I = A clear turning circle of 1500 to 1800mm should be provided

39) Provide a mobile working counter - an island.
40) Provide a distance of 1800 to 2400mm between facing work surfaces.
41) Provide a waterfall lip to the edges of all worktops to prevent spills.
42) Provide a clear knee space (free of brackets, pipes and cables) 700mm high, 600mm deep and 800mm wide below hobs, sinks and task areas.
43) Provide a clear knee space, 700mm high, 600mm deep and 800mm wide, beside the oven, washing machine and refrigerator.
44) Ensure that the controls for all fittings are clearly visible, simple and easy to operate with one hand.
45) Provide a wall mounted fire blanket and multi-purpose handheld fire extinguisher at 450 to 1300mm above floor level within the kitchen (Optional).
46) Position ovens so that the controls are 750 to 1050mm above floor level.
47) Ensure oven displays are no higher than 1200mm.
48) Ensure that cooker hood controls are positioned within reach of every one expected to use the kitchen. If necessary, locate remote from hood.
49) Provide a heat-resistant pull-out shelf below the oven, as wide as the oven and at least 250mm deep. It should be suitable for taking heavy dishes.
50) Cooker hobs to provide a visual and audible warning that rings are hot when switched off. E.g. a smart induction cooker hob.
51) Place microwave oven on a surface or build into a unit so that the base is not more than 900mm above floor level.
52) Ensure that microwave oven controls are no more than 1150mm above floor level.
53) Specify a floor covering that is slip-resistant and easy to clean.
54) Ensure that oven doors open sideways to more than 100°.
55) Provide and install smart cooker hobs, microwave/ ovens that are able to connect and communicate with other devices in the home.



Legend:
A = Tiled splashback protects the wall
B = Kitchen sink
C = Clear knee-space below the worktop for minimum width of 800mm at key task areas and beside appliances

Figure 7: Clear knee-space for person seated

e) Laundry Area

1) Provide all plumbing supplies, ventilation, drainage and electrical connections required for laundry machines in a separate utility space with full height glass partition, tiled walls and floor.
2) Provide a minimum 800mm square cupboard or space in the laundry/ utility room to fit a washer-dryer with drainage connection and power points.
3) Provide and install a smart washer-dryer which is able to connect and communicate with other devices in the home. The washing machine should be a front loader and have colour contrasted buttons/ knobs which facilitates easy access and visualisation for the person on a wheelchair/ with dementia.
4) Provide a cupboard or space in the laundry/ utility room 800mm deep and 1500mm wide to fit a washing machine with drainage connection and power points.
5) Ensure that controls and displays are easy to use.
6) Provide a clear space in front of laundry machines of at least 1200mm.
7) Switches are accessible and placed between 700 and 900mm above floor level.
8) Ensure that slip-resistant flooring is continuous under laundry machines and base units.
9) Provide a floor drain in laundry/ utility room in case of flooding and for cleaning.
10) Provide a plinth for front-loading machines, so that the door is accessible without stooping.
11) Provide a plinth toe-space 150mm deep and 250mm high below the machines to allow everyone to get close to the laundry machines.
12) Provide task lighting above the work surface.
13) Provide internal lighting to each shelf to make retrieval from storage easier for all.
14) Provide and install a portable or collapsible laundry hanger (wall rather than ceiling mounted) which is easier for the person with dementia and person on a wheelchair to manage and access.

f) Bedroom

1) Large windows with easy to reach opening sections.
2) Windows should be operable with one hand, with lever fixings between 800 and 1200mm only.
3) Windows should have one section without a transom between 800 and 1500mm.
4) Provide and install plain, non-patterned auto blinds (with smart sensors) which are colour contrasted with the wall. Auto blinds should not prevent natural sunlight from coming into the room unless it is very glaring.
5) At least 800mm clear space on either side of the bed and more at the end of the bed.
6) Sockets and switches are installed at between 400 and 1000mm above floor level.
7) Good colour contrast between walls, floor, skirting and window frames.

8) Ensure that double and twin bedrooms are at least 13000 mm squared in area.
9) Ensure that a single bedroom is at least 8000mm^2 .
10) Provide clear access space of 800mm on both sides and at the end of the double bed.
11) Provide a clear space for a turning circle of 1500mm in the double bedroom.
12) Provide a clear space for a turning circle of between 1500 and 1800mm within the room.
13) Locate the bathroom immediately adjacent to the main bedroom, with a full height door or 'soft spot' between them, for future installation of a door.
14) Provide light switches at the entry door and on both sides of the double bed.
15) Provide bedroom at entry level.

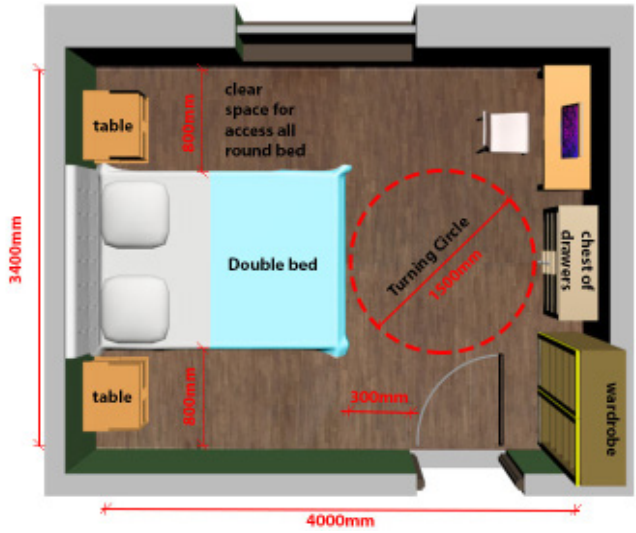


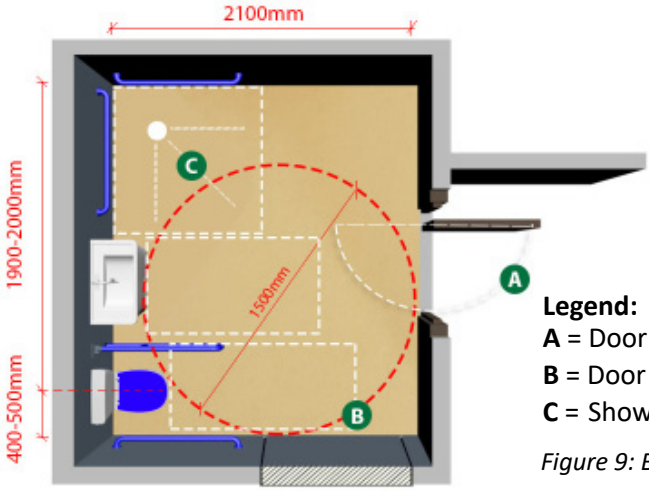
Figure 8: Double bedroom floor plan

16) Provide "see-through" wardrobes with adjustable shelving and hanging rails at varied heights. Height of the wardrobe should be wheelchair accessible with colour contrasted grab handles.
17) A clear turning circle of 1800 to 2400mm within the room will allow for full accessibility, e.g. by motorised wheelchairs and stretcher chairs.
18) Provide a dressing table with chair. It should be a minimum of 686mm from the floor to the bottom of the table. The table top should not exceed 864mm in height. A sturdy solid chair with side arms and hollow base is also preferred for the elderly as it provides better support.

e) Bathroom-Toilet

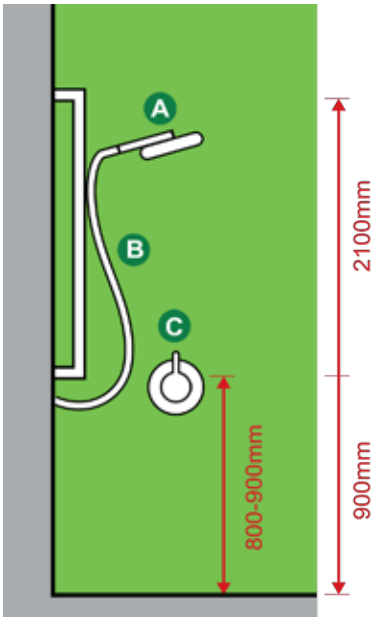
1) Provide a turning circle of minimum 1500 to 1800mm, with a 200mm overlap of the basin allowed.
2) Provide a sliding bathroom door with colour contrasted grab handle.
3) Bathroom door lock (if installed) is operable from the outside.

4) All walls are constructed to be strong enough to take fittings and rails with wall tiling, waterproofing and special vinyl sheet used in local hospitals.



Legend:
A = Door opens outwards
B = Door link to main bedroom
C = Shower location

Figure 9: Bathroom with shower

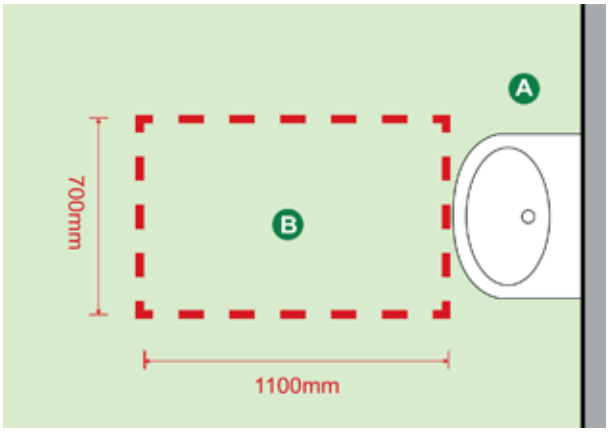


Legend:
A = Shower head should be adjustable between 900 and 1200mm above floor level
B = Provide a 1500mm long flexible hose to the shower head, on a vertical slide bar
C = Locate the thermostatic shower controls 800 to 900mm above the floor level

Figure 10: Activity space at shower area

5) Provide the potential for a hoist-track to be installed, supported by the ceiling construction.
6) Locate the bathroom immediately adjacent to the main bedroom, with a full height door or 'soft spot' between them.
7) Level access to shower area with clear demarcation.
8) Provide below floor drainage and a drainage point for shower area.
9) Level access showers can be fitted with curtains to control the spray of water.

10) Locate thermostatic shower controls 800 to 900mm above floor level.
11) Provide a level access shower area of minimum dimensions 1100 x 1100mm.
12) Provide a detachable handheld additional shower head with a 1500mm long flexible hose, on a vertical slider bar, height adjustable between 900 and 2100mm above floor level.
13) Ensure the shower head projects far enough into the shower area to easily reach a seated user.
14) Supply a drop-down seat (colour contrasted) fitted at a height of 400 to 480mm for showering.
15) Provide a location for toiletries that can be accessed while using the shower.
16) Provide colour contrasted handrail.
17) Ensure good visual contrast between walls, floor and fittings.
18) Provide a basin at a height of 750 to 800mm above floor level, with flexible water supply pipes and easily adjustable waste connections.
19) Provide a clear access zone of 700 x 1100mm minimum from the front of the basin from any obstruction under the basin bowl.
20) Provide a large basin that is not pedestal or semi-pedestal type and has a knee space of at least 600mm below the basin bowl.
21) Provide a height adjustable basin.
22) The basin should be large enough for everyone to use. Where space is restricted, the basin can overlap the toilet access zone by 200mm.
23) Centre the toilet at 400 to 500mm from any side wall.



Legend:
A = Basin supported off the wall with no pedestal beneath for easy access
B = Clear activity space required of 700 x 1100mm, from any obstruction under the basin bowl

Figure 11: Activity space in front of hand basin

24) Provide a clear access zone of 700 x 1100mm in front of the toilet.
25) Provide a colour contrasted lever handle to the cistern, rather than a push button mechanism. Locate the lever handle on the side away from the wall. Alternatively, this can be sensor-triggered.
26) Install lever taps that can be used single handed and with a closed fist.
27) Ensure taps have a clear indication of the difference between water volume and temperature control. Alternatively, this can be sensor-triggered, as mentioned in point #25.

28) Provide concealed mirrors within the vanity top at a height between 800 and 2100mm from the floor.
29) Provide specific fittings for items such as soap, shampoos, toothpaste and brushes in accessible locations for everyone to use.
30) Install shelving and cupboards for storage within the bathroom.
31) Provide colour contrasted fixtures and fittings and ensure all fittings contrast visually with their background.
32) Provide clothes hooks at two heights: 1100mm and 1700mm from floor level.
33) Install handrails and grab rails where useful.
34) Provide anti-scald settings to the shower.
35) Provide low-glare task lighting of 300 lux.

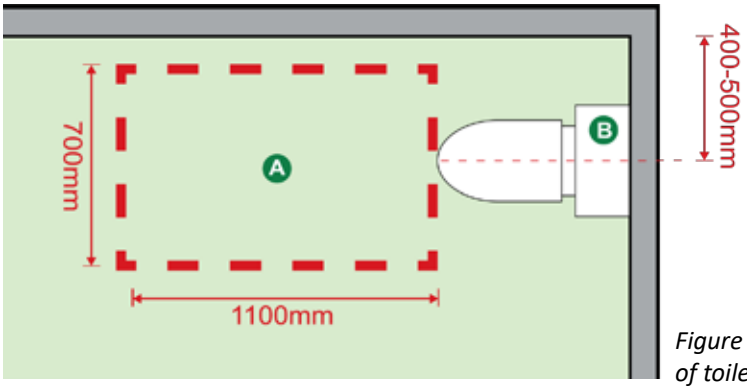


Figure 12: Activity space in front of toilet and position from wall

Legend:
A = Clear activity space required of 700 x 1100mm
B = Toilet located 400 to 500mm from wall to allow for ease of use and later installation of grab rails

36) Install moisture resistant low-glare task lighting above basin and shower.
37) Conceal or protect all pipework including heating and hot water supply pipes, and drainage, allowing for easy access in case of repairs/ maintenance that will not damage the finish of the bathroom.

i) Storeroom cum Bomb shelter

1) Ensure storeroom is fully accessible with an outward opening door and internal lighting.
2) Door to be camouflaged with wall mural to prevent wandering behaviour into the storeroom. This can be a tic tac door.
3) Provide cupboards that are not deeper than 600mm.
4) Provide wide and shallow cupboards, 300 to 400mm deep, with shelving.
5) Provide visual contrast at the front of shelves to make it easy to distinguish contents and shelf position.
6) Provide adjustable height hanging rods for clothes and shelves suitable for wheelchair heights.
7) Consider a pull-out larder type shelving system in deep cupboards, suitable for small items that can be accessed from both sides.

3 FLOORING

a) Use compliant flooring.
b) Use, firm, durable and securely fixed floor finishes, selected in relation to the likely volume of use.
c) Provide good slip resistance in flooring materials to ensure a firm foothold and wheel grip of at least R10 in bathrooms and kitchens.
d) Avoid shiny or reflective finishes.
e) Provide visual contrast between floor and wall surfaces.

4 LIGHTING AND SWITCHES

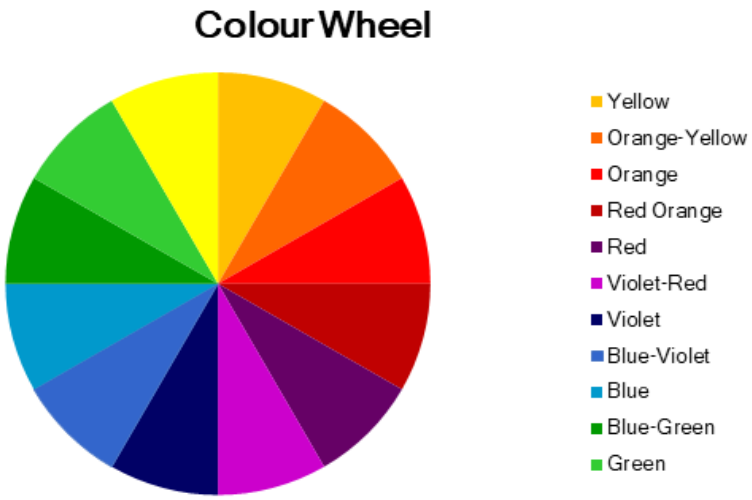
a) Ensure all outlets, switches, sockets and controls are clearly visible and easy to reach and operate, using one hand and do not rely on single finger operation.
NOTE: Opaque weatherproof protective socket cover can be used at a later stage to prevent unwanted turning on and off of switches.
b) Ensure switches, background and mounting surfaces are visually contrasting with surrounding surfaces.
c) Use a consistent arrangement, position, style and sequence of fittings throughout the home.
d) Install all outlets, switches and sockets at a consistent height between 450 to 1200mm from the floor and at least 500mm away from an internal corner.
e) Avoid locating any fittings less than 500mm from an internal corner.
f) Install two- or three-way switch as necessary.
g) Provide all light switches and other switches (such as security systems, etc) that are toggle, rocker, push or touchpad in design.
h) Ensure all switches and devices are easy to use and do not require greater than 22 Newtons force.
i) Incorporate 20mm deep switch housings in lieu of 10mm for wall mounted lighting switches to allow installation of remote control switches.
j) Provide a lighting system that can accommodate additonal fittings and provide options for various brightness levels.
k) Avoid glare by carefully considering the position of lighting sources in relation to areas where tasks may be carrried out.
l) Provide an even distribution of task lighting, particularly for kitchen work surfaces, to ensure that people are not working in their own shadow.
m) Provide an even distribution of diffused light where possible.
n) Avoid fittings that do not entirely cover the light source, where the light source may be visible and cause glare.
o) Locate light bulbs where they can be changed easily or use pull-down light fittings where appropriate.

p) Install photocell lighting between bedrooms and a bathroom to assist wayfinding at night.

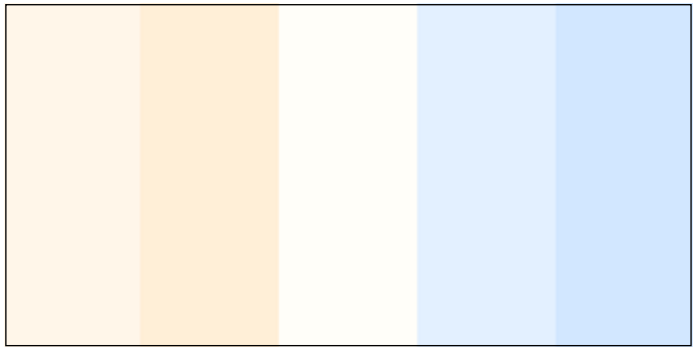
q) Ensure the recommended levels of illumination in internal environments:

Location in the home	Recommended level of illumination (lux)
Entrances	150
Bathroom-toilet	300
Switches and controls	100
Counters	300
Corridors, passages	150
Signs, information displays	200

Appendix 7 - Colour Wheel



The colour wheel provides a range of warm and cool colours to contrast with white or a light pastel colour as seen in the appended range of pastel colours. **NOTE:** Natural wood colour is an alternative option to contrast against pastel for a more classic look.



05: Biographies

Dr Koo May Yeok (Mrs Wan) is the Assistant Director in the School of Health and Social Sciences at Nanyang Polytechnic (Singapore). Her portfolio includes:
1) leading the NYP-StarHub Centre for Connected Care which emphasizes on a dementia- and elderly-inclusive design/environment;
2) overseeing e-learning development and education technology;
3) spearheading research, innovation, enterprise and collaborative projects with industry partners; and
4) overseeing faculty and student exchange programmes.

She is also a recipient of several local and overseas bursary and study awards. She has extensive clinical and academic experience and holds a Bachelor of Nursing from the Lincoln School of Health Sciences, La Trobe University (Australia), MSc Advanced Practice (Critical Care) with Distinction from the European Institute of Health and Medical Sciences, University of Surrey (United Kingdom), and PhD from the Faculty of Biology, Medicine and Health, School of Health Sciences / Division of Nursing, Midwifery and Social Work, University of Manchester (United Kingdom).

She is a member of the Dementia and Ageing Research Team (United Kingdom) and Sigma Theta Tau International (Honour Society of Nursing), Reviewer for (i) Dementia: The International Journal of Social Research and Practice, (ii) Ageing and Society and (iii) Intensive and Critical Care Nursing Journal (United Kingdom), and Education Officer of the Nursing Informatics Chapter, Singapore Nurses Association (Singapore).

She has been invited to present at several local and international conferences and has authored the PhD Thesis entitled, "Under one Roof; Intergenerational Care for People with Dementia in Singapore-Chinese Families - A Case Study Design" and a book chapter, “Social Research Methods in Dementia Studies: Inclusion and Innovation. Chapter 8: Photography and case study interviewing to document intergenerational family care in Singapore-Chinese families where one member is living with dementia.” These are some of the relevant projects which she is involved in:
- Principal Investigator (Singapore) of the Economic and Social Research Council International network research grant project on dementia-friendly community/ neighbourhoods.
- Co-Principal Investigator of MOE TIF grant application project i.e. Neuromorphic AI-based Smart Automated Fall Prevention System for the elderly.
- Lead of Central Singapore CDC Do-Good-Grant Project.
- Lead of S.E.E.D and TOTE Board SIR Funds of the Virtual Dementia Home Series Project.

Stephen Chan is Head of the Alzheimer's Disease Association (ADA) Caregiver Support Centre. He was also Centre Manager of New Horizon Centre (Tampines) for over 10 years. His work experience in the eldercare sector includes providing direct care as an Occupational Therapist, supervising and mentoring staff, and overseeing operations at the day-care centre. As a consultant and trainer for the ADA Academy, he has provided consultation and training to family caregivers, professional caregivers, as well as eldercare services providing care to persons with dementia.

Stephen has been involved as a member of the Ministry of Health Dementia Care Taskforce, as well as, the Agency for Integrated Care work-group, to develop standards on Centre-based Community facilities. He has a Masters of Gerontology from UniSIM, Singapore, and a Bachelor of Health Science in Occupational Therapy from the University of Sydney, Australia. He has attained the WSQ Advanced Certificate in Training and Assessment (ACTA). Stephen is also appointed as a member of the National Transplant Ethics Panel of Lay Persons, which serves on Transplant Ethics Committees to ensure that living organ donations in Singapore are altruistic and ethical.

Ms Koh Hwan Jing is Head of the Academy at the Alzheimer's Disease Association, which provides training programmes for professional and family caregivers of people with dementia, as well as consultancy services for external agencies serving people with dementia. She has a wide range of experiences working with people with dementia including hospital-based services, dementia day care, home based intervention, and nursing homes.

Hwan Jing has served as a member of the Ministry of Health Dementia Care Taskforce and Agency for Integrated Care Dementia Nursing Home Design Resource Panel. She has a BSc (Hons) in Occupational Therapy from the University of Exeter, UK (2000), and a Masters in Mental Health Studies from King's College London, UK (2007). She has attained the WSQ Advanced Certificate in Training and Assessment (ACTA), is a certified instructor for Mental Health First Aid (Singapore), and certified in Dementia Care Mapping (Advanced User).

Michael Tan is a lecturer at the School of Design in Nanyang Polytechnic. He is also in the NYP360 (Healthcare) cluster taskforce working with various healthcare institutions on possible collaborations and innovations.

Prior to joining NYP, he was practising architecture at RSP Architects for eight years. He is a firm believer and advocate of sustainable designs and practices. As a certified BCA Green Mark Manager, he has played a key role in attaining the Singapore's BCA Green Mark Platinum Awards for various developments such as JCube (shopping mall with ice skating rink).

He is a Registered Architect with the Board of Architects Singapore and graduated with a Master of Architecture from National University of Singapore. As a certified BCA Universal Design Assessor, he seeks to drive the cause for inclusive design both in the industry and in the academic curriculum. He has also collaborated and completed student industry projects with Jurong Community Hospital and Tan Tock Seng Hospital.

Tan Khee Soon is a Lead Specialist (Industrial Design) at the School of Design in Nanyang Polytechnic. His main objective at the School is to nurture young creative talents so that they will become the next generation of confident designers whose designs will make the world a better place.

In his past career, Khee Soon has worked on various display and exhibition projects, notably for the Shell companies in Malaysia and Brunei; trophy designs such as the Singapore Quality Award, the People Excellence Award, and the Innovation Excellence Award; product designs such as the award-winning HP Omnigo 100 personal digital assistant, and the Soybrew automatic soymilk maker, for which he had an apparatus patent and a Japan Good Design Mark. He has also worked on numerous publications and books.

Khee Soon is a founding member of the Designers Association Singapore (now known as the Design Business Chamber Singapore), and has sat on various committees that champion the cause of design in Singapore.